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Wildland Fire—An American Legacy

United States Department of Agriculture
Forest Service

Editor's note: This issue of *Fire Management Today* is the first of two special issues focusing on fire history and past fire management practices in the United States. The first issue addresses wildland fire before the 20th century; the next will focus on aspects of wildland fire management in the 20th century. Articles in this issue by Stephen W. Barrett, Hutch Brown, Stephen J. Pyne, and Gerald W. Williams discuss fire history and use in centuries past, exploring their implications for land managers today and in the decades to come.

Frederic S. Remington, The Grass Fire*, 1908 (oil on canvas). Artwork courtesy of the Amon Carter Museum, Fort Worth, TX (1961.228).*

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On the Cover:

The Grass Fire *(detail—the entire painting is shown on the facing page), a 1908 painting by Frederic Remington, depicts a band of American Indians using fire on the Great Plains against an enemy. In warfare, Indians used fires for such purposes as covering a retreat, panicking an enemy into flight, camouflaging an ambush, depriving an enemy of fodder for horses (in the West), and destroying enemy villages and cropfields (in the East). Remington's painting matches the depiction of Indian fire use by James Fenimore Cooper in his 1827 novel* The Prairie *(see the excerpt on page 28). Indian fire use, mostly for peaceful purposes, was so extensive that it shaped ecosystems across North America.*

The FIRE 21 symbol (shown below and on the cover) stands for the safe and effective use of wildland fire, now and throughout the 21st century. Its shape represents the fire triangle (oxygen, heat, and fuel). The three outer red triangles represent the basic functions of wildland fire organizations (planning, operations, and aviation management), and the three critical aspects of wildland fire management (prevention, suppression, and prescription). The black interior represents land affected by fire; the emerging green points symbolize the growth, restoration, and sustainability associated with fire-adapted ecosystems. The flame represents fire itself as an ever-present force in nature. For more information on FIRE 21 and the science, research, and innovative thinking behind it, contact Mike Apicello, National Interagency Fire Center, 208-387-5460.

FIRE 21

Firefighter and public safety is our first priority.

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Where Have All the Fires Gone?

Arizona State University

Stephen J. Pyne

In the United States, few places know as much fire today as they did a century ago. Fires have fled from regions like the Northeast that formerly relied on them for farming and grazing. They have receded from the Great Plains, once near-annual seas of flame, ebbing and flowing with seasonal tides. They burn in the South at only a fraction of their former grandeur. They have faded from the mountains and mesas, valleys and basins of the West. They are even disappearing from yards and hearths. One can view the dimming panorama of fire in the same way that observers at the close of the 19th century viewed the specter of the vanishing American Indian.

> The fires that once flushed the myriad landscapes of North America were fires that people once set and no longer do.

Missing Fires, Missing Peoples

And with some cause: Those missing fires and the missing peoples are linked. The fires that once flushed the myriad landscapes of North America and have faded away are not fires that were kindled by nature and suppressed, but rather fires that people once set and no longer do. In some places, lightning has filled the void. But mostly it has not, and even where lightning has reasserted itself, it has introduced a fire regime that can be quite distinct from those shaped by the torch.

Anthropogenic (human-caused) fire comes with a different seasonal signature and frequency than natural fire. Moreover, it is profoundly interactive. It burns in a context of general landscape meddling by humans—hunting, foraging, planting—in ways that shape both the flame and its effects. So reliant are people on their fire monopoly that what makes fire possible generally makes human societies possible. What prevents one retards the other. Places that escaped anthropogenic fire likely escaped fire altogether.

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Pre-Columbian Fire Practices

Did American Indians really burn the land? Of course they did. All peoples do, even those committed to industrial combustion, who disguise their fires in machines. The issue is whether and how those fires affected the landscape. Much of the burning was systematic. Pre-Columbian peoples fired along routes of travel, and they burned patches where flame could help them extract some resource—camas, deer, huckleberries, maize. The outcome was a kind of fire foraging, even fire cultivating, such that strips and patches burned as fuel became available. But much burning resulted from malice, play, war, accident, escapes, and sheer fire littering. The land was peppered with human-inspired embers.

The aboriginal lines and fields of fire inscribed a landscape mosaic (see Lewis and Ferguson (1988) for a different terminology). Some tiles were immense, some tiny. Some experienced fire annually, some on the scale of decades. In most years, fires burned to the edge of the corridor or patch and then stopped, melting away before damp understories, snow, or wet-flushed greenery. But in other years, when the land was groaning with excess fuels and parched by droughts, fires kindled by intent or accident roared deep into the landscape. People move and fire propagates; humanity's fiery reach far exceeds its grasp of the firestick. Remove those flames and the structure of even seldom-visited forests eventually looks very different.

What Burning Meant

How effective were these burns? That, of course, depends. If the land was fire prone, people could easily seize control over it. They simply burned before natural ignition arrived, sculpting new fire regimes, forcing the biota to adjust. The aboriginal firestick became a lever that, suitably sited, could move whole landscapes, even continents. The outcome was particularly powerful where places had the ingredients for fire but lacked a consistent spark. That people supplied. They made flame an environmental constant, which left fuel and climate as the principle variables in determining how extensively fire burned. This is worth repeating: People transformed ignition from chance into choice, from something that was sparked through lightning's lottery into something as chronic as sunshine.

People were less effective in places that were fire intolerant, that lacked wet–dry climatic rhythms, that favored shade forests with scant understories of sun-hungry vegetation, that had neither spark nor adequate combustibles. The solution, of course, was to make fuel—to slash woods into kindling, to open canopies, to grow fallow. And this, from a fire ecology perspective, is the meaning of agriculture. One could fashion fuel, dry it, and burn it, more or less in defiance of natural biases. Forests broke into a kaleidoscope of fields and fallow, a multitude of new habitats for flame. Not least of all, agriculture could complement an aboriginal economy and thus carry anthropogenic fire almost everywhere. The eastern half of the United States knew fire precisely for these reasons. Only the most inhospitable landscapes escaped.

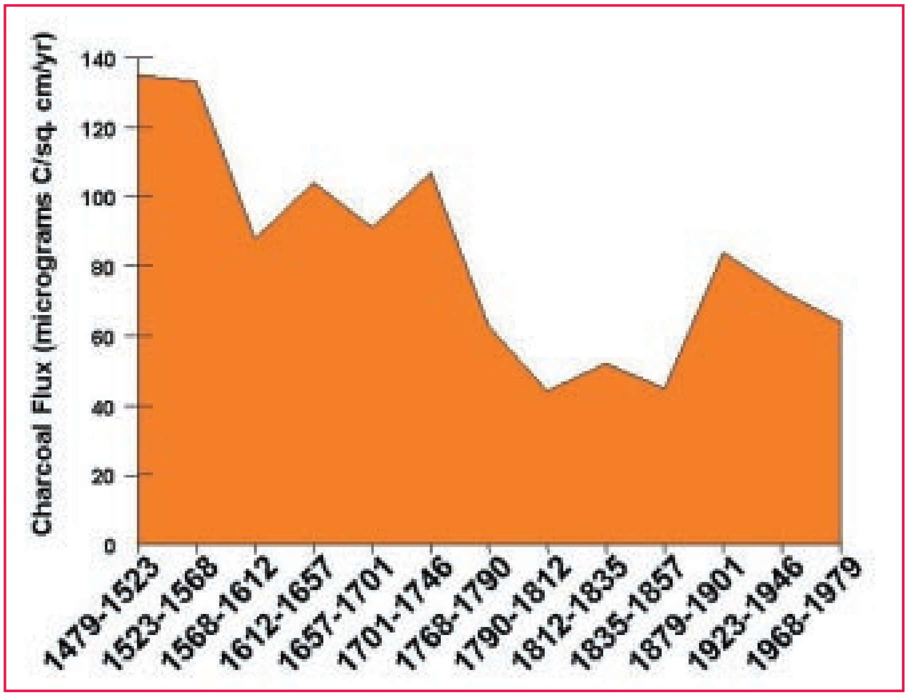
Missing Megafauna

Still, complications always exist. Human history is lumpy—its kindled flame flickers with the winds of migration, war, and disease. Humanity's restless hand, moreover, fiddles compulsively with the land on scales that range from fire-pruning blueberry bushes to fire-scouring densely packed conifers. Not least of all, what people do to a biota, quite apart from how they use fire, can affect fire regimes. This is most clearly seen in the human impact on and through animals, which both shape biotas and crop off biomass. What grazers and browsers consume through the slow combustion of respiration cannot feed the rapid combustion carried by flame.

The aboriginal firestick became a lever that, suitably sited, could move whole landscapes, even continents.

Evicting those animals—and three-quarters of North America's megafauna disappeared as pre-Columbian peoples spread across the continent—left more biomass unconsumed and shifted the character of what remained. In fire-prone places, the outcome was more fuel for flame and a rapid shift to increasingly open and grassy landscapes. The beasts that continued to flourish could not consume the "surplus," leaving a kind of grazing gap into which fire poured. Likely these creatures survived because they could accommodate the new fire regime.

In fire-intolerant places, however, the reverse could occur. Eliminating the animals helped eliminate fire. Without their crunching, trampling, and rooting, shady woodlands could overgrow the scene, filling the cracks through which flame could enter the landscape. In North America, the missing megafauna did not return until Europeans introduced domestic livestock, which found a bonanza of ready-made pastures and proved invaluable in rolling back the shaded woods. Open landscapes that had once fed fire now fed horses, cattle, sheep,



A chronology of charcoal preserved in sediments off the Pacific coast of Central America (Suman 1991). Note that the greatest input occurred in the 50 years prior to the Spanish Conquest ca. (1523). When the native population crashed, so did the fire regimes. Analogous events probably occurred across most of North America.

Forests broke into a kaleidoscope of fields and fallow, a multitude of new habitats for flame.

swine, and donkeys. Closed landscapes that had driven fire to the margins now saw flame's return.

The Mystery of the Missing Flame

Fire is as effective removed as applied, and therein lies much of its ecological (and moral) magic. Places that had known regular fire, perhaps for thousands of years, suffered when those fires vanished. Set aside and protected as reserves, the public lands have witnessed staggering biotic changes that could not have occurred had fire continued. And it is obvious that fire did not continue: The evidence is scrawled like woody graffiti all over the land itself.

The usual explanation is that Europeans stopped the fires; in a loose sense, they did. A further explanation is that Europeans introduced an unholy trinity of environmental evils—overgrazing, crude logging, and systematic fire suppression. All this is also true, and misleading. It ignores the adoption of Indian fire practices by settlers and the attempted adaptation of European fire habits to a New World. The critical divide was not between Indians and Europeans but between city and country, between those who resided on the land and those who lived in urban areas, between those who grew up with their hand on a torch and those who knew fire only in stoves or through books. It is worth recalling that the greatest challenge to early fire control was the doctrine of "light burning," deliberately promoted as the "Indian way" of forest stewardship. Ultimately, what snuffed out free-burning fire was not simply the removal of the American Indian but also the failure to replace the Indians' fires with others. That brash experiment could only have happened through full-bore industrialization.

Worse, that too-simple explanation for the missing flame sustains a problematic myth: that Europe found a wilderness and tried to render it into a garden. Closer to the truth, the critics can well reply, is that Europe found a garden and has tried to render it into a wilderness. Yet the myth has power, and the choice between stories has meaning for fire management. The first story argues that nature alone can restore itself; the second, that anthropogenic fire must return.

Keeping the Flame

The missing fires are those that were once set by the now missing peoples, the Indians who were removed and the newcomers who, on the public lands, failed to pick up the Indians' fallen torches. The reasons for putting some of that flame back are compelling. But returning fire to the land in hopes of restoring pristine pre-Columbian vistas is not one of them. We must reinstate fire because we cannot sustain the landscapes we value without burning. We should reinstate fire because burning is what we do as human beings, as holders of a species monopoly over flame, for whom fire neutrality is not an option. We have no choice, no more than did American Indians, Australian Aborigines, or European peasants. We must decide how to apply and withhold fire in the landscape because we still remain—all of us, all peoples, across a hundred millennia—the keepers of the planetary flame.

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Editorial Policy
Fire Management Today (*FMT*) is an international quarterly magazine for the wildland fire community. *FMT* welcomes unsolicited manuscripts from readers on any subject related to fire management. Because space is a consideration, long manuscripts might be abridged by the editor, subject to approval by the author; *FMT* does print short pieces of interest to readers.

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Contributors Wanted

We need your fire-related articles and photographs for *Fire Management Today*! Feature articles should be up to about 2,000 words in length. We also need short items of up to 200 words. Subjects of articles published in *Fire Management Today* include:

- Aviation
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- Fire behavior
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- Prevention
- Safety
- Suppression
- Training
- Weather
- Wildland–urban interface

To help prepare your submission, see "Guidelines for Contributors" in this issue.

Introduction to Aboriginal Fire Use in North America

Gerald W. Williams

Evidence for the purposeful use of fire by American Indians has been easy to document but difficult to substantiate. Many people discount the fact that Indians greatly changed ecosystems so they could survive and flourish in North America. However, a growing body of literature is showing that many presettlement fires that were once believed to have been natural were in fact intentionally caused. Exploring how American Indians used fire will help us better understand how conditions in our ecosystems today were shaped by humans in the past.

Pristine Wilderness?

By the time that European explorers, fur traders, and settlers arrived in many parts of North America, millions of acres of "natural" landscapes or "wilderness" were already manipulated and maintained for human use, although the early observers did not recognize the signs (Blackburn and Anderson 1993; Botkin 1992; Denevan 1992; Doolittle 1992; Lewis 1973, 1982; Pyne 1995; Shrader-Frechette and McCoy 1995; Stevens 1860; Stewart 1954, 1955, 1963; Whitney 1994; Wilson 1992). Early explorers and fur trappers often observed huge burned-over or cleared areas with many dead trees "littering" the landscape, without knowing whether the fires were natural or Indian caused.

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> "There was no 'pristine wilderness' here. Prairie and forest were to a large extent the creation of indigenous peoples."
>
> *–Historian Dennis Martinez*

Many written accounts by early settlers noted evidence of burned or scorched trees and open prairies or savannas with tall grasses in the river basins (Lorimer 1993; McClain and Elzinga 1994; Russell 1983; Stevens 1860; Whitney 1994). The abundance of rich prairie ready for the plow was one of the primary reasons for settlers to head west to the present-day States of California, Idaho, Oregon, and Washington, and later to establish homesteads on the Great Plains. As Dennis Martinez (1998) has noted, "There was no 'pristine wilderness' here. Prairie and forest were to a large extent the creation of indigenous peoples. The main justification by Europeans for genocide—that land was not used to its productive potential by its Native inhabitants—was false."

Fragmentary Evidence

Still, documentation of the Indian use of fire is fragmentary at best. Historically documented incidents are rare; photography was invented after most tribes had disappeared or surrendered their traditional ways. A few early paintings and drawings do show how Indian fires were set (see cover illustration). But researchers today must rely primarily on indirect references and incomplete accounts by early settlers, missionaries, trappers, and explorers.

How Natural Is "Nature"?

Researchers today tend to believe that the concepts "nature" and "wilderness" are human constructs, not reflections of an original pristine landscape. Many researchers note that people have been part of ecosystems since long before recorded time. In the contemporary view, people are *part* of ecosystems, have *evolved* with ecosystems, have *used parts and pieces* of ecosystems for survival, and have *changed portions* of ecosystems to meet their needs. In North America, as Emily Russell (1997) has observed, "humans have been a part of the ecosystem over the past ten centuries of major climatic change, so that all forests have developed under some kind of human influence.…This influence must be accounted for as an important part of any study of forest structure and dynamics."

Until recently, few people acknowledged the impact that Indian fire use had on the land. As Stephen Pyne (1995) has put it, "[E]ven a decade ago the question of 'Indian burning' was a quaint appendix to fire management." "[I]t is at least a fair assumption," a classic forestry textbook in the 1970's declared, "that no habitual or systematic burning was carried out by the Indians" (Brown and Davis 1973). Early researchers labeled the notion that American Indians routinely burned large areas of wildland "inconceivable" (Raup 1937) and "preposterous" (Coman 1911).

Many people still believe that American Indians lived in complete harmony with the environment, neither disturbing nor destroying but taking only what was absolutely needed for survival. As Daniel Botkin (1990) has pointed out, the impression of a "benign people treading lightly on the land" is wrong. "Native Americans had three powerful technologies: fire, the ability to work wood into useful objects, and the bow and arrow. To claim that people with these technologies did not or could not create major changes in natural ecosystems can be taken as Western civilization's ignorance, chauvinism, and old prejudice against primitivism—the noble but dumb savage."

Complex Burning Patterns

The many original diaries, letters, books, and reports by eyewitnesses of Indian fire use from the 1600's to the 1900's have yielded considerable evidence that American Indians did use fire to change ecosystems (Barrett 1980, 1981; McClain and Elzinga 1994; Russell 1983; Whitney 1994). Of course, not all tribes burned the landscape often. For example, Indians living directly along the coast in the Pacific Northwest rarely used fires, because their food came from the ocean and rivers. But the tribes living a few miles inland extensively used fire to maintain the prairies or savannas they depended on for food (Norton et al. 1999).

In the Northeast, the impact of Indian fire use was equally mixed. As Emily Russell (1983) has pointed out, "There is no strong evidence that Indians purposely burned large areas….The presence of Indians did, however, undoubtedly increase the frequency of fires above the low numbers caused by lightning." As might be expected, Indian fire use had its greatest impact "in local areas near Indian habitations."

Role of Indian Fire Use

Fire was the most powerful tool Indians could use to create landscapes capable of sustaining thriving, growing societies (Trudel 1985; Whitney 1994). Indian-set fires differed from natural fires in

Pitfalls in Researching Indian Fire Use

Many studies purport to document Indian manipulation of ecosystems through fire use and other means. Some make sweeping generalizations (e.g., "Indians burned the prairies"), whereas others are very specific (e.g., "The women of the Kalapuya Indians burned the prairies and foothills of the middle Willamette Valley every fall"). However, most studies suffer from basic methodological shortcomings:

- ***Underreporting:*** Some studies focus on instances of fire use by Indian people that did not result in ecosystem changes.
- ***Overreporting:*** Some studies attribute ecosystem changes to Indian fire use when those changes have natural explanations.
- ***Misinterpretation:*** Some studies misinterpret the unfamiliar language and perspectives—far removed from those of today—in source materials that can be up to four centuries old.
- ***Reliance on secondary sources:*** Some studies cite other studies to support their conclusions instead of examining the primary sources of evidence.
- ***Reliance on hearsay:*** Some studies rely on reports of Indian fire use, especially by early settlers, that amount to hearsay or third-party accounts.
- ***Overgeneralization:*** Some studies fail to account for regional and tribal variations in the use of fire.
- ***Imprecision:*** Some studies fail to name the tribe or band that used fire in the ecosystem, the exact location or even the general area of fire use, or the purposes of burning (such as hunting or improving pasture for game).

their seasonality, frequency, and intensity (Lewis 1985; McClain and Elzinga 1994; Pyne 1995). Reasons for burning were many; they varied from tribe to tribe and region to region. Most accounts indicate that Indians used fire to achieve "mosaics, resource diversity, environmental stability, predictability, and the maintenance of ecotones" (Lewis 1985).

American Indians tended to burn ecosystems differently depending on the resources being managed. Hardly ever did the various tribes purposely burn when the forests were most vulnerable to catastrophic wildland fire (McClain and Elzinga 1994; Pyne 1995). Indeed, for some Indians, saving the forest from fire was crucial for survival (Barrett 1980; Booth 1994; Fish 1996; Lorimer 1993; Phillips 1985). For the most part, tribes set fires that did not destroy entire forests or ecosystems, were relatively easy to control, and stimulated new plant growth.

Burning seasons varied by ecoregion. In the boreal forests of Canada, for example, Indians tended to burn in late spring, just before new plant growth appears. In the more arid southern Rockies and Sierra Nevada foothills, where most plant growth occurs in winter, Indians tended to set fires during late summer or early fall. Wherever Indians burned, they usually did so at regular intervals of up to 5 years.

Impact of Indian Fire Use

The cumulative impact of burning by American Indians profoundly altered the landscape in many parts of North America. Many ecosystems first encountered by Europeans were, as Stephen Pyne (1982) perhaps best put it, "the result of repeated, controlled, surface burns on a cycle of one to three years, broken by occasional holocausts from escape fires and periodic conflagrations during times of drought….So extensive were the cumulative effects of these modifications that it can be said that the general consequence of the Indian occupation of the New World was to replace forested land with grassland or savannah, or, where the forest persisted, to open it up and free it from underbrush."

Wherever Europeans went, they generally stopped the Indians from burning, usually by eliminating them from the land. Ironically, more forest exists today in some parts of North America than when the Europeans first arrived. As Pyne (1982) observed, "The Great American Forest may be more a product of [European] settlement than a victim of it." The implications for land management today are profound: Should we restore fire on millions of acres of Federal lands to help ecosystems recover some semblance of their presettlement vigor? The legacy of fire use by our American Indian predecessors deserves careful scrutiny as we enter the 21st century.

Further Reading

For more information on aboriginal wildland burning, see (in addition to the articles in this issue of *Fire Management Today*) especially the excellent studies by Henry Lewis (1973, 1982, 1985) on California and Canada, by Emily Russell (1983) and Gordon Whitney (1994) on the Northeastern United States, and by William McClain and Sherrie Elzinga (1994) on the Midwestern United States. Robert Boyd (1999) has edited a collection of outstanding studies on wildland burning by American Indians in the Pacific Northwest and parts of Canada. Stephen Pyne's many works contain ample information about aboriginal people and their use of fire in North America and other parts of the world.

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Documented Reasons for Indian Fire Use

Henry T. Lewis (1973) concluded that American Indians burned the landscape for at least 70 different reasons. Other researchers have listed fewer reasons, using different categories (Kay 1994; Russell 1983; Whitney 1994). What follows is a summary of 11 documented Indian purposes for using fire in ways that modified ecosystems.

Hunting. Indians burned large areas to force deer, elk, and bison into small unburned areas for easier hunting. Fire was also used to drive game over cliffs or into impoundments, narrow chutes, and rivers or lakes where the animals could be easily killed. Some tribes used a surround or circle fire to force rabbits and other game into small areas. The Seminoles (in present-day Florida) even used fire to hunt alligators. Some Indians used torches to spot deer and attract fish for spearing or netting. Some used smoke to dislodge raccoons and bears from tree cavities.

Crop management. Indians used fire to harvest crops, especially for collecting tarweed, yucca, greens, and grass seed; to improve yields of camas, seeds, and berries (especially raspberries, strawberries, and huckleberries); to prevent abandoned fields from growing over; to clear areas for planting corn and tobacco; to facilitate the gathering of acorns by clearing the ground of vegetation around oak trees; to roast mescal; and to obtain salt from grasses.

Insect collection. Some tribes used a fire surround to collect and roast crickets and grasshoppers. Fire was also used to harvest pandora moths in pine forests and to collect honey from bees.

Pest management. Burning was sometimes used to reduce pest populations, including rodents, poisonous snakes, and such insects as black flies and mosquitoes. Indians also used fire to kill mistletoe in mesquite and oak trees and the tree moss favored by deer (thereby forcing game animals into the valleys, where they were easier to hunt).

Range management. Fire was often used to keep prairies and meadows open from encroaching shrubs and trees and to improve browse for deer, elk, antelope, bison, horses, and waterfowl.

Fireproofing. Some Indians used fire to clear vegetation from areas around settlements and near special medicinal plants to protect them from wildland fires.

Warfare and signaling. Indians used fire to deprive the enemy of hiding places in tall grass and underbrush, to destroy enemy property, and to camouflage an escape. Large fires (not the Hollywood version of blankets and smoke) were ignited to signal enemy movements and to gather forces for combat.

Economic extortion. Some tribes burned large areas to prevent settlers and fur traders from finding big game and then to profit from supplying them with pemmican and jerky.

Clearing areas for travel. Indians used fire to clear overgrown trails for travel. In forests and brushlands, burning improved visibility for hunting and warfare.

Tree felling. Indians used fire in different ways to fell trees. One way was to bore two intersecting holes into the trunk, then drop burning charcoal into one hole and allow the smoke to exit from the other. Another way was to surround the base of the tree with fire, thereby "girdling" the tree and eventually killing it.

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Websites on Fire*

USFS Fire News

Looking for a quick wildland fire news update? The Website maintained by the USDA Forest Service's Fire and Aviation Management Staff features a Webpage with news clips and photos for the public, the media, and the wildland fire community. Updated regularly, the news page includes items on wildland fires and firefighters; safety alerts; job openings; fire management operations, policy, and resources (including congressional action); and upcoming fire-related events. More than 1,000 people a day from more than 20 countries use the page to stay abreast of current wildland fire news. *Found at* **<http://www.fs.fed.us/fire/news.shtml>**

Global Fire Monitoring Center

For news and information on wildland fires worldwide, a good place to start is the Website of the Global Fire Monitoring Center (GFMC). Founded in 1998 by international cosponsors, the GFMC monitors and archives information on wildland and prescribed fires at the global level. In addition to back issues of the journal *International Forest Fire News*, the Website features global fire inventories and models; data bases on wildland fires and fire seasons around the world; information on international programs and projects, including meetings and training courses; and links to wildland fire resources worldwide. *Found at* <**http://www.ruf.uni-freiburg.de/fireglobe**>

* Occasionally, *Fire Management Today* briefly describes Websites brought to our attention by the wildland fire community. Readers should not construe the description of these sites as in any way exhaustive or as an official endorsement by the USDA Forest Service. To have a Website described, contact the editor, Hutch Brown, at USDA Forest Service, Office of Communication, P.O. Box 96090, Washington, DC 20040-6090, tel. 202-205-1028, fax 202-205-0885, e-mail: rbrown/wo@fs.fed.us.

Early Fire Use in Oregon

Gerald W. Williams

For thousands of years, Oregon's ecosystems have been molded by human activities, especially through the use of fire. Long before the first Europeans arrived, American Indians used fire in both the valleys and the mountains of Oregon to improve food and other resources. Their impact on the land, recorded in fragmentary accounts by early explorers, trappers, and settlers, has profound implications for land managers today, especially in the Pacific Northwest.

No deliberate records of Indian fire use were kept by contemporary observers. Probably the best serendipitous records came from the Willamette Valley in western Oregon. From the early 1810's to the 1890's, a series of explorers, fur trappers, missionaries, and settlers in the Willamette Valley made many observations of the countryside and its inhabitants, including their purposeful use of fire.

The Willamette Valley

The Willamette River and its tributaries drain both the Cascade Mountains of central Oregon and the coastal ranges to the west (fig. 1). From its mouth on the Columbia River near Portland, OR, the Willamette extends more than 180 miles (290 km) to the south and southeast. Near Eugene, the valley is about 30 miles (50 km) wide; near Corvallis and Albany, it extends to more than 50 miles (80 km) wide; and at Portland, it narrows to 10 miles (16 km) wide.

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> The first white travelers in the Willamette Valley found extensive prairie and oak savanna maintained through Indian-set fires.

The valley bottom is generally flat, with rolling hills and hummocks. The first travelers in the early 1800's found "extensive areas of prairie, oak openings, and occasionally oak forests" (Habeck 1961) along a meandering river bordered by wetlands (fig. 2) (Towle 1979, 1982). For homesteaders, the valley was a paradise of deep alluvial soils and abundant water. With few trees and rocks to clear away, it was virtually ready for the plow.

Early settlers found the Kalapuya people living in the bottomlands of the Willamette and lower Umpqua Valleys. Separated into six or more bands, the Kalapuyas gathered roots from camas (*Camassia quamash*) and seeds from grasses, hunted blacktail deer (*Odocoileus hemionus* spp.), and caught Chinook salmon (*Oncorhynchus tshawytscha*) and Pacific lamprey eels (*Lampetra tridentata*). Transportation was on foot or by dugout canoe (Barnett 1937; Mackey 1974).

Valley Burning by Indians

Accounts by early trappers and settlers describe the widespread use of fire by the Kalapuyas. To reduce the brush, according to one source (Cornutt 1971), "the Indians would set fire and burn off one side of the valley in the fall of each year." Another source (Riddle 1953) described how "the country was burned off" when tarweed (*Madia* spp.) seeds were mature in late summer or fall. After burning the land, the Kalapuyas would harvest the fire-roasted tarweed seeds by beating them off the scorched plants into baskets. Indians burned partly to improve hunting. "By burning the prairies," observed local historian Robert Clark (1927), "the Indians forced the deer to graze on convenient hunting grounds, and they by this method also made it easy to collect wild honey, grasshoppers and crickets."

David Douglas, the renowned Scottish botanist for whom the Douglas-fir (*Pseudotsuga menziesii*) is named, kept a careful journal of his travels through the Willamette Valley (Davies 1980). On August 19, 1825, Douglas described the Indian practice, told to him by a native, of burning areas of downed wood to cultivate tobacco in the ashes. On September 27, 1826, he found "beautiful solitary oaks and pines" in the southern Willamette Valley, noting that the entire area was "all burned and not a single blade of grass except on the margins of rivulets to be seen." On September 30, 1826, Douglas recorded the reasons for the widespread burning: "Some of the natives tell me it

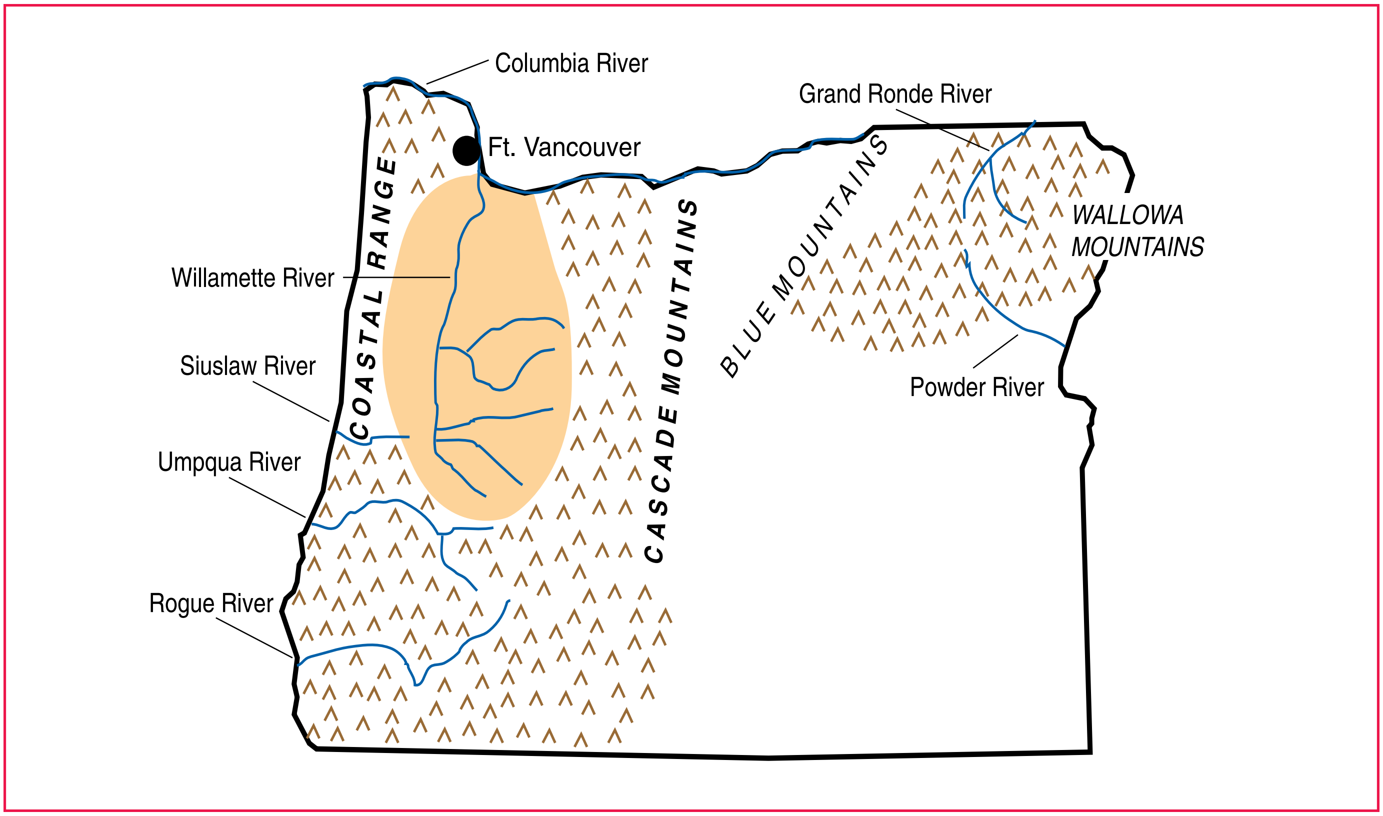

Figure 1—*Oregon in the 1800's, showing major valleys and mountain ranges. The Willamette Valley is the shaded area. American Indians routinely used fire in Oregon's valleys and mountains to increase food and other resources for survival. Illustration: Gene Hansen Creative Services, Inc., Annapolis, MD, 2000.*

Figure 2—The Willamette River From a Mountain, *an oil painting by Paul Kane in about 1850. Kane's painting shows the open prairie that settlers found in the Willamette Valley, the result of periodic burning by American Indians. Photo: Courtesy of the Royal Ontario Museum, Toronto, Ontario, Canada, ©ROM.*

is done for the purpose of urging deer to frequent certain parts, to feed, which they leave unburned, and of course they are easily killed. Others say that it's done in order that they might the better find wild honey and grasshoppers, which both serve as articles of winter food."

In 1841, a U.S. military expedition ventured from Fort Vancouver down the Willamette Valley along a trail originally blazed for fur trading by the Hudson Bay Company. Led by Lt. George F. Emmons, the party traveled overland all the way to San Francisco Bay. Several diaries and journals exist to document the travel.

In the southern Willamette Valley, the Emmons party found "hilly prairie, charred by a recent grass fire" (Stanton 1975). Crossing into the Umpqua Valley, the explorers encountered smoke and fire reaching from the prairie to the distant hills. Upon entering the Rogue Valley, they discovered the origin of the fires: "Indian signs were numerous," Titian Ramsey Peale (Poesch 1961) noted in his journal on September 27, "though we saw but one, a squaw who was so busy setting fire to the prairies & mountain ravines that she seemed to disregard us." Two days later, the party reported the Coast Range on fire (Beckham 1971).

Indian Fire Use in the Mountains

Most American Indian tribes in Oregon did not live in the mountains and forests. They visited the mountain areas during summer and fall, leaving before the snows came. Nevertheless, the mountain forests were important for Indian survival, supplying materials for food, shelter, and clothing.

> After burning the bottomlands, the Indians would harvest the fire-roasted tarweed seeds by beating them off the scorched plants into baskets.

Documentary evidence of Indian fire use in the mountains, though fragmentary, is important to understand (Barrett and Arno 1982; Seklecki et al. 1996). John Minto (1908), an early Oregon pioneer, noted that setting fires in the Cascade Range, for the Molalla people, "was their agency [method] in improving game range and berry picking." According to Minto, small prairies dotted the western slopes of the Cascades, from the valley floor nearly to the crest (at 4,000 to 6,000 feet [1,200–1,800 m]). According to another Oregon settler, the "Pioneer of 1847" (1911), "The Indian method was to burn the old burns about every three years or as soon as there was growth enough to make a good fire. They would burn early in the Summer before the logs and old stumps were dry enough to burn."

Hunting was reportedly an important purpose for Indian fire use in the mountains. USDA biologist Frederick Coville (1898) maintained that Indians customarily "set fires in the [Cascade] mountains intentionally and systematically, in connection with their fall hunting excursions, when deer were driven together and killed in large numbers." Prince Helfrich (1961), a long-time fishing and hunting guide in the western Oregon Cascades, told of meeting a very old Indian in the early 1900's. Reminiscing about his youth, the old man spoke of "his hunts [in the Cascades] and the killing of bear and deer and elk, and the burning off of the brush in the fall to make more hunting ground....The burning off of the brush would be done in the fall as the Indians returned to Eastern [central] Oregon. Since it was late in the season the rains would soon extinguish the fires before any great damage was done. The burning made easier access through the country as well as forage for horses and big game animals."

Stephen Barrett (1980), who has written extensively about Indian use of fire, interviewed people who still remembered the old Indian ways in western Montana. He concluded that tribes such as the Salish and Kootenais often ignited both intentional and unintentional fires in the region. "Indian fires were apparently set primarily in valley-bottom grasslands [much like the Willamette Valley in Oregon] and lower-elevation forests dominated by ponderosa pine [*Pinus ponderosa*], Douglas-fir or western larch [*Larix occidentalis*]," observed Barrett. "Although relatively rare, some Indian fires occurred in high-elevation forests." Most fires were set in fall and spring, when their intensity could be best controlled. Fires set during the summer months were usually unintentional.

In the Blue Mountains of northeastern Oregon, especially in the Grande Ronde and Powder River country, fires set by Indians were

For Indians in the Cascade Range, setting fires was a method for improving game range and berry picking.

common as late as the mid-1800's (Langston 1995; Robbins and Wolf 1994). "The Cayuse, Nez Perce, Paiute, Umatilla, and Shoshone tribes had heavily used the Blue Mountains for centuries and had altered the landscape accordingly," noted Nancy Langston (1995). "Native Americans had traveled, traded, hunted, fished, gathered roots and berries, maintained herds of horses [sometimes numbering in the thousands], burned the hills to improve hunting and grazing, and fought wars in the Blues for centuries before whites showed up."

Indians reportedly used fire in almost every western forest type. In the central Sierra Nevada of California, fire was used to manage oak groves for acorns, to prevent forest encroachment in utilized areas, to deprive enemies of cover, and to improve hunting (Anderson 1993; Bean 1973; Reynolds 1959). Harold Weaver (1967) noted that fires burned in ponderosa pine forest "as frequently as fuel accumulated in sufficient quantity to support combustion over the forest floor, whenever weather conditions were favorable, and whenever lightning strikes or Indians caused them to start." Stephen Arno (1985) documented fire use by Indians in various forest communities, including pinyon–juniper, chaparral and oakbrush, interior montane forests, interior subalpine forests, and maritime forests. However, reliable documentation on the exact sites and the extent of the areas burned is often difficult to obtain.

Postsettlement Burning

Beginning in the mid-1800's, settlers arrived from the Eastern United States seeking homesteads in the Oregon territory, especially in the Willamette Valley—the end of the Oregon Trail. Wagon trains traversed the trail annually, delivering thousands of homesteaders to Oregon. Others arrived by ship after sailing around South America and landing at Fort Vancouver.

Most settlers viewed the mountains and forests as formidable obstacles on the long overland journey. They rarely settled in the mountains. Those who did used fire to clear the land and keep forested areas open for grazing, following burning traditions learned from the Indians. However,

Homesteader in 1909 on Oregon's Umpqua National Forest. Few settlers in Oregon chose to live in the mountains, but many visited the mountains seasonally for range and other resources. Following the American Indian example, they often used fire to exploit mountain resources. Photo: Courtesy of National Agricultural Library, Special Collections, Forest Service Photograph Collection, Beltsville, MD (H.M. Hale, 1909; 79653).

Indian Versus Settler Fire Use

The American Indians generally burned parts of ecosystems to promote habitat diversity, especially through the "edge effect." Using fire to maintain a variety of habitats gave the Indians (as well as animals) greater food security and resource stability. By contrast, white settlers used fire to promote ecosystem uniformity, especially when it came to crop production and pasturelands.

most fires set by the whites were not carefully managed; some escaped, ravaging mountain forests.

Those who settled in the valleys often seasonally used mountain resources such as trees and grass, much as the American Indians had seasonally used the mountains for thousands of years. From the late 1800's to the mid-1900's, for example, the mountain prairies were extensively used in summer and fall for sheep grazing (Rowley 1985; Williams 1985; Williams and Mark 1995). When the shepherds left the mountains in the fall, just before the snow came, they often set fires to improve grasses for the following summer (Williams and Mark 1995).

Miners sometimes ignited fires to burn public forestland adjacent to their claims in order to expose the rocks and soil, thereby facilitating mineral discovery (Harley 1918). Large areas of forest surrounding mining claims, camps, and districts were reportedly often burned over. Other fires were caused by careless hunters, anglers, and travelers, usually when they left their abandoned campfires burning (Harley 1918). Some pioneers reportedly set fires just to see the forests burn (Lutz 1959); many early Americans treated forests carelessly, considering them an inexhaustible resource.

Burning in the Forest Reserves

Beginning in 1891 with the Forest Reserve (or Creative) Act, millions of acres of mountainous forestland in the public domain (all in the West) were set aside as forest reserves. Under the Organic Act of 1897, the USDI U.S. Geological Survey (USGS) began mapping and

In the Blue Mountains of northeastern Oregon, fires set by Indians were common as late as the mid-1800's.

Oregon white oak (Quercus garryana) *(above), now in decline due to competition from Douglas-fir* (Pseudotsuga menziesii) *(below, in cross-section; the Douglas-fir engulfed a nearby Oregon white oak). The oak once flourished in groves and savannas that covered Oregon's river valleys. American Indians maintained the oak ecosystems through their frequent use of fire, which eliminated fire-intolerant competitors. Photos: Courtesy of National Agricultural Library, Special Collections, Forest Service Photograph Collection, Beltsville, MD (above—Ray Filloon, 1936, 321063; below—Ernest L. Kolbe, 1935, 303495).*

describing the forest cover on the forest reserves (Williams 1997). The survey work resulted in 3 major reports and 13 professional papers. Several of these studies mentioned Indian burning of ecosystems at the turn of the century; all of the studies documented and mapped extensive burned-over areas and huge expanses of second growth, mostly without attributing a fire cause.

Indians continued to burn Oregon's wildlands into the late 19th century, even on some forest reserves. John Minto, a strong supporter of sheep grazing on Oregon's Cascade Range Forest Reserve, noted in 1898 that "the Warm Springs Indian reserve is bounded on the west by the [Cascade] summit, and the Indians have the rights of hunting and grazing their ponies on the entire [Cascade] range, to which many of them resort every season, when (by custom from which they see not reasons to desist) they renew the old berry patches and coarse grasses of the dry lake beds by fires" (Williams and Mark 1995).

In 1899, Salmon B. Ormsby, superintendent of the forest reserves in Oregon, reported that five wildland fires on the Cascade Range Forest Reserve were caused by Indians "setting out" fires (Anonymous 1899). According to Ormsby, "the most reckless people encroaching on the reserve are the Indians from the reservations [Warm Springs] and the half-breeds, who, in their berry-picking and hunting expeditions, set most of the fires, by leaving their camp fires burning when moving from one place to another" (Williams and Mark 1995). At about the same time, Oregon sheep owner Fred A. Young reported that "there is also any number of fires caused by hunting parties of Indians from the Warm Springs reservation, whom I have seen set out fires in the mountains to make the atmosphere smokey so that game would not scent them" (Williams and Mark 1995).

> Early settlers in the mountains used fire to clear the land and keep forested areas open for grazing, following burning traditions learned from the Indians.

Well into the 20th century, Indians continued to burn in the steep mountain country of northern California. In 1918, a Forest Service district ranger on the Klamath National Forest deplored fires set by "the renegade whites and indians in the district" (Harley 1918). According to the ranger, "the indians will sometimes try and burn off the leaves and humus under the oak trees, to facilitate the gathering of acorns." They also set small fires to improve vegetation growth for basket material.

Impact of Indian Fire Use

American Indians in the Willamette, Umpqua, and Rogue Valleys clearly used fire to modify

Presettlement Fires—Natural or Human Caused?

At the turn of the 20th century, when the U.S. Geological Survey (USGS) mapped vegetation in the newly created forest reserves, it reported evidence of widespread wildland fires. Although the USGS did not indicate a fire cause, its reports left the impression that the fires were caused by lightning. Today, the impression lingers that fires in the presettlement mountain West were mostly caused by hundreds and even thousands of lightning strikes per year.

Lightning in fire-adapted ecosystems does not usually cause fires. Lightning tends to strike individual trees, high rocky points, and other places where no ignition occurs or small snag fires result. Most snag fires are soon extinguished by the rain that usually accompanies lightning; the few fires that persist often smolder and die without ever spreading.

In Oregon, the mountains are indeed susceptible to heavy lightning storms in late summer and early fall, and the storms do start fires. Historically, Indians probably started fewer fires than did lightning; however, their carefully controlled burns—timed in spring or late fall to coincide with proper fuel and other burning conditions—would spread without extinguishing until they achieved the desired effect. Indian fires therefore likely had greater and longer term impacts on the mountain forests and prairies than did lightning fires.

Indians continued to burn Oregon's wildlands into the late 19th century, even on some forest reserves.

the environment. "In the case of the Willamette Valley, as much as 2 million acres [800,000 ha] of land were maintained in prairie and savanna as a consequence of aboriginally set fires," noted Douglas Booth (1994). Lightning could not have been the primary cause of these prairie fires, because the Willamette Valley experiences very few lightning storms.

Fire use to increase food resources was so central to aboriginal survival in Oregon's valleys that it formed an essential part of the Indian lifestyle and culture (Boag 1992; Boyd 1986; Johannessen et al. 1971). Yet the type of burning practiced by the Kalapuyas and others has not occurred since the 1850's. As a result, the native Oregon white oak (*Quercus garryana*) "is now a declining type, largely due to replacement by Douglas-fir on most sites," according to James Agee (1990). Eliminating competition from Douglas-fir would require burning the Willamette Valley at least every 5 to 10 years (Agee 1990).

The evidence for Indian burning is less compelling for the mountains than for the valleys (Booth 1994). Few early travelers, settlers, and writers reached remote areas in the mountains, so records are fewer than for the valleys. Still, travelers and explorers did note the parklike appearance of many forests in the mountains, especially in areas of ponderosa pine (Stevens 1860; Weaver 1967).

Scattered historical evidence suggests that mountain forests were managed through the use of fire by both the Indians and the early settlers. What is not clear is the frequency of burning. Fire scars from old trees, pollen studies, and charcoal layers in lake sediments can indicate fire frequencies for most areas, but they cannot reveal the fire cause, the total area burned, or the season of burning. In each regard, historical accounts vary considerably (Williams 1999).

Implications for Wildland Management

Most forest and savanna areas in North America have had thousands of years of human interaction and management. American Indians, who themselves were newcomers to the New World some 12,000 to 30,000 years ago, adapted to the environments they found and in turn modified those environments for their survival. Fire was the major tool that American Indians used to render ecosystems livable.

Little of the original open prairie remains today; millions of acres have been transformed into farms, pastures, highways, and cities. The basis for much of our forest health crisis nationwide lies in the almost complete cessation of Indian burning in fire-adapted ecosystems, largely accomplished by the early 1700's in the East and the 1850's in the West. The crisis is commonly attributed to the advent of systematic fire suppression and the Smokey Bear mentality in the 20th century. Although partly true, this explanation is not as sufficient as some would like to believe. To fully come to grips with our forest health crisis today, we must go back to much earlier land management decisions that ended thousands of years of Indian interactions with the land, especially through the use of fire.

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Fire History Along the Ancient Lolo Trail

Stephen W. Barrett

> Crossing the Bitterroot Mountains on the Lolo Trail was a daunting experience for the historic Lewis and Clark Expedition.

For untold centuries before 1900, the Lolo Trail was a notoriously difficult route across the Bitterroot Mountains in present-day north-central Idaho (fig. 1). Indeed, this approximately 150-mile (240-km) mountain traverse was by far the most dreaded segment of the several-thousand-mile Lewis and Clark Expedition of 1804–06 (DeVoto 1953; Moulton 1988). Factors such as steep terrain, dense forests, fickle weather, and lack of game combined to make travel on the Lolo Trail a daunting experience. Although much of the trail follows high ridges, some segments descend several thousand feet into the deep and twisting Lochsa Canyon, only to climb out again in just a few miles. Worse, the area's lush, often impenetrable forests are periodically destroyed by intense wildland fires, producing heavy snagfalls. Foot travel along the ancient trail was far more arduous than in the broad valleys and plains that Captains Meriwether Lewis and William Clark had earlier encountered on their journey.

Today, recreationists and students of cultural history can drive much of the original Lolo Trail, seeing a vignette of the historic journey by Lewis and Clark. Post-1900 fires and modern management have eliminated much of the primeval forest along the trail, but tree ring research can be used to interpret the forest conditions at various times. In 1995, I sampled fire history along the Lolo Trail in the Powell Station portion of the

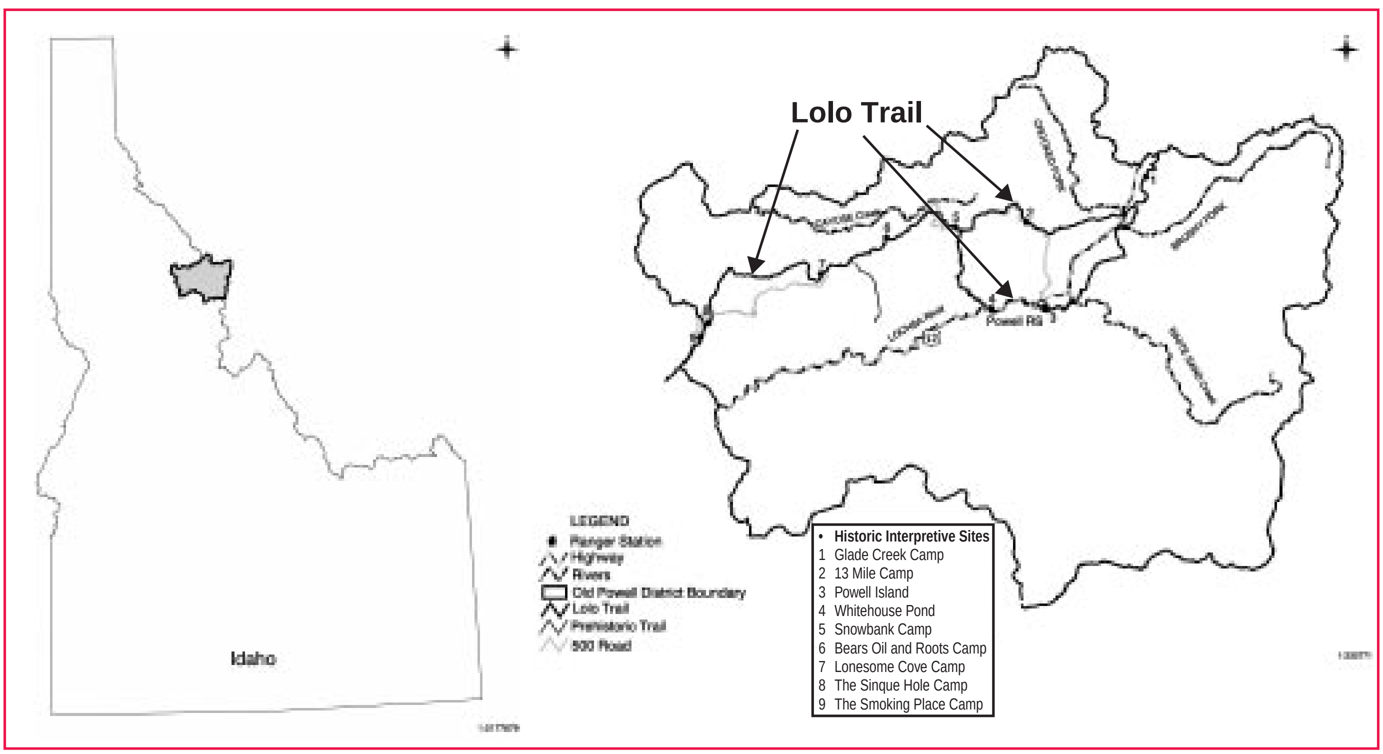

Figure 1—*Location in Idaho (left) of the Powell Station portion of the Lochsa Ranger District, Clearwater National Forest; and, within the Powell Station area (right), of the Lolo Trail, including upper and lower loops. Used by early-day American Indians to cross the rugged Bitterroot Mountains, the trail was one of the most difficult traverses faced by the Lewis and Clark Expedition (1804–06).*

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Lochsa Ranger District,* Clearwater National Forest, ID. The goal was to document long-term fire history as a primary basis for interpreting past and current forest environments along the trail. What were conditions like for Lewis and Clark? How do they differ today? And what are the implications for ecosystem-based management?

Lodgepole pine and mountain hemlock, now 200 to 400 years old, dominate much of the ridgeline traversed by the ancient Lolo Trail. Photo: Courtesy of Steve Barrett, Kalispell, MT © 1995.

Landscape Fire History

Northern Idaho has a notorious recent fire history (Barrett 1982, 1995; Koch 1942; Larsen 1929). For example, hundreds of thousands of acres of forest were destroyed by extensive fires during droughts in 1889, 1910, 1919, and 1934 (Barrett 1995). Determining long-term fire history can be challenging in many locales, but most areas contain some remnant old growth or at least scattered fire-scarred veterans and well-preserved snags. In the Powell Station area, most of the forest along the Lolo Trail occurs in the stand replacement fire regime (where fires occur infrequently but with sufficient severity to result in mortality for most trees) (Quigley et al. 1996). Scarred trees typically are rare, and fire history is interpreted largely from age class analysis. The remaining forest along the Lolo Trail is in the mixed-severity fire regime, comprising relatively dry south-facing stands in the Lochsa Canyon. These usually contain a few fire-scarred trees, but they rarely survive more than one or two fires before succumbing during relatively severe conflagrations. Historically, lightning probably caused most fires along the Lolo Trail, because intentional burning by American Indians occurred largely in valley grasslands and adjacent dry forests (Barrett and Arno 1982; Boyd 1999).

I sampled fire history for a zone about 50 miles (80 km) long and 1 mile (1.6 km) wide, bisected by the Lolo Trail. I obtained fire scar and forest age class data from 67 plots (Arno and Sneck 1977; Barrett and Arno 1988), including at 13 historic sites visited by Lewis and Clark. In the Powell Station area, about one-third of the Lolo Trail passes through montane and riparian forests at low elevations, and the remaining two-thirds passes through subalpine forests and meadows. Nearly pure stands of mountain hemlock (*Tsuga mertensiana*) occupy north aspects at high elevations (such as from 6,000 to 7,000 feet [1,800–2,100 m]), but the ancient Indian trail usually traversed the more easily traveled south sides of ridges, where less dense stands of lodgepole pine (*Pinus contorta*) and beargrass (*Xerophyllum tenax*) are interspersed with grassy glades and rock outcrops. I took fire scar and pith samples from old-growth stands dominated by lodgepole pine and/or western larch (*Larix occidentalis*), and from stands of mixed conifers such as western larch, Douglas-fir (*Pseudotsuga menziesii* var. *glauca*), grand fir (*Abies grandis*), Engelmann spruce (*Picea engelmannii*), subalpine fir (*A. lasiocarpa*), western redcedar (*Thuja plicata*), and western white pine (*Pinus monticola*).

An estimated 22 fires occurred between about 1510 and 1960 (fig. 2), for an areawide mean fire

* The study was conducted in the Powell Ranger District, which is now administered by the Powell Ranger Station as part of the Lochsa Ranger District.

Historically, fires occurred somewhere along the 50-mile trail corridor at least every two decades, on average.

interval (MFI) of 21 years. That is, fires occurred somewhere in the nearly 50-mile-long (80-km-long) trail corridor at least every two decades, on average. Six or seven fires apparently produced most of today's age class mosaic, yielding an MFI of about 70 years for major stand-replacing fires.

Fire frequency has varied widely over time. For example, fires were very active throughout the 1700's, when area MFI was just 11 years. Fires declined during the 1800's (the MFI was 30 years), at the height of the cool, moist Little Ice Age (Graumlich 1987). Subsequent drought-induced fires between 1910 and 1929 burned large portions of the area, and no important fires have occurred since then due to systematic fire exclusion. Before about 1930, actual intervals between fires in the corridor ranged from about 3 years to 43 years, but were usually between 10 and 20 years. The fire-free interval in the last seven decades is therefore unprecedented since at least the mid-1600's, and is four times longer than the pre-1929 MFI of 17 years. Moreover, the current fire interval now equals the 70-year MFI found for major historical fires.

Challenges for the Lewis and Clark Expedition

The data provide new perspective on some of the hardships endured by early travelers. For example, ridgetops often contain multiple intersecting burn margins from fires on either side. The ancient Lolo Trail thus passed through a diverse forest mosaic, including immature stands that must have been difficult to traverse due to heavy postfire snagfalls and dense regeneration.

Lewis and Clark took at least 5 days to cross the Bitterroot Mountains via the Lolo Trail in September 1805 (DeVoto 1953). On September 13, in the eastern trail segment, a possible error by their Shoshone guide caused Lewis and Clark to leave the Lolo Trail near Glade Creek (Moulton 1988). Consequently, the party had a very trying day in the steep, densely forested Lochsa Canyon. Decades of heavy logging have depleted the old growth in this area, but the trail still contains three of the oldest forest age classes found (from fires in about 1510, 1571, and 1733). Thus, the 1805 mosaic was highly variable, with stands ranging from just 20 to 300+ years old.

Three forest age classes (from fires in about 1733, 1784, and 1810) dominate the 12-mile (19-km) lower trail segment from Packer Meadows to Powell Island and the 13-mile (21-km) higher elevation segment between 21-Mile Camp and Snowbank Camp (fig. 3). Captain Clark's journal entry on September 14 verifies that the lower trail was much more difficult to traverse than the more open lodgepole pine stands east of Packer Meadows (near the present-day Lolo Hot Springs). "The Mountains which we passed to day," observed Clark, "[were] much

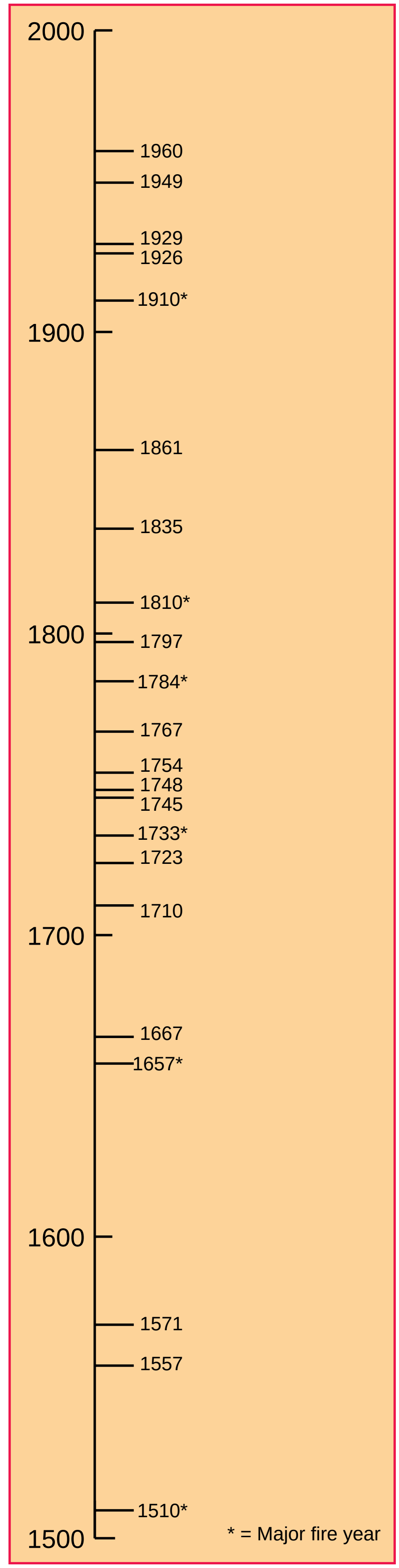

Figure 2—*Estimated fire years along the Lolo Trail in the Powell Station portion of the Lochsa Ranger District, Clearwater National Forest, ID.*

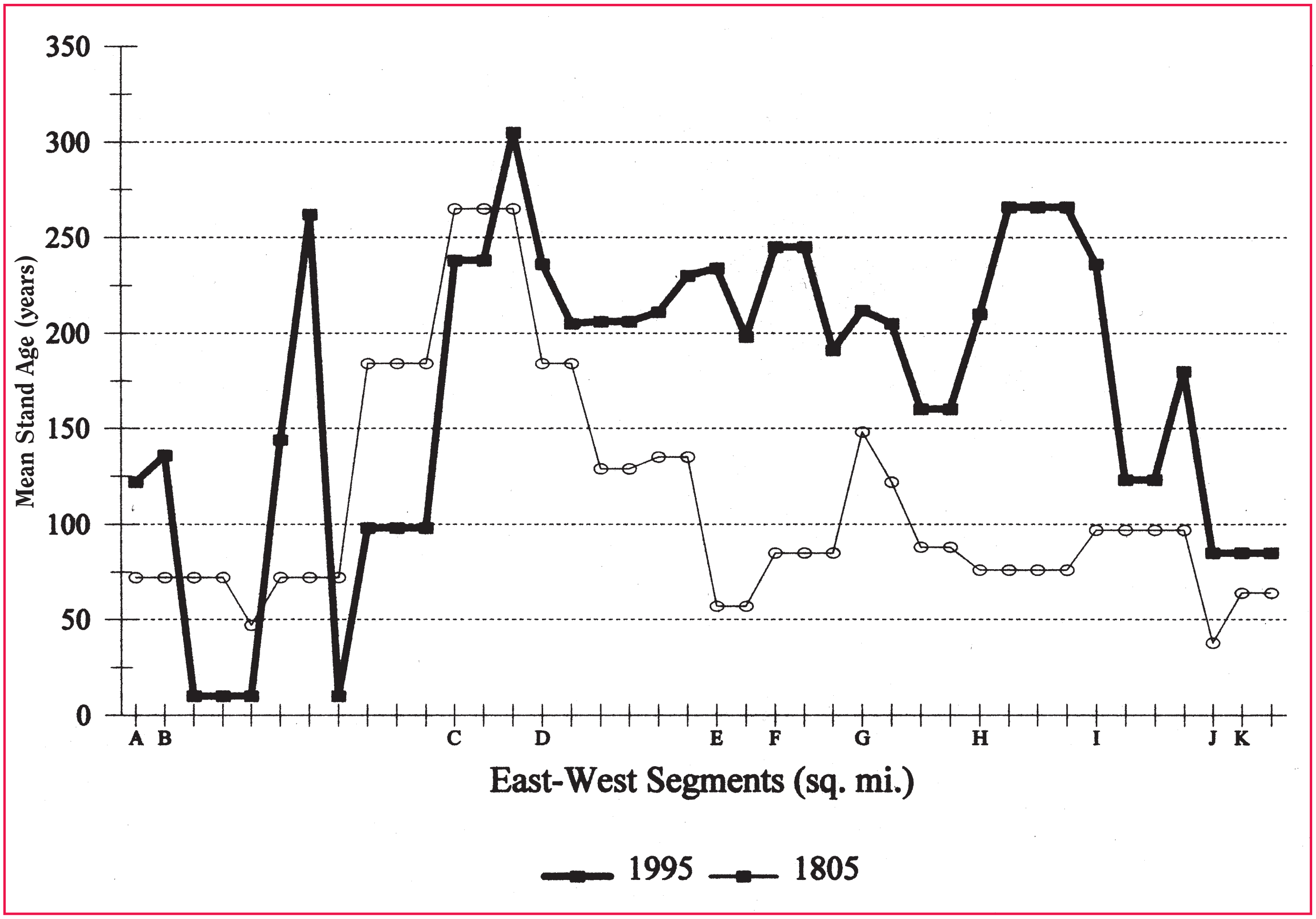

Figure 3—*Forest age class mosaic along the Lolo Trail in 1805 and 1995. Timber harvesting and fire exclusion have reduced landscape diversity since 1805. Also, the 1995 mosaic is skewed toward old stands, possibly indicating high fire risk. Mean stand ages are based on dominant seral classes in consecutive square miles of the Lolo Trail corridor from east to west along the lower trail loop. A = Packer Meadows; B = Glade Creek Camp; C = Powell Island; D = Whitehouse Pond; E = Snowbank Camp; F = Cayuse Junction; G = Bears Oil and Roots; H = Indian Post Office/Lonesome Cove; I = Howard Camp; J = Sinque Hole; and K = Smoking Place.*

worst than yesterday the last excessively bad & Thickly Strowed with falling timber & Pine Spruce fur Hackmatak & Tamerack, Steep & Stoney our men and horses much fatigued" (Moulton 1988).

Ironically, an extensive fire occurred shortly after Lewis and Clark passed through this area. An 1810 age class dominates the forest mosaic for more than 15 miles (24 km) between Brushy Fork and Squaw Creek. Conceivably, the outcome of the expedition could have been different had the fire occurred just a few years earlier. Faced with a vast and impenetrable recent burn, the explorers might well have been forced to abandon this route, as they had done 3 weeks earlier in central Idaho's virtually impassable Salmon River Canyon.

On September 15, Captain Clark described the trail up Wendover Ridge as "winding in every direction to get up the Steep assents & to pass the emence quantity of falling timber which had [been] falling from dift. causes i e fire & wind and has deprived the greater part of the Southerly Sides of this mountain of its green timber" (Moulton 1988). I found that a fire in about 1784 likely produced this tangle of fallen snags, whereas older stands along upper Wendover Ridge (near Snowbank Camp) apparently regenerated after fires in about 1510, 1557, and 1710. Thus, the party had to traverse four widely varying age classes in just 6 very steep miles (10 km). The 1810 fire subsequently destroyed most of these stands, but scattered remnants exist along the upper trail today.

Post-1800 forest age classes (from fires in 1810, 1861, and 1910) now dominate the south-facing slopes between Snowbank Camp and Indian Post Office. However, older stands of mountain hemlock and mixed conifers (regenerated after fires from 1657 to 1784) still occupy many north slopes in the upper Cayuse drainage, as well as

Packer Meadows, near Lolo Hot Springs, MT. Lewis and Clark camped in this area on September 13, 1805, and June 29, 1806. Such glades among the high-elevation lodgepole pines allowed easier travel and provided grazing and water for horses. Photo: Courtesy of Steve Barrett, Kalispell, MT, ©1995.

between Lonesome Cove and Gravey Creek. To the west, extensive stands of 60- to 80-year-old lodgepole pines (regenerated after fires in 1910, 1919, and 1929) blanket the remaining 8 miles (13 km) of trail between upper Gravey Creek and the former Powell District's western boundary, including at the Sinque Hole and Smoking Place historic sites. Here, only a few fire-scarred veterans and burned snags remain from the 1657–1784 period.

Throughout their journey across the Bitterroots, Lewis and Clark were repeatedly hampered by windfalls, largely from fire-killed snags. For instance, numerous detours on September 19 forced the party to travel nearly twice the direct distance of the trail near Hungery Creek (just west of the former Powell District boundary). Today's Lolo Motorway follows much of the ancient trail, but recreationists can scarcely appreciate the trials and tribulations that earlier travelers endured. Although the forest mosaic has changed, portions of the primeval forest remain—stands that were young or middle aged when Lewis and Clark passed through. Only the lower trail loop (for example, near Powell Island) contained much old growth in 1805—that is, dense river bottom stands that regenerated after fires in the 1500's and before. Conversely, drier lodgepole pine stands occupied most subalpine terrain near Packer Meadows and between Snowbank Camp and the western boundary of the former Powell District. Clearly, the Indians showed Lewis and Clark that the high country was much easier to traverse.

On their return from the Columbia River in 1806, Lewis and Clark again struggled across the dreaded Bitterroot Mountains. But the rest of the trip went fairly smoothly, with the help of Indians along the way. The weather, in particular, remained favorable—thanks to a ceremony observed near Lolo Pass? (See the sidebar on page 27.)

Implications for Ecosystem-Based Management

The fire-generated mosaic in 1805 was evidently quite diverse, both compositionally and geographically (fig. 3). But by 1995, timber harvesting together with fire exclusion had reduced landscape diversity. The eastern trail corridor is now dominated by early-successional forest on large clearcuts, interspersed with patches of old growth. Conversely, the subalpine forest in the middle to western trail segment is documented by middle to old age classes, with no

High-elevation lodgepole pines that regenerated after a fire in 1810, shortly after the Lewis and Clark Expedition traversed this area. Understories are more open along ridgelines, where beargrass and other short plants predominate. Photo: Courtesy of Steve Barrett, Kalispell, MT, ©1995.

Over the last five centuries, six or seven major fires produced the bulk of today's forest age class mosaic along the Lolo Trail.

Table 1—*Intervals between stand-replacing fires near 15 historic sites along the Lolo Trail, Powell Station portion of the Lochsa Ranger District, Clearwater National Forest, ID.*

Site	*Fire intervals (years)*		
	Cover type[a]	*Montane/riparian forest zone*	*Subalpine forest zone*
Packer Meadows/Glade Creek Camp	L, LP, S–F	—	113, 143, 177
21-Mile Camp	L, MC, WRC	223, 400	—
Powell Junction	LP	—	116
Powell Island	L, WRC	239, 300	—
Whitehouse Pond	L, WRC	223	—
Wendover Ridge	L, LP, MC	100, 126	—
Snowbank Camp	LP, MH	—	100
Cayuse Junction	LP, MC, MH	—	126
Bears Oil and Roots	LP, MH	—	204
Indian Post Office/Lonesome Cove	LP, MC, MH	—	53, 88, 184, 219, 272
Howard Camp	LP, MH	—	77, 126, 151, 200, 204, 253
Sinque Hole/Smoking Place	LP	—	75, 113
All sites (average)	***—***	***230***	***150***

a. L = western larch; LP = lodgepole pine; MC = mixed conifer; MH = mountain hemlock; S–F = spruce–subalpine fir; WRC = western redcedar.

young fire-regenerated stands. Interestingly, many of the area's old lodgepole pine stands might actually be easier to traverse afoot now than during the 1800's, because they have more openings, fewer understory trees, and less dense snagfalls.

Nonetheless, seven decades of fire suppression have promoted increasing homogeneity in unlogged portions of the trail corridor. Before 1930, the MFI in a given subalpine stand was about 150 years long and about 230 years long in montane and riparian stands (table 1). In 1995, about half the stands in unlogged areas were relatively old, and another 15 percent were mature (from 80 to 100 years old). Thus, about two-thirds of the stands in the mosaic are now within or approaching the upper range of historical replacement intervals. Stand senescence from windthrow, insects, and diseases is widespread, especially in the subalpine zone, frequented by lightning. Because old to middle-age stands are often contiguous in the central to western portions of the trail, major stand-replacing fires might be imminent.

Stand-replacing fires are the predominant fire severity type in the Lochsa country (Quigley et al. 1996). However, patchy underburns also occasionally occurred along subalpine ridges and lower elevation south slopes. Purposely igniting some fires might help thin stands, but could temporarily increase fire hazards by

The ancient Lolo Trail passed through a diverse forest mosaic, including immature stands difficult to traverse due to heavy postfire snagfalls and dense regeneration.

Burning by American Indians in the Northern Rockies

On its historic journey in 1804–06, the Lewis and Clark Expedition observed several instances of Indian fire use in the northern Rockies, mostly in valley bottom grasslands and lower elevation forests dominated by ponderosa pine, Douglas-fir, or western larch. On August 23, 1805, as the expedition was leaving the headwaters of the Missouri River, Captain Meriwether Lewis noted widespread Indian fire use in his journal (DeVoto 1953):

I laid up the canoes this morning in a pond near the forks; sunk them in the water and weighted them down with stone […] hoping by this means to guard against both the effects of high water, and that of the fire which is frequently kindled in these plains by the natives.

About a week later, on August 31, members of the expedition saw large signal fires near the Lemhi River on the headwaters of the Columbia (Thwaites 1904–05):

This day warm and Sultry, Prairies or open Valies on fire in Several Places. The countrey is set on fire for the purpose of collecting the different bands [of Pend d'Oreille], and a Band of Flat Heads to go to the Missouri where they intend passing the winter near the Buffalow.

On June 25, 1806, Captain William Clark observed the following ceremony while camped near Lolo Pass, southwest of present-day Missoula, MT (DeVoto 1953):

Last evening the [Flathead] indians entertained us with setting the [subalpine] fir trees on fire. they have a great number of dry limbs near their bodies which when Set on fire create a very sudden and emmence blaize from bottom to top of those tall trees. they are a boutifull object in this situation at night. this exhibition remi[n]de[d] me of a display of firewo[r]ks. the nativs told us that their object in Setting those trees on fire was to bring fair weather for our journey.

accelerating the accumulation of dead fuels. Therefore, selective harvests before reintroducing fire might provide effective mitigation, at least near important cultural sites.

Future Challenges

Historical fire cycles and forest age class maps can serve as useful guides for selecting and scheduling stand treatments. For example, the Lolo Trail study area contains roughly 21,000 acres (8,500 ha) of subalpine forest with a mean stand replacement interval of 150 years. Therefore, fires historically burned an average of about 140 acres (57 ha) of subalpine stands per year. At that rate, and because seven decades have passed without significant fires, about 9,800 acres (4,000 ha) of subalpine forest—nearly half the total subalpine area—are theoretically overdue for replacement. Similarly, the fire cycle for the 11,000 acres (4,500 ha) of montane and riparian forest suggests that about 3,300 acres (1,300 ha) might have burned between 1930 and 1995. All told, as much as 40 percent of the forests in the corridor might have burned in the absence of fire suppression. Timber harvest has removed much of the old montane forest, but not in the subalpine zone. Therefore, management for ecosystem processes and recreation values would reasonably focus on today's subalpine stands.

Given northern Idaho's rather notorious fire history (Larsen 1929; Koch 1942; Barrett et al. 1997), future wildland fires along the Lolo Trail could become conflagrations that consume most of the "backlog" of unburned stands. Even with relatively aggressive management, fires will presumably continue to play a dominant role in shaping forests along the Lolo Trail. The question is how future management will influence that natural process.

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Fire Use in James Fenimore Cooper's *The Prairie**

James Fenimore Cooper (1789–1851) was an early American novelist whose works often feature frontier life. *The Prairie* (1827) concludes Cooper's *Leatherstocking Tales* about the frontiersman Natty Bumppo, from his youth in upstate New York to his old age as a Great Plains trapper. In *The Prairie*, the old trapper and his friends escape from pursuing American Indians by hiding in tallgrass. That night, the Indians ignite the prairie to flush out their quarry. The trapper saves the day by lighting an escape fire. Cooper's novel suggests that American Indians and frontiersmen were proficient in the use of fire.

"Ah's me!" said the trapper. "The imps [enemy Indians] have circumvented us with a vengeance. The prairie is on fire!" Bright flashes of flame shot up here and there in a broad belt about their place of refuge. Huge columns of smoke were rolling up from the plain; the red glow which gleamed upon their enormous folds proclaimed louder than words the character of the imminent and approaching danger.

"Come lads, come," the trapper exhorted. "Put hands on this short and withered grass where we stand, and lay bare the 'arth." [After a circle was cleared of fuel, the trapper used his flintlock to ignite a handful of dry grass.] Then he placed the little flame in a bed of the standing fog [tallgrass], and withdrawing from the spot to the centre of the ring, he patiently awaited the result. As the fire gained strength and heat, it began to spread on three sides, dying of itself on the fourth, for want of ailment [fuel]. It cleared everything before it, leaving the black and smoking soil. By advancing to the spot where the trapper had kindled the grass, they avoided the heat [from the main fire], and in a very few moments the flames began to recede in every quarter, leaving them enveloped in a cloud of smoke, but perfectly safe from the torrent of fire that still furiously rolled onward.

* *From* The Prairie by James Fenimore Cooper *(Cornwall, NY: Dodd, Mead and Co., 1951), pages 282–288. To facilitate reading, the excerpt does not indicate omitted words and passages.*

Wildland Burning by American Indians in Virginia

Hutch Brown

Two days after first sighting the coast of Virginia in 1607, the Jamestown colonists noticed "great smokes of fire" rising from deep in the woods. "We marched to those smokes," recalled George Percy (1607), "and found that the savages had been there burning down the grass as, we thought, either to make their plantation there or else to give signs to bring their forces together, and so to give us battle." One of the first things the English discovered about American Indians in Virginia was that they burned their wildlands.

One of the first things that the English discovered about American Indians in Virginia was that they burned their wildlands.

The purposes for burning—agricultural clearing or military signaling—are speculative in Percy's account. Notable, however, is the fuel type mentioned: grass. Grassland in Virginia rapidly succeeds to forest unless maintained by grazing, mowing, or fire. In his account, Percy suggests a possible reason for its persistence—American Indian fire use.

A Burning Question

Was burning by American Indians extensive enough to influence Virginia's ecosystems? The answer, according to one early USDA Forest Service researcher, is emphatically yes. Hu Maxwell (1910) claimed that had the colonists not "snatched the fagot from the Indian's hand," Virginia would have become one vast "pasture land or desert."

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At the other extreme, Emily Russell (1983) has challenged the notion that American Indians burned much at all. Most colonial accounts that describe Indian life, she notes, do not mention wildland burning. But such accounts in Virginia are generally limited to what visitors saw Indians doing in their villages, which would not have included setting vegetation on fire.

Today, many researchers agree that disturbances, both natural and manmade, helped to shape the patchwork of presettlement ecosystems sometimes known as the primeval forest. Wildland fire is capable of making fundamental, long-term changes to ecosystems in the mid-Atlantic region. For example, slash fires in the early 20th century severely burned the Dolly Sods area on the Monongahela National Forest, WV. The original red spruce forest never recovered; a dense tangle of heaths now covers much of the burn site.

The overwhelming majority of wildland fires in Virginia are ignited by humans (Main and Haines 1976; Stapleton 1999) and probably have been for thousands of years. For the past 4,000 years, lightning fires have been uncommon on most of the Atlantic seaboard (Delcourt and Delcourt 1996, cited by Barber 1999; Patterson and Sassaman 1988). Local concentrations of natural fires might have favored fire-adapted species in some areas (Stapleton 1999; Williams 1998); but in most of Virginia's presettlement landscapes, frequent fire would have depended on activities by American Indians. If we are to preserve and restore our eastern wildland ecosystems, then we must first understand the role American Indians might have played in using fire to make presettlement ecosystems livable and productive.

A thorough study of the role that Indian fire use played in Virginia's presettlement ecosystems would require examining evidence, both qualitative and quantitative, from multiple sources (see sidebar on page 31). However, a single source—accounts by colonial explorers and travelers—can provide a useful preliminary overview of the impact that Indian fire use might have had on wildland ecosystems in Virginia.

Why Did Indians Burn?

Based on historical evidence, four purposes for burning—agriculture, hunting, range management, and travel—might have opened

The Forest Primeval

Many people believe that the first English to settle North America found an ancient, impenetrable wilderness stretching uninterrupted from the shores of the Atlantic to the banks of the Mississippi. The popular view of a pristine wilderness inhabited by American Indians who left no trace on the land is rooted in the Romantic notion of "the forest primeval" promoted by such poets as Henry Wadsworth Longfellow.

The Romantic view entered the early conservation movement through the writings of Henry David Thoreau and others (Williams 1999). It plays a strong role in today's environmental movement (Brown 1999) and has even influenced the science of ecology (Whitney 1994). For example, ecologists often conceive of forest succession as a progression toward a stable, self-perpetuating "climatic climax" (or "potential natural") forest. Implicit in the notion of the climax forest is the goal of returning to an undisturbed state of forest stability—the condition that prevailed in the Romantic imagination before the arrival of Europeans.

Old-growth remnants today suggest that there is some truth to the Romantic notion of a forest primeval, but only on some sites (Whitney 1994). Research has shown that the pre-Columbian eastern temperate forest was actually a complex, relatively unstable (Davis 1981) patchwork of ecosystems that included extensive grasslands. Disturbances at various scales, from the decline of a single species to the destruction of vegetation for miles around, helped to shape—and could change—presettlement ecosystems in various ways, depending on such factors as soil, climate, geography, and human activities (Patterson and Sassaman 1988; Pyne 1982; Whitney 1994; Williams 1999). Accordingly, there is also some truth to one researcher's claim that "most of the forests seen by the first settlers in America were in their first generation after one or another kind of major disturbance" (Raup 1967).

Virginia's landscape and affected its ecosystems the most.

Slash-and-Burn Agriculture. All of Virginia's native populations practiced agriculture, from the Coastal Plain (Rountree 1989) to the western valleys (Brinker 1998). Small farming communities were concentrated near freshwater springs or creeks along major waterways (fig. 1) (Smith 1612; Barber 1999).

Although the American Indian presence was permanent throughout Virginia, Indians periodically moved their villages from site to site. An excavated archeological site at Seneca Rocks, on the headwaters of the Potomac River in what is now West Virginia, shows that a farming village flourished there for about 20 years, then was abandoned (Brinker 1998). Two centuries later, an almost identical village was built on the same site, only to be abandoned again after a single generation. Why?

Each village required, depending on its size and location, from a few acres to hundreds of acres of fields for corn, beans, and squash (Archer 1607a; Rountree 1989; Smith 1624). Villagers cleared the fields by felling, girdling, or firing trees at the base and then using fire to reduce the slash and stumps. The farmers did not use fertilizer, so soil productivity gradually declined, requiring new fields to be cleared. Fishing and hunting depleted local fish and game, and trash and waste disposal diminished local water quality over time. Meanwhile, tree felling for fuelwood, new cropfields, and building materials eventually pushed the forest out of easy reach. A few decades after a village was established, these circumstances combined to make the village untenable (Brinker 1998). The inhabitants then moved on. The original site, if left undisturbed, passed through successional stages until reaching climax forest two or three centuries later. Depending on local conditions, it might take decades or even centuries for the site to be suitable for renewed inhabitation.

With every change in location, a village used fire to clear new land and left an even larger amount of cleared land behind. Traces of clearings abandoned during previous decades might be scattered over many miles. From its farming activities alone, a single village occupying 50 acres (20 ha) might leave a disturbance pattern,

Sources of Evidence for Indian Fire Use

Did wildland burning by American Indians affect presettlement ecosystems in Virginia? Relevant sources of evidence (adapted from Whitney 1994) might include:

- Historical materials, including written accounts, maps, and drawings;
- Statistical records, especially land surveys;
- Studies of old-growth forests or ancient individual trees;
- Archeological evidence, especially from excavated Indian village sites; and
- Paleoecological studies, including pollen and charcoal analyses from sediments.

Evidence from different sources does not always agree. Despite eyewitness accounts of bison in Virginia, archeologists have found no supporting evidence such as bison bone fragments in excavated Indian fire- and trashpits (Stapleton 1999). But bison did not spread into Virginia until the 14th or 15th century (Haines 1970), whereas most archeological excavations are on earlier, "prebison" sites (Brinker 1999).

at any given time, on hundreds of acres of widely scattered tracts at various successional stages. Where populations were relatively concentrated, this broad pattern of impact probably helped provoke warfare among peoples competing for limited resources such as hunting grounds. As stocks of deer declined on the coastal plain, for example, the Powhatans organized large upriver hunts in areas claimed by the Monacans, leading to occasional bloody battles (Rountree 1989; Strachey 1612).

Hunting. Fire was widely used in Virginia during organized hunts. Villagers, "commonly two or three hundred together" (Strachey 1612), would form a large circle and ignite the forest leaf litter,

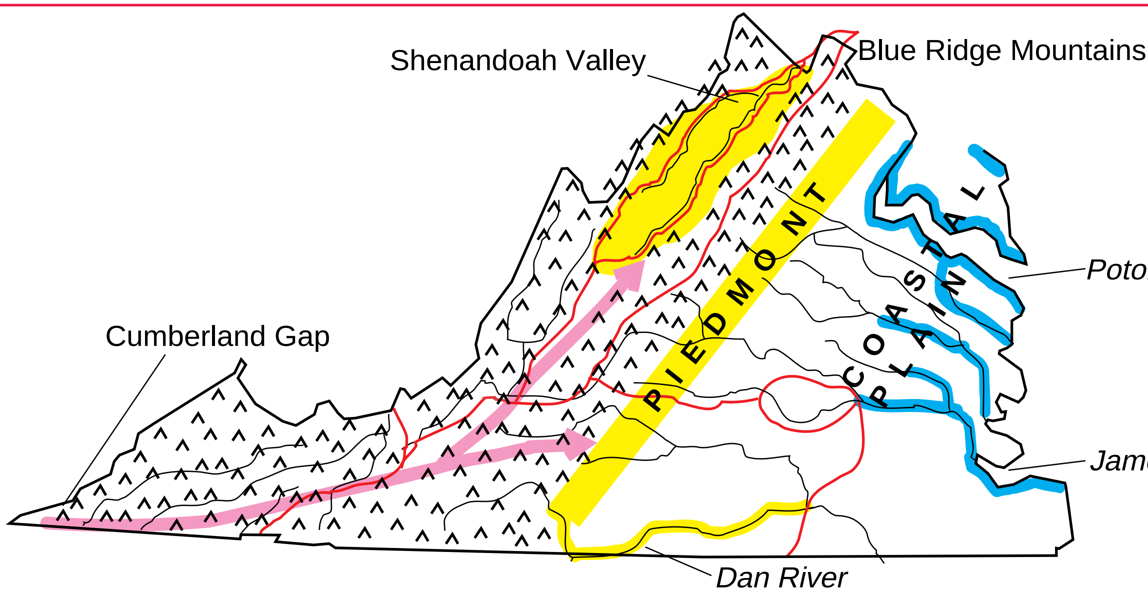

Figure 1—*Virginia in about 1600, showing some of the areas where fire use by American Indians might have affected presettlement vegetation. Areas of Indian settlement on the Coastal Plain are based on Smith (1612); areas of settlement in the interior are not shown, but were similarly concentrated along waterways. American Indians burned lands adjacent to their villages for agriculture, hunting, and other purposes, opening the forest and promoting pines and oaks over less fire-resistant species such as maples and beech. The western Piedmont and Shenandoah Valley had fire-maintained grassland or open woodland that probably reached southwestward along valleys to the Cumberland Gap, providing a migration corridor for bison (Haines 1970). The major Indian trails shown were used for regional trade and travel (Lambert 1989; Randolph 1973); not shown are the many local trails along rivers and ridges. Frequent fire use to maintain such trails probably formed corridors of open pine and oak forest. Illustration: Gene Hansen Creative Services, Inc., 2000.*

driving deer into the center where they could easily be killed. Or they would burn a line of forest across a point of land, driving game into the river to be shot by hunters in canoes (Smith 1624). Fire surrounds were organized in autumn, when leaf litter was plentiful and there were fewer ladder fuels to turn a surface burn into a raging canopy fire.

Communal fire surrounds were more efficient than individual hunts, which might go for weeks without success. However, communal hunts represented a larger—and therefore riskier—investment of time and energy. To reduce the risk, hunters ignited areas known to abound in game, which had the self-reinforcing effect of increasing future game stocks in those areas. Even in closed forest, underburning multiplies the quantity and quality of deer browse, attracting and supporting increased deer herds (Mellars 1976). The fire surround thus functioned not only to drive game, but also to regenerate game for future hunts. By improving browse through fire, the hunters could concentrate animals in limited areas where they were easiest to find and kill.

Range Management. European settlers found extensive areas of open game habitat throughout the East, commonly called "barrens" (Pyne 1982). The American Indians used fire to maintain such areas as rangeland. Europeans reported evidence of widespread grassland or savanna in two parts of Virginia: the Piedmont (including the Dan River watershed in southern Virginia) and the Shenandoah Valley (fig. 1).

In the Piedmont, after "marching into the country" from Little Falls on the Potomac River (near present-day Washington, DC),

"Chieftain of Virginia," from a drawing in about 1585 by John White near the ill-fated Roanoke colony in what is now coastal North Carolina. Note that the hunting ground behind the "chieftain" is sparsely wooded; sharp forest margins suggest careful disturbance control. White's drawing matches Henry Spelman's (1613) mention of open areas in coastal Virginia supporting luxurious grass for game. Illustration: U.S. Library of Congress, Washington, DC.

Four purposes for burning—agriculture, hunting, range management, and travel—would probably have opened Virginia's landscape and affected its ecosystems the most.

American Indians and Colonists in Virginia

Colonial accounts suggest that at least 13,000 people, or about 2 people per square mile, were living in what is now Virginia in 1607, when Jamestown was founded (Rountree 1989). Estimates are highly conjectural, partly because European epidemics and 17th-century wars for control of the inland beaver trade devastated American Indian populations in eastern North America before settlers actually encountered them. The pre-Columbian population might have been much higher.

After accounting for the effects of epidemics and warfare, one researcher calculated that pre-Columbian population densities reached 50 people per square mile in parts of coastal New England (Cook 1976, cited in Whitney 1994). The coastal Virginians under the Powhatan confederacy, also sustained by agriculture and rich fishing grounds, probably had similarly high population densities, at least locally. Moreover, the Powhatans' inability to conquer the inland Chickahominies, Monacans, and Manahoacs suggests that populations of the Piedmont interior were comparable in size. Archeological excavations indicate that the Tutelos and others who occupied the mountain valleys to the west maintained extensive villages in the floodplains and frequent camps in the uplands for hunting and other purposes (Barber 1999).

The Jamestown colony, established in 1607 by a few dozen settlers from England during a rare prolonged regional drought, faced starvation and was almost abandoned in 1610. But ships from England brought fresh supplies and new settlers, and the colony soon expanded. By 1616, after destroying nearby native villages, the colonists had established a series of settlements from the mouth to the falls of the James River.

The Powhatans, eager to trade for English tools and other manufactures, generally tolerated the Jamestown settlement until too late. In 1622, they finally launched a coordinated series of assaults that nearly wiped out the English. In 1644, after another failed military campaign, the Powhatans suffered bloody reprisals that broke their power for good. By the 1750's, decimated by European diseases and warfare, most native peoples—including populations in the interior—had abandoned their fields and villages in what is now Virginia. A tiny Indian reservation remains on the Pamunkey River near the original seat of Powhatan power.

Samuel Argall (1613) spotted "a great store of cattle as big as kine [cows]" that were "heavy" and "slow." From his description, what Argall must have seen were bison, a grassland indicator species. The explorer John Lederer (1672) prepared a map of his travels showing "savanae" throughout Virginia's western Piedmont. In the same area, the traveler Robert Beverley (1705) described "large Spots of Meadows and Savanna's, wherein are Hundreds of Acres without any Tree at all; but yield Reeds and Grass of incredible Height."

In the Dan River watershed, the surveyor William Byrd (1733) saw extensive areas "pretty bare of timber," including vast cane-breaks—a type of vegetation that needs frequent fire to flourish (Komarek 1974). Byrd's survey party found scattered bison and took the opportunity to kill one for food.

In the Shenandoah Valley, the traveler Robert Fallam (1671) found "brave meadows with grass about a man's height." John Fontaine (1716), who accompanied the expedition led by Virginia Governor Alexander Spotswood into the Shenandoah Valley, reported finding "the feeting of elks and buffaloes, and their beds," sure signs of grassland. George Washington surveyed parts of the Shenandoah Valley in 1752, after American Indians had disappeared from the area and their burning had ceased, but before extensive European settlement. He found many "barrens" with old burnt stumps and patches of hardwood saplings (Spurr 1951), signs that the prairie had once been burned to remove the trees and was now succeeding to forest.

To the south, localities in the upper James River watershed, such as Cowpasture and Calfpasture, reportedly took their names from the bison herds that once roamed the tallgrass prairie northward from the Cumberland Gap into the Shenandoah Valley (Fithian 1775). Bison reportedly once used a salt lick near present-day Roanoke, in southwestern Virginia, on their migrations through the Allegheniеs to the Piedmont (Haines 1970). Daniel Boone blazed the Wilderness Trail in 1769 on a well-trodden bison path through the Cumberland Gap, suggesting that grassland corridors once reached from southwestern Virginia into the Piedmont and Shenandoah Valley (fig. 1).

By using fire to improve browse and remove thickets, American Indians kept game animals concentrated on relatively open hunting grounds where they were easiest to find and kill.

Even coastal Virginia had patches of fire-maintained rangeland. "The country is full of wood in some parts," Henry Spelman (1613) reported, implying that there were other parts without forest. "[The Powhatans] have marish ground [marshland], and small fields for corn, and other grounds whereon their deer, goats [sic], and stags feedeth." Open areas such as old cropfields, periodically reburned to prevent forest succession, supported patches of shrubby habitat with "rank [plentiful] grass" for deer and elk (Spelman 1613). John Smith described one such area, where "all the woods for many an hundred mile for the most part grow sleight" (Arber 1910). Frequent burning would have been necessary to maintain such fire-stunted woodland.

Spelman's use of the term "their" to describe the game on the range maintained by the Powhatans suggests proprietorship. Wildland burning, including fire surrounds, took an investment of time and energy toward future hunting success. Groups therefore claimed and defended the areas they burned. For example, when John Smith once blundered into a Powhatan fire surround, he was promptly captured and the others in his party were killed (Smith 1608), even though the Powhatans generally tolerated the Jamestown colonists and often traded with Smith.

Fire-adapted species on the George Washington and Jefferson National Forests, VA. The endangered Peters Mountain mallow (left) requires fire for germination. Prescribed fire in Table Mountain pine–pitch pine forest (right) promotes pine regeneration by opening serotinous cones and suppressing competing vegetation. For thousands of years, such fire-adapted species flourished in Virginia despite a low incidence of lightning fires, suggesting that fire use by American Indians played a role in sustaining fire-adapted ecosystems. Photos: Steven Q. Croy, USDA Forest Service, George Washington and Jefferson National Forests, Roanoke, VA, 1995.

Travel. Colonial explorers discovered Virginia by ship or by following trails known to their American Indian guides. Most used trails leading up the major rivers from the coastal plain into the interior. Another set of trails, leading along the spine of the Blue Ridge and the branches of the Shenandoah River, connected to a network of regional trails (fig. 1) used by American Indians for trade and travel (Randolph 1973; Lambert 1989). The trails were maintained through fires kindled annually "by the Indians that happen to pass that way," according to William Byrd (1728). "They cannot travel but where the woods are burnt," John Smith (1624) noted.

In addition to using fire-maintained trails to reach specific destinations near and far, American Indians traversed Virginia's wildlands in search of game and edible plants. They routinely burned areas near their villages to help them find and gather food. Fire not only promoted game browse, but also reduced deadfall, leaf litter, and underbrush, facilitating passage and making it easier for hunters to spot and stalk their prey (Mellars 1976).

European explorers reported evidence of widespread grassland or savanna in two parts of Virginia—the Piedmont and the Shenandoah Valley.

How Did Burning Affect Ecosystems?

About 16,000 years ago, at the peak of the last ice age, Virginia was largely covered by tundra and jack pine forest (Davis 1981). As the ice sheet retreated, successive waves of temperate forest species invaded Virginia from the south and west. American Indians entered Virginia at least 11,500 years ago (Barber 1999), roughly coinciding with the rapid spread of oak into Virginia about 11,000 years ago (Davis 1981). By about 8,000 years ago, oak and pine dominated much of Virginia (Kneller and Peteet 1993; Maxwell and Davis 1972). The role of fire in oak and pine regeneration (Abrams 1992; Apfelbaum and Haney 1991; Barnes and Van Lear 1998; Brose and Van Lear 1998; Komarek 1974; Van Lear and Watt 1993; Whitney 1994; Williams 1998), coupled with the comparatively slow spread of such fire-intolerant species as beech and maple (Davis 1981), raises a question: Did Indian fire use during the Holocene (the last 10,500 years) help to shape the forest that colonists found in Virginia?

In a detailed study for the late Holocene (the past 3,900 years), Delcourt and Delcourt (1996, summarized by Barber 1999) found that Indian fire use in western North Carolina resulted in a changing mosaic of vegetation types that included fire-adapted species on some sites and fire-intolerant communities on others. Colonial accounts in Virginia suggest that Indian fire use had a similarly patchy pattern of impact on the land.

Forest Communities

Most of Virginia was wooded when the Jamestown colonists arrived. Many trees were enormous—Robert Beverley (1705) reported forest trees so large that they were free from branches up to 70 feet (21 m) above ground.

But the colonists did not report certain telltale signs of fire-free old growth. In undisturbed forests, as individual trees die from pests, disease, and windthrow, canopy openings result in patches of thick successional vegetation, and large quantities of leaf litter and deadfall accumulate. Such features are strikingly absent from most colonial accounts. "Thick[et]s there is few," Smith (1624) wrote, and Strachey (1612) observed that the forest floor was "clean" and "at least passable both for horse and foot." In 1634, Andrew White even claimed that forest trees near the Potomac River were "commonly so farre distant from each other as a coach and fower [four] horses may travel without molestation" (Frius 1971).

Indeed, colonial accounts describe remarkably open forests (Rostlund 1957). After discovering the area where "the savages" had been burning grass, George Percy (1607) and his party of Jamestown colonists "pass'd through excellent ground full of flowers…and as goodly trees as I have seen" into "a little plat of ground full of fine and beautiful strawberries," a mixed landscape of open forest and meadow. Members of the Spotswood expedition were able to travel upriver on horseback all the way to the Blue Ridge, then enjoy sweeping vistas from its crest (Fontaine 1716). By contrast, the density of Virginia's forests today prevents most horseback travel and blocks the view from almost every ridgetop.

In the absence of frequent lightning fires, presettlement Virginia's clean forest floors and open, varied landscapes were probably due to frequent fire use by American Indians. Underburning would have reduced the underbrush and debris, facilitating passage and promoting the abundant herbaceous cover that the colonists admired each spring. Herbaceous growth and edge habitat along fire-cleared openings would have multiplied such game species as deer and turkey (Komarek 1965; Mellars 1976; Whitney 1994). Increased light and heat in open areas would have favored dry-forest species such as oaks. Burning would also have affected interior forest recruitment, promoting the fire-resistant keystone species that dominate oak–hickory communities and are frequently mentioned in colonial accounts.

In addition to oak and hickory, the Jamestown colonists found abundant pine, enough to support a pitch and tar industry (Archer 1607b; Strachey 1612). Pines are successional species on Virginia's Coastal Plain; undisturbed stands succeed to hardwood forest within about 100 years (Komarek 1974; Monette and Ware 1983). The pine forests found by the Jamestown colonists were probably successional woodland on old cropfields or village sites cleared by fire.

On upland slopes and ridges throughout western Virginia, fire-dependent forests of pitch pine and Table Mountain pine were more common before European settlement than now (Williams 1998). Without fire, these forests succeed to oak on all but the most exposed sites. Regular burning on ridgetops by pre-Columbian travelers and hunting parties would have kept many western ridges and slopes under grass or open pine forest, with views of the valleys below.

Overall, American Indian fire use probably had a mixed impact on Virginia's forests, greatly affecting areas near villages, trails, and hunting grounds while scarcely touching areas that were uninhabited and little used (Clark and Royall 1996; Russell 1983). Of course, Indian fires would have burned deep into adjacent unused areas and might have occasionally climbed into the canopy to become high-severity crown fires that could have spread for miles. But in areas distant from human habitation and travel, such events might have been too sporadic to have had much long-term effect (Patterson and Sassaman 1988).

Even in well-populated areas, the impact of Indian fire use was probably uneven. Jamestown colonists reported many fire-intolerant hardwood species, including elm, ash, and beech. Presettlement landscapes near Indian villages probably supported a patchwork of communities ranging from moist forest assemblages on the wetter sites (perhaps similar in appearance to older bottomland or cove forests today) to relatively open, fire-maintained oak and pine forests on the drier sites, interspersed with patches of grassland.

Did Fire Keep Beech Out of the Canopy?

American beech is mentioned less often in early colonial accounts from Virginia than many other tree species, particularly oak. William Strachey (1612), for example, cataloged coastal Virginia's trees in detail, describing their utility for both the colonists and the American Indians. He listed oak, elm, ash, walnut (including hickory*), cypress, cedar, sassafras, pines, and even wild rose, but did not mention beech. John Smith (1624) wrote that the "woods that are most common are oak and walnut [hickory]," then listed a number of other species that did not include beech.

One study has suggested that undisturbed stands of pine on Virginia's Coastal Plain succeed first to oak forest and finally to forest dominated or codominated by beech (Monette and Ware 1983). In the absence of fire and other disturbances, oak is known to give way to shade-tolerant species such as beech and maple on many sites in the eastern temperate forest (Barnes and Van Lear 1998; Brose and Van Lear 1998; Olson 1996; Van Lear and Watt 1993; Whitney 1994). If beech was at least as important as oak in Virginia's presettlement forest canopy, then why did colonial accounts seem to ignore it?

One reason might be American Indian underburning. Beech is slow growing and thin barked, vulnerable to fire. Frequent fire would have suppressed beech in favor of more fire-resistant species such as oak (Barnes and Van Lear 1998; Van Lear and Watt 1993). If presettlement underburning prevented beech from becoming widely established in the forest canopy, then pine and oak–hickory forests would have predominated and the colonists would not have reported extensive beech.

* Europe has no native hickories (*Carya* spp.). The early colonists classified hickory as a type of walnut (it does belong to the walnut family).

Prairie and Savanna

Early explorers were awed by the expanses of grassland they found in some parts of Virginia, especially in the Shenandoah Valley. In the Piedmont, dry oak–hickory forest in the rain shadow of the Blue Ridge likely opened into patches of savanna or grassland covering hundreds of acres. West of the Blue Ridge, a fire-maintained tallgrass prairie probably blanketed some valley floors, bordered by forest and interspersed with groves of trees in the wetter areas. After the American Indians stopped burning, the large grassland herbivores disappeared from all of these areas, which promptly sprouted trees. In 1733, for example, William Byrd's survey party in the Dan River watershed found abandoned, overgrown Indian village sites; a few scattered bison; and miles of "young saplings, consisting of oak, hickory and sassafras" (Byrd 1733), signs of grassland succeeding to forest.

In a letter to John Adams, Thomas Jefferson (1813) observed that American Indian fire use "is the most probable cause of the origin and extension of the vast prairies in the western country, where the grass having been of extraordinary luxuriance, has made a conflagration sufficient to kill even the old as well as the young timber." Jefferson was only partly right: The midwestern prairie peninsula extending from Illinois into Ohio is often attributed to the period known as the Hypsithermal Interval (about 7,300 to 3,900 years ago) (Wilkins et al. 1991) or to the dry air masses from the base of the Rocky Mountains that still bring drought to the Midwest (Whitney 1994). However, trees rapidly grew all over the midwestern prairie soon after European settlement, suggesting that Indian fire use played a role in maintaining the midwestern grasslands (Pyne 1982).

It seems doubtful that grasslands in Virginia could have had a similar climatic origin. Wilkins et al. (1991) have shown that the Big Barrens of Kentucky, a grassland outlier of the midwestern prairie peninsula, formed only after the Hypsithermal Interval, possibly as a direct result of Indian fire use. Moreover, the effects of dry air from the Great Plains are minimal in Virginia (Whitney 1994). In recent millennia, Virginia's climate has been too moist and natural fire too rare to sustain prairie or savanna. The prairie in Virginia's mountain valleys and the open woodland in the western Piedmont were probably formed and almost certainly maintained through seasonal burning by American Indians to promote browse for bison and elk.

A Legacy of Fire

The Jamestown colony was founded on the myth that Virginia was, as John Smith (1624) put it, "a plain wilderness as God first made it." The wilderness myth persists to this day in the notion that the East was once covered by a primeval forest that a squirrel could have crossed "from bough to bough for a thousand miles and never have seen a flicker of sunshine on the ground" (Adams 1931).

That squirrel must have taken a tortuous route across Virginia's checkered landscape. Studies suggest a similarly varied landscape, including broad swathes of grassland and savanna, in other Eastern States (Day 1953; Rostlund 1957; Pyne 1982; Patterson and Sassaman 1988; Whitney 1994). In addition to grasslands, the ecosystem mosaic probably included large areas of successional woodland maintained through burning techniques that were likely as effective as any we know today.

Of course, any conclusion based on the limited evidence of historical accounts alone must remain hypothetical. Still, accounts by early European settlers and travelers, coupled with what we know about Virginia's climate in recent millennia, consistently point to one conclusion: that at least some of Virginia's ecosystems evolved with, and depended on, frequent burning by American Indians. Shaped and maintained to make the land livable, such ecosystems should not be confused with wilderness. Instead, they should be treated as what they were—a cultural imprint left on the land by Virginia's first inhabitants.

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First Peoples First in Fire Shelter Use*

American Indians, though skilled in the use of fire, were occasionally entrapped by wildland fires. Meriwether Lewis and William Clark witnessed one such incident on their historic expedition from St. Louis, MO, to the mouth of the Columbia River. On October 28, 1804, a prairie fire near a Mandan village north of present-day Bismarck, ND, overran several people. As Clark testified in his journal, a boy survived under a fresh bison hide—perhaps the first recorded use of a fire shelter.

The Prarie was Set on fire (or cought by accident) by a young man of the Mandins, the fire went with such velocity that it burnt to death a man & woman, who Could not get to any place of Safty, one man a woman & Child much burnt and Several narrowly escaped the flame. a boy half white was saved unhurt in the midst of the flaim, Those ignerent people say this boy was Saved by the Great Medison Speret because he was white. The couse of his being Saved was a Green buffalow Skin was thrown over him by his mother who perhaps had more fore Sight for the pertection of her Son, and [l]ess for herself than those who escaped the flame, the Fire did not burn under the Skin leaveing the grass round the boy. This fire passed our Camp last [night] about 8 oClock P.M. it went with great rapitidity and looked Tremendious

* From Bernard DeVoto, ed., *The Journals of Lewis and Clark* (Boston and New York: Houghton Mifflin Company, 1997 [1953]), p. 60.

Reintroducing Indian-Type Fire: Implications for Land Managers

Gerald W. Williams

Today, many Federal and some State forests are being ravaged by insects and diseases and are prone to catastrophic wildland fires. Over the decades, foresters have found that eliminating fire from fire-adapted forests does not restore them to pristine parklands and primeval wilderness (where "man is but a visitor"). Instead, removing fire usually creates an environment or ecosystem that has never before existed (Pyne 1995; Schiff 1962).

> Removing American Indians from the land effectively ended wildland burning practices that had lasted for millennia.

What Is Indian-Type Fire?

Reintroducing Indian-type fire is not the same as allowing lightning-caused fires to burn or applying prescribed fire for fuels management. Lightning-caused fires usually start in late summer or early fall, when temperatures are high and humidity is low; by contrast, American Indians usually burned when fuel and other conditions permitted controllable, low-intensity fires, often in spring or late fall. Prescribed fire for fuels reduction, usually in combination with clearcutting, selection harvesting, thinning, grazing, or even raking and piling of fuels, has a different, more uniform character and purpose than Indian-type burning.

Indian-type fire is intensive land management, where not every area is treated at the same time in the same way. The idea is to create a mosaic of forests and grasslands, not monocultures. The result is a combination of open prairie or savanna, shrubland, young trees, mature stands, and old-growth forest.

Degraded Ecosystems

Federal foresters at the turn of the 20th century, under the guise of "scientific forestry," firmly believed that their mission was to save wild nature (Langston 1995). But many presettlement ecosystems were hardly natural. As Nancy Langston (1995) has noted, "[American] Indians had been changing those lands for millennia, reshaping them according to their needs and desires." The primary tool Indians used to reshape ecosystems was fire. White settlers, according to Langston, "hated the fires that swept through the mountains, and usually saw the Indian burning practices as threatening the open [ponderosa] pine [*Pinus ponderosa*] forests they loved. They failed to realize that excluding fire would lead to the demise of what they liked most about the forest."

Removing American Indians from the land, whether directly through warfare or indirectly through relocation to reservations, effectively ended wildland burning practices that had lasted for millennia, even on the reservations. The result was a striking transformation of America's forestland (Botkin 1990; Gruell 1985; Wilson 1992). "English settlers recorded a marked shift in the forest vegetation after the Indians retreated farther west," observed Samuel Wilson (1992). "At first the forest [in the East] was described as 'parklands,' with little vegetation at ground level. After the Indians died or moved away, the Europeans began to describe the forest as dense and scrubby, with impenetrable thickets of vegetation beneath the woodland canopy."

Western landscapes underwent a similar transformation following the removal of Indian populations and their fire. In 1897, the Oregon pioneer John Minto described how the oak forests and open prairies of Oregon's Willamette Valley had changed (Williams and Mark 1995). Much of the land, Minto said, was originally unforested, kept open "by grass fires, set by the native [Indian] race." The last large fires in Oregon's mountains were also "set out, I believe, by the

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The Forest Service and Bureau of Land Management together administer several hundred million acres of grassland and other grazing land where Indian burning techniques can and should be used.

Indian-Type Fire on the Reservations

Somewhat ironically, most American Indian tribes have come to manage the forests on their reservations—some 17.1 million acres (6.9 million ha), primarily in the West and Southwest—in the same way as most other forest owners, as potential income from timber sales. Accordingly, they have traditionally suppressed fires swiftly and at any cost.

But the attitude on the reservations is changing. Tribal foresters and ecologists are now using prescribed fire to reduce fuel accumulations, change species composition, and manage vegetation structure and density for healthier forests and rangelands. In the 1990's, tribal forests used prescribed fire to treat about 55,000 acres (22,000 ha) annually—about 20 percent of the estimated 300,000 acres (121,000 ha) that could benefit from periodic controlled fire (Haglund 1998). Other forestland on reservations is considered unsuitable for prescribed burning due to air quality concerns or excess fuel accumulations.

Indians." Now, said Minto, "tens of thousands of acres of what was open land 50 years ago grew into dense forests," such that "there is a greater area in Oregon of timber growth today than there was 50 years ago."

Secretary of the Interior Bruce Babbitt (1997) illustrated the growing problem for Federal land managers with an example from Idaho's Sawtooth Mountains, where "the pre-settlement mosaic of young and old stands of mixed species has mutated into a solid, uniformly older, and highly explosive lodgepole [*Pinus contorta*] forest." The weakened trees were more susceptible to insects, disease, and conflagrations. How did this happen? The answer, said Babbit, is inscribed in the ancient ponderosa pines through their annual growth rings. The rings show that light, nonlethal surface fires swept through the open forest every 7 to 10 years until the 1890's. After that, the telltale black smudges disappear. "Ninety rings ago," Babbitt concluded, "when fire exclusion became the mission of the newborn [USDA] Forest Service, the number of ponderosas per acre had doubled."

Is Restoring Fire the Answer?

Reintroducing fire to the land in ways that emulate the past practices of American Indians, on its face, sounds both interesting and timely (Saveland 1995). But the idea has skeptics. Portions of a public raised on Smokey Bear might resist a notion so seemingly at odds with decades of promotions against careless fire use. Others would surely regard the reintroduction of fire as a waste of a valuable resource (trees). Still others, of course, would welcome the idea as a long-overdue prescription for saving the Nation's forests.

Unfortunately, using Indian-type fire is no cure-all for what ails our Nation's forests. Research increasingly shows that nurturing a "friendly flame" through small fires in the underbrush will not suffice to solve the problem of wildland fuel buildups. During the "disastrous" fire season of 1994, for example, when about 3.3 million acres (1.3 million ha) burned in the Western United States, the acreage burned was not nearly enough from an ecological perspective. "Intense and wide-ranging fires," George Wuerthner (1995) observed, "at times may in fact be necessary for ecosystem health and forest regeneration."

Land managers face a critical policy problem. The intense blazes necessary for rapid fuel removal—and for some ecosystem processes—occur only under severe fire conditions. "Yet, as a matter of policy," noted Wuerthner (1995), "most [Federal and State] agencies call for fire suppression under these extreme conditions."

However, the use of Indian-type low-intensity fire is certainly part of the answer. In the 1990's, land managers found that prescribed fire, if carefully managed, can yield excellent results by reducing fuel loads, burning out the underbrush that can choke new trees, and stimulating new seed production and natural regeneration. The Forest Service and USDI Bureau of Land Management together administer several hundred million acres of grassland and other grazing land, where Indian burning techniques can and should be used. Several Western States have hundreds of thousands of acres of State forestlands that could also benefit from Indian-type fire use. Of course, large industrial landowners will continue to manage their forests for maximum fiber production, probably excluding most fire. But private woodlot owners might be motivated to use fire or similar techniques approved by their State forestry departments to improve their wildland resources.

Restoration Challenges

Sound practices for restoring ecosystems or improving forest health, including the use of fire, are predicated on careful plans. In planning, land managers should consider the difficulties inherent in restoring a past "natural" condition. Basic questions about the role of people in ecosystem management have no easy answers. Moreover, it is far from clear what restoring "natural" conditions means.

Is the goal to restore ecosystems as they were 25, 50, or 100 years ago, during the settlement and modern periods? Or does restoration mean returning to presettlement conditions during the golden age of the fur trappers, some 150 to 300 years ago? Or should we return to the pre-Columbian era before 1492, or

Objections to Indian-Type Fire Use

Not all fire researchers and managers agree that land managers should simulate Indian burning. In a survey of wildland fire experts from around the country, Bruce Kilgore (1985) found eight basic objections to reintroducing aboriginal-type fire. Each objection below is followed by a counterargument.

1. *It has not been demonstrated that Indian burning played a significant role in altering forest ecosystems.*

Indian fires were utilized extensively in almost every locality or ecosystem of North America, although not every area was burned.

2. *We will never have sufficiently accurate data to understand the extent, seasonality, and intensity of Indian fires.*

Accurate data are lacking for every area, but we do know quite a lot about the extent or location of fires, intensities, timing or seasons of burning, and frequency of fires.

3. *We do not simulate other factors that have changed—extirpated plants and animals, Indian hunting, and Pleistocene glaciers.*

Other ecosystem components (such as wolves in Yellowstone) are being considered for reintroduction, just like fire.

4. *Lightning fires were a major source of fire for millions of years, yet the Indians have only been in North America a short time—minor in evolutionary or ecological terms.*

Lightning caused fewer fires in the forests and especially the prairies than previously thought. Moreover, because Indians routinely burned many areas of forest and underbrush, lightning fires had less chance to have a major impact than today.

5. *Simulating past Indian burning would amount to preserving an artifact; ecosystems must be free to evolve.*

Most North American ecosystems have coexisted with fire for millennia. By simulating Indian burning, we are striving to maintain these ecosystems.

6. *What is our goal? Do we want to restore processes that existed before Europeans arrived or before all human beings arrived?*

The goal is to revive fire regimes to produce healthier, fire-adapted, resilient ecosystems.

7. *In some areas, frequent Indian fires and lightning fires have the same impact on vegetation.*

Lightning does not usually cause fires at the same time of year as do human-caused fires. Moreover, lightning fires are hotter and very difficult to control, whereas Indian-type fires are cooler and relatively easy to control.

8. *We have come too far to expect society to accept simulated Indian fires in parks and wilderness areas.*

Using Indian-type fires might be the only way to prevent potentially catastrophic wildland fires (such as in Yellowstone National Park in 1988), prevent insect and disease outbreaks, and restore ecosystems. The biggest problem with reintroducing Indian-type fire on a regular basis will be getting the public to accept the smoke.

In planning, land managers should consider the difficulties inherent in restoring a past "natural" condition.

perhaps even to conditions that existed before humans arrived in North America, some 12,000 to 30,000 years ago? Depending on the target era chosen, restoration requirements will vary greatly (Flores 1997; Forney 1993).

Indeed, attempting to restore conditions to what they once were might seem futile. As Nancy Langston (1995) observed, "After we interfere with a [forest] community, that community's history proceeds along paths quite different from those it would have taken without our interference….We cannot simply backtrack to a time before some particular decision we now regret, because so many additional changes have radiated out from that original action." Restoring ecosystems to an arbitrarily chosen past "natural" condition would mean eliminating decades, centuries, or even millennia of human impacts, a difficult if not impossible task. As Emily Russell (1997) put it, "We cannot assume that just because active management has ceased, some preexisting 'natural' community will reassert itself. Even the eliminating of non-native species or the reintroducing of native and natural processes cannot erase the effects of centuries or even millennia of human impact."

Management Responsibility

Abdicating management responsibility to let "nature" do its work—through lightning-caused fires, floods, disease, and insect outbreaks—is not a realistic option. If an area is ready to burn, it makes little difference whether the fire is ignited by lightning or by management, as long as the outcome enhances ecosystem functions. "Management issues of this kind involve judgment, followed by action," Starker Leopold observed (Kilgore 1985). "They are not resolved simply by allowing natural ecosystem processes to operate."

Moreover, if Federal land managers choose a presettlement or pre-Columbian landscape as the "natural" condition to strive for, the American Indian presence in the landscape will still be lost forever. "Re-creating the vegetation at the time of European discovery," Stephen Pyne (1995) noted, "or preserving select natural processes does not re-create the historic wilderness experience because the most critical element, the encounter with humans, many hostile, all alien, is gone." Pyne argues that to restore "natural" conditions without the Indians and the things they did, including burning, is to construct an artificial landscape that is historically and ecologically incomplete.

Range of Variability

Similar problems apply to the concept "range of natural variability" (Flores 1997; Forney 1993; Kilgore 1985; Pyne 1995; Shrader-Frechette and McCoy 1995). How far back do we go in measuring the range of variability? Do we even know the exact abundance and range of flora and fauna at any given point in time? Even if we do know, how can we recreate ecosystems that can sustain them?

Most ecosystem restoration efforts today—at least on the Federal lands that dominate the West—rely on the range of variability, documented through extensive

Where Do People Fit Into Ecosystems?

Reintroducing fire poses difficult questions about the fundamental role of people in ecosystems:

- Are ecosystems natural or human constructs?
- Are humans part of ecosystems?
- How many years does it take for humans (such as the original American Indian immigrants) to be considered a natural, native part of ecosystems?
- Should we address ecosystems and their many components without considering people?
- Are humans the problem or the solution in ecosystems? Should humans be excluded from ecosystems or is management by people the answer?
- When we restore or preserve ecosystems, what are we doing it for? Who is asking us to restore or preserve ecosystems (the plants, the animals, or people)?
- Should we include our knowledge of past human impacts on ecosystems in future ecosystem management?

research efforts, to assess current forest health. Knowing the range can give managers some idea of how to better manage the flora and fauna on the land. However, restoration of ecosystems, especially those that are or were fire dependent for thousands of years, is not easy. It will take work, time, and money.

Managers and specialists have many opportunities to research fire-adapted ecosystems to determine historical conditions. The first step is to discover an area's fire history by documenting the "original" vegetation and any changes over the last 150 to 250 years (Seklecki et al. 1996). This might involve digging into old books and archives, field survey notes by the Bureau of Land Management (known until 1946 as the General Land Office), forest surveys by the U.S. Geological Survey, and other repositories of land and vegetation data. After an extensive paper/map investigation, the next step is to talk to or interview older residents and American Indian tribal elders on how they manage or managed the land. After compiling the preliminary data, there is still the final step of interpreting the results. Fire history, as Clinton Phillips (1985) explained, can be "difficult to interpret because of continual past changes in the fire environment and the overlapping effects of natural fires, Indian fires, and other fires….[M]anagers must use extreme care in translating the information into current fire management programs."

Support for Fire Use

The Federal land management agencies currently support ecologically based (ecosystem) management. Ecosystem restoration in the interior Pacific Northwest is a national management priority, as draft environmental impact statements for the Interior Columbia Basin Ecosystem Management Project show. For multiple reasons, thinning, prescribed burning, and reintroducing Indian-type fires are important components of many restoration strategies. Jim

> Abdicating management responsibility to let "nature" do its work—through lightning-caused fires, floods, disease, and insect outbreaks—is not a realistic option.

Prescribed fire site during (above) and after (below) a burn to promote turkey brood habitat on the George Washington and Jefferson National Forests, VA. Many eastern ridgetops were burned by American Indians to clear trails for travel and improve browse for game. Photos: Steven Q. Croy, USDA Forest Service, George Washington and Jefferson National Forests, Roanoke, VA, 1995.

Reasons for Using Fire

Ffolliott et al. (1996) and Wuerthner (1995) have noted a number of benefits from fire in montane forests, woodland ecosystems, and desert shrub and grassland communities.

- ***Reducing fuel loads.*** Periodic prescribed fires can reduce ground fuel loading, but managers must be careful not to create a fire that will kill existing trees (unless that is a goal).
- ***Disposing of slash.*** Piling and burning slash from timber harvest greatly reduces the threat from wildland fire and removes breeding places for insect pests and disease.
- ***Preparing for replanting.*** Burning helps prepare the soil for planting seedlings or tree seeds by reducing leaf litter, slash, and downed woody material, as well as grasses and shrubs. But managers must ensure that the fire is not too hot, that potential seed trees are not killed, and that the mineral soil is exposed for planting. Some trees and plants, including giant sequoia, lodgepole pine, and quaking aspen, require periodic fires to germinate seedlings.
- ***Thinning stands.*** Fire can be used to thin overstocked, stagnated, diseased, or insect-infested forest stands. Burning can be a low-cost and effective method to reduce stand density, releasing survivors from competition and creating vigorous trees. However, fires can kill too many trees or leave others so badly scorched that they might take years to recover.
- ***Increasing plant growth.*** Fire use can enhance certain plant growth. Fire can reduce soil pathogens, increase soil fertility by recycling nutrients from burned vegetation, and invigorate remaining plants by releasing roots and foliage from competition. In addition, the removal of tree litter and shrubs often promotes desirable, fire-adapted species. Timing of the burns is critical—spring, summer, fall, or even winter might be best for particular species.
- ***Improving wildlife and fish habitat.*** Fire use can enhance or reduce food and cover for wildlife and fish for years after a burn. For example, fires produce snags for cavity-dwelling species and deadfall in streams for fish and aquatic-insect habitat. Yet very different strategies and fire outcomes might be needed for different types of wildlife resources, such as large open areas, small dense stands, and repeated fires.
- ***Changing hydrologic processes.*** Fire reduces litter that can prevent moisture from reaching tree roots, allowing some nutrients to more quickly enter the soil. But runoff from a burn site will often increase, carrying away some nutrients; and heavy rains or snowmelt in burned watersheds can adversely affect soil stability for years.
- ***Improving aesthetic environments.*** Fire use can help keep a forest open and parklike, and it can protect people and property from wildland fires. However, the public often perceives the actual fires and their immediate aftermath as detrimental.

Saveland (1985), a Forest Service fire ecologist, has recommended that "disturbance ecology in general and the use of prescribed fire in particular be considered core competencies of the agency [Forest Service]."

In the 1990's, support for fire use on Federal lands grew dramatically. Secretary of the Interior Bruce Babbitt repeatedly reiterated his strong support for prescribed fire on the Federal forests and grasslands. In 1995, the Federal land management agencies adopted a new interagency wildland fire policy (Federal Wildland Policy 1995) that promotes the use of fire to meet wildland resource objectives. In the same year, the Forest Service set a goal of burning 3 million (1.2 million ha) acres annually by the year 2005 (F&AM 1995). By 1998, prescribed burn acreage on Forest Service lands had soared from the previous annual average of 385,000 acres (156,000 ha) to 1.25 million acres (500,000 ha) (Bunnell 1998).

Unresolved Issues

Costs. Prescribed fire management to restore a forest or watershed to its condition in, say, the mid-18th century would not be cheap. Depending on the site, such a project would require extensive prework, multiple burns, and careful monitoring and control. Fire use always entails a risk that the fire will escape, and the concomitant risk to human life and property must be considered in the overall plan. Moreover, prescribed fire inevitably stirs ingrained public fears. "It's one thing to sell the idea of using carefully tended, intentionally set fires or allowing certain wildfires to burn as a forest-rejuvenating force in the abstract," remarked an editorial in

The Missoulian (Editor 1998), "but people often tend to react emotionally when the flames kick up."

Smoke. Smoke in the atmosphere is a growing problem for land managers and landowners. Under the Clean Air Act, the Environmental Protection Agency is committed to keeping the air as clean and pure as possible for human health. Also, smoke can reduce visibility many miles away from its source, diminishing the quality of scenic views (Federal Wildland Policy 1995; Potter and Fox 1996). Smoke is managed by minimizing its generation and by dispersing it in the atmosphere. The preferred method, minimizing smoke production, is difficult because it often conflicts with other fire management objectives (Potter and Fox 1996). The threat to health from smoke in the atmosphere, combined with the need to preserve scenic quality in class I airsheds over national parks and most wilderness areas (National Academy of Sciences 1993), might be the most serious obstacle to reintroducing Indian-type fires in ecosystems.

Soil Nutrients. Prescribed fires, like wildland fires, can affect the quantity of nutrients in the soil. Very hot fires can reduce soil productivity by eliminating nutrients and by killing many of the microorganisms necessary for nutrient cycling. Even relatively cool Indian-type fires can affect nutrient cycling. In addition, according to new ecosystem guidelines for the Forest Service and Bureau of Land Management, downed woody material should be conserved on forest sites to promote nutrient cycling. But woody debris sometimes breeds insects and diseases that can devastate standing trees, and it can also form a potentially dangerous fuel load (Potter and Fox 1996).

Fuel Load. In some forests, decades of fire exclusion, coupled with drought, insects, and disease, have built up heavy fuel loads. In

Smoke lingering over national forestland. Smoke in the atmosphere is a growing problem for land managers and landowners, endangering health and reducing the quality of scenic vistas. Photo: USDA Forest Service, 1992.

Bruce Babbitt on Reintroducing Fire*

…To restore health, character, and structure to our forests, then, the obvious first step is to bring back their own ancient predator: wildland fire.…

Where forests are crowded with homes, we must continue to keep fire out. Where the public worries at smoke and flame, we must explain and prepare them for this progression in our stewardship values. At the root of the recent [catastrophic wildland fire] infernos lies a basic yet overlooked truth: We don't have a "fire problem" in the West. We have a fuels problem.…

We once thought all fire was evil. Now some think all fire is good. But that simple mind set doesn't work. Fire is neither good nor evil; it is a part of the natural process of change, a tool, a complex force that can be used to meet restoration goals.…

It is now time to take the same approach to the restoration of forest ecosystem health.…[A]t the Federal level, we must integrate fuels management with suppression funds.…And Congress, in turn, needs the support of the voters who elected them. So I challenge you, the American people, to recognize how fire and smoke—rising from the ashes like the mythical phoenix—can and must continue to play an essential, natural role in the life cycle of the wildlands we live in and love.

* From a 1997 speech by Secretary of the Interior Bruce Babbitt (see Babbitt 1997).

stands where various tree species and age classes intermix, a combination of fuels ranging from duff to shrubs to small trees can form a "ladder" that a fire can quickly climb from the ground into the canopy, turning a low-intensity surface burn into a raging canopy fire. Reducing ladder fuels is difficult and very expensive.

Silvicultural Techniques. Silvicultural techniques such as thinning can be used to remove unwanted trees and debris from the forest floor, making a stand less susceptible to catastrophic wildland fire. However, such methods do not have the same long-term ecological impacts as Indian-type fires. Moreover, they are neither easy to plan nor cheap.

Combination of Methods. Foresters today often use silvicultural techniques to remove unwanted or overgrown vegetation, then reintroduce Indian-type fire (Devlin 1998; Eskew 1995; Federal Wildland Policy 1995; Shindler 1997). As the American Indians found out centuries ago, low-intensity fires can reduce unwanted vegetation and fuels, combat insects, and kill diseased trees before they become transmission agents.

But Indian-type fires also accomplish much more. After fires are restored, the forests and grasslands will have a much different look. As Jim Saveland (1995) explained, "I see open stands of large pine trees (for example, longleaf pine [*Pinus palustris*] in the southern Coastal Plain, ponderosa pine in the West), lush native bunchgrasses, and a carpet of wildflowers. There are clumps of regeneration. I smell the pine and wildflowers. I hear the birds—songbirds, hummingbirds, woodpeckers, and raptors. There is a great diversity of life, especially in the understory. The midstory is sparse. If I look closely, I can see evidence of 'no trace' logging. Fire is an integral part of this forest."

The Future of Indian-Type Fire

On millions of acres of Federal forestland, the reintroduction of Indian-type fire is a distinct possibility. After decades of fire exclusion, fuel buildups on many of our Nation's forests have set the stage for catastrophic wildland fires. Under these conditions, we cannot simply let nature run its course. Lives, property, and wildland values are at stake for generations to come.

The basis for much of today's forest health crisis lies in the cessation of the Indian burning that once sustained vast ecosystems nationwide. Although we have the ability to change our management, fundamental questions remain: What do we want to change and why? Are we actually "improving" or "protecting" the forests? Or are we being just as arbitrary and capricious as past land managers?

A first step might be to agree that healthy forests and grasslands at all scales support multiple habitats, including open, prairielike conditions; areas of shrubs and young trees; mature stands; and old growth. The next step is to work to include the public in our vision for our Nation's wildlands. It

Restoring Ponderosa Pine Forest*

An ambitious plan is under way on the Missoula Ranger District, Lolo National Forest, MT, to restore a degraded ponderosa pine forest. Eighty years of fire exclusion have radically changed the ecosystem. Douglas-firs fill the spaces between the big pines and western larch, making the forest resemble a thicket.

Ironically, the only way to save the old growth now is to log the mountainside timber stands, taking out the Douglas-fir and leaving the pine and larch, whether living or dead. After giving the big trees the space they need, low-intensity fire will be reintroduced. "If we want to grow old trees," said Mike Hillis, a wildlife biologist for the Lolo National Forest, "if we want to grow deer and elk, we have to let fire back into the forest."

It will be difficult to put fire, insects, disease, and windthrow—each of which have a place in the forest—back into balance. "Historically, these were processes that happened a little bit at a time," said District Ranger Dave Stack. "We can't just put fire back into the thicket, or we'll lose everything. It will burn so hot and fast, we won't be able to stop it." Before fire can be reintroduced, the trees must be thinned. "It's going to take a long time," observed Stack, "longer probably than the 80 years it took us to get here." "But we've got to at least get the mechanism started," said Hillis. "Or we will lose it altogether."

* Based on Devlin (1998).

will not be easy, not everyone will agree, and it will be expensive. But it will be worth it to work toward a time when, as Jim Saveland (1995) has put it, we "once again steal fire from the mountain gods and through a great relay, bring fire and the message of disturbance ecology back to the modern-day people of the world. And perhaps one day, the Phoenix will replace Smokey Bear as the de facto symbol of the Forest Service."

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New Automated System for Tracking Federal Excess Personal Property

Roberta Burzynski, Jan Polasky, and Diana Grayson

The USDA Forest Service has developed a new automated system for States to use in tracking vehicles, parts, and other equipment received through the Federal Excess Personal Property (FEPP) Program. The Federal Excess Property Management Information System (FEPMIS) will reduce errors and slash paperwork by eliminating the need to repeatedly enter the same information at different points in the property management process. The interactive data base will allow sharing of the data needed to acquire, use, track, manage, and dispose of property by more than a thousand users throughout the United States and its territories.

FEPMIS will reduce errors and slash paperwork by eliminating the need to repeat information at different points in the property management process.

Advantages

One of the key features of FEPMIS is flexibility. Each State can decide, based on the size and extent of its fire management organization, how many levels will have access to the data base. For example, California is expected to set up its system differently from Delaware. A State can have two users manage its whole program, or it can give access to any combination of additional levels, such as district, station, or local unit.

Users at the highest level can perform all functions, and those at lower levels have designated access that is limited by system security. Information entered at any level updates the central data base so that the same information will not need to be entered again.

Capabilities

Participants in the FEPP Program can use FEPMIS to acquire Federal excess personal property, track property after it is in their possession, and then return it to the Forest Service for disposal.

Acquiring Property. From the time a local user requests specific property, FEPMIS builds a property file that is viewed, updated, and employed by subsequent users to approve, acquire, receive, and distribute the property.

Tracking Property. After a local unit has property in its possession, FEPMIS automates inventory, biennial reconciliation with Federal records, and annual reports to Congress. Some standard reports are built into the system, and a variety of others can be generated. FEPMIS accommodates approvals for and modifications to property, such as cannibalizing and installing in other vehicles. The system also has built-in reminders, for example, that a document is still open, that an inventory is due, or that a cooperative agreement under which property was loaned needs to be renewed.

Disposing of Property. When property is no longer useful to the borrowing unit, FEPMIS compiles the history of the property, with all the information needed by the Forest Service to make it available to other units or to dispose of it. States report all excess property to the Forest Service to determine the method of disposal. FEPMIS then documents the physical disposal and simplifies Forest Service accounting through a link to the National Finance Center.

Providing Online Help. Through an electronic link to the FEPP Desk Guide, which is posted on the Internet, FEPMIS puts help at the user's fingertips.

Software and Hardware

FEPMIS is an application developed using commercially available Oracle Lite* software. The system

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FEPMIS can be used to acquire Federal excess personal property, track the property, and then return the property for disposal.

was inspired by a design prepared by William Hale at the Missouri Department of Conservation. The Forest Service developed the prototype for FEPMIS under a cooperative agreement with the U.S. Army Information Systems Software Development Center in Fort Lee, VA. IBM will finalize the system. Jan Polasky managed the system development project.

States will supply their own hardware. Requirements are at least a 486-speed processor and Windows 95. The Forest Service will provide each State with five copies of Oracle Lite.

FEPMIS will have a central data base server accessible via the World Wide Web. Users can work either directly in the data base via the Web or offline on a PC. When a user is finished working in FEPMIS on a PC, logging onto the Web or dialing an 800 number will synchronize data in the data base and on the PC.

Implementation

User training begins in fall 2000 and is being conducted by a nationwide Forest Service team—the same team that reviewed the system before field testing in Missouri and Pennsylvania in summer 2000. Implementation of the system will start with the State Foresters and proceed through consecutively lower organizational levels. By spring 2001, all users should be on board.

Setup will be fast and easy. After the Forest Service enters names into the user data table, users need only enter some additional identifying information to begin using the system. The Forest Service will maintain the data table of users, which identifies level of access, in the central data base.

Potential for Expansion

Two additions to FEPMIS are planned. The ability to scan bar codes will further simplify acquiring, managing, and inventorying property. A link to the General Services Administration will allow users to request a piece of property and receive data for insertion directly into the property record.

For more information on FEPMIS, contact April Baily, FEPP National Program Officer, USDA Forest Service, Fire and Aviation Management, Washington, DC, 202-205-0891 (voice), abaily@fs.fed.us (e-mail).

Acknowledgment

The authors thank Beverly Duplessie, property disposal specialist, USDA Forest Service, Northeastern Area State and Private Forestry, Newtown Square, PA, for reviewing the manuscript.

About the FEPP Program

The Federal Excess Personal Property (FEPP) Program loans, without charge, equipment that is no longer needed by the Federal Government (usually the military) to States and communities for fire protection. Equipment most often loaned includes trucks that can be converted to engines, as well as generators, pumps, fire hoses, breathing apparatus, and protective clothing. State Foresters and local fire departments that use the equipment pay only the costs of transporting, converting, and maintaining it. When no longer needed or usable, the equipment is returned to the USDA Forest Service for disposal. The Forest Service administers the FEPP Program in cooperation with the State Foresters, who in turn maintain agreements with rural fire departments.

Photo Contest for 2001

Fire Management Today invites you to submit your best fire-related photos to be judged in our annual competition. Winners in each category will receive awards (first place—camera equipment worth $300 and a 16- by 20-inch framed copy of your photo; second place—an 11- by 14-inch framed copy of your photo; third place—an 8- by 10-inch framed copy of your photo). Winning photos will appear in an issue of *Fire Management Today*. All contestants will receive a CD–ROM with all photos evaluated in the competition.

Categories

- Wildland fire
- Prescribed fire
- Wildland-urban interface fire
- Aerial resources
- Ground resources
- Miscellaneous (fire effects; fire weather; fire-dependent communities or species; etc.)

Rules

- The contest is open to everyone. You may submit an unlimited number of entries from any place or time, but for each photo, you must indicate only one competition category.
- Each photo must be an ***original color slide***. We are not responsible for photos lost or damaged, and photos submitted will not be returned (so make a duplicate before submission).
- You must own the rights to the photo, and the photo must not have been published prior to submission.
- For every photo you submit, you must give a detailed caption (including, for example, name, location, and date of the fire; names of any people and/or their job descriptions; and descriptions of any vegetation and/or wildlife).
- You must complete and sign a statement granting rights to use your photo(s) to the USDA Forest Service (see sample statement below). Include your full name, agency or institutional affiliation (if any), address, and telephone number.
- Photos are judged by a photography professional whose decision is final.
- Photos will be eliminated from competition if they lack detailed captions; have date stamps; show unsafe firefighting practices (unless that is their express purpose); or are of low technical quality (for example, have soft focus or show camera movement). (Duplicates—including most overlays and other composites—have soft focus and will be eliminated.)

Postmark Deadline

March 2, 2001

Send submissions to:

USDA Forest Service
Attn: Hutch Brown
Editor, *Fire Management Today*
USDA Forest Service
Office of Communication
P.O. Box 96090
Washington, DC 20090-6090

Sample Photo Release Statement

(You may cut out and use this statement. It ***must be signed.***)

Enclosed is/are __________ (*number*) slide(s) for publication by the USDA Forest Service. For each slide submitted, the contest category is indicated and a detailed caption is enclosed. I have the authority to give permission to the Forest Service to publish the enclosed photograph(s) and am aware that, if used, it or they will be in the public domain and appear on the World Wide Web.

Signature ____ Date ____________________

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