

ABORIGINAL USE OF FIRE: ARE THERE ANY “NATURAL” PLANT COMMUNITIES?

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INTRODUCTION

Evidence for the purposeful use of fire by American Indians (also termed Native Americans, Indigenous People, and First Nations/People) in many ecosystems has been easy to document but difficult to substantiate. Commonly, many people, even researchers and ecologists, discount the fact that the American Indians greatly changed the ecosystems for their use and survival. Scientists often attribute old fire scars found in tree rings to “natural” causes, such as lightning rather than anthropogenic causes (Kilgore 1985 and Pyne 1995). However, there is a growing literature that many of the so-called “natural” fires were intentionally set. A knowledge of the Indian use of fire will understand how ecosystem conditions today have been shaped by humans in the past. The implications of restoring fire to ecosystems for management of million of acres of federal lands are profound.

The following accounts of Indian burning of ecosystems focuses on the Pacific Northwest, where some of the best documentation of Indian use of fire exists (see Appendix B). For other parts of North America, see the excellent studies by Henry Lewis (1982, 1985) on the forest areas of Canada, as well as the articles by Emily Russell (1983, 1997) and Gordon Whitney (1994) for the East (especially the northeast) and William McClain and Sherrie Elzinga (1994) for the Midwest region of the United States. Stephen Pyne's (1982, 1995) books contain information on aboriginal people and their use of fire in North America, as well as other parts of the world.

"NATURAL" LANDSCAPES OF NORTH AMERICA

For over 100 years there was the idea that nature could only be “natural” when left on its own. Massive landscape changes, such as caused by hurricanes or volcanoes, or even small changes like landslides caused by heavy rainfall, would, if left alone, recover to the natural “order” of nature, undisturbed, peaceful, with harmony restored. In this view, nature is wonder, filling the human body and soul with beauty and spirit of the grand works of God. Painters of the mid-1800s “Hudson River School” emphasized, through magnificent, large-scale painting, this notion of the glory and spirit of nature untamed, wild, and beautiful beyond imagination. George Perkins Marsh, in his classic book *Man and Nature*, originally published in 1864, set the tone for much of the conservation movement of the late 19th century and the environmental movement of the mid- to late-20th century as he wrote about the stability and resiliency of nature:

Nature, left undisturbed, so fashions her territory as to give it almost unchanging permanence of form, outline and proportion, except when shattered by geologic convulsions; and in these comparatively rare cases of derangement, she sets herself at once to repair the superficial damage and to restore, as nearly as practicable, the former aspect of her dominion (Marsh 1864: 29).

There are elements of this simplistic philosophic notion that still live on in society as a whole and especially the minds of the environmental community. The writings of the eminent conservation/environmental scholars in the last century have tended to take these idealistic and romantic, almost transcendental, notions into the realm of gut-wrenching emotion and action to save what is left of

the “natural” environment. Dennis Martinez pointed out the ties between the early writers and the environmental movement:

The principal prophets of the modern environmental movement—Emerson, Thoreau, Muir and Leopold—have repeated and enlarged the same theme of nature functioning optimally when left alone. Modern environmental preservationists draw their most compelling inspiration from their earlier transcendental philosophers...nature itself is viewed as a kind of divine manifestation. Nature is conceived as being perfect because God is perfect. Transcendentalism grew out of 17th and 18th century English natural theology which saw God revealed through his principal work, nature. You could know God if you knew his creation (Martinez 1998: 1).

The last few decades, however, have seen significant changes in the ecological basis for defining nature, as well as wilderness “untrammeled by Man” (Botkin 1990). Where for almost a century, ecologists and environmentalists have viewed ecosystems as in perfect harmony with climax vegetation everywhere before the European settlers came to North America: “Early ecologists recognized the presence of disturbance but focused on the principle that the land continued to move toward a stable or equilibrium condition. Through the years, however, scientists have acknowledged that equilibrium conditions are largely the exception and disturbance is generally the rule. Natural forces have affected and defined landscapes throughout time (Federal Wildland Policy 1995: 1).”

Human activities have also influenced and changed ecosystems. Researchers today are tending to believe that the concepts of “nature,” “natural,” and “wilderness” are human constructs and that people have been part of ecosystems since before recorded time. People, in this contemporary notion, are *part of ecosystems*, have *evolved with ecosystems*, have *used parts and pieces of ecosystems* for survival, and have *changed portions of ecosystems* for their needs:

No forests [shrublands or grasslands] are unaffected; 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, although its intensity has varied greatly over time and space. This influence must be accounted for as an important part of any study of forest structure and dynamics (Russell 1997: 129).

By the time 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 (e.g., Blackburn and Anderson 1993; Botkin 1992; Denevan 1992; Doolittle 1992; Lewis 1973 and 1982; Pyne 1995; Shrader-Frechette and McCoy 1995; Stevens 1860; Stewart 1954, 1955, and 1963; Whitney 1994; and Wilson 1992).

Early explorers and fur trappers often observed huge burned over or cleared areas with many dead trees “littering” the landscape, without knowledge of whether the fires were natural or Indian caused. Written accounts by settlers remain incomplete, although many noted that there was evidence of burned or scorched trees and open prairies or savannas with tall grasses in every river basin (e.g., Lorimer 1993; McClain and Elzinga 1994; Russell 1983; Stevens 1860; and Whitney 1994). The abundance of rich prairie land (“ready for the plow” without having to clear the land) was one of the primary reasons for settlers to head west to the Oregon Territory (including the current states of Oregon, Washington, and parts of Idaho) and California, and eventually to “back-fill” the Great Plains. Dennis Martinez noted that:

The North America that European peoples invaded and settled was not a “virgin” land undisturbed by people. 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 (Martinez 1998: 13).

INDIAN USE OF ECOSYSTEMS

By the turn of the twentieth century, many native languages and tribes were becoming extinct and knowledge of the "old" ways was dying. Only a handful of ethnographers and anthropologists (many employed by the Smithsonian Institution and/or the American Bureau of Ethnology) felt the need to record the Indian languages and lifestyles before the last of many tribes disappeared (Suttles and Jonaitis 1990). Even fewer of these researchers asked questions about the native peoples deliberately changing ecosystems.

Yet there is a growing body of literature (ethnobotany) about American Indians using native plants for food, medicine, and ceremonial uses, as well as plants/shrubs/trees for food, clothing, shelter, and tools. In addition, there is extensive documentation of tribes changing water flow (canals), practicing farming, grazing (horses, sheep, and cattle since the 1600s), using vegetation, wood, and bone for decorative arts, minerals for many uses, and building structures of wood, rock, and ice (Denevan 1992 and Doolittle 1992). These and other purposeful uses of and changes to "natural" ecosystems remain, for the most part, to be well documented (Kilgore 1985).

There is universal acknowledgment of early American Indians having used the ecosystems in which they lived. There is also the impression among many that the Indian people lived in complete harmony with the environment, not disturbing nor destroying, taking only what was absolutely needed for survival (Whitney 1994). However, as Daniel Botkin pointed out, these impressions of a "benign people treading lightly on the land" is wrong:

It often seems that the common impression about the American West is that, before the arrival of people of European descent, Native Americans had essentially no effect on the land, the wildlife, or the ecosystems, except that they harvested trivial amounts that did not affect the "natural" abundances of plants and animals. But 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. There is ample evidence that Native Americans greatly changed the character of the landscape with fire, and that they had major effects on the abundances of some wildlife species through their hunting (Botkin 1990: 169).

ROLE OF FIRE BY INDIANS

Documentation of the Indian use of fire is fragmented at best, non-existent in others. Historically documented incidents are unusual, photographs of Indians setting fire to the forests and grasslands are , apparently, non-existent for the mid to late 1800s (photography was invented as an art form in the late 1830s and available on a limited basis in the 1840s and 50s, long after many tribes ceased to exist). However, there are a few paintings and drawing from collections (e.g., Frederick Remington and Charles M. Russell) that show how the Indian set fires were set. This leaves the modern researcher with only indirect references from settler and missionary diaries/reminiscences, fur trapper and military explorations that are often incomplete. Suzanne Fish noted in her article fire ecology and humans:

Because direct evidence for the burning practices of prehistoric inhabitants...is negligible, historic accounts and ethnographic descriptions figure prominently in modeling fire use in the past...It is especially difficult to evaluate human influence in the distant past when both vegetation and culture were quite different from their counterparts of later [and present] times (Fish 1996: 127).

The Indian and fire management literature are filled with simple statements or references/citations about the Indian use of fire, as well as other intentional changes in ecosystems. Some are quite generic (e.g., "Indians burned the prairies") while others are quite specific (e.g., "The women of the Kalapuya Indians

burned the prairies and foothills of the middle Willamette Valley every fall"). However, most of these studies or reports have some basic methodological problems in that they:

- Are not reporting instances of ecosystem changes caused by Indian people ("under reporting").
- Attribute Indian causes or intentions to normal ecosystem changes ("over reporting").
- Are far removed in time from the original source material (most observations are 150+ years old).
- Tendency to cite/reference secondary or even farther removed studies for their conclusions.
- Tend to rely on hearsay or third party accounts, especially among the settlers.
- Ignore (don't account for) regional/tribal variations in the use of fire.
- Do not specify which tribe or band actually used fire in the ecosystem.
- Usually did not specify the exact location or even the general area of fire use.
- Often did not document the uses or purposes of fire (hunting, grazing, etc.).

However, when a few writers have looked at many original diaries, letters, books, and reports from the 1600s to the 1900s, they have found considerable evidence of the extensive use of fire and purposeful changes in ecosystems (McClain and Elzinga 1994; Russell 1983; and Whitney 1994). Stephen Barrett (1980 and 1981), among others, also was able to utilize oral traditions from surviving tribal members to document the use of fire in ecosystems.

There are, however, those who disagree as to the *extent* of fire use. Steve Pyne wrote that "even a decade ago the question of 'Indian burning' was a quaint appendix to fire management (Pyne 1995: 242)." One example of this can be found in the classic, college-level, forestry textbook on fire control by Art Brown and Ken Davis: "It is known that Indians at times set fires...[Yet] it is at least a fair assumption that no habitual or systematic burning was carried out by the Indians (Brown and Davis 1973: 16)." Hugh Raup, writing in 1937, noted that Indian caused fires in the northeast were uncommon and the idea that they burned the entire New England area every year, or even every 10 to 20 years "is inconceivable." Another author also called the idea that Indians purposely burned the forests to preserve them "preposterous" (Coman 1911).

There is evidence that *not all tribes* used fire extensively. For example, Indian tribes along the northwest Pacific Coast rarely used fires in the ecosystems they were living, as their subsistence food came from the ocean and rivers. However, a few miles inland, fire was used by different tribes to a much greater extent because they used the forest and prairie or savanna portions of ecosystems to survive. Yet for some tribes and bands of Indians, saving the forest from fire was of paramount importance for their survival (Barrett 1980; Booth 1994; Fish 1996; Lorimer 1993; and Phillips 1985).

The purposeful use of fire was the most powerful tool in the Indian "tool chest" that could change parts or even whole ecosystems to benefit tribal survival and sustain thriving, growing societies (Trudel 1985 and Whitney 1994). However, as pointed out by Emily Russell in her study of Indian caused fires in the northeastern United States:

There is no strong evidence that Indian purposely burned large areas of the forested northeastern United States frequently. The presence of Indians did, however, undoubtedly increase the frequency of fires above the low numbers caused by lightning. The increase from the "natural" situation was greatest in local areas near Indian habitations...There is no evidence that the Indians had the ability or even the desire to stop wildfires... (Russell 1983: 86).

Most primary or secondary accounts relate to the purposeful burning to establish or keep "mosaics, resource diversity, environmental stability, predictability, and the maintenance of ecotones (Lewis 1985: 77)." These purposeful fires by almost every American Indian tribe differ from natural fires by the seasonality of burning, frequency of burning certain areas, and the intensity of the fire (Lewis 1985; McClain and Elzinga 1994; and Pyne 1995).

Great variations have been found for intentional burning of forests and prairies by American Indians. In doing so, American Indians tended to burn ecosystems and habitats differently depending on what

resources were being managed. Hardly ever did the various tribes purposely burn when the forests were most vulnerable to catastrophic wildfire (McClain and Elzinga 1994 and Pyne 1995). Tribes set fires that, for the most part, were not destructive of entire forests or ecosystems, relatively easy to control, and designed to encourage new growth of plant species (see Appendix A). Emanuel Fritz, a distinguished forester at the University of California, noted that Indian set fires were not set with improving or protecting the forest:

The stories of old residents of the redwood region concerning the acts of the Indians are conflicting. Some believe that the Indians set the woods afire every season that there was a sufficient accumulation of litter to support a fire—every four or five years—and that the course of an Indian traveling through the woods could be charted from a distance by the succession of smokes as he set fires. Others say that the Indian was afraid of fire and set it only to drive game or to burn out his enemies, or that his prairie fires escaped into the woods. Others argue that Indians set fires deliberately to make travel easier. Many white men ascribe to the Indian superior powers of intelligence and a forestry knowledge not equalled by present-day students of the forest. This group believes that “Indian forestry”, which means frequent burning, is the only kind of forestry that should be practised in the standing timber today...It is certain that he occasionally set the woods afire over many centuries but it is extremely doubtful that he did it with any thought in mind for improving or safeguarding the forest for the trees themselves. He was not a malicious or willful destroyer, yet his fires were doubtless set for his own convenience or needs rather than those of the forest. The redwood forest has survived in spite of Indian fires and those other pre-white-man fires, the causes of which can only be surmised (Fritz, 1931: 939-940).

For those Indian tribes that used fire in ecosystems, the tribes in the boreal forests of Canada, for example, tended to burn in the late spring just before new growth appears, while in areas that are drier, such as the southern Rockies and Sierra Nevada, fires tended to be set during the late summer or early fall since the main growth of plants and grasses occurs in the winter. Indians burned selected areas yearly, every other year, or intervals as long as five years. Steve Pyne put much of the Indian use of fire into perspective as he reported that:

the modification of the American continent by fire at the hands of Asian immigrants [now called American Indians, Native Americans, or First Nations/People] was 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. Even under ideal circumstances, accidents occurred: signal fires escaped and campfires spread, with the result that valuable range was untimely scorched, buffalo driven away, and villages threatened. Burned corpses on the prairie were far from rare. So extensive were the cumulative effects of these modifications that it may 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. Most of the impenetrable woods encountered by explorers were in bogs or swamps from which fire was excluded; naturally drained landscape was nearly everywhere burned. Conversely, almost wherever the European went, forests followed. The Great American Forest may be more a product of settlement than a victim of it (Pyne 1982: 79-80).

INDIAN BURNING OF LANDSCAPES EXAMPLE OF THE WILLAMETTE VALLEY, OREGON

There are no purposefully kept historical documents of the Indian use of fire by the American Indians themselves. Probably the best accidental records of Indian use of fire in ecosystems came from the Willamette Valley of western Oregon--the end of the Oregon Trail. The valley has hosted a series of explorers, fur trappers, missionaries, and settlers from the early 1810s to 1890s who have offered many observations of the countryside, inhabitants, and the purposeful use of fire. What the first travelers noted, as in other parts of the country, was that the Willamette Valley vegetation consisted of "extensive areas of prairie, oak openings, and occasionally oak forests (Habeck 1961: 67)." The valley was homesteaded heavily in the mid- to late-1800s by immigrants from both the yearly wagon trains driving overland on the Oregon Trail and the ships sailing around the tip of South America to land at Ft. Vancouver, their land departure point for settling the Willamette Valley.

The Willamette River and its tributaries drain water from both the Cascade Range and the Coast Range mountains of western Oregon. With the mouth near Portland, the river extends more than 180 miles to the south and southeast. The valley near Eugene is about 30 miles wide, extending to more than 50 miles near Corvallis and Albany, narrowing to around 10 miles at Portland. The bottom of the Willamette Valley is generally flat with rolling hills and hummocks. The area, in the early 1800s, was characterized by extensive prairie/grasslands/savannas, a meandering river, wetlands, and patches of valley oaks (Habeck 1961 and Towle 1979 and 1982). Extensive prairie areas, with tall native grasses, greeted explorers and fur trappers alike. For settlers, who were often farmers, the valley was like a heavenly place with deep alluvial soils and abundant water (from the sky and the rivers), few trees, shrubs, or even rocks and "ready for the plow."

Indian Population in the Willamette Valley

The Kalapuya Indians were essentially hunters and gatherers in the bottoms of the Willamette and lower Umpqua Valleys. The Kalapuya people, separated into six or more bands, gathered camas roots (*Camassia quamash*), seeds from grasses, hunted blacktail deer (*Odocoileus hemionus* spp.), caught some Chinook salmon (*Oncorhynchus tshawytscha*) and Pacific lamprey eels (*Lampetra tridentata*). Transportation was mostly by walking, sometimes by dugout canoe. By and large, they were a peaceful people (Barnett 1937 and Mackey 1974).

By the time the settlers began arriving in great numbers in the 1840s and 50s, many of native Kalapuya bands and families were on the verge of extinction. Widespread disease outbreaks would forever change Indian life in western Oregon: The demise of up to 90 percent of the native people because of new diseases (i.e. smallpox and malaria) introduced accidentally and wide-spread epidemics (e.g. flu) against which the Indians had little or no immunity (Boyd 1975). Some of the Indian people died because of disease contracted through contacts with ocean voyagers from various European countries such as Spain, Russia, England, and the U.S.

It is even possible that the first wave of European disease came in the 1500s when a probable Spanish Manila galleon shipwrecked near Tillamook Head on the Oregon coast. Sailors from other nations, along with new diseases, came in the 1600s, 1700s, and very early 1800s via wooden ships being blown off course and floating helplessly along the Japan Current through the North Pacific and eventually wrecking along the rugged coastline. European contacts along the coastline began fleetingly with the Spanish, English, and finally the American ocean explorers of the mid- to late-1700s looking for the famed "Northwest Passage." The degree of disease spread and probable deaths among the native peoples of the Pacific Coast and inland will never be known.

Only after overland expeditions, such as Lewis and Clark, reached the Pacific Ocean on November 15, 1805, and then fur companies arriving in the spring of 1811 with traders setting up outposts throughout the Pacific Northwest, did disease become widespread and especially dangerous to the native populations. However, Lewis and Clark noted that some of the Indians they encountered among the

Indians at the mouth of the Columbia River were marked with smallpox scars, evidence of contact with outsiders from the Pacific Ocean. Probably the worst situation was the “fever” or “ague” (possibly malaria or influenza) which came into the reaches of western Oregon and Washington in the mid-1830s from a party of Hudson Bay Company trappers who had visited California in the never-ending search for new sources of beaver (Boyd 1975). Robert Clark explained:

The history of the Indians after the coming of the whites is a sad story of decline. Lieutenant Charles Wilkes [in 1841] estimated the rate of their decrease in population at 25 per cent per year. Estimates for earlier years are conflicting and unreliable and [yet] we may summarize briefly by giving the Indian population of Oregon Territory at not over 150,000 in 1800, not over 50,000 in 1835, and not over 30,000 in 1840....Thus the Indians of the Willamette Valley, with the exception of a few Chinookians of probable mixed blood, have entirely disappeared....The Indian system of living was incompatible with that of the whites. We must conclude that the Indians of the Willamette Valley were unusually peaceful, friendly, and hospitable and that they were in general more tolerant of the whites than might have been expected [and more tolerant than the white settlers were of the Indians]....Previous to the coming of the whites the Indians had been able to maintain themselves since their chief struggle had been with nature; but they lacked protective moral customs, medical knowledge and adequate weapons with which to withstand the white invasions (Clark 1927: 1-67-69).

Other factors also had significant roles to play in the demise of native cultures of the Willamette Valley. Included in this list were warfare (with old enemies and new immigrants), new technologies (horses, iron, and firearms), change of economy (to fur trading and sheep grazing), different food sources (farming and federal handouts), and treaties (restricting or removing Indians from traditional lands). Each of these, and more, had many consequences, some positive but many negative, on native cultures and populations.

Indian Use of Fire in the Willamette Valley Bottoms

There are numerous accounts of the Kalapuya Tribe burning the bottom lands of the Willamette Valley. It can be well established that the Indians in the valley burned the valley floor for many centuries before the coming of the white fur traders, missionaries, and settlers. The early demise of many of the Indian inhabitants, treaties removing most of the remaining Indian people to distant reservations, and their farmer replacements by the 1850s meant that an entire way of living with the land was gone, never to be restored.

Two accounts by early settlers describe the widespread use of fire by the Indians to keep the brush down, streams open, and collect seeds in the neighboring Umpqua Valley to the south:

Before the white settlers came to the valley, the Indians would set fire and burn off one side of the valley in the fall of each year. This kept the brush from crowding in and the streams open. After they would fire in the fall, the squaws would get out and pick tarweed [*Madia* sp.] seed, which they were very fond of. The tarweed grew about two and a half feet tall and would still be standing after the fire. The squaws would beat the seeds off into their baskets. Then they would grind them into a meal with a mortar and pestle. They also beat the seeds to a pulp and made them into a mush, which they relished (Cornutt 1971: 36).

During the summer months the squaws would gather various kinds of seeds of which the tar weed was the most prized....When the seeds were ripe the country was burned off. This left the plant standing with the tar burned off and the seed pods left in the pods. Immediately after the fire there would be an army of squaws armed with an implement made of twigs shaped like a tennis racket with their basket swung in front they would beat the seeds from the pods into the basket. This seed gathering would only last a few days...All seeds were ground into meal with a mortar and pestle (Riddle 1953: 65-66).

Robert Clark, a historian writing about the Willamette Valley, described the Kalapuya's hunting and gathering methods, including the use of fire:

Lack of horses and adequate weapons limited the hunting activities of the Willamette Valley Indians and caused them to invent ingenious methods of killing game. Practically the only weapon used was a very elastic bow made of white cedar to which was fitted an arrow of pine or hardwood with a barb of iron, copper or stone....The success of the method [of disguising oneself as a deer and rubbing antlers together] depended on the tameness of the deer and its presence in the open spaces, and when the Indians found that the whites with their startling guns and wholesale slaughter were making the deer too shy to hunt, they prepared to drive out the intruders in 1814. By burning the prairies 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. The insects were dried and made into a pemmican by means of a pestle and mortar (Clark 1927: 1-52).

The use of fire by the Kalapuya people was their way of ensuring the continual renewal of their lands, plants, and animals. The Willamette Valley bottoms were highly adapted to the use of fire that were intentionally set by the original inhabitants.

Early Travelers to the Willamette Valley

The Lewis and Clark expedition of 1804-1806 gave a number of early accounts of Indian burning as they crossed the Great Plains along the Missouri River, over the northern Rockies, and down the Columbia River to its mouth at the Pacific Ocean. The expedition leaders were told about a major river flowing from the south on their return journey in the spring of 1806. The party had to slightly backtrack to explore the mouth of the Willamette River (which they named as the Manning River) but did not venture southward into the Willamette Valley for more than 25 miles, thus their observations were limited.

Next came the Pacific Fur Company (John Jacob Astor's enterprise) which in 1811 established a fur trading post near the mouth of the Columbia River, which they appropriately named Ft. Astoria. Accounts of their adventures through the Willamette Valley in the years 1811-13 are sketchy at best. During the War of 1812, the "Astorians" sold Ft. Astoria, under duress, to the North West Fur Company (a British concern). The Northwest Fur Company in turn merged with the Hudson's Bay Company (HBC) in 1821. The HBC moved the major fur post from the mouth of the Columbia River upstream about a hundred miles to a new site dubbed Ft. Vancouver. The fort site is across the Columbia River from Portland and near the mouth of the Willamette River.

The Willamette Valley became the major north-south trade route of HBC trapping parties to California in the 1830s and 1840s. The HBC sent large fur trapping expeditions, usually one per year, southward through the Willamette Valley, and continuing to the Umpqua, Rogue, and Sacramento Valleys. Many of their journals have been translated and published in a variety of sources (e.g., Scott 1923).

The HBC trapped many species of animals for their fur, hunted big game species for food, and established outposts in all reaches of their fur expeditions, including California, to trade with the Indians and eventually the settlers. Beaver (*Castor canadensis*) pelts were often traded to the East and England to make the stylist beaver top hats, while the sea otter (*Enhydra lutris*) and river otter (*Lutra canadensis*) pelts were traded in the Orient (Gibson 1992 and Hammond 1993).

In the fall of 1826, the HBC ordered Peter Skene Ogden and his party of trappers to clear or "trap out" the Snake River country in southern Idaho of all beaver and related fur species with the intent of stopping American fur trappers (and settlers) from entering the southern Idaho area. It was not entirely successful in keeping the Americans from coming, but may have slowed their progress.

David Douglas Description in 1825-1826

David Douglas (1798-1834) was a renowned Scottish botanist and naturalist. He made several specimen collecting trips to the Pacific Coast from 1825 to 1833 under the auspices of the Royal Horticultural Society of London (Beckham 1995). Douglas made his headquarters at Ft. Vancouver under the watchful eye of the Hudson's Bay Company. Douglas discovered more than 50 species of trees including the sugar pine (*Pinus lambertiana*) and Douglas-fir (*Pseudotsuga menziesii*), which is named for him, as well as more than 100 species of flowers, grasses, shrubs, and ferns. Journals of his two trips through the Willamette Valley described both the country in the mid-1820s and Indian burning:

[August 19, 1825] The natives cultivate it [tobacco] here...They do not cultivate it near camps or lodges, lest it should be taken for use before maturity. An open place in the wood is chosen where there is dead wood, which they burn, and sow the seed in the ashes....[He unexpectedly met the Indian grower and after some appeasement] became good friends. He then gave me the above description of cultivating it. He told me that wood ashes made it grow very large. I was much pleased with the idea of using wood ashes. Thus we see that even the savages on the Columbia [actually the Willamette River about 30 miles above Portland] know the good effects produced on vegetation by the use of carbon [ashes] (Davies 1980: 47).

[September 27, 1826] Country [southern Willamette Valley] undulating; soil rich, light, with beautiful solitary oaks and pines interspersed through it, and must have a fine effect, but being all burned and not a single blade of grass except on the margins of rivulets to be seen (Davies 1980: 94).

[September 30, 1826] Most parts of the country [southern Willamette Valley] burned; only on little patches in the valleys and on the flats near the low hills that verdure is to be seen. Some of the natives tell me it 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 (Davies 1980: 94).

[October 6, 1826] Marched sixteen miles. As I walked nearly the whole of the last three days, my feet are very sore from the burned stumps of the low brushwood and strong grasses (Davies 1980: 96).

Such conditions temporarily halted his attempts at collecting botanical specimens. Finding grass to feed his horses became a difficult problem for several days. He finally crossed the lower ridges separating the Willamette Valley from the Umpqua Valley. From this point, Douglas went southward with the HBC party led by Alexander McLeod. They crossed into the upper reaches of the Coquille River, then back into the Umpqua Basin. At this point, Douglas returned to Ft. Vancouver with a messenger party.

South Seas Exploring Expedition 1841

In May to October of 1841, an official U.S. military oceanic expedition entered the Oregon territory. This excursion into the Pacific Northwest was only part of their round-the-world, scientific exploring expedition from 1840 to 1842. Led by Lt. Charles Wilkes, the ships and men under his command sailed into the Columbia River and visited Ft. Vancouver. Wilkes led part of his group to the Puget Sound country, then sailed south to San Francisco (Stanton 1975).

Lt. George F. Emmons led another party of 39 down the Willamette Valley along the HBC trail, eventually to connect with the Wilkes contingent in the San Francisco Bay area. Several diaries and journal exist to document the overland travel. The Lt. Emmons party rode their horses up the Willamette Valley toward California, engaging several settlers to help guide them. Most of the settlers were interested in obtaining U.S. support for their budding cause of becoming a U.S. territory, but to no avail. This was, in the strictest sense, an exploring party, not the first wave of U.S. military control over the country (Stanton 1975).

The party observed at the southern end of the valley a "hilly prairie, charred by a recent grass fire (Stanton 1975: 261)." Near this point, the Emmons party crossed into the Umpqua Valley. At Ft. Umpqua, near present-day Elkton, the party found smoke and fire:

The air was thick with smoke and fog that made the sun a dark bloody color and no larger than a doubloon. Rounding up the horses they broke camp at ten o'clock in the morning of the eighteenth and proceeded over the prairie. A thin line of fire was crossing it, too, crawling slowly before the wind and ascending the distant hills. These fires were not dangerous in themselves, but they were a devilish bother, for not only did they deprive the party of game and the horses of feed, they also exposed small stones that lamed the horses....On September 22 they reached the pass through the Umpquas. The woods were charred from a recent fire and the trail dust turned them all black (Stanton 1975: 261-262).

After crossing into the Rogue Valley, Titian Ramsey Peale mentioned Indian burning on the 27th of September 1841: "Indian signs were numerous, through we saw but one, a squaw who was so busy setting fire to the prairies & mountain ravines that she seemed to disregard us (Poesch 1961: 192)." Two days later the party reported that the Coast Range mountains were on fire (Beckham 1971).

Settlers in the Willamette Valley

The Willamette Valley was the end of the Oregon Trail for thousands of settlers coming overland from the United States in the 1840s and 1850s (Oregon did not become a state until 1859). The wonderful prairies filled with grasses higher than a horse's back and "free" land which had never seen the plow were powerful attractants to people who wanted a new start. The generous Oregon Donation Land Act of 1850 allowed settlers to patent—acquire ownership of public domain—some 2.6 million acres of land in Oregon and Washington, many of these lands were in the valley bottoms of western Oregon (Beckham 1995).

Most of the early settlers did not realize that the whole environment was crafted by Indians through the use of fire. Only a few trappers, missionaries, and settlers came early enough to actually observe the Kalapuya bands that burned the lower valley quite extensively every fall:

Certain very definite sections of the Willamette [Valley] region as it appeared to the first white men can be distinguished. The country below the [Willamette or Oregon City] Falls and eastward to the Cascade Range was then heavily timbered....by contrast...the open country above the Falls seem even more pleasant and peaceful as a place of settlement....Prairies and woodland blended in "beautiful proportions" in this popular place of settlement....From what is now Benton County "Green Prairies" broken by timbered hills stretched as far as the Calapooia Mountains to the south. Clover and timothy were growing on these plains, which during the dry season appeared brown and

towards the junctions of the three rivers that make the Willamette, showed superior luxuriance....At the time the first wave of immigrants came to Oregon the Indians were still burning the level plains from Linn County to the limits of the valley. Since the Indians had burned the timber, except below the Falls and around water courses, grass was the greatest crop in the Willamette Valley (Clark 1927: 1-33-34).

Another description of the lower Willamette Valley can be found in the published reminiscences of Francois Xavier Matthieu. He came to the valley quite early in the settlement period - 1842. His biographer, H.L. Lyman, "painted" a word description of what F.X. Matthieu saw in September on his arrival:

French Prairie [a settlement of retired HBC employees and their families] is the borderland between the originally heavily timbered country of the lower Willamette [Valley] and the more open lands of Marion County [to the south] and the big prairies of the upper valley. Matthieu found the country of the French settlers even more beautifully diversified than at the present, the practice of the Indians, then but recently discontinued, of burning the prairies over, having brought the whole country for miles together to the condition of a park. Stately groves of fir and oak, broke the monotony of the grassy levels, while from almost any point of view the panorama of distant mountain scenery was uninterrupted (Lyman 1900: 87-88).

Following the Rogue River Indian War against their southern neighbors (caused by miners), the surviving Indian families were moved in 1855-57 from the valleys of western Oregon. Other treaties, negotiated in 1854-55 by Indian superintendent Joel Palmer, also removed most of the remaining Indian people in western Oregon from their homelands, sending them to reservations in the Coast Range—the Siletz and Grand Ronde Indian Reservations. Thus, it is not surprising that few of the immigrants knew about Indian burning, much less to have seen it with their own eyes. Other than a few scattered accounts of burning by the Kalapuya people, the rest are lost forever.

Through the turn of the 20th century, settlers often used fire to clear the land of brush and trees in order to make new farm land for crops and new pastures for grazing animals—the North American variation of slash and burn technology—while others deliberately burned to reduce the threat of major fires—the so-called "light burning" technique. Since the uplands were still in government ownership (public domain), many settlers adjacent to the hills often either deliberately set fires and/or allowed fires to "run free." Also, sheep and cattle owners, as well as shepherds and cowboys, often set the alpine meadows and prairies on fire at the end of the grazing season to burn the dried grasses, reduce brush, and kill young trees, as well as encourage the growth of new grasses for the following summer and fall grazing season.

Late in the 19th Century and early in the 20th, such practices were discouraged because of the damage that fires caused to watersheds, game animals, and trees. This method of burning, also widely used in the South, became known as "Paiute forestry," a direct but derogatory reference to the burning habits of earlier American Indian tribes (Greeley 1920; Saveland 1995; and Schiff 1962).

Summary of Indian Burning in the Willamette Valley

It is obvious that the Kalapuya Indians of the Willamette Valley, as well as the Umpqua Indians, and Rogue River Indians farther to the south, used fire with great regularity to modify their environment. "In the case of the Willamette Valley, as much as 2 million acres of land were maintained in prairie and savanna as a consequence of aboriginally set fires...Fires were also set in the small prairie areas of western Washington, but involved, at most, no more than 200,000 acres (Booth 1994: 52-53)." Lightning, as the primary cause of these prairie fires, is not an issue since the valley experiences very few thunder/lightning storms. However, the nearby mountains during August and September are susceptible to heavy thunder and lightning storms.

Fire use was highly controlled in the Willamette Valley with a specific purpose in mind: Food supply. Fire use was essential to their lifestyle and culture and survival (Boag 1992; Boyd 1986; and Johannessen et al. 1971). Yet the type of burning that was used by the Kalapuya Indians has not occurred since the 1850s. Without periodic fire, caused by Indian burning, the Willamette Valley is now faced with a situation in which the native Oregon white or Garry oak (*Quercus garryana*) "is now a declining type, largely due to replacement by Douglas-fir on most sites....Oregon white oak can be overtopped by much younger Douglas-fir where fire is no longer an environmental factor....[To eliminate the fir as a competitor would] require a fire at least every 5 to 10 years (Agee 1990: 33-34)." As with most prairie/savanna areas, most of these highly desirable lands have been converted to cultivated farmland, while poorer lands are now often used as ranches for grazing animals. Other areas of the Willamette Valley are now under asphalt, cement, and houses as the population of settlers and cities have expanded greatly over the last 150 years.

INDIAN BURNING OF LANDSCAPES - EXAMPLES IN THE MOUNTAINS

Indian use of the mountains and forests, especially the use of fire, is not well understood. Tribes outside the lowland valleys tended to be more nomadic, depending a great deal on horses for transportation. Some mountain areas were used extensively by the Indians for many thousands of years.

Most American Indian tribes did not live in the mountains and forests. They visited the mountain areas during the summer and fall seasons, leaving before the snows came. For the Indians, the forests and mountain areas were vitally important for survival, supplying food, shelter, and clothing from the various natural elements found there. In the winter months, the tribes or bands of Indians would stay at lower elevations in the valleys and lowlands where deer were plentiful and the climate was usually wet and mild.

Documentary evidence about their use of fire to change or improve the conditions in the mountains are fragmentary, but important (Barrett and Arno 1982 and Seklecki et al. 1996). John Minto, an early Oregon pioneer, related that the Molalla Tribe in Oregon often set fires in the Cascade Range when he noted that "fire was their agency [method] in improving game range and berry picking (Minto 1908: 153)." He also noted that small prairies could be found on all the western slopes of the Cascades from the valley floor to almost the crest (4,000 to 6,000 feet). Another Oregon "Pioneer of 1847" related that Indians burned portions of the mountain forests in the northern Cascade Range of Oregon:

the Indians and early settlers had complete charge and Summer fires were a rare thing, for the reason there was nothing to burn...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. This light growth would make a light fire and would hardly smoke the old logs, and just as soon as the fire reached the green timber it stopped, as everything in the timber was too wet to burn (Pioneer of 1847 1911: 10).

Stephen Barrett, who has written extensively about Indian use of fire, commented on the Indian set fires in the western Montana area:

From interviews [with 60 persons] and historic journals it is apparent [that] Indians often ignited both purposeful and careless 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*]. Although relatively rare, some Indian fires occurred in high-elevation forests. According to informants in the study, Salish and Kootenais purposefully set fires mostly during the fall and spring, when climate and fuel conditions are usually conducive to relatively low-intensity fires...Historical journals show fires were also set during summer months, but were then usually careless or unintentional ignitions (Barrett 1980: 18).

Meanwhile in the Blue Mountains of northeastern Oregon, especially in the Grande Ronde and Powder River country, fires set by Indians were a common occurrence as late as the mid-1800s (Langston 1995 and 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. 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 (Langston 1995: 44).

In the steep mountain country of northern California, American Indian populations burned the forest areas well into the 20th century, as the following observation from a Forest Service district ranger recounts:

There is also another source of fires [other than settlers, prospectors, and hunters], which I call the renegade whites and indians [sic] in the district, these I am glad to say are in the minority, but they do lots of damage considering their number. They set fires for pure cussedness or in a spirit of don't care a damativeness, they have nothing at stake, and don't care whether the fire damages others or not. In good acorn seasons the indians [sic] will sometimes try and burn off the leaves and humus under the oak trees, to facilitate the gathering of acorns. My past experience has proven that fires caused by "Indians burning for basket material" are invariably small fires, as the location of the material needed is not productive of large fires (Harley 1918: 2).

Settlers and the Mountains

For the early settlers, however, the mountains and forests were seen as "pretty" yet formidable obstacles to be overcome in the long overland journey on the Oregon Trail. With very few exceptions, the mountain and heavy forest areas were not settled. Documentation of Indian uses or practices are very fragmentary, at best, however, accounts of early settlers using fire for an easy way to clear the land, as well as keep open the forested areas for grazing, are widely known.

For the overland settlers, they found the mountains and forest to be quite inhospitable and practically inaccessible. For a few hardy farmers in the mountains, they found the growing seasons were short, frosts could occur at any month of the summer, snow came early, and the summers were very dry. Not very encouraging to settlement. Yet, others saw the forests and mountains of northeastern Oregon as an "empty wilderness waiting for the hand of the white man to bring it to perfection (Langston 1995: 44)." This usually meant using the resources, like trees and grass, but not living on the often harsh land, much as the American Indians had done for thousands of years.

As a consequence, the mountain ranges and evergreen forests were often viewed as scenic backdrops to the farms and cities, and increasingly as sources for irrigation and drinking water. It took many years for the mountains and forests to be seen as recreation areas for settlers and city dwellers.

In addition to fires started by American Indians, sheep herders also set fires in the mountains. Mountain prairies were extensively used in the summer and fall season for sheep grazing from the late 1800s to the mid-1900s (Rowley 1985; Williams 1985; and Williams and Mark 1995). From the 1880s to 1910s, the early grazing owners who used the high mountain meadows for sheep grazing during the summer months. When the herders left the mountains in the fall, just before the snow came, they often would "set out" fires to improve grasses for the following summer (Williams and Mark 1995).

Adjacent land owners to the forest reserves, while clearing their land for farming or grazing, would sometimes accidentally cause forest fires to ravage the mountain forests while clearing their land for farming or grazing (escaped fire). Another group of fires were caused by careless hunters, anglers, and

travelers - usually from campfires allowed to burn after leaving the campsite (Harley 1918). There are reports of some pioneers setting forest fires just to see the forests burn (Lutz 1959)!

At other times, fires were intentionally set by miners to burn the adjacent public domain forest to expose the rocks and soil in order to make mineral discovery easier (Harley 1918). Large forest areas surrounding mining claims, camps, and districts were often observed to be burnt over. Although, this was in the tradition of the burning practices learned from the Indians, most of the fires set by the settlers and miners were not carefully managed.

Forest Reserves Established in the Mountains Beginning in 1891

Beginning in 1891 with the Forest Reserve (or Creative) Act, millions of acres of mountainous public domain land that were covered with forests were set aside as forest reserves. However, management of the vast public forests would have to wait until 1897. In that year, the USDI Geological Survey (USGS) began several projects of mapping and describing the forest cover on the forest reserves in the West (there were no forest reserves in the East). This was the direct result of the so-called Organic Act of 1897 (Williams 1997). The USGS reports were published during the next three years—1898-1899, 1899-1900, and 1900-1901. In addition, 13 professional papers were published as a result of this survey work. Several of the USGS reports on the forest reserves mention information about Indian burning of ecosystems at the turn of the century. All the reports on the forest reserves mapped standing timber, rock and ice, extensive burned over areas, as well as huge areas covered with second-growth forests. The acres of the various types of mapping elements have never been calculated. For the most part, attributions as to the cause of these burned over areas are not provided, although several reports indicate that Indians caused at least some fires—these mapping and forest cover functions were taken over by the new USDA Forest Service in 1905.

Thus, as with many fire research efforts in the 1970s and 1980s, the reader is left with the impression that the burned areas were naturally caused by lightning. Even in the 1990s, with the advent of computers and satellite imagery, there is the lasting impression that fires in the mountains were mostly caused by hundreds and even thousands of lightning strikes every year. The evidence, however, is not overwhelming as using this logic it would seem "reasonable" that every acre of forest and savanna would burn every year because of the multitude of lightning strikes, which is clearly not the case. Also, lightning-caused fires are typically middle to late summer events, whereas the Indian-caused fires were often set deliberately in the spring and late fall, at a time when lightning-type fires were only remote possibilities. In addition, most lightning tends to strike individual trees, high rocky points, and other places where either no fires could start or where small snag fires would slowly burn or be put out by rain that often accompanies the thunder storms.

Indians, who had lived and managed the land for millennia, set fewer fires (ignitions) than lightning, but the Indians had greater and longer term impacts on the mountain forests and prairies. While today there is no way to indicate how many of these early fires were human caused, it seems likely prior to the 1850s that many, if not most, were Indian set fires. John Minto, a strong supporter of sheep grazing in the Cascade Range Forest Reserve of Oregon noted in an 1898 State of Oregon report on "forestry interests" that "it must not be forgotten that the Warm Springs Indian reserve is bounded on the west by the 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: 601)."

A short article printed in Portland, Oregon, newspaper *The Oregonian* on December 9, 1899, summarized from a report from the superintendent Salmon B. Ormsby of the forest reserves in Oregon, which noted that during the 1899 fire season five forest fires in the Cascade Range Forest Reserve were caused by Indians "setting out" fires. Superintendent Ormsby also reported several months earlier that "the most reckless people encroaching on the reserve, according to the superintendent, 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: 722)." 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 [Indian] 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: 692)."

During a sheep grazing investigation in the summer of 1897 in the Cascade Range Forest Reserve in Oregon, USDA biologist Frederick V. Coville reported that Indian burning in the Cascade Range came in the fall:

Historically considered, we must look to the Indians as the first manipulators of forest fires in this region. It is a clearly established fact, based on observation, that the Indians of the Willamette Valley in western Oregon were accustomed before the advent of white men in that region, to as late a period as the early [18] forties, to set fire to the grass for the purpose of burning it off...Just how many of the old burns in the Cascade reserve are to be attributed to the Indians it is impossible to say....it is undoubtedly true that at certain seasons it was their custom to set fires in the mountains intentionally and systematically, in connection with their fall hunting excursions, when deer were driven together and killed in large numbers (Coville 1898: 29-30).

Prince Helfrich, a long-time fishing and hunting guide in the western Oregon Cascades from the 1920s-1960s, substantiated the Coville report:

As a boy living in the McKenzie Valley [of western Oregon] in the early 1900s, I remember the coming of the Indians each summer....I recall an old Indian who slid off his horse this way [helped by a buckskin string tied to the saddle horn] On inquiring if the old man was sick I was told that he was an old, old man—107 summers old. That night I talked with the old man through an interpreter. He told me many tales of his younger days - of his annual coming to the McKenzie Valley over old Indian trails through the Cascades [from the Warm Springs Indian Reservation], of his hunts 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 (Helfrich 1961).

In the dryer, central Sierra Nevada range of mountains in California, Anderson (1993), Bean (1973), and Reynolds (1959) reported that Indian tribes used fire extensively to manage oak patches (for the acorn food supply), prevent encroachment of trees into areas utilized by the tribes, to set out fires to deprive enemies of hiding cover, and to improve hunting. Harold Weaver noted that "everywhere, throughout the ponderosa pine forests, there may be observed the fire-scar and tree-ring record. Throughout the major portion of these forests, fires occurred 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 (Weaver 1967: 143)." Stephen Arno noted that Indian fires were used in the pinyon-juniper (*Pinus spp.-Juniperus spp.*) communities, chaparral and oakbrush communities, interior montane forests, interior subalpine forests, and maritime forests (Arno 1985). However, reliable documentation of exact sites or areas burned varies considerably from area to area.

Summary of Indian Burning in the Mountains

There is much less evidence for Indian burning of the forests in the mountains than in the lower valleys (Booth 1994). In part the relative lack of information may be the result of far fewer white travelers, settlers, and writers in the remote reaches of the mountains. The consequences of intentionally using fire in the forested mountains are difficult to establish and document, except to note that early travelers and explorers noted the park-like appearance of many mountain forest areas, especially in the Ponderosa pine country of the West (Stevens 1860 and Weaver 1967).

Through scattered historical evidence it is becoming clear that forest areas were managed through the use of fire by both the Indians and the early settlers. What is not clear was the interval or frequency of burning in the mountains. Fire scars from old trees, pollen studies, and charcoal layers can give an indication of fire frequencies for most areas, but the problem remains as to the cause, the total area that was "fired" at any one time, and the season of burning. Historical accounts vary considerably on all these issues (Williams 1999).

DIFFERENCES BETWEEN INDIAN FIRE USE AND WHITE SETTLER FIRE USE

Generally, the *American Indians* burned parts of the ecosystems in which they lived to promote a **diversity of habitats**, especially increasing the "edge effect," which gave the Indians, as well as animals, greater security and stability to their lives. Their use of fire was different from *white settlers* who burned to create greater **uniformity in ecosystems**, especially when it came to crop production and grazing or pasture lands.

In general, during the presettlement period, Indian caused fires were often interpreted by early white observers as either purposeful (including fires set for hunting and agriculture as well as those for simple amusement) or accidental (campfires left smoldering or escaped smoke signaling fires).

REINTRODUCTION OF FIRE - IMPLICATIONS FOR LAND MANAGEMENT AGENCIES

Today, we have a situation where the federal and some state forests are being ravaged by insects, diseases, and prone to catastrophic fires. Over the decades, foresters have found that eliminating fire from the forests which have been adapted to fire and fire regimes does not restore them to pristine, parklands, primeval, wild wilderness (where "man is but a visitor"), rather the lack of fire usually creates an environment or ecosystem that has *never before existed* (Pyne 1995 and Schiff 1962).

Nancy Langston pointed out that the federal foresters at the turn of the 20th Century, under the guise of "scientific forestry," firmly believed that:

they had come to save wild nature. But the forests and grasslands were not natural, nor were they wild, if by natural and wild we mean free of human management. Indians had been changing those lands for millennia, reshaping them according to their needs and desires. The forests that so pleased the whites were in large part artificial....[White settlers] hated the fires that swept through the mountains, and usually saw the Indian burning practices as threatening the open [Ponderosa] pine forests they loved. They failed to realize that excluding fire would lead to the demise of what they liked most about the forest (Langston 1995: 42).

John Minto, who did not like the forest reserve system in Oregon and opposed their management (the exclusion of sheep or the reduction in the amount or timing of sheep grazing), noted as early as 1897 that by preventing fires, the oak forests and open prairies of the Willamette Valley in Oregon have changed:

As much of it was not in forest when the white man came here had been made open, and the openings were kept so by grass fires, set by the native [Indian] race. It is now 50 years since the pasturing on the open range lands of the Willamette valley by domestic

stock prevented the further use of dry grass fires. It is also 50 years since the most destructive forest fires occurred on the coast side of the Coast range, and on the Cascade range near Mount Jefferson, both set out, I believe, by the Indians, who yet take their horses to the Cascade range for summer pasture. Since the dry-grass fires ceased in Western Oregon reforestation has been steadily carried on as far from mature trees as the winds would carry the seed of the Douglas fir; so that tens of thousands of acres of what was open land 50 years ago grew into dense forests....there is a greater area in Oregon of timber growth today than there was 50 years ago (Williams and Mark 1995: 457).

Along the same line, Daniel Botkin (1990), George Gruell (1985), and Samuel Wilson (1992) noted that after Indians, with their methods of burning the forest understory, were removed to reservations or killed by disease and warfare, the forests in the East and the West changed:

English settlers recorded a marked shift in the forest vegetation after the Indians retreated farther west. 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 (Wilson 1992: 16).

Reintroduction of fire into these ecosystems, to emulate the past practices of American Indians, on its face sounds both interesting and timely (Saveland 1995). Recently, Secretary of the Interior Bruce Babbitt commented on the growing problem for federal forest land managers:

In Idaho's Sawtooth Mountains, 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. A tinder box....In crowded forests, weakened trees become more susceptible to insects and disease [and wildfire]...

Why is this happening? To find the answer, we must ask Idaho's oldest living historians, the ancient ponderosa pines themselves. Their language, inscribed in the growth rings....once translated the story is unequivocally clear: ...through the 1880s, the annual rings are blackened by fire scars on every seventh to tenth ring [which indicates that] light, non-lethal ground fires swept under that tree and through the forest every seven to ten years....

Then, about 115 rings ago, the...tree ring pages no longer bear the telltale black smudges, meaning that the frequent, low-intensity restorative fires were no longer burning across the forest floor...Ninety rings ago, when fire exclusion became the mission of the newborn Forest Service, the number of ponderosas per acre had doubled (Babbitt 1997).

In some cases, the agencies will be faced with a public that has been so ingrained with the Smokey Bear ethic that taking fire back into ecosystems seems at odds with decades of anti-fire promotions. For others, the reintroduction of fire will appear to be a waste of a valuable resource (trees), while for some it will be a long overdue savior of the federal forests. In reality, it is none of the above:

The inability to control all fires was aptly demonstrated during the summer of 1994, when wildfires burned approximately 3.3 million acres of the Western United States—despite full suppression efforts. Most media accounts called it a "disastrous summer," but from an ecological perspective, the acreage burned was not nearly enough. Intense and wide-ranging fires at times may in fact be necessary for ecosystem health and forest regeneration...

[Jeff] Manley [from Kings Canyon-Sequoia NP] say the idea of "friendly flame" or "small fires creeping about the underbrush" was promoted as the answer to fuel buildups.

However, research by [Linda] Mutch [from the National Biological Service] and other scientists is calling into question such policies, Manley says...This leads to a critical policy problem. The only time hot, intense blazes necessary for rapid removal, as well as maintenance of some ecosystem processes, occur is when severe conditions prevail. Yet, as a matter of policy, most [federal and state] agencies call for fire suppression under these extreme conditions (Wuerthner 1995: 35-36).

There are a number of questions for ecologists, natural resource managers, and the public relating to the reintroduction of fire into ecosystems. These are questions that deal with philosophical concepts of the positive benefits of fire in ecosystem restoration work:

- Are ecosystems *natural or human constructs*?
- Are *humans* part of ecosystems?
- How many years does it take for humans to be considered as a *natural, native species*?
- Should we consider ecosystems, and the many components, *without people*?
- Are *humans the issue* or the problem in ecosystems?
- Should humans be *excluded*?
- Are humans the *solution*?
- 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 or animals)?
- Should we include knowledge of past human-caused changes in *future management*?

Saving the Forests - All Fire is Bad

Conservation or scientific forestry, since its beginning with Gifford Pinchot in the late 1890s, came to believe that fire was the bane of the forests. Forest fires had to be eliminated in order for the forests to grow and thrive. Forest fires not only destroyed the standing trees but burned the fragile seedlings and young trees springing forth for the next generation of forest. Fire was seen as the moral and mortal enemy of the forests (Saveland 1995 and Schiff 1962). The understanding that humans influenced ecosystems through the use of fire:

shifted after European settlement in North America, when it was believed that fire, unlike other natural phenomena, could and should be controlled. For many years fire was aggressively excluded to protect both public and private investments and to prevent what was considered the destruction of forests, savannas, shrublands, and grasslands. While the destructive, potentially deadly side of fire was obvious and immediate, changes and risks resulting from these fire exclusion efforts were difficult to recognize and mounted slowly and inconspicuously over many decades (Federal Wildland Policy 1995: 1).

Some settlers in the West and South--and other places as well--undertook efforts in the late 1800s and early 1900s to "light-burn" or sometimes referred to as "Paiute forestry." This burning technique was thought by the forestry professionals to be very destructive to young trees, which it is to some species, but beneficial to others. The Forest Service experimented with so-called "light-burning" during the late 1910s, but found that this was very dangerous (Graves 1920; Greeley 1920; Olmsted 1911; Roth 1920; and Schiff 1962). Therefore, people setting these type of fires, similar to earlier Indian techniques, were effectively stopped after the turn of the century. Jim Saveland noted that Henry Graves and William B. Greeley (2nd and 3rd Chiefs of the Forest Service, respectively), firmly believed that stopping fires in the forests was the key management philosophy:

Chief Forester Henry Graves declared in 1913 that "the necessity of preventing losses from forest fires requires no discussion. It is the fundamental obligation of the Forest Service and takes precedence over all other duties and activities." Chief William Greeley's autobiography begins with recollections of the 1910 fires [in the Northwest]

and the statement, "fire prevention is the No. 1 job of American foresters." He openly professed that he considered "smoke in the woods" as the yardstick of progress in American forestry...(Saveland 1995: 18).

In 1921, Chief William B. Greeley arranged the first national conference on the subject of fire. It was called the Mather Field Conference. "The decade preceding this conference was marked by controversy between advocates of fire protection/suppression. Fire control and light burning were viewed as an either/or proposition...[Afterward,] the protectionist policies formulated by Coert duBois, Stuart Show, and E.I. Kotok became dominant (Saveland 1995: 14)." This conference was the ending of the light-burning arguments and the beginning of the concerted efforts to stop all fire in the forests (Pyne 1982).

As early as the 1930s, the Forest Service, came to realize that in certain areas fire was actually beneficial:

It has been a surprise and shock to many to learn that the whole South does not fall nicely into a simple national pattern in which the policy of complete fire exclusion uniformly applies. During the last few years there have been loud and indignant protests from some quarters of the longleaf pine belt against fervent, emotional fire-prevention propaganda. In fact, so serious became the question of fire policy that the Forest Service felt called upon in 1932 to issue a statement ["Federal Policy Relating to Controlled Burning in Cooperative Fire Protection in the Longleaf Pine Region" by Forest Service Chief Robert Y. Stuart, report dated June 16, 1932] recognizing the possibility of using controlled burning in the longleaf pine type... (Harper 1937: 230).

Fighting forest fires by federal forest rangers was only half-hearted at best from the 1890s to 1930s. Many times during the earlier years, fire fighters were putting out spot fires, fighting larger fires within safety limits, or simply "herding" the fires until the fall rains or snow put the fires out. Additional help, if there was any, often came from nearby communities and farms, sometimes from the cities. There was little training except for the handful of Forest Service fire fighters. There was not a large ranger force, or money, to employ hundreds or thousands of firefighters to fight the large and very large forest fires.

From an earlier era, a Klamath National Forest district ranger had an interesting idea that he shared in a letter to his forest supervisor to use missionary assistance to keep the Indians from burning the forest:

I have a scheme up my sleeve which may make you laugh, but never the less I am in earnest about it, and it might work out to good advantage. There is this lady here, Mrs. Watkins, who has been here over a year doing general missionary work amongst the indians [sic]...My scheme is as follows - Let the [Forest] service hire this woman to work amongst the indians on a general educational basis. She could go to work about May 1, and her duties would be to travel up and down the river between Orleans and Elliots, stopping at different indian houses, talking to them in regards to their own welfare, but the principal point to impress on them would be the fire question. This woman can do more in one season towards causing the indians to adopt our theories in regards to fire than we can do in five (Harley 1918: 2).

In 1933, with the advent of the Civilian Conservation Corps (CCC) literally thousands of young men were trained in fire fighting techniques then placed on fire lines when needed. The CCC made a big difference in the capability to reduce fire losses and put out forest fires on federal, state, and private lands. It is only during and after this period that there were enough firefighters to make a difference.

During World War II, forest fires were felt to be the enemy, just as much as the soldiers and sailors fighting in battle. Before the end of the war, the Smokey Bear image came to be identified with the anti-forest fire campaign. Then in 1950, a real bear was located to embody the notion of Smokey. He was transferred to the National Zoo in Washington, DC. One of the most identifiable images in the media today, Smokey has influenced millions of young people with the posters, comic books, toys, radio and

television spots, films, and the famous slogan "Only You Can Prevent Forest Fires" (Chase 1995; Lawter 1994; Lewis 1973; Morrison 1976; and Robbins 1985). However, this 50-year legacy of Smokey, and the federal agencies, putting out all fires is beginning to change.

When Nat Stephenson, an ecologist with the National Biological Service working in the Sierra Nevada forest of California, sees the charred boles and snags of burnt trees, he smiles. He takes it as "a sign that ecosystem processes are going along as they have in the past." Such an attitude toward fire is still not widely held by the American public. Ingrained with the Smokey Bear mantra that "only you can prevent forest fires," most people view fire as a destructive force that must be contained and suppressed. The problem is that fire suppression is not a solution (Wuerthner 1995: 33).

Today, the fighting of forest fires is almost a full-time occupation. Fire fighting in the nation's forests involves highly coordinated efforts between the Forest Service, Bureau of Land Management, National Park Service, Fish & Wildlife Service, Indian tribes, state forestry departments, and many local fire fighting organizations (Haglund 1998). At times, such as when the 1988 Yellowstone and 2000 fires were raging, the fire fighting forces were assisted greatly by national guard and regular army troops. However, the fighting of fires can be a very dangerous lifestyle, as evidenced by the 14 fire fighters who perished after being caught in a quickly spreading, deadly fire—called the South Canyon/Storm King Fire—near Glenwood Springs, Colorado, on July 6, 1994 (South Canyon Fire Accident Investigation Team 1994). The situations become even more dangerous when excess fuels litter the forest floor or small shrubs and trees form "ladders" for fires to jump to the tops of the tree stands and "crown" or burn excessively hot, killing the trees and savaging the soils.

Saving the Forests With Fire - What Can Be Done Today?

Today, forest managers are faced with a situation where forest fires are beginning to be valued to "save the forests." It is ironic that for more than a century (especially 50 years of Smokey) that the federal agencies can even talk about the need to burn, and that all fire is not "bad" (Pyne 1982; Saveland 1995; Schiff 1962; and Tall Timbers Research Station 1998). Although there has been widespread use of prescribed fire to prepare an area for planting after timber harvest, the purposeful introduction of fire into standing forests is relatively new and somewhat controversial, especially among the fire control professionals. However, the controversy is more than 60 years old, as noted by V.L. Harper:

There seem to be two different forms that a [national] fire policy might take:

1. Should fire exclusion be the public policy with fire used only sparingly, if at all?
2. Should controlled burning be recognized in the public policy?

There appears to be some foundation for the belief that if the latter alternative were accepted as a management measure [or]...if fire is truly a part of forest management, just as thinning is....forest management would then be the main issue and not fire exclusion. As many are quick to point out, the trouble with such a policy is that reform would be slow. Good psychology would dictate making an issue of something simple to preach (Harper 1937: 230).

For the most part, the Forest Service, related federal land management agencies, and the states responded to the fire policy question with a uniform notion of complete exclusion (alternative one above). This total exclusion of fire in ecosystems is often touted as the reason that today there is a forest health crisis in the West. However, the problem started 50-200 years earlier with the exclusion of the American Indian. The Indians for thousands of years used what today we would call "prescribed fire" to improve the forests. Almost 20 years ago a study of prescribed fire use, in relation to deer populations, noted:

An experiment has been carried out by foresters [in California] on the effect of planned burning. In dense, unburned chaparral areas the deer count was 30 per square mile.

After the first burning of the study area the count of deer rose to 98 per square mile. This figure went up to 131 per square mile in the second year, presumably as a result of increased feed. By the fifth and sixth years the count had dropped to 84. Testimony from the Indians is clear on the point that they were well aware of the beneficial effects of burning off chaparral areas at intervals to increase the deer supply. The problem now is how to start the process again after a lapse of more than a century...As land managers, the Indians were in some ways far ahead of us today (Heizer and Elsasser 1980: 73).

The federal agencies, which administer the largest amount of contiguous forest land in the U.S., tout that they can recreate the park-like, presettlement conditions that greeted the first explorers and settlers (Babbitt 1997). Ironically, during the 1990s, it has been found that a "light touch" or prescribed fire, if carefully controlled, can yield excellent results in the forests, eliminating or reducing fuel loads, burning out the underbrush which can choke new trees, as well as stimulate new seed production and natural regeneration.

The Forest Service and the Bureau of Land Management administer several hundred millions of acres of grazing/grassland, where Indian burning techniques can and should be used. Several western states have hundreds of thousands of acres of state forest lands which are administered by their departments of forestry or natural resources. Potentially, these forest lands could or should also have restoration efforts, including Indian-type fire, applied to those areas. Large industrial private lands owners and managers could use fire on their lands, but it seems unlikely that they, for the most part, will be managing their forests for anything other than maximum fiber production. There is an area where some fire or similar techniques could be used - private woodlot owners.

In restoration of ecosystems or improving forest health, time becomes a problem. Are the agencies talking about 25, 50, 100 years ago during the settlement and modern era? Or perhaps the meaning of restoration and health really means the pre-settler/trapper era of 150 to 300 years ago. How about the pre-Western influence era or pre-1492, or even the pre-Indian era of more than 12,000 years ago? Which time period is chosen as the "target" will have many implications for ecosystem restoration efforts (Flores 1997 and Forney 1993). Nancy Langston observed:

trying to recreate an ideal forest community from the past would be hopeless. As the example with fire suppression and root patterns shows, 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. Each disturbance, whether human or natural, represents a branch in the path of forest history, and each action takes the forest in a slightly different direction. 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 (Langston 1995: 39).

In addition, the Federal agencies have the problem, if they chose some arbitrary date or era, of trying to lock in one particular time period in a dynamic system and calling it "natural." Realization of the use by people since the last "Ice Age" in North America throws into question what could/should be considered "natural ecosystems" that have not been influenced by humans: "the goal of maintaining or creating conditions as they would exist without people, a 'natural' landscape...is not easy as it might appear, however. We cannot remove people and expect that their past influences will disappear (Russell 1997: 87)." Author Emily Russell continues to explain:

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 (Russell 1997: 151).

Steve Pyne, prolific fire researcher and writer, also wrote recently on the subject of 'natural processes' and the role of humans, especially the American Indians who lived with the North American environment for many thousands of years before the advent of the European settlement:

Re-creating the vegetation at the time of European discovery 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. It was those native peoples who made the wilderness "wild," which is to say, exotic, unpredictable, dangerous, exciting, and wondrous to those for whom it was not already home. Similarly dismissing the things those people did, including burning, only sustains a landscape that is historically incomplete (Pyne 1995: 244).

The same problems apply to the concept of "range of natural variability"—how far back should the variability extend, do we even know what the true extent of flora and fauna actually existed at any point in time, and even if we did know, how could we recreate such an environment today (Flores 1997; Forney 1993; Kilgore 1985; Pyne 1995; and Shrader-Frechette and McCoy 1995)? Most ecosystem restoration efforts today (at least on the federal lands that dominate the West) rely on this range of variability, documented through extensive research efforts, to assess current forest health. Knowledge of the range can give managers some idea about what can or should be done with the flora and fauna on the land. However, restoration of ecosystems, especially those that are or were fire dependent for thousands of years, will not be an easy task. It will take much work, time, and money to accomplish.

Bruce Kilgore (1985) noted that not all fire researchers and managers agree that simulated Indian burning should be a management tool. In a survey Kilgore conducted with fire experts from around the country, he found eight basic objections to the reintroduction of aboriginal-type fire:

1. It has not been demonstrated that Indian burning played a significant role in altering forest ecosystems.
2. We will never have sufficiently accurate data to understand the extent, season, and intensity of Indian fires.
3. We do not simulate other factors that have changed--extirpated plants and animals, Indian hunting, and Pleistocene glaciers.
4. Lightning fires were a major source of fire for millions of years, yet the Indians have only been here a short time--minor in evolutionary or ecological terms.
5. Simulating past Indian burning would amount to preserving an artifact; systems must be free to evolve.
6. What is our goal/objective? Do we want to maintain processes as they existed before Europeans arrived or before all human beings arrived?
7. In some areas, frequent Indian fires and lightning fires have the same impact on vegetation.
8. We have come too far to expect society to accept simulated Indian fires in parks and wilderness (adapted from Kilgore 1985: 61-62).

Answers to these eight objections to the reintroduction of fire into ecosystems involve far more extensive explanations than can be provided here. Yet some short answers may help:

- 1) Indian fires were utilized extensively in almost every locality or ecosystem of North America, although not every area was burned.
- 2) 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) Other ecosystem components (e.g. wolves in Yellowstone) are being looked at for reintroduction, just like fire.
- 4) Lightning has caused fewer fires in the forests and especially the prairies than previously thought, and with many areas of forest and underbrush being lightly burned regularly, there was less of a chance that lightning could have caused major damage.
- 5) Ecosystems currently in most parts of North America have coexisted with fire for millennia, we are striving to keep these systems going, if possible.
- 6) The goal is to revive or renew ancient fire regimes, which may produce more "healthy," fire-adapted, resilient ecosystems.
- 7) Lightning does not cause fires at the same time of year as do human caused fires--lightning fires are hotter and very difficult to control, Indian-type fires are cooler and relatively easy to control.
- 8) Indian-type fires may be the only way to prevent potentially damaging wildfires (e.g. Yellowstone National Park), prevent insect and disease outbreaks, and restore ecosystems. The biggest problem with the reintroduction of Indian-type fire on a regular basis will be the issue of smoke and the public.

There are many opportunities for managers and specialists to engage in research activities dealing with fire adapted ecosystems. One important aspect of fire history is to discover what research has already been completed on the "original" vegetation and document any changes that have occurred over the last 150-250 years (Seklecki et al. 1996). This may involve digging into old books and archives, as well as USDI Bureau of Land Management (General Land Office until 1946) field survey notes, USGS forest surveys, and other repositories of land and vegetation data. After an extensive paper/map investigation, the next step would be to talk to or interview older residents and American Indian tribal elders on how they manage or managed the land. When these preliminary sources are compiled, there is still the problem of interpreting the results. Clinton Phillips explained: "look at fire history in an area to determine the natural role of fire. But...that history [may 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....managers must use extreme care in translating the information into current fire management programs (Phillips 1985: 89-90)."

Another method of simply abandoning most forest areas to let "Nature" work--through lightning-caused fires, floods, disease, and insect outbreaks--is not going to return the forest to "natural conditions" (as noted above). Starker Leopold, as quoted in Bruce Kilgore's article, noted that "if the area is ready to burn, it makes little difference...whether the fire is set by lightning, or by [a forest manager or scientist],...so long as the result approximates the goal of perpetuating a natural community....Management issues of this kind involve judgment, followed by action. They are not resolved simply by allowing natural ecosystem processes to operate (Kilgore 1985: 65)."

A recent notion of letting natural fires burn has been called the "let-burn" policy. Although the idea has been around for decades, as a national forest and national park management policy it came under attack in the aftermath of the Yellowstone fires of 1988. Although it was shown that the Yellowstone fires were not caused by letting fires run free in the park, any mention of this management philosophy or tool became such a problem that agencies no longer use the term (Arno and Brown 1991 and Czech and Ffolliott 1996).

Restoring the Forests - Unresolved Issues

The federal land management agencies are currently espousing the theme of ecologically-based (ecosystem) management. As with the recent Interior Columbia Basin Ecosystem Management Project (ICBEMP) environmental impact statement has shown, restoration of ecosystems in the northwest interior will be a prime management consideration for the future. Restoration of Indian-type fires, as well as prescribed burning and thinning, are important components of many restoration strategies. Jim Saveland, Forest Service fire ecologist, suggested that:

disturbance ecology in general and the use of prescribed fire in particular be considered core competencies of the agency. Prescribed fire is one of the most powerful tools available for the silviculturist, the range manager, the wildlife biologist, and the wilderness manager. Prescribed fire is desperately needed to restore the health of the long-needle forests and other fire-adapted communities... (Saveland 1995: 18).

Ironically, forest areas that are on Indian reservations—some 17.1 million acres mostly in the West and Southwest—have received similar treatments as have the federal forests and parks, i.e. when a fire starts in the forests or grasslands, put it out at any cost, the sooner the better. Even the Indian tribes, after decades of seeing the trees on the western Indian reservations as income for self determination rather than forests, are also changing:

Although tribes remain deeply committed to wildfire firefighting and fire training, there is a separate, but no less important desire to return fire to tribal forest ecosystems...Fire ecologists and tribal foresters view prescribed fire as a useful tool for reducing moderate natural fuel accumulations, or changing species composition, vegetation structure or density. Taken together, these fire-related benefits will help restore natural diversity, eventually improving the health of at-risk forests, woodlands and rangelands.

Currently, prescribed fire is being used to treat about 55,000 tribal forest acres annually, less than 20 percent of the 300,000 acres that could benefit from periodic controlled fire. Another 1.5 million acres, many close to communities, are considered unsuitable for prescribed burning because of air quality concerns, or because excess natural fuel accumulations prevent safe fire use (Haglund 1998: 44).

Secretary of the Interior Bruce Babbitt, always a strong supporter of prescribed fire on the federal forest and grasslands, recently stated:

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 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...At 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 (Babbitt 1997).

As recently as October 22, 1998, a two-page briefing paper was written by Dave Bunnell, the Forest Service national fuels specialist, which highlights the issue of the need to change the national fire management program. These proposed changes will impact to the agency, the public, and affected ecosystems in many ways:

Fire management programs are undergoing dramatic changes. The past five years have marked an interagency fire policy change which promotes the use of wildland fire to meet preplanned resource objectives in and out of wilderness. The fuel treatment...has increased prescribed burn acreage from a 10-year average of 385,000 acres to 1.25 million acres in 1998...

We have general direction provided at the National level...The publication, "Course to the Future: Positioning Fire Management," shows us that fire-adapted ecosystems are at great risk to loss from wildland fire. This document defines long-range goals for fuel treatment of 3MM [3 million] acres annually by the year 2005 in these ecosystem types and a dramatic increase in funding to \$120-\$150MM annually...

We find ourselves moving forward, but not fast enough to meet the needs of the program. Fire managers alone cannot achieve the goals of the program without the understanding, commitment, and support of line officers through the revision of current Forest Plans. Fire managers must also commit to needed changes in program and skill mix, workforce analysis and resource priority setting...

Success in the program will be measured by increasing firefighter and public safety, decreasing fire suppression expense, increasing forest and range health and minimizing the consequences in inevitable wildland fires on valued resources and smoke production on social values...

Additional fuel buildups and urban sprawl add complexities that may defeat our technical capability at increasing rates...We need to address these program changes quickly and effectively, or risk exorbitant costs, potential increases in property and resource damage, loss of life and dramatic changes in ecosystems that have historically been maintained by fire (Bunnell 1998: 1-2).

Restoring ecosystems through the use of fire, assuming human-caused prescribed fire, runs many risks. One of the most troubling is the **cost**. Prescribed fire management to restore a forest or watershed to mid-18th Century conditions will not be cheap. This type of fire management will, depending on the site, require extensive pre-work, multiple entries, and careful monitoring and control. The risk of an "escaped" fire is always high in the list of issues. The increased risk to human life and property has to be considered in the overall plan.

An editorial in the *Missoulian* (Missoula, MT) on August 24, 1998, noted some of the many concerns with the modern use of fire in ecosystems:

Interior Secretary Bruce Babbitt...did us all a favor last week in publicly voicing his support for allowing some wildfires to burn largely unimpeded by firefighters. The government policy of allowing certain lightning-caused fires to reclaim their natural and necessary role in shaping healthy forests isn't exactly new. Nor is high-level support for the policy. But support for natural-fire policies tends to run strong in, say, the middle of February, and tends to diminish once fire season reaches its peak. There's nothing like fire on the mountain to get people excited....the notion of fire as an unmitigated evil has been so ingrained in the minds of the public that it's not altogether easy to get people to embrace a more complicated understanding of fire. 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, but people often tend to react emotionally when the flames kick up.

Smoke in the atmosphere is a growing problem for land managers and owners. The Environmental Protection Agency (EPA) is greatly concerned with keeping the air clean and pure as possible for human health reasons under the Clean Air Act of 1990 (and earlier) provisions. Also, there is the smoke problem in terms of visual disturbance, even miles from the fire source (Federal Wildland Policy 1995 and Potter and Fox 1996). Managing smoke from fires is not an easy task:

Smoke management has two primary components, i.e., management of the fire process itself to minimize the generation of pollution and utilizing the dispersive nature of the atmosphere to dilute emissions before impacting people and population centers. The former, managing the fire itself, is much preferred in pollution prevention. However, fire process management to minimize smoke production is often at odds with other aspects of fire management objectives (Potter and Fox 1996: 206-207).

Ironically, the State of Oregon, which has not had Indian-set fires for 150 years, allowed grass farmers in the Willamette Valley of western Oregon to burn their grass and wheat stubble every fall to rid the fields of insects, disease, and unwanted vegetation. After one especially smokey, fall day in the early 1970s, people became agitated, contacted the governor of the state, and petitioned the state to ban field burning. After decades of battles, by the late 1990s almost all field burning has stopped. Yet it is doubly ironic that historical accounts of smoke in the western valleys, which sometimes were very dense for weeks or months every summer and fall, were almost always associated with Indian fires.

A similar problem with field burning has cropped up in SE Washington State in the rich farmland of the Palouse region:

The president of Save Our Summers, she [Patricia Hoffman] successfully led an effort to all but eliminate Eastern Washington farmer's longtime practice of burning their bluegrass fields to increase seed production. Along with the American Lung Association and Spokane-area doctors, she filed suit last month [September 1998] against the federal Natural Resources Conservation Service to keep it from letting farmers burn wheat stubble..."It's unsafe to live in Eastern Washington now," she said. "People should be warned before they come here." But by attacking stubble burning, farmers say clean-air advocates end up pitting one environmental value - clean air - against clean waters and erosion-free [no-till] farming. It's a classic farm-city conflict... (Sorensen 1998: A22).

With the possible reintroduction of Indian-type fires in ecosystems, smoke in the atmosphere that may affect human health may be the most restrictive aspect to this management tool in the future. Tied closely to this is the need to keep smoke out of Class I air-sheds over national parks and most wildernesses for scenic quality (National Academy of Sciences 1993).

There are also concerns about **soil nutrient** gain or loss from these fires. If the prescribed fires are very hot, there is the problem of reducing soil productivity through loss of nutrients, as well as killing many of the life necessary microscopic fungi, insects, and plants. If the fires are "cool" (as the Indians tended to use) then nutrients can more easily be transferred to the soil, but this may not always be the case. In addition, there are new ecosystem guidelines for the Forest Service and the Bureau of Land Management to conserve as much down, woody material as possible on forest sites. Yet there are at least two problems that need to be addressed: Woody debris, left over from logging operations or natural tree and branch fall, can under the right circumstances be a haven for insects and diseases that could be devastating to standing trees. This woody debris also can have the disadvantage of creating a large, potentially dangerous, fuel load, which can make fires burn hotter and cover more acres (Potter and Fox 1996).

The intent of reducing the fire **fuel load** in the forests is only part of the solution. Some forest areas because of drought, insects, and disease have serious build-ups of fine fuels. Because of multi-aged stands, with trees of all ages and species intermixed, there are the so-called "ladder fuels" which allow fire to be transferred quickly from the ground to the crowns of the tallest trees. The ability to reduce these fuels loads will not be easy and will be very expensive. The heavy fuel loading has been caused by the lack of fire in the earlier stages of forest growth.

There are **silvicultural techniques** that can be used effectively in making a tree stand less susceptible to catastrophic fire. Often talked about is the use of silvicultural methods (e.g. thinning) to remove unwanted trees and debris (fuel) on the forest floor. However, the use of these methods alone should not be considered as having the same long-term, ecological impacts as Indian-type fires in the ecosystem. Moreover, these methods are not easy to plan or cheap to implement.

A recent research/management project in northeast Oregon Blue Mountains area highlights the problem and tasks of using mechanical thinning to restore ecosystems:

The scale of the fuel problem in [Columbia River basin] east-side forests is hard to comprehend. For nearly a century, we have successfully suppressed fires, especially the lower intensity kind that feed off the debris on the forest floor. During the same period, the forests have tended towards fir rather than [Ponderosa] pine. This has all set the stage for much more extensive and hotter fires. "Historically, the Blue Mountains experienced many more lower intensity, surface fires [which are consistent with Indian burning]. These less extensive and less intense fires tend to preserve large forest structure," [Forest Service Researcher Jim] McIver explains...

There [above the community of La Grande, Oregon] in 1996, the La Grande Ranger District [of the Wallowa-Whitman NF] identified the Limber Ridge as a high-priority fuel-reduction project with up to 80 tons per acre of potential fuel. Managers worked with researchers to design, implement, and monitor a plan to reduce fuel. Their objectives were to measure fuel reduction, soil disturbance, and operational economics in three replicate stands, as well as to monitor potential effects on wildlife...

McIver recalls many challenges: reduce fuel to about half of observed loadings by removing both standing and down dead wood; remove some smaller diameter green trees to create growing space for the residual stands; accomplish fuel reduction economically and without damaging the residual soils or stand; and demonstrate sensitive and feasible logging practices for fuel reduction on a larger scale (Duncan 1998: 2-3).

The methods of choice today seem to indicate that a **combination of methods** should obtain the desired effects. Silvicultural techniques can remove unwanted or overgrown vegetation, thus creating conditions such that Indian-type fire could be reintroduced (Devlin 1998; Eskew et al. 1995; Federal Wildland Policy 1995; and Schindler 1997). Sherry Devlin, writing for the *Missoulian* newspaper, talked with Mike Hillis, a wildlife biologist from the Lolo National Forest, and Steve Arno, research scientist at the Intermountain Fire Sciences Laboratory, and Dave Stack, district ranger on the Missoula Ranger District of the Lolo National Forest:

By keeping fire out of fire-dependent forests, the Forest Service radically changed the ecosystem, Arno said. Douglas firs filled in the spaces between the big old pines and larch until the forest was a thicket...Ironically, Hillis said, the only way to save the old growth now is to log these mountainside timber stands. Log the Douglas fir, leave the pine and larch, living and dead. Give the big trees the space they need, then give them the low-intensity fire they need. "We have to whack some trees and put in some fire,"

Hillis said. "If we want to grow old trees - if we want to grow deer and elk - we have to let fire back in the forest."...

The resulting forest will not look like the dense forests to which the public has grown accustomed over the past 80 years...."What we've realized is that all these natural processes - fire, insects, disease and windthrow - have a place in the forest," he [Hillis] said...But, said [District Ranger Dave] Stack, it's not that easy to get them back into balance. "Historically, these were processes that happened a little bit at a time," he said. "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." There really is no way to restore fire without first thinning the trees, Stack said. "It is going to take a long time, 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."

As the American Indians found out many years ago, low intensity fires can reduce unwanted vegetation and fuels, combat insects, and kill diseased trees before they become transmission agents to the rest of the forest. Yet prescribed fires only treat the symptoms—they are not the solution. In areas that have a long history of fire regimes, intensive management by fire is more than just reduction of fuel loading. The forests and grasslands will have a much different "look" to them after fires are returned. Jim Saveland explained his vision for restored fire-adapted ecosystems:

I see open stands of large pine trees (for example, longleaf pine in the Southern Coastal Plan, 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 (Saveland 1995: 16).

CONCLUSION

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 12-30,000 years ago, adapted to the environments that they found and they adapted the environment to their survival. Fire was been the major tool that American Indians used to change ecosystems to their survival.

Little of the original open prairie remains today as millions of acres have been transformed into farms, pastures, highways, and cities. However, federal land managers still control millions of acres of forest land. The federal forests are currently being managed under an ecosystem-based approach where the reintroduction of Indian-type fire is a distinct possibility.

The basis for much of the "forest health crisis" of today really started with the almost complete cessation of Indian burning in the early 1700s in the East and the 1850s in the West. The common reason that many state for this crisis was the advent of the forest rangers and the Smokey Bear mentality since the turn of the 20th Century. Part of that is true, but not as much as some people would like to believe. We must remember that the agencies have not created problems by fighting fires, rather the problems began years before with the cessation of Indian caused fires.

It is no wonder that ecosystems today have great forest health problems (accumulated fuels, diseases, and insects). Federal land managers are constantly faced with a forest situation which is explosive. Starting fires to emulate Indian burning techniques may be too late for many areas to return them to a pre-settlement period. Many, but not all, Indian fires burned prairies and forest areas with low intensity, but high frequency burns. Only occasionally, especially during times of drought, were the forests and prairies ravaged by unchecked fire. Threat of wildfires still haunt the federal land management agencies today and millions of dollars are spent annually to fight these forest fires.

We have the ability today to change the management of the federal forests, yet several fundamental questions remain: One problem is 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 our predecessors in trying to manage for what we as professionals believe is the "right thing to do"?

One important factor to remember is that to restore human-caused (Indian) fire to ecosystems is *not the same* as allowing lightning-caused fires to burn until the fall rains or snows put them out or through a prescribed fire program to reduce fuel loading in the forests. Lightning-caused fires most often start in the late summer or early fall, when heat is high and humidity is low—which is not when most of the Indian-caused fires were usually started. Fuel reductions—to lower the threat of wildfire—can be accomplished by prescribed burning in combination with clear cutting, selection harvesting, thinning, grazing, or even raking and piling of fuels.

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 "healthy" forest and grassland at all scales should have open prairie-like conditions, shrub areas, young trees, mature stands, and old-growth trees. But to do so, the federal land managers and the public need a shared vision of the future. It will not be easy, it will not have everyone in agreement, and it will be expensive.

Jim Saveland concluded his 1995 article with the following, which still has application:

And perhaps it is time to 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 defacto symbol of the Forest Service (Saveland 1995: 18).

APPENDIX A

DOCUMENTED PURPOSES OR REASONS FOR INDIAN BURNING

As noted earlier, documentation for the Indian use of fire is sometimes weak or nonexistent with many writers not taking the time to ferret out the original sources, identify the particular tribes, time of year for burning, or even the purposes for which they burned. This has led many researchers to conclude incorrectly that lightning, not humans, caused all the "natural" fire scars that have been observed in many parts of North America.

In other cases, the evidence is very strong and convincing. One such study, actually a film, was produced by Henry T. Lewis. The 33-minute long film entitled "Fires of Spring" documents the Indian/First Nations people of northern Alberta, Canada, in their traditional use of fire in ecosystems, as well as their contemporary use of fire.

Keeping large areas of forest and mountains free of undergrowth and small trees was just one of many reasons for using fire in ecosystems. What follows is a **summary** of eleven documented purposes of reasons for changing ecosystems through *intentional* burning by American Indians.

This activity has greatly modified landscapes across the continent in many subtle ways that have often been interpreted as "natural" by the early explorers, trappers, and settlers. Even many research scientists who study presettlement forest and savannah fire evidence tend to attribute most prehistoric fires as being caused by lightning (natural) rather than by humans.

This problem arises because there was no systematic record keeping of these fire events. Thus the interaction of people and ecosystems is down played or ignored, which often leads to the conclusion that people are a problem in "natural" ecosystems rather than the primary force in their development.

Henry T. Lewis, who has authored more books and articles on this subject than anyone else, concluded that there were at least 70 different reasons for the Indians firing the vegetation (Lewis 1973). Other writers have listed fewer number of reasons, using different categories (Kay 1994; Russell 1983; and Whitney 1994).

In summary, this compiler has identified eleven major reasons - see next page - for American Indian ecosystem burning, which are derived from well over 300 studies (Williams 1999):

Interestingly, many of the reasons listed below for burning by the American Indians are the same as those for modern times (Ffolliott, Cabrera, and Guido 1996). See the modern reasons in Appendix B which follows this Appendix.

Hunting - The burning of large areas was useful to divert big game (deer, elk, bison) into small unburned areas for easier hunting and provide open prairies/meadows (rather than brush and tall trees) where animals (including ducks and geese) like to dine on fresh, new grass sprouts. Fire was also used to drive game into impoundments, narrow chutes, into rivers or lakes, or over cliffs where the animals could be killed easily. Some tribes used a surround fire to drive rabbits into small areas. The Seminoles even practiced hunting alligators with fire. Torches were used to spot deer and attract or see fish at night. Smoke used to drive/dislodge raccoons and bears from hiding.

Crop management - Burning was used to harvest crops, especially tarweed, yucca, greens, and grass seed collection. In addition, fire was used to prevent abandoned fields from growing over and to clear areas for planting corn and tobacco. Clearing ground of grass and brush to facilitate the gathering of acorns. Fire used to roast mescal and obtain salt from grasses.

Improve growth and yields - Fire was often used to improve grass for big game grazing (deer, elk, antelope, bison), horse pasturage, camas reproduction, seed plants, berry plants (especially raspberries, strawberries, and huckleberries), and tobacco. Fire was also used to promote or improve plants (such as willow, beargrass, deergrass, and hazelnut), as many were used for important storage/carrying baskets, clothing, and shelter.

Fireproof areas - Some indications that fire was used to protect certain medicine plants by clearing an area around the plants, as well as to fireproof areas, especially around settlements, from destructive wildfires. Fire was also used to keep prairies open from encroaching shrubs and trees.

Insect collection - Some tribes used a "fire surround" to collect & roast crickets, grasshoppers, pandora moths in pine forests, and collect honey from bees.

Pest management - Burning was sometimes used to reduce insects (black flies, ticks, fleas & mosquitos) and rodents, as well as kill mistletoe that invaded mesquite and oak trees and kill the tree moss favored by deer (thus forcing them to the valleys where hunting was easier). Some tribes also used fire to kill poisonous snakes.

Warfare & signaling - Use of fire to deprive the enemy of hiding places in tall grasses and underbrush in the woods for defense, as well as using fire for offensive reasons or to escape from their enemies. Smoke signals used to alert tribes about possible enemies or in gathering forces to combat enemies. Large fires also set to signal a gathering of tribes. During the Lewis & Clark expedition, a tree was set on fire by Indians in order to "bring fair weather" for their journey. At least one tribe in the Northwest used fires set at the mouth of rivers to "call" the salmon to return from the ocean. There is one report of fire being used to bring rain (overcome drought).

Economic extortion - Some tribes also used fire for a "scorched-earth" policy to deprive settlers and fur traders from easy access to big game and thus benefitting from being "middlemen" in supplying pemmican and jerky.

Clearing areas for travel - Fires were sometimes started to clear trails for travel through areas, especially along ridges, that were overgrown with grass or brush. Burned areas helped with providing better visibility through forests and brush lands for hunting, safety from predators (wolves, bears, and cougars) and enemies.

Felling trees - Fire was reportedly used to fell trees by boring two intersecting holes into the trunk, then drop burning charcoal in one hole, allowing the smoke to exit from the other. This method was also used by early settlers. Another way to kill trees was to surround the base with fire, allowing the bark and/or the trunk to burn causing the tree to die (much like girdling) and eventually topple over. Fire also used to kill trees so that the wood could later be used for dry kindling (willows) and firewood (aspen).

Clearing riparian areas - Fire was commonly used to clear brush from riparian areas and marshes for new grasses, plant growth, and tree sprouts (to benefit beaver, muskrats, moose, and waterfowl). Species affected included cottonwoods, willows, tules/bullrushes, cattails, mesquite, as well as various sedges and grasses.

APPENDIX B

BENEFITS OF FIRE IN THE FUTURE

Ffolliott, Cabrera, and Guido (1996) and Wuerther (1995) noted a number of benefits of fire for the future in montane forests, woodland ecosystems, and desert shrub and grassland communities. What follows is a **summary** of those eight reasons for changing ecosystems through *intentional* burning.

Reducing Fuel Loads - Periodic prescribed fires can reduce the ground fuel loading in the forests and woodlands. However, it is necessary to not create a fire situation that will kill existing trees, unless killing the trees is also an objective of the burning.

Disposing of Slash - Timber harvesting and pre-commercial thinning operations leave highly flammable materials. By piling and burning of these woody materials, the threat of wildfire and as a breeding place for detrimental tree insects and disease are greatly reduced.

Preparation for Replanting - The preparation of the soil for tree planting, either as seedlings or with seeds, can be greatly facilitated through the use of burning. Leaf litter, slash, and downed woody material, as well as grasses and shrubs, can be eliminated or greatly reduced by using fire. Careful preparation needs to be taken to 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 require periodic fires to germinate seedlings, e.g. Sequoia, lodgepole pine, and aspen.

Thinning Stands - Fire can be used to thin overstocked, stagnated, as well as insect and disease infested forest stands. Burning can be a low-cost and effective method to reduce the density of existing stands, which reduces competition for the survivors and creates vigorous trees. However, fires can kill too many trees or leave others so badly scorched that they may take years to recover.

Increasing Plant Growth - Certain plant growth can be enhanced through the use of fire. The release of nutrients from the burned woody and other vegetative material can increase soil fertility, soil pathogens can be reduced or killed, and plant vigor can be promoted by the removal of roots and foliage from competing plants and trees. In addition, the removal of tree litter and shrubs can often favor plant growth of desirable, fire-adapted species. Timing of the burns is critical - spring, summer, fall, or even winter may be the best time for particular plants.

Improving Wildlife and Fish Habitats - Food and cover for different species of wildlife and fish can be enhanced (improved) or reduced by the use of fire for years after a burn. Yet managing for deer, small birds, or fisheries will require very different strategies and techniques. Sometimes large open areas will be needed, other times small dense stands are necessary, as well as situations where repeat fires are required. Fires also produce snags for cavity dwelling species, as well as dead trees that fall into streams creating additional fish habitat and aquatic insects.

Changing Hydrologic Processes - Fire reduces litter depths, which can affect soil water and moisture available for trees and plants. Often the more water will flow off the site and some nutrients will leave the area, while others will quickly enter the soil complex. Soils, under heavy rains or melting snows can adversely affect soil stability in burned watersheds for several years.

Improving Aesthetic Environments - Use of fire can help keep the forest open and “park-like” with large trees (e.g. Ponderosa pines). Also burning can protect people and property from wildfires. However, the actual fires and the aftermath are often thought by the public to be detrimental.

APPENDIX C

USE OF FIRE LISTING OF TRIBES THAT HAVE DOCUMENTED BY AUTHOR AND DATE OF PUBLICATION

TRIBE	REFERENCE
Achumawi	Smithsonian (1978a)
Algonquins (Eastern and Virginia)	Smithsonian (1978b)
Apache	Baisan (1990); Baisan & Swetnam (1990 and 1995); Bahre (1985); Fish (1996); Kaib, et al. (1996); Kruse, et al. (1996); Morino 1996; Seklecki, Grissino-Mayer, and Swetnam (1996); Swetnam & Baisan (1996 and In Press)
Bannock	Gruell (1983)
Blackfeet	Barrett (1981); Chase (1986); Gruell (1983)
Cahuilla (Mountain)	Bean (1972); Drucker (1937)
Cayuse	Langston (1995)
Cherokee	DeVivo (1991); Guyette and Cutter (1997)
Chirariko	Smithsonian (1978a)
Chumash	Timbrook, Johnson, and Earle (1982)
Chumash (Emigdiano)	Harrington (1943)
Cocopa	Castetter and Bell (1951)
Coeur d'Alene	Barrett (1980); Barrett (1981); Chase (1986)
Costanoas (Ohlone)	Henson and Usner (1993); Smithsonian (1978a)
Cree	Chase (1986)
Cupeno	Drucker (1937)
Delaware	Guyette and Cutter (1997); Smithsonian (1978b); Whitney (1994)
Diegueno (Northern)	Drucker (1937)
Diegueno (Southern)	Drucker (1937)
Fernadeno	Harrington (1943)
Flathead	Barrett (1980); Barrett (1981); Chase (1990)
Hupa	D. Lewis (1994)
Huron	Guyette, Dey, and McDonnel (1995); Smithsonian (1978b)
Illinois	McClain and Elzinga (1994)
Iroquois	Clark and Royall (1995); Whitney (1994)
Iroquois (Northern)	Smithsonian (1978b)

**LISTING OF TRIBES THAT HAVE DOCUMENTED USE OF FIRE
BY AUTHOR AND DATE OF PUBLICATION
(continued)**

TRIBE	REFERENCE
Kalapuya	Beckham (1986); Boag (1992); Boyd (1986) Bunting (1997); R. Clark (1927); S. Clark (1905); Davies (1980); Douglas (1905); Down (1926); Gibson (1985); Goodall (1903); Habeck (1961); Harvey (1947); Hines (1881); Johannessen, et al. (1971); Lyman (1900); Minto (1908); Morris (1934); Morwood (1973); H. Scott (1924); L. Scott (1923); Sperlin (1931); Stanton (1975); Surdam (1937); Tobie (1927); Winterbotham (1994); and Zenk (1990)
Kalapuya (Tualatin Band)	Beckham, Toepel, and Minor (1982); Smithsonian (1990)
Kalapuya (Yoncalla Band)	Applegate (1930); Hargreaves (1928); Hines (1881)
Kamia	Gifford (1931)
Karok/Karuk	Harrington (1932); Martinez (1998)
Kawaiisu	Smithsonian (1986)
Kipawa	Dey and Guyette (1996)
Klickitat	Bourdeau (1990); Fahnestock and Agee (1983); Filloon (1952); Hunn (1990)?
Kootenai	Barrett (1980); Barrett (1981); Chase (1986); Schaeffer (1940); White (1996)
Kumeyaay	Shipek (1989); Shipek (1993)
Lassik	Keter (1995)
Lehmi Reservation People	Taylor (1974)
Lenni Lanape	Russell (1983)
Luiseno	Smithsonian (1978a)
Machican	Smithsonian (1978b)
Maidu (Northern)	Dixon (1905)
Mandan	Botkin (1995); Cutright (1969)
Miami	McClain and Elzinga (1994); Whitney (1994)
Mingo (?)	Whitney (1994)
Mississippian Culture	Guyette and Cutter (1997)
Miwok (Eastern)	Smithsonian (1978a)
Mohave	Castetter and Bell (1951)
Molalla (?)	Abbot (1857); Minto (1898); Minto (1908)
Mono (Western/Monache)	Kilgore and Taylor (1979)
Narragansetts	Cronon (1983)
Nez Perce	Irving (1843); Langston (1995)
Nipissing	Dey and Guyette (1996)
Ojibway	Martinez (1998)
Ottawa	McClain and Elzinga (1994); Martinez (1998); Whitney (1994)

**LISTING OF TRIBES THAT HAVE DOCUMENTED USE OF FIRE
BY AUTHOR AND DATE OF PUBLICATION
(continued)**

TRIBE	REFERENCE
Paiute (Mono Lake, Ash Valley, and Owens Valley Bands)	Langston (1995); Steward (1933); Stewart (1939)
Patwin	Smithsonian (1978a)
Potawatomie/Potawatomi	McClain and Elzinga (1994); Martinez (1998); Whitney (1994)
Pend d'Oreille	Barrett (1980); Chase (1986)
Pima	Fish (1996); Rea (1979)
Rogue (Athapaskans)	Hannon and Olmo (1990); Poesch (1961); Smithsonian (1990)
Salinas	Henson and Usner (1993)
Salish	Barrett (1980); Barrett (1981); Chase (1986); White (1980)
Seneca	Whitney (1994)
Serrano	Smithsonian (1978a)
Serrano (Kitanemuck)	Harrington (1943)
Shasta	Abbot (1857); Martinez (1998); Smithsonian (1978a)
Shoshone (Lemhi)	Chase (1986); Langston (1995); Steward (1938)
Skagit	White (1980)
Sioux	Botkin (1995)
Takelma	Martinez (1998)
Tillamook	Sauter and Johnson (1974)
Tipai	Smithsonian (1978a)
Tohono O'odham	D. Lewis (1994)
Tolowa	Drucker (1939)
Umatilla	Elliott (1910)?; Elliott (1937)?; Langston (1995); H. Scott (1924); Townsend (1978)
Umpqua, Lower	Waite (1930); Winterbotham (1994)
Umpqua (Cow Creek Band)	Cornutt (1971); Riddle (1953)
Utes	Smithsonian (1986)
Utes (Northern)	D. Lewis (1994)
Warm Springs Reservation	Helfrich (1961); Minto (1898); Oregonian (1899a and 1899b)
Wailaki	Keter (1995)
Winnebago	Whitney (1994)
Wyandotts (?)	Whitney (1994)
Yaqui	Fish (1996)
Yokuts (Northern Valley)	Smithsonian (1978a)
Yuma	Castetter and Bell (1951)
Yurok	Chase (1995)

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