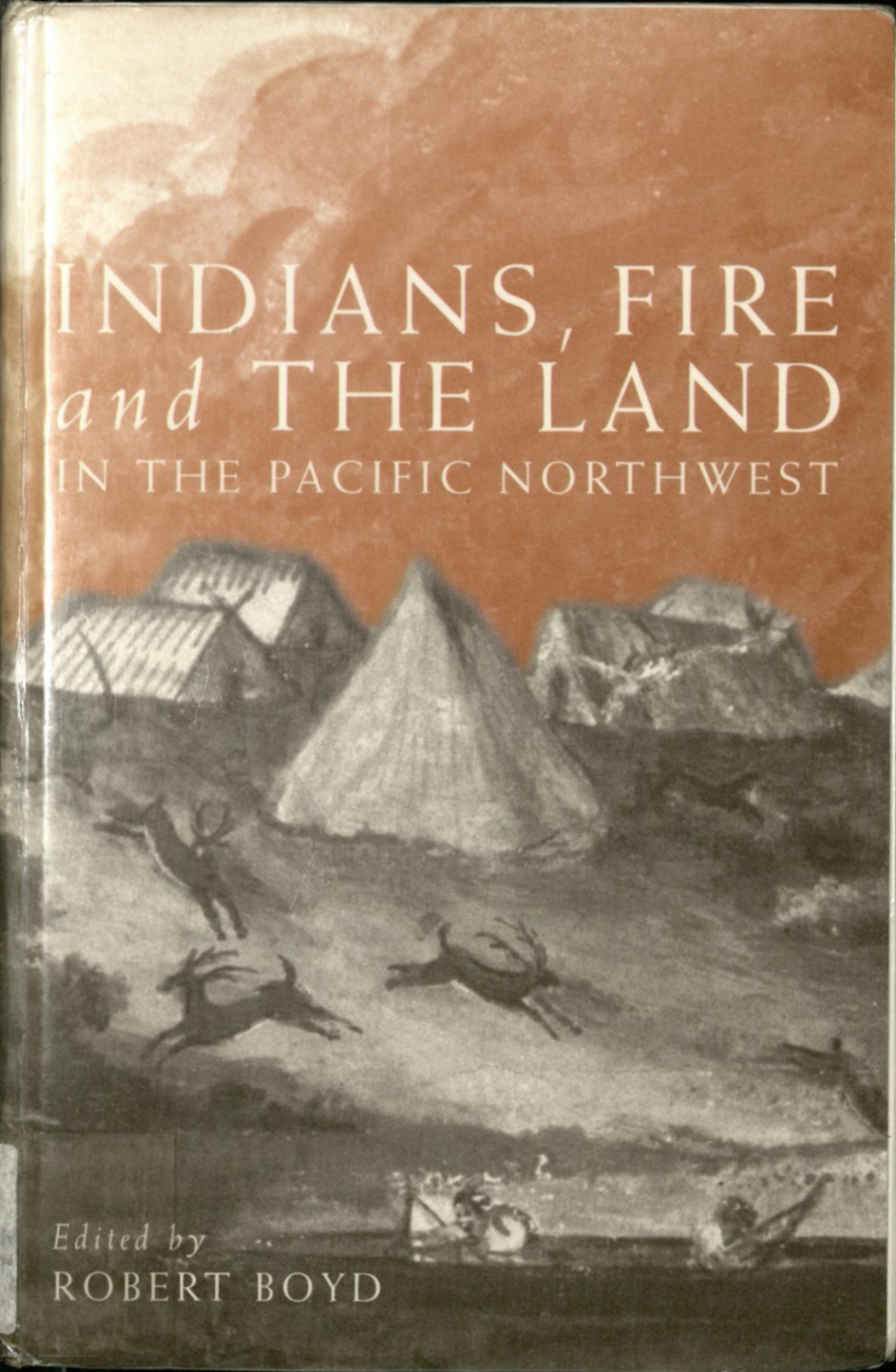
INDIANS, FIRE *and* THE LAND

IN THE PACIFIC NORTHWEST



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Strategies of Indian Burning in the Willamette Valley[1]

Robert Boyd

Introduction

Previous Research

In 1971, geographer Carl Johannessen and colleagues at the University of Oregon published an article, "The Vegetation of the Willamette Valley," which proposed that, prior to European contact, the Willamette Valley, though surrounded by dense forests of Douglas-fir, was an open oak-savanna grassland. They also presented historical evidence to show that these prairie grasslands were maintained by annual fires set by the aboriginal inhabitants of the valley, the Kalapuya Indians. In 1979, geographer Jerry Towle, citing Johannessen *et al.*'s evidence, suggested that archaeologists and cultural anthropologists should incorporate the heretofore neglected historical information on anthropogenic burning and its relationship to Willamette Valley Indian subsistence. Building upon what has been established by previous researchers, the present paper attempts to reconstruct the role of man-made fires in the hunting-gathering practices of the Kalapuya Indians.[2]

This paper is organized in three parts: the first is an overview of pre-contact environment and Kalapuya culture; the second presents extant historical data (1826–1847) on Indian-caused fires in the Willamette Valley; and the third considers the relationships between burning and important aboriginal food sources, utilizing all known data on the Kalapuya as well as kindred and adjacent peoples of native Oregon, and from this suggests a reconstructed Kalapuya burning schedule.

Environmental Setting

The Willamette Valley is one of a series of north-south valleys found in the Pacific Coast states of California, Oregon, and Washington. Within the border formed by the Cascade and Coast ranges, the central valley floor is relatively level, interrupted here and there by low-lying hills. Because of its low gradient (rising from less than 30 meters at Champoeg to little over 120 at Eugene),

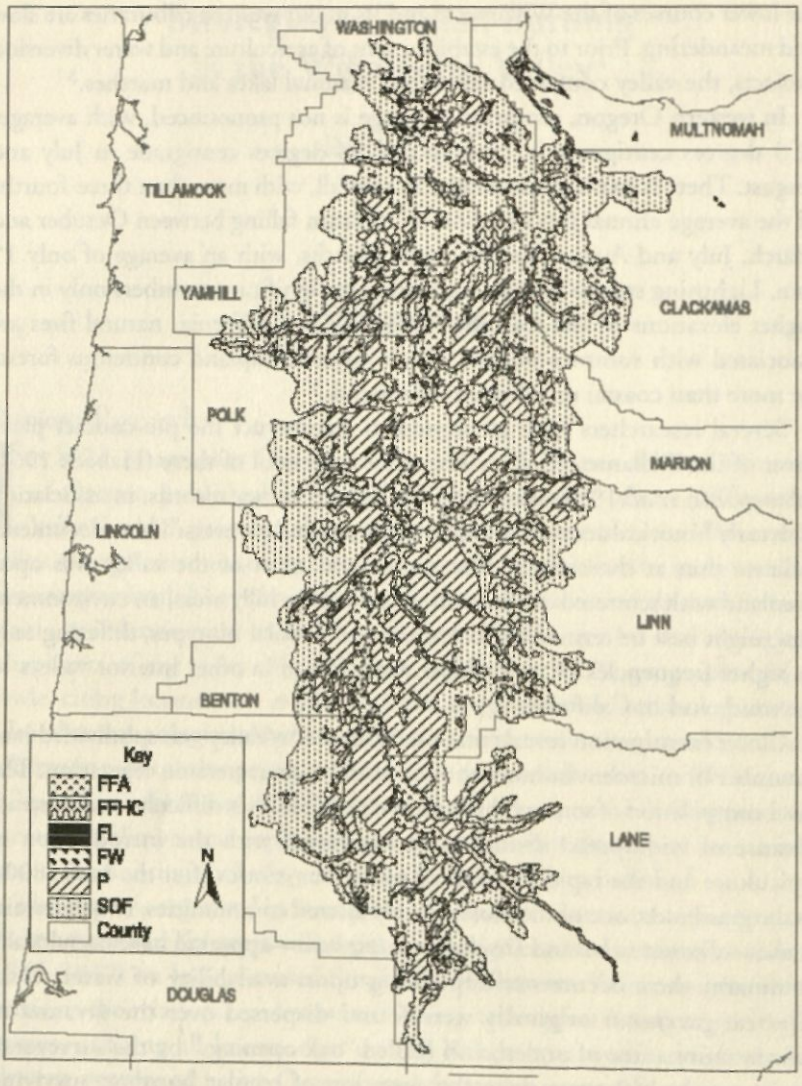
the lower courses of the Willamette and its major western tributaries are slow and meandering. Prior to the establishment of agriculture and water diversion projects, the valley contained numerous seasonal lakes and marshes.[3]

In western Oregon, temperature range is not pronounced, with averages of 3 degrees centigrade in January and 18 degrees centigrade in July and August. There is marked seasonality in rainfall, with more than three-fourths of the average annual precipitation of 965 mm falling between October and March. July and August are the driest months, with an average of only 15 mm. Lightning storms are rare, occurring in significant numbers only in the higher elevations of the Cascade Range. As in California, natural fires are associated with summer storms, which influence upland coniferous forests far more than coastal or valley environments.[4]

Several researchers have attempted to reconstruct the pre-contact plant cover of the Willamette Valley. The most successful of these (Habeck 1961, Johannessen *et al.* 1971) used early 1850s land survey records, in association with early historical accounts of valley explorers and pioneers. These documents indicate that at the time of first settlement, most of the valley was open grassland with scattered concentrations of oaks in hilly areas, an environment that might best be termed an "oak savanna." Similar biotypes, differing only in higher frequencies of xeric plants, were found in other interior valleys to the south and in California.

Closer examination reveals that the Willamette Valley was subdivided into a number of microenvironments, each with its characteristic vegetation. The exact composition of some of these plant communities is difficult to reconstruct because of widespread disturbances associated with the introduction of agriculture and the rapid invasion of numerous exotics after the mid-1800s. In the grasslands, one of the most severely altered communities, two perennial grasses—*Festuca rubra* and *Deschampsia cespitosa*—appear to have been locally dominant, their occurrence depending upon availability of water. Oaks (*Quercus garryana*) originally were found dispersed over the savanna in concentrations free of underbrush (called "oak openings" by the surveyors). In the nearly 140 years since the cessation of regular burning, surviving openings have grown into closed oak forests with understories dominated by hazel (*Corylus cornuta*), poison oak (*Rhus diversiloba*), and serviceberry (*Amelanchier alnifolia*).[5]

A second microenvironment was especially important in the northern portion of the valley, where low elevations, high water tables, and seasonal flooding created marshy areas around low-lying lakes (such as the now-drained Wapato Lake, and Lake Labish), and in gullies containing feeders to the main rivers (known locally as "swales"). Dominant forms here were various species of *Glyceria*, *Juncus*, and bulbous plants such as camas (*Camassia quamash*), wapato (*Sagittaria latifolia*), and wild onion (*Allium* spp.), all favored foods



Map 1. Presettlement vegetation of Willamette Valley, based on General Land Office plat maps, 1851-1865. FFA—Mixed deciduous riparian forest (Oregon ash, bigleaf maple, black cottonwood, red alder, white oak, dogwood, willow). FFHC—Coniferous forest (Douglas-fir, western hemlock, western red cedar, bigleaf maple, yew, vine maple). FL—Red alder swamp. FW—Willow swamp. P—Prairie (wet and dry, undifferentiated). SOF—Savanna and oak woodland (white oak and Douglas fir, locally with ponderosa pine and black oak). Courtesy John A. Christy, Oregon Natural Heritage Program. More detailed coverage at a scale of 1:24,000, based on General Land Office survey notes, is currently under development.

of the aborigines. In the narrow corridor along major waterways, deciduous forests, composed chiefly of ash (*Fraxinus latifolia*) and alder (*Alnus rubra*), constituted a third microenvironment. The winter villages of the valley Indians were located in this zone.[6]

Finally, in the higher elevations of the surrounding Coast and Cascade mountains, dense coniferous forests dominated by Douglas-fir (*Pseudotsuga menziesii*) were found. Although the coniferous forests were exploited minimally by the Kalapuya, the ever-shifting forest edges, with their diverse flora (such as salal {*Gaultheria shallon*}, Oregon grape {*Berberis nervosa*}, and berries {*Rubus* and *Vaccinium* spp.}) were utilized seasonally by the Indians.[7]

The following eyewitness accounts, dating from 1841 and 1844, give some idea of the topography and vegetation of the pre-settlement valley.

> 8/7/41 . . . the Yamhills [Eola Hills] . . . are a little singular being the only hills of any magnitude that rise from the great Walamat Valley—in an extent of Prairie from 60 to (1)00 miles either way . . . from the top of these at an alt. of about 1,000 feet—had a grand panorama view . . . prairie to the south as far as the view extends—the streams being easily traced by a border of trees that grew up on either bank . . . white oak scattered about in all directions. (Emmons 1841)

> Productions Strawberries Rasp Berries Dew Berries Whortle berries service Berries and numerous other kinds so that fruit of that description is plenty from may until September the vallies abound in different kinds of edible roots, the most common of which is La Camas . . . resembles onions in shape and looks but has a sweetish taste and grows abundantly so much so that I am told that . . . when it is in bloom in many places hides almost every other sign of vegetation. The Wappatoo grows in swampland and resembles potatoes these two roots with the acorns that grow on the low scrubby White oaks which far surpass any thing of the kind that I have ever seen and form a range for hogs the best that could possibly be . . . grass of an excellent quality abounds on the high hills and in the vallies . . . the grass commences growing when the rains begin in the fall and continues to grow through the fall winter and spring and dies with the dry weather in summer. (Shaw 1844)[8]

Contemporary researchers agree that the oak savanna of the Willamette Valley was a seral community, maintained by frequent firing. In the nearly 140 years since initial agricultural settlement, with fire removed as an important ecological factor, forest cover (both Douglas-fir and Garry oak) has increased and now covers most areas not cultivated or grazed. Hypothetically, a continuation of current fire control will result in replacement of Garry oak in most areas by mixed stands of Douglas-fir and big-leafed maple (*Acer macrophyllum*), given the inability of the oak to reproduce in its own shade.[9]

Palynological studies indicate that the Willamette Valley has been dominated by oak savanna for more than 6,000 years. The origin of the valley biotype appears to data to the warmer and drier climate of the Hypsithermal period (8000–4000 B.P.) when natural conditions probably prevented the establishment of a closed canopy forest. Yet the Willamette Valley oak savanna has persisted throughout the millennia since that time, despite the appearance of a modern climate amenable to forest growth, and contrary to the pattern of forest spread characteristic of the last century.[10]

Natural fires do not occur frequently enough to account for the continuation of the subclimax vegetation. Some other force must have been responsible. It was this kind of evidence and this line of reasoning that led both James Habeck and Carl Johannessen *et al.* to consider the sizable historical literature on Indian burning in the Willamette Valley, and to hypothesize that regular aboriginal fires were the main cause of the perpetuation of the oak savanna.[11]

Native Inhabitants of the Willamette Valley
The Kalapuya

In pre-contact times, the Kalapuya Indians were the sole inhabitants of the prairies of the Willamette Valley.[12] To the north and west were peoples of the Northwest Coast culture area: Chinookans in the valley of the Columbia; Salishan Tillamook and various "coastal Penutian" peoples (Alsea, Siuslaw, Coos) along the Oregon Coast. To the east were members of the Plateau culture area: Molala on the western slopes of the Cascade Mountains; and various Sahaptin peoples to the east of the Cascade crest.

Although most anthropologists include the Kalapuya in the Northwest Coast culture area, some have been inclined to incorporate them into an expanded Plateau culture area. In 1951, archaeologist Lloyd Collins, utilizing a trait list of 31 items of Kalapuya material culture, found that 45% were shared with Northwest Coast cultures, while 87% also were characteristic of the Plateau culture area. Important Plateau culture traits include a diversified subsistence base with an emphasis on wild root crops, extensive use of earth ovens, seasonally occupied semi-subterranean houses and mat lodges, sweatlodges, buckskin clothing, first fruits ceremonies, rite of passage feasting, and an emphasis on individually obtained spirit power through spirit questing. More recently, anthropologist David French has gone a step further: emphasizing the underlying shared importance of "reliable ample harvests of {wild} plant foods," he suggests that "a Plateau-Valley-California area would have more unity than many writers have supposed. What features set off California from Takelma, Kalapuya, Sahaptin? . . . religious features perhaps

. . . there are no distinctive features." French's "Valley" subprovince includes Kalapuya (Willamette Valley), Umpqua (upper Umpqua Valley), and Takelma (upper Rogue Valley).[13]

Kalapuya economy was based on a diverse assemblage of wild plants, with a secondary emphasis on game. Unlike the Indians of the Northwest Coast culture area, salmon was relatively unimportant to the Kalapuya for the simple reason that the Willamette Falls blocked runs of most anadromous fish.[14] In the total inventory of wild foods, the bulb of the camas lily apparently was of major importance, and prominent mention is given to hazel nuts, acorns, tarweed (*Madia* spp.), wapato, and an assortment of berries (especially the native blackberry, *Rubus ursinus*). Game included two species of deer, white-tailed (*Odocoileus virginianus leucurus*) and the black-tailed (*O. columbianus*) (the former being of major importance), elk (*Cervus canadensis*), a variety of waterfowl, quail, and doves. Small animals and insects were "gathered." Salmon were obtained in barter with Chinookan peoples at Willamette Falls (in return for processed camas cakes and game). The majority of foods were processed and stored for winter use. All in all, it was a diversified resource base, with similarities to both the Plateau (camas, other roots, and berries), and native California (acorns, hazelnuts, tarweed, and grass seeds). As we will see, burning was an important tool in both the collection and management of most of these species.[15]

Lewis and Clark estimated 9,000 Kalapuyans in 1805–1806; a quarter century later, Hudson's Bay Company figures were given as either 7,785 or 8,870. Allowing for mortality from two earlier smallpox epidemics (circa 1775 and 1801–1802) yields a conservative aboriginal population of 14,760, or a density of about one person for every 2 1/4 square kilometers. These figures are compatible with those given for the Tualatin Kalapuya on the basis of winter-village lists, and with figures now generally accepted for hunting-gathering groups occupying similar resource areas in native California.[16]

Direct White contact with the Indians of the Willamette Valley began in 1812, with the exploring parties of Astorian Robert Stuart and Donald McKenzie. This was contact of an intermittent nature, however, limited to seasonal forays by trappers and traders, and for nearly twenty years the Kalapuya remained relatively untouched and unaffected by white influence.

Beginning in 1831 and for each summer thereafter, the Indians of the Willamette and lower Columbia Valleys were subjected to an annual attack of a disease that is now considered to have been malaria. The effect of this exotic disease on a "virgin soil" population that had no genetic or cultural means of coping with it was devastating; in 1841, the surviving population was estimated at 600. Documentary evidence for aboriginal burning of the Willamette prairies comes from both the pre- and post-malaria eras. Although the introduction of endemic malaria certainly caused a shift in subsistence

strategies away from swampy areas where malarial mosquities had become established, and the abandonment of other regions due to gross population decline, large-scale burning by Indians continued over sizable segments of the valley until immigrant settlers forced an end to the practice in the mid 1840s.[17]

The Kalapuya, Umpqua, and Takelma Indians were removed to the Grand Ronde Reservation near the present town of Willamina in 1855. Anthropological field work among surviving Kalapuya was late and piecemeal, gathered in 1877, 1913–14, and the 1930s.[18] The surviving field notes on subsistence (for the best-documented Kalapuya group, the Tualatin) have been assembled in Henry Zenk's 1976 "Contributions to Tualatin Ethnography." Information on Kalapuya burning practices was not gathered by the early anthropologists, however, and there are no living natives who remember aboriginal burning practices (nor have there been for many years). Correspondingly, archaeological data gathered to date are devoid of useful information about the role of anthropogenic fire in aboriginal cultures.

Historical Evidence

Fortunately, there are numerous references in the written records of early explorers and settlers that document regular firing by Willamette Valley Indians. William Morris was the first researcher to use this historical evidence in his 1936 history of forest fires in the Pacific Northwest. Johannessen *et al.* (1971) quote a number of published historical works to support their thesis on the role of aboriginal firing in the maintenance of the oak savanna biotype of the valley, and their summary has been cited as proof of the aboriginal impact on the Oregon environment in many later works by geographers and foresters.[19] Morris and Johannessen *et al.*'s list of sources on burning are not, however, exhaustive, and neither study places the data in a wider ecological or cultural context. In this paper, all available information, both published and unpublished, is considered in order to determine the temporal and spatial patterns of burning in the Willamette Valley.[20] These data are then combined with what is known concerning aboriginal foraging practices, with a goal of infusing cultural meaning to the historical reports.

The first 12 years of White contact with the Kalapuya (1812–1824), when the fur trade was in the hands of the Northwest Company, are very poorly recorded.[21] There are no references to Indian burning practices for this period. With the 1825 initiation of the Hudson's Bay Company's annual southern trapping expedition to California, however, the documentary situation changes.

From the 1826 expedition two important documents, the journals of Alexander McLeod, leader of the party, and David Douglas, a botanist who traveled with him, survive.[22] Departing from Fort Vancouver in early September, the expedition passed through the Willamette Valley during the midst of the summer burning season. Upon entering what apparently was the Yamhill Valley on the 18th of September, McLeod noted "several Indian habitations" and a landscape "much overrun by fire." On the west bank of the Willamette River near the site of Salem, the party was obliged to ford the river in order to find food for their horses because the land was "burned and destitute of grass."[23]

Over the next few days, Douglas recorded:

> 9/27 Country 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 the rivulets to be seen.
>
> 9/30 (heading south) . . . Most parts of the country 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 the deer to frequent certain parts to feed, which they leave unburned and of course they are easily killed. Others say that it is done in order that they might better find honey and grasshoppers, which both serve as articles of winter food.[24]

The landscape continued as above until the party reached the foothills of the Calapooya Mountains.

> 10/2 (McLeod) Pasture is rarely found in the course of this day none has been seen, altho' we traveled good twenty miles and had to put up along a small river that our horses might have the pickings along the margin of the woods, elsewhere the fire destroyed all the grass.
>
> (Douglas) . . . not yet a vestige of green herbage; all burned except in the deep ravines. Covered with *Pteris aquilina* [bracken fern], *Solidago* [goldenrod], and a strong species of *Carduus* [probably *Cirsium*, thistle] . . . My feet tonight are very painful and my toes cut with the burned stumps of a strong species of *Arundo* [probably reedgrass, *Calamagrostis*] and *Spiraea tomentosa* [probably ninebark, *Physocarpus*].[25]

The McLeod expedition spent the next three weeks in the Umpqua country before moving on to California. Douglas separated from the rest of the party and in early November backtracked to Fort Vancouver through what was now a completely altered landscape. Where formerly there had been scorched plains, he found "Country open, rich, level, and beautiful." Fall rains had caused a greening of the prairies. The food supply—deer on the way down—was replaced on the return trip by waterfowl that were stopping on their migration south at newly formed marshes and lakes. In March, when McLeod

and the others returned to Fort Vancouver after spending the winter in California, they found that heavy winter precipitation had flooded large areas: " . . . made little progress owing to the country being inundated, every little brook or low place is full of water."[26]

McLeod's journal from a subsequent 1828 trapping expedition also has been preserved.[27] By this date, the annual burning of the prairies was a well-known phenomenon that the Hudson's Bay trappers considered an impediment to easy travel through the valley. In a letter to the company factor Dr. John McLoughlin at Fort Vancouver, dated September 8, 1828, McLeod complained, "our progress will be dilatory owing to the Country being entirely burnt, poor as our animals are just now in a short time hence they will be much more so."[28] Near the site of Salem, on the same day, McLeod noted "of late the fire had committed such ravages that Scarcely any feeding is left for our Animals." On September 15: "our route led southward, the Want of Grass made us go till 9 P.M. when we reached a small River where there is a little Picking for our Animals." South of the Santiam River, on September 30th, the journal provides a hint of the nature and size of Kalapuya seasonal foraging parties:

> . . . delay was occasioned by the Indians being dispersed in detached Parties in various directions, remote from each other, and as the object of the Party was to obtain horses, as many as possible [from the Indians], much time was lost to visit the different Parties of Indians.[29]

For the next 12 years, despite the presence of numerous trapping expeditions in the Willamette Valley, accounts of Indian burning are relatively sparse. Three documents that do contain some information, however, are a Hudson's Bay Company journal of an 1834 trapping expedition, and the diaries of two Methodist missionaries from an 1840 trip to the mouth of the Umpqua. Along the Long Tom and Mary's Rivers, July 1st and 2nd, the H.B.C. journal noted:

> . . . herbage getting dry & the ground has an arid appearance; on the lower spots grass luxuriant. The Indians set fire to the dry grass on the neighboring hill . . . The plain is also on fire on the opposite side of the Willamette.

The Methodists experienced difficulties soon after leaving Willamette Mission (near modern Salem) on August 19, 1840. The plains south of the Santiam River "had been all overrun with fire a short time previous" which had "stripped them of their verdure, and we could not find grass enough for our horses."[30]

In the summer of 1841, Charles Wilkes, commander of the United States Exploring Expedition, a scientific party surveying the West Coast, sent a party of 28 men under George F. Emmons to explore the Hudson's Bay trail connecting Fort Vancouver with the Sacramento River. After the model of

the Lewis and Clark Expedition, most of the party members kept their own journals of the trip. The longest and most informative of these documents are those of Emmons and his subordinate Henry Eld, both in manuscript; three journals of expedition members, all published, give fewer details. Wilkes himself summarized some of the main findings of the overland party in volumes four and five of the official journal of the Exploring Expedition. The following quotations on Indian burning are drawn from the writings of these six individuals.[31]

Wilkes himself did not participate in the overland expedition. He did, however, penetrate the Willamette Valley as far south as Willamette Mission (near modern Salem) where he witnessed the open prairies of the central valley. His observations are recorded in the June 9th entry from his diary:

> One of the most striking appearances of the Willamette Valley is the flatness of its Prairies in some instances a dead level for miles in extent—and it becomes a problem of some difficulty to solve how they have been produced. Fire is no doubt the cause of them but the way the forests are growing around them would almost preclude this supposition as but thin belt of wood frequently occurs between extensive ones. Since the country has been in the possession of the whites it is found that the wood is growing up rapidly a stop having been put to the fires so extensively lighted throughout the country every year by the Indians. They are generally lighted in Sept. for the purpose of drying the seeds of the [blank] (sunflower) which is then gathered and forms a large portion of their food.[32]

Emmons and the other members of the overland party were forced to wait until Henry Eld, on a survey of Gray's Harbor in the north, was able to join them. Hudson's Bay Company employees warned the Americans that they would have problems if they waited too long.

> an old Hunter at Fort Vancouver [said] that they would find it very difficult to provide grass for their horses on the route, the prairies having been burned by the Indians and that another great difficulty would be the danger of laming the horses, the small stems having been exposed on the surface by the burning of the grass.[33]

At Fort Vancouver on July 31 Emmons said, "the Indians were just commencing to burn the country, thereby interposing an obstacle that increases with my delay."

Emmons entered the Willamette Valley in early August, and waited at Willamette Mission for a full month before Eld finally appeared. Like Wilkes, he also ascended the "Yam Hills" (apparently the modern Eola Hills) for a view of the valley. Near the present town of Newberg, on August 7th, Emmons reported:

> the country becoming smoky from the annual fires of the Indians—who burn the Prairies to dry & partially cook a sunflower seed—which abounds throughout this portion of the country & is afterwards collected by them in considerable quantities & kept for their winter's stock of food. The forests are also frequently burnt to aid them in entrapping their game—these two burnings combined form the greatest obstacle the travelers encountered in this country—one blocking up the way—& the other destroying the food of the animals [i.e., the expedition's horses].[34]

On August 8th, while camped on the west side of the Willamette across from the Methodist mission:

> Wind light and variable—very warm, clouding over after Mer[idian] all the country west of us [present Amity area] apparently on fire from the dense volums [sic] of smoke continually rising—it is fortunate for the settlers that at this season these Prairies are not subject to heavy winds—for if they were there would be no arresting the fires that are so often kindled by the Indians.

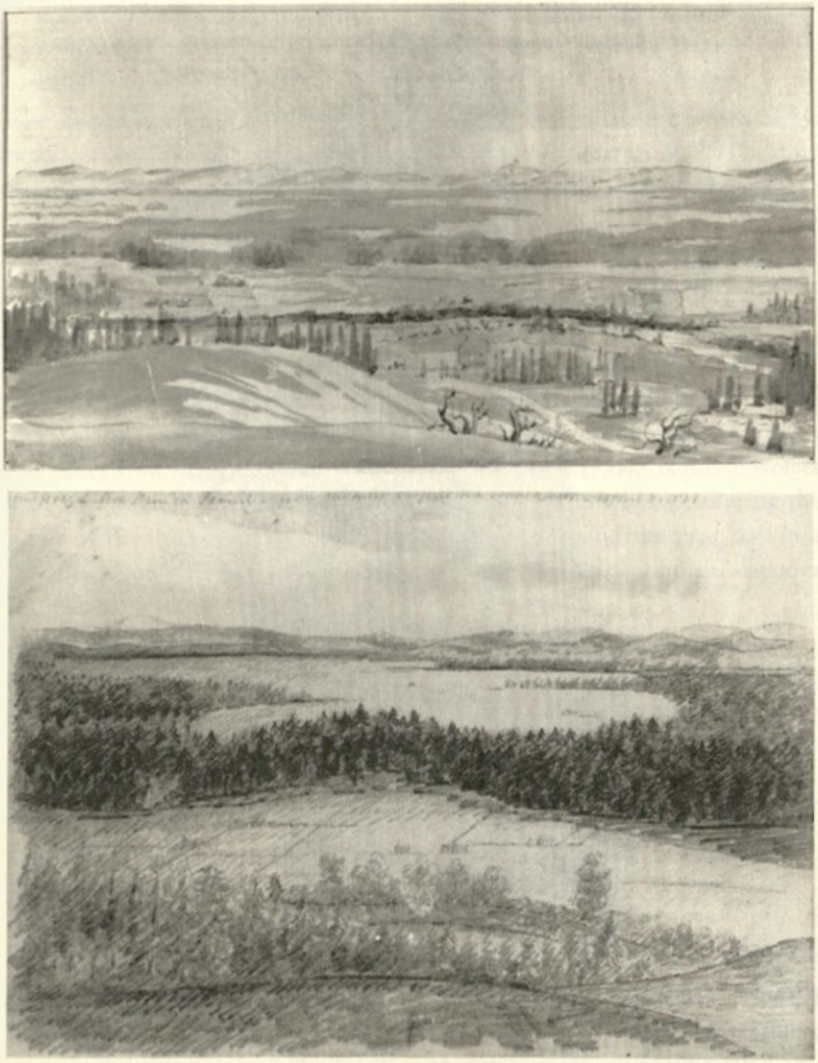
Emmons was reporting from the fringes of White settlement in the Willamette basin, which in 1841 were limited to the lowlands and river bottoms extending from Champoeg south to what is now Salem. On August 10th he traveled the 8 miles from Willamette Mission to the southern terminus of the settled area at the Mission Mill, moving between the wooded margin of the river's floodplain and the grassy high prairie.

> . . . part of our route lay over the low & part on the high prairie bottom—through open and wood land . . . composed of a variety of wood—the principal portion being Pine, Fir, Ash & Oak—with some Cherry, Cotton, Willow etc.—the prairie had not yet been burnt on this side of the river & the grass had all the appearance of made hay.

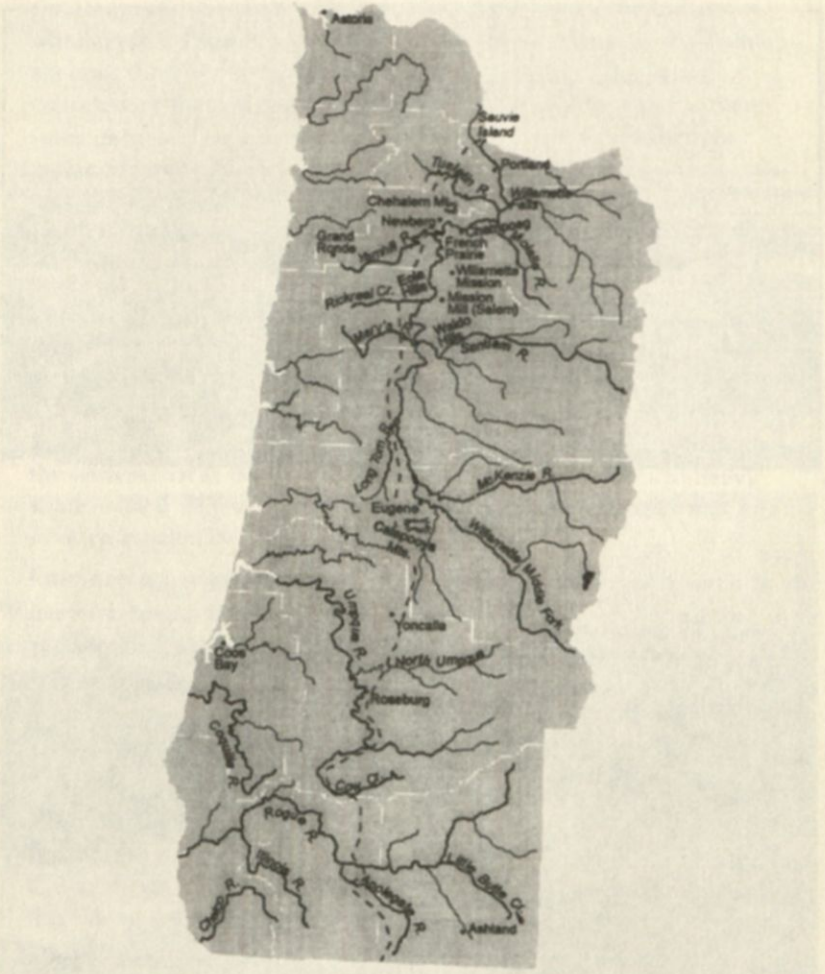
It was early September when Henry Eld and his men finally joined Emmons and the overland journey began. Although the explorers spent only three weeks traversing the interior valleys of western Oregon, it was during the height of the native burning season, and all the journals are replete with references to the aboriginal practice. On September 9th, near present-day Independence, Eld made his first reference to fire.

> Atmosphere filled with smoke consequently unable to see much of the surrounding country. Country much burnt . . . Our route has been through what might be called a hilly prairie country, the grass mostly burnt off by recent fires, and the whole country sprinkled with oaks, so regularly dispersed as to have the appearance of a continued orchard of oak trees.

The following day, another of the party members noted his interpretation of why the natives burned the plains.



Two views of Willamette Valley prairies from Chehalem Mountain. Champoeg is in the foreground, the French Prairie in the distance. Top: by Paul Kane, 1847. Courtesy of the Royal Ontario Museum, 77 ETH 201, 946.15.193. Below: by George Gibbs, 1851. Courtesy of the Peabody Museum, Harvard University.



Map 2. Overland route of the 1841 U.S. Exploring Expedition, with place names mentioned in the text.

> The country continued level, but all the vegetation, except the trees, had been destroyed by fire, said to have been kindled by the Prairie Indians for the purpose of procuring a certain species of root, which forms a principle part of their food.[35]

On the 11th, when the party advanced as far as the Long Tom River, Emmons recorded:

> Weather warm, quite smoky . . . Passed over a level prairie [south of Marys River]—perfectly barren having been burnt like most of the country—could not determine the extent owing to the smoke which confined our view within a space of about two miles round . . . came

> upon the banks of a small River called the Lum-tum-buff . . . the pack animals . . . having traveled all day over the burnt prairie without water . . . rushed headlong down the banks.

The Expedition's botanist found that burning was (to use the words of his predecessor David Douglas) "highly unfavorable to botanizing."[36] The only plant life he encountered was restricted to a narrow band alongside permanent sources of water.

> On the banks [of the Long Tom] grew Dogwoods, *Spiraea*, Willows, Alder, and close by Clumps of a large *Pinus* . . . procured Seed of *Madia elegans* [tarweed], but rascally Indians by setting fire to the prairies had deprived us of many fine plants.[37]

Travel was difficult on the prairies. The days continued "hot and foggy" and visibility, Emmons reported, was "confined . . . within a space of about two miles around." The land was "burnt and parched" (Eld), "bands of wolves were met with," and there was no water or grass for the horses. During the night of the 12th, the animals escaped and were found the next day in a "marshy place."[38] The night of the 13th was spent at the base of the Calapooya Mountains.

> . . . encamped on a fine piece of prairie grounds of about a mile and a half in length and one half mile in width which being well clothed with grass was too valuable to be passed over without giving our horses a chance at it . . . it proved to be a thick smoky evening so as to preclude all possibility of getting the North Star (Eld).

Here the botanist was able to collect some plant specimens.

> Weather very hot and foggy, Plants: Gentians sp . . . *Glaucus* [saltwort] in marshes . . . *Eryngium* [wild carrot] sp . . . *Madia elegans* in great abundance. *Madia*-looking annual. flos: small, yellow, dry banks.[39]

Passing out of the Willamette Valley (though still in Kalapuya territory) the fires continued. The following three passages were written in the Yoncalla area.

> 9/15 Calm, sultry & smoky as ever—the air from the prairies fanning past me—some thing like the heated air from [an] oven . . . (Emmons)

> 9/17 the weather continues thick and smoky the sun seen only occasionally and then of a dense blood red color and looking much larger than [illegible] . . . from daylight to ten A.M. hunting the horses in the smoke . . . through valleys . . . principally oak trees with grass growing under them . . . The prairies mostly today are on fire, winding its course slowly with the wind across the plains and up the hills . . . our route lay directly through where it was burning but the grass is not thick enough to render it very dangerous, and we crossed without injury; it is well the grass is not more than it is or our route

> assumedly would be extremely perilous, it is probably owing to the fact that the prairies are burned every year that the grass is so thin (Eld).
>
> 9/18 . . . the flats between the rising ground is rich deep soil with Clumps of Ash and dogwood, the grass had all been burnt up by a fire which we saw rageing [sic] ahead of us and were compelled to urge our horses through it. Campd. on Billys River. Atmosphere so dense that we could not see more than 1/4 of a mile ahead.[40]

For the next 10 days, the overland party traveled through the territories of two non-Kalapuyan peoples of southwestern Oregon: the Athapascan Umpqua (of the middle Umpqua River) and Takelman-speaking Indians (of the South Umpqua and middle Rogue Rivers). Throughout this region and into the country of the Shasta Indians of northern California, the burning continued.[41]

Following the exceptionally well-documented year of 1841, there is a two-year gap in the record of indigenous burning. In 1844, after two annual migrations over the Oregon Trail had brought more than 2,000 settlers to the Willamette Valley, the last documented occurrences of intentional burning are described for the Indians. All three accounts for this year describe burning or its effects in the Yamhill Valley. Jesse Applegate, a settler of 1843, established a farm on the Rickreall Creek. His "Recollections" contains one of the most graphic accounts of native burning extant.

> . . . we did not yet know that the Indians were wont to baptise the whole country with fire at the close of every summer; but very soon we were to learn our first lesson. This season the fire was started somewhere on the south Yamhill, and came sweeping up through the Salt Creek gap. The sea breeze being quite strong that evening, the flames leaped over the creek and came down upon us like an army with banners. All our skill and perseverance were required to save our camp. The flames swept by on both sides of the grove; then quickly closing ranks, made a clean sweep of all the country south and east of us. As the shades of night deepened, long lines of flame and smoke could be seen retreating before the breeze across the hills and valleys. The Indians continued to burn the grass every season until the country was somewhat settled up and the whites prevented them, but every fall, for a number of years, we were treated to the same grand display of fireworks. On dark nights the sheets of flame and tongues of fire and lurid clouds of smoke made a picture both awful and sublime.[42]

The "sage of Yoncalla" (as Applegate was later known), by his dramatic treatment of this episode, gives a probably exaggerated impression of the normal intensity of the Indian fires.[43] Though certainly productive of great clouds of smoke, they probably were usually more like the slow burn described by the more matter-of-fact Henry Eld.[44]

Although Applegate gives no dates for the above incident other than "late summer," collateral information indicates that it may have been late September. An 1844 manuscript diary written at Willamette Mission, due east of the "Salt Creek Gap" across the Willamette, notes on September 28th and 30th "tended to watching the fire that was burning over the country . . . did chores and watched the fire."[45] Perhaps five weeks later another pioneer, James Clyman, viewed the same landscape described by Applegate, as recorded in the following quotations.

> 11/5/44 Crossed a range of high rounded hills [probably the Dundee Hills] and whare [sic] it had been burned 16 or 18 days it was now green and fair pasturage.<end extract>

Autumn rains, of course, were responsible for this quick revitalization of the vegetation.

> 11/9 . . . the valy [Yamhill] covered in a growth of green grass, the old haveing been burned off not exceeding Thirty days . . . the Wally of the wilhamet skirted with irregular Stripes of green Prairie lately burned off white not burned brown.
>
> 11/11 . . . greate Quantities of wild geese seen flying and feeding on the young grass of the lately Burned Prairies which are Quite Tame and easily approached on horseback.[46]

Clyman's diary covers almost an entire year in the Willamette Valley, until June of 1845. His very descriptive account of the natural vegetational sequence on the prairie lands will be quoted later.

Kalapuya Burning: The Subsistence Context

Omer Stewart was the first anthropologist to record in detail the phenomenon of aboriginal burning. In 1953, he had "completed the first draft" of an eight-hundred page manuscript, including tables and bibliography, presenting the evidence that aborigines the world over burned vegetation, and attempting to determine the effect such burning has had on the so-called "natural vegetation." This manuscript, unfortunately, has never been published. Stewart's approach was cross-cultural in nature; he was not concerned with reconstructing the patterning of anthropogenic fire in local cultural and ecological systems. But his classification of burning incidents by "reasons" lends itself to such reconstruction. In North America:

> Although fire is reported most frequently used to aid hunting—to encircle, to rouse, to stampede—fifteen other reasons for setting fires are given. These were as follows: to improve pasture, improve visibility, collect insects, increase yield of seeds, increase yield of

> berries, increase other wild vegetable foods, make vegetable food available, remove or thin trees to allow other growth, clear land for planting, stimulate growth of wild tobacco, aid in warfare, produce a spectacle, and reduce danger from snakes, insects, etc. Sheer carelessness, of course, is often reported as a cause of fires.[47]

Fire obviously was a multipurpose tool in many pre-White-contact Indian cultures. Not all of the reasons listed here, of course, are reported for the Kalapuya, and only those that are related to subsistence pursuits will be discussed in this paper. It has been suggested that dividing Stewart's many aboriginal reasons for burning "into immediate effect and deferred effect sets is useful."[48] This division works particularly well for the Kalapuya, and will be used in this section of the paper. The "immediate effect set" includes instances where fire was used as a tool in the hunting and gathering process itself. The "deferred effect set" incorporates situations where fire was used to produce long-range future benefits (such as increased yields). Reasons in the first category were relatively obvious to early Euroamerican observers and are more or less well reported in the literature. The second category was subtler and not so apparent to early observers. Since early anthropologists did not conduct in-depth interviews with knowledgeable Kalapuya informants on ecological matters, we have virtually no hard data on burning for future effects. By ethnographic analogy with better-known neighboring Indian cultures, however, it is possible to make suggestive statements. When these probable uses of fire "fit" in with what we know about the Kalapuya subsistence strategy and the pre-White ecosystem of the Willamette Valley, the likelihood of their existence among the Kalapuya is strengthened.

The Circle Deer Hunt

For the Kalapuya, the sources indicate that there were two major direct uses of fire: in the circle hunt of deer and in the gathering of tarweed. The quotation from Emmons (8/7/41, above) states this in no uncertain terms; the following statement from a Salem pioneer of 1847 corroborates Emmons and adds some information of secondary uses of fire.

> The theory that I gained from the old settlers in regard to it [Indian burning] and my own observations is this; up to 1845 the Indians had a custom of burning off the country for the purpose of driving the game and also make the grass grow better, to keep down the undergrowth of timber, and collect seeds.[49]

The most common deer in the Willamette Valley in pre-White times was not the same species found in the forested areas of the valley today. The black-tailed deer (*Odocoileus hemoinus*) has supplanted the white-tailed deer (*O. virginianus leucurus*) over most of its range. The latter now is threatened (due

basically to habitat loss)—and limited to two small herds in the lower Columbia near Rainier and the Umpqua Valley close to Roseburg.

The most frequently mentioned method in the anthropological and historical sources of hunting this small deer was stalking by a single hunter disguised in a partial hide of the animal. Burning might indirectly influence this method of deer hunting by producing restricted feeding areas (yards) where the animals would congregate and be more easily killed. I will discuss this usage in the next section.

Of immediate interest is the use of fire in the communal fall hunt of deer. The fire drive is widely reported throughout French's Plateau-Valley-California culture area. The University of California's areal "Culture Element Distribution" lists report it for 4 out of 10 Indian groups in the Plateau, 11 out of 16 in northeast California, and 10 out of 16 in northwest California.[50] I will discuss three examples: the Kalapuya, Coeur d'Alene (Plateau), and Shasta (Northeast California).

There are two references in the literature on the Kalapuya to a large-scale, communal circle drive of deer. The main source for both apparently was the Santiam Kalapuya, Joseph Hudson.[51] Hudson describes the practice as it existed in the pre-malaria period (before 1831) when the Santiam still had sufficient manpower to carry out the hunt. Hudson was interviewed sometime in the early reservation period (probably around the year 1880) by newspaperman Samuel Clarke and pioneer John Minto.

Samuel Clarke was noted as a writer of popular history, and the following excerpt is drawn from the article "The Great Fall Hunt of the Willamette," which originally appeared in *The Oregonian*, and was reprinted in *Pioneer Days of Oregon History* (1905).

> Old Quinaby[52] and Jo Hutchins [Joseph Hudson] who lived at Grand Ronde both told how their tribes prosecuted a great fall hunt for the purpose of laying in meat for the winter. The bands that occupied the region that included the east side of the valley, from the Molalla to the Santiam, all united in this annual roundup. It required a great force of men to carry out the programme. They formed a cordon around all the territory indicated. Men were placed in position along the rivers named and including the foothills of the Cascades. The great square encircled all Marion County (as constituted today) that is not rough mountainous country. To have placed men a quarter of a mile apart would have required fully 500. They called into active service boys able to draw a bow, and old men not incapable of duty.
>
> This annual hunt was conducted under the orders of the most famous war chief, and all others had to receive instructions and live up to them. There was considerable skill required to do this correctly and effectively . . . Possibilities were carefully calculated in advance and pains taken to plan operations early in the fall of the year, when

> storms were not frequent and the game easily controlled . . . . At a given signal, made by a fire kindled at some point as agreed, they commenced burning off the whole face of the country and driving wild game to a common center . . . If badly managed, the game could break through and escape to the mountains . . . When the circle of fire became small enough to hunt to advantage, the best hunters went inside and shot the game.[53]

The second quotation, which does not mention the use of fire, but otherwise (in broad outline) corroborates Clarke, is from John Minto.

> Joseph Hudson . . . pointed to a time when his people had numbered eight thousand, as he estimated, at which time and later, to the time of his grandfather, Chief San-de-am, his people used the circle hunt, driving the deer to a center agreed upon, by young men as runners, the point to drive to being selected as good cover to enable the bowmen to get close to the quarry.[54]

The chief problem with the Clarke account is that it is hard to believe that all of Marion County was involved in a single drive. Other than this criticism, the outline is similar to circle drives reported from other North American tribes, and probably is ethnographically sound. For instance, the following account from the Coeur d'Alene Indians of the Columbia Plateau in Idaho replicates much of what Samuel Clarke says for the Kalapuya.

> The Indians watch for the proper time to go all together for a hunt or "surround" of deer . . . they determine the extent of the surround, according to the number of hunters of which the band is composed. A hunting-chief is chosen, and all his orders are thereafter executed promptly and punctually . . . When the "surround" is performed in a valley . . . the hunters form a complete circle, determining the size of it by their own number. Then they . . . burn their old rags in a hundred little fires round about, to prevent the deer from escaping from the circle. Pursued in every direction, the terrified animals flee from one clump of wood or brush to another, until finally enveloped on all sides and finding no issue, they fall into the hands of the hunters. It is seldom that a deer escapes them . . . They are easily killed with clubs, lances, and even knives . . . sometimes as many as 200 to 300 are killed in a single surround. Ordinarily, however, the number is less. After the hunt, the flesh of the deer is divided among all the families by the chief of the tribe, or by him who has managed the expedition. The portions are regulated according to the number of persons constituting the different families. The hunter who kills the animal has sole right to the skin.[55]

There are many similarities between the Coeur d'Alene and Kalapuya fire drives. In each case, a high degree of cooperation was necessary, coordinated by a special hunt leader. The communal drives could involve a large number

of people and had the potential of producing considerable return in protein, of great importance in the yearly round of subsistence activities. The Coeur d'Alene quotation also describes the post-hunt distribution of meat, again similar in outline to that reported for other hunter-gatherers.

The fire drive also was common throughout adjacent portions of California; closer at hand, it was used by the Takelma of the middle stretches of the Rogue River. For the neighboring Shasta:

> . . . [when] the oak-leaves began to fall, men went out and set fires in circles of the hills. The ends of the curved lines forming the circles of fire did not meet, and in this opening the women stood rattling deer-bones, while men concealed in the brush were ready to shoot the deer as they rushed out.[56]

Deer, principally white-tailed, was the most important source of animal food for the Kalapuyans. It is mentioned more than any other animal in Jacobs' "Kalapuya Texts." Venison apparently was smoked and stored for winter use. The timing of the circle hunt makes sense in its closeness to the beginning of the five-month winter season and also because it was that time of the year when the animals themselves were fattest, having gorged themselves on newly fallen acorns in the oak openings. The documented pre-settlement presence of elk on the open prairies of the Willamette Valley raises the possibility that they, also, were hunted by the fire drive.[57]

Tarweed

A second major reason why the Kalapuya burned the prairies related to the harvesting of tarweed (*Madia* spp.), a major food source of the valley Indians. Tarweed also was an important wild crop of the Takelma, and was utilized by many California Indians as well.[58]

Burning is always mentioned as an integral part of the tarweed gathering process, but its specific function in this context has never been made clear. The following quotations from two of the three "interior valley" peoples (i.e., Kalapuya and Takelma) describe most of the particulars of tarweed gathering.

According to Jesse Applegate, from 1844 on the Yamhill:

> It was a custom of these Indians late in autumn, after the wild wheat, *lamoro sappolil* [Chinook Jargon] was fairly ripe, to burn off the whole country. The grass would burn away and leave the *sappolil* standing, with the pods well dried and bursting. Then the squaws, both young and old, would go with their baskets and bats and gather in the grain. The *sappolil* we now know as tarweed.[59]

George Riddle, a pioneer of 1851, describes tarweed gathering among the Takelma-speaking Cow Creek Indians.

> During the summer months the squaws would gather various kinds of seeds of which the tar weed was the most prized. The tar weed was a plant about 30 inches high and was very abundant on the bench lands of the valley and was a great nuisance at maturity. It would be covered with globules of clear tarry substance that would coat the head and legs of stock as if they had been coated with tar. When the seeds were ripe the country was burned off. This left the plant standing with the tar burned off and the seeds 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 slung in front they would beat the seeds from the pod into the basket. This seed gathering would last only a few days and every squaw in the tribe seemed to be doing her level best to make all the noise she could, beating her racket against the tip of her basket. All seeds were ground into meal with a mortar and pestle.[60]

Finally, the ethnographer of the Takelma said:

> . . . the stalks . . . of the yellow-flowered tarweed . . . were first burnt down to remove the pitchy substance they contained . . . the seeds were beaten out by a stick used for the purpose into a funnel-shaped deer-skin pouch with the mouth wider than the bottom . . . The seeds were parched and ground before consumption . . . [61]

The plants apparently were burned prior to harvesting to remove the sticky resin and facilitate gathering. If the tar was a hindrance to cattle browsing in the vicinity, it also must have been so for the Indian women who gathered tarweed seeds. The hairs on the seed case also are reported to have a disagreeable odor. Burning apparently was never intense enough to destroy the plants; most sources make a point of stating that the stalks remained standing erect. Firing also may have loosened the seeds in their cases and parched them slightly. Burning must have taken place before the seeds were fully ripe, at which time they fall naturally from the pod.

The implements of tarweed harvest were similar among all three interior valley groups. All used a variation on the seed beater "shaped like a tennis racket," and carried the seeds home in a soft, funnel-shaped basket carried by a burden-strap on the back. The seeds might first be beaten into a bucket or other container and then transferred to the back, or into the burden basket itself, held in front by the Indian women.

Once gathered, the seeds might be parched again with coals in a special ash-bark tray before being ground into a meal with stone mortar and pestle. A Salem settler stated that the meal "resembled pepper in appearance, but was sweet tasting." Jacobs' Santiam Kalapuya informant told him that ground hazelnuts and camas might be mixed with the tarweed meal. The processed seeds then were stored for winter use.[62]

The Indians apparently valued the tarweed highly. The 1877 Tualatin field notes state that tarweed patches were individually owned, and that each plot "might produce 10–20 bushels of seeds."[63] Tarweed therefore received an unusual amount of attention from the Kalapuya: unlike other utilized grass seeds, which simply were beaten off when ripe, *Madia* required burning; and given its high desirability and limited occurrence (at least in some areas) plots of wild tarweed, unlike other food plants, might be considered family or personal property. Elsewhere, species of *Madia* were likewise subject to intense attention.[64] In Chile, among the Araucanian Indians, *Madia sativa* (the major food species in the Pacific Northwest) was domesticated, both for its meal and as a source of oil.[65] The meal has a high protein content; the polyunsaturated oil, described "as clear as the best olive oil," is high in linoleic acid.[66]

Insects

A third direct reason for native grass burning was that it aided in the collection of grasshoppers. "Kalapuya Texts" notes:

> When it was summertime they burned over the land when they wanted to eat grasshoppers. When they burned the land, they burned the grasshoppers (too). And then they (women) gathered up the grasshoppers, and they ate those grasshoppers it is said.[67]

The method of capturing grasshoppers by field burning was widespread in Great Basin and interior valley regions. It also is reported ethnographically for the Takelma, Shasta, and Achumawi-Atsugewi.[68] A more descriptive account is the following, from the "Upper Columbia and the Interior of Oregon" (Sahaptin and/or Paiute) in the 1850s.

> . . . [the Indians] collect a great many large black crickets, and grasshoppers by the bushels . . . I have often seen them encircle the grasshoppers in a ring of fire by igniting the grass; their wings are scorched by the blaze, and they fall to the ground, when the Indians gather around, collect them and eat them . . . [or] they put [them] into a mortar with acorns or bread root, and pound into a mass which is then kneaded, placed on a board and baked for bread—the legs of the grasshoppers and crickets making a very rough crust.[69]

Although the Indians also used fire in the collection of yellow jacket larvae, it did not require burning of sizable areas. Jacobs' fieldnotes state that a fire was set atop the underground nest, driving out the adults and roasting the larvae. Douglas' statement that the Indians burned to get "honey" is a probable reference to this mode of collection. The Takelma had an identical practice.[70] Also reported from the basin and interior valley areas is the use of smoke to drive rodents (ground squirrels in the Willamette Valley) from their burrows.[71]

The above three types of burning yielded immediate rewards—venison, tarweed seeds, and roasted insects.[72] The Kalapuya also burned for reasons that did not produce instant results. The ground under oak trees was fired regularly to remove brush and facilitate future acorn gathering. Some areas were burned to make individual hunting of deer easier. Patches of ground in woody areas were burned prior to the broadcasting of tobacco seeds. And, by ethnographic analogy with the Shasta and others, it is likely that the Kalapuya burned to promote growth of desirable basket-making materials[73] and to create environments favorable to the growth of wild berry and root crops.

Acorn Gathering

Two wild nuts—hazel (*Corylus cornuta*) and acorn (*Quercus garryana*)—were utilized as food by the Kalapuya. Acorns, a staple crop in native California, were relatively less important to the Indians of the Willamette Valley. The Kalapuya lacked both the variety of oak species and the complex methods of acorn preparation used by California Indians.

Nevertheless, the descriptions of oak openings found in the journals of early explorers and settlers indicate that the Kalapuya were concerned enough about the acorn harvest to follow the California practice of burning underneath the trees. The following quotation by a pioneer of 1845 implies as much.

> Upon the slopes of these [Eola] hills are several thousand acres of white oak from six to twenty feet in height, some of them large diameter, and all with large bushy tops: the ground being covered with grass, at a distance they look like old orchards.

Also in 1845, Samuel Hancock commented on the unusual shape of the oak trees in the Willamette Valley: "very low with bushy tops . . . [that] reminded me of the apple trees at home." Regular low-intensity burning of the oak understory apparently produced standardized, well-groomed oak groves that resembled fruit and nut orchards cared for by the more complex techniques of arboriculture familiar to the American settlers.[74]

The ethnographic information on burning in oak groves by the Indians of northern California is relatively detailed and provides a model for the practice among the Kalapuya. The Karok reason for burning under the oaks was as follows:

> Mamie Offield says the trees are better if they are scorched by fire each year. This kills disease and pests. Fire also leaves the ground underneath the trees bare and clean and it is easier to pick up the acorns.[75]

The literature on the Tolowa states:

> Burning under trees to make acorns drop off; also to kill parasites on or underneath trees.

> Before leaving an oak grove after the annual acorn collection, they burned the grass over the entire flat. Tolowa informants claim that this reduced underbrush and kept the grass from growing too high, so that the fallen acorns could easily be located during the next year's harvest.[76]

Although the expressed reason for burning given by native informants was to facilitate gathering, the removal of shrubby growth would have other effects as well. Henry Lewis notes that firing, by reducing competition from other plants, would cause an increase in acorn production. In the Willamette Valley, Samuel Hancock was so impressed with the heavy production of acorns in the oak openings that he stated, "such is the abundance that I have no doubt but that the Indians and bears chiefly subsist on the products of these trees." One emigrant recalled the "very heavy mast of acorns" in the oak openings around Salem in the late 1840s, which, in the absence of continued burning, sprouted and grew into oak forests.[77]

The acorns were not, of course, eaten by the Indians alone, as the passage from Hancock indicates. Bears and rodents favor acorns, but more importantly from the viewpoint of the Kalapuya, so do the deer *Odocoileus virginianus* and *O. columbianus*. In fact, many of the modern constituent understory species in valley oak groves are favored deer browse (including various berries [*Amelanchier* and *Rubus* spp.], vine maple [*Acer macrophyllum*], and hazel).[78]

"Wallammette" by Henry Warre, 1845. Showing oak savanna, with forested areas along waterways and in the distance. Courtesy of The Amon Carter Museum, Fort Worth, #1996.4.10, watercolor and graphite on paper.

Deer Habitat

Besides the communal fire drive, several references suggest that the Indians of the Willamette Valley and adjacent areas maintained, by controlled burning, a variety of microhabitats that simultaneously facilitated the hunt and were favored by deer. These microhabitats included prairie copses and fir groves, cleared forest understories, and burned-over grassy areas.

In reference to the first, it will be recalled that David Douglas said the prairies were burned "For the purpose of urging the deer to frequent certain parts to feed, which they leave unburned and of course they are easily killed." Similarly a Salem pioneer described isolated groves of Douglas-fir in the northern portion of the valley that were purposefully excluded from burning.

> These fir groves had been found necessary by the Indians to induce deer and other wild game to stay in the valley. The groves were undisturbed by fire . . . The Indians burned right up to imaginary lines, but never was the fire allowed to go past or get out of hand. So some authority must have existed among them because bienially the prairies were burned.[79]

Understory burning along forested riverbanks was reported by another emigrant as being important for maintaining elk and deer populations. A contrast was made between the appearance of previously burned and, in the absence of Indian practice, unburned areas in the Pudding River area during the mid-19th century.

> Elk once were very abundant along the placid stream and the ground was strewn with their cast antlers in every direction. Although well timbered this was all open woods when Mr. Cox first saw it [1846]. There was no underbrush. One might ride a horse anywhere and a deer might be seen and followed without impediment . . . The country was kept thus open by the Indians who were compelled by the whites to quit burning it over; then the brush sprung up . . . [80]

Ethnographic descriptions from neighboring peoples inhabiting forested environments emphasized the clearing of undergrowth to facilitate the hunting of deer. Thus the Coos-Kalawatset informant Frank Drew said, "The Inds. used to keep all the brush of all the Sius[law] country burned down so there was no retarding underbrush & deers were then visible from afar." A Klamath informant stated that brush was burned to facilitate hunting: "Now I just hear the deer running through the brush at places we used to kill many deer. When the brush got as thick as it is now, we would burn it off."[81]

Like the clearing of the oak openings to facilitate acorn gathering, the firing of certain environments to make hunting easier had less immediate consequences for local environments. Regular burning promoted the growth and regrowth of tender grasses and forbs favored by browsing animals. Recorded native accounts have emphasized the importance of fire to the hunt.

Others, however, indicate that the Indian had delayed returns in mind when they burned for deer. The following passages from the Tututni ("Ground burned over to produce a better drop of grass to attract wild game") and Tolowa ("Late spring . . . is said to have been the time for burning off the hillsides to improve the hunting grounds")[82] fall into this category, as does the following translated passage, for the Sahaptin Umatilla, recorded by a French traveler in 1853.

> At the end of summer they set fire with greater ease entire prairies; but there is only one useful goal: many weeks later, new grass, green and tasty, grows back, nutritiously richer and preferred by the beasts . . .[83]

One of the most profound effects of annual burning in the Willamette Valley was to encourage the regrowth and consequent year-round availability of grasses used for forage by deer and elk. Later, in a discussion of the seasonal round in the Willamette Valley, I will present documentary evidence for the year-round availability of pasture in pre-contact times. Deer often are described ecologically as being inhabitants of "edge" environments. Such "overlap" zones are characterized by a mixture and consequent diversity of species, both plant and animal. The Indian pattern of burning in the Willamette Valley produced an open prairie, interspersed with stands of oak and isolated fir groves, cut by riverine woods of ash and alder and bounded by mountain forests of Douglas-fir. This environmental mosaic was characterized by an unusual abundance of "edges," and consequently provided an optimum habitat for edge species such as the native white-tailed and black-tailed deer.

Tobacco Cultivation

Tobacco occupies a somewhat anomalous position in Kalapuya subsistence practices since it was the only species that was both planted and grown by "agricultural" methods. Burning was an invariable component of tobacco cultivation.

The basic source for tobacco growth in the Willamette Valley is David Douglas' journal. In late August 1825, near the "village of the Calapooie Indians . . . twenty-four miles above the [Willamette] falls" Douglas wrote:

> An open place in the wood is chosen where there is dead wood, which they burn, and sow the seed in the ashes . . . They do not cultivate it near their camps of lodges, lest it should be taken for use before maturity . . . fortunately I met with one of the little plantations and supplied myself with seeds and specimens without delay. On my way home I met the owner who, seeing it under my arm, appeared to be much displeased; but by presenting him with two finger-lengths of tobacco from Europe his wrath was appeased and we became good

> friends. He then gave me the above description of cultivating it. He told me that wood ashes made it grow very large . . . .Thus we see that even the savages on the Columbia know the good effects produced on vegetation by the use of carbon.[84]

Marys River Kalapuya field notes collected in 1913 state:

> . . . Rotten logs burned up and tobacco-seeds put in with out spading. Occasionally place stirred up with stick. Each family planted for itself. When leaves ripe, they pull them out and dry them.

Nicotiana attenuata ("*N. rustica*" in Douglas) also was planted in burned-over areas by Upper Chinookans, all of the southwest Oregon Athapascans (i.e., Coquille, Tututni, Tolowa), and the Takelma and Shasta of the interior valleys to the south.[85]

Douglas' passage suggests that the Kalapuya were fully aware that ash acts as a fertilizer for planted seeds, and, it seems reasonable to assume, for seeds and rhizomes as well. This knowledge certainly was possessed by other West Coast hunters-gatherers who grew tobacco.[86]

As the above examples imply, the Willamette Valley Indians must have had some understanding of the long-range effects that periodic firing had on the health and productivity of selected species. Burning oak groves to remove brush and refuse to make acorn gathering easier also reduced competition from other plants, killed parasites, and encouraged a higher level of acorn production. Firing areas to shoot deer more easily resulted in increased browse and pasturage for larger numbers of deer and elk. And, according to David Douglas, the fertilizing effect of wood ash on future tobacco propagation and growth was understood fully by the Indians.

Despite a lack of direct documentary evidence for the Kalapuya, it is highly probable that Willamette Valley Indians intentionally burned limited areas to promote the growth and increase the yield of three additional classes of economically useful plants: hazel (*Corylus cornuta*), some species of berries, and many root crops. All of these species are early succession plants that colonize recently burned or disturbed areas. As a group they are characterized by rapid growth, and in the absence of periodic burning are at a competitive disadvantage with longer-lived woody species.

Hazel

The evidence that the Kalapuya burned to effect hazel growth is mostly suggestive. The plant is an early fire follower and was important to the Kalapuya both for its nuts and as a source of basketry material.[87]

Corylus cornuta in the Willamette Valley today is a common constituent of the understory vegetation in stands of *Quercus garryana*. It also is reported as being "Partial to well-drained hillsides, old fields, slashings, and burned over

areas." Once established, hazel grows rapidly and produces a profusion of suckers. Nut-bearing ordinarily does not commence until the fifth or sixth year, and in cultivated varieties, suckers are removed to encourage nut production.[88]

In all of aboriginal western Oregon and northern California, hazel withes were an important material in basketry. Surviving accounts invariably describe the hazel as new growth, harvested from plots that had been burned over the year before. This is the case for the Karok, Shasta, Tolowa, and the polyglot coastal natives of the Siletz Reservation of Oregon. In recent years, Grand Ronde Reservation basket-makers used hazel shoots from burned-over areas, which suggests this was an aboriginal Kalapuya practice as well.[89]

Hazelnuts were gathered by the Kalapuya in August and stored for winter use. Ethnographic data do not indicate that burning was a part of hazelnut collection in the Willamette Valley, though it is reported from elsewhere in western Oregon. The unpublished "Tututni Ethnography" describes burning over hazel-growing areas prior to nut collection in order to roast the nuts. Evelyn Dickson's 1946 thesis, "Food Plants of Western Oregon Indians," mentions burning of hazel patches "after [nut] gathering" by "some Oregon Indians" (affiliation not given, though Dickson's informants included southwest Oregon Athapascans, Kalapuya, and Molala).[90] Burning after harvest may have served as a "cleaning-up" operation, not unlike its function in the oak openings. Whether performed before or after harvest, however, firing would have the secondary effect of removing refuse, competing plants, and smaller branches and suckers, resulting in greater production of hazelnuts in following years.

Berries

Like hazel, most of the berries utilized by the Kalapuya were early succession plants that favor recently burned-over areas. And like hazel, they grow more rapidly and bear more fruit when competing plants have been reduced. For the Kalapuya, important species included, in open areas, the wild blackberry (*Rubus ursinus*) and strawberry (*Fragaria* spp.); and in forest clearings, various species of huckleberry (*Vaccinium*), salal (*Gaultheria shallon*), blackcaps (*Rubus leucodermis*), thimbleberry (*R. parviflorus*), and salmonberry (*R. spectablis*).[91] Some of these berries (*Rubus ursinus* and *Vaccinium*) were dried and stored by the Kalapuya; others were eaten fresh off the vine.

Neighboring peoples burned limited areas to encourage growth of berries. The unpublished "Tillamook Ethnography" states:

> Every few years the berry pickers would burn over the salal or shot huckleberry patch. That meant no berries there next season, but a greatly improved crop the second year. This was done to improve

> blackberry patches as well; these vines bore more lavishly the immediately following season.[92]

Upper Skagit informants in the northern part of Puget Sound recalled that forest clearings were burned over "in a carefully controlled way" to encourage the growth and increase the productivity of various species of berries. Upper Chehalis informants stated that prairie areas were burned for the express purpose of promoting the growth of blackberries. Burning to "increase yields of wild huckleberries" was practiced until recently in areas of the high Cascades of Oregon and Washington by Sahaptin peoples from the Columbia Plateau. Fires were started in October when the huckleberry harvest was complete. David French states that the "Indians had a thorough understanding of the ecological relationships" involved.[93]

Roots

By removing competing woody species, regular burning also favors the growth of several species of wild roots eaten by the Kalapuya. These include the liliaceous species camas (*Camassia quamash*) and wild onion (*Allium* spp.) as well as the tuber of the lupine (*Lupinus* spp.) and the rhizome of bracken fern (*Pteridium aquilinum*). From Whidbey Island, the San Juan Islands, and the Victoria area, there are ethnographic and historic accounts of burning open areas to encourage the growth of both camas and bracken fern.[94] In the Willamette Valley, the closest to a statement documenting that Indians burned to encourage growth of wild roots is the aforementioned 1841 U.S. Exploring Expedition suggestion that fire was necessary "for the purpose of procuring a certain species of root." John Minto's interpretive statement on the reason for burning might be useful here as well. According to him, "fire was the agency used by the Calapooia tribes to hold their camas grounds for game and [waterfowl]."[95]

The Seasonality of Burning

In order to provide a context for the stated and inferred reasons for aboriginal burning in the Willamette Valley, a temporal framework must be established. The context of time is examined in two ways: the yearly round of subsistence activities and the seasonal pattern of plant succession.

From the historical sources quoted above, it is clear that native burning in the Willamette Valley was a phenomenon of late summer and early fall. There is no record of it occurring at any other time of the year—and this may be as much of a climatic as a cultural factor. The earliest data on record is the second of July (from the H.B.C., 1834), and the latest is Clyman's (assumed,

not witnessed) date of the 20th of October (1846). The Methodist missionaries and the members of the Wilkes Expedition encountered the most intense burning during late August and early September (of 1840 and 1841, respectively). The burning season was over by that time of year when the Douglas-McLeod expedition traveled through the valley in late September (of 1826).

Subsistence Round

There is no detailed eyewitness account of the Kalapuya subsistence round. What information we have is incomplete and inferential, and comes from two sources: ethnographic and archaeological. For the Tualatin Kalapuya, Zenk located a yearly calendar in the 1877 ethnographic field notes of Albert Gatschet. This calendar shows that the Tualatin year was divided into halves, corresponding to the dual division of wet and dry seasons. From November through April, the Tualatin resided in "winter villages" located in the wooded (and thereby sheltered) tier along the banks of important northwestern tributaries of the Willamette. Tualatin winter villages apparently were composed of multi-family plank houses, like those of their Chinookan neighbors to the north; however, the surviving evidence from the southern Kalapuya area does not allow us to specify winter-village house type. We are similarly in the dark as to the size of aboriginal social groups for either the winter village or summer foraging units.[96]

Archaeological research by John White (1975) has clarified the nature of local movements during the dry half of the year.[97] White classified recent archaeological sites in the upper Willamette Valley by activity, environment, and seasonality, and arrived at four distinct types. Wet season camps were located in the forested strands of the major river tributaries. For the dry half of the year, there apparently was considerable movement from one environmental setting to another to take advantage of seasonally and locally available wild foods.[98] Three environments and three site types are involved. On the low, wet prairies (White's "primary flood plain") are the multi-activity sites that White deems "base camps." Pits for roasting camas, an exceedingly important food gathered in May and June, are found here. Located along the margin between the grasslands and the forests are White's "valley edge" sites, where hunting seems to have been the most important activity. Poorly known are the dry prairie ("narrow valley plain") sites. It is here that grinding implements—mortars and pestles, implying seed and nut processing—are concentrated. The dry prairies and the grasses and oaks that were found on them were apparently subjected to the most frequent and widespread burning by the Indians.

Seasonal Succession

As mentioned earlier, James Clyman's 1845–46 diary is an exceptionally good source on the seasonal floral succession in the Willamette Valley before its ecology was altered significantly by Whites. By following his notes, it is possible to get an idea of the sequence of wild foods available to the Kalapuya throughout a typical year, and by considering the known facts about anthropogenic burning, to make some statements about the impact fire had on plant succession.

As the record shows, most burning occurred in late August and early September. Clyman's journal in the valley begins on November 2, when rain had already rejuvenated large portions of the landscape.

> (in the Yamhill Valley) I walked over the green hills which were here and there dotted with cattle and horses feeding on the young grass now about three inches high and thick and thrifty as the summer growth of the western Praries. Likewise greate Quantities of water fowl seen on the low ground such as geese duck Brants and Cranes making fine amusement for the Sportsman.[99]

The "young grass," of course, was fire induced, not seeded by Whites. One of the major environmental effects of summer burning was to produce this secondary late fall growth of wild grasses. Fertilized by ash, the fall grasses were tender and nutritious. This second-growth grass certainly was a major winter supply of food in aboriginal times for deer and elk, and probably helped support a larger year-round population of these herbivores than would be possible under natural, non-fire conditions. Most of the wild grass species assumed to have been common in pre-White times in the Willamette Valley have a tendency to become tough, unpalatable, or even dangerous (such as squirreltail) to grazing animals in the fall.[100] Annual firing, of course, would eliminate this disadvantage.

Because the autumn regrowth of grass also was beneficial to cattle, early valley settlers frequently noted it in their journals. Two other accounts, from the Dundee hills of Yamhill County in 1845 and the Cow Creek valley of the upper Umpqua drainage in 1851, follow.

> . . . the grasses on these hills are a species of red clover, that grows in the summer season about one foot high, and a fine grass, which after the clover disappears, keep them clad in green during the winter. They thus furnish a perpetual supply of food for cattle the whole year.
>
> It was near the first of November 1885 that we settled upon the land now known as Glenbrook Farms . . . At that time Cow Creek valley looked like a great wheat field. The Indians, according to their custom, had burned the grass during the summer, and early rains had caused a luxuriant crop of grass on which our immigrant cattle were fat by Christmas time.[101]

Clyman also mentions "great Quantities of water fowl . . . such as geese ducks Brants and Cranes." The Willamette Valley is part of the Pacific Flyway, traversed by birds flying south in October and north in March. Some of the most common varieties on the October flyway today are the mallard, pintail, wigeon, teal (two species), and the Canada goose.[102] In Clyman's time, other species, such as the whistling swan and sandhill crane, now rare, probably were more common. Many of these waterfowl also benefited indirectly from the practice of large-scale burning. Geese especially (as is obvious in an earlier Clyman quote) will feed on tender young shoots of grass favored by fall burning. Various studies have shown that the food supply and nesting habitat of many species of ducks improves as a result of thinning and removal of woody plants through burning.[103] In 1908, John Minto recalled:

> . . . the millions of geese, brants, cranes and swans which wintered in Western Oregon. To me it seems easily unbelievable by a person coming here now to state the quantity of waterfowl, cranes, curlew and snipe which wintered on the grasses and roots of the damp lands of valleys and the sloughs, ponds and streams sixty-four years ago.[104]

A second passage from Clyman (not dated) noted that migratory birds were equally common in the spring: "waterfowl is plenty Beyond all conception in the rainy season all the Lowlands being litterly covered they all move to the north and east during months of April and May."[105] Clyman's and Minto's descriptions both indicate a much larger duck and geese population than we have today. How much of the decrease is due to hunting and how much to loss of habitat is hard to say.

The spring sequence follows:

> 3/1/45 . . . the hills are now fast becoming dry, green, and pleasant the grass which spread itself so nicely over the surface of the earth last fall is now beginning to shoot up and lengthen out.
>
> 3/13 Noticed five different kinds of small vegitables in full Bloom to day.
>
> 3/18 the hills handsomely rounded smoothe and thickly coated with green grass.
>
> 3/21 Strawberries in bloom and the hills completely covered with small flowers mostly purple and yellow.[106]

These passages are notable for their description of the early regeneration of native prairie grasses. Other pioneers noted this phenomenon as well. On February 22, 1833, one of the first settlers of the Salem area recorded "Extensive plains, well covered with grass interspersed throughout with oaks crowned with mistletoe . . . in favorable spots the grass has grown six inches."[107]

Returning to Clyman's diary:

> 4/21 greate Quantities of Firr Grouse on the hills. These grouse are fine eating much resemble a Pheasant [ruffed grouse] in appearance but are nearly double the weight [these were probably blue grouse (*Dendrogapus obscurus*)].
>
> 5/6 the hills have been for some days completely red with the clover now in full bloom
>
> 5/10 I rode through the entire upper settlement of the East of the willhamet [Waldo Hills?] and was highly pleased with the beautiful veriaty of hill and vally so softly varied and intermingled with hill and dale as Likewis timber and Prarie all luxuriently clothed in a rich and heavy coat of vegetation and litterly clothed in Flowers the upland in yallow and the vallys in purple. The Quantity of small flowering vegittiles is verry remarkable and beyond all conception.

A phrase from Wilkes, describing the Eola Hills on June 6, 1841, should help in the identification of the upland plants. "The hills were covered with wall-flowers, lupine, scilla, and quantities of ripe strawberries."[108]

Despite the designation "purple" (blue is more likely), the flowers in the valleys were almost certainly camas, the Kalapuya "staple," the generation of which was favored by burning. In a later entry, Clyman gave details on its former abundance.

> Ten or twelve acres of cammace in one marsh is quite common and in many insteances it will yeild 20 Bushel to the acre . . . these extensive fields are always on wet land and in many places no other vegitable is found to intermix with it.

The Tualatin calendar collected by Albert Gatschet shows that camas was harvested from the beginning of March, when the first shoots appeared, throughout the summer. The most intense activity apparently was in late May, when the plant was in flower. By late summer, when gathering was completed, many camas marshes would be dry and susceptible to burning.[109]

By early June, another sort of flora had reached maturity, according to Clyman:

> 6/6 . . . observed quantities of wild pigeons feeding on the grass seeds several kinds of which are fully ripe.
>
> 6/8 (on the Long Tom?) Passed over a fine undulating country handsomely and thickly coated with grass some haveing the appearance of rye and timothy all kinds However covered in seed which [is] rather remarkable for it is well Known to all the western states that but few of Prarie grasses are laden down with seed and those grown in the oak Hills the more certain.[110]

Although the band-tailed pigeon definitely fed on grass seed, we have no direct documentary evidence that the Kalapuya utilized any seeds other than

tarweed and wild sunflower, both available later in the year. Indirect evidence, however, exists in the form of Kalapuya seed-gathering equipment and locally abundant native grasses whose seeds were widely gathered in California. The seed-beater and conical burden basket that the Kalapuya used in the gathering of tarweed (above) are identical in form to those used to collect a wide variety of seeds by native Californians. At least two genera of native grasses—the bromes (*Bromus*) and wild ryes (*Elymus*), which are common to the Willamette Valley—were important food plants of California Indians. Wild barley (*Hordeum*) and needlegrass (*Stipa*), sometimes collected in California, also were present in the pre-White Willamette Valley. The bromes seed in July and others assumedly do as well.[111]

It was early in July that the 1834 Hudson's Bay Company journal first reported "herbage getting dry," and a few days later "the Indians set fire to the dry area on the neighboring hill." The implication is that there was selective burning at this early date of at least some of the grasses that had outlived their utility. In contrast, the burning of tarweed plots occurred only after that seed had ripened in early September. The extensive burns associated with communal deer hunts took place after the fawns had been weaned and the animals had fattened on acorns, and before the start of the fall rains—that is, late October.[112]

Reconstructed Burning Schedule

Given the above ethnohistoric and ethnographic information, we can reconstruct a probable burning schedule for the Kalapuya. In late spring and early summer, the Indians likely were concentrated at "primary flood plain" sites in the wet prairies, where root crops such as camas were collected and processed. There was no burning at this time. During mid-summer (July and August), the focus shifted to the dry prairies, and "narrow valley plain" sites were occupied more intensively. Burning in July and August apparently was sporadic, most likely occurring after the harvesting of seasonally and locally available wild foods (grass seeds, sunflower seeds, hazelnuts, and blackberries), in limited areas. The immediate effect of the early burns would be a "cleaning up" process; the long-term result would be to facilitate the re-growth, in future seasons, of the plants involved. In late summer, fire was used on the high prairies as a direct tool in the gathering of tarweed and insects. This was followed in October by firing of the oak openings, after acorns had been collected. Finally, from the "valley edge" sites, some Kalapuya initiated large-scale communal drives for deer, which provided a winter's supply of venison. The sequence ended as they returned to their sheltered winter villages along the river banks.

Conclusions

Omer Stewart stated that "Historical and anthropological records indicate that nearly every American Indian tribe set fire to the grass and woody vegetation in the area it occupied." In the Northwest Coast and Plateau culture areas south of the 49th parallel, available records indicate that, out of a total of forty identifiable ethnolinguistic units, twenty-six (65%) practiced some kind of patterned burning (exclusive of burning as a part of tobacco cultivation). The total number that actively managed plant and animal resources with fire probably is larger, since historical and ethnographic data on some groups in this region are exceedingly sparse.

Patterned burning is reported from the Rocky Mountains, Columbia Plateau, Middle Fraser, northern British Columbia, Pacific Coast, and Western Washington (see introduction). Some of the most impressive evidence for the aboriginal use of fire in the Northwest, however, comes from that special cultural subdivision which David French called the "Interior Valley Province." The historic records for the Kalapuya and the ethnographic data on the Karok, in particular, suggest that fire was important in a wide range of subsistence-related activities. The research of Johannessen *et al.* (1971) demonstrates that the Indian use of fire in the Willamette Valley was so frequent and widespread that it maintained what ecologists would call a "fire climax" biotype.

Clearly, fire was an important component in both the cultural and ecological systems of the prehistoric Willamette Valley. The Kalapuya Indians used fire in a wide range of subsistence activities, and fire was essential for maintaining a fire climax biotype. The link between the two systems was the natives' use of fire as a tool—a tool that simultaneously improved the subsistence quest while maintaining ecological diversity. With control over and knowledge of the ecosystemic effects of fire, the Indians established an important symbiotic relationship with their environment. Put in other words, the Kalapuya, like other Native North Americans, became an environmentally selective force, acting through their agent, fire.

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Notes

1. This paper originally was prepared for a reading and conference class with Dr. Wayne Suttles at Portland State University, in the fall of 1976. An abbreviated version was read at the Oregon Museum of Science and Industry in Portland, on January 15, 1977. Later drafts of this paper have benefited from the comments and suggestions of Pamela Amoss, Donald Grayson, Eugene Hunn, Brien Meilleur, Helen H. Norton, and Henry Zenk. I owe a special debt to Henry Lewis, who provided critical comment and encouragement, and shepherded this paper to publication.

2. The original sources, all from geographers at the University of Oregon, are Carl Johannessen *et al.*, "The vegetation of the Willamette Valley" (*Annals of the Association of American Geographers* 61(2): 286–306, 1971); Jerry Towle, Woodland in the Willamette Valley: An historical geography (Ph.D. dissertation, University of Oregon, 1974) and "Settlement and subsistence in the Willamette Valley: Some additional considerations" (*Northwest Anthropological Research Notes* 13(1): 12–21, 1979). The first researcher to assemble historical data on the use of fire by Willamette Valley Indians was forester William Morris, in "Forest fires in western Oregon and Washington" (*Oregon Historical Quarterly* 35(4): 313–39, 1936).

3. Jerry Franklin and C.T. Dyrness, *Natural Vegetation of Oregon and Washington* (orig. 1973; reprinted by Oregon State University Press in 1988), 12.

4. Data on climate come from the National Oceanic and Atmospheric Administration's (NOAA) *Climates of the States* (Washington, 1978), 814; on lightning fire distribution and frequency see William Morris, *Lightning Storms and Fires of Oregon and Washington* (Portland, 1938).

5. On species composition of the grasslands, see J. C. Nelson, "The grasses of Salem Oregon and vicinity" (*Torreya* 19(11); 216–27, 1919), and Franklin and Dyrness, *Natural Vegetation . . .*, 122. John Thilenius's "The *Quercus garryana* forest of the Willamette Valley" (*Ecology* 49(6): 1124–33, 1968) is the source for oak understory composition. Since 1985, there has been important new work on Willamette Valley native vegetation. See in particular the species lists in the appendix to Ed Alverson's "Use of a County Soil Survey to Locate Remnants of Native Grassland in the Willamette Valley Oregon" (pp. 107–12 in Richard Mitchell, Charles Sheviak, and Donald Leopold, eds., *Ecosystem Management: Rare Species and Significant Habitats,* Albany NY, 1990) and in Kathy Pendergrass's "Vegetation Composition and Response to Fire of Native Willamette Valley Wetland Prairies" (M.S. thesis, Oregon State University, 1995).

6. Seasonal flooding may have maintained the open nature of these low-lying areas. Before channelization, drainage, flood control, and other modifications, floods were more frequent and water regularly covered much of this land. See Patricia Benner and James Sedell, "Upper Willamette River Landscape: A Historic Perspective," pp. 23–46 in Antonius Laenen and David Dunnette, eds. *River Quality Dynamics and Restoration* (New York, 1997).

7. The basic source for species composition of these various communities is Franklin and Dyrness, *Natural Vegetation of Oregon and Washington.*

8. The first quotation is from George F. Emmons's "Journal kept while attached to the [U.S.] Exploring Expedition . . . No. 3" (WA MS 166, Western Americana Collection, Beinecke Library, Yale University, New Haven, 1841); the second from Alva Shaw, letter of 1844 (Oregon Historical Society Ms 941, Portland).

Other first-hand descriptions of pre-settlement topography and plant cover include John Work, "Journey from Fort Vancouver to the Umpqua River and return in 1834" (*Oregon Historical Quarterly* 24(3): 238–68); Charles Wilkes, *Narrative of the U.S. Exploring Expedition of 1838–1842* (Philadelphia, 1845); Joel Palmer, *Journal of Travels Over the Rocky Mountains . . .* (Cincinnati, 1847); and A. Shaw, Letter of March 3, 1848 (OHS Mss 941). An excellent description of seasonal changes in vegetation, *James Clyman, Frontiersman: The adventures of a trapper and covered wagon emigrant as told in his own reminiscences and diaries*, Charles Camp, ed. (Portland, 1960) is cited later in this paper.

9. Habeck, "The original vegetation of the mid-Willamette Valley"; Thilenius, "The *Quercus garryana* forest of the Willamette Valley"; Johannessen *et al.*, "The Vegetation of the Willamette Valley"; and Towle, "Woodland in the Willamette Valley." Habeck, "The original vegetation . . .," 16, discusses Garry oak to Douglas-fir transition.

10. The pioneering palynological studies are Henry Hanson's "Pollen study of lake sediments in the lower Willamette Valley of Western Oregon" (*Bulletin of the Torrey Botanical Club* 69(4): 262–80, 1942) and Calvin Heusser's *Late Pleistocene environments of North Pacific North America* (New York, 1960). A more recent overview of the palynological record is Cathy Whitlock's "Vegetational and Climatic History of the Pacific Northwest during the Last 20,000 Years: Implications for Understanding Present-day Biodiversity" (*The Northwest Environmental Journal* 8: 5–28, 1992). See also Estella Leopold and Robert Boyd's "An Ecological History of Old Prairie Areas in Southwestern Washington" (this volume).

11. An interesting sidelight to this history is that prescribed burning, after a hiatus of over a century, re-emerged as an important tool of environmental manipulation in the Willamette Valley. In the decade following the Second World War, an important grass seed industry became established in the south and central valley counties of Lane, Linn, and Marion. Seed growers discovered that annual fall burning was an excellent technique for removing litter and destroying various grass pathogens. Unfortunately, however, large-scale burning produces a great deal of smoke, which becomes trapped in the upper Willamette basin around the city of Eugene. Because of the pollution problem, field burning now is restricted by legislative decree. See Larry Svart, "Field Burning in the Willamette Valley: A case study of environmental quality control" (M.A. thesis, University of Washington, 1970).

12. After the "fever and ague" epidemics of the early 1830s, there was a significant influx of equestrian Sahaptin Klikitats from the Columbia Plateau into the Willamette Valley. These people were forcibly removed to their former homes in the early 1850s, and their descendants reside on the Yakama Reservation.

13. For a summary of the defining traits of the Northwest Coast culture area, see Philip Drucker, "Sources of Northwest Coast Culture," pp. 59–81 in *New Interpretations of Aboriginal American Culture History* (Washington, 1955); and Wayne Suttles, "Introduction," pp. 1–15 in *Northwest Coast*, vol. 7 of the *Handbook of North American Indians* (Washington, 1990). The list of Plateau culture area traits is summarized from Verne Ray, "Culture element distributions XXII: Plateau" (*Anthropological Records* 8(2), 1942). Lloyd Collins's analysis is in his University of Oregon M.A. thesis, "The Cultural Position of the Kalapuya in the Pacific Northwest"; David French's position was stated in "The Columbia-Fraser

Plateau: A little-known part of the world (talk given at the 32d annual Northwest Anthropological Conference, 1979).

14. From Henry Zenk's "Contributions to Tualatin ethnography: Subsistence and ethnobiology" (M.A. thesis, Portland State University, 1976), 69–70: "There is evidence that Willamette Falls presented an insurmountable obstruction to migratory fish during seasonal low-flow conditions. The spring chinook run, which ascended the falls during high water in the spring, was probably the only significant salmon run in the Willamette drainage in aboriginal times. Moreover, spring chinook ran only in the larger tributaries heading in the Cascades (notably in the North and South Santiam, McKenzie, and Middle Fork tributaries), and apparently were non-existent in the smaller and warmer western tributaries such as the Tualatin and Yamhill Rivers."

An intriguing (though unproven) possibility is that, in the lower-gradient tributaries of the western valley, aboriginal burning may have caused erosion and consequent silting of the rivers to the extent that they could not meet the requirements of water clarity and oxygenaton necessary for successful salmon spawning: "While the cultivation of crops is the major cause of indirect depletion, fires set for hunting drives, or for clearings in which wild grasses or other plants may be encouraged to grow are sometimes locally effective agents in the alteration of aquatic environments." (Gordon Hewes, "Aboriginal use of fishery resources in northwestern North America" [Ph.D. dissertation, University of California, 1947], 17). If true, this would indicate an interesting, but certainly unconscious, trade-off on the part of the Kalapuya Indians—promoting an increased prairie plant resource to the detriment of the existence of an anadromous fish resource.

15. The most thorough coverage of Kalapuyan subsistence is still Henry Zenk's 1976 "Contributions to Tualatin Ethnography"; a second major source is Melville Jacobs's "Kalapuya Texts" (*University of Washington Publications in Anthropology* 11, 1945).

16. All these estimates are discussed in detail in Robert Boyd, "Kalapuya Disease and Depopulation," in *What Price Eden?: The Willamette Valley in Transition, 1812–1855* (Salem, 1995). Lewis and Clark's Kalapuyan estimates ("Callahpoewah" and "Shoshones resident on the Multnomah") appear in their "Estimate of the Western Indians," pp. 473–89 in Gary Moulton, ed., *The Journals of Lewis & Clark* vol. 6 (Lincoln, NE, 1990). The Hudson's Bay Company figures are printed in Samuel Parker's "Report of a tour west of the Rocky Mountains in 1835–7," pp. 90–138 in Archer and Dorothy Hulbert, eds.; *Marcus Whitman, Crusader* (Denver, 1936), 123; and *Journal of an Exploring tour Beyond the Rocky Mountains, under the direction of the A.B.C.F.M . . . 1835–7* (Ithaca, 1838), 264.

17. On the "fever and ague" epidemics, see Sherburne Cook, "The Epidemic of 1830–33 in California and Oregon" (*University of California Publications in American Archaeology and Ethnology* 43(3): 303–26, 1955) and Robert Boyd, *The Coming of the Spirit of Pestilence: Introduced diseases and population decline among Northwest Coast Indians, 1774–1874* (Seattle, 1999), chap. 4. The 600 1841 estimate is from the "Diary of [Charles] Wilkes in the Northwest" (*Washington Historical Quarterly* 16(4): 290–301, 1926), 292.

18. Researchers included Albert Gatschet, Leo Frachtenberg, and Melville Jacobs. Melville Jacobs's "Kalapuya Texts" incorporates the most important myth and ethnographic elicitations collected by all three fieldworkers. Unpublished fieldnotes from all three are in the National Anthropological Archives at the Smithsonian

Institution and the Melville Jacobs Collection in the University of Washington Archives; notable documents include Frachtenberg's "Kalapuya Ethnology" (NAA Ms 1923-C, 1913) and Jacobs's "Kalapuya Element List" (undated manuscript at the Bancroft Library, University of California). For more recent ethnographic summaries based on these materials, see Henry Zenk's 1990 "The Kalapuyans," pp. 547–53 in Suttles, *Northwest Coast*; and 1995 "Describing a Vanished Culture: The Aboriginal Kalapuyans," in *What Price Eden?*

19. For instance, Franklin and Dyrness, *Natural Vegetation of Oregon and Washington* (1973); Jerry Towle, "Woodland in the Willamette Valley" and "Settlement and Subsistence in the Willamette Valley" (1974 and 1979); and Samuel Dicken, "Oregon geography before White settlement, 1770–1846 . . .," pp. 1–27 in Thomas Vaughan, ed., *The Western shore: Oregon country essays honoring the American Revolution* (Portland, 1975). More recently, environmental historians have begun citing this literature. See in particular Peter Boag, *Environment and experience: settlement culture in nineteenth-century Oregon* (Berkeley, 1992); and Robert Bunting, *The Pacific Raincoast: environment and culture in an American Eden, 1778–1900* (Lawrence, KAN, 1997).

20. Most of the passages quoted below are first-hand observations preserved in the daily journals and diaries of explorers, traders, and early settlers. In these accounts, references to aboriginal burning generally appear as notational asides to the writer's main purpose. For instance, smoke and fire sometimes were mentioned as part of a daily weather report or as a hindrance to travel. Taken by themselves, such passages have little meaning. Considered in the context of what we know from the field of fire ecology, however, they gain substance. The journals almost always give a date and frequently mention the location or environmental setting of the observation. The picture that emerges shows that Indian burning practices in the Willamette Valley were highly patterned, occurring year after year at regular times and in particular kinds of environments.

21. The only two surviving documents that contain any first-hand information on the valley and its inhabitants are "Robert Stuart's Narratives," pp. 2–263 in Philip Rollins, ed., *The Discovery of the Oregon Trail* (New York, 1935); and *The Journal of Alexander Henry the Younger, 1799–1814*, vol. 2: *The Saskatchewan and Columbia Rivers*, Barry Gough, ed. (Toronto, 1992).

22. Alexander McLeod, "Journal of a hunting expedition to the southward of the Umpqua," pp. 175–219 in Kenneth Davies, ed., *Peter Skene Ogden's Snake Country Journal, 1826–27* (London, 1961) and *Journal kept by David Douglas during his travels in North America, 1823–1827* (New York, 1959).

23. McLeod *"Journal"* (Davies), 175.

24. Douglas *Journal*, 213–14. The first quotation originally was cited in Johannessen *et al.*, "The vegetation of the Willamette Valley," 288; the second in Morris, "Forest Fires in Western Oregon and Washington," 316.

25. The quotations are from McLeod, *"Journal"* (Davies), 179; and Douglas *Journal*, 217 (the latter first cited by Johannessen *et al.*, 289). Similar entries to the above for October 2 follow in Douglas's journal: on the 5th the expedition again camped alongside a "woody stream" where there was fodder for the horses; on the 6th Douglas again reported "my feet are very sore from the burned stumps of the low brushwood and strong grasses." (*ibid.*)

26. Douglas *Journal*, 237; McLeod, *"Journal"* (Davies), 218.

27. Alexander McLeod, "Journal of occurrences on an expedition to the southward of the Columbia," pp. 112–27 in Maurice Sullivan, ed., *Travels of Jedediah Smith* (1934 orig.; 1992 reprint by University of Nebraska Press).
28. P. 11 in *The Hudson's Bay Company's First Fur Brigade to the Sacramento Valley: Alexander McLeod's 1829 Hunt*, Doyce Nunis ed. (Fair Oaks CA, 1968).
29. The quotations are from McLeod's "Journal" (Sullivan), 113 and 119.
30. See Work, "Journey from Fort Vancouver to the Umpqua River," 264; Gustavus Hines, *Oregon; Its History, Condition and Prospects* . . . (Chicago, 1852), 264; and Jason Lee, "Journal of an 1840 trip to the Umpqua" (*The Christian Advocate*, August 25, 1841).
31. The Emmons and Eld journals are held in the Western Americana Collection of the Beinecke Library at Yale University; the full citations are George F. Emmons, "Journal kept while attached to the Exploring Expedition . . . No. 3" (WA MS 166, 1841) and Henry Eld, "Journal. Statistics etc. in Oregon and California . . . Sept. 6th to Oct 29th inclusive" (WA MS 161, 1841). Microfilm copies of both are available locally. The others are *The Brackenridge Journal for the Oregon Country*, O. B. Sperlin, ed. (Seattle, 1931, orig. in the *Washington Historical Quarterly* vols. 21 and 22: var. pp., 1930 and 1931); "Titian Ramsay Peale, 1799–1885, and his journals of the Wilkes Expedition," Jessie Poesch, ed. (*American Philosophical Society Memoir* 52, 1961); George Colvocoresses, *Four Years in a Government Exploring Expedition* . . . (New York, 1852); and Wilkes, *Narrative of the U.S. Exploring Expedition.* The Peale diary is incomplete; that portion covering the Willamette Valley was lost on the expedition during an upset while crossing the south fork of the Umpqua River. A sixth journal of the overland trek apparently was kept by the official artist of the expedition, Alfred Agate. Charles Pickering's *The Races of Man, and their geographical distribution.* (United States Exploring Expedition, vol. 9, Philadelphia, 1848), 39, refers to such a manuscript, in addition to reproducing two of Agate's watercolors of Kalapuya Indians. I do not know the whereabouts of the Agate journal if, indeed, it still exists.
32. "Diary of Wilkes in the Northwest," 53–54.
33. George Sinclair, "Journal on the Porpoise" (Microforms, University of Washington Libraries), entry for October 18, 1841.
34. These comments are similar to those recorded by Wilkes two months earlier, and apparently arise from a shared pool of information.
35. Colvocoresses, *Four Years in a Government Exploring Expedition* . . ., 277.
36. "Letters of David Douglas" (*Oregon Historical Quarterly* 6(1): 76–97, 1904), 78.
37. *The Brackenridge Journal*, 57 (cited by Johannessen *et al.*, 290).
38. Wilkes, *Narrative* vol. 5, 222–23.
39. *The Brackenridge Journal*, 58.
40. *Ibid.*, 216.
41. Documentation for southwestern Oregon from the Wilkes Expedition journals appears in Jeff LaLande and Reg Pullen, "Burning for a 'Fine and Beautiful Open Country': Native Uses of Fire in Southwestern Oregon," this volume. For Indian burning in northern California, see Henry Lewis, "Patterns of Indian Burning in California: Ecology and ethnohistory" (orig. 1973; 1993 revision pp. 55–116 in Thomas Blackburn and Kat Anderson, *Before the Wilderness: Environmental management by native Californians* (Menlo Park, CA).

42. Jesse Applegate, *Recollections of my Boyhood* (Roseburg OR, 1914), 69 (cited by Morris, "Forest Fires," 317 and Johannessen *et al.*, 219).
43. Applegate's account, though certainly based on fact, is suspiciously similar in style to a passage in Washington Irving's *Adventures of Captain Bonneville* (1977 Twayne edition edited by Robert Rees and Alan Sandy, Boston, 245–46), describing burning of prairies by Cayuse Indians in the valley of the Grande Ronde in eastern Oregon. Applegate was a popular writer who modified and retold various boyhood experiences from the pioneer period of the 1840s in such a way as to make them more salable to the reading public of turn-of-the-century Oregon.
44. Eld "Journal," entry of September 17.
45. Alvin T. Smith, "Diary," (Ms 8, Oregon Historical Society).
46. *James Clyman, Frontiersman* . . ., 120–21. The first and third quotations originally were cited by Johannessen *et al.*, 290–91.
47. Stewart's relevant publications are "Why the Great Plains are Treeless" (*Colorado Quarterly* 2(1): 40–50, 1953); "The forgotten side of ethnogeography," pp. 221–49 in Robert Spencer, ed., *Method and Perspective in Anthropology* (Minneapolis, 1954), and "Fire as the first great force employed by man," pp. 115–33 in William Thomas, ed., *Man's Role in Changing the Face of the Earth* (Chicago, 1956). The excerpt on "reasons" comes from "Why the Great Plains are Treeless,"
43. As of this writing (spring 1999), Stewart's magnum opus on Indian burning is being prepared, posthumously, for publication. The publisher is University of Oklahoma Press; the editors are Kat Anderson and Henry Lewis.
48. Homer Aschmann, "Aboriginal use of fire" pp. 132–41 in *Proceedings of the Symposium on the Environmental Consequences of Fire and Fuel Management in Mediterranean Ecosystems* (USDA Forest Service General Technical Report WO-3, 1977), 135.
49. Joseph Henry Brown, statement to Hubert Howe Bancroft, 1878 (manuscript, Bancroft Library, University of California).
50. See Verne Ray, "Culture element distributions XXII: Plateau" (*Anthropological Records* 8(2): 95–262, 1942); Erminie Wheeler-Voegelin, "Culture element distributions XX: northeast California" (*AR* 7(2), 1942); and Harold Driver, "Culture element distributions X: northwest California" (*AR* 1(6): 297–433, 1939).
51. Not to be confused with *John* Hudson, Melville Jacobs' main informant for his Santiam "Kalapuya Texts" (1945), who died in 1954. Joseph Hudson was John Hudson's father's brother. Henry Zenk has supplied me with the following information on Joseph Hudson. Under the name of "Al-qe-ma" or "Yelkma," he was a signer of both the Champoeg (1851) and Palmer (1855) treaties. He was sketched by George Gibbs around 1850 (David Bushnell, "Drawings by George Gibbs in the far Northwest, 1849–51" [*Smithsonian Miscellaneous Collections* 97(8)], 1938). Under the name of "Jo Hutchins" he is cited in at least two published works on the Grand Ronde reservation from the 1870s.
52. Quinaby was another well-known native of the early reservation period. See "Twilight of a Chief" by Oswald West in *The Oregonian* 10/22, 1950, magazine p. 12 for a popularized account of him in the late 1880s.
53. Samuel Clarke, *Pioneer days of Oregon history*, vol. 1 (Portland, 1905), 89–90 (reorganized by the author for clarity). Originally cited in Morris, "Forest fires . . .," 317.

54. John Minto, "The number and condition of the native race in Oregon when first seen by the white man" (*Oregon Historical Quarterly* 1(3): 296–315, 1900), 306–7. Originally cited by Zenk, "Contributions to Tualatin ethnography," 68.
55. *Life, Letters, and Travels of Father Pierre-Jean deSmet, S.J., 1801–1873* . . .vol. III, Hiram Chittenden and Alfred Richardson, eds. (New York, 1905), 1021–22. Another Coeur d'Alene account from deSmet appears in Stephen Barrett and Stephen Arno, "Indian Fires in the Northern Rockies: Ethnohistory and Ecology," this volume. See also John Ross, "Proto-historical and Historical Spokan Prescribed Burning and Stewardship of Utilitarian and Food Resource Areas," this volume, on the Spokan fire surround.
56. Wheeler-Voegelin, "Culture element distributions XX: northeast California"; Driver, "Culture element distributions X: northwest California." See LaLande and Pullen, "Burning for a 'Fine and Beautiful Open Country,'" this volume, on Takelma. The Shasta quotation comes from Roland Dixon, "The Shasta" (*Bulletin of the American Museum of Natural History* 17(5): 381–498, 1907), 431. The Shasta and Takelma also used another communal method involving brush or rope fences, but without fire.
57. On venison processing, see M. Jacobs, "Kalapuya Texts," 103, 251, 366, 369; on the autumn fattening of deer, Walter Taylor, ed., *The Deer of North America* (Harrisburg, PA, 1956), 82. "Robert Stuart's Narratives," 32; and Alexander Ross, *Adventures of the First Settlers on the Oregon or Columbia River* . . . (London, 1849), 36; are the authorities on elk in the Willamette Valley.
58. The basic information of Kalapuya use of tarweed appears in Zenk, "Contributions to Tualatin ethnography," 57–59. On tarweed use by California Indians, see George Mead, "The Ethnobotany of the California Indians: A compendium of the plants, their users, and their uses" (Univers*ity of Northern Colorado Occasional Publications in Anthropology, Ethnology Series* No. 30, 1972).
59. Applegate, *Recollections of My Boyhood*, 68. Originally cited in Zenk, "Contributions to Tualatin ethnology," 230.
60. George Riddle, *History of Early Days in Oregon* (Riddle, OR, 1920), 45–46. Cited in Zenk, "Contributions . . .," 59.
61. Edward Sapir, "Notes on the Takelma Indians of southwestern Oregon" (*American Anthropologist* 9(2): 251–75, 1907), 259. See also LaLande and Pullen, "Burning for a 'Fine and Beautiful Open Country'," this volume, for tarweed gathering among the Coquille Indians.
62. On the various implements of tarweed gathering and processing, see the *Indian Journal of Rev. R[obert]. W. Summers*, Martinus Cowley, ed. (Lafayette OR, 1994), 38–39, 78, 102. Zenk, in "Describing a Vanished Culture," gives Tualatin Kalapuya names for the implements, as well as the special verbs used for beating, pounding, and parching tarweed seeds. On the taste of the meal, see Horace Lyman, "Indian Names" (*Oregon Historical Quarterly* 1(3): 316–26, 1900), 325; on Santiam Kalapuya tarweed preparations, Jacobs, "Kalapuya Texts," 20.

Another seed known to have been collected by the Kalapuya came from sundry species of *Balsamorhiza*, the western "sunflower." Other than the requisite burning in the case of tarweed, the gathering and preparation of sunflower and tarweed seeds was similar. Both were knocked off the plant with a beater into a small basket or bucket and then transferred to a larger soft burden basket on the back (M. Jacobs, "Kalapuya Texts," 37; Sapir, "Notes on the Takelma," 259). The sunflower seeds then were parched and ground into a paste. This similarity in collection may

account partially for the frequent confusion of the two varieties in the early accounts (e.g., Wilkes and Emmons, above). A second significant difference was in the *time* of harvest. *Balsamorhiza* seeds were ripe in July; tarweed in September. See Zenk, "Contributions to Tualatin ethnography," 23, for a discussion of this identification problem.

63. Zenk, "Contributions to Tualatin ethnography," 58.

64. Six species of *Madia* are native to western Oregon. *Madia gracilis* and *M. exigua* were first reported from the West Coast by Vancouver's lieutenant, Archibald Menzies, in 1792. *Madia elegans* was first listed by David Douglas in 1825. Thomas Nuttall recorded the remainder, *M. glomerata, M. madiodes,* and *M. sativa* (though usually under obsolete scientific names), in 1834. *Madia sativa,* the species domesticated by the Chilean Indians, was collected on Sauvie Island, next to Fort Vancouver. C. Leo Hitchcock *et al., Vascular Plants of the Pacific Northwest* (Seattle, 1955) vol. 5, 261.

65. On Araucanian tarweed see Carl Sauer, "Cultivated Plants of South and Central America," pp. 487–543 in Julian Steward, ed., "Handbook of South American Indians" (*Bureau of American Ethnology Bulletin* 143, vol. 6, 1950), 495. The unusual disjunct distribution of *Madia sativa*, on both the West Coast of the United States and in Chile south of the Atacama Desert, is almost certainly the result of "direct, long distance dispersal by migratory birds." See Elsa Zardini, "*Madia sativa* Mol. (*Asteraceae-Heliantheae-Madinae*): An Ethnobotanical and Geographical Disjunct" (*Economic Botany* 46(1): 34–44, 1992), 38.

66. The quotation is from Giovanni Molina, *The Geographical, Natural and Civil History of Chile* (Middletown, CONN, 1808), 95; on protein content see Zardini, "*Madia sativa* Mol.," 40; on the characteristics of tarweed oil, Guillermo Schmeda-Hirschmann, "*Madia sativa,* a Potential Oil Crop of Central Chile" (*Economic Botany* 49(3): 257–59, 1995).

67. Jacobs, "Kalapuya Texts," 26; cited by Zenk, "Contributions to Tualatin ethnography," 131.

68. On the Takelma, see Edward Sapir in LaLande and Pullen, "Burning for a 'Fine and Beautiful Open Country'," this volume; for northern California, Wheeler-Voegelin, "Culture element distributions XX: northeast California," 53.

69. A. N. Armstrong, *Oregon* (Chicago, 1857), 119.

70. Douglas, *Journal,* 213–14; Zenk, "Contributions to Tualatin ethnography," 134.

71. Melville Jacobs, "Kalapuya Element List" (manuscript, Bancroft Library, n.d.); Omer Stewart, "Culture element distributions XIV: Northern Paiute" (*Anthropological Records* 4(3): 361–446, 1941), 369; Wheeler-Voegelin, "Culture element distributions XX: northeast California," 53.

72. Parenthetically, although it is not recorded for the Kalapuya, we might mention here the practice, reported from the Central Valley of California, of burning a species of grass to obtain salt. See Alfred Kroeber, "Salt, Dogs, Tobacco" (*Anthropological Records* 6(1), 1941), 4. The species in question is salt-grass, *Distichlis spicata,* also found in the Willamette Valley.

73. George James, *Indian Basketry* (New York, 1903), 79.

74. The quotations are from Joel Palmer, *Journal of Travels,* 173; and *The Narrative of Samuel Hancock: 1845–1860* (New York, 1927), 46, 48.

75. Sara Schenck and Edward Gifford, "Karok Ethnobotany" (*Anthropological Records* 13(6), 1952), 382. Cited in Lewis, "Patterns of Indian Burning in California," 103.

76. Harold Driver, "Culture element distributions X: northwest California," 381; Richard Gould, "Comparative ecology of food-sharing in Australia and Northwest California," pp. 422–53 in Robert Harding and Geza Telecki, eds., *Omnivorous Primates: gathering and hunting in human evolution* (New York, 1981), 442.
77. Lewis, "Patterns of Indian Burning in California"; *The Narrative of Samuel Hancock*, 48; Joseph Henry Brown, "Statement to Hubert Howe Bancroft," 2.
78. Taylor, *The Deer of North America*, 202, 554–55; Thilenius, "The *Quercus garryana* forest of the Willamette Valley."
79. Douglas *Journal*, 214; George Strozut, "Remembrances of Lewis Judson" (*Marion County History* 1: 21–29, 1955), 21.
80. J. Cox, "Reminiscences." In "Horace Lyman Papers" (Oregon Historical Society Ms. 722).
81. The Coos statement was collected by John Harrington, and was provided to the author by Henry Zenk; the Klamath quotation comes from Omer Stewart's "The forgotten side of ethnogeography," 119.
82. From Cora DuBois's "Ethnological Document No. 6" [Tututni fieldnotes] (Bancroft Library, 1934) and Philip Drucker, "The Tolowa and Their Southwest Oregon Kin" (*University of California Publications in American Archaeology and Ethnology* 35(4), 1937), 232–33. Both are cited in LaLande and Pullen, "Burning for a 'Fine and Beautiful Open Country'," this volume; and by Lewis, "Patterns of Indian Burning in California," 98.
83. Pierre Saint-Amant, *Voyages en Californie et dans l'Oregon* (Paris, 1854), 264. Translation by the author.
84. *Journal kept by David Douglas*, 59 (location), 141 (planting).
85. The Marys River citation is from Frachtenberg, "Kalapuya Ethnology"; French, "Aboriginal Control of Huckleberry Yield" for Upper Chinookans; Homer Barnett, "Culture element distributions VII: Oregon Coast" (*Anthropological Records* 1(3): 155–204, 1937), 175 for southwest Oregon Athapascans; Sapir, "Notes on the Takelma Indians," 259 for Takelma; and Wheeler-Voegelin, "Culture element distributions XX: northeast California," 92 for Shasta. See also LaLande and Pullen, "Burning for a 'Fine and Beautiful Open Country'," this volume.
86. David French, in "Aboriginal Control of Huckleberry Yield in the Northwest" (1957 and this volume) was the first to recognize the significance of Douglas's passage: it shows the ecological understanding that underlaid the Indian practice. There is some confusion over the exact identity of western Oregon native tobacco. French suggests it may have been *Nicotiana quadrivalvis*, a second native West Coast species, not the *N. attenuata* attested from the Plateau.
87. On Kalapuya uses of hazel, see Zenk, "Contributions to Tualatin ethnography," 89.
88. Thilenius, "The *Quercus garryana* forest of the Willamette Valley;" George Sudworth, *Forest Trees of the Pacific Slope* (Washington, 1908), 384; Lloyd Baron, *Growing filberts in Oregon* (Oregon State University Extension Bulletin No. 628, 1978), 20.
89. Schenck and Gifford, "Karok Ethnobotany," 386; James, *Indian Basketry*, and Richard Gould, personal communication, both cited in Lewis, "Patterns of Indian Burning in California," 97 and 99; Leone Kasner, *Siletz: Survival for an Artifact* (Dallas OR, 1976), 40–41; and Henry Zenk, personal communication, 1986.
90. DuBois, ["Tututni Ethnography"]; Evelyn Dickson, "Food Plants of Western Oregon Indians . . ." (M.A. thesis, Stanford University, 1946).

91. M. Jacobs, "Kalapuya Texts."
92. Elizabeth Jacobs, "Tillamook Ethnography" (unpublished manuscript).
93. June Collins, *Valley of the Spirits: the Upper Skagit Indians of western Washington* (Seattle, 1974), 57; Thelma Adamson, "Unarranged Sources of Chehalis Ethnology" (Melville Jacobs Collection, Box 77, University of Washington Archives, 1926–1927); French, "Aboriginal Control of Huckleberry Yield."
94. See in particular Richard White, "Indian land use and environmental change: Island County," 1975 and this volume; Wayne Suttles, "The Economic Life of the Coast Salish of Haro and Rosario Straits" (Ph.D. dissertation, University of Washington, 1951); Helen H. Norton, "Evidence for Bracken Fern as a Food for Aboriginal Peoples of Western Washington" (*Economic Botany* 33(4): 384–96, 1979); Nancy Turner and Marcus Bell, "The Ethnobotany of the Coast Salish Indians of Vancouver Island" (*Economic Botany* 25(1): 63–104, 1971); and Turner and Harriet Kuhnlein, "Camas (*Camassia* spp.) and Riceroot (*Fritillaria* spp.): Two Liliaceous 'Root' Foods of the Northwest Coast Indians" (*Ecology of Food and Nutrition* 13(4): 199–219, 1983).
95. John Minto, "From youth to age as an American" (*Oregon Historical Quarterly* 9(2): 127–72, 1908), 152.
96. Zenk, "Contributions to Tualatin ethnography," 40–41 (calendar); 140 (winter houses).
97. John White, "A proposed typology of Willamette Valley sites," pp. 17–140 in C. Melvin Aikens, ed., "Archaeological Studies in the Willamette Valley, Oregon" (*University of Oregon Anthropological Paper* No. 8, 1975).
98. It might be noted that most early White contact with unacculturated Kalapuya took place during the spring and summer months, when trapping expeditions were undertaken and when the natives were dispersed over the land.
99. *James Clyman, Frontiersman . . .*, 122.
100. USDA Forest Service, *Range Plant Handbook* (Washington, 1937), var. pp.
101. The first quotation is from Joel Palmer's *Journal*, 170; the second from George Riddle's *History of Early Days in Oregon*, 37.
102. Joseph Linduska, ed., *Waterfowl Tomorrow* (USDI Fish and Wildlife Service, 1964), 238.
103. See, for example, Estella Leopold and Nina Bradley, "Fire and productivity," pp. 27–37 in Martin Alexander, ed., *Let the Forests Burn?* (Fort Collins, CO, 1974).
104. Minto, "From youth to age as an American," 152.
105. *James Clyman, Frontiersman . . .*, 136.
106. *Ibid.*, 138–39.
107. John Ball, letter of February 22, 1833 (Oregon Historical Society Ms. 195; published and unpublished versions).
108. *James Clyman, Frontiersman . . .*, 143 Wilkes, *Narrative*, vol. 4, 358.
109. *James Clyman, Frontiersman . . .*, 152; the Tualatin calendar is in Henry Zenk, "Contributions to Tualatin ethnography," 40–42.
110. *James Clyman, Frontiersman . . .*, 154 and 157.
111. On wild seeds gathered by California Indians, see especially Schenck and Gifford, "Karok Ethnobotany," 379—80; and Victor Chesnut, "Plants Used by the Indians of Mendocino County, California" (*Contributions from the U.S. National Herbarium* 7(3), 1902).
112. Work, "Journey from Fort Vancouver to the Umpqua River," 264; *The Brackenridge Journal*, 57; Taylor, *The Deer of North America*, 75 and 82.