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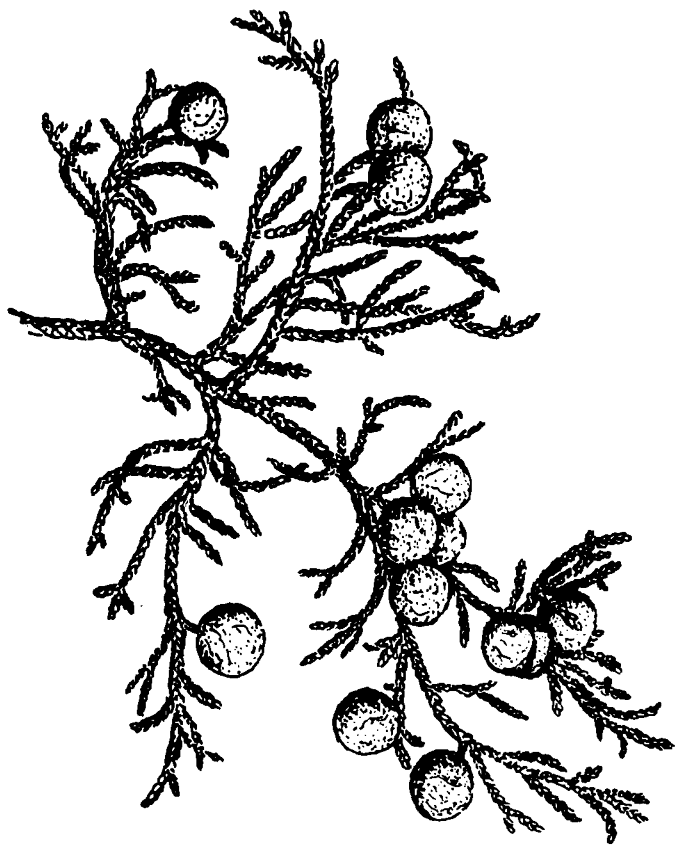
WESTERN JUNIPER MANAGEMENT SHORT COURSE

OCTOBER 15-16, 1984

BEND, OREGON



Sponsored by Oregon State University Extension Service and the Department of Rangeland Resources, Oregon State University, Corvallis, Oregon 97331

Western Juniper Management
Short Course (1984 Oct. 15
Proceedings Western Juniper
Management Short Course

WESTERN JUNIPER MANAGEMENT (*Juniperus occidentalis*)

Western juniper occupies large tracts of country throughout northeastern California, central and eastern Oregon, southwestern Idaho, northwestern Nevada and even into a little of Washington. It has many attributes considered both harmful and beneficial, depending upon one's perspective. Populations can "creep upon you". No simple, easy, or cheap way exists to control it after stands become established. Given the total acreage over which it presently occurs, relatively little is being done to manage it. One would think with that kind of situation that it would not get that much attention.

On the contrary, although never receiving the research attention of plants like big sagebrush, this plant does command a place in the resource managers thinking. It is a formadable plant from a management standpoint. In the areas where it is well adapted, one observes it to grow virtually everywhere and to have a real "grip" on the sites.

This publication is the outcome of a short course held in Bend, Oregon, October 15-16, 1984. Some 23 separate but closely related presentations were made. I had the privilege to review, edit, and on several to write some notes of what was said. An earlier symposium in January 1977 provided the springboard from which to leap on to updating observations and to provide new and, I believe, exciting information. After reading these proceedings, I trust you will know that a real effort was made to bring together the major authorities on the principles and actual practices on the ecology, control, and management of western juniper.

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TABLE OF CONTENTS

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PREHISTORIC DISTRIBUTION OF WESTERN JUNIPER

Peter J. Mehringer, Jr. and Peter E. Wigand

For more than a 1,000,000 years the earth has been locked in glacial climates. At times one-fifth of the ocean's present volume lay frozen in continental, sea and alpine ice that covered nearly one-third of the planet's surface (Andrews 1975). Warm episodes, like the last 12,000 years, may typify less than 10% of Pleistocene time (Imbrie and Imbrie 1979). Climate of the last 500 years may be as atypical of the Holocene, as weather of the last 5 years--reflected in the northern Great Basin's growing lakes--is unusual within the last 150 years and more.

During the last ice age large pluvial lakes overflowed valleys flanked by glacier-capped mountains as woodlands filled the present treeless deserts of western North America (Mehringer, in press). Vegetation--buffeted by numerous glacial-interglacial cycles in which brief warmth punctuated long cold intervals--responded as vagaries of climate, dispersal potential, competition, selection, soils, topography, volcanic eruptions, fire, man and chance dictated.

Knowledge of past responses of juniper to rapidly fluctuating climates of the late Quaternary would enhance understanding of historic changes in juniper distributions. With such information we could evaluate, for example, the uniqueness of historic woodland expansion in western North America, and test notions concerning the long-term integrity of species associations and the role of fire in western juniper communities.

Late Quaternary fossil plant records may even provide clues to the recent and persistent expansion of western juniper, despite chaining, chopping, poisoning and burning. Minimally, they already outline juniper's broad and continuing travels over western North America since the last glaciation (Betancourt 1984; Betancourt and Van Devender 1983; Spaulding, Leopold and Van Devender 1983; Van Devender, Betancourt and Wimberly 1984; Wells 1983). Radiocarbon-dated plant remains from ancient woodrat (*Neotoma* spp.) middens (Van Devender 1983) have been especially important in revealing the responses of desert shrubs and forest trees to late Quaternary climatic variation.

The full-glacial northern perimeter of juniper-pinyon woodlands stretched across the northern Mohave Desert below 1800 meters elevation at about 37° north latitude (Spaulding 1984). There, single needle pinyon (*Pinus monophylla*) extended downward toward the Las Vegas Valley, Nevada, to 3500 feet and Utah juniper (*Juniperus osteosperma*) occupied limestone ridges to 2000 feet. Woodlands of pygmy conifers and xerophytic shrubs flourished in the Mohave, Sonoran and Chihuahuan deserts to the south. When released from the chilling grip of glacial climates, woodland species streamed northward and upward into territory relinguished by pluvial lakes, cold steppe species, and montane conifers. By 7500 B.P. woodland survivors in the southern deserts had all but withdrawn to higher elevations they occupy today, but their ranges no doubt continued to respond to varying environments on a lesser scale.

While abandoning ice-age positions to the south, single-needle pinyon pine and Utah juniper advanced along a broad northern front. Arrival in the Toquima Range, central Nevada, is heralded by increased abundance of their pollen about 6000 B.P. and confirmed by macrofossils from cave fill and woodrat middens by 5000 B.P. (Thompson and Hattori 1983; Thompson and Kautz 1983). Before this time Rocky Mountain juniper (*Juniperus scopulorum*) was present--as it was through the eastern Great Basin where Utah juniper was rare or absent before 11,000 B.P. Apparently, Rocky Mountain juniper was the important late Pleistocene-early Holocene juniper of the central and eastern Great Basin where Utah juniper thrives today.

Although its fossils are lacking, Rocky Mountain juniper's presence in the interior of British Columbia and adjacent Alberta provides indisputable evidence for major Holocene movements from ice-age homes south of continental glaciers, whereas variations in terpenoids of present populations indicate potential refugia and paths of colonization. Adams (1983, fig. 10) suggests eastern Oregon as a Pleistocene refugium from which western Canada was colonized. However, without fossil records the Pleistocene homes and northward passage of these Rocky Mountain junipers remain uncertain.

Dwarf prostrate junipers (*Juniperus communis*, *J. horizontalis*) in woodrat middens led Wells (1983) to envision a full-glacial subarctic landscape fringing the northern Great Basin where western juniper prevails today. Although scores of radiocarbon-dated woodrat middens from many localities in the Great Basin contain Rocky Mountain and Utah juniper, we know little of the late Quaternary history of western juniper.

WESTERN JUNIPER

The Holocene history of western juniper (*Juniperus occidentalis*) is poorly understood because without fossil records present distributions provide too few clues to paths, and rates of advances and retreats. Nonetheless, further knowledge of their distribution, hybridization, and morphological and chemical variation, will be essential to reasonably interpret fossil occurrences. Western juniper fossils present problems of identification because there are apparently northern and southern subspecies and western juniper may hybridize with Utah juniper (Vasek 1966). However, radiocarbon-dated remains from four sites provide the first clues to its recent history.

The oldest of these is from Kings Canyon, California (Figure 1), where twigs and seeds were recovered from several woodrate middens dating from >45,000 to 12,500 B.P. (Cole 1983). Western juniper (reported as *Juniperus* cf. *occidentalis*) next appears as an invader of freshly exposed margins of

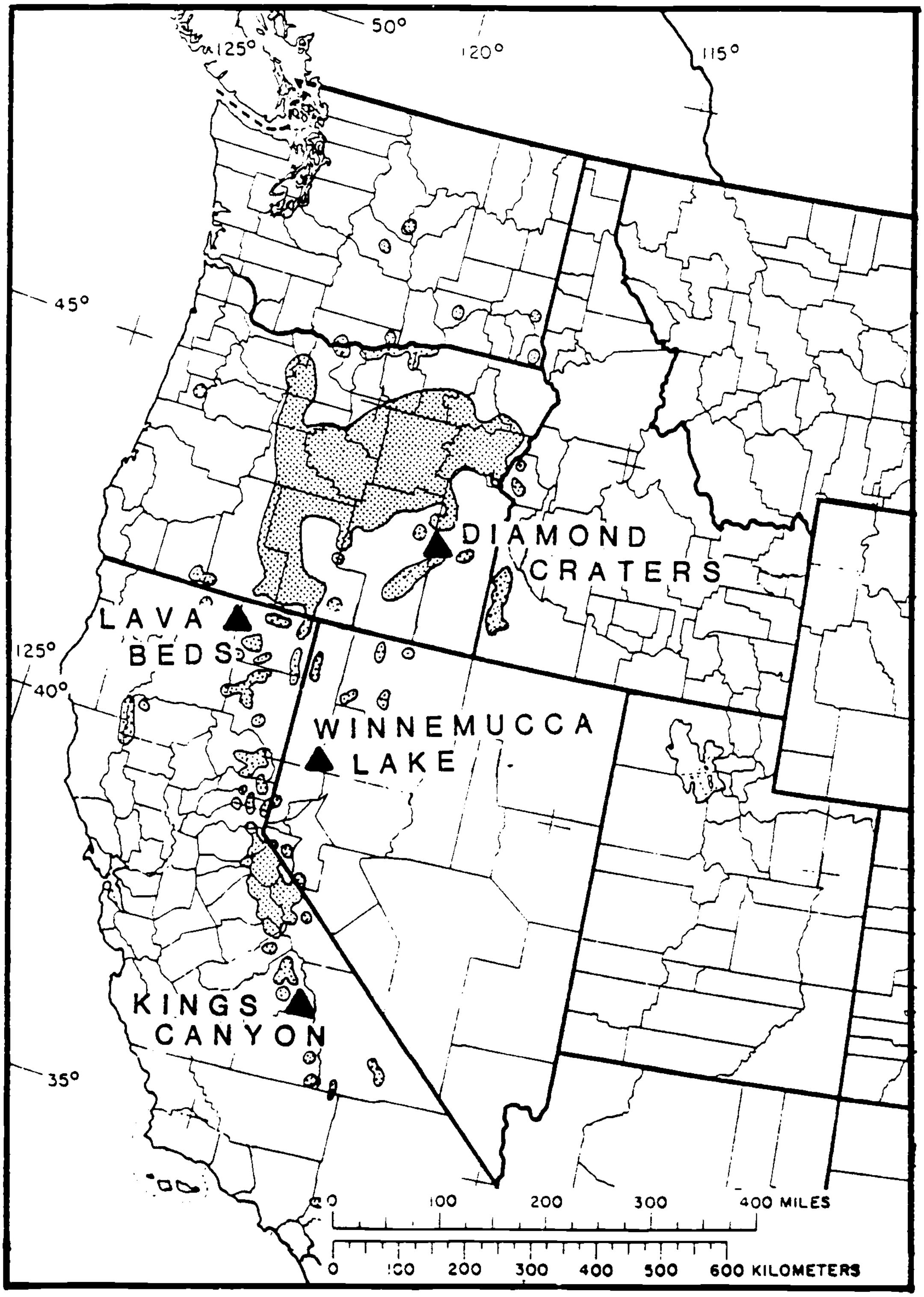

Figure 1. Distribution of western juniper (Little 1971, map 26-W) and locations of woodrat middens with radiocarbon-dated fossils attributed to western juniper (*Juniperus occidentalis*).

Pluvial Lake Lahontan where its remains from woodrat middens from caves of the Winnemucca Lake Basin, Nevada, were radiocarbon-dated from about 12,000 to 11,500 B.P. (Thompson 1984, table 1).

The final reports of radiocarbon-dated fossil western juniper are from northern California and eastern Oregon. Woodrat middens collected from lava tubes and caves at Lava Beds National Monument, northeastern California, furnished estimates of the "natural" vegetation before the disturbances of the past 150 years. As elsewhere in western North America, photographs and historic accounts indicate that, in places, a comparatively open grassy landscape had given way to shrubs and juniper (Johnson and Smathers 1974; Martin and Johnson 1979). Preliminary study of seven woodrat middens revealed past plant assemblages characterized by the same species that occupy the sites today. All were dominated by remains of western juniper, and mountain mahogany (Cercocarpus ledifolius) was abundant in most middens. The dates of these assemblages (Figure 2) confirm appearance of western juniper by 5000 B.P. and its presence, at least sporadically, thereafter.

Diamond Craters, lies just east of the Malheur Marshes and north of Steens Mountain in southeastern Oregon. One of the many explosion craters in this volcanic terrain (Malheur Maar) holds a 50 meter diameter pond (Diamond Pond) that has accumulated sediments and fossil pollen, algae, seeds and molluscs for at least the last 6000 years. Diamond Pond, at 1265 meters elevation, lies astride the sagebrush-shadscale desert ecotone. Juniper pollen is present throughout these deposits and its percentages fluctuate suggesting periods of varying juniper abundance. However, larger fossil pollen percentages might indicate, either expansion or increasing density of juniper, or both.

Lava tubes, caves and rock shelters from 100 meters to 1 kilometer from the nearest living junipers--for the most part evidencing historic expansion--contain woodrat middens dominated by western juniper remains. The radiocarbon dates of these middens range from 3000 to 835 B.P.; the dates, either in clusters or singly, correspond with increasing juniper pollen percentages from the independently dated Diamond Pond cores (Figure 3).

Because the juniper fossils must have come from within the 30 to 50 meters that woodrats are known to forage, the macrofossil records indicate several expansions of juniper over the past 4000 years. Juniper pollen percentages and location of the juniper containing middens record the down-slope movement of woodlands near Diamond Pond the equivalent of about 30 to 100 meters elevation as compared with present distribution of junipers at Diamond Craters.

DISCUSSION AND CONCLUSIONS

The Lava Beds woodrat midden fossils reveal past presence of junipers over their full present elevational range within the monument. Current distributions are the result of the spread of historically documented juniper stands from the rough lava flows at mid-elevations into areas occupied by ponderosa pine lost to drought and beetles, and into grasslands recently invaded by shrubs.

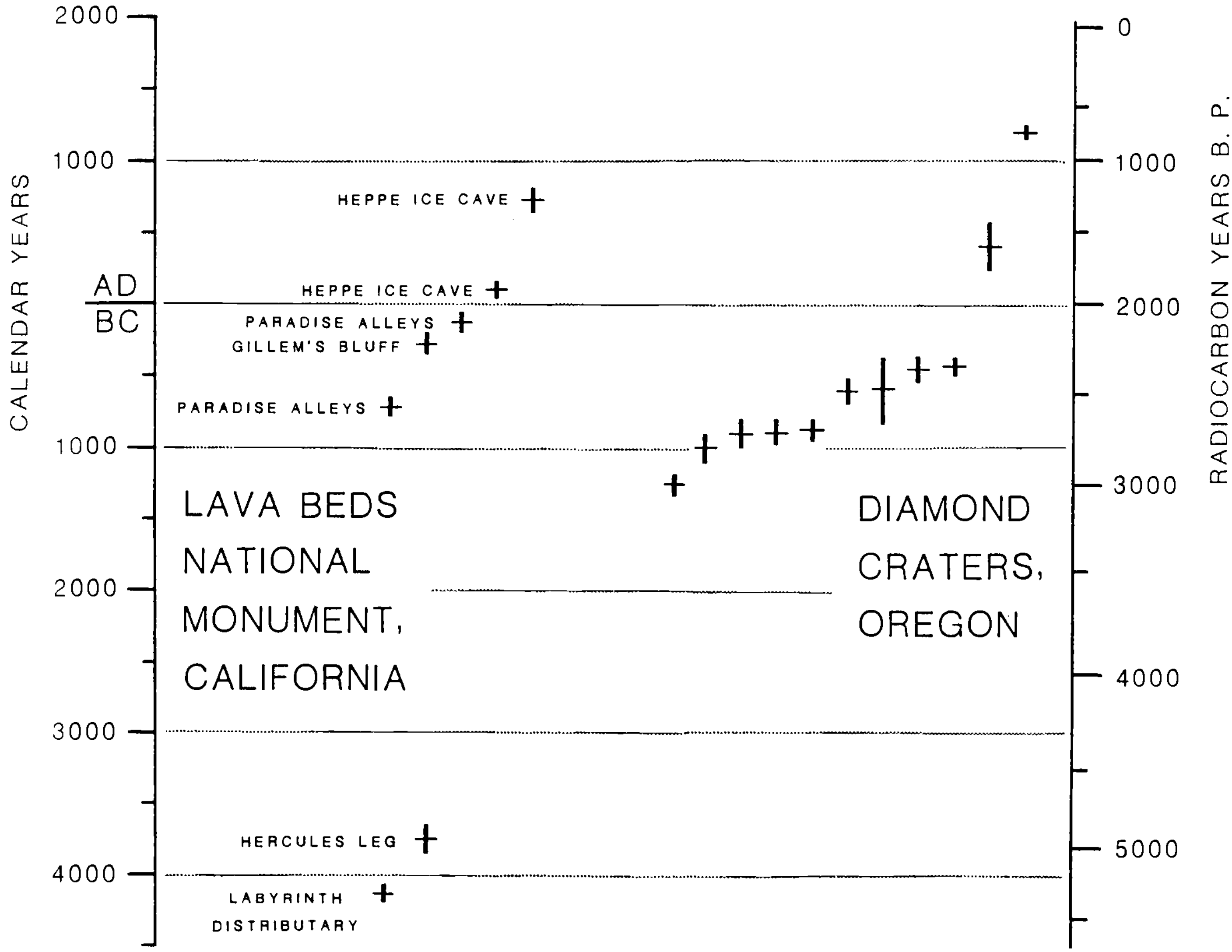

Figure 2. Radiocarbon dates and tree-ring corrected ages (Klein et al. 1982) associated with fossil western juniper from Lava Beds National Monument, northeastern California, and Diamond Craters, southeastern Oregon.

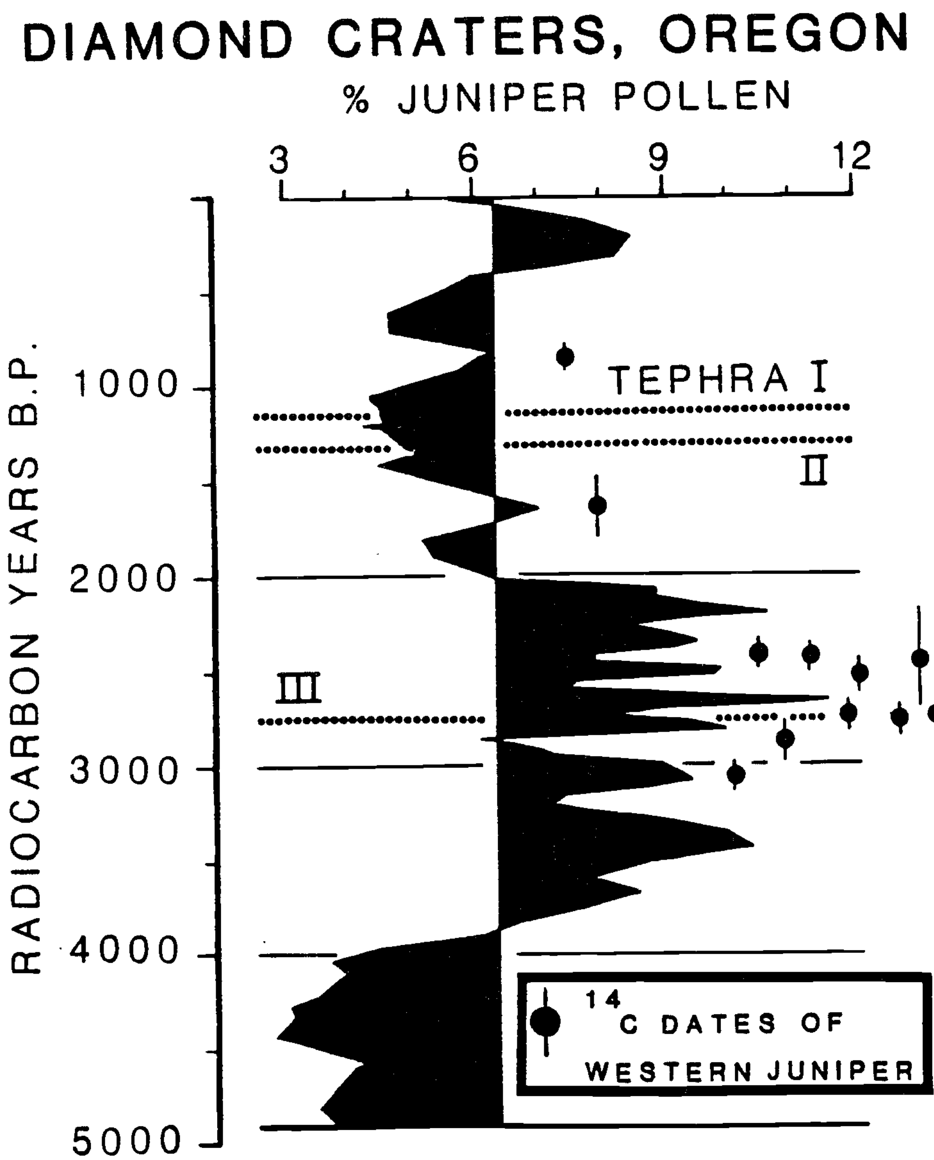

Figure 3. Smoothed juniper pollen percentages of samples from Diamond Pond (Malheur Maar) cores, plotted about their mean for the last 5000 ^{14}C years, and radiocarbon dates associated with western juniper remains from woodrat middens from nearby lava tubes 100 m to 1 km outside the present range of juniper.

All locations but two (Gillem's Bluff 1280 meters and Heppe Ice Cave 1615 meters) are near 1500 meters elevation and probably supported western juniper and some ponderosa pine 100 years ago (Martin and Johnson 1979, fig. 1). Although adjacent to ponderosa pine forest, Heppe Ice Cave is currently surrounded by dense curl-leaf mountain-mahogany and western juniper, and its two woodrat middens (Figure 2) are dominated by these species. Ponderosa pine was not recovered from these or the other five middens.

During the last century the area around Gillem's Bluff supported a bunchgrass-sagebrush community (Johnson and Smathers 1974, fig. 5). Encroachment of juniper and native and exotic pioneer dominants, and increasing density of sagebrush since then have been attributed to heavy grazing and control of wildfires. Although a few small junipers grow near the Gillem's Bluff midden site, an active woodrat midden there lacks juniper. Yet, 2200 years ago western junipers occurred sufficiently near to assure their collection by woodrats when neither overgrazing nor fire suppression could account for their presence.

The fossil records show that the persistent recent advance of western juniper in eastern Oregon is not unique to the historic period of grazing by cattle, sheep and horses, and reduced fire frequencies. In fact, the rate and degree of change in the comings and goings of western juniper over the late Holocene are equal to or greater than those seen over the past hundred years. For example, compare the abrupt decline and increase in percent juniper pollen about 2900 B.P. and the sudden decline at 2200 B.P. (Figure 3).

If the pollen record from Diamond Pond is a reasonable reflection of the behavior of western juniper in eastern Oregon, then, on the average, the period from about 4000 to 2000 B.P. witnessed expanses of juniper woodland exceeding those of today. Also, historic juniper expansion may be no more significant than a similar event that began about 400 years ago and waned 200 years later.

According to the study of fossil pollen and seeds of aquatic plants from the Diamond Pond cores, each of the increases in juniper pollen corresponds to periods of relatively deeper water. Other apparent correspondences between grass and sagebrush pollen, and the abundance of charcoal over the last 2000 years must be studied in more detail. But, with further analyses of lake cores and woodrat middens we hope to reconstruct the relationships between grass and shrub dominance, fire frequency or intensity, climate and the prehistoric distribution of western juniper.

ACKNOWLDGEMENTS

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SETTLING THE CENTRAL OREGON RANGE--1860-1900

Ward Tonsfeldt

"The poorest man...could spare the price of a horse for flour."

In January of 1898, John Newton Williamson--a Prineville stockman, attorney, and U. S. Congressman--watched his home county emerge from a recession. "I will make the statement, truthfully as I think, and without any pretense of booming the county, that Crook County has withstood the pressures of the recent hard times as well as any community on the Pacific Coast...this statement of facts simply proves the assertion that a stock raising country is the best country on earth for a poor man" (Shaver et al, 1905). Although the economic opportunity that the central Oregon range offered in 1898 was no longer as attractive as it had been thirty years earlier when the first settlers arrived, the promise of free grass and unfenced acres exercised a powerful appeal to "poor men" until well into this century. It is beyond argument that the semi-arid region of the west like the central Oregon range offered the last frontier in the contiguous states, but the appeal of that frontier and the quality of opportunity that it offered are points worth exploring. This is especially true now as the public perception of the settlement period on the western ranges threatens to change from a viewpoint favorable to the early stockmen to one that castigates them as men dedicated to "making high profits with minimal expenditures and effort" as they participated in a "frenzied quest for easy money that spread like wildfire through the West" (Ferguson and Ferguson, 1983).

The range country of old Crook county, which was southern Wasco county before 1882, now includes Crook, Deschutes, and Jefferson counties. Lying well to the south of the rich grasslands of the Columbia basin and well to the west of the richer grasslands of the Harney basin, Crook county--with its high altitude, limited moisture, and poor soil--attracted fewer stockmen than either of its neighboring regions. Added to this, the relative obscurity of the area and its distance to markets further delayed settlement. By the late 1860's, when the first few emigrants were arriving in central Oregon, newspapers were already heralding Ben Snipes as a "cattle king" reigning in The Dalles; and John Devine and W. B. Todhunter had come north from California to establish the famous Whitehorse Ranch in southeastern Oregon (Oliphant, 1968).

The settlers came for the grass, but the quality of the grazing they found was uneven. The first explorers formed a mixed opinion of the area's grazing potential. Peter Skene Ogden had remarked in his journal of the 1926 expedition that the soil on the Crooked River was "remarkably rich and in some parts the grass seven feet high" (Rich, 1950). Nathaniel Wyeth, who traversed the Deschutes drainage in 1834 for the Pacific Trading Company, took little notice of the vegetation or at least recorded little in his journal. J. C. Fremont commented several years later on the river-bottom meadows, but did not seem to regard the country as especially inviting. In 1845, a party of emigrants led by Stephen Meek wandered the length of the Crooked River drainage seeking an easier route to The Dalles. Their retinue included 198 wagons, 2,299 loose cattle, 811 oxen, and 1,051 goats. This amount of livestock surely made the party sensitive to the area's grazing potential, but they formed no favorable impression. Writing about his experiences many years later, W. A. Goulder remarks that

> The new route was a trackless waste, covered, for the most part, by immense fields of sage-brush that grew tall, strong, and dense. Through these sage-fields we were obliged to force the oxen, the teams taking turns, day about, in breaking their way through the sage. It often consumed a good deal of time in the morning in compelling the oxen to begin their daily task of breaking road. (1909)

In 1859, Captain H. D. Wallen led a well equipped military exploring party into the Crooked River valley. They camped at a spring that must have been the head of the south fork of Crooked River. Wallen was delighted with what he saw.

> Obtaining the required information, we took our departure at an early hour the next morning, travelling east by south over a rolling prairie country, interspersed with cedar and pine timber, until we pitched our tents at Antelope spring. The spring is situated in a forest of pine timber, with an undulating country for miles around. I have seldom seen a more delightful spot. The scenery is beautiful, soil arable and good, timber in unlimited quantities for building and fencing purposes, and the extent of grazing country sufficient for numberless flocks and herds. Had this part of Oregon been explored, it must certainly have been settled long since in preference to other portions of the country more remote and far less desirable, as it possesses every requisite to make glad the heart of the farmer. (1860)

At another point in his report, Wallen pursues the stock raising theme further.

> As an evidence of what Oregon is as a stock raising country, I give the following received from a farmer living on the Fifteen Mile creek: "In the spring of 1851 I purchased a cow, for which I paid fifty dollars; since then I have sold four hundred and twenty-one dollars worth of stock, have on hand nine cows and calves and eight yearlings, valued at seven hundred and eighty dollars, all the increase from that cow since she has been in my possession." (1860)

The difference in agricultural conditions between Fifteen Mile creek in the Columbia basin and the Crooked River valley may have been lost on Wallen, but it was apparent his colleague Captain John Drake, who commanded a party in the area to Wallen's five years later. In the Columbia basin, Drake found "good grass," but farther to the southeast, he found that "the grass, in ascending the Crooked River plateau, appears to grow worse." His reaction to the country west of the Crooked river was even less favorable:

> I do not regret the trip, as I succeeded in gaining a knowledge of the country that I could not have acquired by any other means. As for the country I have no desire to visit it, or any portion again. It is a desert to all intents and purpose, utterly worthless, sandy, rough and rugged places with a stunted growth of juniper covering the surface (Knuth, 1964).

When eyewitnesses disagreed about the country's potential, what was a poor man to think?

By 1867, "people of the Willamette valley who wanted homes and were willing to brave the dangers of Indian country to secure them" were crossing the Cascades to the range. Not surprisingly, they settled on creek bottoms on the western flanks of the Blue mountains. Trout Creek, Willow Creek, Hay Creek, Ochoco Creek, Mill Creek, Camp Creek and others filled with isolated homesteads (Shaver et al, 1905). The 1870 census of the Ochoco District records 160 inhabitants. Fifty-two of them engaged in farming or stock raising, twenty-five kept house, two cut lumber, and one served the community as a blacksmith (Toepel and Beckham, 1978). Most of them seemed pleased with the prospects of the new land. George Barnes, whose father, Elisha Barnes, brought some of the first sheep into central Oregon, remembered it twenty years later as a stockman's Eden.

> This was, certainly, as fine a country then as a stock man would wish to see. The bottoms were covered with wild rye, clover, pea vine, wild flax and meadow grass that was waist high on horseback. The hills were clothed with a mat of bunch grass that seemed inexhaustable. It appeared a veritable paradise for stock (Shaver et al, 1905).

In a letter written to her family in 1871, Kate Robbins, who had settled that year on Ochoco Creek, is equally positive if less lyrical. "It is a great grass country for cattle and horses, also sheep thrive remarkably well. All the hills and little valleys are covered with rich grass which fattens very rapidly, and of course the cows give lots of milk..." (Jan. 19, 1871). In addition to livestock and dairy products, the country offered abundant game and limited but lively social diversions. Barnes' account of one of his neighbors suggests that at least some of the settlers soon lost their Willamette Valley inhibition and came perilously close to a state of nature.

> If he [James McDowell] could get enough to eat and plenty of tobacco, he did not care if he was ragged or dirty. He was always happy, and during our ragged period....[he] was in his element. He shaved once a week with a butcher knife and stood ready to back his "mar" against any horse in the county for fifteen buck hides (Shaver et al, 1905).

McDowell's expedient of wagering buck hides on horse races points up a feature of life on the central Oregon frontier: although the land offered an easy enough living at first, it was difficult to convert the grass or the livestock into cash (Oliphant, 1978). For the Robbins family, the business of marketing the cattle, lambs, and horses was a major part of their work. In 1871, Abner Robbins spent the summer in Idaho finding a buyer for "seventy-five head of beef and twenty-five or thirty horses." "It will be a hard summers work" Kate remarked," but money is the object" (March 31, 1871). Later that summer, Kate's daughter Eunice felt the pinch for currency in a letter to her grandmother. "As soon as we can find a greenback, will send it" (August 27, 1871). By 1875, Abner was supplementing his income from stock raising by buying other homesteaders' stock in the valley "at low prices" and driving them with his own to sell in Idaho (Feb. 2, 1875). Cortley D. Allen, who first came to the range country in 1872 and returned to settle in 1877, summarized the settlers' plight in a newspaper interview in 1922.

> People think we first settlers should all be rich. Our trouble was lack of transportation. I have sold cattle to be driven to Cheyenne, and others to be driven to California. Men with capital would buy calves at $2.50 a head, and let them out to us on shares. We gave them half of the selling price, and that way we would get a start. Some years we would make money, and other years conditions would be bad and we would be cleaned out again...Those who did make a success of the cattle business found it a rough life. They camped under the juniper trees at all seasons of the year, no matter what the weather, sometimes with few blankets. Almost every day was spent in the saddle... It was a rough life, but we liked it.

While homesteaders like Allen and the Robbins family were riding the ranges and the market cycles of the 1870's, other stockmen with more capital and grander ambitions were casting a speculative eye on central Oregon. In 1873, Dr. David Baldwin of Oakland, California established the Baldwin Sheep and Land Company on Hay Creek. It grew to become one of the largest and most prosperous sheep ranches in the northwest. The Teal and Coleman ranch, headquartered on Trout Creek, also began its rise to prominence during this period. Although homesteads as such were limited by the terms of the Homestead Act of 1862, additional land was available through the provisions of the Timber Culture Act of 1873 and the Stone and Timber Act of 1878. Using these programs, homesteaders who felt the need of more land could acquire it for little expense or trouble. Ike Mills, for example, who settled on Grindstone Creek in 1896, put his home place together from a 160-acre homestead tract and a 160-acre Stone and Timber Claim (Clark, 1978). Better financed emigrants were able to purchase large tracts of land from several sources. The State of Oregon offered school sections and swamp lands for sale. Road companies offered their alternate sections along their right of ways. Fraudulent operators like S.A.D. Puter, "king of the Oregon land fraud ring," offered bogus filings of Stone and Timber claims. The amounts of public land offered for sale by these means strains the imagination: the Willamette Valley and Cascade Mountain Road Company received 861,504 acres of federal land for right of way and resale, The Oregon Swamp Lands Act acreage consisted of an initial claim of 526,903 acres (later pared to 249,244 acres), and the state school sections amounted to nearly 3.5 million acres (Swift, 1909). The terms of sale for these lands was typically one dollar an acre, with 20% down and the balance due in ten years. S. A. D. Puter's nefarious activities in Crook County included filings on valuable timber tracts as well as filings on sparsely timbered grazing lands. Writing from the Oregon state penitentiary in 1908, Puter described one of his Crook County "timber claim" filings: "The township constituted the best summer sheep range in that part of Oregon. It was partially covered scraggly timber, which had no market value at the time, if at all. In many places there were long stretches of splendid grazing land upon which there was not a stick of timber of any account."

Assembling large parcels of land appealed to some stockmen, but most others were content to embrace the philosophy of the open range and not worry about deeds, mortgages, or fences. The common practice in the early 1870's was to graze the stock all year on the range without feeding hay or fencing pastures. The bunchgrass dried naturally to a nutritious winter feed, and as long as the snow depth was not too great, cattle wintered well enough. For this reason, the virgin range that had not been grazed before and was still available in the 1870's would have been especially attractive for its accumulation of dried bunchgrass. The warm Chinook winds that often followed snowstorms made winter grazing practical. The "Stockman's Prayer," first printed in The Dalles Weekly Mountaineer in 1872, offered a humorous reflection of the stockmen's optimism.

"Oh stockmen's God! O thou
To whom we always look
And humbly, trusting bow
In prayer and praise - CHINOOK!
On thee we more rely
Than all the hay and straw,
Or barley, oats, and rye
For thy propitious thaw.
O grant thy winds and rains
Upon us poor to send,
And we'll not pray again
Until next fall. Amen."

When the wind did not come, as in the winters of 1871-2, 1874-5, and 1879-80, the cattle simply starved, the settlers accepting the losses as an inevitable part of the livestock business (Oliphant, 1968).

The Robbins family seemed to value their 160-acre homestead claim more for the access it offered to the range than for any intrinsic value that it had as a piece of real estate. In March of 1871, Kate reported that Abner was fencing and plowing ten acres for "his male horse to run in" while he sold stock in Idaho (March 31, 1871). Two years later, most of the claim had been fenced and the tillable land was let on shares to "Mr. Lawson, who is to do all the work for half the grain" (April 2, 1874). Four years later, in 1878, the range had begun to deteriorate and the alternatives facing the family were less attractive. Abner found himself cutting 5,000 rails to fence a "large pasture" as "every one who is [in] cattle is fencing a pasture to keep the grass for his own use." Kate was not sanguine about the family homestead: "Taxes are very high. We paid this year $140.00 and no real estate at all for we never have got a deed for this place and don't know as we ever will. We will sell it whenever we get a chance and put money into land that we can get a deed for" (Jan. 18, 1876).

There is considerable evidence that the "veritable paradise for stock" was gone by the end of the 1870's. Kate Robbins reported that "there has been so much stock brought into the [Ochoco] valley that the hills are getting pretty bare" (Jan. 18, 1878). The reasons for this decline include the fact that there were more cattle on the range, that low prices encouraged stockmen to hold cattle instead of selling them, and that enclosure of bottom land for pasture or hay fields decreased the carrying capacity of the range as a whole (Oliphant, 1968; Brogan, 1964). Although 1880 is often mentioned as the first year the settlers fed their stock during the winter, the Robbins family was cutting hay as early as 1876--"twenty tons, and we shall need every straw of it before spring" (July 26). In 1878, 1879, and 1880, large numbers of cattle were driven out of the county, even though the market conditions were at an all-time low. Kate Robbins reports in 1878:

> I think there was about five thousand head taken out of this valley last year, probably more. They pay $10.00 for cows. $12.00 for two year old steers, $15 for three year olds, and $20 for four and upwards. Horses are all prices, but have never fell in value as cattle have when we came here seven years ago Abner paid $40 for cows with calves and thought he was doing well (Jan. 18, 1978).

In 1880 as many as 200,000 cattle were driven eastward from the Pacific Northwest (Oliphant, 1968). Although the origin of the cattle is indeterminate, at least one drive of legendary proportions originated in Crook County in that year. Teal and Coleman, whose ranch on Trout Creek was one of the largest in the area joined with John Todd, who operated the Farewell Bend Ranch on the Deschutes, to drive their stock to Cheyenne, Wyoming for marketing. The drive was less than successful. Blackleg took many of the cattle on the trail, and the remaining stock fell through the ice on the Platte river and drowned. Todd was bankrupted by the drive, and Teal and Coleman never recovered (Brogan, 1964; Shaver et al, 1905).

In the aftermath of the big drives of 1879 and 1880 came a shift in emphasis from cattle to sheep. "The large droves of cattle which were driven from Crook county in 1879 lessened the amount of horned cattle on the range, and since that time particular attention has been paid to horses and sheep" (Shaver et al, 1905). Two of the largest operations in the 1880's and early 1890's pointed the way for other smaller operations. The Hay Creek Ranch, under the management of John Edwards after 1880, won wide recognition for its breeding of Merino and Rambouillet sheep. At the height of its operations, the Hay Creek flocks numbered 50,000 sheep producing an annual clip of 500,000 pounds of wool (Clark, 1981; Brogan, 1964; Shaver et al, 1905). The Buck Creek Ranch, home place of William W. Brown, was started in 1880 by Brown and his brother. Although the operation lost 9,500 sheep in the winter of 1889, it peaked several years later at 22,000 sheep, 25,000 horses, and the control of 140,000 acres of range (Toepel and Beckham, 1978; Clark, 1981). The wool business, like the cattle business, had its ups and downs. In 1894, the Antelope Herald reported that the residents of Hay Creek were "repairing their public roads with wool, preferring to utilize it in this way rather than to haul it to The Dalles and lose money on it" (Shaver et al, 1905, p. 713).

By the end of the 1880's--twenty years after its initial settlement--Crook county had confirmed itself as reasonably prosperous stock raising area. In 1890, census records indicate that there were 19,888 beef cattle in the county, 4.9% of Oregon's total 403, 348. The sheep numbered

249,154, or 13.9% of the state's flock of 1,780,312 (Strong, 1940). The implications of this dependence on livestock was not lost on early commentators:

> The inhabitants [of Crook county] were as well or better off than those of the most favored agricultural region of Oregon. They were not in an agricultural community and stock was their wealth. They had a sufficient number of horses, cattle, and sheep to sell to purchase breadstuffs for a decade to come. They had no worn out agricultural machinery that was not paid for and but a few were under mortgage. The poorest man in their midst could spare the price of a horse for flour. (Shaver et al, 1905, p. 714)

The next decade saw almost continuous conflict for what was left of the open range. The "sheep and cattle" wars raged during these years with cattlemen and sheepmen competing in atrocities to each other's haystacks, flocks, and--occasionally--persons. One of the few heros of this period was Roscoe Knox, who write arrogant and hilarious letters to the Oregonian as "The Sheep Shooters Corresponding Secretary" (Clark, 1981). "We are the direct and effective means of controlling the range in our jurisdiction. If we want more range we simply fence it in and live up to the maxim of the golden rule that possession is nine points of the law" (Shaver et al, 1905). The Crook county livestock assessment of 1897 included 320,000 sheep, 40,000 cattle, and 10,500 horses; in 1906, A. S. Ireland, who was the supervisor of the newly formed Blue Mountain Forest Reserve, estimated that 340,000 sheep and 40,000 cattle and horses were grazing public forest land on the west ranges of the Blue Mountains alone. (Shaver et al, 1905; Hodgson, 1909).

Officially, the open range ended with the formation of the forest reserve in the first decade of this century and the passage of the Taylor Act in 1934. For many of the people involved, however, the end of the open range was a personal rather than historical event. By 1884, the Robbins family had moved into Prineville. After Ben Snipes' short reign there were no more "cattle kings" in the Columbia basin and Peter French--the most visible of the large landholders in the Harney Basin--was shot by an irate homesteader in 1897. John Newton Williamson was prosecuted by a Federal grand jury for land fraud in 1905. Forest grazing limits forced Edwards to sell the Hay Creek ranch in 1910. Bill Brown's last big round-up occurred in 1917, when he paraded 10,000 horses past Army purchasing agents at Benjamin Lake. Within a year or two, horses were nearly worthless and he retired to the Methodist Old People's Home in Salem (Toepel and Beckham, 1978; Clark, 1981).

To return to our initial question, then, was stock raising country the best country on earth for a poor man during the settlement period? For Abner Robbins and Cortley Allen, the answer is probably "No." They managed a modest living, but did not prosper, leaving the range with little to show for their efforts. Others were more fortunate, of course, but the evidence suggests that the stockman's paradise the settlers sought was--like its Biblical namesake--a prelude to a life of hard work and modest results. It is most likely that Robbins and Allen and others would have been as prosperous and more comfortable had they remained in the Willamette Valley working in a sawmill or practicing a mechanical trade. They would have missed out, however, on the great adventure of their lives. We need to remember that there are frontiers of land and frontiers of the spirit and that people value the latter as well. In 1929, thirty years after our period of interest, Alice Day Pratt "starved out" and left her homestead near Post:

> I gave away my chickens to friends who had helped me in many a tight place. These friends...were to care for...my ponies, which were to run...as long as they lived. (I blessed the fact that <u>horses</u> were so over-abundant that <u>they</u> were unencumbered with a mortgage.)
>
> Success may be the smallest and least important of the fruits of endeavor; it is the endeavor itself--that is its own reward.

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WESTERN JUNIPER AND THE RANGE SITE CONCEPT

Hugh Barrett

The Soil Conservation Service in Oregon uses criteria based on easily observed soil and geologic features to determine if western juniper has a place in the climax (potential) plant community of a site or if it has invaded that site. Before I describe the criteria we use, I will review some of our basic assumptions and some of the problems we have encountered in the classification of range plant communities.

First, why are we interested in the classification of plant communities and why, especially, are we using the climax concept in this effort? These two questions are those most commonly asked. The SCS and other agencies use a system of classification based on the climax plant community that a site is capable of supporting. This classification system relies on soil and other environmental factors such as climate and topography identified in soil survey on rangeland. These surveys are rather extensive in nature. Sites, or the environmental conditions that give rise to sites, generally occur in predictable patterns throughout the landscape. It is the job of the soil scientist and and range specialist in a soil survey to determine that pattern, to isolate the several environmental factors for detailed study and to describe their combined effects as expressed in the plant community.

Since these are relatively extensive surveys, we are in effect developing a predictive model that can be applied over a large area. The alternative would be to conduct extremely intensive surveys, but this would require much more manpower and investigative effort. We also feel that management is not yet refined to that detail.

Now - why climax? Rangeland plant communities are dynamic in nature, never static. To use present vegetation as the basis of a classification system is to doom that system to immediate obsolescence. The range site concept, when applied with emphasis on soil, environmental and historical information looks beyond the present situation to provide a standard of comparison. A forester knows that a 50-year old Douglas fir with a diameter breast height (DBH) of eight inches and a height of 45 feet is in poor shape - only because he knows what a 50-year old Douglas fir can look like. A rancher, weaning 8-month old calves at a 300 pound average is going to be looking for reasons why those calves are not gaining because he knows what those calves were capable of doing.

So it goes with range vegetation. If we have a reasonably good idea of what a plant community is capable of producing and what the proportion of species is when the community is at equilibrium with its environment, we are then able to judge its health.

The term "range site" has been used several times so far. It is defined as follows: "A range site is a distinctive kind of rangeland that differs from other kinds of rangeland in its ability to produce a characteristic natural plant community. A site is the product of all environmental factors responsible for its development. It is capable of supporting a native plant community typified by an association of species that differ from that of other range sites in the kind or proportion of species or in total annual production."

The environmental factors that act together in the development of a distinct native plant community include:

1. Soil - depth, texture, stoniness, drainage, available water capacity, chemistry, (parent material) inherent fertility, etc.

2. Climate - the timing and amount of precipitation, temperature, storm types (convectional vs cyclonic).

3. Topography - steepness of slope and aspect, position in the landscape (modifies climate).

4. Fire - frequency and intensity of naturally occurring fire (usually function of climate).

5. Biological activity - native herbivore use, insects, plant diseases.

The climax concept can enrage the meekest of hearts and stir heated debate in the friendliest of groups so it is with some trepidation that I discuss this subject.

The climax (or sub-climax depending on your persuasion) that I wish to describe is one in which a plant community is in equilibrium with the environment. It is a point - now hypothetical in many cases, somewhere along the successional gradient at which the stand exhibits the greatest stability by way of species diversity and production. This property of stability would enable a site to rebound relatively quickly from natural disturbances such as drought, wildfire, grazing by native fauna and insects that are inherent in site development.

I am not referring to a stagnated end point that results from overprotection and a lack of stimulation that we see in fully protected stands. Nor is this point one in which the stand is occupied by species tolerant of abnormally frequent or severe fire or concentration of displaced big game herds. To several of you, I am defining a pyric-biotic dis-climax, while to others I am describing an ecological or environmental climax - the stage that would occur before man began to consciously manipulate the environment.

How do we establish this point? It is done by evaluating relict sites and their associated soils when they are available. When they are not, the experience of the observer is heavily dran upon. Knowledge of plant and community response to fire or the lack thereof, or to grazing at varying levels of intensity is called on. In some cases we have the benefit of historical and botanical records of the area, or information derived through research to support our efforts in site reconstruction. Nonetheless, we must acknowledge the fact that this is reconstruction - our best effort at a description of natural potential - a judgement call on the part of the observer. If looked on as an hypothesis, subject to testing and revision, I accept it. But, not as a natural truth etched in stone.

For years, western juniper has been the scourge of those attempting to classify potential plant communities or to describe range sites that are correlated to specific soils. Today, western juniper is distributed from the north bank of the Truckee River in western Nevada to just south of the Columbia River near Shaniko and Tygh Valley and from Bend, Redmond, and Warm Springs in the west to parts of southern Idaho. At first glance, western juniper appears to belong on most, if not all, landforms, soils, aspects and in most precipitation zones below the Ponderosa pine belt.

This has given us problems in our soil/site correlation work. Not only were we unable to predict the presence or absence of juniper in the present or potential stand but when do we cross the fine line between rangeland and woodland? Often in a soil survey, a type location or model soil pit was established in a straight-forward shrub-grass site with no evidence of past or impending juniper occupation. At this point, all was well - we had a recognizable soil unit that consistently produced a predictable native plant community.

Sooner or later, that same soil on a similar landform, slope aspect, etc. will be found producing juniper in thinly scattered savannahs or dog-haired stands. Our basic premise is that a single phase of a soil series such as Hapgood FSL 5-15% slopes (as an example) will give rise to only one site, yet we were seeing two sites. The soil scientist was often sent scrambling to find soil differences that would allow him to separate soil "A" from its exact replica. We were, in effect, splitting soils on present vegetation and establishing sites on present rather than potential plant composition.

This being the case, all predictive value of our surveys was in jeopardy and with that ability lost, a survey is not worth conducting.

Each acre becomes a new world requiring detailed inventory to be identified and understood and each ridgetop offers a panorama of confounding complexity. All practical value of the classification scheme was gone.

The predictiva value of the range site and its description looks beyond the present situation and provides a standard for the determination of range health, range condition, and offers a basis for the prescription of management techniques to direct change or maintain current conditions within the community.

As I mentioned in the beginning of this discussion, we are using a set of criteria that is a great help in sorting out the puzzle of western juniper. While this set of criteria is helpful in distinguishing sites in which juniper is best adapted from those where it is not, they only assist in this determination and do not rule out on-site interpretation.

Western juniper is considered to be best adapted on sites where the right combination of climatic, soil and other environmental conditions exist.

Within the mesic and frigid temperature regimes, soils with properties which combine to provide: (1) rapid infiltration, (2) low evaporation, (3) deep percolation and (4) low soil moisture tension favor the long-term presence of western juniper.

Examples of sites that are considered to support juniper in climax are very stony or extremely stony soils, rock outcrops, rimrock and very deep, coarse sands. Medium and fine textured soils which tend to favor grassland or shrub/grass steppe vegetation where fine fuels have been reduced and lack periodic fire are considered to be invaded sites when juniper is present.

ECOLOGICAL STUDIES ON WESTERN JUNIPER IN CENTRAL OREGON

Lee E. Eddleman

For many people western juniper appears as a phenomena of our time but that seems to be a product of the time they spend in the areas where western juniper is present and their particular location of observation and interest.

Some see it as a long time resident if they live and work in areas where the soils are mostly pumice sands. Others see it as product of the last century if they live and work in the area around Prineville or John Day where soils are derived from basalt lava flows or sedimentary formations and view the historic stand as those along the rocky ridges. Still others see western juniper as a very recent phenomena composed of those just recently visable trees above sagebrush or bunchgrass plants.

As part of the ongoing research at the OSU Rangeland Resources Department, I have begun looking at the reasons for the rather recent expansion of western juniper onto central Oregon's rangelands, for the effects on the range resources as a consequence of that expansion, and examining the response of understory herbage to the removal of western juniper. Potential causal factors of expansion are given in Figure 1, some of which we have affected through management. Figure 2 points out those resources which we suspect are more or less impacted by the long term presence of western juniper.

Population Dynamics

Age structure was examined on a long gentle northerly aspect slope in the Prineville area. The upper slopes as well as the lower slopes have been part of the recent expansion of the tree as no old trees were observed to be present in the area except in some rock at the top of the ridge above the upper stand studied. Other population studies are being carried out but the age classes here are of interest.

Upper Slope

The upper slope has as its oldest trees ones which established in the 1890s. The major increase in tree numbers occurred in the years 1908 through 1925. Seventy-five percent of those trees now present established during this period. From 1895-1907 about 10 trees per acre had developed. In the next 17 years 82 more trees established on each acre. The rapid increase in western juniper occurred prior to the older trees reaching what is surmised to be a high reproductive phase in that they were less than 20 years old. One could assume that the seeds came from offsite especially during the initial phases of rapid establishment.

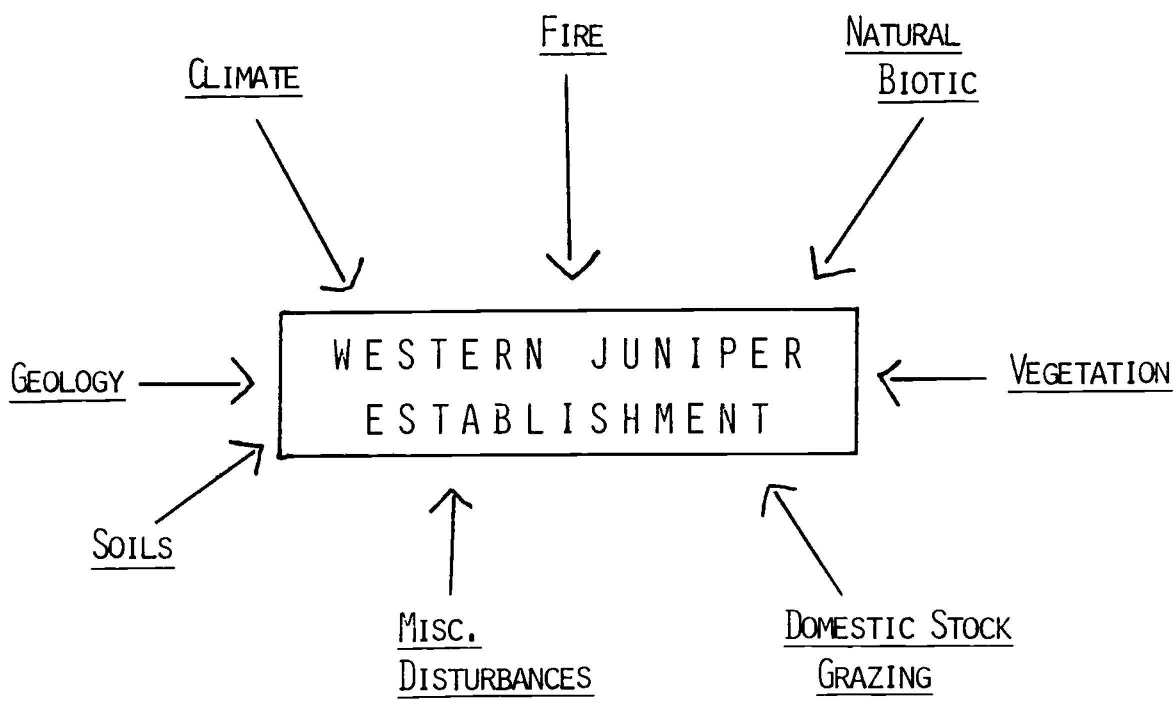

Figure 1. Probable causal factors of western juniper establishment.

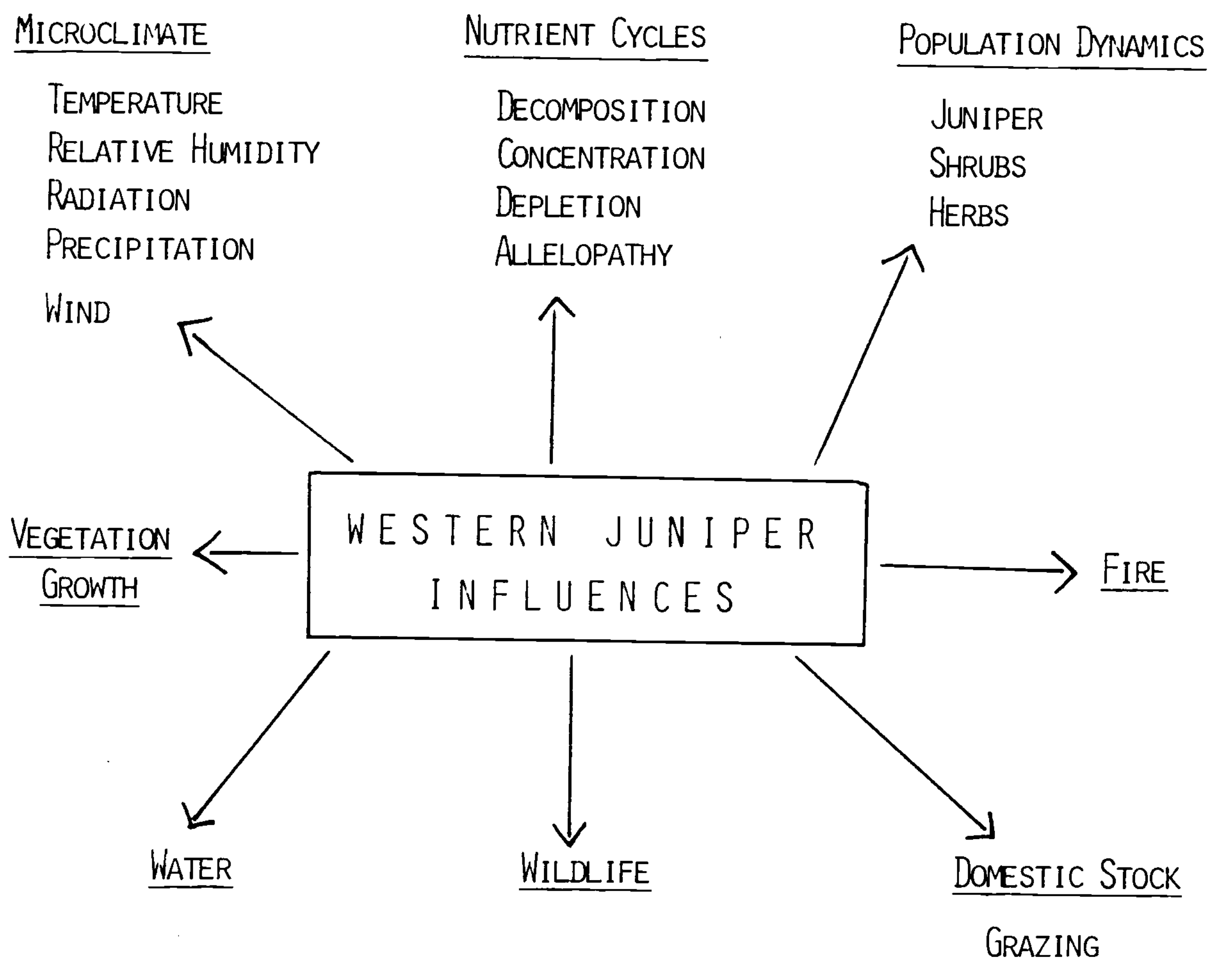

Figure 2. Resources impacted by the development of western juniper forests.

Midslope

The oldest tree at midslope established in the late 1890's. Rapid increase in numbers of trees began in 1939. At this time (1939) there were about 4 trees in excess of 40 years of age on the area. By 1948 there were 66 trees per acre of which 44 were added from 1939 through 1948, with few trees added after that date. The midpoint in the flush in establishment is about 28 years later at midslope than on the upper slopes.

Lower Slope

The oldest tree found was established in the late 1880s. Rapid expansion in density began in 1935 and continued through 1950. During this period 239 trees per acre established as opposed to 22 per acre prior to that period. There has been a general low in establishment of new trees since 1950.

The establishment period for the lower and midslope area tends to be similar at least as to the initial phase and the timing of significant increases in populations. However, there are many more trees per unit area on the lower portion of the slope than anywhere else upslope.

There are several possible reasons for the high number on the lower slope relative to the upper slopes. Water dispersal of seed down slope is possible over frozen soil (a rather frequent occurrence in the area) so that most seed wind up near the lower portion of the slope. There are some problems with this assumption that I'll cover in the next section on regeneration.

Reproduction Characteristics

In the areas in which I have been working the youngest trees on which I have found fruit were 25 years old. Typically I find some fruit production on 40 year old trees but they do not really produce significant amounts of fruit until they are 50-70 years of age and are dominant trees on a site.

A second observation based on preliminary sampling is that trees in the interior of the forest are strongly dominated by male cone production. There are both male and female trees as well as every possible ratio of the two sexes on any particular tree. Western juniper are reportedly capable of shifting their sex from year to year but my sampling in central Oregon so far would not indicate that a significant switch takes place.

Coupled with the above is the preliminary finding that those trees along the edges of clearings and roads and trees along fencelines contain individuals producing more female cones.

If high producing females remain consistantly high or remain potentially capable of doing so then we may have a possible way of slowing down future population explosions by removal of these individuals in the interior of forests, along the margins of clearcuts and by careful selection of leave trees.

A second aspect of reproduction is the location of or requirement for the germination and establishment of new plants. What I am finding in central Oregon is that new western juniper plants are associated primarily with sagebrush crowns with and without a bunchgrass being present. Secondarily they are found in bunchgrass plants, and thirdly, although becoming more important as stands close, beneath juniper trees themselves. In general the following relationships exist: new juniper plants being found under sagebrush-47%, bunchgrass-14%, and juniper-15%. Less than 1% of the plants were found growing in the open on bare soil.

Juniper seed appear to spread via water. I have observed significant dispersal in overland flow when the soil is frozen both during storm activity and spring runoff. Aerial photos show high densities along water courses some of which carry water only in the spring. It may be that the majority of seed disperses along water courses after being carried down slope by overland flow and that these channels represents sites of optimum establishment success.

Western juniper did not necessarily come in with overgrazing since, as noted earlier, new plants establish readily in both mature bunchgrass and big sagebrush plants. Therefore, reduction of grass competition was not a necessary prerequisite. However, one probable control of western juniper establishment was fire since young plants are susceptable. Grazing does reduce fine fuel buildup which would reduce fire frequency and when this is coupled with fire control efforts we may have accounted for part of the expansion. However, grazing, especially heavy grazing, reduces both litter buildup and standing dead plant material which opens the site up to soil compaction, soil freezing and overland flow of water which would favor significant downslope movement of seed.

Another factor not covered in the research but observed in the central Oregon juniper system and documented elsewhere is the impact of birds on the spread of juniper seed. Both the Robin and Townsend Solitare winter in the juniper zone. Both consume large numbers of berries digesting only the pulpy covering and depositing the seeds below perching sites.

Growth

Information presented here was taken from sites that probably are not very productive for western juniper. In any case the indication is that with increasing density of western juniper, firstly diameter growth is affected negatively, followed by height growth reduction as stands continue to thicken. Growth in closed stands by subdominant trees is diameter affected while the understory small trees grow little in height and diameter growth is nearly nonexistant.

	Per year			
	Height		Diameter	
	cm	in.	cm	in
Open, dominant	9	(3.5)	0.8	(.3)
Closed, subdominant	9	(3.5)	0.4	(.1)
Closed, young	3	(1.2)	0.2	(.05)
Highest Rate	11	(4.3)	1.3	(.5)

Figure 3. Western juniper growth

These values for growth are simply height and diameter divided by age. However, for the first trees to establish on the site the early growth period is one of much faster growth than illustrated here. We now have height values in excess of 25 cm (10 inches) per year for some sites in the margin of the ponderosa pine zone. Diameter growth is also greater on these areas.

Nutrient Cycling

This project was conducted with Dr. Paul Doescher of the Department of Rangeland Resources at OSU in which we wanted to ascertain the degree of soil nutrient redistribution due to the long-term presence of western juniper.

Soils were collected at three depths; 0-8 cm; 8-16 cm; and 16-24 cm along a horizontal gradient beginning at the bole and including:

1 - bare area with deep litter,

2 - beneath bunchgrasses under outer portion of canopy,

3 - interspaces between juniper canopies.

Soils were analyzed for several nutrients to determine if these trees had modified the nutritional system. We found more nitrogen beneath young juniper in the surface 5 inches than elsewhere in the system (.28% vs. .17% or less). The interspaces yielded lower values but these were statistically non-significant.

No differences in P, NA, or MG were found with depth or distance from the bole. Lowest values for K were found in the interspaces at all depths while values obtained from below the canopy were similar to each other.

Under mature 100 year old trees Ca declined with soil depth and with distance from the bole. The amounts in the interspace areas were the lowest values obtained.

Whether or not these changes significantly affect forage production in the intact system is not known. But, if Ca plays a role in N metabolism, which it likely does, then there may be a significant modification. And, that modification may have an impact on forage growth following western juniper removal.

A second portion of this study involved growing mountain brome plants in the greenhouse on soils collected from various zones about the tree. This experiment was designed to measure differences in above ground production of herbage, if any, between zones. Unfortunately, in the greenhouse used at OSU we had great difficulty with a number of molds which vigorously attacked the plants. As a result, we found no statistical differences in production. But, since the differences we saw in the remaining healthy plants were rather apparent, this project needs to be redone.

Understory Structure

Understory structure of existing western juniper stands is being studied at three locations in the pumice sand area, north of Sisters, near West Butte and at the Prineville airport. Also, three areas east of Prineville on soils derived from basalt lava flows are being examined.

One of the intriguing questions in looking at the understory structure is the place of sagebrush and native bunchgrasses in the existing systems. What changes do, in fact, take place in the existing vegetation as western juniper develops on a site either by increasing its density or by becoming older and bigger? Some of the stands under study are composed of very old trees with regeneration common. Ages of the oldest trees exceed several hundred years, however, I do not have the age structure established at this point. Other stands are dominated with trees that have come in within the last 100 years. Of particular interest to me is the status of Idaho fescue in the two systems.

The area north of Sisters is an area donated to the Nature Conservancy known as Wildhaven. The area has a history of grazing although the intensity is not known, nevertheless, cheatgrass is a prominant part of the system today.

Idaho fescue occupies a particular position in the understory lying within rather strict limits of 290° NW to 40° NE and confined to the area of canopy influence.

Thurber's needlegrass dominated communities lie between 190° SW and 290° NW. The remainder of the understory, 40° NE to 190° SW is dominated by cheatgrass and this latter community extends beyond the canopy edge 1.5 meters (4.5-5 feet) within those bearings.

Which comes first the Idaho fescue or the tree? If we look at the area north of Sisters and another site located north of Millican we see some indication of the tree coming first and the dependency of Idaho fescue on the modifying effect of the tree canopy. In the heavier textured soils around Prineville the opposite is likely to be going on.

Response to Overstory Removal

One of the projects underway deals with the response of the understory herbaceous layer to removal of western juniper. Stands being examined have canopies of about 15-20% and appear to be fairly well closed as all western juniper regeneration of less than 3 feet tall is growing at a very slow rate. Milda Vaitkus, a graduate student at the OSU Rangeland Resources Department, is conducting this effort.

Trees were cut from blocks in the fall of 1982 and sampling of response of the herbaceous layer began in the summer of 1983 and was repeated in 1984.

Final summation and analysis is not complete at this point. But, first year's data on some of the forage species at one location is available. The basic assumption was that removal of a dense cover of western juniper should result in a significant response in the herbaceous layer due to the removal of competition for light, nutrients and water.

Obviously, clearing western juniper from any area involves expense of some kind and it would be nice to obtain a return on such an investment. In this study we were particularly interested in the perennial forage plants but other plant species have been measured as well.

Sampling was done on a tree by tree basis in which the understory (below the canopy) vegetation was sampled separately from that in the interspaces (between canopies) of western juniper. Trees sampled and reported on here were the larger trees in the study area. They had an average diameter of 23 inches and an average height of 23 feet. Soils were a clayey skeletal, mont, pachic Argixeroll. The surface 12 inches is a gravelly clay loam below which is a cobbley clay. Total soil depth to weathered rock is 24 inches.

Results

First year response was not overwhelming when compared to the natural stand (Figure 4). Squirreltail did respond in a positive way but only on those areas previously covered by a western juniper canopy. The response in the other category was tied to a group of annuals primarily annual forbs, and in particular, *Epilobium paniculatum*.

Figure 4. Herbage production (lbs/acre) in western juniper

	Natural Stand		Cleared - 1st Year	
	Below Canopy	Between Canopies	Below Canopy	Between Canopies
Native bluegrass	51	115	60	131
Idaho fescue	79	70	51	65
Bluebunch wheatgrass	7	12	8	6
Squirreltail	43	22	136	4
Junegrass	4	1	14	2
Other	357	325	549	360
Total	542	545	818	568

The only other significant features in this situation are that native bluegrass produced more in the canopy interspaces than beneath the canopy and that major herbage production response came only on those areas previously covered by western juniper canopies. There was no response by any species in the canopy interspaces.

When one looks for possible explanation, a rather long list emerges. Some possibilities are:

1. Western juniper has only a small impact on the understory.

2. Western juniper affects only a portion of the plant species present.

3. The amount of available soil moisture was sufficient to meet all the demands of all species including western juniper (ppt was about 18 inches October-June for the year noted above).

4. Nutrients are the factor limiting production and no nutrient release occurred the first year. They could be tied up in juniper residues which are not easily broken down by the soil microbes.

5. Juniper has so modified the system physically and chemically that response is limited to a very few species.

6. Forage species are in such low vigor that they cannot respond.

7. Annuals have pre-empted the moisture released by western juniper removal thus eliminating any possible response by the desirable forage plants.

The implications are that removal of western juniper trees which have understories like those studied will have to be followed by site preparation and seeding of desired forage plants to obtain a significant response.

WATER RELATIONS IN WESTERN JUNIPER

Richard F. Miller

Western juniper has developed various strategies enabling it to be an effective competitor for soil water on the high desert. Stomatal position, root distribution, leaves present throughout the year, and longevity are just a few mechanisms enabling this tree to survive and effectively compete with other growth forms. A knowledge of juniper growth and development will help enlighten us as to the impact juniper has in the range ecosystem. This information should be helpful in designing some range improvement programs.

Phenology

Male cones develop in early April. Berries on the female trees come on 2-3 weeks later, however, the previous years berries remain. Leaf elongation begins in June but the major portion of growth occurred in July of 1984 on the Squaw Butte Experimental Range (Figure 1). An average of 10 new leaf scales per twig per season were developed to account for approximately 15-20% annual leaf turnover per year.

Physiology

Concentration of nonstructural carbohydrates was higher in the leaves than in the small twigs immediately behind the leaves (Figure 2). However, seasonal fluctuation between the two plant parts were similar. Stomates (openings for gas exchange such as H_2O, CO_2 and foliar applied herbicides) are positioned under the leaf scales, decreasing the influence of high temperatures and low humidity and limiting the access to foliar applied herbicides. When soil water is available, air and soil temperatures are the primary environmental factors influencing growth and transpiration. When soils are frozen, transpiration is minimum and water movement through the roots greatly restricted. The ability of juniper to conduct water through its root system is much lower at cold soil temperatures (above 32° F) than warmer soil temperatures. Water stress in the plant can be very high in the spring when air temperatures are high, but soil temperatures are still low.

Water tension in juniper is highest in the winter when water loss, although low, is probably higher than water movement through the roots. Juniper may be more susceptible to fire at this time when foliage is dry. As soil temperatures warm, the ability to use free soil water depends largely on air temperatures and relative humidity. Figure 3 shows the relationship between evaporation potential and transpiration.

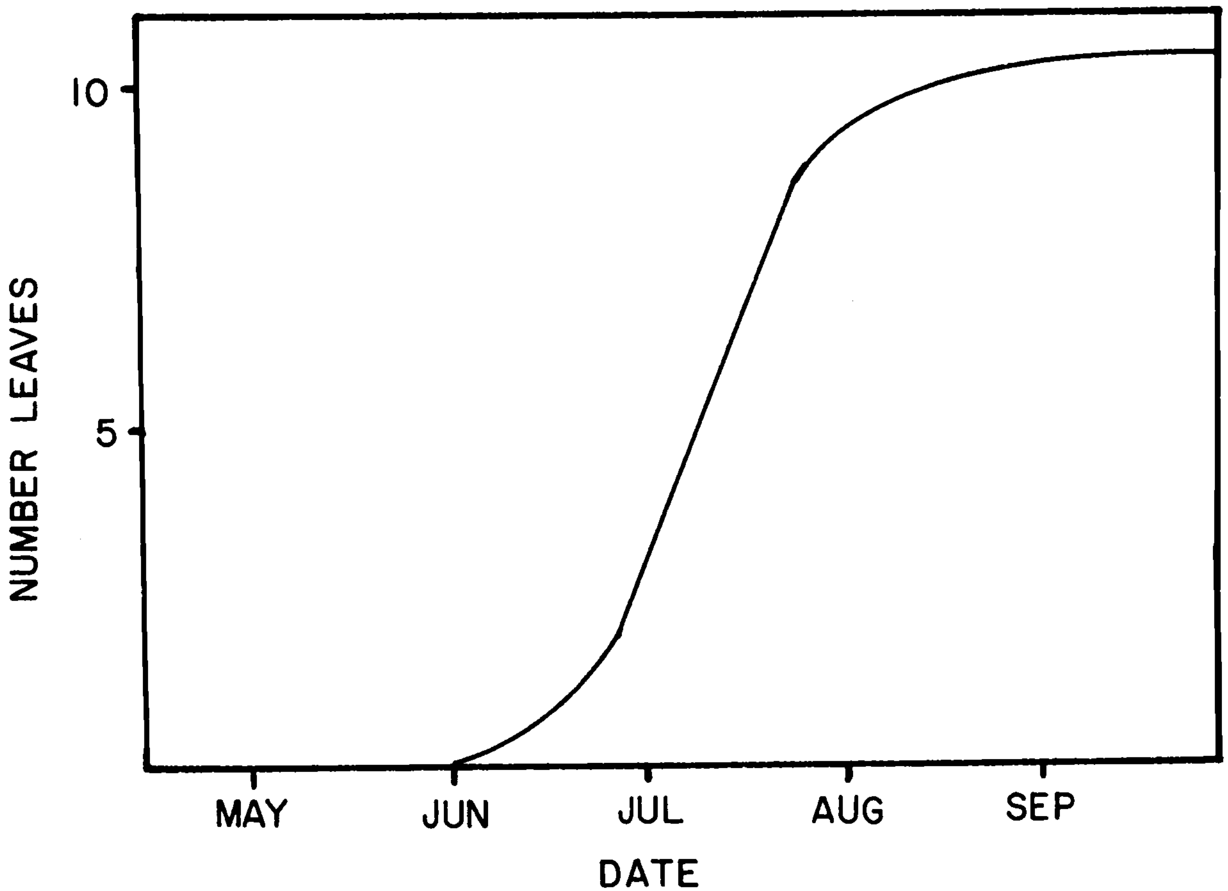

Figure 1. Seasonal leaf growth of western juniper on the Squaw Butte Experimental Range.

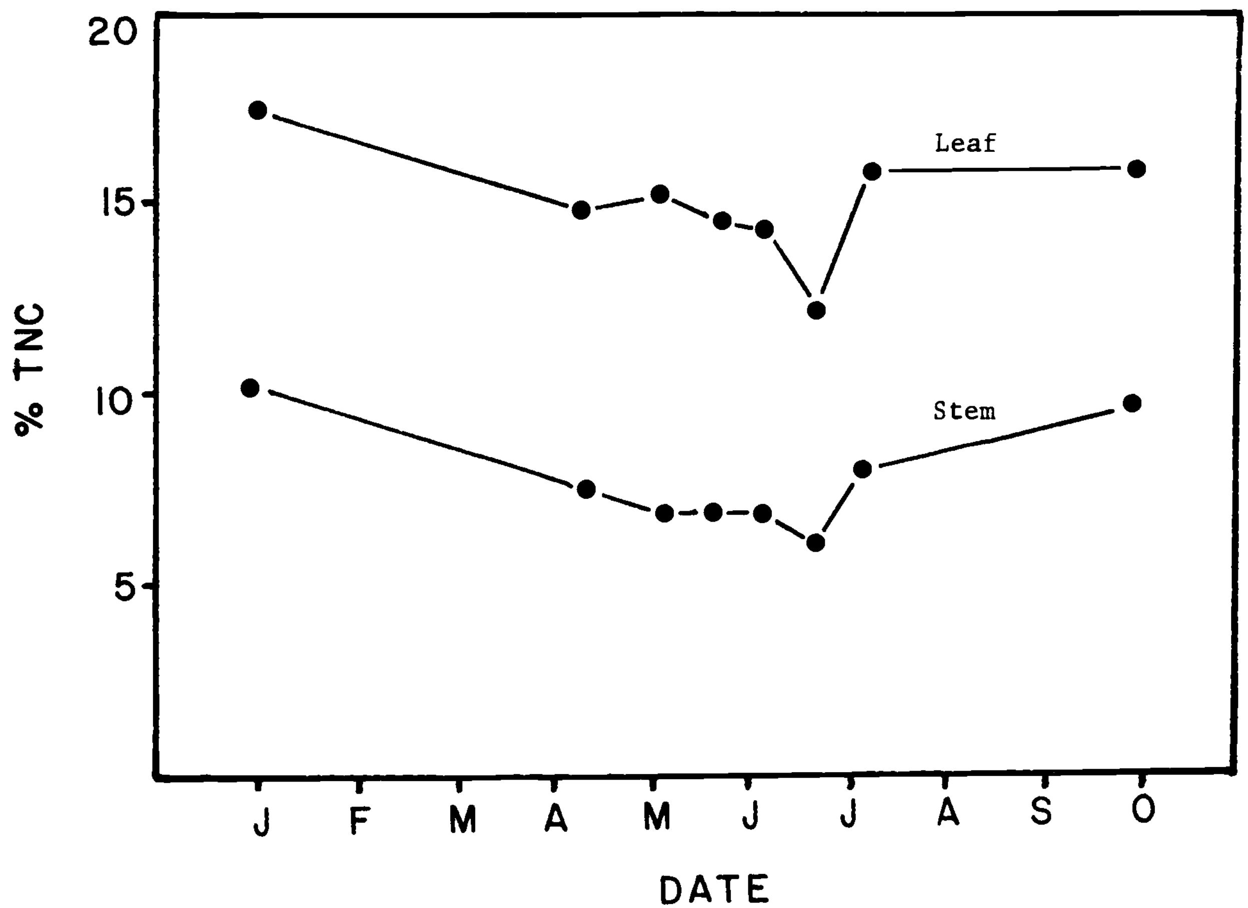

Figure 2. Seasonal pattern of nonstructural carbohydrates in western juniper for 1983 on the Squaw Butte Experimental Range.

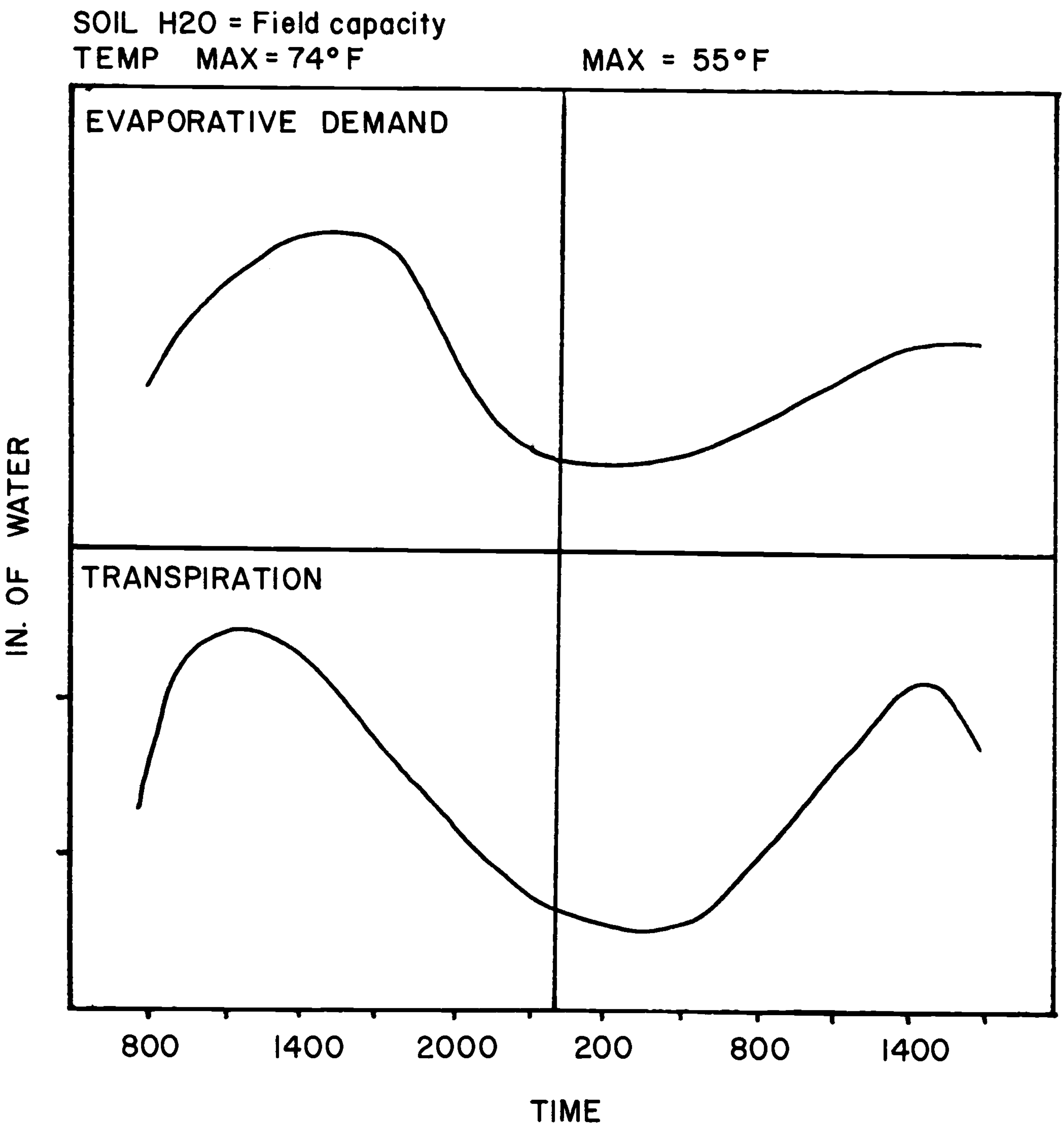

Figure 3. The relationship between transpiration (inches of water lost) and daily evaporative demand (a function of temperature and humidity) for western juniper.

The amount of evaporative surface area or leaf surface present depends upon the size of the stem (Figure 4). The tree has to be able to transport enough water through its trunk from roots to support the leaf area. The sap wood transports water; whereas, the heartwood stores it. Water is believed to only move laterally from heart to sap wood, but vertically through sap wood. Thus, the sap wood area at the base of the tree would have a large bearing on the amount of foliage or evaporative surface a tree can support. Work is progressing on developing a predictive model of water use by western juniper (Figure 5). Only rough estimates have been made to date. Examples of how the model could calculate water use in two climatic conditions are shown in Figure 6. Under the cool conditions, 100 trees per acre of an average of 12" diameter would use 200-250 gallons. However, when the temperature was 90° F. with 15% relative humidity those same trees would use 450-500 gallons per day. Many other conditions can be simulated in the model which can be used on a daily basis or over a period of years.

Summary

Western juniper is extremely well adapted to sites on which it is found. Its water use characteristics put it in a highly competitive position. Knowledge of these characteristics gives the manager some insights into the impact this plant has on the range site and possible control strategies and tactics. Examples cited were possible susceptibility to fire during water stress periods (tactics) and differential water use by the proposed predictive models on a management unit or watershed basis (management strategies).

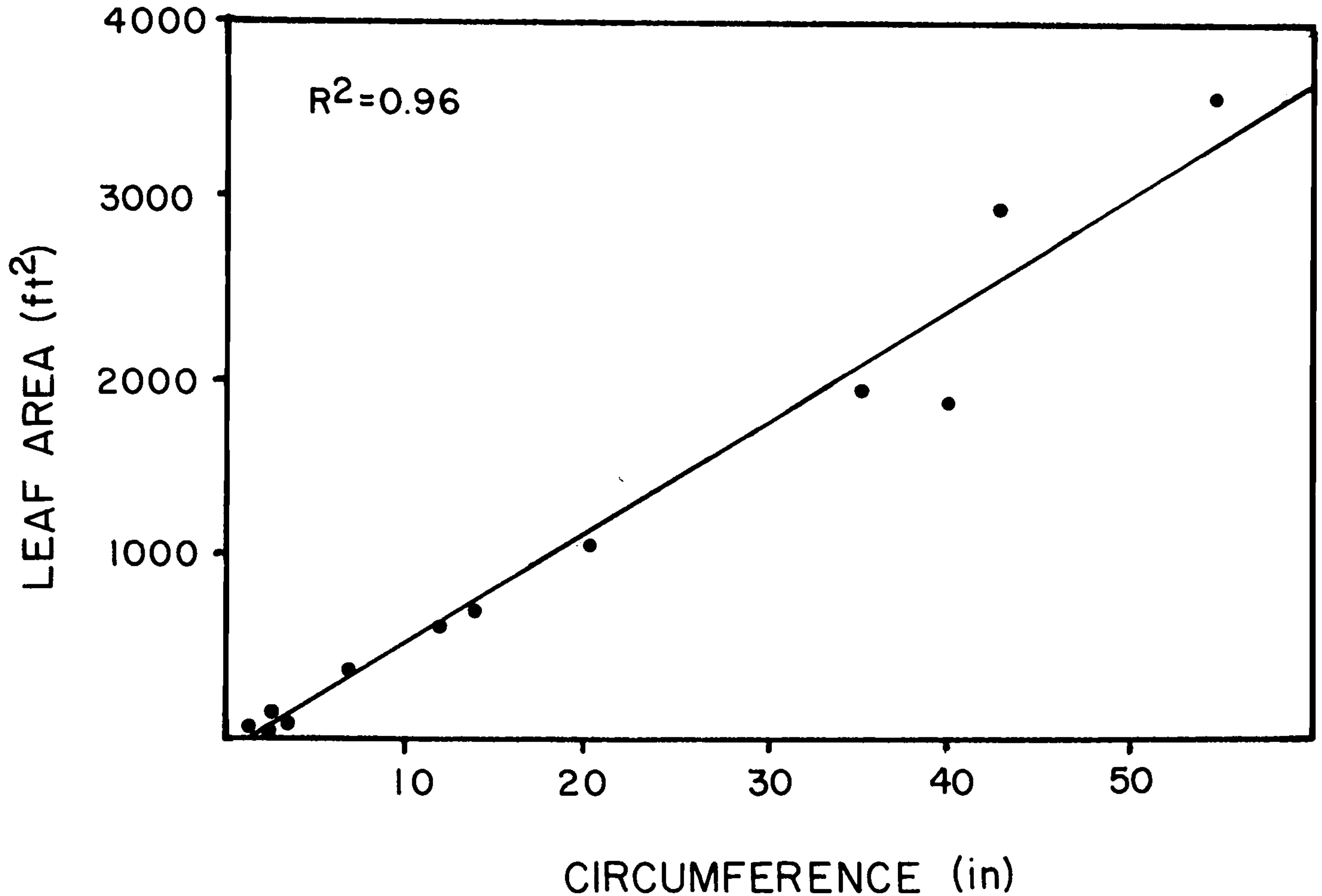

Figure 4. Relationship between basal circumference at the litter layer and leaf surface area for western juniper.

Juniper Water Loss Model:

JUOC H_2O loss = (Daily evaporative demand) (Leaf Conductance)(Total Leaf Area)

Inputs: Julian Day

Max. Min. temp.

Relative humidity if available

Tree density

Ave. Basal circumference at litter layer

Latitude

Assumptions: Soil temp $> 0^{\circ}$ F

Soil water source available

Figure 5. Proposed juniper water loss model.

Example:

Climatic Conditions

1. Cool - Temp = 60^{o} F	2. 2. Hot - Temp = 90^{o} F
RH = 20%	RH = 15%
VPD = 12 g/m^3	VPD = 25 g/m^3

Single Tree 12" Diameter = 2124 ft^2 LA

Cool = ¼ gal/hr	Hot = ½ gal/hr
Cool = 2-2.5 gal/day	Hot = 4-6 gal/day

1000 trees/ac. Ave 12" Diameter = 212,400 ft^2

Cool = 25 gal/hr	Hot = 50 gal/hr
Cool = 200-250 gal/day	Hot = 450-550 gal/day

Figure 6. Estimated water use by western juniper under two different climatic conditions.

ECOLOGICAL STUDIES OF WESTERN JUNIPER IN NORTHEASTERN CALIFORNIA

James A. Young
Agricultural Research Service
Reno, Nevada

Western juniper occurs from the central Sierra Nevada Mountains north into Washington. Although soil/geology do differ, the basic tree growth patterns appear to be similar. An intensive study was made in Lassen County, California, on private ranch land over a 10 year period. The following are summaries of this work.

The age, density, and fire history of western juniper (Juniperus occidentalis Hook.) trees growing on range sites of contrasting potentials were investigated. The 1,000 ha study area consisted of 65% big sagebrush (Artemisia tridentata Nutt. subsp. wyomingensis (Rybd). Beetle) and 30% low sagebrush (A. arbuscula Nutt.) plant communities. Density of western juniper trees was 150 and 28 trees/ha on the big and low sagebrush sites, respectively. The oldest western juniper found growing in the big sagebrush communities became established in 1855, and 84% of the existing trees became established between 1890 and 1920. The oldest trees on the low sagebrush sites had established by 1600, and most of the existing trees established before 1800. At the beginning of the 20th century, the western juniper populations on big sagebrush sites were doubling in density every 3 years. The rate of establishment on these sites has slowed until 1,370 years would now be required to double the population size. The rate of population growth on low sagebrush sites has varied from decade to decade with a trend to double the population every 200 years and trees that become senescent at about 400 years of age. About 0.4% of western juniper on the low sagebrush sites had fire scars, some of which indicated the occurrence of multiple fires. These fire scars indicated that since 1600 there were periods of up to 90 years when no fires scarred the trees. Changes in the frequency of wildfires appear to be the most logical explanation for the sudden invasion of trees into big sagebrush communities, but current technologies for reconstructing fire chronologies are woefully inadequate in this environment. (J. Range Manage. 1981. 34:501-506.)

A cost evaluation was conducted of four alternatives for improvements on maturing western juniper (Juniperus occidentalis) woodlands. The alternatives were: (a) the use of picloram (4-amino-3,5,6-trichloropicolinic acid) to kill the trees with no further treatment, with a total cost of $78/ha ($31/acre); (b) picloram with sufficient limbing and/or removal of trees to allow passage of a rangeland drill for seeding at a cost of $448/ha ($179/acre); (c) mechanical clearing and burning of the trees at a cost of $595/ha ($237/acre); and (d) wood harvesting and slash disposal at a cost of $2,080/ha ($832/acre). The picloram and limb, mechanical, and wood-harvesting treatments provide mechanically seedable sites, but of considerably different quality in terms of ease of seeding and chances of seedling establishment. The mechanical treatment requires a large capital investment, while the wood-harvesting treatment requires a large amount of labor. Based on equivalent energy values, the wood-harvesting operation would produce a profit for the landowner who could afford to invest the labor. For a specific woodland, a combination of treatments would be most cost effective. (J. Range Manage. 1982. 35:437-442.)

Stem flow is the water from precipitation that is intercepted by plant canopies and conveyed down the outside of stems to wet the soil at the base of the plant. For western juniper (*Juniperus occidentalis* Hook.) trees, stem flow was only a small fraction of the precipitation intercepted by the canopy. However, this moisture may be important in the nutrient flux of the trees. The first stem flow in the fall after the summer drought was enriched in nitrate-nitrogen although the quantity of nitrogen per unit area was small. The combination of favorable moisture and temperature conditions at the base of the tree leads to litter decay and nitrification. The root system of the trees had many fine roots in the area that received stem flow. Canopy interception and stem flow should be taken into consideration in application of soil active herbicides for control of western juniper. (Weed Science. 1984. 32:320-327).

CHARACTERISTICS OF WATERSHED OCCUPIED BY WESTERN JUNIPER

John C. Buckhouse

There is a tremendous diversity of soil surface conditions on juniper-occupied sites. As western juniper density increases, one can find evidence of typical surface erosion between trees.

Western juniper anatomy encourages stem flow of precipitation. There are many evidences of rill erosion originating from the bases of juniper trees as a result of stem flow concentrations. Rills begin the unraveling process and, unchecked, can develop into massive gullies.

Oregon studies using simulated storms produced by an infiltrometer show that sites dominated by juniper have low infiltration rates and high potential sediment production (Figure 1). These studies clearly indicate the hydrologic and watershed management significance of this type.

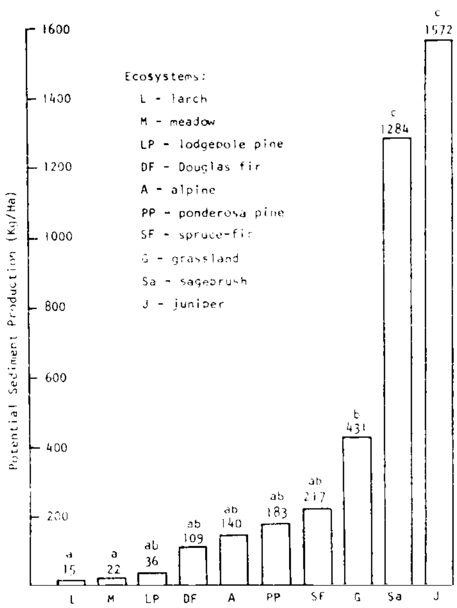

Figure 1. Potential sediment production in 10 Blue Mountain ecosystems. Different lower case letters indicate differences in statistical significance ($P<0.10$).

In a western juniper control effort, various disturbance levels occur. Activities such as chaining or bulldozing lower infiltration rates on the disturbed surface, but the form of the treatment can so manipulate the surface as to allow for longer infiltration opportunities and therefore compensate for lower infiltration rates. The form in which litter is redistributed can have beneficial effects. If water can be held on the site longer, then increased infiltration through better detention phenomena occurs. It appears, therefore, that two sets of conditions are at play here: (1) The degree of disturbance dictates the degree of infiltration rate destruction (for example, chaining and windrowing represent a massive disturbance, whereas chainsawing with debris-left-in-place cutting is a minimal disturbance; hot fires are massive disturbance, cool fires are minimal). (2) Litter which forms debris dams and holds water on the surface allows significant water to infiltrate, albiet at a lower rate than if such retention/detention facilitators were absent.

Statements are frequently made that controlling western juniper makes more moisture available. Since juniper grows from about 11" annual average precipitation to 15 and perhaps as much as 20" annual precipitation, the response obviously depends upon the precipitation zone. At the lower zones, below approximately 12-14", the released water is more likely to be used on site if herbaceous vegetation is sufficient to use it. Without sufficient vegetation, there can actually be more soil erosion. Above about 15" precipitation, free water may be obtained so that springs, streams, and other water bodies are improved.

Time of grazing after a juniper control effort can have large effects, particularly before herbaceous vegetation has had an opportunity to hydrologically ameliorate the site. Hoof effects on damp soils do compact the surface soil. Therefore, grazing when soils are wet to moderately wet, generally in early spring, will have some negative impact. Grazing when dry or in winter when frozen will leave fewer negative effects.

The following conclusions appear logical:

1. Increased disturbance and bare ground increases the compaction possibilities and, therefore, amplifies reduction in infiltration rate.

2. The more successful the herbaceous vegetation is, whether seeded or released, the less the amount of resulting sediment will be.

3. Time is a great healer. Effects of compaction fade with freeze/thaw, wetting/drying and growth cycles. Herbaceous vegetation thickens or thins with time and thus extends its influence to that degree over the site.

JUNIPER MANIPULATION AND THE IMPLICATIONS ON WILDLIFE HABITAT

Wayne Elmore

Juniper is a very controversial species; although touted as an excellent fuel source, it is cussed by those who choose to cut it. Ranchers and watershed specialists have shown the detrimental effects of juniper establishment on ground cover and forage production through studies and practical application. The practices used for juniper control have been many and varied, including injected poisons, chaining, sawing, bulldozing, and fire. All, however, have one commonality, a high cost and impacts on wildlife habitat.

The juniper-big sagebrush-bunchgrass habitat, in the midst of all its shortcomings, provides essential habitat for approximately 146 species of wildlife. Because wildlife species respond to the structure of vegetation more than the species composition, the alteration of juniper stands on these wildlife species has many different effects on habitat utilization.

As western juniper matures and changes in structure it meets varying needs and niches for wildlife. From seedling to mature tree it provides shade, cover, food, and nesting habitat for species like deer mice, coyotes, robins, mule deer, antelope, wood rats, and even elk. The expounded value of this succession has been correlated with the value of the animals using it. For example, a group of trees that may provided habitat for nesting passerine birds does not gather much attention in resource management.

If this same stand had a 75% crown closure and provided essential winter thermal cover for deer or antelope the value and interest is automatically increased. This philosophy however can be clouded when the species is listed as protected, threatened or endangered.

We recognize that the economic value of juniper, in relation to wildlife, is directly proportional to the observer's own values of the wildlife species present. This being our basis we can now look at different manipulation practices and weigh our own individual benefits or losses.

Table 1 lists the breakdown of wildlife use, by groups, for the three major structural juniper habitats in Central Oregon.

Table 1

Juniper - Big Sage - Grass	
Reptiles and Amphibians	14
Birds	88
Mammals	44
Total Species	146
Juniper - Low Sage - Grass	
Reptiles and Amphibians	8
Birds	59
Mammals	34
Total Species	101
Juniper - Grass	
Reptiles and Amphibians	9
Birds	41
Mammals	21
Total Species	71

As we alter these sites structurally we also alter the wildlife species composition. The more structural layers we remove the more species affected (Table 2).

Table 2
Number of Wildlife Species Affected by Changes in Habitat

Present Habitat	Future Habitat	No. Wildlife Species Affected Existing Use	Adversely Impacted	Favorably Impacted
Juniper-Big Sage-Bunchgrass	Big Sage-Bunchgrass	146	62	32
Juniper-Big Sage-Bunchgrass	Bunchgrass	146	96	40
Juniper-Big Sage-Bunchgrass	Crested Wheatgrass	146	132	5
Juniper-Low Sage-Bunchgrass	Low sage-Bunchgrass	101	61	20

Chaining and windrowing is one of the most detrimental practices because it reduces several structural layers at once. Most areas require reseeding of shrubs and grasses to help reestablish diversity. Wildlife use of windrowed trees usually is limited to the outer 1/3 of the piles because chaining also picks up shrubs which increases compaction. Long windrows can also be an impediment to big game movement when animals are moving to or from cover. Breaks should be located every 200 feet and be approximately 50 feet wide to increase use.

Pushing and piling of trees with cats is becoming a very common method for controlling juniper. The flexibility of individual selection of trees however allows protection of specific areas for thermal cover, individual trees that possess good habitat characteristics, and the development of tree piles that are beneficial to wildlife. Cover areas for big game should be 2 - 5 acres in size and have at least a 75% crown closure. Leave areas that contain a range of tree sizes and ages will also reduce impacts on small mammals and birds. Varying the size of piles that will not be burned later helps increase edge effect and structural diversity. Large piles should be no bigger than 25 feet in diameter and 8 feet in height. These piles are not only used by small mammals and birds but provide very good thermal and escape cover for mule deer and elk. Construction of these tree piles to include easy access into the center is very valuable to species such as cottontails and bobcats. This is especially true in our area where caves for bobcat denning are very limited. Using a standard of one pile per acre you would only remove 7.2 acres/section or 1.1%, from vegetative production. Diversity can also be improved by not piling all of the trees. Occassional single trees can be left in place to provide cover for rabbits, birds and small mammals. Dead trees or snags should always be left to provide perch trees for hawks, owls, and other birds. Those with holes and hollow centers will continue to be used by small mammals, bluebirds and other cavity nesting species.

Chainsaw felling or "debris in place" also has flexibility but not as much as the latter. The selection of individual trees and cover areas that are considered good for wildlife can be more easily scrutinized. However, the development of tree piles for added diversity is limited. Small mammal inventories conducted in 1976-78 where chainsaw thinning was used showed twice as many species and a 60% increase in deer mice, pinon mice, and ords kangaroo rats over unthinned areas. This is primarily attributed to the micro climates and vegetative litter that develops under the individual trees that does not occur when piling is used. Sight distances, or the ability to clearly see big game species, is much higher in these areas than in areas where adequate tree piles and cover areas are provided. Most big game avoid large expanses of open terrain.

It is recognized that maintenance of control sites is needed to prevent reestablishment of juniper. The practice presently being used by most groups is prescribed fire. Results have been varied but the impacts are fairly uniform. There is a reduction of shrub structure, general removal of debris, and an increase in grass species. This is very beneficial for big game spring and fall forage but reduces the diversity for many other species including big game. Soil sterilization is common under piles and individual trees because of the high heat generated. Fires can destroy some beneficial plants so some risk is involved.

Seeding frequently is required to reestablish vegetation. The need for burning is not the primary difference of opinion among resource managers but the timing of these burns and the intensity is. Some feel that areas should be burned within 5 years after thinning to control seedlings, however, others feel adequate control can still occur fifteen to 20 years later. The longer burning is deferred the longer high habitat diversity is maintained. Some promise has been observed using spring burns because of the lower heat produced. Most of the body wood is retained and soil sterilization is reduced.

The placement of juniper in eroded gullies has proven to be a fairly successful technique for stabilizing these areas. A variation of this technique has also been used to stabilize cut banks on streams. The junipers trap silt and provide a stable area for shrubs, trees and grasses to establish. This improves fish and wildlife habitat for over 80% of the species in Central Oregon. Junipers placed in perennial streams should be restricted to the banks only. If they are placed in large numbers in the channel they will trap silts throughout. This will ultimately raise the channel and force it to seek out a new low elevation. This practice also reduces the development of pools and riffle areas needed for fish habitat.

Management practices that encourage the establishment of riparian vegetation are much more beneficial for wildlife habitat and soil stability. Riparian improvement allows silts to be trapped along the banks, ultimately deepening and narrowing the channel and providing a permanent solution.

Wet areas, which frequently appear after juniper control, also offer a unique opportunity to increase diversity and improve habitat. They can provide a unique structural zone or they can become a concentration area for livestock. Areas that are already present can be easily protected by pushing trees around them in a circle. This gives protection and increases the diversity around them even more.

When planning a juniper control project, visualize how the area will look afterward. Know which trees to leave and why they are being left. Control projects can be done with high quality outcomes in mind for a multiplicity of purposes.

BIOMASS AND HARVESTING SYSTEMS FOR WESTERN JUNIPER

Jerry D. Budy

The western juniper woodland found in central Oregon and northeastern California is similar in many aspects to the pinyon-juniper woodland of the Great Basin. Both types are classified as non-commercial because of their low productivity. Low volumes per acre and poor stem form also make these woodland species undesirable in terms of conventional forest products. In addition, the conventional harvesting systems, such as, ground, cable, or aerial, are not practical or economically feasible for these woodlands. However, in recent years, there has been considerable interest in removing western juniper biomass in order to improve the understory biomass or forage value of these woodlands and/or rangelands. The objectives of this paper are to provide information on the biomass characteristics of western juniper and to suggest potential harvesting techniques which may be feasible.

A study was conducted in northeastern California to determine the biomass characteristics of western juniper. Tree density in the study area was 115 trees per acre. Mean tree height was 6.1 m (20 ft.) and diameter breast height (dbh) was 25 cm (10 in.). Tree age ranged from 40-83 years. The tallest tree sampled was 11.9 m (39 ft.) and 83 years old. The largest diameter tree was 58 cm (23 in.) and 79 years old. This tree had a green biomass of 1415 kg (3,113 lb.). Based on the trees sampled for biomass, approximately 50% of the green weight was moisture. This 50% moisture content was also fairly uniform for the various biomass components, bole, branches, twigs, and foliage. The bole sections averaged 55% moisture content while the foliage was slightly lower at 45%.

The distribution of biomass in the various tree components on a percent weight basis for the largest diameter juniper was equal to 49% in the bole, 21% branches, 12% twigs, 3% deadwood and 15% foliage. The tree components are based on the diameter size of the material: bole $>$ 7.5 cm, branches 2.5 to 7.5 cm; and twigs $<$ 2.5 cm. In a conventional fuel wood harvesting operation, usually the biomass larger than 7.5 cm (3 in.) is removed; whereas, the other components are left on the site as slash. Depending upon the stocking, the green biomass of western juniper can range from 50 to 75 tons per acre. On the average, usually 50% or more of the biomass is left on the site as slash. A clearcut acre in the study area yielded 48 tons of green biomass. Of this total, 21 tons were removed as fuel wood and posts; whereas, 27 tons were left as slash. The remaining slash requires additional treatment in order to make the operation successful. This treatment or disposal may involve fire or mechanical methods.

Since western juniper woodlands can yield approximately 8-11 cords per acre, conventional fuel wood harvesting is considered by some to be the solution to our current problems. Fuel wood harvesting appears practical in localized areas which are close to population centers where there is a high demand for fuel wood. Fuel wood harvesting is labor intensive and the economics are such that large scale operations seldom survive for more than a couple of years. The time requirement to cut, limb, pile the slash and gather the fuel wood was approximately 7 hours per cord. Based on the studies in northeastern California, fuel wood harvesting does not appear to be feasible if one way transportation distances exceed 50 miles. In addition, the remaining slash still adds additional costs for the disposal or treatment.

Whole tree harvesting for chips, extractives, or other products appears to be the best alternative for removing the overstory in order to release a supressed understory or to permit reseeding of desired species. It may be better than prescribed burning because it is less damaging to the understory vegetation and may provide products of value. The use of a feller-buncher and whole tree chipper are feasible for the harvesting operation, however, transportation of the chips is still a limiting factor. There is, however, an attractive process being evaluated at the present time. A company from Medford, Oregon, has constructed a mobile distillation module which distills biomass or chips right on the site. This process would thus eliminate the costly transportation of the low value chips and provide chemicals and hydrocarbon compounds which could be transported more economically. The residue of the destructive distillation process is charcoal which could be briquetted and, again, transported cheaper than the raw chips. It is interesting to note that over 100 years ago, there was a thriving charcoal industry serving the mining camps in order to offset the high cost of transporting fuel wood.

VALUES OF WESTERN JUNIPER PRODUCTS AND A METHOD

ESTIMATING JUNIPER CORDWOOD

Douglas Parker and Maurice Ziegler

Juniper timbered lands offer the private land owner a variety of management options. A land owner may decide that the greatest value to be derived from an area is the visual and scenic beauty it offers and thus decides not to do any disturbance to the area. Another management option may be to increase the range capacity of a certain portion of the area by removing all the junipers in that particular area. Maybe the land owner would just like to receive some monetary revenue from the area. The list of possible management objectives for juniper timbered areas goes on and on and is limited only by imagination.

No matter what the management objective is, the land owner must first decide what he/she wants to accomplish before proceding any further in land management.

If the decision is to remove some or all the junipers in a particular area, the next step is to determine how to physically accomplish the task and maybe what revenue can be realized.

There have been many attempts and speculation in the past on products that could be utilized from juniper. There have been attempts to chip the trees and use them as hardboard. In this area the hauling distance to any existing utility plants is prohibitive and is currently not economically feasible.

Paneling, pressed chipboard, and other lumber products made from juniper is another avenue that has been investigated. Currently the procedures for transporting, drying, sawing and manufacturing these products are too costly and involved for a large commercial application. Juniper is utilized for the making of "hobby products: such as clocks, furniture, and decorative items, but the quantity of material needed for these products is very insignificant.

Many uses for juniper do exist, but there are only three uses for the wood that have any significant amount of demand from the public. These uses are for juniper boughs, juniper fence posts, and firewood.

Juniper boughs are collected from many areas in the late summer and fall. These boughs are incorporated into the making of Christmas wreaths, which are sold through the country. Bough cutters are looking for trees with a heavy crop of berries.

On the Prineville BLM district, 17 permits for a total of 74,300 lbs. of juniper boughs were sold in 1983. Over 100 tons have been taken from central Oregon in a good year. The selling price for juniper boughs is in the range of 1 - 2 cents per pound. This is one product that can be realized from juniper timbered lands without physically removing the trees. The boughs or limb tips are removed and there is no need to cut down the entire tree.

In areas where the junipers are young and growing vigorously, they produce a form which may be utilized for posts and poles. These posts and poles are harvested for use in corrals and fences because the wood has resistance to rot.

If a thinning objective is desired, post/pole harvesting could be an option. Not all the junipers in an area are suitable for this product so some trees will inevitably be left uncut. Standing posts should be worth 10 to 25¢ each depending on size. A Willowdale rancher accomplished clearing by getting post cutters to come on his land.

The predominant use in this region for juniper is as a fuel wood. Juniper provides a fairly large volume of heat or BTU's when burned, but it also has a few drawbacks. When using juniper as a fuel wood quite a bit of residue ash remains after burning. Also, the string bark of juniper captures dust particles which are very abrasive to chainsaws. This makes it difficult to cut juniper as it dulls the chain and decreases the life of both the chain and bar. In spite of these disadvantages, many people prefer juniper as a fuel wood to other types available in this area. It sells at a premium each winter $5 to $10 per cord more than pine firewood.

As an example, from the Prineville district in 1983, 1056 permits were sold for a total of 5,592 cords. On an average, 5,000 cords are sold annually to the local public by BLM alone. A few private land owners are also selling juniper from their lands. Many are allowing woodcutting as an offset to clearing costs. An average stand of juniper should have a value of $20 to $25 per acre, which should equal the costs of clearing.

The BLM and USFS in this area charge $2.50/cord on their lands for personal use permits. Bid prices of competitive sales have ranged from $6 to $16 per cord for selectively marked juniper. These figures should help you in setting your own price for fuel wood on your property.

These three major products currently being utilized from juniper trees allow the land owner the possibility of accomplishing an objective without major cost and possibly realizing a profit.

Procedure for Estimating Juniper Fuelwood Volume on a Given Piece of Property

The following procedure may be useful in estimating juniper:

1. Determine the number of acres on the property.

2. Measure a 1/10th acre circular plot, record the trees falling within it.

3. A 1/10th acre plot is 37.2 feet in radius. An easy way to determine the boundary of the plot is to premeasure a piece of rope (37.2 ft.). Drive a stake into the ground for plot center, attach the rope to the stake. Pull the rope tight and walk around in a circle, recording the trees inside the plot.

   When a tree is within the 1/10th acre plot, record its diameter (or) circumference) and height. The diameter (or circumference) of a tree is measured at approximately 12 inches up the bole of the tree from ground level. The circumference is the distance around the tree at the same point. This can be measured with a simple flexible tape measure (carpenters tape, cloth tape, etc.)

   The height of the tree can be estimated from the ground level to the top of the tree. This measurement is in 5 foot increments.

Example of the number of trees found on a 1/10th acre plot.

No. of Trees	Circumference	Height
2	28 ins.	20 ft.
1	40 ins.	30 ft.
1	84 ins.	45 ft.

4. After measuring the number of trees on the plot, look up the corresponding number of cords for a given diameter (or circumference) and height from Table 1.

Example

28 inch circumference and 20 foot height tree contains 0.08 cords.

No. Trees	Circumference	Height	Number of Cords Per Tree
2	29 ins.	20 ft.	0.08
1	40 ins.	30 ft.	0.18 (From
1	66 ins.	45 ft.	0.56 Table 1)

Multiply the number of trees by the appropriate number of cords and sum the number of cords.

No. Trees	Circumference	Height	Number of Cords Per Tree	Total Number of Cords
2	29 ins.	20 ft.	0.08	0.16
1	40 ins.	30 ft.	0.18	0.18
1	66 ins.	45 ft.	0.56	0.56

Total Number of Cords on a 1/10th Acre Plot .90

Multiply the number of cords on a 1/10th acre plot x 10. The result is the number of cords per acre.

.90 cords per 1/10th acre plot times 10 equals 9.0 cords per acre.

Multiply the number of acres on the property times the number of cords per acre.

9 cords per acre times 40 acres equals 360 cords.

Generally juniper has some rotten wood that is not usable for firewood or other products. A percentage of unusable wood (defect) is determined by cutting down a few trees and making an estimate as to the percentage of defect showing in the cut surface.

Example: A few trees were cut down and an estimate was made that about 25% of the cut surface is rotten wood.

360 total cords on the 40 acres times 0.25 (25%) equals 90 cords of rotten wood

360 total cords on 40 acres
- 90 cords of rotten wood
270 cords of solid wood on 40 acres

This is generally called "applying a defect factors (25%)" to a gross volume (360 cords) to get the net volume (270 cords) of wood.

Generally more than one plot would be taken on a piece of property. A 1/10th acre plot should be taken for about every 10 acres of land greater than 40 acres in total. There is no limit to the number of plots that can be taken; take as many plots as is felt would adequately cover the property.

Example: On 40 acres take a minimum of 4 to 5 plots. On 100 acres, 10 plots might be sufficient. On 10 acres a minimum of 3 plots should be taken.

The more plots that are taken the better the estimate of cords per acre. The plots should be spread out evenly over the property.

If more than 1 plot is taken, total up all the cords for each diameter and height and divide by the number of plots. This will yield the average number of cords per 1/10th acre plot. Then multiply by the number of acres to get the total cords of wood on the property.

The information in this section is intended to give only an estimate of the number of cords on the property. This will not be an exact figure, but is intended to give some idea of the number of cords available. The table was designed to be used on the Prineville district and presents only volumes averaged from many areas. Your property may be more or less productive or less than these average volumes. Remember that the final figures are only estimates and should be used as such.

In summary, when a land owner has decided to manage his/her land, the first step to decide on is the objective. Determine what physically will be done and how to do it to the best interest of the landowner. Decide on objectives that will help insure compliance with the objectives. It is not a bad idea to make some sort of estimate of the available product from the management area. This will help in setting up a cost to benefit comparison for the project.

Table I: Volumes in "cords"(1) for juniper trees by diameter or circumference and heights. * (Deschutes County)

Diameter(2)	Circumference(2)	HEIGHT (feet)(3)									
		10	15	20	25	30	35	40	45	50	55	60
5	16	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.11	0.12
7	22	0.03	0.04	0.06	0.07	0.09	0.10	0.12	0.13	0.14	0.16	0.17
9	28	0.04	0.06	0.08	0.10	0.12	0.13	0.15	0.17	0.19	0.21	0.23
11	35	0.05	0.07	0.10	0.12	0.15	0.17	0.20	0.22	0.25	0.27	0.30
13	41	0.06	0.09	0.12	0.15	0.18	0.22	0.25	0.28	0.31	0.34	0.37
15	47	0.08	0.11	0.15	0.19	0.23	0.26	0.30	0.34	0.38	0.41	0.45
17	53	0.09	0.14	0.18	0.23	0.27	0.32	0.36	0.41	0.45	0.50	0.54
19	60	0.11	0.16	0.21	0.27	0.32	0.37	0.43	0.48	0.53	0.50	0.64
21	66	0.12	0.19	0.25	0.31	0.37	0.43	0.50	0.56	0.62	0.68	0.75
23	72	0.14	0.22	0.29	0.36	0.43	0.50	0.57	0.65	0.72	0.79	0.86
25	78	0.16	0.25	0.33	0.41	0.49	0.57	0.66	0.74	0.82	0.90	0.98
27	85	0.19	0.28	0.37	0.46	0.56	0.65	0.74	0.84	0.93	1.02	1.11
29	91	0.21	0.31	0.42	0.52	0.63	0.73	0.84	0.94	1.04	1.15	1.25
31	97	0.23	0.35	0.47	0.58	0.70	0.82	0.93	1.05	1.17	1.28	1.40
33	104	0.26	0.39	0.52	0.65	0.78	0.91	1.04	1.17	1.30	1.43	1.56
35	110	0.29	0.43	0.57	0.72	0.86	1.00	1.15	1.29	1.43	1.58	1.72
37	116	0.32	0.47	0.63	0.79	0.95	1.10	1.26	1.42	1.58	1.73	1.89
39	122	0.35	0.52	0.69	0.86	1.04	1.21	1.38	1.55	1.73	1.90	2.07
41	129	0.38	0.56	0.75	0.94	1.13	1.32	1.51	1.69	1.88	2.07	2.26
43	135	0.41	0.61	0.82	1.02	1.23	1.43	1.64	1.84	2.05	2.25	2.46
45	141	0.44	0.66	0.89	1.11	1.33	1.55	1.77	1.99	2.22	2.44	2.66
47	148	0.48	0.72	0.96	1.20	1.44	1.68	1.92	2.15	2.39	2.63	2.87
49	154	0.52	0.77	1.03	1.29	1.55	1.80	2.06	2.32	2.58	2.84	3.09
51	160	0.55	0.83	1.11	1.38	1.66	1.94	2.22	2.49	2.77	3.05	3.32
53	166	0.59	0.89	1.19	1.48	1.78	2.08	2.37	2.67	2.97	3.26	3.56
55	173	0.63	0.95	1.27	1.59	1.90	2.22	2.54	2.85	3.17	3.49	3.81

CORD(1): 4 feet x 4 feet x 8 feet, or 80 cubic feet of solid wood.

DIAMETER & CIRCUMFERENCE(2): Measured 1 foot up from ground level.

Height(3): Total tree height from ground level to top of tree.

Data for this table was developed on the Prineville District, Bureau of Land Management, Prineville, Oregon, by Forester Don Lougee (retired).

* This table reflects the total cord wood yield from juniper trees before deducting for defect.

MECHANICAL CONTROL OF WESTERN JUNIPER

This session featured presentations on bulldozing, chaining, and chainsawing with emphasis given to practical on-the-ground applications.

BULLDOZING

Schwab Ranch - Presentation made by Crook County Extension Agent, Tom Bunch, for ranch manager Denny Denton.

The L.S. Ranch is located in the Crooked River Watershed north of the river between Post and Paulina. Over 13,000 acres of juniper and 7,000 acres of sagebrush have been cleared and sprayed in the past 5-7 years. Considerable soil surface disturbance occurs with the dozing operation. Occasional trees are left for shade. Trees are piled, left for a year or two, and then burned. Every disturbed area is immediately seeded with an electrical driven spinner-seeder mounted on the back of the bulldozer. After the trees are piled, crested wheatgrass seed is immediately broadcast with the tractor in reverse gear and moving in a "snakelike" pattern to achieve seed coverage and compaction of the seedbed. Formerly, before the spinner-seeders were obtained, dozing would occur for an hour and then the operator would dismount and hand broadcast seed for 30-45 minutes with a cyclone seeder.

Highly skilled tractor operators are crucial to success. They can accurately "pick out" 2-3 foot tall trees "on the run" and thus keep the apparent encroachment to a minimum. Standard smooth dozer blades are used. The "ball" of soil under the base tends to be held tightly so a brush rake would not be helpful.

Seedings have been highly successful. Forage for some 2-3 times more cattle is provided. More spring flow is observed along with more stream flow. The bird population is improved, especially quail and chuckars. Some juniper piles are not burned which provide shelter for birds, rabbits, and deer. Deer also consume juniper foliage in hard winters. Costs average $35-40 per acre, some of which has been offset by ASCS cost-sharing.

Bonnieview Ranch - E. J. Kropf, Post, Oregon.

This ranch of 40,000 acres has approximately 10,000 acres of juniper. Since 1979 with cost-sharing through ASCS, over 5,000 acres have been cleared with two catepillar D-6's and two 60 horsepower cats equipped with 6 way dozer blades. In order to be economic, the ranch had to be able to run more cattle. Upon analysis, the best alternative was to clear juniper and either seed grass or permit resident perennial grasses to increase.

Smaller trees are removed by the smaller tractors. Careful site selection keeps the tractors off the heavy textured soils and off steep slopes. This keeps cost down and production up. Junipers growing on sandy or loam soils are much easier to remove.

Where the site needs it and where better soils are evident, crested wheatgrass is drilled. An earlier 1,200 acre area broadcast seeding failed. Seeding is not done on high elevation sites. Crested wheatgrass is more competitive to natives which is not desirable. Native grasses are allowed to recover which is both more practical and economically feasible. However, crested wheatgrass can reduce grazing pressures on native ranges since it can be grazed earlier and more intensively.

Costs have averaged $21 per acre in 1979-82 over 5,000 acres. Benefits include more cattle forage and the resultant increases in herd numbers, an increase in calf weaning weights, more perennial grasses, and fewer annuals. Considerably more water surface springs and stream flow is available. Examination of the precipitation records, shows that precipitation changes cannot account for the increased water so the juniper removal was responsible.

Soil erosion appears to have been checked in the juniper control areas. Some trees were piled in gullies but not in live streams. Some piles of trees were not burned which results in improved bird and small game cover. Also, some standing trees remain for big game cover.

The juniper control program on the Bonnieview Ranch has produced changes which benefit not only the ranch, saleable product--cattle, but also the entire watershed through better water and soil conservation and a larger and more stabilized wildlife population. The quality of the upland management strongly determines the rate and quality of improvement in the lower watershed areas.

Rance Kastor, John Day, Oregon.

This ranch is located northeast of John Day. It is part of the old Herman Oliver Ranch which at one time ran 1200-1400 cows. At the time of the ranch purchase, only 200 cows could be grazed for 2 months and steer calves weaned at 430-440 pounds. From 12-20" of annual precipitation occurs with the higher elevation producing ponderosa pine and fir. Approximately 200 junipers per acre were choking productivity. Only two small creeks had stock water.

A program of juniper bulldozing was initiated upon purchase in August with 1,000 acres cleared in the first year. Water immediately began flowing in springs and the creek picked up. Cost to push trees varied from $15 to $100 per acre. The high costs were associated with removing the very large juniper near the pine. Some trees consistently would yield one cord of fuel wood per tree. Many fence posts and corral poles were made by leaving the cut post one year, peeling the bark and then dipping in pentachlorophenyl/diesel.

Juniper is managed in relation to the kind of habitat it could create for wildlife as well as for the improvement in forage. Calf weights improved by 100 pounds apiece and an additional 100 cows are run for 3 more months (late April to late September). Essentially, carrying capacity for cattle was doubled while only using perhaps 3/4 of the available forage. Deer and elk abound. Deer harvest weights improved from 190 to 205 pounds over the past 5 years. Numbers of elk went from 28 to 133 with at least 13 bulls in residence.

Water production has been impressive. Enough water was produced in one watershed to allow irrigation of 60 acres through installation of a contour ditch. The creek was fenced separately. Many willows returned and there is no bank erosion. Also trout populations are high.

Some 48 ponds were constructed and a brush pile left below each pond. This allows good escape cover for upland birds and rabbits. It attracts porcupines as well as coyotes. Live junipers are often left in draws that do not have live water. Deer often prefer some live junipers (light green without berries) and those also are left.

In the pine zone, junipers averaging 20" diameter "on the stump" were removed resulting in greatly increased pine growth. In some cases it was necessary to thin the pine 5 years after juniper removal.

In one situation, junipers were chainsawed on 200 acres to compare with bulldozing. Subsequent forage production was higher where bulldozing was used. Also, cereal rye or barley was planted for grain on the better sites. Grain yields were definitely better on sites where dozer cleared.

Good follow up is important. After the clearing job is finished, go over the area to remove the remaining young trees with a Pulaski or small chainsaw. If this is done soon, 100 acres per day can be covered. Small young trees can be burned with a blow torch, but it is more costly and no more effective.

CHAINSAWING

Arleigh Isley, Grant County Extension Agent, Canyon City.

Costs and Benefits

Chainsawing and bulldozing are comparable in costs but each type of control is best suited to specific situations. Juniper control in Grant County varies from $26-$71 per acre depending on the site and operator's experience and whether the control is contracted by the hour or acre. The type of control does not seem to alter costs significantly. Therefore, the control measures should be selected more on final objectives and site specifications rather than cost.

Costs are closely associated with the age and density of the stand being cleared. Older trees in dense stands are much more expensive to control than young trees in dense stands or thinner stands. Steepness of the slope and stoniness are also significant factors in control costs. Other vegetative cover and the decision to seed or not seed the site are major decisions relating to the overall costs and benefits of the project.

The land manager should consider the benefit-cost ratio in deciding control methods and follow-up rather than just cost. The cheapest control may not always provide the maximum benefit-cost ratio.

Juniper Control

Site Selection:

Select the site for juniper control that will provide the greatest return for the money spent; ie. benefit/cost ratio. Factors to consider are forage production, water production including quality and quantity, enhancement of other assets and resources, location relative to need, season available, other forage available and cost of control.

Control Method

Shallow Stony Soil and/or Steep Slopes:

Saw with possibly follow-up fire. Shallow stony soils or steep slopes whether rocky or not are usually easily eroded and any method chosen for control should not disturb the soil or contribute to erosion. Often perennial grasses appear to be completely absent from the site. After good juniper control followed by proper grazing management, perennials appear and the range starts recovery in 3 to 5 years. Proper management depends on the site, ie. soils, slope gradient, climax species and present range condition.

Saw operator skill and adherence to safety are extremely important. Generally several lower limbs will have to be cut before a clean cut on the trunk can be made. Maintaining a sharp chain is critical to high production.

Deeper Productive Soils:

Bulldozing, chaining, chainsawing, and fire. Any of these methods may be appropriate on deep soils depending on the present vegetative cover, potential forage production, type and amount of forage needed, steepness of slope and cost.

Follow-up or Future Control

Probably the cheapest juniper control is fire. Prescribed fire is very effective when the new juniper is less than six feet high and adequate fuel is available. Chemicals such as picloram are also effective at this stage of the invasion. After the initial juniper control effort, chaining or dozing should not be needed. Chainsawing may be appropriate in some situations.

Management After Control

Grazing needs to be intensely managed, NOT ELIMINATED. The grazing season, site treated, present range condition, past use and future needs must all be considered in developing the management plan.

The first year grazing should be limited to early spring, April and early May, or late fall, after September 15th. Little damage is done by grazing native cool season grasses during the dormant season. Let grasses grow fully during the main growing season in order for them to increase in size and possibly produce mature seed.

Do manage so as to achieve several purposes. This will help to spread the costs over multiple benefits.

CHAINSAWING

Earl McKinney, BLM, Prineville.

If the sites being considered for juniper control are on either: (a) steep north exclosures with good grass cover and small trees, or (b) fair to good condition sites with grass, brush and moderate sized trees, try burning first. It is much cheaper, but if the sites will not burn, then the chainsaw is probably the next best alternative.

If gully erosion control work is a major purpose, then the chainsaw is a good tool for it. For gully work, limb the trees up to about 1/3 to 1/2 their height and try to place in the gully with the butt upstream. Trees with the butt branches removed and butt upstream are much more likely to stay in place and catch silt.

Lay out chainsaw work for winter time to get bids from unemployed loggers. A fellow who knows how to handle a saw can cut 10 times as much as a greenhorn will cut. A good man will average 3 acres per day in average juniper (150 stems per acre). An exceptional man will average 5 acres per day.

Costs are running the BLM $10-25 per acre depending upon distance from town and quality of salvage wood. An average of $20 per acre may be appropriate for budgeting purposes. Several local ranchers are getting their cutting done for virtually nothing using ASCS cost-share money and giving the cutter the fire wood.

The primary value of the chainsaw is that it is the cheapest way to get enough fuel on the ground to carry the fire that the range sites need as a first step toward recovery.

CHAINING

Jim Cornwell, Soil Conservation Service, Madras.

The practice of using an anchor chain to control western juniper has been used with varying intensities over a period of at least 15 years in Jefferson County. A project done in 1983 will be described which is representative of a well-managed operation.

Chaining is done by two cat tractors traveling parallel to each other with an anchor chain stretched between them. The chain is towed in a 'U' shaped fashion with the tractors spaced apart about one-half the length of the chain. Chains vary from 130' to 300' in length with links weighing 50 pounds to 90 pounds each. There are many variations and modifications of chains available. The main purpose of the chain is to uproot or break off juniper trees.

The major site treated was a droughty rolling hills range site on shallow cobbly silt loams of less than 12% slopes. The site was in poor and low fair range condition producing 200-300 pounds per acre of herbaceous material. Bluebunch wheatgrass was providing up to 80% of the herbaceous production. It was judged that the bluebunch wheatgrass stand was adequate to respond to the reduction in competition if properly managed.

The juniper stand on this site was typical of much of eastern Jefferson County's juniper covered rangelands. No trees were over 80 to 90 years old. Stand density varied from 30 to 100 trees per acre with about 1/3 to 1/2 of them about 80 years old and 25 to 35 feet in height. The larger trees are the ones that will be affected by the chaining. The remaining 1/2 to 2/3 were sapling and seedlings from 1 to 12 feet in height. These trees are tough and flexible so few will be uprooted or broken off by the chain. The roots of the larger ones may be weakened making their removal by bulldozing easier.

The chaining was done with two-325 horsepower tractors pulling a 130' anchor chain with 90 pound links. Chaining was done "one-way" or just once over by going around and around the control area. Past studies here demonstrated that chaining once and dozing is more economical than "double chaining" or twice over and dozing. Chaining also is most efficient when turns are minimized by going around a unit with no sharp turns or done in long narrow strips. Chaining covered about 12 acres per hour. With tractors of this size, more acres per hour could be chained with a longer chain.

Piling was done by using a Case 850 tractor of about 75 horsepower. This small tractor was used to doze out the smaller trees and push them into windrows or piles with the larger trees that were broken off or uprooted by the chain. One of the large cats was then used to doze the larger trees that were still rooted and the windrowed junipers into piles. Using the smaller cats to pile and doze young trees causes less soil displacement and destruction of grasses and other desirable plants. About 60 hours of the small tractor's time and 21 hours of the large tractor's time was used to doze and pile.

The final operation required one man about 71 hours with a chain saw and hand tools to remove those junipers not dozed. These were the trees judged not worth the tractor time or the disturbance of desired plants to eliminate them or were not seen by the cat operator.

Initial observations and planning for the site were made in October 1982, the clearing done in June 1983, and followup observations made in August 1984. The clearing has resulted in reducing the juniper stand to an estimated 2 or 3 trees per acre which are less than one foot tall.

Total production of bluebunch wheatgrass is about the same as occurred before. Some of the mature plants were removed in the dozing operation but there now are commonly occurring seedlings and the mature plants are more vigorous.

Thurber's needlegrass now occurs where it was not previously detected. It probably was there previously but was of such low vigor that it was not observed. The most obvious change has been the increase in production of annuals, in particular willowweed (Epilobium paniculatum) and cheatgrass. In both cases the increase was due to increased vigor as well as an increase in the number of plants. This is to be expected any time such severe competition is removed as the annuals can more readily respond.

Follow-up management has been planned to achieve the goal of increasing forage production. Grazing was deferred until late fall of 1983 and will be deferred this year also. Deferment is being used to improve the vigor of bluebunch wheatgrass and encourage establishment of new plants.

After one year of this grazing treatment and reduced competition, the objective of increased forage production is being achieved. During the next growing season we will check again to see if we are progressing as expected and adjust management accordingly.

Costs for the 209 acre job totalled about $9,000 or an average of $42.83 per acre.

Operation	Cost/Acre	Percent of Total
Chain rental	$ .50	1
Chain transport to site (includes moving cats)	2.39	6
Chaining-tractors and operators (12ac/hr @ $110/hr each)	18.32	43
Piling (20.7 hrs. @ $110 + 60 hrs @ $28.14)	18.90	44
Hand labor followup (71 hrs @ $8.00; includes saw cost)	2.72	6

Considerations to see if chaining is appropriate:

1. Stand composition - are the trees susceptible to chaining?
2. Site suitability - rockiness, soils, slope
3. Availability of equipment, cost and skill of operators
4. The need to doze or some other practice to clear the juniper following chaining.

If chaining is appropriate, we need to consider what the goal is of removing the juniper and plan the practice appropriately.

Do we need to seed to achieve our goal and if so, we need to consider timing and seeding method.

Consideration needs to be given to leaving cover for livestock and wildlife. Most chainings on private land are small enough that wildlife cover is close by but cover for livestock within a fenced unit may be of high concern.

Some of the advantages of chaining are:

1. Reduced time for dozing and piling.

2. Makes dozing easier so smaller equipment may be used.

3. Not as destructive to other vegetation as straight dozing.

4. Helps prepare the seedbed with scarification.

One potential of chaining that needs to be investigated is the preparation of a site for a prescribed fire.

PRESCRIBED BURNING OF LIVE STANDING WESTERN JUNIPER AND POST-BURNING SUCCESSION

Steve Bunting

Fire holds the interest of ranchers and public resource managers for a number of reasons. Western juniper does not resprout so the plant can be controlled with fire providing the site can be burned. Observations of areas which have been burned at different times in the past appear to suggest that presence/absence of fire played a significant historic role. Fire is perceived to be a less extensive control measure than other techniques. As discussed by Peter Mehringer in the first paper, western juniper may be described as being somewhat episodic in nature, in that, it has been in this part of the country for a long long time, but there were "ebbs and flows". Some believe fire could have had much to do with this.

Juniper encroachment rates seem to be somewhat affected by management but encroachment/invasion will occur if seed is present and site factors are satisfactory for germination. Thus, competition levels and grazing by herbivores could affect invasion rates, but will <u>not</u> keep juniper out. Reducing, or even eliminating livestock grazing, will not reverse the trend of invasion. Grazing can control the amount of fine fuel, and direct heavy herbaceous or shrubby competition no doubt can affect juniper plant growth rate. Grazing could have had some affect in restricting fires by reducing the amount of fine fuel.

Where juniper is already present, active control measures are needed to change its population and to maintain desirable vegetative composition. In studying the long time successional patterns where juniper is present, trees do not become dominant for the first 30-50 years. During this period, there should be several good opportunities to apply appropriate and effective control measures. During the next 30-40 years, stands can reach their maximum density and cover and have a firm and virtually irreversible hold on the site.

Prescribed Fire Research

Since fall 1979, research into prescribed burning into live standing western juniper has been carried out on Bureau of Land Management land in the Owyhee Mountains of southwestern Idaho by range resources staff members of the University of Idaho and Bureau personnel. Much has been learned over the last 5 years. Initially fires were conducted in late September and early October with very limited success due to low temperatures, low wind speeds, and lack of fine fuel. When burning time was moved to mid-September and even when using a helitorch in addition to a drip torch to initiate fire, limited success was had primarily for the same reasons. It was not until the burning period was moved to mid-August to mid-September that some success occurred.

Dry, warm conditions were necessary for a fire to carry. Because the tree itself is approximately 50% moisture, getting a fire going rapidly in openings where fine fuel often is more prevalent seems to be necessary in order to get enough heat for crowns to catch. Using a helitorch greatly helps to accomplish this since fire can be spread rapidly, especially in hard to light areas. The helitorch can have many advantages although flying time can be expensive. Some of the obvious advantages occur on large areas which may be less accessible with ground equipment and/or where visibility on the ground is limited. Also where a fire or series of fires can be rapidly lighted, the helitorch may be the only effective means.

The fire prescription now being used and recommended is:

wind: steady, greater than 5 mph, about 8 mph seems optimum.
temperature: at least 68^{o} F., 75^{o} F or more is optimum.
relative humidity: not over 30%, less than 25% desirable.
barometric pressure: high or rising.
precipitation: burn before the first fall rains. If significant rains have occurred, wait 5-7 days.

Try to have at least 500 pounds fine fuel per acre available. When there is less than 500 pounds per acre, considerable difficulty exists for fire to carry into the live standing trees. This can be compensated for to some degree by factors such as greater wind speed, higher temperature, lower relative humidity, lower fuel moisture and dense sagebrush cover. Fire intensity is dependent upon a combination of these factors. If fall greenup of herbaceous plants occurs before a prescribed fire can be carried out, both fire behavior and plant responses are negatively affected. Consequently, burning before fall greenup is desirable. Since fires often will not carry in old pure stands, they can serve as natural fire breaks.

Site Selection

Selection of the proper sites to burn is a major factor in determining the eventual success or failure of the project. Normally, a wide variety of successional stages of juniper development is available to choose from when burning. Often when selecting sites for range improvement, it is recommended that the sites of highest potential in the lowest condition be chosen for treatment. These criteria may not be the most cost effective when using prescribed fire in general, and particularly in juniper types.

The following order of burning ease and juniper control effectiveness is recommended:

1. Early stages of juniper invasion into sagebrush-grass or meadow vegetation (25-50 year old plants). These stands vary in juniper density but the trees are normally less than 10 feet tall and there exists substantial understory vegetation.

2. Open stands of juniper which may be of older age but have not begun to close to a point where the understory vegetation is significantly being reduced.

3. Mature stands (> 75 years) which have significantly affected the understory composition.

4. Mature stands (> 150 years) which vary in density

   a. Open savannah type
   b. Dense uneven aged stands

5. Juniper stands invading low sagebrush vegetation (A. arbuscula/F. idahoensis habitat types).

Post-Fire Successional Relationships

Post-fire succession depends on a large number of factors, some of which can be predicted in advance. Experience and observations show that 90% of the perennial plants will be present on the site over the succeeding 5 years will be there at the time of the burn. Also, the older the stand of juniper, the less likely there will be a diverse stand of perennial plants there. Consequently, less plants will be introduced by seeding; most of the succession will be from the plants already on the site. This can pose problems when species such as cheatgrass are highly prevalent, since the competition they provide to recovering perennials can be severe.

Succession depends upon the fire intensity to a great extent. Very hot fires, although achieving high damage to the juniper, can also seriously slow the initial succession of desirable herbaceous plants. Developing specific prescriptions for each site situation can help overcome this problem.

Figure 1 shows some general successional relationships as a function of time since the fire. Observations indicate that perennial forbs generally recover faster than perennial grasses. Forbs such as arrowleaf balsamroot (Balsamorhiza saggittata) and lupine (Lupinus spp.) seem not to be harmed by most fires. Species of Agoseries, Crepis, and Taraxicum can increase after fires. It will often require 4-5 years before the first perennial grass seedlings establish, even when there is not apparent heavy competition. Western needlegrass (Stipa occidentalis), however, may establish more quickly when seed sources are available.

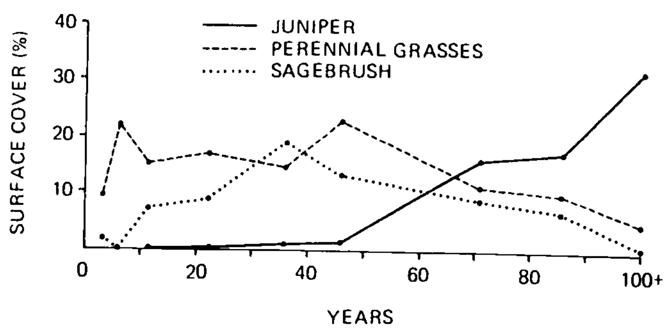

Fig. 1. *Surface cover of juniper, perennial grasses, and sagebrush by age of burn.*

(Taken from Barney, M. A. and N. C. Frischknecht. 1974. J. Range Manage. 27:91-97)

General reactions to fire on species by species basis are:

1. Mountain big sagebrush (Artemisia tridentata ssp. vaseyana) rapidly re-establishes. Seed germination is enhanced by heat.

2. Antelope bitterbrush in western juniper communities has a low, 6% or less, resprouting potential after fire. It also has low seedling establishment rates and relatively short life span. It has been observed that population densities decline 50 to 100 years after establishment. Also, individual plant vigor and productivity declines after 70 years of age. As the stand of juniper becomes older, bitterbrush density declines. The frequency of fire is critical if bitterbrush populations are to be maintained in these communities. If fire is too frequent, bitterbrush will decline due to its poor resprouting potential. However, if fire or some other disturbance does not occur to set back succession and re-establish a young bitterbrush stand, the species will decline and eventually die out due to the domination of the site by juniper.

3. Ceanothus can increase due to apparently fire broken dormancy of seeds which are on site. In fact, seedlings can occur when no existing Ceanothus plants are present.

4. Idaho fescue can be seriously damaged by fire. With the hot fires needed to burn juniper, 25-40% will commonly be lost. Part of this may be that Idaho fescue often is rooted in the litter (needle mat) underlying the trees and this, of course, burns.

5. Bluebunch wheatgrass seems not to be greatly harmed by fire and comes back readily, especially in the above average precipitation years.

6. Thurber's needlegrass is quite sensitive, but western needlegrass is not in that it reproduces well by seed after a fire.

Broadcasting seed, whether domestic or native species, has not produced good results. Often seedbeds are too soft and with a crust on the soil. Firm seedbeds are necessary for a reasonable seedling success. A combination of induced grazing pressure and broadcast seeding might be successful, but stock density would need to be high to achieve the desired seedbeds affect.

Because juniper seems to be "harmless" in the first years after control or in the early years of "initial" encroachment/invasion, there is a tendency to not use any control practice on these sites. On the contrary, such young stands offer the best possibilities for inexpensive, effective control. Scheduling successful burns before establishment of dense juniper with decreased fine fuels is recommended.

Economics

Burns currently are done for $10-15 per acre. As people become more skilled, costs could go down. Also, when many units are planned in advance and when good burning years occur, costs can be reduced by taking advantage of these conditions.

Summary

Prescribed burning live standing trees has limitations, but successes have been achieved. Aids such as fuel wood cutting, dessicants or perhaps herbicide application and mechanical control can be effectively used with controlled fire. If care is taken when chosing treatment sites, prescribed fire can be effectively and economically used. Short term losses or at least reductions of some species such as Idaho fescue and bitterbrush will need to be accepted. Unfortunately, the technology to treat dense stands effectively with fire has not been developed to this point. These stands can probably be more effectively treated with mechanical means. Some of them can be burned but the areas may have little vegetal cover remaining after fire, and, unfortunately, desirable plants cannot be readily re-established on these areas. Fire monies can be better spent treating areas in which the invasion has not advanced very far. These areas can be then maintained as sagebrush-grass or meadow ecosystems.

WESTERN JUNIPER CONTROL: FROM SITE SELECTION TO FOLLOWUP MANAGEMENT

Earl McKinney

Western juniper constitutes a problem and a challenge to management on some 100,000 acres in the Prineville BLM district. During the last 10 years, juniper on over 15,000 acres has been treated, most often on a chainsaw followup prescribed burn sequence. The problem posed by juniper varies greatly, but from a resource standpoint, the most serious is the development of bare soil and gullies. This occurrence is more severe on droughty south exposure range sites, but can happen on most all sites over time.

Juniper roots provide extreme competition in the tree interspaces, so vegetative cover decreases. Soils dry out more rapidly. Precipitation, when it does occur, starts to form small gullies and small gullies become large gullies. Without manipulation of juniper, the problem is irreversible.

Juniper was cut on almost all sites available, but there was a definite tendency to select those which seemed to have the most forage potential and also where gullies or small streams were available for the butts of juniper to be placed. Several benefits have accrued as a result of sawing juniper and also burning the slash. Not all areas received the burn treatment.

Notable results were a 5-10 fold vegetation increase the first 5 years after cutting. Under proper grazing management, many plants had the opportunity to set seed. Grass stands thickened markedly and where trees were placed carefully in gullies, significant quantities of silt deposited.

Upon close analyses of the cutting without followup burning treatment, some interesting findings were made.

1. Some sites in situations showed little improvement over the past 5 years.

2. Some stands did not respond well; notably clay upland sites.

3. Many young trees were showing up indicating that there may be a limited life expectancy of cutting benefits.

4. Some gullies did apparently heal in 10 years and where adequate soil-water existed, willows established. Streams were flowing with live water over long periods, but many gullies still existed with disappointing amounts of bare soil.

5. Gully plugs formed by the downed trees would often not last, as branches decaded and washed out silt and ran under the pile. When rhizomatous grasses started, this was greatly minimized.

Consequently, followup fires were tried with surprising benefits. It is true that the appearance of a good burn is considered an eyesore by some. However, soon the vegetation recovers. Most sites treated by cutting and burning about 7 years later have responded productively. Rolling hills sites in "fair" range condition have come back well. Those in "poor" condition did have high cheatgrass responses which helped to control sedimentation. However, revegetation with productive native perennials takes time and in some cases, seeding is desirable. Droughty bottom lands respond well as do moist bottom lands. Both basin and creeping wildrye increase readily on these sites. Excellent vegetative responses, primarily with Idaho fescue, occurred on north exposures. South exposures pose a real problem when seriously degraded, but experience shows they do revegetate after sawing and fire.

Objectives should determine the priority of action. If increasing forage production is paramount, then treating those potentially most productive sites in the highest ecological condition would be first priority. If deer habitat is a high objective, then the size of a project and its position on the landscape would be more important than site. If curtailing soil erosion is the first priority, treatments should be done on a watershed/subwatershed basis regardless of site. In fact, those sites producing the most sediment will be of high priority in the watershed, if priorities have to be set within units. Often a juniper south exposure site because it is producing much silt will be treated before a north exposure Idaho fescue site.

Conclusions

Objectives should determine the sequence of site and conditions treated. Probably more south exposure sites should be treated. Do not allow too much time to accrue between cutting and fire. Burn before needles fall from the branches; waiting too long makes fire difficult to carry and therefore the tendency to burn under more extreme conditions when this may not have been necessary.

PRESCRIBED BURNING OF JUNIPER-GRASSLAND

ON THE CROOKED RIVER NATIONAL GRASSLANDS

Frank Russell

The Crooked River National Grassland is composed of 100,000 acres lying mostly between Prineville and Madras. The lands were formerly privately owned in the early years (1910-1935±) and were farmed to annual crops. It was uneconomical to farm in this area of low and variable annual precipitation. In time, the U.S. Government through provisions of the 1937 Bankhead-Jones Act took possession and management. The U.S. Forest Service has had management responsibility since 1954. Approximately 60,000 acres have been revegetated with introduced species. Over 50,000 acres are still in the native state.

Western juniper has encroached strongly both onto the seeded areas and native rangeland. In several seeded areas, 100 trees per acre can be found 20 years after treatment. Many native range sites have 400 trees per acre.

Over the years, prescribed fire has proven to be the most effective, successful and cost efficient means of addressing the juniper problem. Areas seeded with crested wheatgrass and alfalfa have been successfully burned to control juniper and at the same time stimulating the herbaceous plants.

Based upon experience at the Grassland, burns will cost $1.00-$20.00 per acre depending upon unit size and time of year of the fire. One private contract of $6.25 per acre to meet specific objectives was recently made. Current policies are not to seed more land and to burn juniper on seeded areas to retain the investments made in the past. Seeding is not practiced after fires until after the response of the resident species is determined. Approximately 20 years passes before juniper needs to be controlled on seedings.

Burn on a rotation basis to keep juniper in check. Although every 20 years seems to be important from a forage production perspective, every 30 to 40 years may be better from the standpoint of wildlife (deer habitat). Large broadcast type burns are not desirable for deer habitat. Since the Forest Service needs to plan management for this use in some areas, approximately one-third is chainsawed and burned to create diverse stand structure. In other areas, one tree of every three is felled and the area burned successfully when the fuel is dry. Spring burns are desirable before new plant growth.

Standing juniper has been burned successfully under conditions of 12-15% relative humidity, 6-7 mph wind and greater than 70^{o}-90^{o} F temperatures.

Plowed or graded fire lines are no longer used since they revegetate with annuals and are extremely slow to go to perennials. Much preferred is to use existing roads. Sometimes there are none where the fires are to be. In these cases, either black lines or wet lines are proven highly effective. Black lines are pre-burned areas during the green season when fires cannot spread. Equipment such as a mint field flamer is used. A wet line is used at the time of the burn itself by laying down a water line and lighting right beside it. As a federal agency, the Grassland managers have access to standby fire crews which has helped greatly.

DEVELOPING PRESCRIPTIONS FOR BURNING
WESTERN JUNIPER SLASH

Steve Lent

What is a Fire Prescription

A fire or burning prescription is a set of directions that clearly describe the desired accomplishment or objectives of a burn and what the fire needs to do to achieve those desired results.

There are several elements that should be included in the set of directions for a burning prescription. The most important elements are:

A. Stated objectives for a prescribed burn.
B. Desired fire behavior to accomplish fire effects.
C. The ignition strategy affecting fire behavior.
D. Preburn monitoring to aid in determining when environmental conditions are favorable to burn.
E. Evaluation process to determine results of the burn.

Treatment Specifications

Objectives

Clear objectives must be stated in the prescription to determine the desired accomplishment of the burn. Without precise objectives, the target is unclear. It is best to have measurable objectives so that they can be better evaluated. This may require preburn data collection to determine existing conditions. Before and after pictures may well be adequate. The objectives of the burn are the basis for development of the prescription.

Examples of poor objectives are: (1) Reduce fuel loading, (2) Improve range/ wildlife habitat and (3) Inhibit juniper invasion. Examples of some better objectives are: (1) Reduce 1 and 10 hour time lag (TL) fuels to 3 tons/acre or less, (2) Make 90% of stand area accessible to cattle and big game, and (3) Kill 90% or more of junipers less than 10 feet. Kill 40-50% of all larger junipers.

Desired Fire Behavior

Once the objectives have been established, the fire characteristics that are needed to produce the desired accomplishment must be stated. The fire and its effects are the final integrators of all prescription variables.

Tables and illustrations at the end of the article contain prescriptions and fire behavior predictions for a large number of species.

Fire Behavior Elements of Prescription

Rate of Spread

This is usually expressed in chains/hour (one chain equals 66 feet). This may affect heat duration and fire effects. A slow rate of spread may mean a longer residence time and potential damage to certain plants. Specify acceptable range, how fast or how slow, in the prescription.

Flame Length

The slant of flames (length from base to tip) is probably the most used variable. It has a strong influence on scorch heights. Albini (1976) gives methods for estimating flame length.

Fire Intensity

This is the amount or rate of heat released per unit of time for each unit of length of fire edge. This is usually expressed in BTU/ft/sec. This is difficult to measure but if using intensity in the prescription, one should specify the acceptable range - how hot or how cool the fire should be.

Required Environmental Conditions

The environmental factors that produce the desired fire behavior and fire effects must be determined. Specific required environmental conditions are necessary to determine the proper time to burn.

Environmental Condition Variables

Windspeed and Direction

Usually windspeed is given for a measured 20 foot interval above ground. The important element for burning is the midflame windspeed. It is important because it affects how a fire behaves and especially influences scorch height. Direction determines fire movement and smoke direction.

Temperature

Influences how fast fuels will dry and the effect of fire on plants and soil.

Relative Humidity

One of the most used prescription variables. It influences fine fuel moisture content and how a fire will burn. An acceptable range of RH should be given for a high and low end of prescription window.

Fuel Moisture by Size Class

The moisture content of fuels by each size class determines how that size class will burn. Size classes are normally broken down as follows: 0-¼", ¼"-1", 1"-3", and 3+". Fuel moisture is defined as the water content of a fuel particle expressed as a percent of the oven dry weight of the fuel particle. A low moisture content may be desired in fine fuels to carry the fire, but a high moisture content in large fuels to reduce heat output. Methods of measuring fuel moisture are weighing of fuel sticks and fuel moisture meters.

Examples of 10-hour time lag (TL) fuel moisture and fire behavior are shown in Appendix A.

Vegetation Condition

The state of vegetation, whether active or dormant, can modify effects of fire on it. Some plants are highly susceptible to fire in the active stage, but resilient in the dormant stage.

Table 1. Fuel moisture content (FMC) and fire effects[1/]

10 Hour Time Lag (FMC (%)	Fire Effect
25	Fuel will not burn
15-20	Fuel will burn slowly
7-14	Fuel burns well. Good comsumption of fuels less than 6" diameter. Many prescribed burns are conducted in this FMC range.
1-4	Fuel burns too rapidly for good control or management. Total consumption of fuels less than 9" diameter.

[1/] These are only generalizations. Effects may vary in certain vegetative types.

Live Fuel Moisture

The moisture content of live fuels may make a difference in whether or not it is consumed. This may modify burn characteristics.

Soil Moisture

The amount of moisture in the soil is important for determining the protection of some plants, especially in root sprouting.

Precipitation

Affects the moisture content of fuels, plant, and soil. It is a good indicator of when to burn. It may be helpful to specify how many days after last precipitation that burn will be conducted. Amount as well as duration are important.

Season

The time of year can be very important in that it relates to plant conditions, as mentioned above, sprouting and seed sources. The burning objectives will determine the season of year to burn.

Ignition Strategy

The prescription should state which firing pattern, igniting technique and ignition method will be used to achieve the treatment objectives. Ignition strategy can be used to achieve the treatment objectives. Ignition strategy can be used to modify fire under any given conditions.

Ignition Technique

Ignition of a prescribed burn area may be accomplished in various ways. The ignition technique used depends on the intensity of fire needed to meet objectives. A summary of ignition techniques and methods is included at the end of this article.

Ignition Method

The ignition method can be chosen after the ignition technique has been selected. The ignition technique, fuel vegetation type and size of area to be burned will put constraints on the ignition method.

Preburn Monitoring

The prescription should provide directions for monitoring the required environmental conditions that are correct to begin the burning operation. The preburn monitoring should include the measurements to be taken, when and where they will be taken, and the precision needed. Examples include weather measurements, fuel moisture readings and soil moisture readings. Once the prescribed conditions are determined to be within range a test fire may be utilized to determine if the desired fire behavior will be achieved.

Prescription for Juniper Slash

The following prescription elements are for burning juniper slash areas on BLM lands in the Bear Creek area. The objectives for the burns were:
(1) Kill 80% of the live juniper less than six feet tall within units
(2) Eliminate down juniper slash by 70%. These prescription parameters have been refined and have resulted in favorable meeting of objectives. It is important to tailor the prescription to meet objectives. These prescription variables would probably apply to most prescribed burning of juniper slash areas.

Fuel Elements

Fuel Loading

Fuel loading should be at least 400 to 700 lbs/acre of fine fuel. Slash fuel, ¼" to 3+" material, should be at least four tons/acre (approx. 15 trees/acre). Trees should still retain their needles. It is important to rest the proposed burn area from grazing in the summer before burning to increase fine fuel loading and continuity for better spread.

Fuel Continuity

Fuels should be relatively continuous with only a few major fuel breaks within the unit. If fuels are sparse and not continuous the area may not burn without extensive lighting.

Preparation

It is important to prepare the area to be burned in some manner so it can be controlled. Existing roads or natural barriers such as rock slides, rock flats, or wide stream channels should be incorporated as boundaries of burn area. A fireline may be dozed 10-12 feet wide around the area to be burned in combination with blacklining. The BLM is presently burning 100 foot blackline around units in the spring when there is little chance of escape. The burned areas green up and by summer make a very good control line. Escapes can be costly, so preparation should be given careful consideration.

Weather Conditions

The following are experienced ranges for best results. Any number of combinations may work and it may require some experimenting. Spring burning has been tried but fire has not carried as well as desired.

1.	Temperature	80° to 95° F
2.	Relative Humidity	10% to 20%
3.	Wind speed	5 to 20 mph
4.	One hour fuel moisture (0"0¼" fuel)	4% to 10%
5.	10 hour fuel moisture (¼"-1" fuel)	5% to 11%
6.	Live fuel moisture	60% to 70%
7.	Season	Late summer-early fall
8.	Precipitation	Two or more days after significant rain

Ignition Strategy

Firing Technique

Strip head or head fire depending on how fire is burning. If there is little wind, ring or center fire burning may be an excellent alternative. Different methods may have to be utilized depending on how fire is burning.

Firing Method

The recommended method of ignition is the use of the drip torch. If a heli-torch and helicopter are available and cost is not excessive they would be a quick and safe way to ignite units. It is important to have enough burning fuel to complete the burn.

Fire Behavior

Optimum rate of spread has been observed to be 5-23 chains per hour. Flame length should be 3-8 feet. A 20 foot tree can be burned with 8 feet of flame length. Fire intensity should be 60-400 BTU/ft/minute.

Evaluation

The prescription should include directions to determine if the treatment objectives were met. Careful documentation of all observations of the elements of the prescription is important. Good documentation is the only way one will know what went right or what went wrong with the fire. It also provides a means to improve or reutilize future prescriptions.

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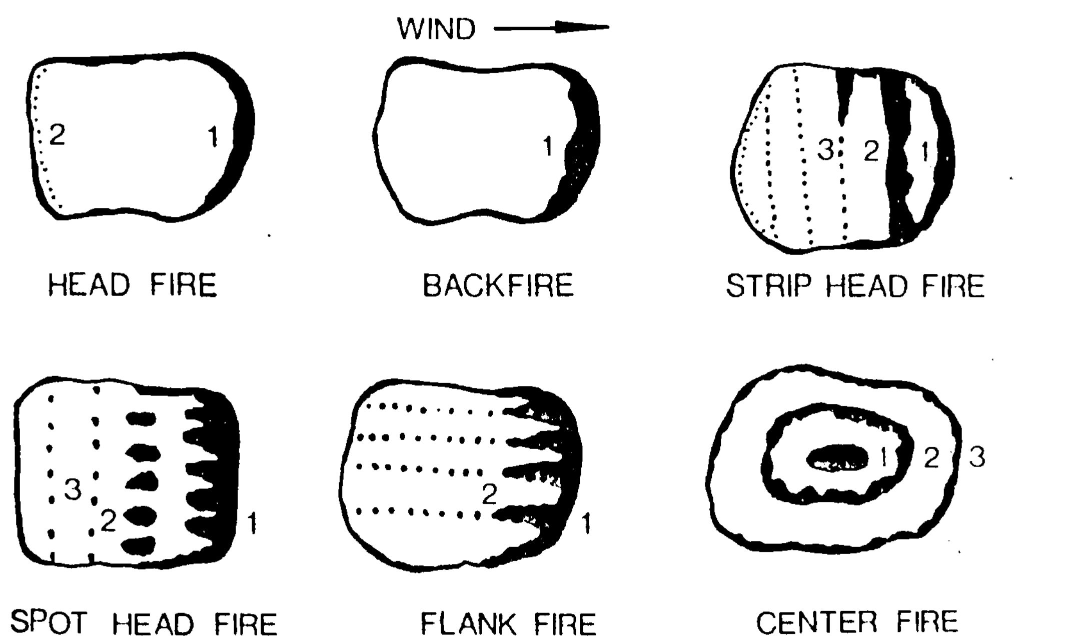
From <u>Planning for prescribed Burning in the Inland Northwest</u>. (Martin and Dell 1978)

Firing techniques for prescribed burning

Technique	Where used	How done	Advantages	Disadvantages
Head fire	Large areas, brush fields, clearcuts, under stands with light fuels	(1) Backfire downwind line until safe line created (2) Light head fire	Rapid, inexpensive, good smoke dispersal	High intensity, high spotting potential
Backfire	Under tree canopy, in heavy fuels near firelines	(1) Backfire from downwind line; may build additional lines and backfire from each line	Slow, low intensity, low scorch, low spotting potential	Expensive, smoke stays near ground, the long time required may allow wind shift
Strip head fire	Large areas, brush fields, clearcuts, partial cuts with light slash under tree canopies	(1) Backfire from downwind line until safe line created (2) Start head fire at given distance upwind (3) Continue with successive strips of width to give desired flames	Relatively rapid, intensity adjusted by strip widths, flexible, moderate cost	Need access within area; under stands having 3 or more strips burning at one time may cause high intensity fire interaction
Spot head fire	Large areas, brush fields, clearcuts, partial cuts with light slash, under tree canopies; fixed-wing aircraft or helicopter may be used	(1) Backfire from downwind line until safe line is created (2) Start spots at given distances upwind (3) Adjust spot to give desired flames	Relatively rapid, intensity adjusted by spot spacing, can get variable effects from head and flank fires, moderate cost	Need access within area if not done aerially
Flank fire	Clearcuts, brush fields, light fuels under canopy	(1) Backfire downwind line until safe line created (2) Several burners progress into wind and adjust their speed to give desired flame	Flame size between that of backfire and head fire, moderate cost, can modify from near backfire to flank fire	Susceptible to wind veering; need good coordination among crew
Center or ring fire	Clearcuts, brush fields	(1) For center firing, center is lighted first (2) Ring is then lighted to draw to center; often done electrically or aerially	Very rapid, best smoke dispersal, very high intensity, fire drawn to center away from surrounding vegetation and fuels	May develop dangerous convection currents; may develop long distance spotting; may require large crew



From Planning for Prescribed Burning in the Inland Northwest (Martin and Dell 1978)

Ignition methods for prescribed burning[1/]

Method	Where used	How used	Advantages	Disadvantages
Flamethrower	Slash or brush; broadcast or jackpot burning	Burner walks firelines or skid trails and ignites fuel combinations	Fastest hand-carried igniter; burner can reach several feet with flame to avoid walking in slash brush	Somewhat more expensive and complicated than drip torch, heavier to carry and uses more fuel than drip torch does
Drip torch Drag torch	Almost any situation	Burner walks firelines, trails or through fuels, dropping burning fuel	Simple, light, inexpensive, reliable equipment	Slower than flame thrower; burner must often move through heavy fuel
Helitorch	Clearcut slash; could be used in brush or other low vegetation	Helicopter carries large drip torch in sling; drips burning fuel	Very fast ignition; not committed to predetermined firing plan	Helicopter expensive; safety not yet determined
Electrical ignition (primacord/ jellied gasoline)	Clearcuts in west coast States; heavy slash and smoke dispersion considerations	(1) Primacord is wrapped around metal or plastic containers of jellied gasoline (2) Electrically detonated in desired pattern	Extremely rapid ignition and convective buildup; excellent for smoke dispersal	Expensive to wire; once wired must burn
Fusees	Anywhere; best used as an auxiliary to other methods when needed	Burner walks fireline or trails or through fuels; must hold flame to fuel for short period to insure ignition	Inexpensive, light; can be carried in vest or pocket to use as auxiliary method	Very slow; must pause to hold flame to fuel; expensive in labor time to start fire
6-inch igniter cord-safety fuse (DAID'S)	Large or remote areas, from aircraft; Australia, Everglades	(1) Ignited by cigarette lighter (2) Dropped from plane or helicopter to start spot fires (3) Flames 15-20 seconds after ignition	Can ignite remote areas; intermediate expense; can cover large area	Dangerous if mishandled or in crash
Potassium permanganate/ ethylene glycol capsules	Large or remote areas, from aircraft; Australia	(1) Chemicals mixed by liquid injection (2) Dropped from plane or helicopter to start spot fires (3) Ignites 30-60 seconds after mixing	Capsule and contents inexpensive; can easily cover large areas	Best only for large remote areas

[1/] Martin (1977).

APPENDIX A

EFFECTS OF FIRE ON SOME PACIFIC NORTHWEST VEGETATIVE TYPES

GRASS AND GRASSLIKE SPECIES

Species	Prefire regeneration mode	Mode, Post-fire regeneration response 1/	Degree of fire resistance 2/	Comment	References
Bluebunch Wheatgrass	warm season bunchgrass. Seed dependent	seed germination or weakly rhizomatous, moderate to rapid	moderate	Response variable with season of burn, intensity and past graze mgt.	Willms et al. 1980b; Uresk et al. 1976 Wright et al. 1979
Bottlebrush Squirreltail	cool season bunchgrass. Wind dispersed seed	seed germination, residual plant survival, rapid	resistant	More resistant to mid-summer than spring burning.	Wright 1971
Cheatgrass	annual, heavy seed, prolific seeder	seed germination, very rapid	very resistant	Very hot burn with litter consumption reduces post burn density.	Daubenmire 1968 Young et al. 1976
Crested wheatgrass	warm season bunch grass, seed dependent	moderate to slow	susceptible to moderate	Response variable with season of burn intensity & past graze mgt.	Anderson & Bailey 1979 Wright et al. 1979
Idaho fescue	cool season bunchgrass, heavy seed	seed germination, residual plant survival, moderate to slow	susceptible to moderate	Resistance variable due to season of burn, plant moisture and fire intensity.	Conrad & Poulton 1966 Wright et al. 1979
Kentucky bluegrass	cool season, rhizomatous	rhizome elongation, rapid	resistant	Most damage from hot, spring burning.	Daubenmire 1968
Mat Muhly	warm season, seed rhizome	moderate	resistant		Anderson & Bailey 1980
Needle and Thread	warm season bunchgrass, heavy seed	moderate to rapid	susceptible	Autumn burns least detrimental, prevent high fuel loads prior to burn.	Wright 1971
Pinegrass	rhizome, seed	very rapid	resistant to moderate	Palatability improved by burning.	McLean 1969 Tiedemann & Klock 1976
Prairie junegrass	cool season bunchgrass, heavy seed	residual plant survival, rapid to moderate	susceptible to moderate		Wright et al. 1979
Sandberg bluegrass	cool season bunchgrass, heavy seed	residual plant survival, rapid	moderate to resistant		Wright et al. 1979
Slender wheatgrass	warm season bunchgrass, heavy seed	slow	very susceptible	Most susceptible to early spring & late August burn.	Bartos 1979
Thurber needlegrass	warm season bunchgrass, heavy seed	slow	susceptible	Autumn burns least detrimental, prevent high fuel loads prior to burn.	Uresk et al. 1976
Timber oatgrass	warm season, seed	moderate	moderate	Increased from mid-summer burning.	Minore et al. 1979
Elk sedge	rhizomes, heavy seed	rhizome extension, very rapid	resistant	Developed under light underburning.	Hall 1976
Long-stolon sedge	deep rhizomes, heavy seed	rhizome extension, very rapid	resistant	Very resistant to hot, mid-summer burns - excellent competitor.	Volland 1976
Ross sedge	shallow rhizomes, heavy seed	rhizome extension, rapid to moderate	resistant	Not as aggressive as elk sedge or long-stolon sedge.	Tiedemann & Klock 1976

1/ Post-fire Regeneration Response (Based on number of years to approximate preburn frequency or coverage):

Slow	>10 years	Rapid	2-5 years
Moderate	5-10 years	Very rapid	1-2 years

2/ Degree of Fire Resistance (Probability that at least 50 percent of species population will survive or reestablish after passage of a fire):

Resistant	>65 percent chance	Susceptible	10-34 percent chance
Moderate	35-64 percent chance	Very susceptible	<10 percent chance

APPENDIX A (continued)

HERBS

Herbs Species	Prefire regeneration mode	Mode, Post-fire regeneration response 1/	Degree of fire resistance 2/	Comment	References
Balsam root	windborne seed, thick caudex	caudex regrowth, rapid	resistant		Wright et al. 1979
Beargrass	corm	corm budding, moderate	moderate	Resistant to light burns.	Stickney 1980
Bedstraw	sticky seed, animal dispersed	seed germination, moderate	moderate	Resistant to light underburns.	Anderson & Bailey 1980 Anderson & Bailey 1979
Bracken fern	deep rhizomes	rhizome expansion, very rapid	very resistant	Not reported to be affected by burning.	Lyon & Stickney 1976 Tiedemann & Klock 1974
Broadleaf arnica	shallow rhizomes, windborne seed	rhizome expandion, rapid	resistant		Lyon & Stickney 1976
Buckwheat	winged, light seed	seed germination, slow	very susceptible		Wright et al. 1979
Death camas	deep underground corm	corm regrowth, rapid	resistant		Wright et al. 1979
Fireweed	wind dispersed seed, moderate deep rhizome	rhizome and seed, very rapid	resistant		Tiedemann & Klock 1976 Lyon & Stickney 1976 Bartos 1979
Heartleaf arnica	wind dispersed seed shallow rhizomes	rhizome elongation, rapid to moderate	moderate to susceptible	Resistant to spring and light underburns.	Hall 1976 McLean 1969
Indian paintbrush	deep taproot	caudex regrowth, moderate	moderate		McLean 1969
Lambstongue	windborne seed	seed germination, rapid to moderate	resistant		Wright et al. 1979
Lupine	heavy seed, deep taproot	candex regrowth, heat scarified seed, rapid	resistant		Lyon & Stickney 1976 McLean 1969
Pearly everlasting	seed dependent, airborne	seed germination, moderate	resistant		Minore et al. 1979
Sheep sorrel	seed dependent, airborne	seed germination, moderate	resistant		Minore et al. 1979
Sidebells pyrola	heavy seed, shallow roots	seed germination, slow	susceptible		McLean 1969
Strawberry	shallow roots, stolons	stolon budding, rapid to moderate	moderate to susceptible	Resistant to light burns.	Hall 1976 McLean 1969
Twinflower	shallow roots, stolons	stolon budding, moderate	susceptible		McLean 1969
Western yarrow	seed dependent, airborne	seed germination, moderate	resistant to moderate		Wright et al. 1979 Anderson & Bailey 1980

APPENDIX A (continued)

SHRUB SPECIES

Species	Prefire regeneration mode	Mode, Post-fire regeneration response 1/	Degree of fire resistance 2/	Comment	References
Antelope bitterbrush	heavy seed, animal dispersed	Basal stem sprouts, seed germination, rapid to slow	Very susceptible to moderate	Variable results with post-burn sproating based on season of burn, plant vigor and soil moisture situation.	Wright 1972 Blaisdell & Mueggler 1956
Bearberry	fleshy seeds shallow roots	stem budding moderate	moderate to susceptible	Most resistant to light burns.	McLean 1969 Stark-Steele 1977
Big huckleberry	Rhizomes, seed	vigorous sprouter, rapid to moderate	resistant	Difficult to underburn without pre-treatment	Minore et al. 1979 1976
Big sagebrush	Windborne seed	seed germination, slow	very susceptible	Burning commonly used to control species	Wright et al. 1979
Bitter & Chokecherry	heavy seed, animal dispersed	stem budding, rapid to moderate	resistant	Establishes on hot, midsummer burns	Anderson & Bailey 1980
Common snowberrry	Rhizomes, seed	Vigorous sprouter, rapid to	resistant		McLean 1969
Curleaf mountain mahogany	heavy, wind dispersed seed	seed germination, slow	very susceptible	Underburn when shrub moisture high but understory grasses cured.	Wright et al. 1979
Currant	heavy fleshy seed, animal dispersed	seed scarified, basal stem sprout, rapid	moderate	Common pioneer on hot burns xeric sites	Wright 1972
Deerbrush	heavy seed	seed heat scarified, stem sprouts, rapid	resistant		Kilmore 1973
Elderberry	heavy fleshy fruit animal dispersed	basal stem sprouts, moderate	moderate		Wright 1972
Golden chinkapin	Sticky, heavy seed animal dispersed	stem sprouts, rapid	resistant	Aggressive increaser after burning	Volland 1976
Greenleaf manzanita	Fleshy heavy seed animal dispersed	Heat scarified seed, moderate	resistant	Occupies site within 10 years of burn.	Volland 1976 Wright 1978
Green and Gray Rabbitbrush	airborne seed	Stem sprouting, rapid	moderate to resistant	Complete mortality by burnin rarely documented	Wright 1972
Grouse huckleberry	fleshy seeds, shallow roots and stolons	stem budding, moderate	moderate		McLean 1969
Horsebrush	windborne seed	Basal stem sprouts, rapid	resistant		Wright 1972
Mallow ninebark		Basal stem sprouts, moderate	moderate		Wright 1972
Ocean spray	windborne seed	Basal stem sprouts, moderate	moderate		Wright 1972

APPENDIX A (continued)

SHRUB SPECIES

Species	Prefire regeneration mode	Mode, Post-fire regeneration response 1/	Degree of fire resistance 2/	Comment	References
Oregon boxwood	deep taproot	stem bud, moderate	susceptible to moderate		Wright 1971 McLean 1969
Oregon grape	Shallow rhizomes	Rhizome buds, moderate	moderate to very susceptible	Damage from burning varies considerably with reported study.	Wright 1972 McLean 1969
Princespine	heavy seed, moderate deep root and rhizomes	rhizome buds, slow	susceptible	Intensity of burn appears unimportant.	Stark-Steele 1977 McLean 1969
Rabbitbrush goldenweed	light, airborne seed	stem sprouts rapid	resistant	Common pioneer in conflagration burns.	Volland 1976
Redstem ceanothus	heavy seed	Basal stem sprouts, heat scarified seed, rapid	resistant	Establishes on hot, mid-summer burns.	Wright 1972
Rose	heavy fleshy fruit, animal dispersed	basal stem sprouts, moderate	moderate		Wright 1972
Salmonberry	fleshly seed animal dispersed	rhizome buds, rapid	resistant		
Scouler willow	airborne seed	stem sprouting, rapid	resistant		Lyon & Stickney 1976
Serviceberry	heavy, fleshy seed animal dispersed	basal stem sprouting, moderate	moderate	Damage from burning varies with intensity and season of burn	Wright 1972 Lyon & Stickney 1976
Snowbrush	heavy seed	stem buds, heat scarified seed, rapid	very resistant	Common pioneer in conflagration burns. Occupies within 5 years.	Tiedemann & Klock 1976
Spirea	light weight seed	rhizome and basal stem sproats, moderate	moderate		Lyon & Stickney 1976 Wright 1972 Tiedemann & Klock 1976 Wright 1978
Vine maple	heavy, winged seed	stem buds, rapid	moderate		Lyon & Stickney 1976
Western thimble-berry	rhizomes, fleshy seeds	rhizomes, rapid	resistant		

APPENDIX A (continued)

TREES

Species	General Response to Fire	Comments	References
Douglas-fir	Old trees fairly resistant to fire	Young trees susceptible to through scorching of crown or girdling of tree; fire can be used to control species	Franklin et al 1981;
Engelmann spruce	Susceptible to all but light fires	Fire can be used in control-species	
Incense-cedar	Old trees resistant to fire	Young trees readily killed & species controlled by fire	
Lodgepole pine	Killed or injured by all but light surface fires	Seeds prolifically after fire, even where not serotinous	Perry and Lotan 1979; Cochran 1973; Lotan 1976
Ponderosa pine	Probably most resistant to fire of any western tree	Often killed by crown damage from intense fires	Weaver 1968; Hall 1977; Wright 1978; Soerlaatmadja 1966
Quaking aspen	Top readily killed by all but light surface fire	The species root-suckers profusely after fire	Bartos 1979; Bailey and Anderson 1980
Sugar pine	Old trees resistant to fire	Young trees susceptible to fire.	Kilgore 1973
True firs	Killed or injured by all but light fires	Species generally reduced by fire	Kilgore 1973; West 1969
Western hemlock	Old trees somewhat resistant to fire where extensive root damage not caused by complete duff consumption	Species generally reduced by fire	Franklin et al 1981
Western juniper	Old trees somewhat resistant to all but intense fire	Fire can be used to control increase in juniper	Wright et al 1979;
Western larch	Some consider it the most resistant Northwest tree; seedlings more susceptible than ponderosa pine seedlings	Able to refoliate after scorching of crown	Debyle 1976; Stark 1977 Stickney 1980
Western white pine	Killed or injured by all but light fires	Species generally reduced by fire	Kayll 1968

OREGON REGULATIONS GOVERNING OPERATIONS/SLASH BURNING IN WESTERN JUNIPER STANDS

John Jackson

In Oregon, wildland areas are identified as either "classified" (eg. commercial pine or fir timberlands) or "unclassified" (eg. grasslands, pure juniper areas, desert, etc.). Western juniper is considered as a non-commercial species. In Oregon, classified forest lands come under the jurisdiction of the State Department of Forestry and are included in a fire protection district. Depending upon the conditions under which juniper occurs, it may be in a classified forest land status and subject to Oregon burning regulations.

Juniper could be considered in three separate situations. In any of the cases, it is probably desirable to contact the local Department of Forestry office to determine which of the three apply.

1. Operations on Class II and III ("classified") Timberlands:

   Contact local Oregon State Forestry Department office to determine if subject area is "classified forest-land." Mixed juniper-pine stands or juniper stands adjacent to pine stands are probably classified; others may not be.

   a. If subject land is classified, the Oregon Forest Practice Act will apply to any activity having to do with the growing, culture or harvest of a forest species (eg. pine, fir, etc.). Ask for the Forest Practices Forester and file a "Notification of Operations."

   b. If subject land is paying "Forest Patrol Assessment" any operation must comply with ORS 477, "Protection of Forests and Vegetation from Fire." This includes filing for a "Permit to Operate Power Driven Machinery."

   c. The "Notification of Operation" and "Power Driven Machinery Permit" are obtained from the Forestry Department by filling out one form.

   On operation on "unclassified" lands or lands not protected by the Forestry Department, neither of the above apply.

2. Burning of Juniper Lands Within a District Protection Boundry:

   a. Burning may require a Slash Burning Plan and/or Burning Permit. Check with the local Forestry Department Office.

b. The local Service Forester may be able to provide technical assistance, advice and some supervision of a burning project on private lands (Forest Class II and III).

3. Burning of Juniper Lands Outside of an Official Protection District:

   a. A phone call to the closest wildland fire agency (State Forestry, BLM, USFS, etc.) is appropriate prior to burning. In many counties, the county court/commission or county fire chief may be charged with issuing burning permits on unprotected areas.

   b. Service Forester is not authorized to assist in burning outside the protection boundary.

In some cases, memos of understanding between agencies of government exist whereby they notify each other when fires are to be conducted. Regarding burning on private land, it is only good sense to notify neighboring land owners before a fire. It is highly desirable for them to participate. Even when good planning has occurred, fires do get out of control and burn into nearby ownerships. With those owners' participation, likelihood of litigation is less.

PLANT SUCCESSION FOLLOWING WESTERN JUNIPER CONTROL WITH PICLORAM

Ray Evans

This 7-year study was conducted in the same area in northern California as that reported earlier in the proceedings by Jim Young. The specific study site was 65 acres of 70 trees per acre averaging 28 feet in height and 1-1½ feet in diameter. The site itself was 4,500 feet elevation. Soils were clay loam 10-32" deep and average precipitation was 17" during this 1975-82 study period (range of 7-28"). Canopy averaged 40%.

In two separate years, picloram at 14 grams of 10 K (10% a.i.) material per meter of tree height was applied under each tree in 4 randomly located 1/4 acre plots with matching untreated plots. Very few perennial herbaceous species were present. Annual forbs were the primary vegetation component. Over the 1975-82 period, vegetation, soil moisture, litter accumulation, and nitrogen content of the soil was monitored at three positions in relation to the dead standing trees - base, mid-canopy, canopy edge, and interspaces. Total cost of the picloram and application was $21 per acre.

Although considerable yearly yield variation occurred, the overall biomass pattern in Figure 1 could be discerned. In terms of botanical composition, cheatgrass became dominant within the area covered by the dead canopy. In the interspaces, medusahead increased to 50% frequency by 1982; whereas, it was not present in 1975. Annual forbs declined. Cheatgrass between the trees initially increased after treatment but declined from 61% to 30% frequency during the 7 years.

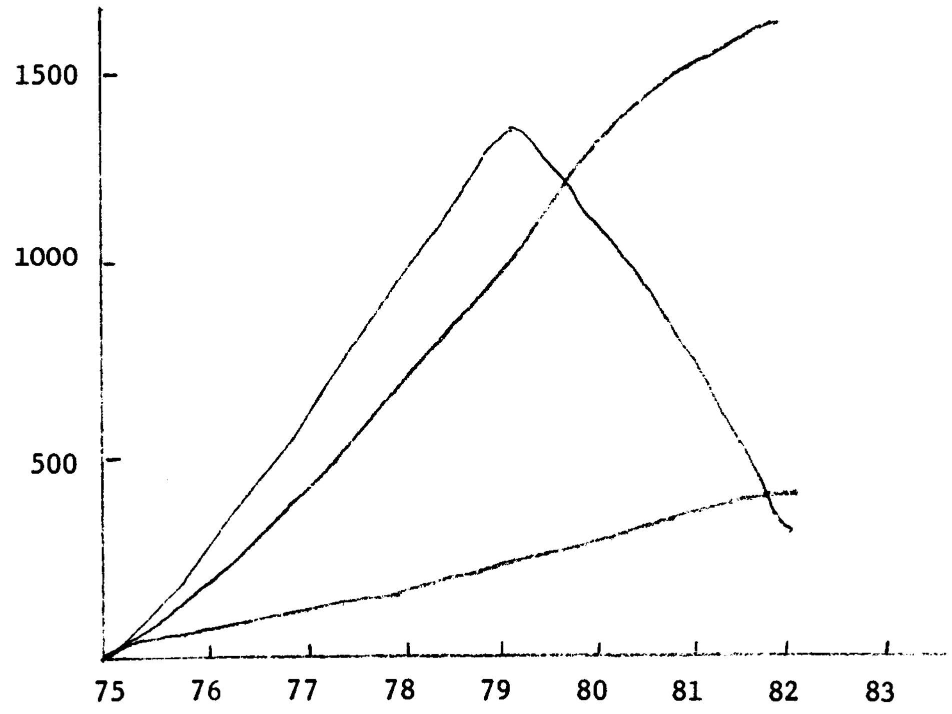


Figure 1. Trends in herbaceous biomass following juniper control with picloram.

Live western juniper had a large effect on available soil moisture. With the trees killed, moisture through the 24" depth remained available for herbaceous and shrub growth through the spring-summer period. Under live trees, moisture became limiting during the May to August period.

Examining the N status of the soil showed a fairly direct correlation of herbage yields over the 7-year period (Table 1).

Table 1. Nitrogen status in soil following juniper kill with picloram.

	Tree Base	Mid-Canopy	Canopy Edge
	-------------	N (ppm)	------------------------
1976	2.0	0.3	0.1
1977	1.7	.2	.6
1978	1.3	.3	1.0
1979	1.0	.3	1.6
1980	1.2	.6	2.9
1981	2.6	1.0	0.4
1982	5.0	2.7	0.2
1983	5.1	2.7	0.2

Treating stands of young junipers with picloram is a recommended practice; however, after western junipers mature, herbicide application must be followed with limbing or other mechanical treatment in order to seed desirable forage and browse species. This research may not be directly applicable to other treatments, but in general, does point out that after control of western junipers, understory vegetation responds dramatically. The closest activity to the use of picloram may be chainsawing without fire because neither physically disturbs the site. Burning no doubt would result in different soil nitrogen status because the litter mat would burn. Whether position on site for potential productivity would change (distance from tree center) is not known, but general trends could well be similar. The largest factor affecting the kind of vegetation following juniper control definitely is the species on site at the beginning. However, the soil moisture and nutrient release phenomena will definitely affect the amount and kind of vegetation to be produced.

Picloram is a restricted-use herbicide, not because of high mammalian toxicity, but because of its extreme phytotoxicity. Registration labels for picloram vary with state. See specific state label before using.

FOLLOW UP - WESTERN JUNIPER MANAGEMENT

Thomas R. Bunch

There are many management alternatives following juniper control and/or removal. The one alternative that we very seldom should select is "Continued Management as in the Past".

This could be the best alternative if our juniper program was a "prevention" or "maintainance" program related to future competition of juniper.

An example could be where we had a desirable stand of perennial plants with juniper re-invasion and we used a program to prevent future competition with such programs as fire, chemicals, hand removal, etc. We will discuss these practices in more detail later as they are associated with other alternatives.

Before going any further, let me review briefly the recent 20+ years' history related to juniper control east of the Cascades in Oregon and predominantly the central part of the state where thousands and thousands of acres have been treated by one or more methods.

The older programs were predominantly a mechanical process - chaining, dozing, chainsaw, etc. Many areas treated were mis-evaluated as it relates to the stand of remaining desirable perennial grass species.

A good example is with Sandbergs bluegrass. This plant seldom, if ever, will provide sufficient forage and watershed protection to warrant a juniper control program. Broadcast seeding in this situation, on other than the highly disturbed areas, was a complete failure and waste of dollars, time and effort. Using a rangeland drill in this situation was no more successful than broadcasting, other than on the disturbed areas. Drilling on disturbed areas was better than broadcasting. Many thousands of these acres could have been mechanically treated to provide a seedbed for desirable species. Yes, it would cost a few dollars more, but we then would have had the opportunity to recover our original costs and we wouldn't be wondering how we were going to treat the area again in 10, 20 or 30 years. We have actually arrived at this point in time on many areas.

The other side of the coin is where desirable perennial species were present and mis-identified or not even observed due to utilization and a seeding program was introduced, where management was all that was needed - not additional capital investment.

These last few comments can be summed up in a little different way. Determining where do we start with a juniper program is one of the most important decisions, if not the most important. Where will we get a positive response - either through forage release and/or seeding? If we were concerned with livestock forage, will the site selection move us from 20 ac/aum to 2 ac/aum or some other desired goal? Will we be able to pay the bill?

Again, it will only be a unique situation where management can stay status quo, following an original juniper control program, if we are to recover our costs. I define "our" costs to include both the private and public contributions. The ASCS program has been a large contribution on private lands.

But, we can apply management to obtain successful results both in the short and long run situations. Let us set the stage to consider additional alternatives toward desirable productivity whether it be domestic or wildlife feed, watershed, etc. We have an original, successful juniper control program with a desirable understory of perennial plants. Seeding is not needed. We know 100% of all juniper trees, seed and seed sources will not have been eliminated.

What can we expect in this situation?

1. The small seedlings missed in the original control program will grow.
2. Conditions usually are such that some seed on site will germinate and seedlings become established.
3. New seed will reach the site through water and bird distribution. When evaluating some areas one wonders if juniper seed may have both wings and legs to move with.

Let us examine 3 management alternatives under this situation: early grazing, non-use and fall grazing.

1. Graze early in the spring and move. This will do three or four things for us on site.
   a. Obtain utilization of annuals and less desirable perennial species such as cheatgrass, Sandbergs bluegrass and squirreltail.
   b. We set back growth in time of plants like bluebunch wheatgrass and Idaho fescue. This allows us many times to get by the late May and early June frosts and therefore, obtain production of viable seed.
   c. The early use tends to lengthen our moisture supply available for desirable deep rooted plants, as there is less plant material utilizing the moisture. One could look at this similar to weed control in dryland wheat.
   d. It allows use of all acres to help offset all costs of operation from treatment to the paying of taxes.
   e. This program provides a situation whereby the desirable plants complete their growth life cycle, accumulating root reserves, and producing viable seed.
2. Non-use the first year produces the following results
   a. Increases the vigor of the less desirable plants.
   b. Increases seed production of most annuals.
   c. Uses up available moisture for plant growth earlier in the year.
   d. Reduces the chance for viable seed production of our desirable species.
   e. Does not derive any income to help pay bills.

3. Fall grazing results are:

   a. Obtaining all the same results as non-use "except".

   b. We do derive some income to pay bills.

   c. We may tramp in desirable seed if produced. But, we are assisting the establishment of non-desirable plants at the same time and creating more competition.

   d. Fall grazing, after green up, sets back the spring growth of our desirable plants.

I must add if early spring grazing to you is turn out March 20 and do nothing until June 20, then spring grazing is, by design, a failure. Ask yourself, is this management or designed mis-management?

I suggest that juniper control programs be re-evaluated at no more than 10 year intervals to determine follow-up treatment.

1. We accepted in the start of this discussion that we would have missed some seedlings with the original treatment and additional seedlings would become established.

2. We need to control seedlings before they become a real competitor with our desired forage resource.

3. We have about three choices:

   a. Fire - small trees are easily burned.

   b. Mechanical - grub hoe - axe - labor intense, etc.

   c. Chemical - hopefully, chemical will become a viable, cost effective alternative in the future.

I cannot overemphasize the re-evaluation aspect following the original treatment. This also means we must "see" and "understand" what we are looking at. In the past many of us have been more adept at "seeing" Indian artifacts, old bottles, etc. than "seeing" the beginning of a real big problem.

Consequently, we became problem solvers not preventors.

I also suggest that we have considerably more tools through knowledge today and can expect more in the future. Therefore, we can prevent making the same mistake we made in the past years.

Time has not permitted me to examine seeding following a juniper treatment. The same management principles apply-related to competition, growth, harvest, and overall management.

Site selection for treatment and understanding what is and will be needed to have a successful and profitable program cannot be overemphasized. Juniper control only, where seeding is needed and the extra effort and dollars are not put forth to seed, is a job half done and will need to be started all over again in the future.

In Summary

1. Evaluate and identify the needs associated with site selection for a juniper control program.
2. Select a management alternative that will produce results in both the short and long run.
3. Continue re-evaluation -- move into a prevention program of management.

One Last Comment

When you are involved in a physical change, juniper control, sagebrush control, seeding, etc., it provides the basis for more intensive management than occurred in the past. Let's take advantage of this opportunity.

If we do, it means or causes a change in management on the surrounding units. I suggest that the greatest amount of accomplishment over time will be on the associated acres and not just the physical treated site.

Use physical treated sites as the catalyst to obtain improvement over a much greater area through management

The cow is probably the best and most economical management tool we have available today on a wide scale basis. We obtain drastic, immediate changes that are easily observed, with bulldozers, chemicals, fire, etc. But, unless we manipulate the cow to manipulate the vegetation after a drastic change, we will revert back to the old status-quo syndrome.

With the new knowledge and a better, true understanding of the old, I suggest we will see more progress in juniper-sagebrush management in the next 5 years than in the past 25 years.