Western Juniper (*Juniperus occidentalis*)

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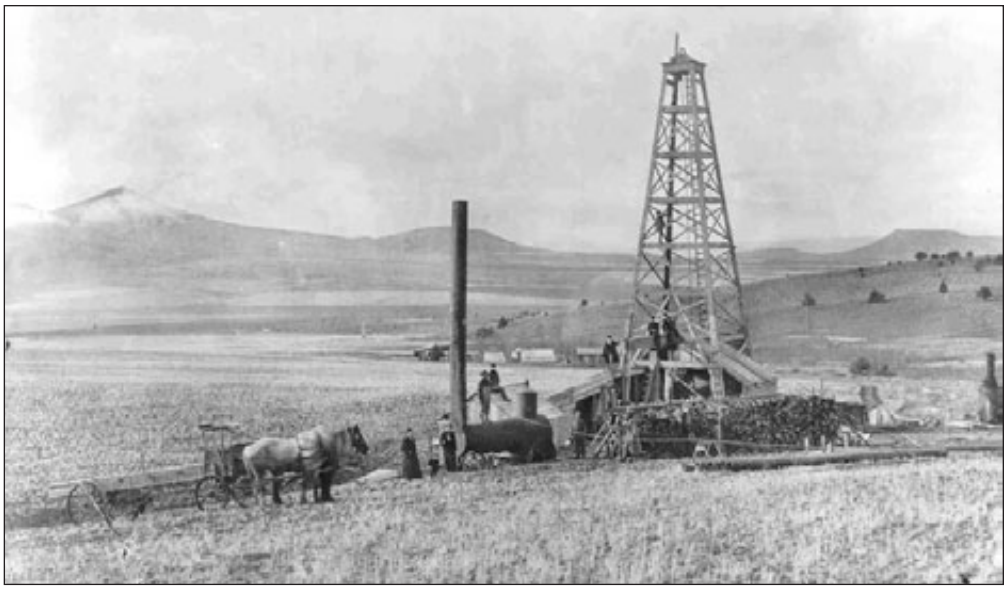
"Maligned by many and admired by few" is how Stu Garrett (1995) described western juniper in the Plant of the Year article in the fifth issue of *Kalmiopsis*. This is such a common, well-known species, so why are we revisiting it as plant of the year? A single page doesn't begin to do justice to this remarkable tree of Oregon's "High Desert." There's more to this native plant than first meets the eye and, as with most things, greater knowledge brings greater appreciation.

Western juniper is nearly omnipresent on the dry side of Oregon. Almost every hill and every valley, if not dominated by it, has at least has one or two hiding in the shadows. It is so ubiquitous that its presence is often lost in the background. Even while sitting in the shade of a western juniper, botanists have been known to omit it from their plant list for the site.

It's a plant with a dual identity. At times it plays the wizened monarch of the rimrock, its girth and gnarly visage testaments to its age. At other times, and in other places, it's the upstart, the bully. It moves onto land it did not previously occupy, ousting the long-standing inhabitants, and wreaking havoc in an otherwise nice neighborhood.

Humans venerate the old beaten up snags and barely living remains, which inspire them to designate wilderness areas (*e.g.,* Oregon Badlands near Bend), create photographic art, and write poetry; in contrast, expanding populations of younger trees are the target of wholesale slaughter. It seems that people either love this juniper or hate it, really hate it.

My hope with this article is to present, in mostly layman's terminology, a clear and concise overview of western juniper for those who may not be familiar with this native tree. The scope is limited to its basic biology, some ecological information, and some of the effects of its changing presence on the natural landscape. Recently, copious research has been published on the subject. For readers who want to learn more about this native conifer, I recommend *Biology, Ecology, and Management of Western Juniper*, a technical reference produced by Oregon State University (Miller *et al.* 2005), which served as a basis for much of what is presented here.



These photos were taken from essentially the same location on the Crooked River National Grassland. Top photo was taken in 1905 and shows a farming operation with the homestead in the lower center of the photo, at the site of a spring. Western juniper exists as scattered trees on the ridge in the near background. Ninety years later, bottom photo shows the same scene in 1995. The ridge is virtually covered with trees, as are the buttes in the far background. Western juniper has even invaded the long-abandoned tilled ground, and the spring is gone. Photos courtesy A. R. Bowman Memorial Museum, Prineville.

Western Juniper or Something Else?

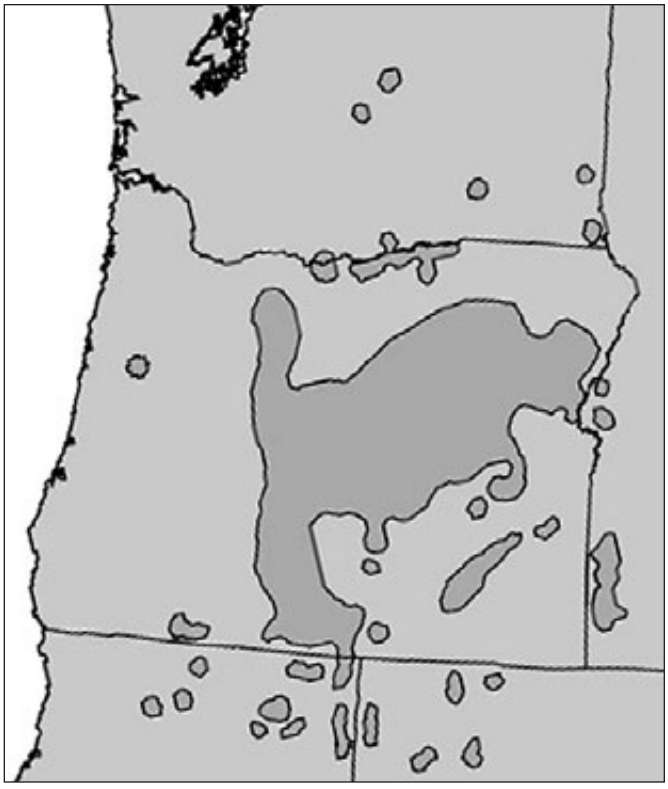
Junipers are members of the cypress family (*Cupressaceae*), a coniferous bunch that includes the majestic redwood (*Sequoia sempervirens*) as well as the cypress species described by Frank Callahan in this issue. In Oregon, we have three native junipers: western juniper (*Juniperus occidentalis*), common juniper (*J. communis*) and Rocky Mountain juniper (*J. scopulorum*) (Oregon Flora Project 2013).

Common juniper is easy to distinguish. It generally grows at higher elevations, seems to be more prevalent in the Cascades and west, and the plant is mostly decumbent, while western juniper is erect, usually with a central stem (trunk). Also, leaves of common juniper are longer (up to ¾ inch) and needle-like, in contrast to western juniper's appressed short leaves (less than ¼ inch) (Hitchcock and Cronquist 1973).

Rocky Mountain juniper more closely resembles western juniper, but its leaves are almost always in pairs. Western juniper's leaves are more commonly whorled, but they are sometimes paired, as well. Also, Rocky Mountain juniper is at the edge of its range in Oregon, and is only found in the extreme northeastern part of the state.

Sierra juniper (*J. grandis*, formerly *J. occidentalis* var. *australis*), which grows in California and Nevada, is dioecious; an individual tree generally bears either all male or all female cones. In contrast, western juniper is monoecious, normally bearing male and female cones on the same tree, although some trees may produce predominantly one or the other (Miller *et al.* 2005).

William Jackson Hooker, Director of the Royal Botanic Gardens in Kew, described western juniper in 1838 from a collection by David Douglas in 1825 from "the higher parts of the Columbia [River], at the base of the Rocky Mountains" (Kew Herbarium Catalog). The largest populations of western juniper are in Oregon, but it also grows in scattered locations in Washington, northeastern California, extreme northwestern Nevada and southeastern Idaho (USGS 2013).



The current range of western juniper (*Juniperus occidentalis* var. *occidentalis*) (USGS 2013).

Its Morphology – What Western Juniper Looks Like

Western juniper is the dominant tree across much of the non-montane landscape of eastern Oregon. Mature trees are typically 13 to 32 feet in height with a single, erect stem up to about two feet in diameter (Miller *et al.* 2005). Anyone from central Oregon can vouch that western juniper comes in almost as many shapes and sizes as there are trees. Trees have been documented to be as tall as 78 feet and to have stems more than six feet in diameter (American Forests Big Tree Register 2013).

The leaves of mature trees are scale-like, and usually no more than a tenth of an inch in length. These scales overlap each other on the stem as opposite pairs or in whorled groups of three, so what the lay person might call a juniper leaf is actually a number of tiny leaves overlapping each other along the entire length of a branchlet. Each leaf also has a resinous ridge, resulting in an overall stickiness. In contrast, leaves of young junipers are long and needle-like. In fact, young

Immature male cones of the western juniper. Within a couple of months these cones will have released their pollen and, by late summer, will have dropped from the tree. Photo taken by author, Feb. 20, 2013, near Prineville.

Female cones of western juniper. Photo taken Feb. 15, 2013, west of Redmond. Photo by author.

trees (under 25 years) appear so unjuniper-like that the novice can easily mistake them for an entirely different plant. I once witnessed a seasoned BLM range conservationist bait a cadre of fresh-faced summer range technicians into identifying a four-inch juniper as a phlox.

Junipers are coniferous, which means "to bear cones." In common vernacular, the female cones are called juniper berries because they look like small gray-blue berries. The male cones begin to develop during the late summer and early fall of one year, and then shed their pollen early the next spring. They appear as small, brown extensions of the green branchlets, and as pollination approaches, predominantly male trees will appear reddish-brown as the cones swell and eventually open. Male cones drop soon after they release their pollen.

The end of pollination is a time of celebration throughout eastern Oregon, because for many Oregonians, juniper pollen is a severe spring allergen (Pollen Library 2013). However, the physical act of a tree releasing its pollen is remarkable. Once, a rancher told me that he saw a juniper tree "shudder," just before it shot off a noxious cloud of yellow pollen into the surrounding air. The shuddering part is questionable, but a slight breeze can certainly trigger the simultaneous release of billions of grains of pollen from open cones.

Galls caused by a wasp are often mistaken for female cones. Photo taken by author, Feb. 15, 2013, west of Redmond.

The female cones begin to develop in the spring, and by summer they've reached their mature size, although it will be another year or more before they drop. The mature cone consists of a glaucous (covered by a waxy coating), deep blue, berry-like structure that contains two or three seeds enclosed in a resinous pulp.

Many trees have growths that appear to be cones, but are actually insect galls formed by larval infestation of a branchlet. Midge larvae (*Walshonmyia* spp.) and moth larvae (*Heinrichiesa sanpetella*) have both been documented from these galls (Purrington and Purrington 1995). A colleague once came to me during a field trip, embarrassed and red-faced, admitting that for years she had told people these galls were the female cones of western juniper.

The bark of an older western juniper is usually furrowed. Photo taken by author, Feb. 15, 2013, west of Redmond.

The Geezer Factor –How to Know an Old Tree When You See It

Like people, the appearance of western juniper trees changes with age, and with the oldest one documented at 1,600 years old, there can be a lot of change. However, you can't simply judge the age of a tree by its size; genetic and environmental factors greatly influence how fast and how large a tree grows. A tree 30 feet tall with a DBH (diameter breast height, 4.5 feet from the ground)

of 24 inches, for example, might be 200 years younger (or more) than that stunted, scraggly tree on an exposed, windswept basalt ridge nearby. Other characteristics can help identify a tree as a geezer (Miller *et al*. 2005), although counting tree rings is the only accurate method.

Most obvious is its overall shape. Young trees are more likely to have a cone-shaped top, reflecting their fast-growing nature. Tree tops become more rounded at about 150 years of age, and at this age the terminal growth of the leaders on the branches in the upper area becomes limited. Older trees also have trunks and large branches that are twisted and often dead. Even the tops can die, producing what is known as a "spike" top. Sometimes a live branch is connected to the rest of the tree only by a narrow strip of living tissue (cambium), with the rest of the branch dead.

The tree's trunk also provides clues for aging. Bark on an older tree is usually furrowed or in strips, and not scaly like that on a younger tree. The bark of the oldest trees often turns from gray to red. Also, because heart rot is so common in older trees, the trunks are often hollow. Old-growth juniper usually makes for poor firewood, but good habitat for small mammals and birds.

Just like the old guys at the coffee shop, old trees have their friends. The dead and dying branches play host to the colorful chartreuse lichen (*Letharia vulpina*), often collected for its decorative value, and the thick duff (shed leaves and other organic matter that holds moisture) below these ancient trees gives rise to extensive communities of moss (*Tortula ruralis*).

It is a treat to come across one of these ancients in its natural habitat, be it on a windswept basalt rimrock high above the valley below, or as part of an old-growth juniper savannah on sandy, ash-derived soils in central Oregon. The proverbial "if only they could talk" certainly applies, and one can only imagine the stories these trees could tell.

Surviving in a Harsh Environment: An Accomplished Competitor

Perhaps most fascinating are the various ways western juniper is able to achieve a competitive edge. One adaptation is the change in the ratio of male to female cones depending on environmental factors. Although each tree has separate male and female cones, it's common for trees to be predominantly male or female; anecdotal evidence suggests that the sex ratio changes according to availability of moisture. Reportedly, female cones proliferate during wet years and male cones during drought. In support of this observation, a study of monoecious plants by Freeman and others (1981) showed a tendency for male cones to be more prevalent on xeric sites and for female cones to be more abundant on mesic sites.

Another trait that confers a competitive advantage to western juniper lies in how its seeds are disseminated. Beyond the usual methods of gravity, wind, and water, juniper "berries" are favored by a number of birds (*e.g.*, American Robin (*Turdus migratorius*), Cedar Waxwing (*Bombycilla cedrorum),* Pinyon Jay (*Gymnorhinus cyanocephalus*) and Townsend's Solitaire (*Myadestes townsendi*)), especially in the winter. After feeding, the birds find a suitable perch to process their meal, where the seeds pass through the gut and are eliminated. Later they germinate where dropped, as evidenced by lines of young junipers along fences. Birds often perch on shrubs, especially sagebrush (*Artemisia* spp.), where there is a further advantage to juniper in that the seed finds itself in a

A typical ancient western juniper, showing the rounded, partially dead crown, dead and broken branches, and an abundance of the lichen *Letharia vulpina*. Photo taken by author, Feb. 15, 2013, west of Redmond.

protective microclimate that moderates temperature and moisture extremes typical of arid central and eastern Oregon. In fact, western juniper seedling establishment has been documented to be the most successful when it occurs within the confines of a sagebrush canopy (Soulé *et al.* 2004). Various mammals also eat juniper "berries," including coyote (*Canis latrans*), kit fox (*Vulpes macrotis*), and mule deer (*Odocoileus hemionus*) as evidenced by juniper seeds in the scat; that cattle sometimes browse both foliage and fruit can also be seen in their droppings (Frank Callahan, pers. comm.).

Juniper seeds have the capacity to remain dormant until environmental conditions are suitable for germination. Dormancy can be broken by exposure of the seed to suitable cool-moist conditions (stratification). Moreover, genetic variability in the capacity for dormancy among seeds allows a single seed crop to germinate successively over a period of several years (Miller *et al*. 2005).

Since dependable moisture in Oregon's arid lands lies far below the soil surface, germinated juniper seedlings immediately begin to grow taproots, which continue to penetrate deeper and deeper over the subsequent decade. Above-ground structures, stems and leaves, are produced during this period as well, but are not the priority. The long, needle-like leaves of juvenile juniper may maximize photosynthesis necessary for root development. However, the stomata on these leaves are less protected than on mature scale-like leaves, which exposes the young plant to desiccation during hot, dry seasons. Thus, in addition to providing a protected environment for seed germination, sagebrush shelter increases juvenile survival by lowering temperature and increasing humidity.

Home is Where the Root Is – Almost Anywhere

Using a 1988 survey of the extent of western juniper in eastern Oregon, Gedney and others (1999) looked at occupied habitats and concluded that ideal conditions for western juniper are sites with annual precipitation of 10 to 15 inches, an elevation ranging from 4,000 to 5,000 feet, arid-xeric or xeric-arid soils, and landform positions of terraces and flood plains, or plateaus and uplands. Those are apparently optimal conditions, but under current land management practices, western juniper is a master in establishing itself under a wide variety of environmental conditions.

The colorful chartreuse lichen, *Letharia vulpina*, commonly grows on dead branches of older western juniper trees. Photo taken by author, Feb. 15, 2013, west of Redmond.

This branch is predominantly male, as evidenced by the proliferation of male cones, but a few female cones are also present, as well as the moth-induced galls. Photo taken by author, Feb. 20, 2013, near Prineville.

Gedney and others (1999) found western juniper on sites where the mean annual precipitation exceeded 30 inches and on sites with as little as five inches. Elevation ranged from about 1,000 feet up to 8,000 feet. The Oregon Flora Project data contains a record of western juniper from a site only 223 feet in elevation, and the species also occurs along the Columbia River near Mosier at 100 feet elevation (Frank Callahan, pers. comm.). Gedney and others (1999) reported western juniper on soil series within all 18 soil classes found in eastern Oregon (http://soils.usda.gov/technical/classification/taxonomy/), as well as on 10 associated vegetative-topographic land forms (*e.g.*, basins and valleys, grass-shrub uplands, lava flows).

Once Here and There, Now Nearly Everywhere

Although on a different timescale, western juniper, like many of Oregon's residents who came from California, migrated northward when temperatures warmed after the Pleistocene. The earliest evidence of western juniper in Oregon is pollen from lake and pond sediment cores near Fort Rock, which is about 7,000 years old (Bedwell 1973). Once established here, western juniper populations expanded and contracted in response to cyclic climate changes until about 1860.

Ecologists (Gedney *et al*. 1999; Miller *et al*. 2005) now separate the geographic range of western juniper into two time periods, before and after Euro-American settlement, with the line of demarcation about 150 years ago (1870). Based on tree-

ring analysis, as well as on old photographs and other historical documents, pre-settlement juniper occupied specific sites on the landscape, areas more or less impervious to large-scale wildfire. These included such sites as rimrock and sandy soils where the scarcity of fine fuels prevented stand-replacing fires (Burkhardt and Tisdale 1969). Without a stand-replacing fire, the trees were allowed to mature. This further insulated them from fire because old trees are not so vulnerable to fire as their younger relatives, which may germinate in response to fire, but are just as quickly killed by a subsequent fire (Tirmenstein 1999).

All was well and good until European settlement of the West changed how fire was allowed to influence the natural landscape. Along with the outright control of fire, the introduction of livestock grazing caused a reduction in the fine fuels necessary to carry wildfire. Areas previously subject to periodic fires that restricted western juniper to the rimrock and other "fireproof" sites no longer burned. Thus juniper had free rein to expand its range, a situation exacerbated by favorable climatic conditions that promoted juniper reproduction (Soulé *et al.* 2004).

Grazing associated with settlement also removed the native bunchgrasses and introduced unpalatable exotic annual grasses and forbs that became flash fuels, further altering the timing and severity of wildfires. Other effects of grazing were trampling and other soil disturbance that removed the biotic crust and altered nutrient cycles, infiltration and runoff patterns, and provided an ideal seedbed for juniper. Controlling wildfires allowed young western juniper to survive and reproduce; at the same time, density of fire-sensitive sagebrush also increased, further enhancing establishment of juniper seedlings. Over half of the present-day juniper forest was established between 1850 and 1900 (Gedney *et al.* 1999).

Recent research adds another factor contributing to the range expansion of western juniper: the rise in atmospheric carbon dioxide. According to Knapp and others (2002), increased atmospheric CO_2 enhances growth of woody species, including western juniper, which would help explain an increase in juniper density even in areas where the natural fire cycle continued.

Today, the abundance of western juniper in Oregon is much different than it was even 80 years ago. The 1988 inventory estimated that western juniper existed on six million acres in Oregon, ranging from mature juniper forests to landscapes where juniper occurs as an infrequent solitary tree. Habitats included grasslands, sagebrush shrub-steppe, marshes, aspen stands, and ponderosa pine/mixed fir forests. Juniper forest, defined as at least 10 percent crown cover of juniper, was mapped on 2.2 million acres. This is a five-fold increase over the estimated 420,000 acres identified in 1936 (Gedney *et al.* 1999).

This Can't Be Good: Human-mediated Changes Alter Western Juniper's Role in Our Environment

An old-growth juniper woodland or savannah, consisting of scattered old trees, infrequent seedling survival, and a healthy understory of shrubs, herbs and grasses, provides many benefits: habitat for a variety of native wildlife and invertebrates; healthy soils with intact mineral and hydrological cycles; and a vigorous diversity of vegetation covering the landscape. Conversely, an increasing density of post-settlement western juniper has many interrelated and negative effects on many aspects of the environment. While not exhaustive, the following discussion covers the major points.

Western juniper has a competitive edge in both disturbed and relatively undisturbed environments. Once it has put a taproot down to a dependable source of water, the tree produces lateral roots, forming an extensive mat of fibrous roots close to the soil surface. These lateral roots normally extend out for at least a distance equaling the height of the tree, but can extend to three times the tree height (Miller *et al*. 2005).

A young western juniper is nurtured within the protective confines of a mature big sagebrush (*Artemisia tridentata*). Photo taken by aurhot, Feb. 20, 2013, near Prineville.

The widening canopies intercept up to 42 percent of the precipitation (Young *et al.* 1984), resulting in less surface moisture for understory plants that must also compete for soil moisture with an expanding mass of lateral juniper roots. As an evergreen, western juniper continues to transpire and extract soil moisture during cool seasons when understory species are dormant. At some sites, the growing season for understory plants was reduced by six weeks through a reduction in available soil moisture (Bates *et al.* 2000). Once soil moisture has been depleted, the overlapping resinous leaves of mature western juniper cover the stomata, minimizing transpiration.

Changes in soil fertility begin to occur, including a shift of organic matter and essential nutrients from the tree interspaces to under the juniper canopy and of the above-ground nutrients stored in plant biomass to the juniper. Less sunlight and water as well as fewer nutrients are available to the understory plants (Klemmedson and Tiedemann 2000).

Eventually, composition and density of the understory change. On some sites, especially the drier sites with a restrictive soil layer, the species with shallower roots, such as Thurber's needlegrass (*Achnatherum thurberianum*), are the first to go. On others sites, it's the sagebrush that pays the price. More mesic sites with Idaho fescue (*Festuca idahoensis*) seem to maintain a healthy cover of native grasses and herbs in spite of western juniper dominance. Other sites become dominated by annuals, for example, cheatgrass (*Bromus tectorum*) (Miller *et al.* 2000). One can't always predict how a site will change, but by the time the shrubs weaken and die, the juniper has won.

Reduction and loss of the associated understory plants result in further environmental decline. Additional modifications to the hydrology of the site occur. Fewer plants in the interspaces means the soil is more susceptible to the effects of raindrop splash and overland flow. Water that was previously slowed by these plants and their associated organic matter and allowed to percolate into the soil, now flows freely across the landscape. The result is soil loss and additional degradation of the site (Pierson *et al.* 2007). The loss of understory species further reduces the ability of the site to carry fire. The fine fuels are gone, and a mature, post-settlement woodland has made itself virtually fireproof.

The abundance and composition of wildlife species change as the result of conversion to western juniper woodland. Open woodland with a low density of western juniper, which also includes a healthy shrub component, provides maximum structural complexity for songbirds. Conversion to a closed juniper forest and the associated loss of the shrubby understory reduces habitat complexity and causes a corresponding decrease in the number and diversity of avian species (Noson 2002), although some cavity nesters (*e.g.*, Mountain Bluebird (*Sialia currucoides*) and Red-breasted Nuthatch (*Sitta canadensis*)) prefer juniper woodland. Food and cover for small mammals is also lost, while some species, such as bushy-tailed woodrats (*Neotoma cinerea*), rabbits (*Lepus* spp. and *Sylvilagus* spp.), and porcupines (*Erethizon dorsatum*), thrive as western juniper increases (Maser and Gashwiler 1978). Large herbivores use western juniper habitats for food and cover, but as sites transition to a closed woodland, shrub species are lost. This adversely affects species that rely on sagebrush for food and cover, such as Greater Sage Grouse (*Centrocercus urophasianus*). Additionally, as the trees increase in density, an animal's ability to spot predators is decreased. More trees also mean more ideal perch habitat for birds of prey, which keep populations of small mammals and birds in check.

Say It Ain't So: Another Viewpoint

As with most things in life, there are two (or twenty-two) perspectives. Some subscribe to the viewpoint that, even though western juniper expansion has a demonstrable effect on species composition and herbaceous biomass, there are few detrimental effects on hydrology, soils, or wildlife habitat on affected sites (Belsky 1996).

Conclusion

If your sole experience with western juniper has been a blur in the background during your sub-sonic drive from Bend to Burns in search of that special *Eriogonum*, hopefully you gained some knowledge by reading this article. This important native Oregon plant has its place, but its ongoing increase across the landscape definitely presents challenges. These challenges, of course, have led to research studies designed to halt its advance and restore damaged ecosystems. Consideration of these topics is left for a later chapter. Now that you have a better appreciation for western juniper, on your next hike, take a moment to ponder that tree before you and appreciate it for more than just its shade. How old is it? What do the cones look like? Would I have found this tree here 200 years ago? What other species depend on it for their survival?

The leaves of trees generally younger than 25 years old are noticeably longer and grayer in color than those of the mature trees. Photo taken by author, Feb. 20, 2013, near Prineville.

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References

American Forests Big Tree Register. 2013. http://www.americanforests.org/bigtree/juniperus occidentalis. (accessed March 2013).

Bates JD, Miller RF, Svejcar TJ. 2000. Understory dynamics in cut and uncut western juniper woodlands. J. Range Manage. 53:119-126.

Bedwell SF. 1973. Fort Rock Basin Prehistory and Environment. Eugene (OR): Univ. Oregon Press. 189 pp.

Belsky AJ. 1996. Viewpoint: Western juniper expansion: Is it a threat to arid northwestern ecosystems? J. Range Manage. 49:53-59.

Burkhardt JW, Tisdale EW. 1969. Nature and successional status of western juniper vegetation in Idaho. J. Range Manage. 22:264-270.

Freeman DC, McArthur ED, Harper KT, Blauer AC. 1981. Influence of environment on the floral sex ratio of monoecious plants. Evol. 35:194-197.

Garrett S. 1995. The Western Juniper (*Juniperus occidentalis*). Kalmiopsis 5:27.

Gedney DR, Azuma D L, Bolsinger CL, McKay N. 1999. Western juniper in eastern Oregon. Portland, OR: USDA Forest Service, Pacific Northwest Res. Sta. Gen. Tech. Rep. PNW-GTR-464. 53 pp.

Hitchcock CL, Cronquist A. 1973. Flora of the Pacific Northwest. Seattle (WA): Univ. Wash. Press. 730 pp.

Jepson Flora Project. 2013. Available: http://ucjeps.berkeley.edu/IJM.html (accessed 1/15/2013)

Kew Herbarium Catalog. 2013. *Juniperus occidentalis* holotype. http://apps.kew.org/herbcat/detailsQuery.do?imageId=&pageCode=1&presentPage=1&queryId=1&sessionId=2762051B3A634D00F1680764F476F4C0&barcode=K000088396. (accessed 3/28/2013).

Klemmedson JO, Tiedemann AR. 2000. Influence of western juniper development on distribution of soil and organic layer nutrients. Northwest Sci. 74:1-11.

Knapp PA, Soulé PT, Grissino-Mayer HD. 2002. Detecting potential regional effects of increased atmospheric CO_2 on growth rates of western juniper. Global Change Biol. 7:903-917.

Maser C, Gashwiler JS. 1978. Interrelationships of wildlife and western juniper. Pp. 37-82 *in* Proc. Western Juniper Ecol. and Manage. USDA Forest Service GTR-PNW-74.

Miller RF, Bates JD, Svejcar TJ, Pierson FB, Eddleman LE. 2005. Biology, ecology, and management of western juniper (*Juniperus occidentalis*). Oregon State Univ. Agric. Expt. Sta. Tech. Bull. 152. 77 pp.

Miller RF, Rose JA. 1995. Historic expansion of *Juniperus occidentalis* (western juniper) in southeastern Oregon. West. North Amer. Nat. 55:37-45.

Miller RF, Svejcar TJ, Rose JA. 2000. Impacts of western juniper on plant community composition and structure. Jour. Range Manage. 53:574-585.

Noson AC. 2002. Avian communities in relation to habitat influenced by fire in sagebrush steppe landscape. MS Thesis, Oregon State University, Corvallis, OR.

Oregon Flora Project. 2013. Plant Atlas. Oregon State University, Corvallis, OR. http://www.oregonflora.org/atlas.php. (accessed January 2013).

Pierson FB, Bates JD, Svejcar TJ, Hardegree SP. 2007. Runoff and erosion after cutting western juniper. Rangeland Ecol. Manage. 60:285-292.

Pollen Library. 2013. Available: http://www.pollenlibrary.com. (accessed 1/29/2013).

Purrington FF, Purrington TM. 1995. *Heinrichiessa sanpetella* Neunzig (*Lepidoptera*: *Pyralidae*) is an inquiline in juniper midge galls (*Diptera: Cecidomyiidae*). Entom. Soc. Wash. 97:227.

Soulé PT, Knapp PA, Grissino-Mayer HD. 2004. Human agency, environmental drivers, and western juniper establishment during the late Holocene. Ecol. Appl. 14:96-112.

Tirmenstein D. 1999. *Juniperus occidentalis*. In: Fire Effects Information System, (Online). U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). http://www.fs.fed.us/database/feis/. (accessed 1/31/2013).

USGS. 2013. Digital Representations of Tree Species Range Maps from *Atlas of United States Trees* by Elbert L. Little, Jr. (and other publications). http://esp.cr.usgs.gov/data/little. (accessed 1/16/2013)

Young JA, Evans RA, Easi DA. 1984. Stem flow on western juniper (*Juniperus occidentalis*) trees. Weed Sci. 32:320–327.

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