OLD GROWTH WESTERN JUNIPER WOODLANDS[1]

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SUMMARY

Researchers and resource managers in forestry, rangeland, and ecology have generally overlooked semiarid old-growth woodlands. These ancient woodlands have some of the oldest trees in the Intermountain region, exceeding ages of 1,000 years. Typically, old-growth are structurally more complex than postsettlement woodlands, adding biological diversity to the landscape and providing an important source of habitat for many organisms. Mapping and inventorying old-growth woodlands are extremely important in developing management and land-use plans.

INTRODUCTION

Old-growth juniper and pinyon woodlands in the West generally do not fit the typical image most people have of old-growth coniferous forests. In a recent symposium in the southwest, Swetnam and Brown (1992) stated, "Many peoples' image of old-growth are the stately monarch trees with shafts of sunlight streaming down through tall, dense canopies. However, in the southwest, many of the old-growth stands do not fit this stereotype." Some of the oldest stands throughout the Intermountain West are low statured, open, semiarid woodlands composed of such species as bristlecone, limber pine, juniper, and pinyon. Old woodlands usually differ in structure and function from postsettlement woodlands thus adding diversity at the community and landscape levels. Although considerable research has been conducted in old-growth for other conifer species, work addressing old-growth in juniper and pinyon woodlands is very limited. In addition, the concern over the rapid expansion of juniper and pinyon woodlands during this century has overshadowed the presence and value of these presettlement woodlands. Ancient woodlands are frequently overlooked in management plans and inventories where they are often lumped with postsettlement stands. Wildlife studies conducted in juniper or pinyon-juniper woodlands have also not separated post- from presettlement stands. In addition, there have been occasions when mature western juniper woodlands have been misidentified as old-growth.

The intent of this paper is to describe old-growth as it relates to western juniper woodlands, summarizing their characteristics and variability, then contrasting these ancient woodlands with younger postsettlement stands.

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OLD-GROWTH: A GENERIC DESCRIPTION

Old-growth work in the northwest United States has been focused on the more mesic heavily forested areas. In the Great Basin, documentation of old-growth woodlands is almost non-existent. What is known about old-growth juniper and pinyon comes largely from anecdotal mentions in the literature, noting the occurrence of presettlement trees on rimrock, low sagebrush tablelands, and other fire resistant areas. Several attempts have been made to describe pinyon-juniper old-growth (Popp et al. 1992, Mehl 1992) but little quantitative work has been conducted in these stands.

The US Forest Service defines old-growth forests generically as ecosystems distinguished by old trees and related structural attributes. Their definition states that old-growth encompasses the later stages of stand development that typically differ from earlier stages in a variety of characteristics which may include tree size, accumulations of large dead woody material, number of canopy layers, species composition, and ecosystem function (USDA Forest Service 1993). Structural features important in characterizing old-growth in the Intermountain West vary widely across forest type, climate, site conditions, and disturbance regimes (Kaufmann et al. 1992).

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Although structure, composition, and ecology of semiarid woodlands is considerably different than the wetter heavily forested areas, the principles for defining these stands, which are based on tree age, stand structure, and function, should remain the same. Nonetheless little to no information is available on stand structure, rates of mortality and the general ecology of these semiarid woodlands. Information relating old-growth woodlands to wildlife values is also limited since very few wildlife studies have described stand structure or separated old-growth from postsettlement woodlands.

Old-Growth Juniper: A Single Tree Perspective

A frequently asked question is; "What is an old-growth juniper?" One age separation frequently made is on the basis of tree establishment occurring prior to or following Eurasian settlement. In the Intermountain Northwest the rapid expansion of western juniper coincided with Eurasian settlement in the late 1860s and 1870s (Burkhardt and Tisdale 1976, Miller and Rose 1995, 1999). Woodland expansion for much of this region began in the 1870s. Based on the chronology of past events throughout the northern Great Basin, we define postsettlement trees as having established sometime after 1870, and presettlement trees establishing before 1870. However, old-growth can also be based on structural characteristics of the tree, which develop slowly over time. As juniper ages, canopy morphology shifts from cone shaped to a rounded top. As age advances the tree may also develop a combination of the following characteristics: broad nonsymmetric tops, deeply furrowed bark, twisted trunks or branches, dead branches and spike tops, large lower limbs, trunks containing narrow strips of cambium (strip-bark), hollow trunks, large trunk diameters relative to tree height, and branches covered with a bright yellow green lichen (*Letharia* sp.) in both juniper and pinyon. Tree size, particularly height, which correlates poorly with age, is dependent upon site characteristics.

Tree age within an old-growth stand is an important index in assessing the stage of old-growth woodland development. Assessing stand age also determines the rarity or uniqueness of the woodland. Individual western juniper trees can easily attain ages exceeding 1,000 years (Miller unpublished data). The oldest living western juniper tree (*Juniperus occidentalis* ssp. *occidentalis*) currently reported is just over 1,600 years old. However, many old trees cannot be aged because trunk centers are rotten.

Old-Growth Juniper: A Woodland Perspective

At the community level, old-growth juniper woodlands are best described on the basis of the presence of old trees and structural characteristics such as standing and down dead, decadent living trees, cavities, and branches covered with lichens. A single set of attributes and quantities cannot classify all stands as either old or young. Waichler (1998) recently developed a quantitative old-growth western juniper description for the aeolian sand region in Central Oregon. She stated structural characteristics that distinguished these old growth western juniper woodlands from postsettlement stands were tree growth form, standing dead, down dead, lichen growing on the dead branches, and cavities. These stands were also characterized by a relatively open overstory canopy. Old-growth woodlands in central Oregon contained a minimum density of 80 trees ha^{-1} at least 200 years old. These trees were typically 16 cm in diameter, contain less than 90% of a full canopy, and exhibited morphological characteristics of old-growth trees. However, some trees retained the postsettlement growth form with symmetrical conical canopy shapes up to 250 years. Tree canopy cover ranged between 10 and 35% with tree basal areas varying from 18 to $39m^2$ ha^{-1}. Dead wood within the stand was primarily retained as detritus in live trees and as standing dead trees. A minimum of 10 standing dead trees/ha (25 cm diameter) and 1 large (3.3 m length and 25 cm diameter) downed piece/ha occurs.

The prehistoric record indicates the distribution and dominance of presettlement western juniper woodlands have greatly fluctuated during the past 5,000 years (Miller and Wigand 1994). Western juniper generally increased during periods of mild wet climate, declining with an increase in fire at the end of these wet periods. The pollen record indicates western juniper declined during the past 500 years before settlement. In contrast, stands that have established after the 1870s appear to be considerably more dense, have developed under different environmental conditions, and occupy more productive and deeper soil sites than these presettlement woodlands.

In Oregon, it is estimated that less than 3% of the current 5 million acres of western juniper woodlands are characterized by trees > 100 years old (USDI-BLM 1990). Although not well documented, similar proportions of western juniper old-growth are probably found in northeastern California, northwestern Nevada, and southwestern Idaho. Acreage of old-growth is not known since mapping and inventory of old-growth western juniper woodlands is limited throughout its range. In addition, the proportion of pre- and post settlement trees varies across ecological provinces.

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ECOLOGICAL PROVINCES

Ecological provinces[2] (Fig. 1) provide a useful first cut to separate or classify old-growth juniper woodlands. Not only does the abundance of old-growth woodlands vary among provinces but it is likely that stand structure, composition, and probably the ecology also differ. Soils in the High Desert and Klamath ecological provinces, and the Owyhee Plateau in the Humboldt province are primarily derived from igneous rock (basalt, andesite, and ryolite). Igneous rock is also the most abundant parent material in the southwestern portion of the Snake River province, where western juniper occurs. In these provinces old-growth juniper typically grows widely spaced on shallow, rocky, heavy clay soils, or rimrock supporting limited fine fuels to carry a fire. Juniper Mountain, in Harney and Lake Counties, is a unique example of dense, old-growth woodlands growing on deep well-drained soils, which typically supports mountain big sagebrush steppe community types. Sedimentary soils, which occupy a large portion of the John Day province, support widely spaced old trees with little understory to carry fire. The aeolian sands in the Mazama and eastern edge of the High Desert provinces support the most extensive stands of old-growth western juniper woodlands.

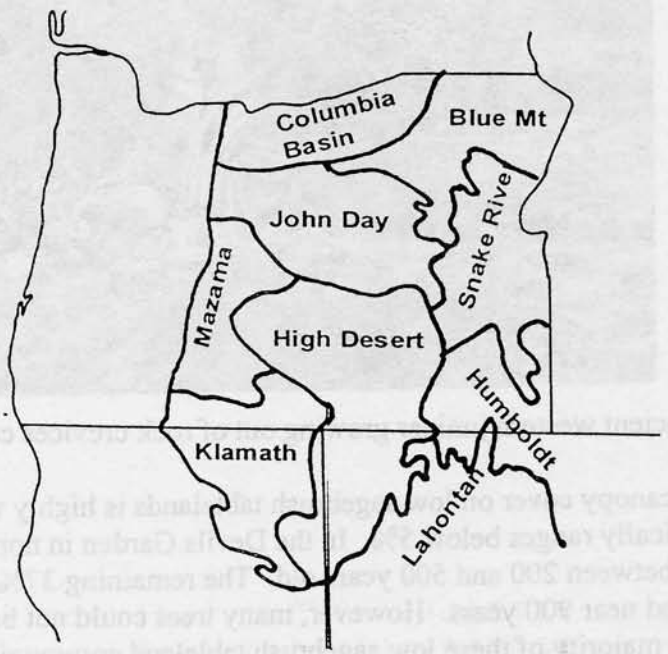

Figure 1. Ecological Provinces in eastern Oregon (derived from Anderson 1956, Cronquist et al. 1972, and Bailey 1980).

[2] Ecological provinces are defined by floristics, plant-soil relationships, climate, topography, geology, and soils. However similarities and dissimilarities of vegetation between provinces are not always clear. Derived from Anderson 1956, Cronquist et al. 1972, and Bailey et al. 1994.

Igneous zone: High Desert, Klamath, Humboldt, and Snake River Ecological Provinces

Presettlement juniper trees are typically found on rocky surfaces or ridges (Fig.2), and low sagebrush tablelands in the High Desert, Klamath, Humboldt, and Snake River Ecological Provinces. The low sagebrush tablelands occupied by presettlement juniper trees (Fig. 3) most likely account for the greatest proportion of old-growth juniper across these provinces. Old-growth juniper probably accounts for less than 3% of the woodlands across these provinces. The dominant grass is typically Sandberg bluegrass, with Idaho fescue growing beneath the juniper tree canopies. These juniper/low sagebrush tablelands often occupy extensive flats typically with less than 5% slope, although slopes can approach 30%. The rocky, shallow heavy clay soils are primarily of igneous origin. Although soils are shallow juniper roots often penetrate the fractured bedrock.

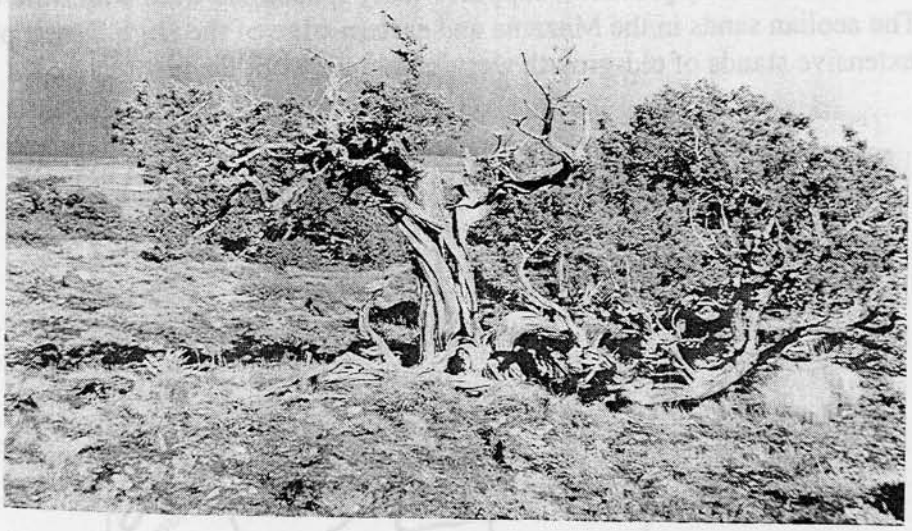

Figure 2. Ancient western juniper growing out of rock crevices covered by a few inches of soil.

Tree canopy cover on low sagebrush tablelands is highly variable and may approach 20%, but typically ranges below 5%. In the Devils Garden in northern California, 63% of trees aged ranged between 200 and 500 years old. The remaining 37% were older than 500 years with the oldest aged near 900 years. However, many trees could not be aged because of rot. Tree densities in a majority of these low sagebrush tableland communities have increased during the past 100 years (Young and Evans 1981, Miller and Rose 1995, 1999). Low presettlement tree densities in these communities can probably be attributed to limited tree establishment due to heavy clay soils, slow growth rates, and occasional fires. Occasional fires did burn across these low sagebrush Sandberg bluegrass community types with estimated return intervals of 100 to 200 years (Young and Evans 1981, Miller and Rose 1999). However, single tree lightening fires were probably more common occurrences across the juniper low sagebrush tablelands.

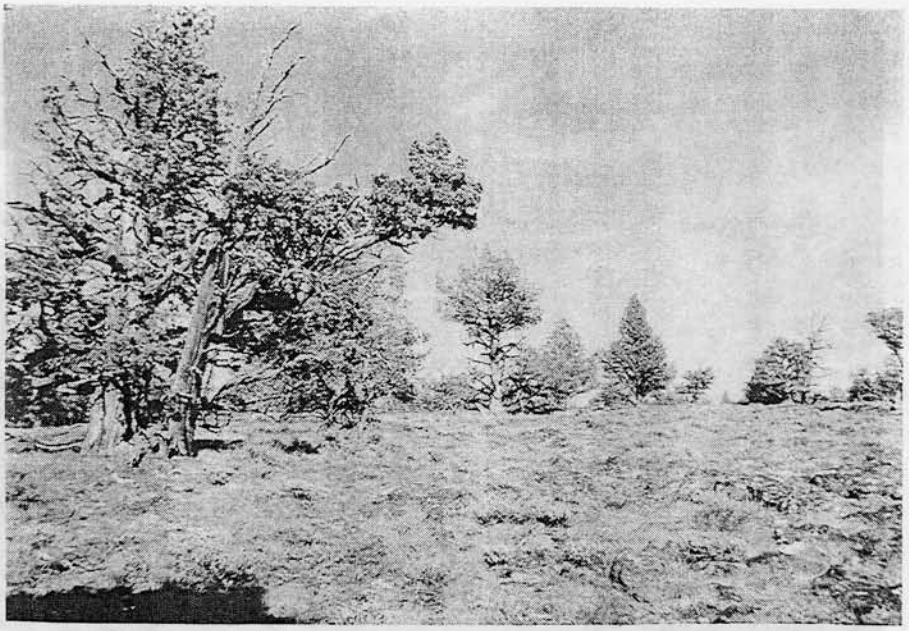

Figure 3. Juniper low sagebrush Sandberg bluegrass tablelands. Tree canopy is usually sparse and trees are widely scattered.

On the deeper igneous soils, fire limited the development of old-growth western juniper woodlands (Miller and Wigand 1994). These soils typically support mountain big sagebrush steppe communities. Mean fire intervals between 12 and 25 years occurred in these shrub steppe communities (Houston 1973, Burkhardt and Tisdale 1976, Martin and Johnson 1979, Miller and Rose 1999). However, Juniper Mountain located east of Alkali Lake in south central Oregon is an exception (Fig.4). This site may serve as a model as to what most of the mountain big sagebrush type would have looked liked if fire had played a minor role in the sagebrush ecosystem. This is the only old-growth stand we have measured throughout the range of western juniper that exceeds 30% canopy cover. On the north and northeast aspects the tree canopy cover ranged between 35 and 50%. On south and southwest aspects tree cover ranged between 20 and 35%. Shrub cover accounted for less than 1% of the understory cover. Dominant herbaceous species were Idaho fescue on the north aspects and Thurber needlegrass on the south aspects.

Sedimentary soils in the John Day Ecological Province

Very little work has been conducted on old-growth juniper on these soils. The majority of these soils occupied by old-growth western juniper occur in the John Day province with limited amounts occurring in the High Desert and Klamath provinces (Fig 1). These soils usually support a very low density of trees and sparse understory incapable of carrying fire (Fig. 5). The accumulation of both down and standing dead and decadent trees on many of these sites indicates the presence of very old stands. Tree ages on these soils exceed 1,000 years. Dead trees may remain standing for hundreds of years. The center growth rings on several of these trees go back 100 BC. These old-growth stands probably account for less than 3% of the juniper woodland component in the John Day province.

Figure 4. Dense ancient western juniper woodland growing on the north aspect of Juniper Mountain, in eastern Oregon. Soils are deep loamy Argixerolls and Haploxerolls. Tree canopy cover varies from 35 to 50%.

Figure 5. Ancient western juniper trees growing on sedimentary soils in central Oregon.

Aeolian sands in the Mazama and western High Desert Ecological Provinces

The aeolian sand region is located in the Mazama and northwestern portion of the High Desert Ecological Provinces, just east of the Cascade Mountain range (Fig.1). This region supports the most extensive stands of old-growth western juniper woodlands (Fig. 6). These old woodlands probably account for over 10% of the juniper woodlands in the Mazama Province. Soils in the Mazama Province are strongly influenced by Mazama pumice. In the northwest corner of the High Desert Province, sources of wind blown sands are primarily from Pleistocene lake beds, and Mount Mazama and Newberry Craters pumice. Stand structure varies across these provinces but are generally open with tree canopy cover typically ranging between 10 and 20%. Live tree density ranged between 41 and 123 per acre, standing dead $\leq$9 per acre, and down dead $\leq$7 per acre. Very slow decomposition rates allow for an accumulation of dead wood on these sites. Burned stumps and standing weathered trees can persist for hundreds of years. Old-growth stands were typically mixed age with 63% of the trees > 200 years (Waichler 1998). Several trees have been aged between 1,200 and 1,600 years old. Fires were typically small, burning single to several trees within a stand. However, old fire scars on these landscapes indicate occasional extensive fires burning in these stands. Idaho fescue, western needlegrass, and bluebunch wheatgrass (primarily on the west and southwest aspects) frequently dominate the understory. However, in the Bend and Redmond area which lies below 5,000 feet, rabbitbrush and cheatgrass will dominate the understory on sites that have been overgrazed or mechanically disturbed. In contrast to other provinces, tree removal by cutting also results in a loss of Idaho fescue and an increase in cheatgrass and rabbitbrush.

Figure 6. Old woodland growing on aeolian sands. Tree canopy cover is 15% and dominant understory grass is Idaho fescue.

WILDLIFE VALUES

It is important that future wildlife work describes both woodland structure and stand age. Old-growth woodlands are typically more structurally complex than postsettlement woodlands. More than 80 species of animals use living trees with decay, hollow trees, snags and logs in the interior Columbia River Basin (Bull et al. 1997). Although their report excluded juniper species, current breeding bird surveys showed old-growth western juniper woodlands provide important habitat for many bird species. Preliminary results from our songbird surveys indicate an increase in cavity nesters in old-growth compared to postsettlement woodlands. Densities of cavity nesting mountain blue birds, red- and white-breasted nuthatches have been consistently greater in old stands. Some of our highest counts of mountain blue bird also occurred in shrub steppe communities adjacent to old-growth stands. Our lowest counts have been recorded in closed postsettlement stands. At this time we are currently collecting information on cavity densities and minimum tree ages where cavities are typically found. Wood rats also commonly nest in the hollow trunks of western juniper. In addition to wood rats, the abundance and diversity of small mammals is typically greater than in postsettlement woodlands (Willis and Miller 1999).

During the winter, a large abundance of frugivores, including western and mountain bluebirds, cedar waxwings, American robins, and townsend solitares have been reported in the extensive juniper stands in central Oregon in the Mazama Province (Contreas 1997). These stands are predominately open old-growth woodlands, with 15% or less canopy cover supporting good crops of juniper berries. Dense woodlands produce very few berries (Miller and Rose 1995). We have observed heavy berry crops on trees over 500 years old growing in relatively open stands. Tree density appears to have a greater effect on the potential berry production than tree age.

MANAGEMENT CONSIDERATIONS

Before we can address how we should manage old-growth juniper woodlands in the Intermountain West we must ask the question what should these old-growth stands be managed for? Old-growth juniper and pinyon woodlands make up a small percentage of the juniper and pinyon woodland. These old-growth stands are structurally and topographically more complex than the younger more abundant woodlands, adding biological diversity to the landscape and providing an important source of habitat for many organisms. Many of these stands are also very esthetically pleasing and provide recreational, cultural and spiritual opportunities. Kaufmann et al. (1992) states, "old-growth provides us with a tremendous opportunity for retaining or enhancing biological features unique to old-growth ecosystems." We should evaluate fire policies influencing these old stands including both fire suppression and let burn decisions. Recent changes in overstory and/or understory can alter the response of these communities to fire. However, continued fire suppression in some woodlands may increase the potential for large stand replacement fires. Fuel woodcutting also appears to be a rather wasteful use of this limited resource, unless cutting is designed to remove postsettlement trees and restore presettlement stand structure.

Studies are needed to determine and describe the range of old-growth characteristics throughout the Intermountain West. Mapping and inventorying old-growth woodlands is extremely important for developing management and land-use plans. Development of an old-growth woodland classification system used in inventories would prove helpful in developing management plans. We also need information on gap dynamics, tree mortality, and succession following disturbance. This information will allow us to predict how these woodlands respond to disturbance. It will also allow us to evaluate pre- and postsettlement changes in community structure and composition that have occurred in old-growth stands, define desired future conditions, and develop management programs to restore or maintain old woodlands. To be successful old-growth woodlands cannot be managed on a single tree basis but only at the community and landscape levels. These old stands are an important landscape component in the Intermountain West, because they support many plant and animal species and interact with adjacent plant community types.

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