WESTERN JUNIPER ENCROACHMENT INTO ASPEN STANDS IN THE NORTHWEST GREAT BASIN

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SUMMARY

Western juniper (*Juniperus occidentalis*) is invading and replacing quaking aspen (*Populus tremuloides*) stands in the Northwest Great Basin. Peak establishment of western juniper into aspen began at the turn of the century. Seventy-seven percent of aspen stands sampled have either been replaced, are dominated, or actively establishing populations of western juniper. The primary reason for western juniper encroachment into aspen is the lack of fire since the turn of the century and heavy browsing by wild and/or domestic ungulates. As western juniper replace these aspen stands, percent bare ground increases, herbaceous plant cover decreases, and soil properties are altered.

INTRODUCTION

Quaking aspen communities are declining due to encroachment of western juniper in the Northwest Great Basin (northern Nevada, northeastern California, and eastern Oregon). Although these communities constitute a small portion of the landscape across the Great Basin they contribute significantly to the biodiversity of wildlife and plant species. In aspen/grass stands located in the Great Basin of southeastern Oregon, 84 wildlife species reproduce and 110 wildlife species forage within these sites. In aspen/mountain big sagebrush, 95 wildlife species reproduce and 117 wildlife species forage within these sites (Maser et al. 1984). From this information, one may conclude that only riparian areas exceed aspen sites for the greatest majority of wildlife use proportional to total land area in southern Oregon.

Aspen communities generally have more lush undergrowth than neighboring coniferous forests (Mueggler 1985a). Aspen undergrowth can vary from less than 500 lb/acre to over 4,000 lb/acre. This variability is due to different environmental conditions, levels of animal use, and successional status of individual stands (Houston 1954, cited by Mueggler 1985b). If conifers overtake an aspen site, the understory vegetation is altered (Mueggler 1985a). Conifers more effectively shade the forest floor and change herbaceous quantity and species composition. Undergrowth in aspen communities decreases as the number of conifers increase (Mueggler 1985b). Bartos and Campbell (1997) state that when conifers overtake aspen communities, less water is available to the watershed, understory biomass vegetation is significantly reduced, and the diversity of wildlife and plant species declines. The greatest concern over conifer invasion is the permanency of aspen exclusion from succession once a climax conifer community persists.

In the Rocky Mountain region, Utah alone has 1.6 million acres of aspen (Mueggler 1988). Utah's aspen dominated lands have decreased by approximately 60% since European settlement (Bartos and Campbell 1997, 1998). With this in mind, one might ask if aspen in the Northwest Great Basin have decreased since settlement? And, are losses similar to those reported for aspen in Utah?

Today, western juniper inhabits over 8 million acres in the Northwest Great Basin. Extensive study has shown that western juniper is expanding its range into meadows, shrub-grasslands, riparian areas, and aspen stands (Miller and Wigand 1994, Miller and Rose 1995, Miller 1996). The most susceptible aspen communities are below 7,000 ft in elevation because this marks the upper elevation limit for western juniper (*Juniperus occidentalis* spp. *occidentalis*). On Steens Mountain in eastern Oregon, Miller and Rose (1995), found the greatest densities of western juniper occurred in aspen stands verses sagebrush community types. In these locations, western juniper are invading and replacing aspen. Due to aspen's limited distribution and ecological importance in the Northwest Great Basin, western juniper encroachment is very alarming.

The magnitude of aspen loss and the extent and effects of western juniper invasion into aspen communities in the Northwest Great Basin are unknown.
Loss of aspen warrants attention because of the ecological diversity it adds to landscapes predominated by sagebrush and juniper. By gaining a better understanding of western juniper encroachment into aspen communities, land managers and owners can make effective and proper decisions on how to perpetuate and maintain the aspen community.

OBJECTIVES

The focus of this study was to determine the extent and ecological effects of western juniper encroachment into aspen stands in the Northwest Great Basin. The objectives of the study include:

1. Determine the extent of western juniper invasion into aspen stands in the Northwest Great Basin.
2. Assess aspen stand age or time since last disturbance and when western juniper began to significantly invade aspen stands.
3. Determine the effects of aspen stand structure (density, cover, and age) on western juniper encroachment.
4. Determine the effects of western juniper invasion on soils previously influenced by aspen. Soil characteristics studied included C, N, and pH.
5. Measure the difference of C and N in aspen and western juniper litter.
6. Determine presettlement disturbance intervals in aspen stands.

STUDY AREA

Aspen stands typically were located along the north and northeast base of ridges where wind deposition causes excess snow accumulation. Elevation of aspen stands varied between 4900 and 7000 ft. Geographic locations of aspen communities studied in the Northwest Great Basin included:

Southeast Oregon	Northwest Nevada	Northeast California
Steens Mountain	Sheldon Refuge	Cedar Creek
Lakeview region:	Massacre Rim	McDonald Peak
Abert Rim	Mosquito Lake	Nelson Corral
Fishcreek Rim		
Coleman Rim		
Long Canyon		
Chewaucan Drainage		

METHODS

A 50 ft circular plot was laid in the middle of each aspen site sampled. Within this plot age, density, and canopy cover was measured for both aspen and western juniper. Percent bare ground and herbaceous plant cover was also measured. Soils were collected from aspen stands with no juniper and from aspen stands that had been completely replaced by juniper. These soils were then sent to a soils lab to determine differences in soil characteristics such as plant available nutrients and pH. Aspen and western juniper litter was collected from litter traps within stands and analyzed for differences in C and N.

RESULTS AND DISCUSSION

Extent of Western Juniper Encroachment Into Aspen

Western juniper is encroaching into aspen stands throughout the entire study area (below 7,000 ft elevation). Of the 91 aspen stands sampled, 86 (or 95%) contained various densities of western juniper. The average density of western juniper is 637 trees per acre of aspen (Fig. 1). These densities include all size classes from large adults to small juveniles. Twelve percent of aspen stands sampled have been completely replaced by western juniper. Twenty-three percent of aspen stands are in a state of regression with well-established western juniper populations on the brink of overtaking them. In 42 % of aspen stands sampled, western juniper is very common but not yet dominating.

As old aspen die, understory western juniper trees replace the aspen filling in the canopy holes. This is partially due to limited aspen recruitment. Statistical canopy cover data from this study shows that as aspen canopy cover decreases, juniper canopy cover increases. Presently, average juniper canopy cover in aspen stands is 27%. Fifty-one percent of aspen stands have over 10% juniper canopy cover. In 21% of the stands, western juniper accounts for to over 40% canopy cover. As western juniper canopy cover increases, bare ground increases and herbaceous plant cover decreases.

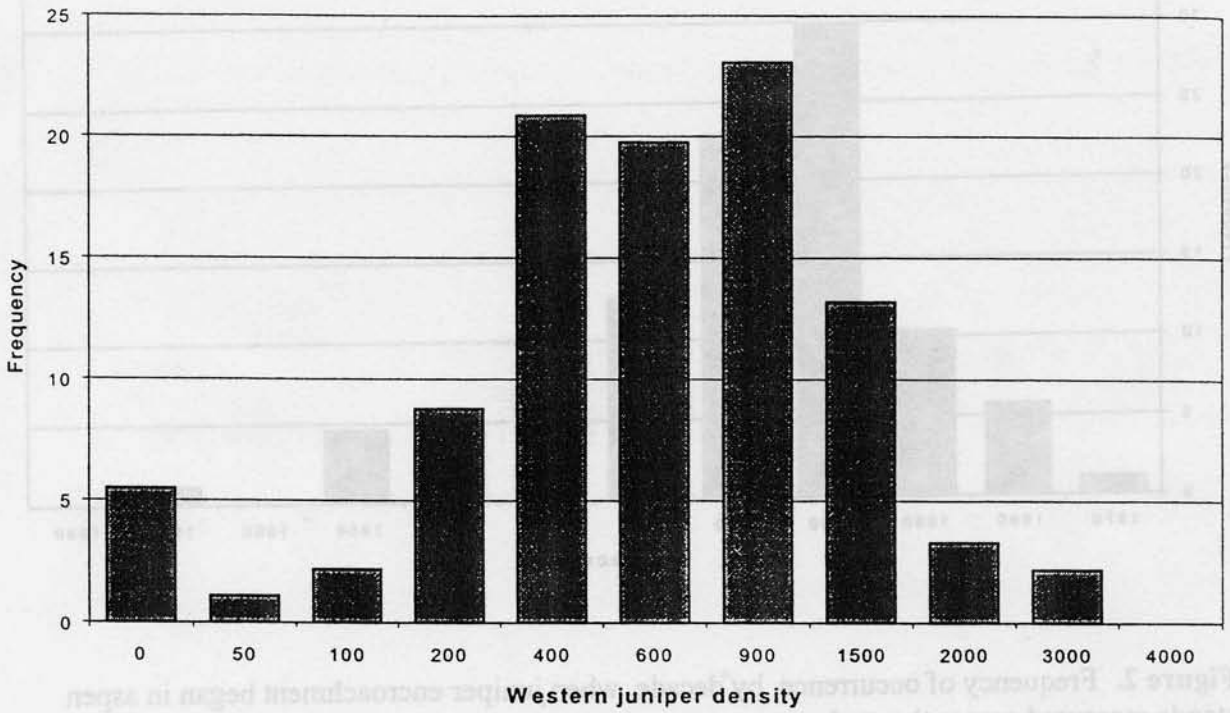

Figure1. Frequency of occurrence of different levels of western juniper densities across aspen stands sampled.

Succession of juniper into aspen communities has been attributed to events that occurred around the turn of the century. From aged tree data, western juniper encroachment peaked from 1900 to 1929 with 66% of the sampled trees establishing during this period (Figure 2). Only 5% of western juniper occurring in aspen stands are greater than 100 years old and no trees were older than 145 years. Reasons for expansion of young juniper include: optimum climatic conditions at the turn of the century, reduced fire resulting from European settlement with subsequent livestock use and fire suppression, and an increased seed source (Miller and Wigand 1994, Miller and Rose 1995, Miller 1996). Browsing by domestic and wild large herbivores has also limited aspen recruitment. Previous to this time, frequent fire events excluded juniper from aspen stands and perpetuated aspen stand vigor through suckering. Today, fire in aspen stands is considered an unusual event (DeByle et al. 1987). As a result, old and decadent stands continue to deteriorate throughout the West (Jones and DeByle 1985, DeByle et al. 1989). Thus, western juniper maintains an established foothold in the under-story, subsequently fills in canopy gaps as old, adult aspen die, and eventually replaces the entire stand.

Aspen Stand Dynamics

What is the current state of aspen stands in the Northwest Great Basin? Aspen stands sampled across the study area average 98 years old. Forty-seven percent of these stands are greater than 100 years old (Fig. 3). Since aspen longevity is relatively short, stands over 100 years old begin to regress. As individual aspen die, holes open in the canopy. In uneven-aged

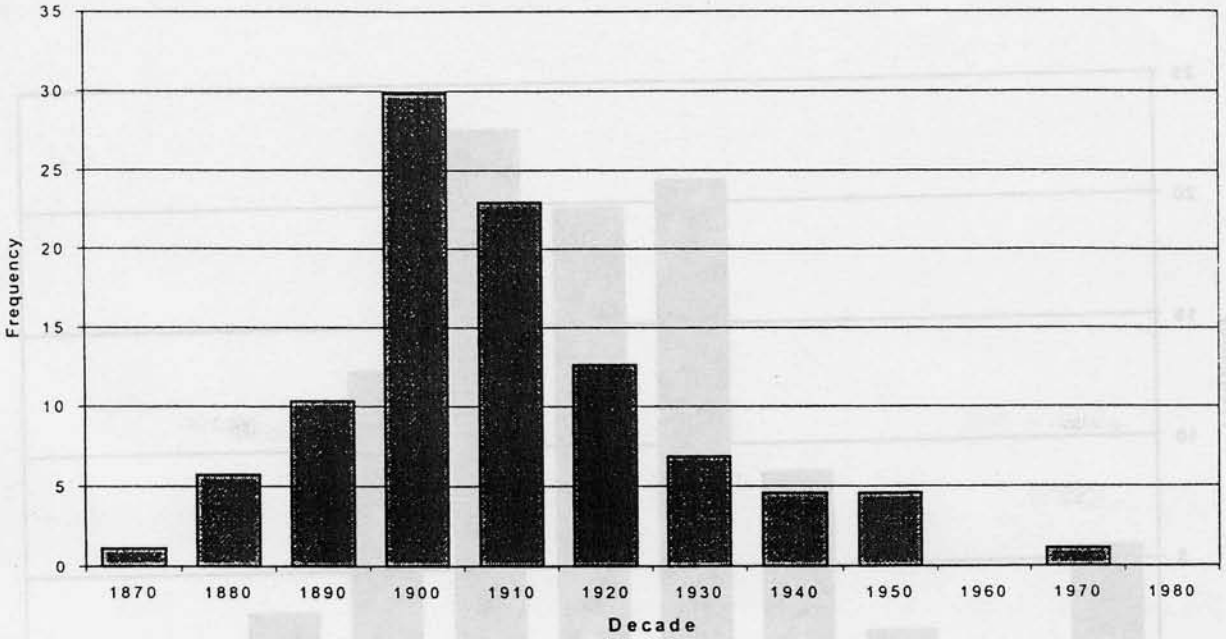

Figure 2. Frequency of occurrence, by decade, when juniper encroachment began in aspen stands measured across the study area.

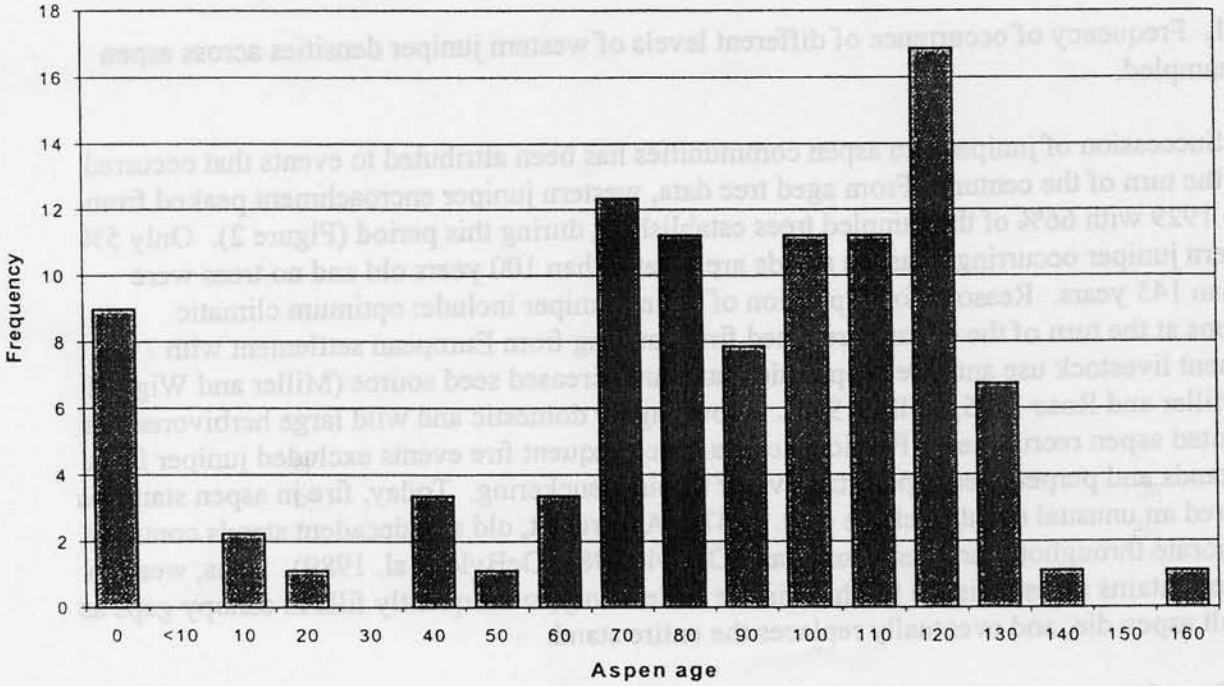

Figure 3. Frequency of occurrence aspen age for dominant canopy cover trees across the study area.

stands of aspen, younger aspen will fill these openings. However, most stands in the northwest Great Basin are even-aged. When an individual tree dies, no juvenile aspen are available to immediately fill the canopy gap. Of all aspen sites sampled across the study area, 70% had no active recruitment of new aspen. The other 30% had varying degrees of recruitment which still may not sustain aspen stands experiencing encroachment by longer-lived juniper. Additionally, aspen stands across the study area have an average of 20% dead trees in the stand. This perpetuates aspen stand decline because live adult aspen continue to release auxins that inhibit aspen regeneration while sun-loving juniper receive sufficient light in the under-story to grow and fill the gaps of dead and dying aspen.

Effects of Western Juniper Encroachment on Soil Previously Influenced by Aspen.

What changes, if any, does western juniper encroachment cause to soils? To find out, two categories of soils were sampled: 1) soils influenced by aspen, and 2) soils once influenced by aspen but now dominated and influenced by western juniper.

Soils influenced by western juniper had a higher C to N ratio and a higher pH than the aspen soil. By having a higher C to N ratio, less N is available for plant growth. This higher C to N ratio in soils can be attributed to western juniper litter as it also has a higher carbon to nitrogen ratio than aspen litter. Additionally, western juniper binds-up nutrients within the tree, not recycling it back to the soil as quickly as aspen since it is longer-lived and evergreen. Soils influenced by western juniper also had higher amounts of salts, lime, and sulfate, and lower amounts of magnesium, iron, manganese, and copper.

CONCLUSION

The majority of aspen stands sampled in the Northwest Great Basin were in various stages of western juniper encroachment. Seventy-seven percent of aspen have either been replaced, dominated, or rapidly establishing populations of western juniper. The primary reason for western juniper encroachment into aspen is lack of fire since the turn of the century and over browsing of young suckers by domestic and wild herbivores. Frequent fire events exclude juniper from aspen stands and induce suckering thus perpetuating the stand. However, in the absence of fire, western juniper will continue to replace aspen. In southern Colorado fire return intervals in aspen communities were estimated at 60 years (Romme et al. 1996). Long term effects of juniper to soil may render the site unsuitable for aspen and its associated plant component. To sustain or reclaim aspen, prescribed fire and allowed natural fire needs to occur at pre-settlement intervals. The majority of stands need an urgent proactive plan for fire reintroduction. Fire treatments should continue over space and time to invigorate the stands and deter future western juniper invasion. Overuse of young aspen suckers must also be decreased to allow for adequate aspen recruitment.

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