OREGON DEPARTMENT OF FISH AND WILDLIFE

JUNIPER WOODLAND MANAGEMENT

An Application of the
Fish and Wildlife Habitat Mitigation Policy

1994

Habitat Conservation Division
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CONTENTS

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Summary

Western juniper[1] occurs as an important habitat component in many eastern Oregon ecosystems. The distribution and abundance of juniper has varied greatly over geological time. Prior to settlement, juniper was largely restricted to pumice sands east of the Cascades, rocky outcrops in the Great Basin and shallow soil areas in both sagebrush grasslands and montane forests. Following settlement, livestock grazing, fire suppression and other land use practices significantly altered the ecosystem functions of existing juniper stands and the establishment of juniper cover (afforestation) over an area approximately ten-times larger than existed 100 years ago.

Significant degradation of resource values (including wildlife habitat, watershed functions, and forage values) has been accompanied by an increase in juniper on many sites. Juniper is frequently identified as the primary cause of resource loss during restoration and enhancement efforts in affected areas rather than the underlying land use patterns. Proposals to convert juniper to shrub or grassland types that do not address the underlying causes for the increase of juniper may actually have adverse effects on wildlife and other resource values, and will not result in the desired permanent resource recovery. Large-scale projects designed to capture marketable juniper values may also have adverse consequences for wildlife habitat.

The Oregon Department of Fish and Wildlife (Department) desires to cooperate with land managers and assist with the design, implementation and evaluation of western juniper woodland management in order to protect existing habitat values and to enhance habitat values threatened by juniper afforestation. These guidelines provide information and criteria to guide Department recommendations toward that purpose.

The Fish and Wildlife Habitat Mitigation Policy (OAR Chapter 635 Division 415) provides the context for Departmental recommendations concerning the desired distribution and abundance of juniper habitats. It also provides flexible criteria to evaluate any activity intended to manage juniper (including the Department's own actions) that is subject to regulation by local, state, or federal agencies and which could result in adverse impacts on fish and wildlife habitat. In some cases, it may be appropriate for the Department to recommend juniper management actions as deferred mitigation for the unforeseen and unintended consequences of past development activities.

These guidelines include a literature review intended to aid in the resolution of conflicting claims about the role of juniper in resource degradation. They also contain specific recommendations concerning alternatives for juniper stand treatment and post-operation maintenance necessary to protect the desired composition, structure, and function of resulting ecosystems.

[1]Common and scientific names used in the text are given in Appendix A.

BACKGROUND

Juniper Woodland Issues

Western juniper woodlands currently occupy approximately 2,000,000 acres in eastern Oregon. They provide important habitat for many wildlife species. The quantity and quality of habitat available for those species, and for other species dependent on adjacent plant communities, has been significantly altered during the last 100 years by the increasing density in existing woodlands and the juniper afforestation of former sagebrush plant communities.

Some observers of this trend suggest that it is accelerating geometrically; that the entire mountain big sagebrush type, and perhaps other plant communities as well, may be moving towards super dominance by juniper with concomitant resource alteration (Bedell et al. 1993; Rumpel et al. 1991; Bedell 1986; Caraher 1977; Burkhardt and Tisdale 1969). This perception has resulted in proposals to manage juniper woodlands that are different in degree and scope from what was done historically. If implemented, these management activities would have significant consequences for the distribution and abundance of juniper throughout large areas of eastern Oregon.

The Bureau of Land Management (BLM) Juniper Working Group, a resource management team chaired by Phil Rumpel, acknowledged that existing BLM land use plans needed to be updated because they only address this problem in a very broad sense (Rumpel 1991; but see BLM 1992a:2-21 et seq. and 1992b, examples of a recent plan and proposed plan amendment addressing juniper woodlands). The Juniper Working Group projected a budget of $23,000,000 was needed to restore lost biological diversity and productivity on 675,000 acres of "established dominant trees", and an additional $4,040,000 would be necessary to treat new juniper woodlands, primarily by burning.

Potential commercialization of the juniper resource also poses concerns for wildlife managers. For example, the design of a proposed chipping demonstration project in Nevada calls for the removal of "whole stands" within a 30-mile radius of the chip storage facility (Anon. 1986). Other management strategies are being developed to utilize juniper for multiple-cash crops or products, including Christmas trees, decorative boughs, essential oils, fenceposts, forage, fuelwood, furniture, hardboard, particle board, paneling, veneer and other products (Evans 1988; Buckman and Wolters 1986; Herbst 1977).

Other observers feel that the rate of juniper afforestation and potential consequences have been greatly overstated, and that schemes proposed to manage juniper stands are themselves very risky for the resource (e.g., DeBano and Klopatek 1988; Gifford 1986; Mehringer and Wigand 1986; Schmidt 1986; Brown, Evans, and Young 1985; and Hibbert 1979, 1983). Among other things, these critics caution that factors and processes driving vegetation change in juniper systems are complex, largely site specific, and that without a thorough site-history analysis, the consequences of intervention (or non-intervention) cannot be anticipated.

Many private and public land managers have already experimented with juniper woodland management projects in an effort to maintain or restore resource values. Evaluation of the benefits of these actions is made difficult by the lack of follow-up on the results of many of those projects. Yet the number and extent of juniper woodland management projects is certain to increase in the future.

Juniper Characteristics

Western juniper occurs in southeast Washington, eastern Oregon, southwest Idaho, northeast California, and northwest Nevada as a variant of the pinyon-juniper woodland; a forest type occupying more area in the Intermountain Region than all other forest types combined (Cronquist et al. 1972). Many plant communities with widely distributed plant species occur within this forest type, but only juniper occurs consistently throughout this range (Martin 1980; Dealy et al. 1981, 1977).

Bedell et al. (1993) describe adaptations of juniper to environmental conditions in eastern Oregon as follows: Germination takes place in all types of soils under cool, moist conditions, primarily beneath shrubs, aspen, or other juniper and conifers. Slow growth follows for the first 8-15 years, and 20-30 years may be required to overtop a host. Once overtopping occurs, growth proceeds rapidly. Western juniper becomes reproductive as early as 25 years of age if they are without competition from other vegetation, and become fully reproductive at approximately 75 years of age when the tree is 9-10 feet in height. Adult trees are large, long-lived, and very prolific, sometimes producing up to 45,000 female cones in a single year.

Young western juniper woodlands are found mostly on sites previously occupied by mountain big sagebrush/Idaho fescue and mountain big sagebrush/bluebunch wheatgrass plant communities (Bedell et al. 1993). Active afforestation of grass and shrublands by juniper, or conversion of already forested types, is being reported in ponderosa pine, sagebrush/bunchgrass communities, mountain mahogany, bitterbrush, aspen and riparian areas (Rumpel et al. 1991). Although new juniper woodlands may occasionally be located upslope from juniper trees occupying historic (pre-settlement) sites, they are usually found downslope (Bedell et al. 1993), showing the importance of gravity and water in cone dispersal. Juniper woodlands typically consist of low, evergreen trees that vary in form from shrub-like (with more than one branch arising at or near the ground) to low trees with straight trunks averaging 10 to 30 feet tall and 1 to 2 feet thick (Cronquist et al. 1972). Trees growing under optimum conditions occasionally reach up to 87 feet high with a trunk diameter of 13 feet. Juniper longevity has been estimated to be nearly 1000 years.

Juniper trees are usually spaced far enough apart that their branches do not touch; under these conditions the understory is usually composed of shrubs and herbaceous plants. In thick or heavily stocked stands, the understory contains very little herbaceous and shrub cover. Burkhardt and Tisdale (1969) report densities of over 800 juniper trees per acre in seral stands in southwestern Idaho. Densities of just over 400 trees per acre are typical of new juniper woodlands in Oregon, with more than half of these hidden within the shrub canopy (Bedell et al. 1993; Eddleman 1986).

Western juniper occurs in a broad range of seral stages - from scattered trees to dense, climax woodlands, encompassing stand sizes from one to 400,000 acres (Burkhardt and Tisdale 1969). Successional relationships are poorly known, although periodic fire, domestic livestock grazing, fuel and timber harvest, climatic change, and increasing atmospheric CO_2 levels have all been implicated as important influences (Miller et al. in press; West and Van Pelt 1986). Stand composition varies altitudinally and geographically (Cronquist et al. 1972), with almost pure stands at the lower elevational limits of the zone (determined by lack of moisture). Widely spaced stands may grow on deeper soils with big sagebrush, on rocky ridges with low sagebrush, and with stiff sagebrush on lithosols (Mehringer and Wigand 1986). At higher elevations, ponderosa pine often enters the association, forming a mixed woodland and eventually replacing the juniper at the upper limits of its range.

Pollen records indicate that juniper has experienced several large, altitudinal range displacements in the region since the end of the last ice age, 10,000 to 12,000 years B.P. (before present) (Miller et al. in press; Mehringer and Wigand 1984, 1986; Mehringer 1985). Trends toward increasingly warmer and drier conditions during the last 300 years B.P. have concentrated juniper distribution at elevations between about 1600 and 6500 feet on sites averaging 10 to 20+ inches of annual precipitation. On these sites, precipitation occurs principally as snow in winter and rain in spring and fall (Dealy et al. 1977). Juniper woodlands represent the driest, tree-dominated zone in the Pacific Northwest (Franklin and Dyrness 1988).

Before settlement, western juniper was present throughout eastern Oregon on three distinct types of substrate: pumice sands along the east front of the Cascade Mountains, rock outcrops in the Great Basin, and shallow soil areas underlain by deeply fractured bedrock in both sagebrush grasslands and montane forests (Bedell et al. 1993).

After settlement, established stands of juniper increased in density, sometimes as much as 10-12 times (Miller 1993). Typically, juniper spread into adjacent grass and shrubland communities. While all researchers agree that changes in fire regime and overgrazing by livestock following settlement were fundamental causes of juniper afforestation of grass and shrublands, other cultural practices (firewood collection, continued livestock grazing, cultivation, logging, mining, road construction and water diversion) and their consequences (e.g., increased atmospheric CO_2 levels, introduction of aggressive weed species) have contributed to current conditions (Miller et al. in press; Branson 1985; Lanner 1977).

Juniper acreage increased slowly in the late 1800s, perhaps caused by waves of seedling establishment during the relatively mild and wet climate between 1850 and 1923 (Miller et al. in press). The primary factor contributing to enhanced seedling survival following germination appears to have been reduced fire frequencies following settlement (Miller et al. in press; Branson 1985; Dealy et al. 1977). Livestock grazing has been implicated indirectly in juniper afforestation of sagebrush communities by reducing fire frequency through removal of fine fuels, and to a lesser extent by reducing juniper competition by perennial grass species. Many mammal and bird species also assist the process as primary vectors for juniper seed dispersal (Miller et al. in press).

Afforestation by western juniper has accelerated since the 1920s, probably due to an expanding seed source (Miller et al. in press; see also, Dealy et al. 1977). The speed with which this is occurring is apparent on Steens Mountain (Miller et al. in press). Prior to 1870, juniper densities on Steens Mountain were low; old trees were restricted to rocky outcrops. After a period of gradual increase, the total number of juniper on Steens Mountain doubled between 1975 and 1990, and the amount of juniper pollen has increased 500%, an indication of enhanced reproductive capacity as young juniper trees are reaching maturity.

Conversion of sagebrush communities to western juniper woodlands results in major changes in microclimate, water quantity and quality, and nutrient cycles. A summary of available literature confirms that significant differences exist for water cycles between sagebrush and juniper communities (Eddleman and Miller 1991; Miller et al. 1989), including potential decreases in understory production, water quality, annual stream flows and water yield, and increased peak stream flows. Yet experiments involving pinyon juniper removal often demonstrated only slight or temporary increases in soil water (Schmidt 1986; Everett and Sharrow 1985; Baker 1985; Hibbert 1979, 1983). In one case, killing juniper overstory increased water yield only if the dead trees were left in place to provide shade and wind resistance that reduced evaporation (Baker 1985).

Comparison of 10 natural ecosystems in the Blue Mountains found juniper systems produce, on average, significantly more sediment in simulated rainstorms than any other ecosystem (Buckhouse and Gaither 1982). However, it may be incorrect to conclude that such rates are intrinsic to the presence of juniper or can be easily remedied by its removal. Juniper systems are very heterogenous in terms of site and stand conditions, a situation further confounded by differences in past use, so that practical or comprehensive generalizations may be impossible to make (Evans 1988; Schmidt 1986; see, Evans 1988 and Buckman and Wolters 1986 for discussions of past uses).

Juniper can remain physiologically active during early spring, late summer and fall, allowing it to appropriate available moisture and nutrients at times when other plants are inactive (Bedell et al. 1993; Jeppesen 1977). Analysis of the distribution of nutrients in a juniper stand indicate nutrient concentrations occur in the tree and in the dense mat of fine roots beneath mature trees (Doescher et al. 1987). Greater access to nutrients and the ability to retain and recycle them within a zone of influence may give juniper a significant competitive advantage compared to shrub or herbaceous species.

With the addition of western juniper to a community, plant species richness initially increases. As the site succeeds to a closed woodland, plant species richness and abundance decreases (West and Van Pelt 1986; Burkhardt and Tisdale 1969). The actual decrease depends on site characteristics. On drier sites, such as lower elevation mountain big sagebrush plant communities, woodlands with 25 percent juniper canopy cover may be almost devoid of understory, while wetter sites may retain a moderate understory beneath 45 percent juniper canopy (Miller 1992). Bedell et al. (1993) note that perennial forbs are reduced first, followed by shrubs, and large bunchgrasses. Small bunchgrass are the last perennial species to be reduced. Occasionally, the only plants to remain in a heavily stocked juniper stand are low

growing annuals capable of using early season moisture. Understory plant losses occur more quickly and completely on shallow soils, and where grazing intensity is high.

Wildlife Use of Juniper

Wildlife uses of individual juniper trees increase or change as trees mature, with considerable variation between individual trees. These uses include diverse reproductive, feeding and protective cover functions; values which are greatest at the ecotone between juniper and sagebrush types, and where juniper stands are isolated from other forested communities (Maser and Gashwiler 1977). Large, mature or old-growth individuals provide the most diverse wildlife use opportunities and are an extremely valuable habitat component.

The number and type of wildlife species present in a particular juniper stand varies widely according to stand conditions, as well as characteristics of surrounding vegetation, location, season, and from year to year. Puchy and Marshall (1993) conservatively estimated that 95 species regularly occur in juniper woodlands (Table 1).

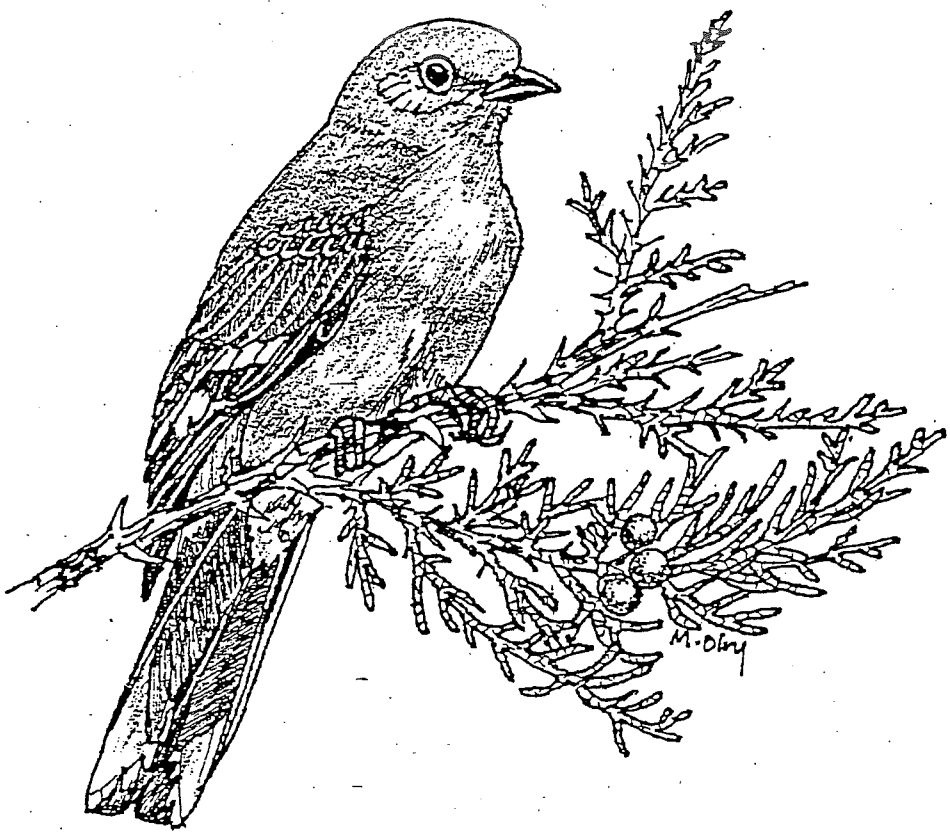


TABLE 1. Species regularly occurring in western juniper woodlands in Oregon.

Species	Status	Province					
		ESC	CB	HLP	BR	BM	OU
Long-toed Salamander	X	W				W	
Pacific Treefrog	XF	W	W	W	W	W	W
Sagebrush Lizard	FC	D	D	D	W	D	W
Western Fence Lizard	X	W	W	W	W	D	W
Side-blotched Lizard	X		W	W	W		W
Short-horned Lizard	XF	D	D	W	W	W	
Western Skink	X	D	D	D	W	D	D
Southern Alligator Lizard	XF	L					
Rubber Boa	X	D	D	D	D	D	D
Sharptail Snake	Xc		D				
Racer	X	W	W	W	W	W	W
Striped Whipsnake	X	L	D	D	D		D
(continued)							

Source: Puchy and Marshall (1993).

LEGEND

Species
- I - introduced
- G - game

Status
- X - general use
- C - used for cover
- F - used for feeding
- R -used for reproduction
- c - critical (species for which listing as threatened or endangered is pending or may be appropriate if immediate conservation actions are not table, includes some peripheral species which are at risk throughout range, and some disjunct populations)
- u - status unclear pending further study, may be susceptible to population decline
- v - vulnerable (sustainable populations may be maintained through continued or expanded use of protective measures)
- 2 - candidate for listing under federal Endangered Species Act, additional information needed
- S - federally listed "sensitive species" due to current, rapid population declines, small, widely dispersed populations, or which inhabit specialized or unique habitats.

Province
- ESC - East Slope Cascades
- CB - Columbia Basin
- HLP - High Lava Plains
- BR - Basin and Range
- BM - Blue Mountains
- OU - Owyhee Uplands.

Within Province Column
- W - widespread
- D - discontinuous or partial occupation of Province
- L - local population
- B - breeder, not present yearround
- N - nonbreeder
- Y - breeder, present yearround
- a - abundant
- c - common
- u - uncommon
- r - rare
- i - irregular

TABLE 1. Continued

Species	Status	Province					
		ESC	CB	HLP	BR	BM	OU
Gopher Snake	X	D	W	W	W	D	W
Night Snake	X		D	D	D		D
Western Rattlesnake	X	D	W	W	W	W	W
Turkey Vulture	RF	Cb	Cb	Cb	aB	Cb	cB
Sharp-shinned Hawk	F	uY	uY	uY	uY	uY	uY
Cooper's Hawk	F	uY	uY	uY	uY	uY	uY
Red-tailed Hawk	RF	cY	cY	cY	cY	cY	cY
Ferruginous Hawk	RF2c	uB	uB	uB	uB	uB	rB
Rough-legged Hawk	F	cN	cN	cN	cN	cN	cN
Golden Eagle	RF	uY	uY	uY	uY	uY	uY
American Kestrel	RF	cY	cY	cY	cY	cY	cY
Prairie Falcon	RF	uY	uY	uY	uY	uY	uY
Chukar (I,G)	RF	aY	aY	aY	aY	aY	aY
Mourning Dove (G)	RF	cY	aY	aY	aY	aY	aY
Great Horned Owl	RF	cY	cY	cY	cY	cY	cY
Northern Pygmy Owl	RFu	uY	uY	uY	uY	iY	uY
Burrowing Owl	RFc	uY	uY	uY	uY	uY	uY
Long-eared Owl	RF	uY	uY	uY	uY	uY	uY
Common Nighthawk	RF	aB	cB	aB	cB	cB	cB
Common Poorwill	RF	uB	uB	uB	uB	uB	uB
Rufous Hummingbird	F	uB	uB	uB	uB	uB	uB
Northern Flicker	RF	cY	cY	cY	cY	cY	cY
Dusky Flycatcher	RF	cB	uB	cB	aB	cB	cB
Gray Flycatcher	RF	cB	cB	cB	cB		uB
Ash-throated Flycatcher	RF	uB	uB	uB	uB	uB	uB
Western Kingbird	F	cB	cB	cB	cB	cB	cB
Horned Lark	RF	cY	aY	aY	aY	aY	aY
Tree Swallow	F	aB	aB	aB	aB	aB	aB
Violet-green Swallow	F	aB	aB	aB	aB	aB	aB
Northern Rough-winged Swallow	F	uB	uB	uB	cB	cB	uB
Bank Swallow	Fu	uB	uB	uB	uB	cB	uB
Cliff Swallow	F	aB	aB	aB	aB	aB	aB
Barn Swallow	F	aB	aB	aB	aB	aB	aB
Steller's Jay	F	cY	uN	uN	rN	cY	
Pinyon Jay	RF	uY		uY			

TABLE 1. Continued

Species	Status	Province ESC	CBL	HPB	BRM	BOU
Black-billed Magpie	RF	cY	cY	cY	cY	cY	cY
Common Raven	RF	uY	uY	cY	cY	cY	cY
Mountain Chickadee	RF	cY	uY	cY	uY	cY	uY
Rock Wren	RF	cY	aY	aY	aY	cY	aY
Canyon Wren	RF	uY	uY	uY	uY	uY	cY
Mountain Bluebird	RF	cY	cY	cY	cY	cY	uY
Townsend's Solitaire	F	uY	aN	cN	cN	uY	uN
American Robin	F	aY	aY	aY	cY	aY	aY
Sage Thrasher	RF	cB	cB	cB	cB	cB	cB
Bohemian Waxwing	F	iN	iN	iN	iN	uN	iN
Cedar Waxwing	F	uY	uY	uY	uY	cY	uY
Northern Shrike	F	uN	uN	uN	uN	uN	uN
Loggerhead Shrike	RF2S	uB	uB	uB	uB	uB	uB
European Starling	RF	cY	cY	cY	cY	cY	cY
Yellow-rumped Warbler		cY	cY	cY	cY	cY	cY
Black-throated Gray Warbler	RF	cB	uB	uB	uB	uB	uB
Townsend's Warbler	F	uB	uN	uN	uN	uB	uN
Green-tailed Towhee	RF	cB		cB	cB	uB	cB
Brewer's Sparrow	RF	cB	cB	aB	aB	uB	aB
House Finch	RF	aY	uN	uN	uY	aY	uY
Pine Siskin	F	aY	uN	uN	cY	cY	uN
Western Small-footed Myotis	X	D	L		W	L	W
Long-eared Myotis	X	W	W	W	W	W	W
Little Brown Myotis	X	W	W	W	W	W	W
Long-legged Myotis	X	W	W	W	W	W	W
Yuma Myotis	X	D	D	D	D	L	D
Silver-haired Bat	X	W	W	W	W	W	W
Townsend's Big-eared Bat	X2c	D	D	D	D	D	D
Pallid Bat	Xv	D	W	D	W	W	D
Mountain Cottontail	X	W	W	W	W	W	W
Black-tailed Jackrabbit	X	D	W	W	W	D	W
Yellow-pine Chipmunk	X	W	D	D	D	W	D
Least Chipmunk	X		D	W	D	W	D
Golden-mantled Ground Squirrel	X	W	W	W	W	W	W
Townsend's Ground Squirrel	X	D	W	W	W	D	W
Great Basin Pocket Mouse	X	D	W	W	W	D	W

TABLE 1. Continued

Species	Status	Province					
		ESC	CB	HLP	BR	BM	OU
Ord's Kangaroo Rat	X	D	W	W	W	D	W
Deer Mouse	X	W	W	W	W	W	W
Pinon Mouse	X	W	D	D			
Northern Pocket Mouse	X	D	W	W	W		D
Bushy-tailed Woodrat	X	W	W	W	W	W	W
Common Porcupine	X	W	D	D	D	W	D
Coyote	X	W	W	W	W	W	W
Long-tailed Weasel	X	W	W	W	W	W	W
American Badger	X	D	D	W	W	D	W
Bobcat	X	W	W	W	W	W	W
Mule Deer	X	W	W	?	W	W	W
Bighorn Sheep	X2				D	D	D

Elmore (1985) examined the effects of different grass, forb and shrub characteristics on wildlife species richness in mid-successional juniper woodlands in central Oregon and found variations greater than 100 percent (Table 2).

TABLE 2. Wildlife use, by species groups, for three major structural juniper habitats in Central Oregon.

Plant Community Species Group	Number of Species
Juniper/Big Sagebrush/Bunchgrass	
Reptiles and amphibians	14
Birds	88
Mammal	44
Total	146
Juniper/Low Sagebrush/Bunchgrass	
Reptiles and amphibians	8
Birds	59
Mammals	34
Total	101
Juniper/Bunchgrass	
Reptiles and amphibians	9
Birds	41
Mammals	21
Total	71

Source: Elmore 1985.

Because most wildlife species respond to the structure of vegetation more than to plant species composition, management that alters or reduces the structural diversity of juniper stands has important consequences for wildlife diversity. If juniper structure is altered on sites that are productive and diverse, habitat suitability for some species is reduced or lost. There appears to be a direct relationship between increasing structural alterations and greater species losses (Table 3).

Comparison of the number of species using juniper/sagebrush/bunchgrass with the number using juniper/bare ground habitats in the Great Basin shows striking differences; with 81 species breeding and 117 foraging in the former, and only 21 species breeding and 26 foraging in the latter (Maser et al. 1984).

Comparison of the number of species using different successional stages of western juniper in the Blue Mountains show relatively smaller differences; with an average of 65 species breeding and 86 species foraging in successional stages greater than or equal to 80 years old, and 56 species breeding and 92 species foraging in stages less than 80 years (Thomas 1979; appendix 11).

Current Conditions

The US Forest Service (USFS) prepared an inventory of the "juniper type" in eastern Oregon based on an analysis of photo points and field data collected in 1987 (Oswald 1990). Inventory criteria included at least 10 percent stocking and an analysis of proportional representation by other tree species present in each sample. These criteria excluded an unknown portion of stands in the critical seedling or sapling stage, and an insignificant number of stands managed by the USFS, but otherwise provided a description of current juniper woodlands by area, ownership, age, and other stand and site features.

TABLE 3. Number of wildlife species affected by changes in juniper habitat.

Present Habitat	Future Habitat	Number of Affected Species		
		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

Source: Elmore 1985.

Although a final, interpretive report on the results of the USFS inventory has not yet been completed, 2,172,800 acres of juniper type were identified in eastern Oregon, of which only 201,100 acres occurred in stands over 100 years old. In other words, the USFS estimated that 5.3 percent of the total land area in eastern Oregon (roughly 40,978,000 acres) was estimated to

be in the juniper type, but only 0.5 percent of the total land area was classified as occupying pre-settlement conditions.

The Western Juniper Working Group of the BLM compiled estimates prepared by individual BLM Districts (Rumpel et al. 1991) and determined that 1,004,000 acres in eastern Oregon were occupied by either closed juniper stands (areas of "total juniper domination"), or stands established since 1900 (Table 4). They further estimated an additional 900,000 to 1,200,000 acres of non-juniper shrub and grassland were susceptible to juniper domination during the next 20 years. These estimates predict a total affected area of 2,054,000 acres in eastern Oregon by the year 2111. Accordingly, 2.5 percent of the total land area in eastern Oregon was in closed juniper stands or new encroachment areas, and an additional 2.3 to 2.9 percent of the total land area was susceptible to juniper dominance.

TABLE 4. Estimate of acres (x1000) affected by western juniper afforestation in Oregon by BLM District (corrected).

District	Closed Woodlands	Post 1900	Susceptible Area
Lakeview	160	80	--
Burns	180	300	--
Vale		6	--
Prineville	260	18	-----
Total	600	404	1,050

Source: Rumpel et al. 1991.

A third estimate of juniper distribution was obtained by interpreting LANDSAT imagery acquired in July, 1988 (Kagan and Caicco 1992). This analysis identified 133 primary vegetation types in Oregon, including 15 types defined as components of a juniper woodland vegetation complex (Figure 1) and an additional 11 types feature juniper as a diagnostic or codominant tree species (Table 5). According to this analysis, there are 1,965,200 acres of western juniper woodland vegetation complex in eastern Oregon (approximately 4.8 percent of the total land area), and an additional 1,297,500 acres of vegetation featuring juniper as a codominant tree species (3.2 percent of total land area).

POLICY STATEMENT

It is the Fish and Wildlife Habitat Mitigation Policy (Habitat Mitigation Policy) of the Department to require or recommend, depending on the habitat protection and mitigation opportunities provided by specific statutes, mitigation for losses of fish and wildlife habitat resulting from land and water development actions (OAR 635-415-010). This policy applies to any activities on juniper dominated lands (subject to regulation by local, state, or federal agencies) which affect the distribution or abundance of western juniper and which could result in the net loss of fish and wildlife habitat, including planning, construction, and operational activities.

The Habitat Mitigation Policy directs the Department to recommend mitigation for development actions subject to regulatory authority of other agencies, and to require mitigation as a condition of a permit or order whenever the Department has statutory authority to do so. The Department shall also provide mitigation to meet goals and standards established in the policy when administering its own development actions. This will ensure that Department development actions conform to the same standards recommended or required for others.

The Habitat Mitigation Policy is primarily intended to prevent the loss of habitat values due to development actions. It also provides the flexibility to recommend enhancement of wildlife uses when sites show potential for habitat improvement. Thus, when sites have been degraded by historic uses or through fire exclusion, it may be appropriate for the Department to recommend juniper management action as mitigation for past or continuing development actions.

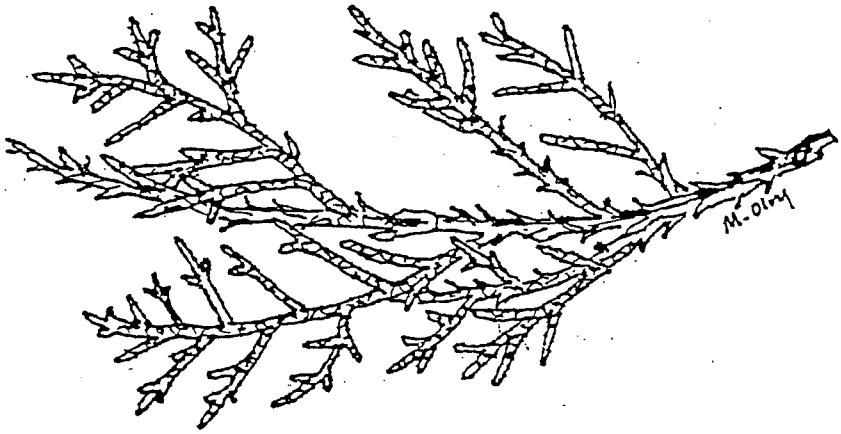


TABLE 5. Actual vegetation cover types in Oregon mapped by the Oregon Gap Analysis Program in which western juniper occurs as a dominant or codominant tree species.

VegetationCover Type	Acres (x1000)
Juniper Woodland Complex	
Juniper-Ponderosa Pine/Big Sagebrush	9.6
Juniper/Bunchgrass	95.4
Juniper/Low Sagebrush/Idaho Fescue	192.0
Juniper/Low Sagebrush/Sandberg Bluegrass	86.7
Juniper/Low Sagebrush/Tall Bunchgrass	52.9
Juniper/Big Sagebrush/Sandberg Bluegrass	13.6
Juniper/Big Sagebrush/Bluebunch Wheatgrass	444.3
Juniper/Big Sagebrush/Bottlebrush Squirreltail-Thurber Needlegrass	134.0
Juniper/Big Sagebrush/Idaho Fescue	333.2
Juniper/Big Sagebrush/Cheatgrass	86.1
Juniper/Mountain Big Sagebrush/Idaho Fescue	41.1
Juniper/Big Sagebrush-Bitterbrush	164.4
Juniper/Bitterbrush/Bluebunch Wheatgrass	43.2
Juniper/Bitterbrush/Idaho Fescue	68.5
Rimrock and Canyon Shrubland, with Sagebrush	200.9
	1965.2
Other Vegetation Characterized by Juniper as a Dominant or Diagnostic Tree Species	
Inland Sand Dunes	36.1
Bluebunch Wheatgrass-Idaho Fescue-Sandberg Bluegrass Canyon Grassland	697.7
Big Sagebrush/Western Needlegrass	82.6
Big Sagebrush Ash Beds	161.5
Big Sagebrush-Squaw Apple/Idaho Fescue	24.6
Big Sagebrush-Bitterbrush/Idaho Fescue	90.8
Big Sagebrush-Bitterbrush/Bluebunch Wheatgrass	15.4
Bitterbrush/Idaho Fescue and Bluebunch Wheatgrass and Western Needlegrass and Dry Sedges	24.1
Curlleaf Mountain Mahogany	27.4
Mountain Mahogany-Juniper Rimrock and Canyon Slopes	34.8
Owyhee Uplands Canyon, Shrubland-Grassland	102.5
	1297.5

Source: Kagan and Caicco 1992.

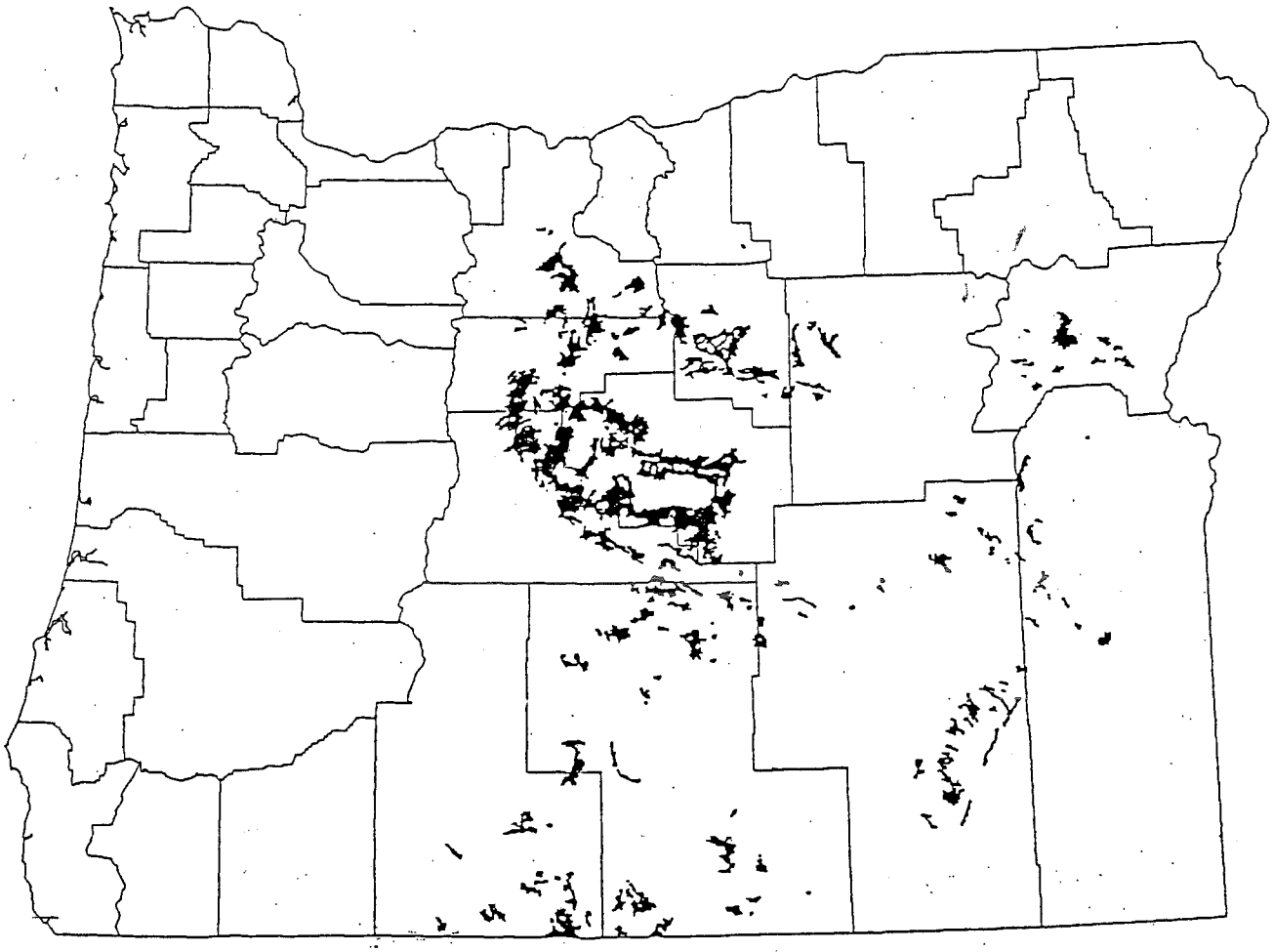


FIGURE 1. Generalized distribution of the juniper woodland vegetation complex in Oregon (black). Stand densities vary among and within the different localities. (Source: data compiled by Kagan and Caicco, 1992.)

MANAGEMENT RECOMMENDATIONS

Priority should be given to understanding project consequences in terms of ecosystem management, including cumulative impacts, with the goal of fostering self-sustaining ecosystem functions (Oregon Dept. of Fish and Wildlife 1992a, 1992b). This requires consideration of a variety of hypotheses and management techniques to increase our ability to predict the consequences of juniper succession, both with and without management intervention (Evans 1988; Schmidt 1986; West and Van Pelt 1986). It also means support for studies to collect baseline data, substantiate success at meeting objectives, and conduct post-treatment evaluations. Projects that lack funding for even minimal evaluation lack professional accountability and should be opposed (Gifford 1986).

Criteria for Determining Management Type and Methods

Management factors to consider at site, watershed and landscape scales include the desired future condition, present successional status, current habitat value and potential for key wildlife species, proposed operations, residual habitat characteristics, and post-operation treatments.

Desired Future Condition

Desired future condition for juniper systems in Oregon should be determined on a site-by-site basis, with consideration for each site's ecological potential, ability to respond to management, and the following factors:

1. Cooperative management of public and private lands for multiple-use and sustained-yield, with appropriate concern for state and federal legal constraints, private landowner objectives, fish and wildlife populations, habitat, and associated recreational opportunities.

2. Soil protection through vegetation management and site specific actions that keep all sites in satisfactory or better condition, with a stable or upward trend.

3. Water quality and quantity that meet or exceed requirements for wildlife needs and other beneficial uses.

4. Plant communities and plant species in the distribution and abundance necessary to sustain functional ecosystems, including all native plant communities, indigenous plant species, and fish and wildlife populations.

5. Restoration of riparian zones to full ecological functioning.

6. Reintroduction and management of fire as a beneficial ecosystem process.

7. Grazing practices that maintain, enhance or restore wildlife values.

8. Secure habitat for special status species, with populations that are stable or recovering.

9. Satisfaction of game species management objectives. (10) Expanded recreational opportunities through improved public access and management.

Successional Status

Intervention before a site is dominated by juniper and while desirable species are still well-represented in the community is less costly and more likely to achieve the desired result. Key variables to consider when evaluating a site's risk of conversion to western juniper woodland, and the likelihood of successful treatment for sagebrush grassland restoration, include:

- Size, number and location of juniper

  Consider present and potential canopy closure, vulnerability to fire, and opportunities to use slash for restoration of forbs, grasses, and shrubs.

- Density and condition of forbs, perennial grasses, and shrubs

  These species must be present for release following juniper removal, or must be reintroduced with subsequent vegetation treatments for successful recovery to occur. Also, if fire is to be used to destroy juniper, these species must be present in suitable quantities to support the flame height necessary to meet management objectives.

- Amount and type of weeds present

  The danger of stimulating infestation by cheatgrass, knapweed, medusahead or other undesirable species, and the need for additional treatments following juniper removal, must be weighed against the availability of desirable species for release.

- Amount of bare soil exposure

  Soil erosion is a common justification for juniper treatment. However, sites which are already in a state of degradation are highly vulnerable to further deterioration as a result of poorly planned management actions. Consider whether low soil cover, high rates of active soil erosion, low soil nutrients, low organic matter content, low cover or abundance of desired plant species, or low vigor of perennial forbs and shrubs indicate degraded conditions and the need for special erosion control measures as part of a juniper management project.

- Amount of wildlife use and habitat values present

  Juniper woodlands provide important life requisites for many birds, small mammals, big game, predators and other wildlife, including species classified as sensitive, threatened or endangered. Some so-called wildlife improvement projects in juniper systems have actually resulted in less productive habitat (Evans 1988). Important

questions to ask include whether the proposed project area needs additional or improved habitat values, how much of the area should be treated for optimum benefits for an evaluation species or species group (see, Habitat Mitigation Policy), when should the area be treated, and what methods should be used to obtain the desired results and benefits.

Juniper Removal

Juniper removal has been prescribed to address a range of resource concerns, including degraded water cycles, soil erosion, wildlife habitat losses, and domestic livestock forage. Increasing market demands for an inexpensive wood biomass for use as energy, fiber, and chemical products may be expected to lead to commercial and rural development projects (including large-scale, whole-tree harvesting and chipping) that will provide further incentives for juniper removal (Anon. 1986; Evans 1988; Herbst 1977; McLain and Henderson undated).

Juniper removal traditionally has meant mechanical treatment, including bulldozing or chaining, followed by piling and burning (Evans 1988; Winegar and Elmore 1977). This often resulted in high nutrient losses and damaged soils that were quickly colonized by weeds (Evans 1988; Everett 1986), and the possible loss of long term productivity (DeBano and Klopatek 1988).

Chemical control has proven to be neither biologically effective nor economical, although some compounds are partially effective on smaller sized trees (Bedell et al. 1993; but see, Evans 1988; Baker 1985; Evans and Young 1986, comparing chemical, mechanical or wood-cutting strategies to control all layers of juniper vegetation).

Western juniper is vulnerable to fire only if sufficient flame lengths can be generated to ignite and consume canopy levels. For trees six to 15 feet tall, this will require large amounts of brush fuel and burning during hot seasons. Burning under such conditions may contribute to further losses of site productivity. Even if livestock are excluded from small burns (e.g., 20 to 40 acres), wildlife are often attracted in concentrations large enough to significantly hinder recovery (Svejcar 1992). This problem may be avoided using larger scale burns, a strategy that may also result in proportionately less disturbed area due to fire-break construction. Successful use of fire as a juniper removal method requires grazing strategies before burning that will allow accumulations of fine fuels needed to carry the fire, and grazing practices following burning to allow for rehabilitation of shrubs and grasses.

The preferred methods of juniper control for trees not susceptible to fire (either due to lack of fine fuels to carry fire from tree to tree, or because tree density or height make burning impractical) are hand-operated power tools, hand saws and axes. These tools offer the primary advantages of selectivity, usefulness in sensitive habitats and areas inaccessible to vehicles, and retention of biomass on site. Determination of what will be left should be made before cutting begins, with individual leave trees marked as a guide for cutting crews. Attempts to make such decisions as cutting occurs, or leaving such decision to individual workers, will lead to less favorable results.

Factors to consider when manually falling juniper trees include timing, tree handling, special habitats, and landscape pattern.

- Timing

  Fall and early winter are preferred so the site will benefit from moisture accumulations during winter that will enhance growth opportunities during the first post-operational season.

- Tree handling

  The least expensive method is to drop individual trees in place, taking care to remove all lower limbs to prevent regrowth. In some cases, cut-and-leave treatments combined with livestock removal from severely degraded sites with extensive bare soil resulted in a doubling of understory cover (from 2.5 to 5 percent) and added 13 plant species in a single year (Miller 1992). Limbs of fallen trees provide a protected environment through which brush and grass can grow without being grazed by big game or livestock, thus providing a good seed source for the surrounding area (Morgan 1992). Laying trees across slopes may also provide significant soil retention benefits during storm runoff periods (Svejcar 1992).

  Limbing the trunk completely and scattering branches may accelerate revegetation of ground that would otherwise be shaded until foliage drops off the fallen tree, a period that may last up to 36 months depending on tree size and canopy density. Scattering branches releases nutrients slowly and moderates microclimate and soil moisture during both summer and winter. Another alternative may be to chip residues and spread or spray them over the soil surface.

  All old-growth western junipers should be retained for their unique habitat value. The best field characteristic with which to identify old-growth appears to be crown form. Young, actively growing individuals typically have a symmetrical, cone-shaped top, while old growth specimens are round or flat-topped. Size alone is not useful, since trees on productive sites may exceed 50 feet in height and 24-inch dbh in 80 years, while less productive sites support 200-year-old trees that are only 12 to 15 feet tall and less than 12-inches dbh (Miller 1993).

  Guidelines for tree retention (standing or unpiled and unburned) suggested by Elmore (1985) include leaving a range of tree sizes and ages, with special attention to: 1) trees greater than 24 inches dbh; 2) occasional single trees for rabbits, birds and small mammals; 3) all dead trees and snags should be left as perch sites for hawks, owls, and other birds; and 4) trees with holes and hollow centers should be left for small mammals, bluebirds, and other cavity nesting species. If material is piled, retain one unburned pile per acre (of variable sizes but no larger than 25 feet in diameter and 8 feet in height) constructed with accessible centers (Elmore 1985) which will maximize their usefulness for species such as cottontails and bobcats, particularly in areas where bobcat denning areas are limited.

- Special habitats

  Degradation of special habitats, such as aspen stands and riparian zones, often leads to juniper establishment and further degradation. If juniper cutting is prescribed to restore such areas, whole trees, branches and trunks generated by cutting are themselves resources that can be used to protect and restore these special habitats.

  Some riparian areas may benefit from juniper retention for shading and channel stabilization. Juniper is very intolerant to high water tables, so individuals left for channel stabilization should succumb naturally as riparian areas recover and the water table rises. Juniper rip-rap (using material cut outside the riparian area) placed on cut banks aids bank stabilization. Upland sites should be treated prior to, or in conjunction with, treatment of riparian sites for successful recovery of the riparian area to occur.

  Thinning or removal of juniper trees on adjacent uplands improved watershed conditions and contributed to the restoration of riparian areas at Bear Creek and Horse Heaven Creek in central Oregon (Chaney et al. 1990; Bedell 1986). It appears that in each case, however, reforms in livestock management were more fundamental to recovery. Grazing modifications at Bear Creek included more than a decade of partial rest followed by four years of complete rest, construction of riparian pastures, and adoption of an early spring grazing system. At Horse Heaven Creek, three years of rest, riparian pastures, and short-early grazing were used. Complete rest from livestock grazing for twenty years without juniper cutting produced similar recovery at a site along the Crooked River in central Oregon, including uplands, and juniper in the riparian zone now appear to be dying spontaneously (Myron 1992).

  Aspen suckers need to be protected from browsing by piling juniper debris in a manner that prevents livestock and grazing wildlife accessing to suckers.

- Landscape pattern

  Wildlife populations or diversity may increase if management promotes plant species richness and vegetation diversity, including breaking-up large tracts of juniper dominance. In general, a mosaic pattern of juniper woodlands and openings is desirable because it provides habitat opportunities for the greatest number of wildlife species. Guidelines concerning the size, shape, and distribution of post-treatment habitat elements are available to maximize project benefits for some featured species or species groups (Table 6).

TABLE 6. Sources for detailed guidelines concerning habitat requirements of selected species using landscapes containing western juniper habitats.

Species	Key Habitat References
Native Trout	Bowers et al. 1979
Salmonids	Everest et al. 1985
Sage Grouse	Call and Maser 1985
Small Mammals	Sieg 1988 (Rocky Mountain juniper)
Elk and Deer	Witmer et al. 1985; Thomas 1979
Mule Deer	Leckenby 1977; 1986; Leckenby and Toweill 1983a, 1983b; Leckenby et al. 1982; Leckenby 1977
Bighorn Sheep	Van Dyke et al. 1983
Pronghorn	Kindschy et al. 1982
Wildlife Diversity	Evans 1988; Elmore 1985; Maser and Gashwiler 1977

Post-Operation Treatments

Fire

The application of fire as soon as treated juniper materials are dry enough to burn (whether to remove dead and down materials, increase access for livestock, or destroy juniper seedlings) has often resulted in high nutrient loss, "scalded or sterile soils", weed infestations, delayed recovery of desired vegetation, and possible long-term losses in site productivity. This is particularly true for degraded sites where materials were piled before burning, resulting in sustained high temperatures.

It is desirable to use fire after five to ten years of rest from livestock grazing during periods when perennial species are dormant. At this point, shrubs and herbaceous vegetation have had time to develop and produce sufficient fuel to support a moderate fire capable of controlling fire-sensitive juniper seedlings and young trees. Virtually all researchers agree that reintroduction of fire is essential to prevent the reestablishment of juniper saplings that must be cut for control, and to encourage the development of vertical and horizontal stand diversity. Maintenance burning at intervals of less than 40 (20 to 25) years should be sufficient to maintain a mountain big sage-grass ecosystem (Miller 1992).

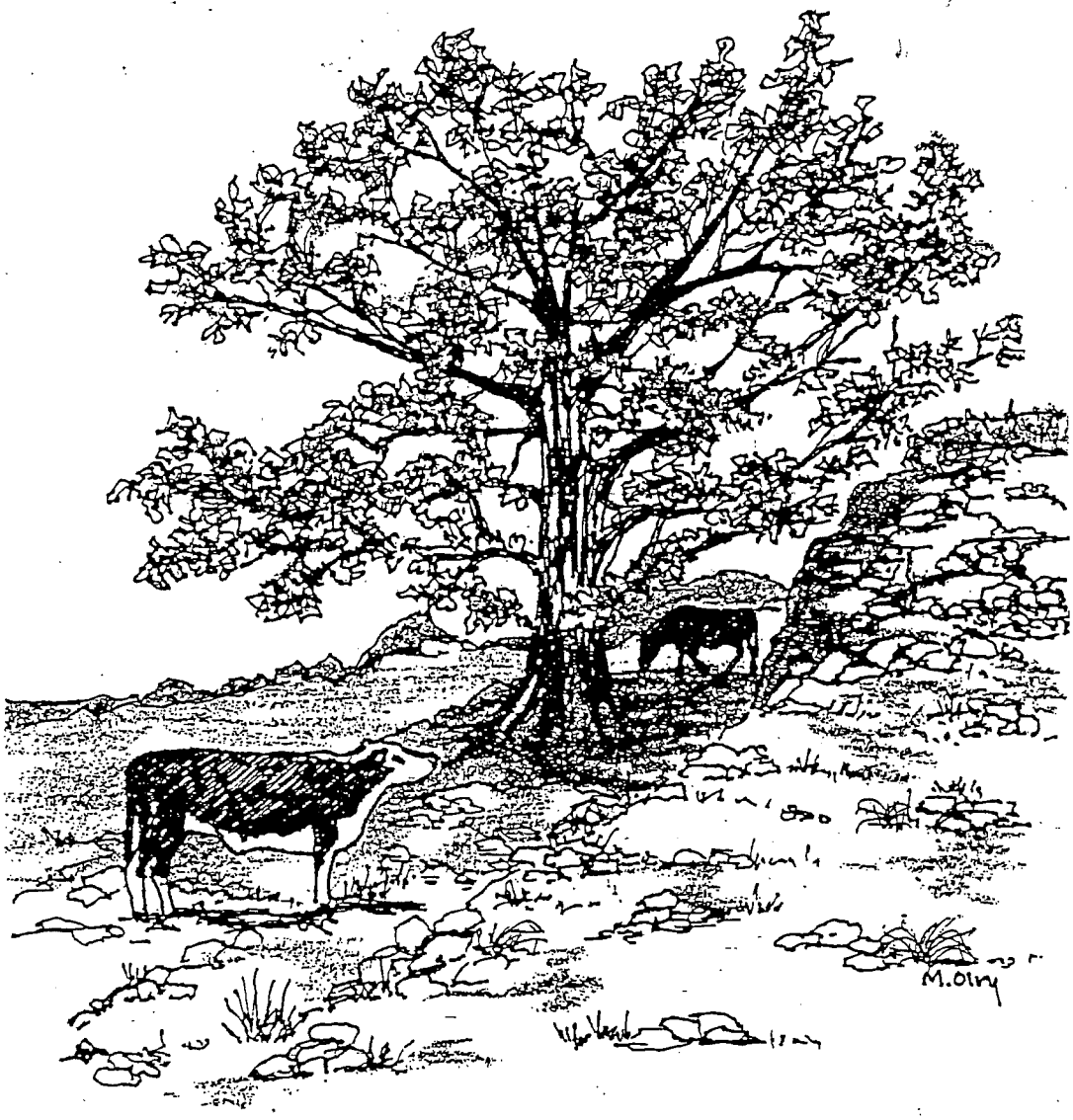
Livestock Grazing

Livestock grazing has been implicated in the expansion of western juniper by reducing grass competition and fire occurrence. Eliminating grazing, or limiting it to light levels, may slow the rate of juniper expansion but is unlikely to stop it altogether.

For site recovery to take place after juniper removal has occurred, it is critical to allow perennial herbaceous and shrub species to spread and become established. In many cases, partial or

complete rest from grazing will be necessary. Rest may be accomplished by area closure, where appropriate, or by reduced accessibility where fallen junipers are left lying. Where good perennial forage is present, two to five years of rest during the growing season, with light grazing allowed during the dormancy (late fall or winter), may be sufficient.

On the most seriously degraded sites, active restoration (such as artificial seeding, weed control, and shrub transplants with an interval of complete rest) may be necessary. Once desired stand conditions are achieved, grazing may resume - provided proper livestock management is integrated with a fuel management program supporting adequate maintenance burning to prevent site regression.



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Appendix A

Common and Scientific Names of Plants and Animals Mentioned in Text

Plants

Quaking Aspen *Populus tremuloides*
Ponderosa Pine *Pinus ponderosa*
Western Juniper *Juniperus occidentalis* var. *occidentalis*
Big Sagebrush *Artemisia tridentata* subsp. *tridentata*
Bitterbrush *Purshia tridentata*
Low Sagebrush *Artemisia arbuscula* subsp. *arbuscula*
Mountain Big Sagebrush *Artemisia tridentata* subsp. *vaseyana*
Curlleaf Mountainmahogany *Cercocarpus ledifolius* var. *ledifolius*
Bluebunch Wheatgrass *Agropyron spicatum*
Bottlebrush Squirreltail *Sitanion hystrix*
Cheatgrass *Bromus tectorum*
Crested Wheatgrass *Agropyron cristatum*
Idaho Fescue *Festuca idahoensis*
Sandberg Bluegrass *Poa sandbergii*
Squawapple *Peraphyllum ramosissimum*
Thurber Needlegrass *Stipa thurberiana*
Western Needlegrass *Stipa occidentalis*

Animals

Long-toed Salamander *Ambystoma gracile*
Pacific Treefrog *Psuedacris regilla*
Sagebrush Lizard *Sceloporus graciosus*
Western Fence Lizard *Sceloporus occidentalis*
Side-blotched Lizard *Uta stansburiana*
Short-horned Lizard *Phrynosoma douglasi*
Western Skink *Eumeces skiltonianus*
Southern Alligator Lizard *Elegaria multicarinatas*
Rubber Boa *Charina bottae*
Sharptail Snake *Contia tenuis*
Racer *Coluber constrictor*
Striped Whipsnake *Masticophis taeniatus*
Gopher Snake *Pituophis melanoleucus*
Night Snake *Hypsiglena torquata*
Western Rattlesnake *Crotalus viridus*
Turkey Vulture *Cathartes aura*
Sharp-shinned Hawk *Accipiter striatus*
Cooper's Hawk *Accipiter cooperi*

Red-tailed Hawk *Buteo jamaicensis*
Ferruginous Hawk *Buteo regalis*
Rough-legged Hawk *Buteo lagopus*
Golden Eagle *Aquila chrysaetos*
American Kestrel *Falco sparverius*
Prairie Falcon *Falco mexicanus*
Chukar *Alectoris chukar*
Mourning Dove *Zenaida macroura*
Great Horned Owl *Bubo virginianus*
Northern Pygmy Owl *Glaucidium gnoma*
Burrowing Owl *Speotyto cunicularia*
Long-eared Owl *Asio otus*
Common Nighthawk *Chordeiles minor*
Common Poorwill *Phalaenoptilus nuttali*
Rufous Hummingbird *Selasphorus rufous*
Northern Flicker *Colaptes auratus*
Dusky Flycatcher *Empidonax oberholseri*
Gray Flycatcher *Empidonax wrightii*
Ash-throated Flycatcher *Myiarchus cinerascens*
Western Kingbird *Tyrannus verticalis*
Horned Lark *Eremophila alpestris*
Tree Swallow *Tachycineta bicolor*
Violet-green Swallow *Tachycineta thalassina*
Northern Rough-winged Swallow *Stelgidopteryx serripennis*
Bank Swallow *Riparia riparia*
Cliff Swallow *Hirundo pyrrchonota*
Barn Swallow *Hirundo rustica*
Steller's Jay *Cyanocitta stelleri*
Pinyon Jay *Gymnorhinus cyanocephalus*
Black-billed Magpie *Pica pica*
Common Raven *Corvus corax*
Mountain Chickadee *Parus gambeli*
Rock Wren *Salpinctes obsoletus*
Canyon Wren *Catherpes mexicanus*
Mountain Bluebird *Sialia currucoides*
Townsend's Solitaire *Myadestes townsendi*
American Robin *Empidonax wrightii*
Sage Thrasher *Oreoscoptes montanus*
Bohemian Waxwing *Bombycilla garrulus*
Cedar Waxwing *Bombycilla cedrorum*
Northern Shrike *Lanius execubitor*
Loggerhead Shrike *Lanius ludoviciana*
European Starling *Sturnus vulgaris*
Yellow-rumped Warbler *Dendroica coronata*
Black-throated Gray Warbler *Dendroica nigrescens*

Townsend's Warbler *Dendroica townsendii*
Green-tailed Towhee *Pipilo chorurus*
Brewer's Sparrow *Spizella breweri*
House Finch *Carduelis mexicanus*
Pine Siskin *Carduelis pinus*
Western Small-footed Myotis *Myotis ciliolabrum*
Long-eared Myotis *Myotis evotis*
Little Brown Myotis *Myotis lucifugus*
Long-legged Myotis *Myotis volans*
Yuma Myotis *Myotis yumanensis*
Silver-haired Bat *Lasionycteris noctivagans*
Townsend's Big-eared Bat *Plecotus townsendii*
Pallid Bat *Antrozous pallidus*
Mountain Cottontail *Sylvilagus nuttallii*
Black-tailed Jackrabbit *Lepus californicus*
Yellow-pine Chipmunk *Tamias amoenus*
Least Chipmunk *Tamias minimus*
Golden-mantled Ground Squirrel *Spermophilus lateralis*
Townsend's Ground Squirrel *Spermophilus townsendii*
Great Basin Pocket Mouse *Perognathus parvus*
Ord's Kangaroo Rat *Dipodomys ordii*
Deer Mouse *Peromyscus maniculatus*
Pinon Mouse *Peromyscus truei*
Northern Grasshopper Mouse *Onochomys leucogaster*
Bushy-tailed Woodrat *Neotoma cinera*
Common Porcupine *Erethizon dorsatum*
Coyote *Canis latrans*
Long-tailed Weasel *Mustela frenata*
American Badger *Taxidea taxus*
Bobcat *Lynx rufus*
Mule Deer *Odocoileus hemionus*
Bighorn Sheep *Ovis canadensis*