Distribution, Composition, and Classification of Current Juniper-Pinyon Woodlands and Savannas Across Western North America

Neil E. West

Abstract—Pinyon-juniper woodlands involve vegetation dominated by about seven species of *Pinus* and 17 species of *Juniperus* scattered over more than 75 million acres of the Southwestern United States and Mexico. The junipers are more widespread latitudinally, longitudinally, and elevationally than the pinyons. The understory is much more diverse and reflects largely local climatic patterns. Grasslands and shrub steppes have successionally preceded pinyon-juniper savanna to woodland on sites with gentle slopes and fine soil textures. Excessive livestock grazing and direct fire control are the major factors which have led to present tree dominance. Tree dominance can be regarded as a sign of ecosystem degradation on sites formerly occupied by native herbs and shrubs. On many sites, trees will be eventually replaced by introduced herbs following fire storms unless proactive management is undertaken.

Tausch (this volume) has outlined how pinyon-juniper woodlands came to be. My task is to outline where these woodlands and savannas are presently found and how they currently vary in tree dominance and understory composition across the western half of the North American midsection. I will conclude with suggestions of how this information can be applied in land management.

Longitudinal and Latitudinal Patterns of Tree Dominance

I am considering here all lands with semiarid climates west of 103° W. long. in North America currently occupied by at least one drought-tolerant juniper (section *Sabina*) and/or one drought-tolerant pine (subsection *Cembroides* = the Pinyons). According to Küchler (1970), this amounts to about 75 million acres in the United States (Fig. 1) and an unknown additional area within Mexico. Juniper-Pinyon woodlands and savannas as a whole are a very coarse category, only useful when comparing nationally or regionally to other coarse (internally heterogeneous) categories such as yellow pine forests or sagebrush steppe.

The most obvious way to begin finer subdivision of these lands is to consider what the dominant trees are. Table 1 indicates the distribution of the major tree species in juniper-pinyon savannas and woodlands across western North America. Junipers are much more widespread than pinyons. The furthest north that self-sown pinyon occurs is in extreme southern Idaho. Thus, juniper only woodlands and savannas occur north of there. Pure pinyon woodlands, dominated by *Pinus monophylla*, exist only in extreme western Nevada and adjacent California where summer precipitation is minimal. From about 38° N lat. southward, pinyons, junipers, and oaks (*Quercus* spp.) become intimately intermingled (West 1998).

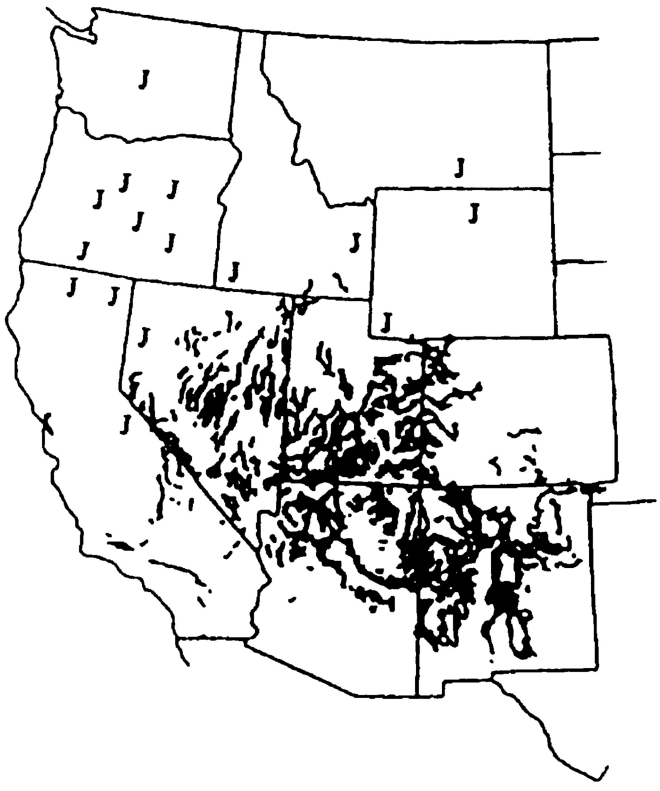

Figure 1—Geographic distribution of juniper-pinyon woodlands in the Western United States (according to Küchler 1970) with J's indicating pure stands of *Juniperus occidentalis* in the Pacific Northwest and *J. scopulorum* in the Northern Rocky Mountains and Great Plains.

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Table 1—Distribution of principal tree species in juniper-pinyon savannas in various sections of western North America. Nomenclature follows Flora of North America Editorial Committee 1993.

Area	Pines	Junipers	Others
British Columbia and Alberta		*Juniperus scopulorum*	
Interior Pacific Northwest (Oregon, Washington, Idaho)		*J. occidentalis*	
Northern Rocky Mountains and adjacent Plains (Montana, Wyoming)		*J. scopulorum* *J. osteosperma*	
Eastern and Central Great Plains		*J. virginiana*	
Great Basin	*Pinus monophylla*	*J. osteosperma*	
Colorado Plateau	*P. edulis*	*J. osteosperma*	
Southern Great Plains and Edwards Plateau		*J. ashei* *J. pinchotii*	
Mogollon Rim	*P. edulis*	*J. monosperma* *J. deppeana*	*Cupressus arizonica*
Baja California Norte (Sierra Juarez)	*P. quadrifolia*	*J. californica*	
Sierra Madre Occidental	*P. cembroides*	*J. coahulensis*	*Quercus* spp.
Big Bend-Trans Pecos	*P. cembroides*	*J. deppeana* *J. flaccida*	*Quercus* spp.
Sierra Madre Oriental	*P. cembroides*	*J. coahulensis* *J. flaccida* *J. monosperma*	*Quercus* spp.
Serranias Meridionales del Altiplano Potosino	*P. ayachuite* *P. cembroides* *P. joharinis*	*J. flaccida*	*Quercus* spp.
Sierra Madre del Sur	*P. teocote*		
Sierra Madre de Chiapas		*J. comitana* *J. gamboana* *J. monticola*	

Elevational Patterns of Tree Dominance

Elevational segregation is usual in regions where both pinyons and junipers occur. Pinyons, being less tolerant of drought and cold than junipers, usually dominate in the middle elevations where both occur. Junipers tend to dominate both the higher and lower elevations of the woodland belt of Intermountain mountain ranges.

Within a given region, the density of woodland, both historically and currently, is strongly related to topoedaphic gradients. The trees persisted throughout past centuries on steeper, rockier, and thus less burned sites. Less steep sites, especially those with finer textured soils are where savannas, grasslands, and shrub steppes have occurred in the past. Various densities of younger trees now occur on such sites, largely because of new fire and grazing regimes recently imposed by Euroamericans. Understanding these dynamic relationships is a key to managing the current situations. For instance, Creque and others (this volume) describe the vegetational and environmental changes in semiarid portions of upper Tintic Valley, Utah. They delineated ecological sites based on soils, topography, and vegetational history. These stratifications can then focus local managerial actions to where it is most justified and responsive.

Patterns in Understory

Juniper-pinyon savannas and woodlands have understories that are both floristically and structurally more variable than the overstory. Generally the understory is compositionally similar to that of adjacent grasslands, shrub steppes, chaparral and forests (West and others 1975; West and Young 1998). For instance, in the western juniper woodlands and savannas of the Pacific Northwest, the understory is mostly a mixture of sagebrushes (Section *Tridentatae* of *Artemisia*) and cool season bunchgrasses. The relatively wet winters and dry summers there favor plants that can either complete their growth before midsummer, like the cool

season grasses, or utilize deep soil moisture, as do the trees and shrubs (Flanagan and others 1992).

South and east of the Pacific Northwest, the portion of warm season bunch and sod grasses increases and the amount of shrubs declines as the fraction of total annual precipitation received during the summer increases. Juniper and pinyon stands of New Mexico, Texas, and northern Mexico thus have more half-shrubs (suffrutescents), such as *Senecio longilobus*, *Gutierrezia* spp., *Brickellia* spp., *Haplopappus* spp., and *Salvia* spp. and succulents, such as various cacti and monocots (for example, *Agave* spp., *Nolina* spp., *Yucca* spp., *Dasylirion* spp.) than true shrubs. Warm season, C_4 grasses which dominate are from the nearby semidesert grasslands or southern mixed and shortgrass prairies, including species of *Aristida*, *Digitaria*, *Eragrostis*, *Bouteloua*, *Hilaria*, *Sporobolus*, *Muhlenbergia*, *Schizachyrium*, *Botriochloa*, *Lycurus*, *Piptochaetum*, and *Leptochloa*, where not excessively grazed (Moir 1979; Pieper 1992).

Forbs associated with juniper-pinyon savanna or woodlands also display distinctive geographic distributions. Understory forbs in juniper stands of the Pacific Northwest and Great Basin are derivatives of the tree-dominated Arctotertiary Geoflora (Axelrod 1976). Principal genera are *Lupinus*, *Penstemon*, *Castelleja*, *Balsamorhiza*, *Allium*, etc. On the Colorado Plateau and south and east of that region, forbs associated with juniper and pinyons are mostly derivatives of the Madro-tertiary Geoflora (Axelrod 1958), a heat-tolerant group of plants. Example genera are *Croton*, *Euphorbia*, *Ipomea*, *Solanum*, *Polygala*, and herbaceous *Salvia* (Pieper 1992; Romero Manzanares and others 1998). Abundance of annuals varies greatly from year to year (Treshow and Allan 1979) making them of little value as indicators of other than near term climatic influences.

Vegetation Dynamics

The foregoing "snapshot" of how we currently find juniper-pinyon dominated vegetation is incomplete without considering the dynamics of the vegetation on several scales in time and space. Tausch (this volume) covered the "deep" past. Focus on the more recent and local can be found in Gruell, Young, and Harper (this volume). Rather than repeating their stories, all I will offer here is the fact that the current conditions are far from the pre-Euroamerican situation when much more savanna (grassland or shrub mosaic with scattered trees) and less woodland (trees are the dominant matrix) and forest (where numerous tree crowns touch) existed.

The local plant community structure where junipers and pinyons are involved shows at least two phases (Fig. 2); a tree-centered phase where microclimates and soils are controlled by the trees; and a non-tree dominated open interspace where some mixture of shrubs, grasses, and forbs prevail. Everett and others (1983) add a third phase, the drip-line. As trees have become the matrix, many attributes of these ecosystems, such as the hydrologic and fire regimes, native animal and microbial communities have been altered as well (West 1998). Full expression of tree dominance, because it leads to diminished understory, has a negative influence on floristic and faunistic richness (West 1998). Long periods of exclusion of livestock grazing do little to aid

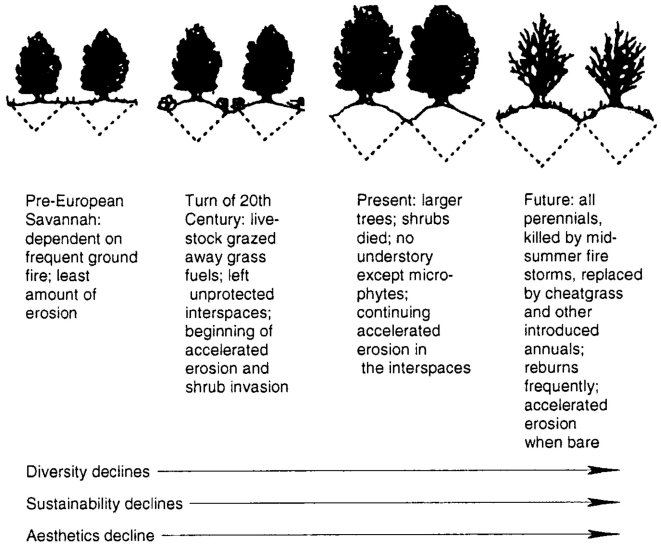

Figure 2—Depiction of how juniper-pinyon woodland structure changes through successional time (earlier to left, later to right). Broken lines are outer limits of tree roots.

recovery of the understory. Increased elk, feral horses, and jackrabbits can keep the diminished understory in check (Yorks and others 1994).

Whether these trends toward tree dominance are degradational or aggradational is a much disputed topic. One's conclusions on this issue determines whether proactive or custodial management is to be favored. While conservation biologists (for example, Belsky 1996) favor hands-off management of these woodlands, many others, myself included, regard the changes on most ecological sites as degradational (West 1998), and thus meriting proactive management.

Numerous forces have independent influences on tree or interspace-dominated phases of juniper-pinyon savannas and woodlands (Table 2). Causes of vegetational change are, however, rarely singular or simple. Synergistic interactions are the norm. The major compound effect is how livestock reduced the fine continuous fuel when savannas prevailed and along with both direct and indirect reductions in fire, allowing the trees to increase. Trees now control most sites and accelerated erosion prevails where slope and surface soil texture allow (Davenport and others1997).

Management Implications

The future holds increased probability of crown-fires, invasion by introduced annuals and short-lived perennials, and then repeated burning and permanent site degradation unless seeding of desirable understory takes place expeditiously. Different portions of the vast juniper-pinyon type have and will change differently. Each ecological site presents different potential in response to both passive and active management. Winward (this volume) tells you how we can recognize these differences and use them for guiding management activities.

Table 2—Summary of forces changing the balance between trees and perennial grasses in pinyon-juniper woodlands. P = pinyons, J = junipers, + means that the growth form increases when the given variable increases, – means that the growth form decreases when the given variable increases.

Forces	Trees	Grasses
Climate		
cool, wet (P)	+	–
warm, dry (J)	–	+
increasing CO_2 in atmosphere	+	–
Grazing		
Extinct browsers	–	+
Livestock	+	–
Elk	+	
Feral horses	+	
Saw flies	–	+
Fire	–	+
Tree harvest	–	
Animals		
Jays and nutcrackers (P)	+	–
Chipmunks and ground squirrels (P)	+	–
Thrushes (J)	+	–
Rabbits and hares (J)	+	–
Livestock	+	–
Parasites	–	+
Pathogens	–	+

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