

Geology, Topography, and Soils of Pinyon and Juniper in the Great Basin and Northern Colorado Plateau

Purpose

This factsheet is an abbreviated version of the ecology section of the book [*The Ecology, History, Ecohydrology, and Management of Pinyon and Juniper Woodlands in the Great Basin and Northern Colorado Plateau of the Western U.S.*](#) by Richard Miller and others. The book is a thorough review of the current knowledge of pinyon and juniper ecosystems, both persistent and newly expanded woodlands. This factsheet provides just highlights—the full text draws from a large volume of research on these semi-arid woodlands with reviews and citations from hundreds of sources.

Distribution

Pinyon and juniper woodlands occupy over 70,000 square miles of the Great Basin and Colorado Plateau, extending across a significant climatic gradient from eastern Oregon to the Four Corners of Utah, Colorado, Arizona, and New Mexico. These semi-arid woodlands typically occupy precipitation zones between 8 and 20 inches, elevations of less than 1,000 to over 8,000 ft, and a wide variety of soils and parent materials. Pinyon and juniper woodlands often project the illusion of being homogeneous, but they vary in age, structure, composition, and often intermingle with other plant communities. The broad heterogeneity of these woodlands and the sites they occupy results in large spatial and temporal variations in ecohydrologic process, disturbance regimes, resilience to disturbance, response to vegetation management, and resistance to invasive species. The most common semi-arid conifer species in this region of the Western United States are Utah juniper (*Juniperus osteosperma* (Torr.) Little), western juniper (*J. occidentalis* Hook.), singleleaf pinyon (*Pinus monophylla* Torr. & Frem.), and twoneedle pinyon (*Pinus edulis* Engelm.). Common but less abundant within this region are Rocky Mountain (*Juniperus scopulorum* Sargent, Gard. & Forest) and Sierra (*Juniperus grandis* R.P. Adams) junipers.

Temperature and amount and seasonal patterns of moisture are the primary variables that determine the distribution of these semi-arid conifers and their varieties. Rapid warming periods interrupted by cold periods during late winter and early spring in the Northwest limit the northwestern distributions of Utah and singleleaf pinyon. Of the four species, Utah juniper is the most adapted to drought. Western juniper typically occurs in cooler, and somewhat wetter environments than Utah juniper. And, the two pinyons are separated by the amounts of summer precipitation.

Soils

Pinyon and juniper woodlands occupy a wide variety of soils, but there are some general differences in soil characteristics that occur between post-settlement and persistent woodlands. Soils occupied by persistent woodlands are

most commonly associated with shallow to restrictive layers including claypans, fractured basalt, and calcareous horizons and extremely cobbly, or very coarse-textured with gravelly surfaces, often resulting in shallow and transient soil moisture storage. Woodlands found on deeper and more productive soils (often with higher levels of organic matter) are mostly relatively young and were previously occupied by shrubland or grassland communities.

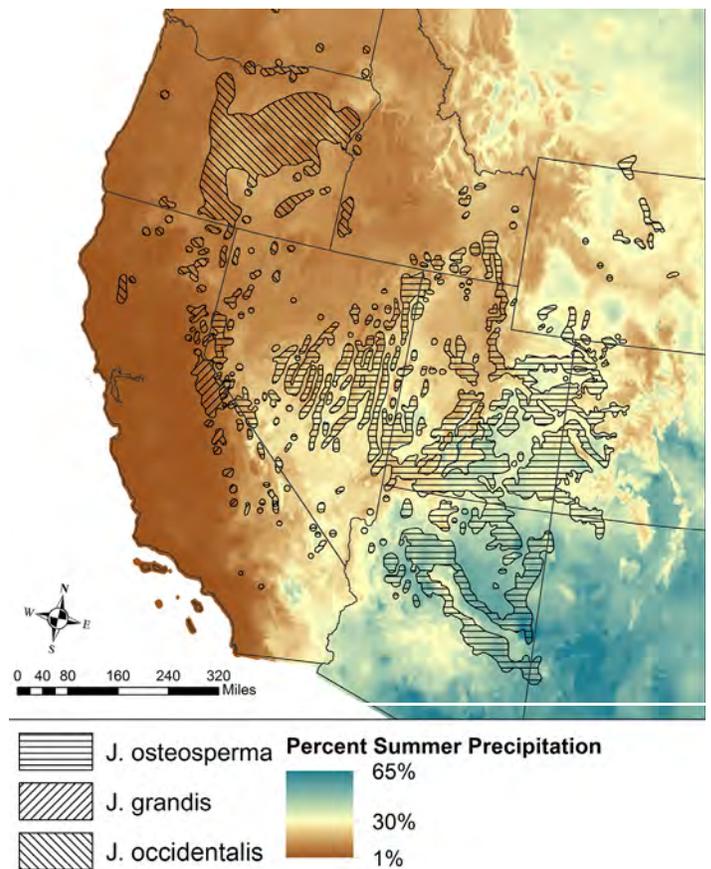


Figure 1. Distribution of three junipers across a monsoonal precipitation gradient in the Great Basin and Colorado Plateau (Map derived by David Board). For a map of Rocky Mountain juniper and pinyon distribution, see the full text.

Seed Ecology

Annual cone and seed development for the four-conifer species is highly variable both temporally and spatially, and requires at least two growing seasons to produce mature seed. Pinyon pines have short lived seeds and junipers relatively long, effecting the longevity and abundance of seed in the seedbank. In singleleaf pinyon, a typical mean seed crop during a year of heavy cone production ranges from 2,000 to 8,000 filled seeds per tree, but values for individual trees vary tremendously. Pinyon and juniper seeds are well adapted for dispersal by both birds and small mammals, with distances commonly ranging from several feet to several miles. Competition from forbs and grasses can reduce seedling emergence, but once established, competition appears to have little effect on survival.

Pests and Disease

Pinyon and juniper species are hosts to a large number of insects, disease, and fungi. All three can cause reductions in seed crops and increase susceptibility to other pests and mortality. Insects are the largest cause of mortality with ips (bark beetle) considered the most important insect mortality agent in the Colorado Plateau. Drought is closely linked to pest-outbreaks and can significantly increase mortality, especially in the Colorado Plateau.

Woodland Succession

Expansion of woodlands into sagebrush ecosystems is characterized by an inverse relationship of an increasing tree overstory and decreasing shrub and herbaceous understory. The time it takes woodlands to go from the very early to late successional stages (Phase I to Phase III) is largely determined by the key components of the ecological site and disturbance history. The shift from sagebrush-dominated ecosystems to woodland influences water, energy, and nutrient cycles; C and N pools; and disturbance regimes, wildlife habitat, resilience, and resistance to invasive species.

Climate Change

The earth's climate has been continually changing, long before the formation of the first pinyon and juniper woodland, and has had significant impact on woodland distribution, migration, expansion, contraction, infill, composition, structure, resilience, and resistance to invasive species. But recent concerns over natural climatic variation linked to anthropogenic effects on climate and disturbance regimes have raised considerable apprehension related to the future of these semi arid ecosystems in the West including pinyon and juniper woodlands. Increasing temperatures and changes in the amounts and seasonal distribution of precipitation will have significant impacts on persistence and migration of woodlands, insect and disease outbreaks, wildfire, and the expansion of invasive annual grasses. These impacts will likely vary regionally and at multiple scales across the Great Basin and Colorado Plateau.

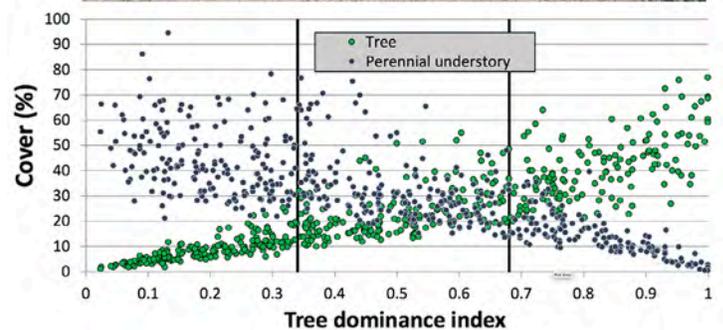
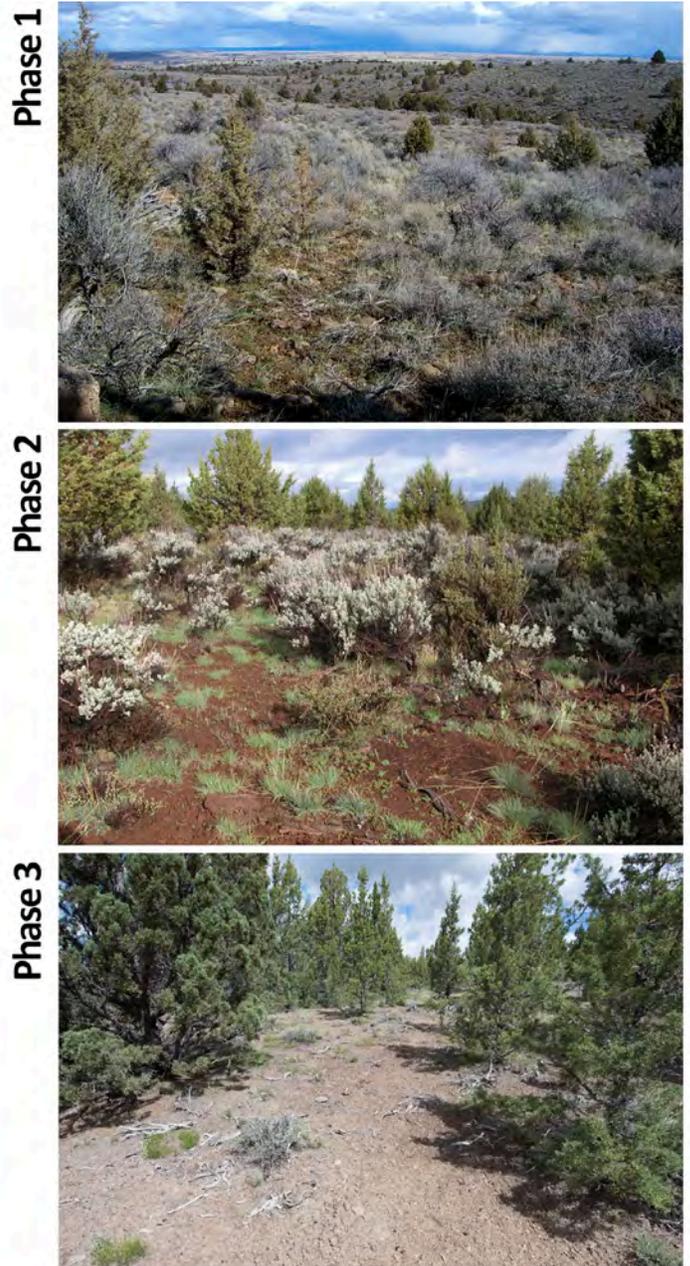


Figure 2. Changes in perennial understory cover and tree dominance (tree cover/[tree+shrub+tall perennial grass cover]) for 11 Great Basin sagebrush steppe sites ranging from Phase I to Phase III pinyon - juniper (derived from Roundy et al. 2014a).