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Pinyon-Juniper Encroachment: Effects on Wildfire

EXTENSION
College of Agriculture, Biotechnology & Natural Resources

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What is pinyon-juniper encroachment?

Pinyon-juniper encroachment is the expansion of pinyon-juniper woodlands into ecosystems that historically were shrublands or grasslands. These tree species have increased in abundance due to fire suppression, land use and favorable climate. A significant portion of this encroachment occurs in sagebrush rangelands and affects many processes within these ecosystems.

Key Points

- Fire exclusion has facilitated pinyon-juniper expansion into sagebrush ecosystems, changing the fuel amount and structure, leading to more severe fires.
- It is easier for invasive species, such as cheatgrass, to establish after more severe fires. Cheatgrass not only outcompetes native vegetation and changes species composition but is also highly flammable, which increases the likelihood of areas transitioning to an annual grassland that is more prone to future fire.
- Management of encroached sagebrush rangelands through tree removal can reduce fire severity and potentially lower the risk of non-native species invasion.

Altered fire regimes

Historically, fire in grasslands and sagebrush shrublands occurred often enough to maintain low tree densities and consume the smaller fuels, which resulted in minimal fuel accumulation. When fires burned, they were less intense, likely remained smaller in size, and had fewer adverse ecological effects. In the mid-1800s, however, wildfire declined for two primary reasons: 1) overgrazing by livestock reduced fine fuels (e.g., grasses and forbs), which reduced fire spread, and 2) fire from both natural ignitions and indigenous burning was suppressed. The reduction of fire over time, combined with substantially smaller populations of perennial grasses and forbs, likely facilitated pinyon-juniper encroachment into sagebrush rangelands. As trees dominate sagebrush ecosystems fuel amount, structure, and continuity change, altering fire behavior and effects in these systems. Total fuel loads in encroached sagebrush ecosystems can be almost six times more than sagebrush ecosystems that have not been encroached, which causes significant changes in how fires burn.

Fuel loads increase with pinyon-juniper encroachment, allowing wildfires to transition from surface to canopy fires. Photo by Dyan Bone.

The change in fuel type and arrangement in encroached sagebrush ecosystems results in more fires that can burn more easily through the crowns of trees instead of patchy, low-lying fires that stay close to the ground. This shift in fire type influences fire frequency, behavior and severity, which are all key components of a fire regime.

In encroached shrublands, the low-lying fuels (e.g., shrubs and grasses) and canopy fuels (e.g., larger shrubs and trees) have better connectivity, creating a ladder of fuels. It is much easier for fires that start in fine grasses on the ground to spread into tree crowns and move quickly across the landscape in these altered systems. Over time, the encroached sagebrush ecosystem can have such high tree cover that it converts to a woodland and has completely different fire dynamics altogether, with a preponderance of high-severity crown fires. In the last few decades, these crown fires in pinyon-juniper woodlands have increased in size and frequency. Contributing factors include increasingly hotter and drier conditions that cause tree mortality, which leads to more fuel and greater invasion of non-native annual grasses that alter fire regimes.

With greater likelihood of high-severity fires comes increased potential for invasion of non-native grasses. Photo by the National Park Service.

The implications of high-severity fires

Evidence shows that tree-encroached ecosystems have higher-severity fires than ecosystems that are not encroached, and these more severe fires alter the landscape in a way that is favorable for invasion by non-native annual grasses. Even before fire, as tree cover increases, understory plants decline, which leads to a greater likelihood of invasive growth post fire. Fire itself can also reduce the amount of native perennial species in the understory. An increase in litter and downed wood causes fires to be hotter and last longer than they historically would, killing the perennial herbaceous plants that would return after more moderate fire. When there are fewer native perennials, there is less competition for sunlight, nutrients and water, making it easier for non-native invasives to establish.

Fire also volatilizes nutrients, increasing their availability to invasive species that can regenerate rapidly after fire. Robust populations of native, perennial herbaceous plants in the understory help ecosystems withstand annual grass invasion, and their survival after fire is crucial to resist non-native establishment. Therefore, when fire occurs at high tree cover and low perennial understory plant cover, a recovery threshold can be crossed and a healthy native ecosystem is not expected after fire. This shift to a different type of ecosystem causes post-fire plant community composition to become unpredictable and can transition the site permanently to non-native grasses.

Management to reduce fuel loads can decrease wildfire severity and improve ecosystem health. Photo by Kyrk Barron.

Additionally, high-severity fires that can occur in encroached sagebrush ecosystems are likely to further influence soils and alter nutrient cycling, which have already changed due to encroachment. Greater loss of vegetation under high-severity fire can result in larger amounts of bare ground that can further increase runoff and soil erosion. The degree of fire severity also influences nutrient and organic matter levels, as fires that result in very high soil temperatures can volatize nutrients, losing

them to the atmosphere. High-severity fires, therefore, can decrease nutrient availability in the soil. Further, trees redistribute nutrients that can become more easily threatened by fire. The increased biomass from pinyon-juniper encroachment results in greater pools of aboveground nutrients, namely carbon, that are susceptible to loss from fire.

Pinyon-juniper management for wildfire risk reduction

Management of pinyon-juniper encroached shrublands can help reduce the risk of high-severity wildfire. Treatments to reduce fuel loads can lessen wildfire severity and are often the first step toward restoring resiliency to the ecosystem. These may include prescribed fire and mechanical removal (e.g., mowing, mastication or cutting), which is then often followed by herbicide and reseeding of native perennials. Site conditions play an important role in driving both the health of the understory and the degree of tree encroachment and invasion of non-native grasses, which can then influence the effectiveness of the treatment. However, with thoughtful management, goals of reducing wildfire risk and improving the health of sagebrush shrublands are both attainable.

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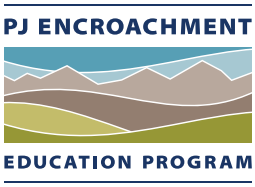

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