THE ROLE OF FIRE IN ASPEN ECOLOGY AND RESTORATION

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Overview

Quaking aspen is generally considered to be a fire-adapted species because it regenerates prolifically after fire, and it can be replaced by more shade-tolerant tree species in the absence of fire. As early-successional aspen stands transition to greater conifer-dominance, they become increasingly fire prone, until fire returns, and aspen again temporarily dominate. While this disturbance-succession cycle is critical to the persistence of aspen on many landscapes, some aspen stands persist on the landscape without fire. The complex role of fire is an important consideration for developing conservation and restoration strategies intended to sustain aspen.

Background

The relatively high fuel-moisture content in many aspen stands often makes them resistant to fire spread (Fig. 1). However, fire will carry through aspen stands when fire-weather and fuel conditions are ideal (e.g., when fire-prone conifers are present). Aspen are easily top-killed by crown fires. However, because aspen has thin bark, even low intensity fires can result in mixed- or high-severity effects, and surviving aspen trees are often stressed and highly susceptible to secondary mortality agents (Baker 2009).

Fig. 1. *Unburned aspen surrounded by severely burned conifers in the Jarbidge Mountains, Nevada*

Following fire, aspen clones (genets) exploit newly available light and nutrient resources to regenerate via vegetative sprouting or "suckering" from lateral roots. The amount of tree (ramet) regeneration depends on several factors including pre-fire stand conditions, fire severity, climate, and post-fire browsing. Although low intensity fire can cause enough mortality in aspen to promote sprouting, high severity fire may be required for prolific aspen regeneration in seral aspen-conifer stands (Krasnow and Stephens 2015). Regeneration from seed may occur if fire is severe enough to expose mineral soil, adequate soil temperature and moisture prevail, and fertile aspen seeds are present. In contrast, some aspen stands recruit adequately without fire, with suckering encouraged by small gap disturbances or overstory senescence (Kulakowski et al. 2004).

Aspen Fire Regime Classification Framework

To more effectively characterize complex aspen fire dynamics, Shinneman et al. (2013) developed a classification framework defined primarily by fire severity and probability, and secondarily by underlying biophysical settings (Fig. 2). This framework includes the following aspen types: 1) fire-independent, stable aspen; 2) fire-influenced, stable aspen; 3) fire-dependent, seral, conifer-aspen mix; 4) fire-dependent, seral, montane aspen-conifer, and 5) fire-dependent, seral, subalpine aspen-conifer. Stable aspen (Types 1 & 2) tend to occur in settings that favor the dominance and stability of aspen over conifers (e.g., due to soil conditions or topographic position) and generally have lower probability of fire. Seral aspen (Types 3, 4 and 5) typically exist because biophysical settings favor both aspen and conifers (or other fire-prone species), yet fire is frequent enough to maintain aspen as part of a dynamic mosaic of forest types.

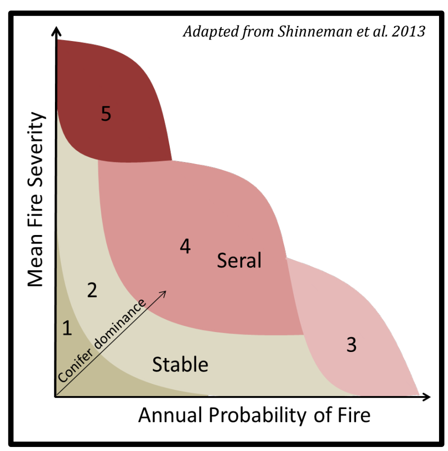

Fig. 2. *Five aspen fire-regime types in two dimensional "fire space"*

Fire Severity and Aspen Regeneration

It is also important to understand how fire directly and indirectly affects aspen regeneration. Recent research (Krasnow and Stephens 2015) from California highlighted aspen responses under different fire and treatment scenarios in seral aspen, and found that higher severity fire increased

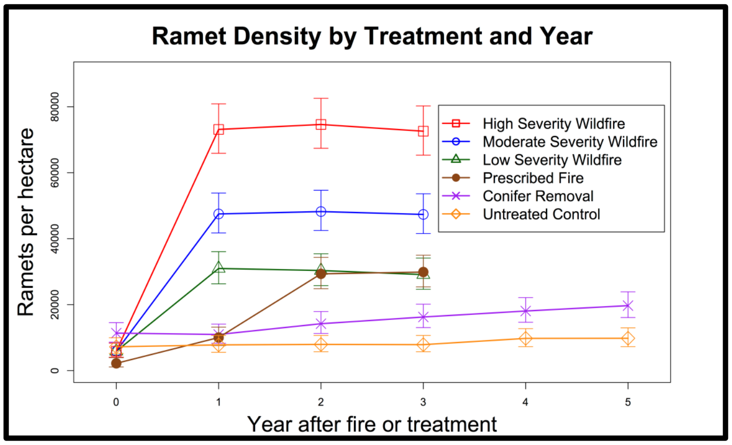

Fig. 3. *Mean aspen sprout density (+/- 95% confidence intervals) over time*

aspen sprout density and growth rates compared to low or medium fire severity (Figs. 3 & 4). Prescribed burns increased sprout density compared to untreated controls, but not as much as wildfire, because prescribed fire is typically low severity. However, even higher-severity fires may lack successful aspen recruitment if livestock and wildlife browsing increase after fire (Bailey and Whitham 2002).

Management Recommendations

Aspen restoration and management strategies are more likely to be successful if they incorporate the functional role of different aspen types and fire regimes at stand- and landscape-scales, and then consider a range of compatible treatments, including managed wildfire, high-severity prescribed fire, conifer removal, or even taking no action (Rogers et al. 2014). For instance, wildfire may allow establishment of new aspen stands by facilitating successful seed dispersal and establishment. It is also important to identify and mitigate stressors that affect aspen recruitment, including post-fire ungulate herbivory. Finally, it is important to engage in active monitoring of aspen stands, to document and plan for changing conditions, and to base management decisions on current and relevant science.

Fig. 4. *Two years post-fire: high severity (left) and low severity (right). Note differences in the density and growth rate of aspen regeneration*

Key Findings:

1. Aspen is a fire-adapted species that can sprout prolifically after fire, though post-fire establishment from seed is more common than once believed.
2. Aspen communities exist within several fire-regime types that reflect frequency and severity of fire, and also represent degrees of fire-dependency, including stable stands that successfully regenerate even in the absence of fire.
3. In seral aspen, high severity fire may increase post-fire aspen sprout density and growth rates compared to lower severity fire.

Sources

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