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Dry forests and wildland fires of the inland Northwest USA: Contrasting the landscape ecology of the pre-settlement and modern eras

Paul F. Hessburg [a,*], James K. Agee [b,1], Jerry F. Franklin [b,2]

[a] USDA Forest Service, Pacific Northwest Research Station, 1133 N. Western Avenue, Wenatchee, WA 98801-1229, USA
[b] College of Forest Resources, P.O. Box 352100, University of Washington, Seattle, WA 98195-2100, USA

Abstract

Prior to Euro–American settlement, dry ponderosa pine and mixed conifer forests (hereafter, the ''dry forests'') of the Inland Northwest were burned by frequent low- or mixed-severity fires. These mostly surface fires maintained low and variable tree densities, light and patchy ground fuels, simplified forest structure, and favored fire-tolerant trees, such as ponderosa pine, and a low and patchy cover of associated fire-tolerant shrubs and herbs.

Low- and mixed-severity fires provided other important feedbacks and effects to ponderosa pine-dominated stands and landscapes. For example, in stands, frequent surface fires favored an ongoing yet piecemeal regeneration of fire-tolerant trees by periodically exposing patches of mineral soil. They maintained fire-tolerant forest structures by elevating tree crown bases and scorching or consuming many seedlings, saplings, and pole-sized trees. They cycled nutrients from branches and foliage to the soil, where they could be used by other plants, and promoted the growth and development of low and patchy understory shrub and herb vegetation. Finally, surface fires reduced the long-term threat of running crown fires by reducing the fuel bed and metering out individual tree and group torching, and they reduced competition for site resources among surviving trees, shrubs, and herbs. In landscapes, the patterns of dry forest structure and composition that resulted from frequent fires reinforced the occurrence of low- or mixed-severity fires, because frequent burning spatially isolated conditions that supported high-severity fires. These spatial patterns reduced the likelihood of severe fire behavior and effects at each episode of fire. Rarely, dry forest landscapes were affected by more severe climate-driven events.

Extant dry forests no longer appear or function as they once did. Large landscapes are homogeneous in their composition and structure, and the regional landscape is set up for severe, large fire and insect disturbance events. Among ecologists, there is also a high degree of concern about how future dry forests will develop, if fires continue to be large and severe. In this paper, we describe the key landscape pattern and process changes wrought by the sum of the settlement and management influences to date, and we point to an uncertain future for ecosystem management. Widespread selection cutting of the largest and oldest ponderosa pine and Douglas-fir in the 20th century has reduced much of the economic opportunity that might have been associated with restoration, and long-term investment will likely be needed, if large-scale restoration activities are attempted. An

* Corresponding author. Tel.: +1 509 664 1722; fax: +1 509 664 1780.
E-mail addresses: phessburg@fs.fed.us (P.F. Hessburg), jagee@u.washington.edu (J.K. Agee), jff@u.washington.edu (J.F. Franklin).
[1] Tel.: +1 206 543 2688; fax: +1 206 543 3254.
[2] Tel.: +1 206 543 2138; fax: +1 206 543 3254.

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uncertain future for ecosystem management is based on the lack of current and improbable future social consensus concerning desired outcomes for public forestlands, the need for significant financial investment in ecosystem restoration, a lack of integrated planning and decision tools, and mismatches between the existing planning process, Congressional appropriations, and complex management and restoration problems.

Keywords: *Pinus ponderosa*; *Abies grandis*; *Abies concolor*; *Pseudostuga menziesii*; Landscape ecology; Mixed conifer forests; Fire ecology; Fire history; European settlement; Historical range of variability

1. Introduction

Ponderosa pine (*Pinus ponderosa*) forests became the poster child for unhealthy forests of the western United States (US) around the time, when Gast et al. (1991) presented their expert panel-based evaluation of declining forest conditions in the Blue Mountains. Thereafter, a number of additional qualitative and quantitative assessments were undertaken to detail changes that had occurred in the Inland West (Everett et al., 1994; Hann et al., 1997; Hessburg et al., 1999a; Huff et al., 1995; Lehmkuhl et al., 1994; O'Laughlin et al., 1993; Perry et al., 1994; SNEP, 1996; USDA, 1993). But forest ecologists and fire scientists were well aware of the importance of historical fires to these environments decades before this time (e.g., see Arno, 1976, 1980; Arno and Allison-Bunnell, 2002; Cooper, 1961a,b; Daubenmire and Daubenmire, 1968; Gruell et al., 1982; Hall, 1976; Morris, 1934a,b; Pyne, 1982; Soeriaatmadja, 1966; Weaver, 1959, 1961).

Usually when people speak of ''unhealthy'' forests, those prone to uncharacteristically intense or large-scale fires, insect outbreaks, and epidemics of forest diseases, they think of relatively dry ponderosa pine forests that have experienced fire exclusion and heavy selection cutting over several entries. The dry pine forests of the *Pinus ponderosa* zone have certainly been affected in this way, but dry mixed conifer forests, primarily in the grand fir (*Abies grandis*), white fir (*Abies concolor*), and Douglas-fir (*Pseudotsuga menziesii*) zones (*sensu* Franklin and Dyrness, 1988), have also been similarly affected by 200 years of settlement and management. We refer to forests in these four zones collectively as the dry forest, and they are represented by a range of cover types. Each cover type in the dry forest was once dominated by ponderosa pine cover under the influence of low- and mixed-severity fire regimes of the last several centuries. Without frequent low-severity or surface fires, Douglas-fir, grand fir, white fir, and on the driest sites ponderosa pine regenerated and released in the understory, and have been growing there for more than three-quarters of a century. To understand what makes these forests currently ''unhealthy'', it is insightful to examine the changes that have occurred to them over the 200-year period of settlement and management.

2. Pre-settlement-era dry forests

Prior to the settlement of the West by European immigrants, most dry forest environments were burned by relatively frequent low and mixed-severity fires (Arno and Allison-Bunnell, 2002). When we refer to low-severity fires, we are describing fires that occurred frequently, usually every 1–25 years, and where less than 20% of the basal area was killed (Agee, 1990, 1993). When we refer to mixed-severity fires, we refer to fires that occurred with moderate frequency, usually every 25–100 years, and where 20–70% of the basal area may have been fire-killed. In the context of dry forests, mixed-severity fires tended to be at the lower end of this 20–70% overstory mortality range. Such low- and mixed-severity fires favored relatively low tree density and clumped tree distribution, light and patchy fuel beds, simple canopy layering, and fire-tolerant tree and associated species compositions (Fig. 1).

In stands, low-severity fires favored fire-tolerant forest structures by removing the lower crown classes (Fig. 2). These fires also cycled nutrients from foliage and branches into the soil, promoted the growth of a low and patchy shrub and herb cover, reduced the threat of running crown fires by continually thinning stands, eliminating fuel ladders, elevating crown bases, and reduced competition for site resources