CALIFORNIA FIRE SCIENCE CONSORTIUM

JOINT FIRE SCIENCE PROGRAM

Research Brief for Resource Managers

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Historical fire regimes: spatial patterns and controls

Taylor, A.H. & C.N. Skinner. 2003. Spatial patterns and controls on historical fire regimes and forest structure in the Klamath Mountains. Ecological Applications, 13(3): 704-719.
http://www.fs.fed.us/psw/programs/ecology_of_western_forests/publications/publications/2003-04-TaylorSkinner.pdf

Management Implications

- Fire diversity = biodiversity! Variation in fire severity is an important source of structural and compositional diversity in forested landscapes
- Season of burn varies geographically and strongly influences species response; thus, restoration efforts should be based on local reference conditions and fire histories
- In areas with complex terrain and frequent, low- to moderate-severity fire regimes, topographic features may serve as important controls on fire spread
- In these areas, the scale of prescribed fire programs should match the scale and arrangement of landscape features and topographic controls

Introduction

Fire has played a critical role in western forests for millennia, shaping community composition and structure and contributing to notably complex patterns of vegetation in the region. However, it is the historical variation in fire regimes – not just fire alone – that has helped create and maintain high levels of diversity in these forests.

Widespread fire exclusion has effectively reduced diversity in these ecosystems, resulting in more homogenous forests that are vulnerable to wildfire and other disturbances. Current restoration efforts focus on the reintroduction of fire to promote biodiversity and restore natural process, yet they are complicated by a lack of understanding of historic patterns of fire and controls on fire spread. Thus, current prescribed fire efforts do not always succeed in mimicking historic fire regimes and achieving desired results.

This paper offers a reconstruction of historic fire regimes and forest age structures in a mixed-conifer forest in the Klamath Mountains of northern California, demonstrating the historic importance of temporal and spatial controls on fire in the area, and providing critical context for current restoration and management activities.

Study Area

This study took place in two small watersheds covering 5745 acres in the Shasta-Trinity National Forest, just west of the town of Hayfork. Elevations in the study area range from 2100 to 4460 ft., and the climate is Mediterranean, with cold, wet winters and hot, dry summers. Forests are diverse in the study area and a wide range of tree assemblages are present, depending on site conditions and history.

Thunderstorms are very common in the summer, and lightning is a frequent source of ignition in the region. Historically, humans were also an important source of ignitions; native peoples in the region commonly used fire to manage the landscape for food plants, hunting, and other resources.

Methods

The study area was stratified by elevation and aspect, and sites were distributed throughout. Sites were located in both live forests and those that had been previously clearcut, but clearcut sites were preferred, as tree aging is easier on cut stumps than on live trees.

Plots varied in size, but they each contained at least 20 conifer stems or stumps. In each plot, basic environmental data were collected, including location, elevation, slope, aspect, species composition, etc., and conifers were aged using cores from live trees and cross-sections from stumps. Species composition and age structure data were analyzed over time to determine landscape-scale patterns and characterize compositional shifts associated with fire suppression.

Cross-dated fire scars from cross-sections were used to characterize historic fire regimes. An average of four fire scar samples were collected at each site, and specific locations were recorded for each cross-section. Year of burn and season of burn were determined for each fire scar, and location data were used to analyze spatial variability in fire return intervals. Stand age structure data were also used to determine historic fire severities.

Results and Discussion

Fire history: The reconstructed fire record spanned the period from 1426-1953, during which 228 fire years were detected. From 1628-1995 – the focal period of the study – 184 fire years were detected.

The position of fire scars within the trees' annual growth rings indicated that fires burned primarily in the midsummer through late fall. Fire return intervals were longest (i.e., fire was less frequent) on north-facing slopes, but they did not vary significantly with forest composition or elevation. Fire occurrence did vary by historic period, with more frequent fire during the pre-Euro-American and settlement periods (every 1.5 years) than during the fire suppression period (every 4.5 years).

The annual area burned in the study area was also much higher in the pre-Euro-American and settlement periods (average annual areas burned of 316 and 262 acres, respectively) than in the fire suppression period (62 acres).

Spatial patterns of fire: Through cluster analysis of fire dates, the authors identified 6 spatially distinct fire occurrence groups. Records indicate that consecutive pairs of fires burned different groups, so the groups comprise a staggered patchwork of fire across the landscape, with environmental controls – including streams, geologic features, and changes in slope aspect – setting fire boundaries through time. Fire return intervals in the groups were similar, though they were significantly shorter in Group 2, which consisted primarily of ridgetop fires.

Species composition was strongly related to elevation and soil moisture potential throughout the study area. However, variation in forest age structures was not associated with topographic variables; rather, forests were heterogenous, with highly variable stand densities and age ranges.

Across the study area, forests have grown denser and less structurally diverse as a result of fire suppression. Trees under 100 years old now greatly outnumber trees over 100 years old, and Douglas-fir and white fir have taken advantage of fire exclusion, maintaining disproportionately successful regeneration rates and outcompeting their neighbors.

Conclusions

This research outlines the intricate spatial and temporal patterns of fire that have shaped forests in the Klamath Mountains. The structural diversity of these forests is directly related to the complexity of the area's fire history, and to the variable terrain by which fire behavior and spread have historically been constrained.

As fire managers develop restoration objectives and projects, they should consider the history of fire in the region and account not only for the historic frequency of fire, but also for patterns of severity, seasonality, and scale. Managers should also take advantage of landscape features and topographic controls, which have long had a strong influence on fire in the region and are likely to remain spatially appropriate (and readily available) into the future.