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JOINT FIRE SCIENCE PROGRAM

Research Brief for Resource Managers

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Fire and fuels management in coast redwood forests

Norman, S.P., J.M. Varner, L. Arguello, S. Underwood, B. Graham, G. Jennings, Y. Valachovic, and C. Lee. 2009. Fire and fuels management in coast redwood forests. JFSP Research Project Reports 158
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While redwood forests occupy a relatively wet and lightning-free band of the Pacific Coast, redwood stands are known to have been shaped by frequent low to moderate severity fires. Tree-ring research shows that sites ranging from dry uplands to moist alluvial flats have burned with frequency similar to sierran mixed-conifer forests, while other sites display a history of low-frequency moderate to high severity fire. Fire frequency and severity relates mostly to Native American fire use, rather than lightning activity. Frequent human ignitions not only kept fuel accumulations low, but indigenous people utilized weather windows that moderated fire behavior. The fire regimes that shape old growth coast redwood forests are the result of complex interactions between human ignitions and strong environmental gradients over short distances.

This report compiles research on fuel conditions, fire history, and fire effects data from contemporary wildfires to provide context for the future management of old growth coast redwood stands and restoration of old growth attributes in second growth forests. The report also investigates fire hazards present in redwood forests and their fire management implications.

Management Implications

- Fire return interval is greatly variable and site specific. Fires had similar frequency in dry upland sites and moist alluvial flats, correlating with gradients of Native American use rather than climatic gradients.
- Growing season fires were found to be more frequent, suggesting Native Americans utilized mild weather windows to reduce fire severity.
- High accumulations of heavy fuels (7.6-20cm), abundant in fire suppressed old growth forests, can result in basal scarring and cambium damage to standing trees.
- Buttresses and flutes 15-25cm from the soil surface showed the most consistent fire scars. Previous fire history research that sampled the tops of stumps is unreliable.
- Basal cavities are indicators of the fire history of a stand and can be used to infer fire return interval and past fire behavior.
- Basal cavities and structural complexities are an inevitable result of routine fires. They are also a leading cause of tree mortality during fire events, either from compromised stability, or being felled as hazard trees or for fire control.

Fuels

Old growth redwood forests have the highest mass and volume of accumulated fuels of any forest type measured at 252 to 619Mg/ha. Only 10% of woody debris mass consists of 1, 10 and 100hr fuels while 90% are 1000hr fuels. While much of the 1000hr fuel mass is made up of logs too large to burn completely, over 50% are under 20cm, a size that is commonly receptive to fire in summer and fall and can have high residence times. Long-duration heat threatens to girdle trees, scorch canopies and sterilize soil. While these fire effects aid in redwood reproduction and the creation of important habitat features, they may be undesirable depending on site-specific management goals.

Fire History

Fire return intervals were found to be highly variable within the northern redwood range, and far more frequent than previously thought, at most sites in recent centuries. Fire scarring from low to moderate intensity fires was most apparent and consistent in near-ground level (15-25cm) buttresses and flutes. Some previous fire history studies only looked at the tops of freshly cut stumps (150-250cm above the ground), resulting in less detection of fire scarring and leading to a widely accepted misconception that fire was relatively infrequent in coast redwood forests. Analyzing patterns of scarring and healing in cavities was also found to be unreliable, as rot and subsequent burns erase scars from past fires. Fire history research conducted using scars within stump-tops and tree cavities may be unreliable.

The occurrence of fire in the redwood range could be influenced by regional drought. Hot droughty years in inland California pull fog onto the coast, lowering temperatures, increasing fuel moistures and making fire less likely in the redwood forest. However, mild years inland do not cause as much fog, leaving the coastal forests more receptive to fire.

The unique climate of the redwood range juxtaposed with indigenous burning practices results in a complicated fire history. Fire frequency did not correlate to climatic gradients, but to gradients of human use. For example, fires weren't registered for over 300 years in a remote portion of Del Norte Coast Redwoods State Park. However, after 1370 fire returned every 31 years on average, coinciding with changes in habitation of the area. Conversely, an old growth redwood forest in Redwood National Park near Ganns Prairie has a fire frequency of 1-5 years, possibly as a result of yearly Yurok ceremonies held in the area. Intensive management by indigenous peoples has been a major driving factor in the development of old growth redwood stands.

Fire Cavities

Deep and complex fire scarring and cavities are common features on old redwoods throughout the range. These scars are formed by cycles of burning, healing and decay, and their size and shape can give clues to the fire return interval of a stand. Using fire scarring and cavities as a metric, authors inferred that fire frequency and intensity varied greatly from site to site, associated with Native American fire use.

Authors categorized fire scars and cavities in order to create a rapid assessment tool for managers to infer site specific fire history. They classified the range of cavity characteristics into a 'redwood cavity index' (Figure 1). They suggest averaging the cavity classes across ~12-tree plots, to infer fire history of the stand, and potential susceptibility to fire.

Class 5 perforated trees have a higher likelihood of failure, and often have other structural complexities that can hold long-duration fire that is very difficult to extinguish. While trees at both humid and dry sites have large cavities and complexities in their canopies, advanced decay found at humid sites may make fire control more difficult than at drier sites. This has implications for managing safety, fire control, and resource goals in wildfire and prescribed fire contexts.

Figure 1: *The 'Redwood Cavity Index' groups basal hollows into 6 classes. Class 1 infers infrequent impacts from high fuel accumulation to previously unscarred trees. Classes 2-5 represent the process of cavity creation, healing and decay with frequent fires.*