

# RESTORATION OF MIXED CONIFER COMMUNITIES USING PRESCRIBED FIRE IN BRYCE CANYON NATIONAL PARK

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## ABSTRACT

A fire history conducted in the mixed conifer community types of Bryce Canyon National Park found the mean fire-return interval has lengthened from 7.5 to 45 years since 1900. Dendroecology, species, diameter, and age-class analysis showed a change in stand composition in favor of white fir (*Abies concolor*) and Douglas-fir (*Pseudotsuga menziesii*) and a 200% increase in fuel accumulation. Recommendations for prescribed burning and mechanical reduction of fuels were incorporated into the Bryce Canyon management plan.

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## INTRODUCTION

A comparison of the present landscape at Bryce Canyon National Park (BCNP) with the landscape shown in historic photographs indicates that a major change has occurred in the vegetation mosaic of BCNP (Roberts et al. 1993). The density of woody vegetation and down and dead woody fuels appears to have increased significantly during the present century. Other studies have concluded that these effects occurred, in part, from changes in the frequency and intensity of wildfires (Fisher et al. 1986, Wadleigh and Jenkins 1996). In these studies, results indicated that frequent, low-intensity surface fires were much more common during presettlement times. It was concluded that grazing and fire suppression practices that began about 1900 had a significant impact on the vegetation changes observed. In such cases, the abundance of woody vegetation generally increases over the short term, but when fires finally do occur they may be of greater intensity (Kilgore and Taylor 1979). Prescribed fires can be used as a means of reducing hazardous fuel loads and reestablishing presettlement fire regimes.

Tree ring analysis is one way of constructing fire histories for areas supporting trees of sufficient age (Arno and Sneek 1977). Other methods including vegetation mapping, species, size and age class distributions, and fuel load inventories are also useful in preparing site-specific fire histories. These data are necessary to determine the extent to which present day fires deviate from presettlement patterns with respect to size, intensity, and location.

Previous fire history studies have documented fire-return intervals using fire scar analysis of ponderosa pine (*Pinus ponderosa*) in BCNP (Buchanan and Tolman 1983, Wight 1989) and for the Paunsaugunt Plateau (Stein 1988). Numerous other studies have similarly documented the fire regime in pre-European settlement ponderosa pine forests in western North America. For reviews of these previous studies see Wright and Bailey (1982) and Agee (1993).

The objectives of this study were: (1) to document vegetation changes resulting from a lengthening of the fire-return interval by suppression of frequent low-intensity surface fires and grazing; and (2) to use this information to develop plans for reestablishing the historic fire regime.

## METHODS

### Study Area

BCNP occupies approximately 14,250 hectares on the east face of the Paunsaugunt Plateau in southcentral Utah. This study was conducted in the mesic mixed conifer-aspen communities located in the south and west portions of the park.

Three areas in the mixed conifer-aspen community type were selected for this study based on the description by Roberts et al. (1992). These were Whiteman Bench, Bridge Hollow, and Yovimpa Pass. Using maps and aerial photos, a transect was established to represent the variety of elevation, aspect, and other features of each area. Ten 0.01 hectare circular plots were established on each of the three transects for sampling.

All trees in each plot were tallied by species. Diameter was measured with a diameter tape or ruler for small trees. A subsample from each diameter class was

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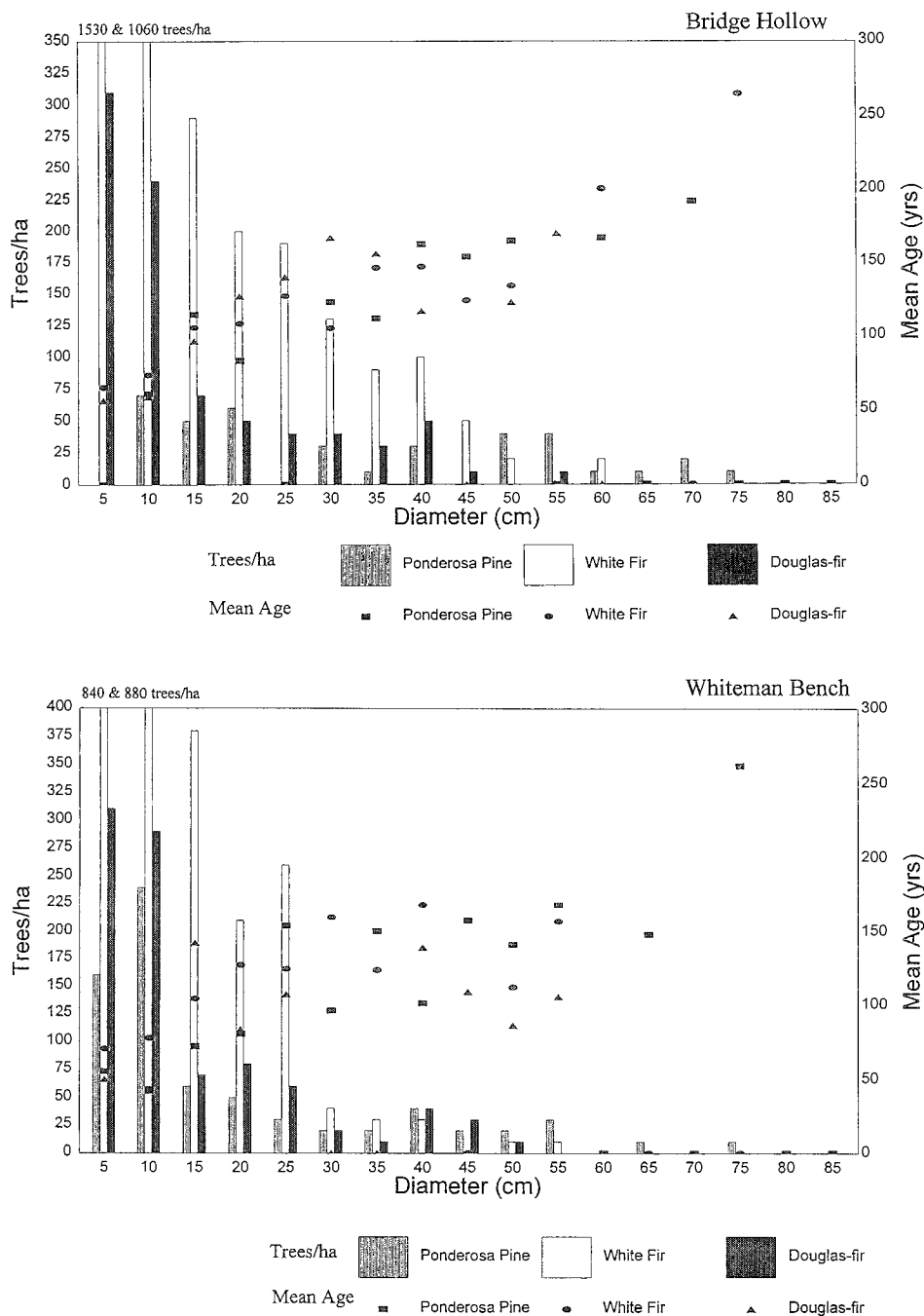


Fig. 1. Number of trees per hectare, mean age, and diameter distribution of trees for data collected in 1993 on the Bridge Hollow, Whiteman Bench, and Yovimpa Pass transects, respectively.

collected using an increment core for larger trees and by cutting a cross section of trees less than 10 centimeters in diameter. While traversing the transects any trees possessing visible fire scars were marked and later sampled using the chain saw wedge technique described by Arno and Sneek (1977). Each sample tree was permanently labeled with a metal tag for long-term BCNP records. All samples were labeled and taken to the disturbance ecology laboratory at Utah State University for analysis.

## RESULTS AND DISCUSSION

The south end of BCNP was historically a mixed conifer forest. Ponderosa pine, white fir (*Abies concolor*) and Douglas-fir (*Pseudotsuga menziesii*) are all represented in the largest and oldest trees observed in all three study locations (Figure 1). The figure also shows, however, that large numbers of the shade-tolerant white fir and Douglas-fir have become established in the last 100 years (Figure 1). Over time, this

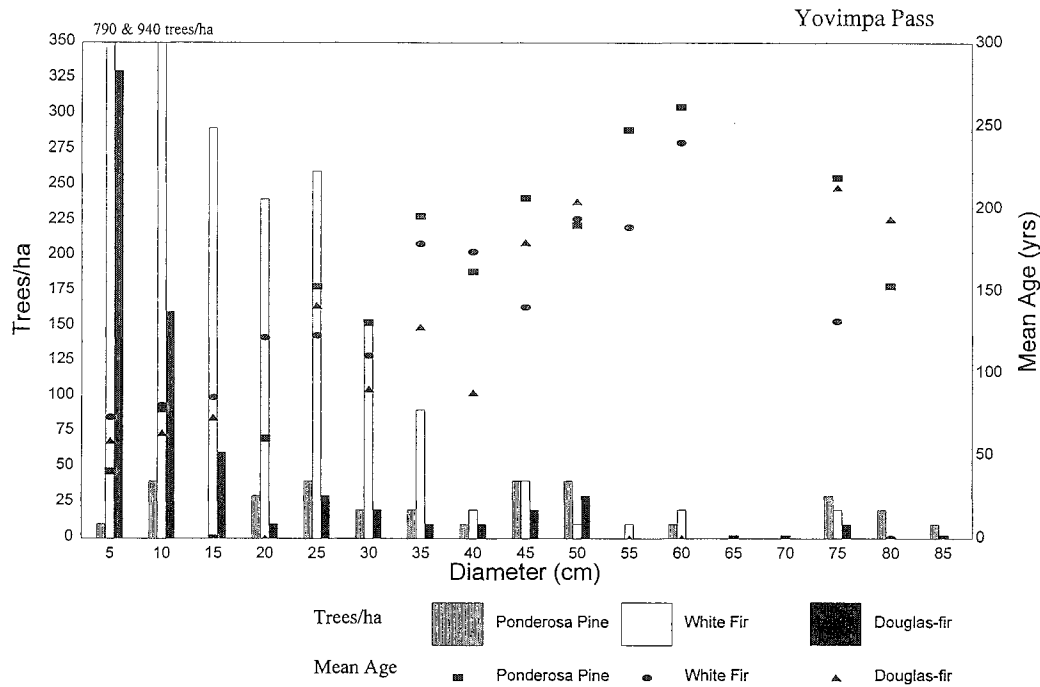


Fig. 1. Continued.

will result in a change of composition where white fir and Douglas-fir will become dominant at the expense of ponderosa pine.

Table 1 shows the mean presettlement fire-return interval found from fire scar specimens collected. For purposes of this study, 1900 was considered as the end of the presettlement era. The return interval was constructed by counting the number of fires documented by scars and dividing the number into the total number of years from the oldest fire documented to 1950 (Agee 1993). This value represents the average number of years between fires sufficiently intense to scar a tree in the study area. Clearly, each fire varied in its ecological significance, depending on its size and intensity. Conversely, there were other fires during the time period that did not scar trees or where fire scars were not found in the present study. The main purpose of presenting these data is to illustrate the frequency with which ignitions occurred even in the mesic mixed conifer type. The fire-return interval can also be evaluated in comparison with the fact that only 2 fires were documented by fire scars since 1900, thus representing a mean fire-return interval of about 45 years. These new data support previous fire history studies by Buchanan and Tolman (1983) who recorded 87 fires in the mixed conifer type from 1616 to 1900 and 6 fires since 1900. Their

data suggested that a fire sufficient to scar a tree occurred in the mixed conifer type once every 3–5 years in the period before 1900. Since that time the interval has been lengthened to 16 years, with one fire in 1959 being the only recorded since 1928. Stein's (1988) fire history of the mixed conifer forests of the Paunsaugunt Plateau on the Powell Ranger District of the Dixie National Forest found a fire-return interval of 15.2–18.4 years. The last recorded fires in the study occurred in 1892, 1902, and 1911.

The abundance of white fir and Douglas-fir could not have occurred over such a wide area under a pattern of frequent low-intensity surface fires. There were areas where these species became established and survived to produce bark thick enough to withstand surface fires. This is indicated in Figure 1 by the presence of older individuals of white fir and Douglas-fir. It is the abundance of small, young trees of these species present that reflects the consequences of an altered fire-return interval. Ponderosa pine is the most fire-tolerant species in the mixed conifer type by producing a 0.3–0.6 centimeter thick dead bark layer in trees as small as 5 centimeters in diameter. On the other hand, white fir bark remains thin, green and photosynthetically active. Therefore, this species is very fire susceptible in trees up to 10 centimeters in diameter. White fir bark is so sensitive to heat that mortality can occur from sunscald after an overstory removal. Even low-intensity surface fires will kill white fir and Douglas-fir seedlings and saplings (Hall 1976). In addition, the low branching habit of white fir (compared to ponderosa pine) creates ladder fuels that increase the potential for a surface fire to move into the crown and thus be more likely to kill the tree.

Table 1. Fire frequency calculations for fire-scarred trees from approximately 1500–1900.

No. of sample trees	No. years	Total fires	Fire frequency
20	399	53	7.5 years

Comparison of these data from Hall (1976) with those presented in Figure 1 shows that 10 centimeter diameter white fir are on average 75 years old and Douglas-fir are over 50 years old. By the time these species reach 15 centimeters in diameter, they are nearly 100 years old. Under the presettlement fire-return interval of 7.5 years it is clear that many white fir and Douglas-fir seedlings and saplings would have been thinned out due to fire-sensitive bark. The decrease in fire frequency since 1900 reported by Buchanan and Tolman (1983), and further documented in this study, supports the notion of an altered stand composition in favor of white fir and Douglas-fir. These data support the conclusions of Roberts et al. (1992) that reduction in surface fire has altered community type structure, reducing the area occupied by quaking aspen and ponderosa pine. Specifically, this study demonstrated an increase in density (expressed as trees/hectare) and an overall change in ecosystem diversity.

The effect that an altered fire regime has had from a fuels perspective is also important in terms of management implications. BCNP has an explicit objective of restoration of the park ecosystem to a condition typical of pre-European settlement and prior to the establishment of fire exclusion policies (Bryant 1994). The preferred alternative for vegetation restoration is to use scheduled prescribed fires combined with mechanical fuel pretreatments. This is an appropriate decision since the altered fire regime has significantly impacted the fuels complex. From a fire behavior perspective the presettlement fuels complex is best described by Fire Behavior Fuel Model 2 represented by a timber overstory with a grass or herbaceous surface stratum (Anderson 1982). With increasing density and mortality associated with older trees the fuel model tends to shift toward Fuel Model 8 or 10 represented by closed timber litter and understory. Based on fuel loading alone a three fold increase in tonnes/hectare may occur (Anderson 1982). Roberts et al. (1993) found 31 tonnes/hectare in the ponderosa pine community (Fuel Model 2) versus 70 tonnes/hectare in the mixed conifer-aspen community type (Fuel Model 10). In addition, the horizontal and vertical continuity increase from model 2 to model 10 increasing the potential for torching and crowning. Clearly, fire behavior under the present fuel conditions will be quite different than what might have been expected prior to fire exclusion. Roberts et al. (1993) concluded that the presettlement fuel complex was better represented by Fuel Model 2 due to more frequent fires. Fire suppression of all wildfires is the policy presently in place at BCNP and will result in increasingly hazardous fuel complexes and more damaging fires in the future. Recent wildfires in the western United States continue to demonstrate the relationship between hazardous fuel complexes and costly and dangerous suppression efforts.

The only solution for BCNP and many other NPS and National Forest lands is to enter into an aggressive, proactive effort to reduce hazardous fuels by mechanical means and application of prescribed fire using scheduled ignitions. The same resources (equipment,

person-power and dollars) need to be made available to accomplish prescribed fire tasks that are made available to fight wildfires. BCNP has instituted a prescribed fire program in the ponderosa pine type near the visitor center and staff housing. The fire management plan recognizes the need for prescribed fires in the mixed conifer type to reduce hazardous fuels and restore stands to presettlement condition. Prescribed fires in this type were scheduled to begin during the fall of 1995 and will continue in the future (Bryant 1994).

This study and many others have demonstrated the negative impacts of fire suppression on ecosystem diversity, fuels, and other resources including wildlife, soil, and aesthetics. Attempts to reestablish presettlement fire regimes will be difficult, dangerous and expensive, but not as great as attempts to further exclude fire from fire-dependent ecosystems.

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