

FIRE HISTORY OF THE LAMAR RIVER DRAINAGE,
YELLOWSTONE NATIONAL PARK, WYOMING

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Objectives

This study's goal is to document the fire history of the Lamar River drainage, southeast of Soda Butte Creek in the Absaroka Mountains of northeastern Yellowstone National Park (YNP). Elsewhere in YNP investigators have documented very long-interval fire regimes for lodgepole pine forests occurring on rhyolitic derived soils (Romme 1982, Romme and Despain 1989) and short-interval fire regimes for the Douglas-fir/grassland types (Houston 1973). No fire regime information was available for lodgepole pine forests on andesitic derived soils, such as in the Lamar drainage. This study will provide managers with a more complete understanding of YNP natural fire history, and the data will supplement the park's Geographic Information System (GIS) data base. Moreover, most of the study area was severely burned in 1988 and historical tree ring data soon will be lost to attrition of potential sample trees.

Specific objectives of the study are to: 1) determine natural (pre-1900) fire periodicities, severities, burning patterns, and post-fire succession within the study area's major forest types (Douglas-fir/grassland, lodgepole pine/subalpine fir/spruce, whitebark pine/lodgepole pine/subalpine fir, and whitebark pine/subalpine fir timberline habitats); 2) document and map the pre-1988 forest age class mosaic; and 3) digitize the age class mosaic map for inclusion into YNP's GIS data base.

Methods

We selected a representative 24,000 ha area encompassing the

Cache Creek drainage, a major first order tributary within the Lamar River drainage. A YNP forest cover type map was consulted to identify stands of apparently different ages, then transects were used to collect evidence of fire history and its role in the development of each stand. Specifically, fire scars and post-fire regeneration were dated from increment boring and occasionally from sawn cross sections (Arno and Sneek 1977, Barrett and Arno 1988). To date, Master Fire Chronologies have been developed for the entire study area and for individual stands by compiling the chronology of fires found for each sample unit. Preliminary interpretations of fire history and post-fire succession also have been developed by analyzing the patterns of fire occurrence relative to stand structure for each forest type.

In subsequent work, aerial photogrammetry will be used to delineate the study area's pre-1988 age class mosaic on 1:24,000 topographic maps, followed by digitizing of the data for the park's GIS data base. Analysis also will focus on an examination of available information in the YNP fire atlas to interpret fire patterns during the post-1900 fire suppression period.

Results

Nine transects, covering over 85 km, produced 182 increment cores from post-fire age classes at 43 sample sites. These age class data were supplemented by fire scar samples from 17 trees (eight from sawn cross sections, nine from increment cores.) Preliminary fire history interpretations are based on these samples as well as tree inventory plots portraying post-fire succession in the 43 stands.

The Master Fire Chronology for the Cache Creek age class mosaic extends to the mid-1700s. There is little fire history evidence prior to that time because a large fire in about 1756, as well as subsequent stand replacing fires, obliterated most evidence of earlier lodgepole pine (*Pinus contorta*) age classes. Therefore, the study area Master Fire Chronology spans the 233 years between 1756 and 1989. (Additionally, fire scarred Douglas-fir in four stands in the Lamar Valley grassland/forest ecotone provided a relatively continuous record of non-lethal surface fires back to 1534). Sampling produced evidence of 11 stand replacing fires during the 233 year period--10 fires produced the forest age class mosaic before widespread stand replacing fires occurred in 1988. These data yield a mean fire interval (MFI) of 23 years for the entire study area. That is, a stand replacing fire

occurred somewhere in the 24,000 ha study area on an average of every 23 years. Moderate to large fires, defined here to be in excess of 400 ha, occurred at least four times during the period, yielding a preliminary MFI of 78 years for such fires. Thus an average of at least two of every three stand replacing fires grew to large size. Two extensive fires occurred during the 233 year period--the 1756 fire apparently burned a large portion of the study area, followed by a 232 year interval before the next drainage-wide fire in 1988.

Results for the Cache Creek study area suggest that area forests experienced a diversity of fire regimes. This is reflected at the stand level by the fire frequencies and post-fire successional patterns found for each forest type. For example, at the study area's western periphery-Douglas-fir/grassland types at the edge of the Lamar and Soda Butte prairies--uneven-aged stands dominated by 300 to 500 year old Douglas-fir (Pseudotsuga taxifolia) experienced frequent surface fires. These no doubt consumed small Douglas-fir regeneration but were non-lethal to most of the larger trees. Eight fire scar samples from four stands in this ecotone produced evidence of 15 fires between 1534 and 1989, yielding an area MFI of 32 years. MFIs for the individual stands ranged from 35 to 50 years, agreeing well with Houston's (1973) results for similar stands elsewhere in the Lamar Valley. Several of these old stands were killed during the 1988 fires.

Valley grassland fires also produced frequent opportunity for ignition in the relatively moist northwest-facing stands (spruce habitat types) in the grassland/forest ecotone. However, surface fires were less frequent and more severe than in nearby dry Douglas-fir habitat types. The data suggest that partial stand replacing fires occurred at 60 to 120 year intervals, producing a typically 2- and occasionally 3-aged seral component of Douglas-fir and lodgepole pine. Maximum ages for moist-site stands adjacent to the valley ranged from 150 to 250 years before total stand replacement, and some stands were killed in 1988.

Different fire patterns were found within the adjacent steep mountain terrain. The 1988 fires killed most lodgepole pine and whitebark pine (Pinus albicaulis) stands in the 24,000 ha study area, but data suggest that past fires ranged in severity from moderate to severe, influenced in part by site type and stand fuel structures. For example, fire frequencies and severities were found to differ markedly by aspect. Moist north slopes [cool-moist spruce (Picea engelmannii) and subalpine fir (Abies lasiocarpa) habitat types] experienced a

predominant pattern of infrequent stand replacing fires at 100 to 250 year intervals. Stand structure data show that moist-site stands usually had a one-aged component of post-fire regeneration (shade-intolerant species) and lacked fire scarred veterans, suggesting that lethal fires were characteristic. Conversely, on south aspects (warm-dry subalpine fire and whitebark pine habitat types) trees with one or two basal fire scars were common throughout the forested portion of the study area (2,000 to 2,900 m). Here the fire scars, and associated stand structure data showing a predominantly 2-aged seral component, suggested that partial stand replacing fires (patchy, lethal surface fire) often occurred. Such fires evidently occurred 50 to 100 years after stand initiation, generally followed by a stand replacing fire at stand age 150 to 250 years.

Evidence of multiple surface fires also was found in the upper subalpine zone, especially in timberline stands (2,900 m) dominated by old whitebark pine. Stands in the upper elevations often attain 400+ years, and veteran whitebark pines often have two to four fire scars. Fire severities varied spatially, producing complex age structures. Upper subalpine stands contain a mix of uneven aged whitebark pine and subalpine fir, and one or two even-aged groups of pines that evidently regenerated after fire. One krummholz stand near Republic Pass had 450+ year old pines with three to four fire scars each and yielded a stand MFI of 83 years. In the upper subalpine zone the combination of sparse fuels, rocky terrain, and recurring surface fires, produces long intervals (often >400 years) between stand replacing fires. Even during the severe 1988 fires many timberline stands experienced only non-lethal or partial stand replacing fire, unlike the remainder of the severely burned study area.

In subsequent phases of this study, data analysis will focus on an examination of fire occurrence during the post-1900 fire suppression period, as well as mapping and digitizing of the forest age class mosaic. Then final report will be prepared in March 1990.

Literature Cited

- Arno, S. F. and K. M. Sneek. 1977. A method for determining fire history in coniferous forest of the mountain west. Gen. Tech. Rep. INT-42. Ogden, UT: U.S.D.A., For. Ser., Int. For. and Range Exp. Sta.

Barrett, S. W. and S. F. Arno. 1988. Increment borer methods for determining fire history in coniferous forests. Gen. Tech. Rep. INT-244. Ogden, UT: U.S.D.A., For. Ser., Int. For. and Range Exp. Sta.

Houston, D. B. 1973. Wildfires in northern Yellowstone National Park. Ecology 54: 1111-1117.

Romme, W. H. 1982. Fire and landscape diversity in subalpine forests of Yellowstone National Park. Ecol. Monogr. 52: 199-221.

Romme, W. H. and D. Despain. 1989. The long history of fire in the Greater Yellowstone Ecosystem. West. Wildl 15(2): 10-17.