Dating Past Fires in Curlleaf Mountain-mahogany Communities

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Abstract

Fire history was investigated in 4 curlleaf mountain-mahogany *(Cercocarpus ledifolius)* communities containing scattered, old ponderosa pine *(Pinus ponderosa)*. Dating cross- sections of fire scars from the pines, through counts of annual growth rings, allowed us to develop reasonably complete fire chronologies extending back to the 1700's. Mean fire intervals in these communities ranged from 13 to 22 years until the early 1900's, but lengthened considerably thereafter. Mountain-mahogany stems with well-developed basal scars (not necessarily caused by fire) were cross-sectioned and finely sanded to enhance the often obscure growth rings. Estimated dates of the mountain-mahogany scars were compared to the pine-derived fire history. This evaluation suggests that where conifers of sufficient age are absent, careful interpretation of mountain-mahogany scars can be used to estimate fire history.

Curlleaf mountain-mahogany *(Cercocarpus ledifolius)* is a large shrub or dwarf tree that is a preferred big game browse in the Intermountain West. Land managers would like to improve the vigor and encourage regeneration of this species, but methods for accomplishing this are not adequately known. In the past, fire was a major disturbance affecting mountain-mahogany, but little information is available concerning the response of this species to fires. Severe wildfires have sometimes killed sizable stands of the species in recent decades. In contrast, other stands apparently survived fires, as shown by occasional scars and charcoal at the base of old stems.

No long-term fire histories have been reported for mountain-mahogany stands. Such information would be useful in interpreting the effects of fires on the longevity and regeneration of this species. However, this species produces indistinct growth rings that are difficult to interpret (Lonner 1972, Roughton 1972).

Some of the mountain-mahogany stands in central Idaho have scattered ponderosa pine *(Pinus ponderosa)* growing among them. Pine forms distinct fire scars that can readily be dated by counting annual growth rings on cross sections of the stem (Arno and Sneck 1977, McBride 1983).

The objective of this study was to derive fire histories for selected mountain-mahogany stands by dating fire scars from mountain-mahogany plants and associated ponderosa pines. This information would complement the information on fire ecology of mountain-mahogany presented by Gruell et al. (1985). Analysis of the ponderosa pine fire scars presumably would yield a long-term fire history for each of the mountain-mahogany sites. Analysis of scars from the mountain-mahoganies would indicate the reliability of this species for determining fire history in stands lacking known fire recorders such as ponderosa pine, inland Douglas-fir *(Pseudotsuga menziesii* var. *glauca)*, or junipers (*Juniperus* spp.).

Methods

Four mountain-mahogany stands which contained scattered ponderosa pine were selected for study with the assistance of the authors of Gruell et al. (1985). These are distributed along 35 km of the Salmon River canyon west of North Fork, Idaho (latitude 45° N., longitude 114° W.). All the stands occupy steep south and west exposures on rocky, decomposed granite substrates at elevations of 1,100 to 1,500 m. All pines were inspected within each stand to identify those having the most intact and long-term records of past fires, represented by the largest number of individual fire scars within the "catface" or multiple fire scar wound. Cross sections were cut from the fire scar wound on 2 or 3 pines within each stand which showed the most complete records (Arno and Sneck 1977). Mountain-mahogany plants having the best developed basal scars (i.e., possible fire scars) were similarly chosen for sampling. Four to 12 individuals in each stand were successfully cross sectioned for growth-ring analysis. (Many of the mountain-mahogany cross sections were collected by L.F. Neuenschwander and S.C. Bunting, University of Idaho, Moscow.)

Ponderosa pine cross sections were sanded and the fire scars were dated by counting annual growth rings (Arno and Sneck 1977). Dating the mountain-mahogany sections was much more difficult even with sanding. An orbital sander and extremely fine paper (220 to 400 grit) were used to remove striations from previous, coarser sanding. This preparation facilitated location of narrow zones of discernible growth rings. Ring counts were made along 2 or more of the clearest zones in each cross section.

Rings on the diffuse porous wood of curlleaf mountain-mahogany (Panshin and deZeeuw 1980) were usually identified best using about 10-power magnification. The relatively large vessels in a single row, marking the springwood, were the easiest feature to identify. The other noticeable feature was the scattered, smaller vessels in the summerwood. Most vessels are filled with cream-colored tyloses—bubble-like intrusions of protoplasm from adjacent cells. Ordinarily there is a band of nonvesseled fibers between the 2 vesseled areas in an annual growth ring, but portions of cross sections exhibiting slow growth often lack this band.

Wood borers (family Buprestidae; Furniss and Barr 1975) destroyed segments of the annual growth rings on some samples, and fungi sometimes caused the rings to appear indistinct. Often the heartwood darkened to a uniform chocolate brown, masking parts of the annual rings. Changing the intensity or angle of lighting or degree of magnification sometimes helped differentiate obscure rings. In cases where these techniques did not help and only one part of the annual ring was identified, we counted that portion as an annual accumulation of wood. Dr. Edwin Burke (wood technologist at the University of Montana, Missoula) and his students independently examined and dated the mountain-mahogany scars.

Results and Discussion

Fire histories for the 4 study stands based on ponderosa pine fire scars are shown in Figure 1. There was close correspondence between dates of fire scars on the individual trees sampled at each site. Thus, in most cases the estimated fire date shown is believed to be within 1 year of the actual date. Mean fire intervals for the 4 sites ranged from 13 to 22 years during the period between 1750 and the early 1900's. In all stands the current fire-free period was substantially longer than any of the pre-1900 fire intervals. Lengthening of fire intervals after 1900 has been identified in most fire history studies in western North America (e.g., Stokes and Dieterich 1980, Martin 1982). This is generally attributed to (1) heavy livestock grazing that removed fine fuels, (2) institution of fire suppression, and (3) a decrease in human-caused (particularly Indian-caused) fires.

At the time this study was conducted, the authors were research forester and research technician in the Prescribed Fire and Fire Effects Research Work Unit of the Intermountain Research Station, U.S. Department of Agriculture, Forest Service, located at the Intermountain Fire Sciences Laboratory, Missoula, Mont. 59807. Andrew Wilson is currently serving in the U.S. Peace Corps in the Philippines.

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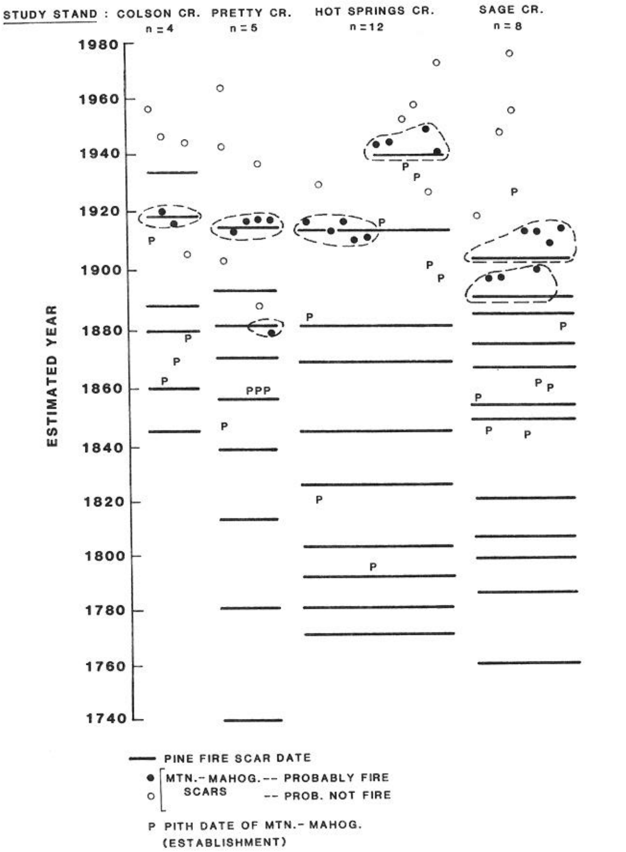

Fig. 1. *Estimated dates of mountain-mahogany scars at the 4 study stands compared with fire years identified from ponderosa pine scars. The fire years are combined records from 2 or 3 adjacent pines in each stand (Arno and Sneck 1977). Dots enclosed in dashed lines are mountain-mahogany scars attributed to fire based upon comparison with pine fire records. Post-1930 scars interpreted as "probably not fire" lacked charcoal. The small fire in 1940 at Hot Springs Creek is from management records (see "Results"). Some of the data from Colson Creek were provided by Stephen Barrett, Systems for Environmental Management, Missoula, Mont.*

About a third of the scars on mountain-mahogany were followed by progressive die back that expanded the edges of the wound over the course of many years following the initial injury. This secondary dieback occasionally gave the impression of separate scars, but it was often associated with activity of wood borers, bark beetles *(Chaetophloeus heterodoxus),* or other weakening agents (Furniss and Krebill 1972, Furniss and Barr 1975). The original scars on mountain-mahogany stems were apparently inflicted by fire (Fig. 2), rolling rocks, ungulates, rodents, or bark beetles (cf. Stuart et al. 1983).

Mountain-mahogany scar dates were superimposed on the fire chronologies for each site derived from ponderosa pine (Fig. 1). Dates of mountain-mahogany scars are rough approximations due to obscurity of much of the annual growth. Nevertheless, dates obtained by Dr. Burke and his students were within 2 years of ours. Missing annual rings, and possible false rings, may be largely responsible for the weak correspondence between dates of apparent fire scars on mountain-mahogany and fire dates established from ponderosa pine.

Defoliation by insects (Furniss and Krebill 1972), fire damage, and extreme drought presumably can cause missing rings in mountain-mahogany. For example, at the Hot Springs Creek stand, a small fire (noted in National Forest fire records) burned in 1 grove of mountain-mahoganies in 1940. This fire left abundant char but did not scar the adjacent pines before it was suppressed.

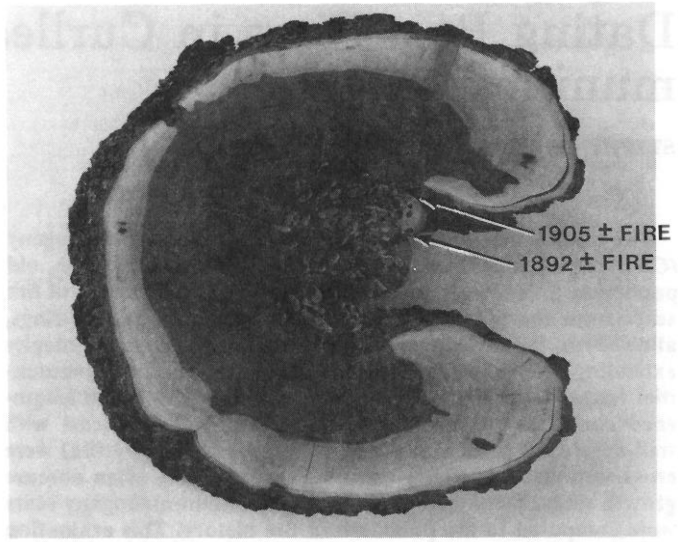

Fig. 2. *Cross section of mountain-mahogany from Sage Creek showing scars evidently caused by fires in about 1892 and 1905. Wood borer tunnels and dark coloration hamper age determination in the heartwood.*

All mountain-mahogany scars attributed to this 1940 fire (Fig. 1) were dated, by ring counts, to more recent years (1941 to perhaps 1949). This suggests that in some years an annual growth ring did not form, possibly due to fire injury.

Mountain-mahoganies apparently recorded 2 of the most recent fires on 3 study sites and 1 fire on the remaining site (Fig. 1). In each study area some scars also dated from well after the most recent fire. A few of these recent scars could be the result of low-intensity fires that did not scar the pines, although National Forest fire records do not reveal any such fires. Other agents are no doubt responsible for most of this recent scarring. Mountain-mahogany scar records extend back only to the late 1800's. This limited duration of mountain-mahogany records is largely attributable to the small number of living individuals that originated 150 or more years ago. Also, many of these old individuals occupied sites with sparse fuels where they apparently escaped being scarred.

Estimated pith dates from the mountain-mahogany stump cross sections were also superimposed on the fire chronologies (Fig. 1). This allowed for inspection of regeneration (age classes) in relation to fire history. These data, though limited, show that mountain-mahogany was able to regenerate during periods when fires were frequent. At 3 of the study sites, regeneration evidently followed fires in the 1850's and early 1860's.

Conclusion

The most reliable method for determining fire history in mountain-mahogany stands is to date fire scars on associated old conifers, or stumps of conifers (Arno and Sneck 1977, McBride 1983). Where conifers are absent, a rough approximation of fire history may be derived by analyzing scars on mountain-mahoganies. After cross sectioning, fine sanding, and careful growth-ring analysis, scars on old mountain-mahoganies can be interpreted to approximately date 1 or 2 of the most-recent fires, extending back perhaps 100 years.

Caution is needed to identify scars caused by agents other than fire. Fire scars tend to occur on the upslope or leeward side of the stem and to be roughly triangular in shape with their base at the ground line (Arno and Sneck 1977, McBride 1983). A fire would normally scar several mountain-mahoganies in a stand, whose cross sections would have similar scar dates. The occurrence of 3 or more stems with well-formed basal scars dating to approximately the same year would be suggestive of an historic fire. Repeated small scars associated with continuing dieback along the edge of the wound are probably not fire scars although the dieback process may have begun after a large fire wound was inflicted.

Scars formed on mountain-mahoganies within the last 50 years can generally be confirmed as fire-inflicted by the presence of charcoal on the bole and by charred wood on the ground surface. Absence of charcoal associated with such relatively recent scars suggests that another agent was responsible. Fire control records may also aid these interpretations. Mountain-mahogany stems with fire scars dating from the late 1800's or early 1900's cannot be expected to retain char evidence although some may be seen.

The pattern of past fires identified at our study sites (Fig. 1) seems consistent with evidence from retakes of early landscape photographs (Gruell 1983) and with analyses of the structure of mountain-mahogany stands (Gruell et al. 1985). These sources of information indicate that frequent wildfires prior to 1900 kept mountain-mahogany largely confined to extremely rocky sites where fuel was sparse. Absence of fire during the past century on many sites allowed the species to increase in abundance. However, mountain-mahogany is currently becoming decadent on many sites and seems unable to compete with associated conifers. Prescribed fire and/or removal of conifers might induce regeneration of mountain-mahogany through seeding or improve the vigor and productivity of existing stands (Gruell et al. 1985).

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