Indian Fires in the Pre-Settlement Forests of Western Montana[1]

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Abstract.--Presents preliminary results of a two-year study examining the pattern of Indian fires in western Montana's lower elevation forests. Interviews and historic journals were used to reconstruct the characteristics of aboriginal burning. Fire scar data from paired stands indicate substantial differences in fire frequency between Indian habitation zones and remote areas before 1860. Fire frequency between the paired stands varied during the settlement period (1861-1910), and fire frequency has been markedly reduced in most stands since the advent of organized fire suppression after 1910.

INTRODUCTION

The influence of Indian-caused fires on the ecology of Northern Rocky Mountain forests has not been investigated, even though such fires are known to have occurred. Schaeffer (1940), Malouf (1969), and Arno (1976) all cite individuals who believed Indian fires occurred before the start of European settlement around 1860. Arno's (1976) fire history study in the Bitterroot Valley documented fires back to about the year 1500. He speculated that Indian fires may have been a factor in several stands having notably high fire frequencies. Mehringer et al. (1977) examined pollen cores from Lost Trail Pass Bog at the head of the Bitterroot Valley. A 12,000-year sample showed a marked increase in airborne charcoal deposits during the past 2,000 years, suggesting a substantial increase in low-intensity fires. However, the mesic climate of that period was not conducive to increased lightning fire occurrence and the researchers considered Indian fires a plausible explanation for the phenomenon.

In 1979 I began a two-year study of Indian fire practices in western Montana. The objective was to determine the ecological effects of Indian-caused fires on Ponderosa pine (Pinus ponderosa)/Douglas-fir (Pseudotsuga menziesii) forests west of the Continental Divide. This report describes the pattern of Indian fires in the region; final results and conclusions are expected by June 1981.

INTERVIEWS AND JOURNALS

Human habitation of present-day western Montana began at least 6,000 years ago (Malouf 1969). The Flatheads and Pend d'Oreilles (collectively known as Salish), and Kootenais were the principal tribes occupying the area when the Lewis and Clark Expedition entered the region in 1805.

The main objective of the 1979 field season was to determine whether Indians set purposeful or unplanned fires in western Montana before intensive settlement by Europeans after about 1860. I also attempted to document details of Indian burning, such as reasons for fire use, seasons of burning, periodicities, and locations and vegetative types where fires occurred. I interviewed descendents of Indians and homesteaders and researched historic journals. Of 60 persons interviewed 24 said Indians purposely set fires, 7 denied this, and 29 did not know. For example, one informant said that in the 1880s his father saw Flatheads burning meadows every few years when they passed through the Ninemile Valley west of Missoula. Journals also often identify Indian fire locations and, as figure 1 indicates, Indian-caused fires were both geographically and temporally widespread.

Most Indian fires occurred in valley grasslands and lower-elevation forests dominated by ponderosa pine, Douglas-fir, or western larch (Larix occidentalis). Ignitions such as signal fires also occurred in high-elevation forests but were relatively rare. According to informants, Salish and Kootenais purposely set fires during fall and spring when climate and fuel conditions are often conducive to low-intensity fires. Journals indicate

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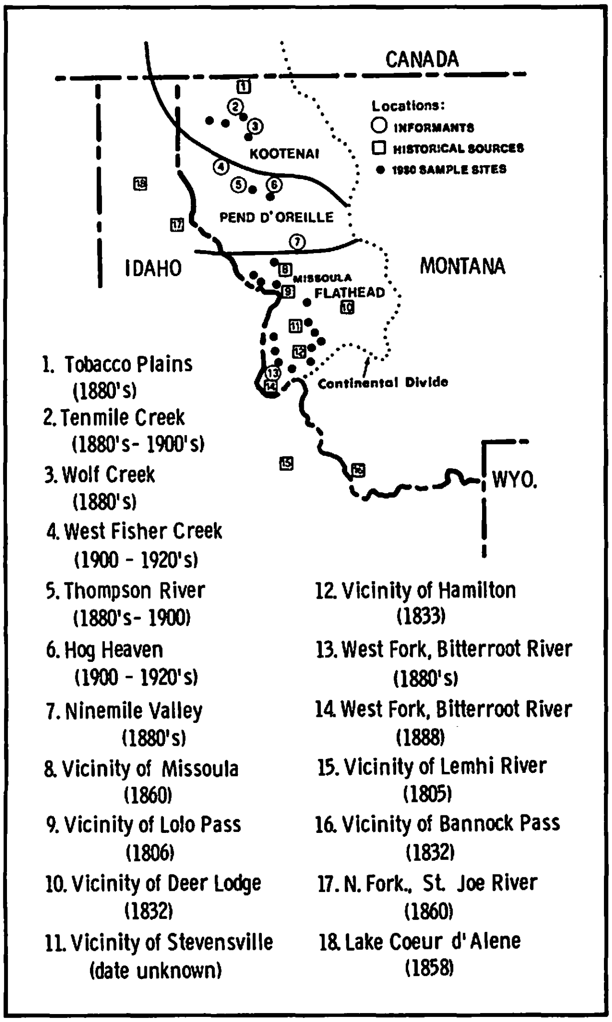

Figure 1.--Known Salish or Kootenai ignitions in the region (ca. 1805-1920) and 1980 sample stand distribution. Solid lines indicate tribal distributions as of 1855 (after: Malouf 1974).

Indians also set fires during summer months, usually by accident (Mullan 1861; Phillips 1940; Schaeffer 1940). Summer fires might well have burned hot enough to kill overstory trees.

Although some persons may have been aware of only one purpose for burning, most intentional fires probably were set to achieve more than one objective simultaneously. For example, several informants said fires were commonly set to "burn out the old, dense underbrush" and stimulate new growth of big game browse. Some said Indians set these fires to enhance berry production or to aid food gathering and travel. Others claimed the Indians burned understories to protect the forest from crown fires by reducing fuel accumulations. These statements and certain journals (Jacquette 1888; Elrod 1906) suggest Indians knew such fires could produce many ecological benefits. It is possible, however, that some informants' perceptions of Indian fire practices were inaccurate. For example, several people said the Salish and Kootenais set fires in order to maintain open, healthy timber stands. Although such stands may have resulted from frequent man-caused and ligntning fires, it does not seem likely Indians set fires to benefit the forest. Similarly, one Salish informant said her mother-in-law and others burned lichens that hang from trees to reduce the threat of wildfires spreading to the forest canopy. If this actually happened, such burning probably was not widespread. Some persons portray the Salish and Kootenais as having been "wise ecologists" but this was not always the case. Journals show Indians also caused careless, destructive fires (Phillips 1940; Johnson 1969; Malouf 1969).

Six informants said the Salish and Kootenais burned to improve forage for horses. The tribes acquired large herds after about 1730 (Roe 1955). Twelve persons said Indians used fire in various ways to improve hunting. Fires were set to favor big game browse, in addition to being used for drives and surrounds. In the winter of 1858 Father Pierre DeSmet wrote about Salish Indians near Lake Coeur d'Alene in present-day northern Idaho:

> On both ends of their line they light fires, some distance apart... The frightened deer rush to right and left to escape. As soon as they smell the smoke of fires, they turn and run back. Having the fires on both sides of them and the hunters in the rear, they dash toward the lake, ... they jump into the water as the only refuge left for them ... (the hunters) let the animals get away from the shore, then pursue them in their light bark canoes and kill them without trouble or danger. (Chittendon and Richardson 1969:1021-22)

Apparently most purposeful fires were set to improve horse grazing (after 1730) or hunting. These and careless fires probably affected the most acres and, thus, are of most interest to ecologists.

Six informants said Indians burned forest understories to encourage food plants, mostly berry-producing species. A Kootenai informant claimed fire also was used to protect medicine plants. His father was a shaman ("medicine man") and told him small ground fires were set to burn unwanted vegetation and to fireproof the area from wildfires. Similarly, six people said Indians often set small fires in and around campsites to clear the tall grasses, weeds, and brush that could conceal enemies. Campsites also were cleared for protection from natural fires or enemy-caused fires. Other studies (Stewart 1954; Lewis 1977) have found that Indians in other regions practiced such burning to create supplies of small firewood or to eliminate insects. Small strip fires may not have affected forest ecosystems to any considerable degree.

The Salish and Kootenais often set fires for communication. In August 1805, members of the Lewis and Clark Expedition saw large signal fires near the Lemhi River in north-central Idaho:

> This day warm and Sultry, Prairies or open Valies on fire in Several Places. The

countrey is set on fire for the purpose of collecting the different bands (of Pend d'Oreille), and a band of Flat Heads to go to the Missouri (River) where they intend passing the winter near the Buffalow ... (Thwaites 1969:49)

Salish and Kootenai signal fires were built large so as to be seen from afar. Small campfires with sophisticated blanket-signaling are a myth. Thus, communication fires had considerable potential to to influence forest ecosystems.

One Salish informant said Indians sometimes cleared overgrown trails with fire. Several historic sources corroborate this statement (Ayers 1899; Johnson 1969). Such fires could affect forest development because they apparently were set in dense vegetation at lower elevations.

Journals indicate Indians often caused accidental fires in the region, although informants did not verify it. For example, in 1832 a trapper named Ferris saw the following incident near present-day Deer Lodge, Montana:

> ...I discovered the burrow of a species of beautiful small spotted fox, and ... sent a (Flathead) Indian boy to camp for a brand of fire... The careless boy scattered a few sparks in the prairie, which, the grass almost instantly igniting, was soon wrapped in a mantle of flame. A light breeze from the south carried it with great rapidity down the valley, sweeping everything before it, and filling the air with black clouds of smoke. ... It however occasioned us no inconsiderable degree of uneasiness as we were now on the borders of the Blackfoot country, and had frequently seen traces of small (war) parties, (which) might be collected by the smoke ... Clouds of smoke were observed on the following day curling up from the summit of a mountain ... probably raised by the Blackfeet to gather their scattered bands, though the truth was never more clearly ascertained ... (Phillips 1940:106-07)

In contrast to findings in other studies (Reynolds 1959; Lewis 1977), tribes in western Montana apparently did not set purposeful fires with much sophistication. Except when used to clear campsites, or during dry weather, fires probably were set arbitrarily and unsystematically. Historical references indicate haphazard ignitions were characteristic (Ayers 1899; Phillips 1940; Johnson 1969; Malouf 1969). Most informants said intentional fires were set and allowed to burn freely because the Indians often were passing through or leaving an area and did not intend to return for long periods. Informants could not give detailed information on fire periodicities, further indicating systematic burning did not occur. The Salish and Kootenais roamed a vast territory and there apparently was little need to plan or manage fires.

FIRE HISTORY INVESTIGATIONS

Methods

I used several methods to determine Indian fire influence on lower-elevation forests dominated by ponderosa pine, Douglas-fir, or western larch. The major approach was to compare fire history in 10 pairs of old-growth stands, one of each pair located in an area of past Salish and Kootenai habitation (hereafter, "heavy-use" stands), the other in an area remote from concentrated use ("remote" stands). Heavy-use stands were usually located in forests bordering large intermountain valleys and remote stands were usually in secondary canyons stemming from valley tributary canyons. Stand size ranged from about 200 to 600 acres (81 to 243 ha.) and stands were paired on the basis of similar vegetation potential (habitat types as per Pfister et al. 1977), elevation, and aspect. Figure 1 shows sample stand distribution.

In each stand, five to seven of the oldest trees with the most basal fire scars were sectioned with a chain saw (Arno and Sneck 1977). This sample number was usually sufficient to document most fires of appreciable size, provided sample trees were well distributed in the stand. I determined fire years from each cross-section in a laboratory and correlated fire years among the sample trees in order to develop a master fire chronology for each stand. A fire chronology was considered to begin when at least two sample trees started to record fires.

I calculated mean fire-free intervals (MFFI) for each stand as follows. Three identical periods for comparing fire frequencies were assigned each pair of stands. The beginning date of the first period was defined as the latest beginning date among the two stands' chronologies (for example, if stand A's chronology began in 1500 and stand B's began in 1600, then 1600 is the mutual beginning date). Two ending dates, 1860 and 1910, were assigned all stands in order to examine fire history for these important periods: 1) the pre-1860 (presettlement) era, 2) 1861-1910 (settlement period), and 3) 1911-1980 (fire suppression period).

A secondary study approach was to closely examine each fire scar with a microscope to see if the season of fire occurrence could be determined. Informants said Indians set most purposeful fires in spring and fall, whereas USDA Forest Service regional data show that nearly 80 percent of lightning fires occur in July and August (Barrows et al. 1977). It was hypothesized that the position of clearly-initiated scars relative to ring structure might show that fires occurred either during earlywood (approximately May 1 to July 1) or latewood (July 1 to September 15) formation, or during the dormant period (September 15 to May 1) in western Montana (E. Burke, Wood Technologist, University of Montana, Missoula, personal communication). This investigation in progress and results will be reported at a later date.

I used a third method to characterize the extent to which Indian fires augmented lightning fires. This approach involves uncontrollable variables and may be the least promising of the methods used. Two sites were intensively sampled in the Bitterroot Valley, the ancestral territory of the Salish as early as 6,000 years ago (Malouf 1974). The objective was to compare MFFI during two time periods in the same stand to see if the MFFI are similar. I assumed lightning fire frequency to be relatively similar during both periods. The periods considered were: 1) the pre-settlement (pre-1860) era--when lightning and Indians were the only ignition sources; and 2) 1931-1980--when lightning is the major causal factor and detailed records of all caused fires are available. The two sites, Goat Mountain and Onehorse Ridge, are especially suited to this approach because: 1) informants and journals indicate Indian fires often occurred in the Bitterroot Valley before 1860; 2) fire suppression records are complete back to 1931; this allows both estimation of mean lightning fire frequencies for 50 years and elimination of man-caused fires from the calculations; and 3) both sites are triangular faces of ridges that slope downward into the Bitterroot Valley and are topographically isolated by large, cliffy, glacial canyons; the possibility of lateral fire spread from other locations, which would tend to increase pre-1860 mean frequencies, is thus markedly reduced.

Twelve or more samples each were collected from Goat Mountain (about 300 acres [122 ha.]) and Onehorse Ridge (about 600 acres [243 ha.]). Pre-1860 MFFI were determined according to the methods described by Arno and Sneck (1977).[3] Modern mean lightning frequencies were estimated by first examining Bitterroot National Forest maps and documenting total ignitions per stand since 1931. Both sites are fully visible from the valley and Forest Service ranger stations, making records very accurate. It was then necessary to subjectively determine which fire-starts might logically have developed into spreading fires if there had been no suppression. I did this by examining Forest Service Individual Fire Reports (Form 5100 series), using date of ignition, fuel types, slope, aspect, position on slope, fire weather data, and nature and duration of each "fire" as decision criteria. I also examined National Weather Service daily temperature and precipitation data for one week before and two weeks after each ignition (weather stations are within ten miles of each sample site). After estimating the total number of potential fires I calculated expected MFFI by dividing the number of fire intervals into 50 years.

[3]The Onehorse Ridge sample site and data for the pre-1860 period are from Arno (1976).

Results/Discussion

Nine hundred forty-six scars from 120 samples revealed 472 individual fires. Ponderosa pine was by far the superior species for high quality scar samples (95 of 120 cross-sections were from this species). I was often able to date unbroken fire sequences from about 1600--the earliest recorded fire was 1443. However, 1700 was the most common approximate beginning date for comparison of paired stand chronologies.

Paired Stand Comparisons

Pre-1860 Fire Frequencies.--Lightning or Indians were essentially the only ignition factors in western Montana before 1860. MFFI for the period were substantially shorter for nine of ten heavy use stands than their remote mates (table 1).[4] Six of the nine heavy-use stands had about twice the incidence of fire (fig. 2). Other studies (Buck 1973; Arno 1976; Dorey 1979; Gruell et al 1980)[5] document similarly short, usually single digit, MFFI for the same forest types in past Salish and Kootenai "heavy-use" areas. I have not found any studies that examine fire history in what can be considered "remote" areas.

I also calculated median fire-free intervals (not listed in table 1). In this case four of the nine heavy-use stands with higher frequencies had about twice as many fires.

In general, the maximum individual fire intervals for most stands did not exceed 35 years although three remote sites had intervals of 59, 62, and 64 years. I interpreted the shortest fire interval to be one year, but such short intervals are difficult to identify.

One possible reason heavy-use stands had shorter MFFI than remote sites is that stands in open valleys may have been prone to record both stand-specific fires and fires which spread in from other locations. Side canyon (remote) stands may have been more likely to only record fires ignited in the immediate vicinity because these sites are often bordered by fire barriers such as streams and inflammable vegetation. However, it seems doubtful that such large MFFI differences could be entirely attributable to this factor. The evidence suggests Indians were a major contributing factor in these differential frequencies. Later in the analysis, I will examine the feasibility of statistical testing to determine the probability

[4]The only remote stand with a higher incidence of fire than its heavy-use mate may be a function of poor site selection. Hot springs in the vicinity of the remote stand are known to have been attractive to the Salish (cf. Two Bear and McCartney Creeks).

[5]Gruell, G.E., W. Schmidt, and S. Arno. 1980. Seventy years of vegetation change in a ponderosa pine forest in western Montana. (Review Draft). USDA For. Service INT.

Table 1.--Mean fire-free intervals (MFFI) and fire interval ranges for 10 paired stands in western Montana, according to 3 time periods.

Paired Stands	Mutual Beginning Date	(x)-1860[a] Heavy Use MFFI	Range	(x)-1860[a] Remote MFFI	Range	1861-1910[b] Heavy Use MFFI	Range	1861-1910[b] Remote MFFI	Range	1911-1980 Heavy Use MFFI	Range[c]	1911-1980 Remote MFFI	Range
FC/RAC	1776	8.4	2-13	42.0	5-59	8.3	3-15	10.0	4-11	35.0	7-35	17.5	9-33+
MC/CG	1697	8.6	2-19	23.3	6-38	25.0	3-21	12.5	2-16	*(1889)	69+	11.9	2-18+
SC/ROC	1704	7.4	3-12	17.3	6-64	8.3	1-9	16.6	10-20	23.3	6-26+	*(1890)	69+
GM/SLC	1737	6.8	3-11	15.3	3-22	5.5	1-6	25.0	9-30	17.5	5-36+	35.0	17+-51
F/DC	1797	7.0	3-11	15.7	4-20	8.3	4-12	10.0	4-21	35.0	7-32+	†(1939)	28-41+
HAC/TC	1700	8.4	3-15	16.0	4-62	16.6	2-35	16.6	4-25	23.3	15-33+	*(1901)	69+
HC/HT	1722	10.6	5-19	19.7	5-43	10.0	4-19	16.6	5-31	23.3	4-26	35.0	4-31+
HH/NB	1710	8.3	2-32	13.6	5-23	6.2	3-14	16.6	7-16	17.5	7-27+	35.0	4-49+
IT/RC	1695	12.7	3-35	16.5	6-36	12.5	6-16	16.6	6-30	35.0	8-36+	†(1918)	7-62+
McC/TB	1729	13.1	5-26	10.1	5-26	7.1	3-15	10.0	5-18	23.3	9-48+	*(1896)	69+
Mean (all stands)		9.1 ±2		18.9 ±9		10.8 ±6		15.0 ±5		25.9 ±7 (9 stands)		26.9 ±11 (5 stands)	

[a] General date of beginning of white settlement in western Montana
[b] General date of beginning of modern fire suppression in western Montana
[c] "+" indicates interval length to 1980; number is either shortest or longest interval in period
*no fires occurred in the period; date in parentheses indicates last fire year
†only one fire occurred in the period; date in parentheses indicates fire year

Sample Stand Key:

FC - Fivemile Cr.	SC - Sixmile Cr.	F - Fairview	HC - Hughes Cr.	IT - Indian Trees
RAC - Rainy Cr.	ROC - Rock Cr.	DC - Doak Cr.	HT - Hog Trough Cr.	RC - Railroad Cr.
MC - McCalla Cr.	GM - Goat Mountain	HAC - Hay Cr.	HH - Hog Heaven	McC - McCartney Cr.
CG - Cutoff Gulch	SLC - Sleeping Child Cr.	TC - Thompson Cr.	NB - North Bassoo Cr.	TB - Two Bear Cr.

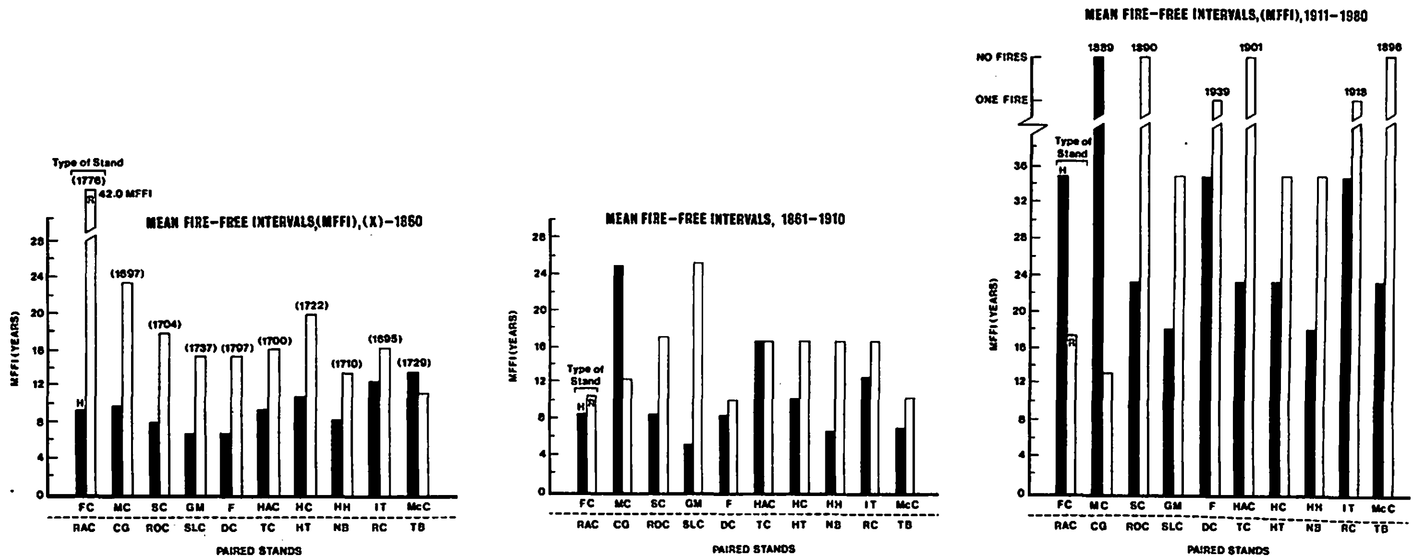

Figure 2.--Time period comparisons of Mean Fire-Free Intervals for 10 paired stands in western Montana (Heavy-use stands: ▮ Remote stands: ▯)

of any chance differences between heavy-use and remote stand MFFI.

The Period 1861-1910.--Informants and journals indicate Indian fires still occurred in western Montana until the beginning of the 20th Century but presumably to a much lesser degree. However, prospectors and others caused many fires in the region in the late 1800s (Ayers 1899; Lieberg 1899). This apparently occurred up until at least 1910, when organized fire suppression aimed at eliminating all fires in the region. MFFI were highly variable for this 50 year period (table 1). Fire occurrence decreased in 40 percent of the heavy-use stands and increased in 50 percent of the remote stands. Eight of ten heavy-use stands had shorter MFFI than remote sites, however, differences are smaller compared with pre-1860 figures. Three of the eight heavy-use stands with shorter MFFI burned more than twice as often as remote stands, one stand pair had equal amounts of fire, and one remote stand received twice as much fire as its heavy-use mate (fig. 2). Median intervals do not differ markedly from means for this period.

Several explanations are possible for such high variability. First, the shortness of the 50 year period may be conducive to variable means--longer time periods usually allow better characterization of fire history. Second, stands in open valleys probably were still subjected to more man-caused and unobstructed lightning fires. However, man-caused fires came into disfavor by settlers toward the end of the period, so some frequency reduction might be expected in heavy-use stands. Conversely, the increase in remote stand fires may have been due to prospectors frequenting backcountry areas where these stands are located. Apparently prospectors set fires with the goal of destroying vegetation to expose mineral outcrops (Lieberg 1899).

Although the data indicate a shift in MFFI between heavy-use stands and remote stands compared with the previous period, there was little change in overall fire occurrence in the region. These data do not support Wellner's (1970) hypothesis that high man-caused and lightning fire frequencies from 1860 to 1935 were unprecedented in Northern Rocky Mountain forests.

The Period 1911-1980.--The data show a substantial increase in MFFI for most stands following the advent of modern fire suppression (fig. 2). Suppression practices became well organized and quite effective throughout the region in the 1930s. Twelve of the 20 stands had MFFI of 35 years or more (table 1). Median calculations are not meaningful for this period due to infrequent fires. In general, heavy-use stands still received slightly more fire than remote sites, perhaps reflecting modern man-caused fires (shorter MFFI from unobstructed lightning fires is no longer a plausible explanation due to efficient suppression). Mean intervals in the 12 stands now equal or exceed the longest individual fire intervals before 1910 for most stands. These results are similar to those of other fire history analyses done in the region (Wellner 1970; Buck 1973; Habeck and Mutch 1973; Loope and Gruell 1973; Arno 1976; Gabriel 1976; Dorey 1979; Tande 1979; Arno 1980; Gruell et al. 1980[5]), however, several of my stands still show relatively short MFFI since 1911. The general reduction in fire frequency is illustrated most dramatically by the McCalla Creek heavy-use stand. Before 1860, fires occurred on an average of every 8.6 years but sample trees have not recorded a fire for the last 91 years.

Goat Mountain/Onehorse Ridge Period Comparisons

Six lightning ignitions occurred on Goat Mountain from 1931 to 1980. After examining fire reports and weather data, I concluded that three or four firestarts had the potential to spread. This would result in an expected MFFI of 16.6 to 12.5 years. The MFFI from 1700 to 1860 for the same stand was 6.7 years.

Seven lightning ignitions occurred on the Onehorse Ridge site during the modern period. The data suggest that as many as five of these might have become spreading fires, for an expected MFFI of 10.0 years. Arno's (1976) data show a MFFI of 5.1 years from 1700 to 1860.

One inherent weakness of this approach is that an "error" in judgement of just one or two potential fires can result in large discrepancies in expected MFFI because the 50-year period is relatively short. However, my estimates of potential fires are conservative, and, if anything, represent an over-estimation of the number of expected fires for both sites. Data from wilderness fire management areas in USDA Forest Service Region One indicate that fewer than 50 percent of lightning ignitions have potential to develop into spreading fires (Division of Aviation and Fire Management, Missoula). Thus, the differentials between pre-1860 MFFI and modern possible MFFI for the two sites may actually be larger than indicated.

CONCLUSION

The paired stand method appears to have the most potential for characterizing the Indian role in an area's fire history. Each approach has limitations. Nevertheless, the combination of informant, historical, and biological data may present the best current means of research into this difficult problem.

This study revealed substantial fire frequency differences in pre-settlement ponderosa pine/Douglas-fir forests in western Montana. The data suggest that the Salish and Kootenai Indians were largely responsible for causing the high frequencies characteristic of stands in habitation zones. After further analysis, I will report on the ecological effects and possible management implications of such frequent fires in this forest type. Perhaps future studies will examine, in detail, what these different frequencies can mean in terms of such management concerns as forest productivity, composition, and protection.

LITERATURE CITED

Arno, S.F. 1976. The historical role of fire on the Bitterroot National Forest. USDA For. Ser. Res. Paper INT-187, Intermt. For. and Range Exper. Sta., Ogden, UT. 29 pp.

__________. 1980. Forest Fire History in the Northern Rockies. J. For. 78:460-465.

__________ and K.M. Sneck. 1977. A method for determining fire history in coniferous forests of the mountain west. USDA For. Ser. Gen. Tech. Rep. INT-42, 28 pp.

Ayers, H.B. 1899. Lewis and Clarke Forest Reserve. pp. 35-80 in 21st Ann. Rep. U.S.G.S. 1899-1900 part V, Forest Reserves. 711 pp.

Barrows, J.S., D.V. Sandberg, and J.D. Hart. 1977. Lightning fires in Northern Rocky Mountain Forests. Co-op Agreement 16-440 CA between USDA For. Ser. Intermt. For. and Range Exper. Sta. and Dept. of For. and Wood Sciences, Colo. State Univ., Fort Collins, 181 pp.

Buck, D. 1973. Fire history of a small portion of Lubrecht Experimental Forest. B.S. Thesis, Univ. Montana, Missoula.

Chittendon, H.M. and A.T. Richardson (editors). 1969. Life, letters, and travels of Father Pierre-Jean DeSmet, 1801-1873. NY, Arno Press, Inc.

Dorey, R.J. 1979. A fire history investigation and the effects of fire exclusion on a ponderosa pine forest in southeastern British Columbia. B.S. Thesis. Univ. British Columbia, Vancouver.

Elrod, M.J. 1906. An attempt on Mount St. Nicholas. Unpub. Manu., Univ. of Montana Archives, Missoula.

Gabriel, H.W. III. 1976. Wilderness ecology: The Danaher Creek drainage, Bob Marshall Wilderness, Montana. Ph.D. diss., Univ. Montana, Missoula. 224 pp.

Habeck, J.R. and R.W. Mutch. 1973. Fire-dependent forests in the northern Rocky Mountains. Quat. Res. 3(3):408-424.

Jacquette, F. 1888. Murder of J. Rombo. Memoirs published in Ravalli Republic, Vol. LXXXIV, No. 138, 7/14/72.

Johnson, O. 1969. Flathead and Kootenai. Arthur H. Clark Pub. Co., N.Y.

Lewis, H.T. 1977. Maskuta: The ecology of Indian fires in northern Alberta. W. Canadian Jour. of Anthropology VII (1):15-52.

Leiberg, J.B. 1899. Bitterroot Forest Reserve. In 19th Ann. Rep. U.S.G.S. For 1897-98. Part V, Forest Reserves: 253-282.

Loope, L.L. and G.E. Gruell. 1973. The ecological role of fire in the Jackson Hole area, northwestern Wyoming. Quat. Res. 3(3):425-443.

Malouf, C. 1969. The coniferous forests and their use in the northern Rocky Mountains through 9000 years of prehistory. In Coniferous Forests of the Northern Rocky Mountains. pp. 271-290. Proc. Center for Nat. Res., Univ. Montana, Missoula.

__________. 1974. Economy and land use by the Indians of western Montana. Garland Pub. Inc., NY.

Mehringer, P., S. Arno, and K. Peterson. 1977. Postglacial history of Lost Trail Pass Bog, Bitterroot Mountains, Montana. Arctic and Alpine Res. 9(4):345-368.

Pfister, R., B. Kovalchik, S. Arno, and R. Presby. 1977. Forest habitat types of Montana. USDA For. Ser. Gen. Tech. Rep. INT-34, 174 p.

Phillips, P.C. (ed.) 1940. W.A. Ferris; Life in the Rocky Mountains (diary of the wanderings of a trapper in the years 1831-32). The Old West Pub. Co., Denver, Colo.

Reynolds, R.D. 1959. Effect of natural fires and aboriginal burning upon the forests of the central Sierra Nevada. M.A. Thesis, Univ. Calif., Berkeley.

Roe, F.G. 1955. The Indian and the horse. Norman, Univ. Okla. Press.

Schaeffer, C.D. 1940. The subsistence quest of the Kootenai. Ph.D. diss., Univ. Penn.

Stewart, O.C. 1954. Forest fires with a purpose. Southwestern Lore XX (4):59-64.

Tande, G.F. 1979. Fire history and vegetation pattern of coniferous forests in Jasper National Park, Alberta. Can. J. Bot. 57: 1912-1931.

Twaites, R.G. (ed.) Original journals of the Lewis and Clark expedition, 1804-06. NY, Arno Press, Inc.

Wellner, C.A. 1970. Fire history in the northern Rocky Mountains. pp. 42-64 In The Role of Fire in the Intermountain West, Proc. Sch. For., Univ. Montana, Missoula.