

Interpreting Fire History in Jasper National Park, Alberta¹

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Abstract.--Fire history in coniferous forests (1665-1975) was related to cultural history and past climate. Fire periodicity increased significantly after European man arrived in the early 1800's. In contrast, extent of fires was not consistently correlated with cultural history periods, but was correlated with climate. The fire regime must be cautiously interpreted in relation to these factors.

INTRODUCTION

In the past decade, historic fire regimes for various coniferous forest ecosystems have been described using dendrochronological techniques. Such studies were lacking for the Canadian Rocky Mountains until 1977 when this study was completed.

The 43,200 ha study area occupies the Athabasca, Maligne, and Miette River valleys which converge near Jasper townsite, Jasper National Park, Alberta. Complex topographic relief varies from gentle sloping terraces and flat valley bottoms to cliffs and ridges of exposed bedrock.

The area represents the extreme northern limit of the eastern Rocky Mountain montane forest zone. Valley bottoms and slopes are predominantly covered by lodgepole pine (*Pinus contorta*). Douglas-fir (*Pseudotsuga menziesii*), white spruce (*Picea glauca*), trembling aspen (*Populus tremuloides*), and balsam poplar (*P. balsamifera*) also occur over a moisture and elevational gradient. Grassland-savanna areas are frequently found in valley bottoms. Higher elevations are dominated by englemann spruce and subalpine fir (*Picea engelmannii*-*Abies lasiocarpa*) forest. Lodgepole pine, however, occurs where portions of these forests have been burned by past fires.

The study area lies in a marked rain shadow of the continental divide. As a result, seasonal total precipitation is lower, and mean daily temperature for May-September warmer than any other part of west-central Alberta. Jasper lies in an area of low lightning frequency, experiencing less than two lightning fires per million hectares per year.

METHODS

Airphoto interpretation was used to distinguish vegetation pattern across the study area. A total of 889 stands were visited and sampled. Vegetation was systematically studied enroute to and within each stand, and fire margins were located and characterized. Changes in species composition, size classes of trees, and remnant stands that had survived previous fires were recorded. Fire scars were collected to document fire dates and increment cores were taken from post-fire trees.

Age data were used to determine areal extent of past fires. The scar dates were used to establish a fire chronology and verify dates of origin for forest stands wherever possible. The fire chronology was based upon 664 fire scars from 435 trees. Airphoto interpretation, field notes, and stand origin dates from 3,388 lodgepole pine and 110 Douglas-fir were verified with the fire-scar record. All of this information was used to construct a stand origin map depicting different forest stands and the fire or fires from which elements of the stand originated. A series of fire year maps was prepared from the stand origin map and field evidence. Details of these techniques are discussed by Tande (1979).

Historical sources from regional museums and archives were reviewed to reconstruct historical geography, check for fire occurrences, and verify fire dates if possible. Incomplete fire statistics for the Park were examined but all fire records from 1907-1968 have been lost or destroyed. As a consequence, the periodicity and pattern of past fires must be based on the fire-scar record and stand origin data.

RESULTS AND DISCUSSION

Fire Regime

The fire history chronology for the 311-year period, 1665-1975, encompassed 72 fires (table 1). Lodgepole pine yielded scar dates back to 1758, and stand origin dates to 1714. Douglas-fir was used to extend the chronology back to 1665. No

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variations in dates due to false or missing rings were encountered for lodgepole pine. However, Douglas-fir dates varied by ± 2 years because of insect damage, resin deposits, and charring by subsequent fires.

The fire scars show that there was a fire in the area every year between 1894 and 1908 (table 1). Fires occurred at 1-9 year intervals from 1837-1971. Intervals were much wider from 1665-1834, varying from 1-36 years. There was a notable decline in the portion of area burned after 1908, corresponding with effective fire suppression in 1913.

There was a fire in the area on an average of once every 4.4 years from 1665-1975. Before effective fire suppression, 46 fires occurred with a mean fire return interval (MFRI) of 5.5 years. Those covering more than 500 ha had a MFRI of 13 ranging from 1-27 years. Fires covering more than 50 percent of the valleys had a MFRI of 65.5 ranging from 42-89 years. Thus, the area experienced recurring fires of widely differing size, with larger fires occurring at much longer intervals.

The stand origin map depicts the present vegetation of the area in terms of its past fire history. It and individual fire year maps have previously been published (Tande 1979). Interactions of fire periodicity, intensity, and areal extent were evident in the diverse pattern of stand age structures. These patterns and field evidence were used to infer the corresponding fire intensities (Tande 1979).

The Jasper fire regime was characterized by frequent and extensive low- to medium-intensity fires and occasional, medium- to high-intensity fires for the period 1665-1913. This fire disturbance regime was responsible for a landscape in all stages of secondary succession. Four major types of vegetation pattern are described in Tande (1979).

Influence of Man on Fire Regime

Archaeological evidence indicates that man has been in the Jasper region for at least 10,000 years. The Athabasca and Miette River valleys have been major corridors through the mountains for all of recorded history and were probably used earlier. European man used these valleys since ca. 1800. Because man has been an integral part of the Jasper environment, his role must be examined when interpreting fire history. One could assume that with greater numbers of people there would be a corresponding increase in fire periodicity. During the period of record, we must consider not only this possible increase in human activity, but also the type of human activity. This is because native use of the area overlapped with use by European man. These cultural distinctions may have resulted in different uses of fire.

The human history of the Jasper Park region has been divided into six major periods (Tande 1977) as follows: The Pre-European Period (ca. 10,000 B.P.-

Table 1. Fire scar dates, intervals between fires, and areal extent of individual fires in Jasper National Park, Alta.

Date of fire	Interval since last fire, years	Major fires ^a	Interval since last major fire, years	Portion of study area burned, %	Known area of burn, km ²	No. of fire scars found
1971	6			0.03	0.22	1
1965	1					1
1964	5					1
1959	3					1
1956	2					1
1954	2					1
1952	1					1
1951	1					2
1950	4					1
1946	2			0.02	0.09	1
1944	1					1
1943	4					1
1941	1					4
1940	1					1
1939	3					1
1936	2			0.2	0.68	5
1934	1					1
1933	1					2
1932	3					1
1929	1					1
1928	3					2
1925	2					1
1923	5					1
1918	3					1
1915	1					9
1914	4					2
1910	2					8
1908	1	**	2	1.4	5.98	17
1907	1			0.8	3.52	7
1906	1	**	1	8.1	34.19	34
1905	1	**	1	4.8	20.47	36
1904	1	**	15	1.2	5.29	4
1903	1					2
1902	1			0.4	1.71	3
1901	1			0.3	1.17	4
1900	1			0.2	0.85	2
1899	1					1
1898	1			0.1	0.21	4
1897	1			0.1	0.21	2
1896	1			0.3	1.07	3
1895	1			0.1	0.32	3
1894	2			0.1	0.16	1
1892	3					1
1889	1	**	1	78.5	338.39	287
1888	5	**	4	2.7	11.64	16
1884	1	**	1	1.8	7.90	7
1883	3	**	3	2.0	8.64	13
1880	2	**	11	1.2	5.29	5
1878	2					2
1876	7					1
1869	6	**	6	1.9	8.00	7
1863	2	**	2	5.5	23.59	12
1861	3	**	3	1.8	7.79	2
1858	7	**	11	8.7	37.68	13
1851	4			0.1	0.32	3
1847	1	**	1	52.3	225.45	34
1846	9	**	9	5.3	22.74	18
1837	3	**	3	18.5	79.74	14
1834	13	**	27	5.6	24.23	13
1821	10			0.2	0.64	2
1811	1					1
1810	3					1
1807	10	**	10	8.2	35.44	3
1797	17	**	17	6.7	28.71	10
1780	9	**	22	2.4	10.14	2
1771 ^c	13			0.4	1.49	1
1758	21	**	21	50.9	219.42	6
1737 ^c	10	**	10	15.5	67.04	2
1727 ^c	13	**	13	12.8	55.08	2
1714 ^c	36	**		2.8	11.96	1
1678 ^c	13	?		0.8	2.92	1
1665 ^c		?		0.9	4.05	1
						Total 664

All scar dates are from lodgepole pine unless otherwise noted.
^aA major fire constitutes a fire burning more than 500 ha (1.2% of the total area).
^cTentative dates based on two Douglas fir fire sections. Fire dates of Douglas fir have been found to vary by ± 2 years when compared to known dates of the area they were collected in.

ca. 1800) was a period of low population density. Small nomadic groups of forest Indians passed through the area but were never permanent residents, owing to harsh mountain environments and sparse game populations.

The Fur Trade Period (ca. 1800-ca. 1830) was an exploration period of major mountain passes as early as 1770-1802. Trading posts north of the study area were sporadically occupied until 1884, and small populations of Indians resided in the valley near these posts. The entire Jasper region was probably penetrated by trappers by 1825.

Trappers, travellers, and explorers passed through the area especially during the first 35 years of the Presettlement Period (ca. 1830-1892). Accounts suggest that there were few, if any, area inhabitants. Continuous local activity was probably less pronounced than during the fur trade.

Approximately 100 natives and homesteaders lived in the area during the Settlement Period (1892-1910). All but one were evicted by 1910. The area was also visited by mountain climbers and scientists, but activity was generally low.

Jasper National Park was established in 1907, before the Railroad Period (1909-1912). Fire control followed rapidly when the railroad company recognized the tourism potential of the Park. The Park had its first three wardens in 1909 as railroad fire hazards and game poaching increased.

In 1913, the railroad began bringing people to Jasper for scenery and recreation, thus beginning the Park Period (1913 to present). The study area has had effective fire control since 1913 because the valley is a major transportation corridor as well as recreation center.

The total number of fires by historical periods increased from past to present, with the exception of the Railroad Period when number of fires was less (table 2). Fire periodicity shortened from 15.1 years in the Pre-European Period to 1.2 years during the Settlement Period. This increase in fire may be related to increased human

activity with time, however, it is partially a result of erasure of older fire sign by subsequent fires. With the establishment of active fire suppression in the Park Period, average fire frequency decreased to one fire every 2.4 years. Since 1908, there have been no major fires and only 0.004% of the area has been burned per year.

The only fire year recorded in the Railroad Period was 1910. Scattered locations of fire scars suggests a number of fires within the year but only a negligible area burned (table 2). Locations are in close proximity to the railroad (Tande 1979), and therefore may have been caused by man. The long MFRI for this period is attributed to wet weather during fire seasons, better patrols on railroad right-of-ways, and mandatory spark arrestors on locomotives (Tande 1977). These results contrast with other major corridors through the Rockies where fire frequency and extent increased during railroad periods.

The Settlement Period had the shortest MFRI with a fire occurring every 1.2 years. The total area burned per year, however, was only 0.99%, whereas 3.0% burned per year in the previous period. While most fires were small, three fires covered 15.5% of the total area. This increase in frequency could have been caused by increasing numbers of people. However, the increase is not necessarily related to an increase in extent of fires. In fact, periodicity appears negatively correlated with extent. This would happen if climate were not conducive to large fires during the period. It could also result partly from suppression efforts and prescribed use of fire by settlers.

Fires of the Presettlement Period account for most of the area burned from 1665-1975. Three percent burned per year, and 13 of the 16 fires were of major extent. The MFRI was 3.9 years, or three times that of the Settlement Period. This decrease in frequency is particularly interesting because there were more people through the area compared to the Settlement Period. In comparing these two periods, we again see that there may not be a causal relationship between fire frequency and extent. If there were, we would expect reduced frequency to have resulted in a reduction of total fire extent.

Table 2. Mean fire return intervals (MFRI) and burned areas for cultural history periods.

Cultural Period	Length of record	Number of fires	MFRI (range)	Number of major fires*	MFRI for major fires* (range)	Area covered by major fires* (%)	Forest burned per year (%)
Total Period (1665-1975)	311	72	4.3 (1-36)	24	13.0 (1-2)	300.5	0.98
Park Period (1913-1975)	63	26	2.4 (1-6)	--	---	--	0.004
Railroad Period (1909-1912)	4	1	4.0 ---	--	---	--	--
Settlement Period (1892-1910)	19	16	1.2 (1-2)	3	6.3 (1-2)	15.5	0.99
Presettlement Period (1830-1892)	63	16	3.9 (1-9)	13	4.8 (1-11)	185.8	3.00
Fur Trade Period (1800-1830)	31	4	7.8 (1-10)	1	31.0	8.2	0.28
Pre-European Period (1665-1800)	136	9	15.1 (9-36)	6	22.7 (10-22)	91.1	0.69

*Fires burning more than 500 ha are termed "major fires" in this study.

As expected, the decrease of activity in the Fur Trade Period resulted in a decrease in fire frequency. In fact, the MFRI was almost double that of the Presettlement Period. Only four fires are recorded, of which one major fire is responsible for most of the total area burned. The cooler, wetter climate of this period apparently inhibited fire ignition, or large extent of fires (Tande 1978). In addition, trappers may have been more careful with fire due in part to a Hudson Bay Company's edict on this subject.

The total area burned per year in the Pre-European Period was more than double that in the Fur Trade Period, although MFRI also doubled. This strongly suggests that man's later influx may have influenced periodicity, but did not necessarily affect total area burned. In fact, the larger extent of fires before 1800 may indicate another factor which governs areal extent and periodicity.

In contrast with fire periodicity, the extent of area burned per year in Jasper fluctuated erratically and is not consistently correlated with human-use patterns. This is especially true of the larger area burned per year before the arrival of the white man in the early 1800's. Other workers have obtained estimates of forest burned per year after 1830 for different regions in the Canadian Rockies. These figures indicate that frequency and areal extent of forest fires were similar throughout the region, even though the areas did not experience equivalent human-use patterns (Tande 1977). Based on these observations, climate may have been the principal factor which controlled the extent of past fires.

Climate

To test the influence of climate, environmental indicators were sought for periods which might correspond to fire years. Since no precipitation records exist for Jasper before 1918, the below-average growth rates of trees in the area were used as indicators of major drought years (Tande 1978).

When all fires between 1700-1913 were plotted against below-mean precipitation periods, 76% of the fires and 92% of the total area burned were accounted for. The 1758, 1847, and 1889 fires occurred during pronounced droughts and accounted for 61% of the total area burned. Only 8% of the area was covered by fires during above-mean precipitation periods. Since the probability of fire is greater during such below-mean precipitation periods, climate was the major environmental factor controlling the extent of past forest fires.

CONCLUSIONS

Man and lightning are only sources of ignition, and whether a forest burns or not is dependent on vegetation and climatic conditions at the time of ignition (Tande 1978). Regardless of ignition source, a climatic change can result in an increase or a decrease in fire extent which will be reflected in annual burn figures. The problem, however, is

that the number of fires and their extent may also be affected when man is present. In this study, it appears that European man has increased fire periodicity in certain time periods since 1800, while having variable effect on fire extent. Data from historical sources, fire history, and climate strongly suggest that native man's impact was negligible. These factors affect the fire history chronology and hence our interpretation of fire regime.

Although the tree-ring record shows that fire has been an important environmental factor shaping the vegetation of Jasper from 1665-1913, caution must be exerted in interpreting this fire history as a "natural fire regime." European man has been part of the Jasper environment for over half the tree-ring record of fire. This means that we must rely more on the portion of the record before 1800 to interpret a more "natural role of fire." Unfortunately, this portion of the fire history data has suffered the greatest loss of information over time due to erasure by subsequent fires.

For these Pre-European fires (1665-1800) there is insufficient evidence to characterize the fire severities. Thus we cannot compare a fire regime of this period with that which has been determined for the total period of record 1665-1913. Without a comparison we cannot determine how representative the fire regime is after the early 1800's.

Even though we may never know the actual sources of historic fires, we must attempt to refine our understanding of past fires in Jasper National Park. Management decisions depend on the best possible interpretation of such information. It will be important to determine the incidence and extent of fire before 1665 to test whether the tree-ring record of historic fires is representative of the Jasper ecosystem.

I recommend that a paleoecological investigation be carried out to document the frequency of fire over a longer time period and allow comparison with the more recent tree-ring record. Likewise, further anthropological and historical geography studies would clarify man's use of fire in the Jasper region. These data are needed before the tree-ring record can be accepted or rejected as the typical forest fire situation in the study area.

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