George E. Gruell[1]

Intermountain Forest and Range Experiment Station
USDA Forest Service
Ogden, Utah

Fire on the Early Western Landscape: An Annotated Record of Wildland Fires 1776-1900

Abstract

Scientific and historical literature was searched for documented accounts of early fires in the "interior West"—Montana, Wyoming, Idaho, Utah, Nevada, and eastern Oregon. One hundred and forty-five accounts of fires by 44 observers were found. The majority of accounts described fires in progress. A smaller proportion referred to burned areas that were encountered; a few simply described regional fire occurrence based on the journalists' observations. Indians were identified as the primary ignition source over wide areas at lower and middle elevations. Some journalists noted that fire enhanced grasses and inhibited growth of woody plants.

The historical record, and fire history based on analysis of fire scars demonstrate that fire was a major perturbation in the interior West. Such knowledge can help resource managers understand subsequent vegetative changes, and can enable them to use prescribed fires intelligently.

Introduction

Various researchers in western North America have concluded that wildfire was a major perturbation before the turn of the century (Stewart 1951, Pyne 1982). This knowledge is important for managing forest and rangelands, for interpreting successional patterns of early-day vegetation, for understanding successional changes that have taken place in modern times, and ultimately for managing forests and rangelands. Vegetational changes, after all, have major implications for management of wildlife, timber, and other resources.

Researchers in various disciplines have cited historical literature that describes early fires in the interior West. Only a few, however, have used these sources to interpret fire's past role in various ecosystems (Moore 1972, Shinn 1980, Barrett 1981). These previous studies provide insight on early fire occurrence in parts of the interior West, but over large areas there was little knowledge of historical fire occurrence. Therefore, a broader search of western literature prior to 1900 was conducted. This paper summarizes and interprets accounts of fire pertaining to a large area of the interior West, including Montana, Wyoming, Idaho, Utah, Nevada, and eastern Oregon.

Methods

Early journals were located and all accounts of early-day fires were recorded. A detailed search was also made through diverse and obscure literature covering the activities of fur trappers, explorers, government surveyors, natualists, emigants, military expeditions, miners, and others. This search turned up other references on fire that had not

[1]Present address: Northern Forest Fire Laboratory, Drawer G, Missoula, Mont. 59806.

been previously reported in the scientific literature. Each narrative was examined and the observer's name, date, and approximate location was recorded. Categories were then developed to aid ecological interpretations about past fire occurrence and effects. These categories included whether the citation described a fire in progress or denoted evidence of past burning, relative size of burn, duration of burning, and ignition source. To the extent possible, fire characteristics, and the direct or indirect effects of fire on vegetation, people, wildlife, and stock were also categorized.

Results and Discussion

The literature search resulted in 145 accounts of fires documented by 44 observers from 1776-1900 (Table 1). Most accounts described fires in progress. Others referred to burned areas that were encountered, while a few simply described regional fire occurrence based on the journalists' observations.

TABLE 1. Listing of fires by state, description, and ignition source (see legend at end of table).

Map No. (Fig. 1)	Observer	Reference	Date	Location	Description[1] IP	WY	HD
Montana							
1	Lewis	Thwaites 1959	7-20-1805	Hauser Lake		I	
2	Clark	Thwaites 1959	7-25-1805	Three Forks		I	
3	Lewis	Thwaites 1959	8-4-1805	Big Hole R.		I	
4	Lewis	Thwaites 1959	8-15-1805	Horse Prairie		I	
5	Lewis	Thwaites 1959	8-23-1805	Clark Canyon Reser.			I
6	Larocque	Hazlitt 1962	9-25-1805	Glendive	U		
7	Clark	Thwaites 1959	7-6-1806	Big Hole			U
8	Clark	Thwaites 1959	7-19-1806	Yellowstone R.	U		
9	Clark	Thwaites 1959	7-30-1806	Miles City		U	
10	Ferris	Phillips 1940	9-1-1831	Big Hole	I		
11	Ferris	Phillips 1940	9-2-1831	Pioneer Mtns.	I		
12	Catlin	Catlin 1891	1832	Northeastern Mont.			U
13	Denig	Ewers 1961	1833	Northeastern Mont.			I
14	Maximilian	Thwaites 1966c	1833	Northeastern Mont.			I
15	Ferris	Phillips 1940	8-13-1833	Bitterroot R.	I		
16	Maximilian	Thwaites 1966c	9-2-1833	Missouri R.		I	
17	Maximilian	Thwaites 1966c	10-30-1833	Missouri R.		N	
18	Russell	Haines, A. 1965	9-10-1835	Hebgen L.	I		
19	Kurz	Hewitt 1969	1851	Northeastern Mont.			I
20	Kurz	Hewitt 1969	11-15-1851	Northeastern Mont.			I
21	Stevens	Stevens 1855	8-29-1853	Milk Cr.	N		
22	Mullan	Mullan 1855a	9-25-1853	Little Blackfoot R.		U	
23	Mullan	Mullan 1855b	12-30-1853	Bighole R.		I	
24	Mullan	Mullan 1855b	12-31-1853	Divide		I	
25	Raynolds	Raynolds 1868	8-14-1859	Wolf Mountains	I		
26	Mullan	Mullan 1863	8-24-1859	Coeur d'Alene Mtns.	U		
27	Mullan	Mullan 1863	8-26-1859	Clark Fork	U		
28	Mullan	Mullan 1863	8-27-1859	Clark Fork	U		
29	Mullan	Mullan 1863	8-28-1859	Clark Fork	U		
30	Raynolds	Raynolds 1868	9-9-1859	Soap Cr.		I	
31	Raynolds	Raynolds 1868	9-10-1859	Little Horn R.		U	
32	Raynolds	Raynolds 1868	9-12-1859	Wolf Mtns.		U	
33	Mullan	Mullan 1861	3-10-1860	Bitterroot R.		I	
34	Stuart, G.	Phillips 1957	7-22-1861	Clark Fork R.	I		
35	Stuart, G.	Phillips 1957	7-29-1861	Clark Fork	U		
36	Stuart, G.	Phillips 1957	7-31-1861	Clark Fork	U		
37	Stuart, G.	Phillips 1957	8-14-1861	Clark Fork	U		
38	Stuart G.	Phillips 1957	9-5-1861	Clark Fork	U		
39	Stuart, J.	MT Hist. Soc. 1902b	5-8-1863	Hardin	U		
40	Stuart, J.	MT Hist. Soc. 1902b	5-16-1863	Fort Smith	I		
41	DeLacy	MT Hist. Soc. 1902a	8-10-1863	Centennial Mtns.		U	
42	DeLacy	MT Hist. Soc. 1902a	9-18-1863	Gallatin R.			I

TABLE 1. (Continued)

Map No. (Fig. 1)	Observer	Reference	Date	Location	Description[1] IP	WY	HD
43	Cole	Hafen & Hafen 1961a	8-31-1865	Powder R.	I		
44	Hayden	Hayden 1873	1872	Gallatin R.		U	
45	Havard	Havard 1878	1877	Northeastern Montana			U
46	Stuart, G.	Phillips 1957	9-16-1881	Judith Mountains			U
47	Stuart, G	Phillips 1957	1885	Judith Mountains			U
48	Ayres	Ayres 1900	late 1800s	Whitefish Range			U
49	Ayres	Ayres 1901	late 1800s	Flathead Forest			U
50	Leiberg	Leiberg 1899a	late 1800s	Priest River			U
51	Leiberg	Leiberg 1899b	late 1800s	North Idaho			U
52	Leiberg	Leiberg 1899c	late 1800s	Bitterroot Mtns.			U
53	Leiberg	Leiberg 1904a	late 1800s	Little Belt Mtns.			I
54	Leiberg	Leiberg 1904b	late 1800s	Absaroka Range			U
Wyoming							
1	Fremont	Fremont 1887	8-19-1843	Kemmerer	U		
2	Fremont	Fremont 1887	8-20-1843	Kemmerer	U		
3	Stansbury	Stansbury 1852	9-21-1850	Fort Steele			U
4	Raynolds	Raynolds 1868	5-17-1860	Powder R.		U	
5	DeLacy	MT Hist. Soc. 1902a	8-19-1863	Alpine	U		
6	Palmer, H.	Hafen & Hafen 1961a	8-6-1865	Powder River	N		
7	Palmer, H.	Hafen & Hafen 1961a	8-11-1865	Fort Reno		I	
8	Bradley	Bradley 1873	1872	Jackson Hole		U	
9	Moran	Fryxell 1943	8-25-1879	Teton Mtns.	U		
10	Moran	Fryxell 1943	8-26-1879	Teton Mtns.	U		
11	Moran	Fryxell 1943	8-27-1879	Teton Mtns.	U		
12	Brandegee	Brandegee 1899	1897	Yellowstone P.			U
Idaho							
1	Lewis	Thwaites 1959	8-30-1805	Salmon R.	I		
2	Lewis	Thwaites 1959	6-25 1806	Lochsa R.	I		
3	Stuart, R.	Rollins 1935	9-10-1812	Soda Springs		U	
4	Stuart, R.	Rollins 1935	9-13-1812	Bear R.	I		
5	Ross	Spaulding 1956	4-24-1824	Lemhi Valley	N		
6	Ogden	Rich 1950	4-15-1826	Portneuf R.	I		
7	Ogden	Rich 1950	4-16-1826	Portneuf R.	N		
8	Ogden	Rich 1950	4-27-1826	Raft R.	I		
9	Work	Haines, F. D. 1971	9-14-1830	Boise		U	
10	Work	Haines, F. D. 1971	9-15-1830	Boise		U	
11	Work	Haines, F. D. 1971	9-28-1830	Magic Reservoir	U		
12	Work	Haines, F. D. 1971	10-5-1830	Magic Reservoir			U
13	Work	Haines, F. D. 1971	2-7-1831	Snake R.		I	
14	Ferris	Phillips 1940	8-19-1831	Snake R.	I		
15	Ferris	Phillips 1940	8-19-1831	Lemhi Range	I		
16	Work	Lewis & Phillips 1923	9-30-1831	Musselshell Cr.		U	
17	Work	Lewis & Phillips 1923	4-19-1832	Lost R.	N		
18	Townsend	Thwaites 1966a	8-16-1833	Wood R.		I	
19	Wyeth	Young 1899	8-10-1834	Mackay	I		
20	Wyeth	Young 1899	8-17-1834	Mountain Home		I	
21	Russell	Haines, A. 1965	9-26-1834	Pocatello	U		
22	Wislizenus	Wislizenus 1912	8-14-1839	Soda Springs		I	
23	Bidwell	Kelly 1930	8-10-1841	Soda Springs	U		
24	Fremont	Fremont 1887	8-24-1843	Cokeville	U		
25	Fremont	Fremont 1887	8-25-1843	Soda Springs	U		
26	Fremont	Fremont 1887	8-26-1843	Soda Springs	U		
27	Fremont	Fremont 1887	10-6-1843	Boise		I	
28	Minto	OR Hist. Soc. 1901	9-6-1844	Soda Springs	U		
29	Minto	OR Hist. Soc. 1901	9-15-1844	American Falls		I	
30	Palmer, J.	Thwaites 1966b	4-29-1846	Boise	I		
31	McKinstry	McKinstry 1975	7-26-1850	Blackfoot		U	
32	Mullan	Mullan 1863	8-22-1859	Coeur d'Alene R.	U		
33	Mullan	Mullan 1863	8-23-1859	Coeur d'Alene R.	U		
34	Stuart, J.	MT Hist. Soc. 1902b	6-11-1863	Bear R.	U		
35	DeLacy	MT Hist. Soc. 1902a	8-12-1863	Centennial Mtns.		U	
36	DeLacy	MT Hist. Soc. 1902a	8-17-1863	Palisades Reservoir	U		
37	DeLacy	MT Hist. Soc. 1902a	8-18-1863	Palisades Reservoir	U		

TABLE 1. (Continued)

Map No. (Fig. 1)	Observer	Reference	Date	Location	Description[1] IP	WY	HD
38	Leigh	Thomp. & Thomp. 1982	9-19-1875	Kilgore	I		
39	Leigh	Thomp. & Thomp. 1982	10-4-1875	Snake R.	U		
40	Leigh	Thomp. & Thomp. 1982	7-8-1876	Teton Cr.	U		
41	Leigh	Thomp. & Thomp. 1982	8-8-1878	Upper Snake R.	N		
42	Moran	Fryxell 1943	8-22-1879	Idaho Falls	U		
43	Moran	Fryxell 1943	8-23-1879	Heise	U		
Utah							
1	Escalante	Alter 1928	9-21-1776	Spanish Fork	I		
2	Escalante	Alter 1928	9-22-1776	Spanish Fork	I		
3	Russell	Haines, A. 1965	3-27-1841	Salt Lake		U	
4	Bidwell	Kelly 1930	8-17-1841	Garland	I		
5	Fremont	Fremont 1887	8-31-1843	Tremonton			I
6	Stansbury	Stansbury 1852	8-26-1849	Huntsville	I		
7	Powell	Stegner 1962	1870	Mtns. Statewide			I
8	Richards	WY Hist. Soc. 1931	7-23-1873	Wasatch Mtns.	U		
9	Richards	WY Hist. Soc. 1931	7-25-1873	Wasatch Mtns.	U		
Nevada							
1	Ogden	Rich 1950	5-15-1826	Goose Creek		U	
2	Ogden	Rich 1950	5-30-1826	Bruneau R.		U	
3	Ogden	Williams 1971	4-20-1829	Independence Valley	I		
4	Ogden	Williams 1971	6-7-1829	Santa Rosa Mtns.	I		
5	Bidwell	Kelly 1930	9-15-1841	Pilot Range	U		
6	Fremont	Fremont 1887	11-8-1844	Reno	I		
7	Bigler	UT Hist. Soc. 1932	8-5-1848	Minden	I		
Oregon							
1	Ogden	Davies 1961	9-24-1826	Deschutes R.	U		
2	Ogden	Davies 1961	9-26-1826	Deschutes R.		U	
3	Ogden	Davies 1961	10-4-1826	Paulina	I		
4	Ogden	Davies 1961	10-29-1826	Malheur Lake		U	
5	Ogden	Davies 1961	5-26-1827	Warner Valley			I
6	Ogden	Davies 1961	6-22-1827	Malheur Lake			I
7	Ogden	Davies 1961	7-14-1827	Vale	I		
8	Ogden	Davies 1961	9-21-1827	Huntington	U		
9	Ogden	Williams 1971	6-20-1829	Malheur Lake	I		
10	Work	Maloney 1945	9-29-1832	Malheur Lake	I		
11	Work	Maloney 1945	9-30-1832	Malheur Lake	U		
12	Work	Maloney 1945	10-1-1832	Malheur Lake		U	
13	Townsend	Thwaites 1966a	9-1-1833	LaGrande	I		
14	Townsend	Thwaites 1966a	9-3-1834	Umatilla R.	I		
15	Bonneville	Todd 1961	8-1834	SE Oregon	I		
16	Wyeth	Young 1899	9-1-1834	Umatilla R.		U	
17	Fremont	Fremont 1887	10-17-1843	LaGrande		U	
18	Fremont	Fremont 1887	10-23-1843	Pendleton		U	
19	Cross	Seitle 1940	8-6-1849	Blue Mtns.	U		
20	Griffiths	Griffiths 1902	1900	Burns		I	

[1] IP Fire in progress
WY Fire within past year
HD Historical documentation of fire

I Indian
N Non-Indian
U Unknown

Each fire's approximate location was plotted (Figure 1). Narratives lacking sufficient detail to plot fire location are listed in inset boxes within the appropriate state. Most of these are observations of smoke that could not be isolated to the approximate point of origin, or, are repeated observations over several days. A few are regional observations of recent and past fires. Though not mappable, these descriptions provide further perspective on the frequency, size, and effect on vegetation. The most explicit of these are Ayres (1900, 1901), Brandegee (1899), and Leiberg (1899a, 1899b, 1899c, 1904a, 1904b).

Most of the narratives of travels during summer and fall mention fires one or more

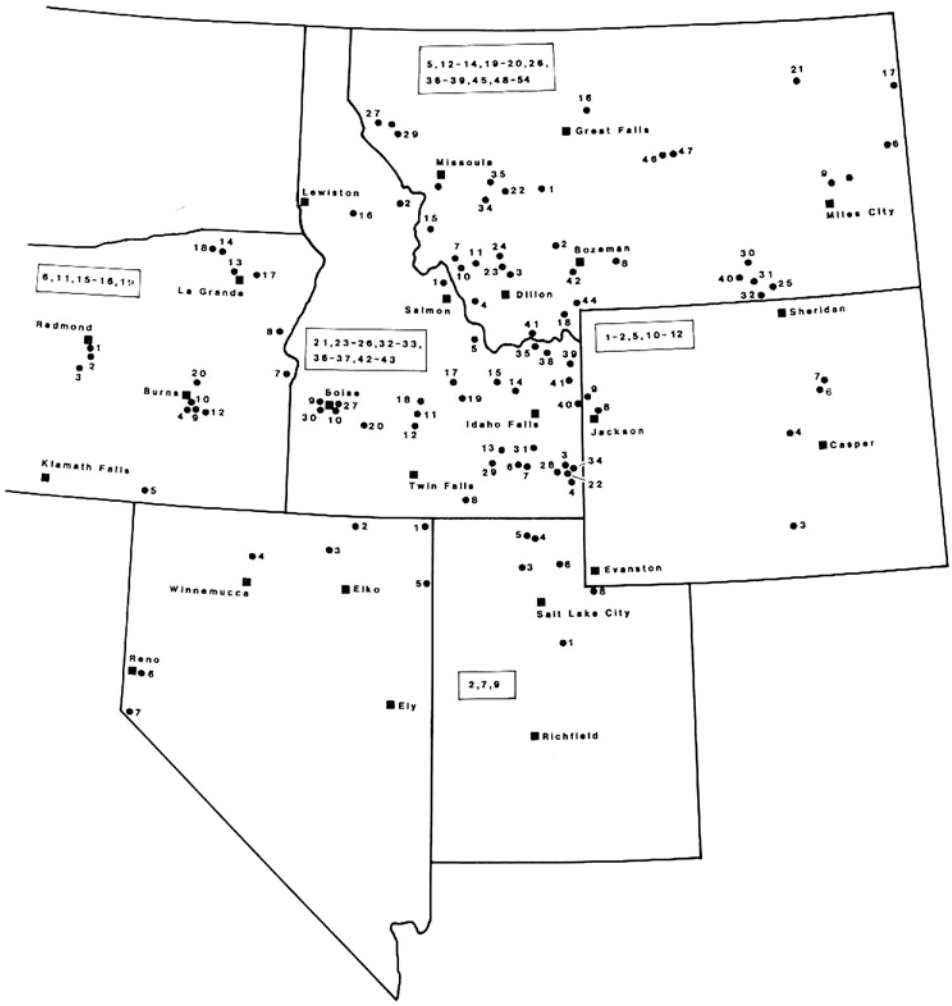

Figure 1. Fires listed in Table 1. Circles are fire locations. Boxed numbers represent observations not mappable or fires reported more than once. Squares are towns and cities.

times. The majority of these reports were made along principal travel routes (Figure 1). Documentation is lacking over large areas where travel was infrequent or not mentioned by the journalist.

Whether early travelers would mention fire seems to have depended on the observer, vegetative type, and season. For example, Lewis and Clark carefully noted events and landscape appearance for scientific purposes (Thwaites 1959). Ten different fires and burned landscapes were cited (Table 1). Others seemed to record only unusual events. Burned landscapes, apparently common in many areas, may not have been mentioned by various journalists. When burned landscapes were recorded, it often was in reference to destruction of grass needed for horse forage. This was experienced by Peter Skeen Ogden (Davies 1961), Maximilian Prince of Weid (Thwaites 1966c),

Lieutenant Mullan (1863), and DeLacy (Montana Historical Society 1902) during the period 1826-63. A fire in progress, however, was likely to be noted. In some regions, fire observations were unlikely because fire was an unimportant ecological force. For example, wildfires were apparently rare on the Laramie plains in 1832; Captain Bonneville noted that the short, scanty growth of grasses was insufficient for hunters to set on fire in the autumn (Todd 1961). There is a dearth of reports from sparsely vegetated regions in the drier, sagebrush valleys. Mention of fire is also unlikely in those journals covering travel during cool seasons or rainy periods when weather conditions precluded fire. Consequently, there is little or no mention of fire in these journals and reports.

Indian-set fires were apparently the primary ignition source over wide areas at lower and middle elevations. Of the 145 references to fires listed in Table 1, 60 (41 percent) were attributed to Indians; 7 (5 percent) were attributed to non-Indians, and 78 (54 percent) made no mention of ignition source. Very likely some lightning fires were inaccurately attributed to Indians, and the fires of unknown origin were caused by both Indians and lightning. Nevertheless, the available record does indicate that Indian-set fires were common (Gruell in press).

The amount of fire on early landscapes seems to have varied by region, depending on weather and fuels. Extensive fires swept through grasslands every year during the period 1832-1877 at various locations in central and eastern Montana as suggested by Denig (Ewers 1961), Catlin (1891), and Havard (1878). Other reports show that very large fires occurred in the forested regions of northwestern Montana during exceptionally dry years. One of these burned about 853 square kilometers (530 square miles) in 1889 on the Lewis and Clark Forest Reserve (presently Lewis and Clark, Flathead, and Lolo National Forests) (Ayres 1901). Likewise extensive fires were reported by Beaver Dick Leigh in 1875 and 1878 in southeastern Idaho (Thompson and Thompson 1982), in 1879 by Thomas Moran in Wyoming (Fryxell 1943), and Captain Bonneville (Todd 1961) and Nathaniel Wyeth (Young 1899) in 1834 in western Idaho and eastern Oregon.

During early government surveys, some observers recorded the effects of fires on vegetation. After an extensive survey of Utah's forests in the 1870's John Wesley Powell (Stegner 1962) concluded that fires set mainly by Indians prevented establishment of trees.

Ayres (1901) reported extensive, almost continuous, burns on the foothills along the east slope of the Rocky Mountain Front. Only weeds and brush, including willow and aspen, were observed on recent burns.

In the Little Belt Mountains of north-central Montana, Leiberg (1904a) noted that during the Indian occupancy there were many fires. Leiberg concluded that these fires were responsible for perpetuating grassy parks on slopes and in the larger canyons.

It was widely recognized that burning of grass improved forage. In August 1833, in the Wood River Valley below Ketchum, Idaho, Peter Townsend observed that the prairie had been recently burned by Indians to improve the crops of next year (Thwaites 1966a).

In October 1943 southeast of Boise, Idaho, Fremont (1887) noted green grass wherever Indian-set fires had burned the landscape.

Similarly, in September 1853, near the confluence of the Little Blackfoot and Clark

Fork Rivers in Montana, Lt. John Mullan (1855b) found young green grass growing abundantly in many places that had been burned over.

In September 1859, while traveling between the Bighorn River and present day Sheridan, Wyo., Capt. W. F. Raynolds (1868) encountered an extensively burned landscape and the temporary absence of grasses. Raynolds believed this was caused by Indian fires. He noted that although the country was black and forbidding, in the spring it would be most beautiful.

Fire's effect on woody plants was also noted by early explorers. For example, Havard (1878) described slow crown sprouting by woody vegetation, after prairie fires in central and eastern Montana. Fremont (1887) observed in August 1843 that Indian fires prevented the establishment of trees on the lower Bear River near present day Tremonton, Utah. The custom of burning to produce better grass had suppressed willow growth.

In July 1850, Byron McKinstry recorded that much aspen had been killed by fire the previous year in the Portneuf Mountains west of Soda Springs (McKinstry 1975).

Fire's effect on valley bottom vegetation in southwestern Montana was noted in the Lewis and Clark journals. Lewis recorded on 4 August 1805, near the outlet of the Big Hole River that in some localities the Indians appeared to have destroyed a great proportion of the low density timber by setting fire to the bottoms (Thwaites 1959).

A subsequent journal entry suggests that these fires were common. On the upper Beaverhead River, Lewis commented that fires were "frequently kindled in these plains by the natives."

Conclusions

These historical fire observations demonstrated that fire was a major perturbation in the interior West. Many of these fires were set by Indians.

Based on the analysis of fire-scarred trees, fire history studies have documented the frequency of early fires in the major cover types of the northern Rocky Mountains, middle Rocky Mountains, and Owyhee Plateau. These studies suggest that fire periodicity varied with climate and fuels. Average pre-settlement fire intervals often ranged from 4 to 20 years in ponderosa pine/Douglas-fir (*Pinus ponderosa/ Pseudotsuga menziesii*) forests in the Bitterroot Valley of western Montana (Arno and Peterson 1983). Scar data from higher and cooler Douglas-fir/sagebrush (*Artemisia vaseyana*) ecotones in Yellowstone Park and southwest Montana suggest fire intervals of 20-40 years (Houston 1973, Arno and Gruell 1983). Shorter intervals probably prevailed in the drier grassland associations. Fire scar evidence in aspen stands in Ephraim Canyon, Utah, showed a mean fire interval of 7-10 years during the period 1770-1875 (Baker 1925). Burkhart and Tisdale (1976) report pre-settlement fire intervals in southwestern Idaho sagebrush-grass/western juniper (*Juniperus occidentalis*) ecotones were comparable to the 13-18 year interval found by Keen (1937) for ponderosa pine forests in eastern Oregon.

Frequent fires in dry regions inhibited optimal growth of woody vegetation. Today, the number and sizes of fires in these regions have been markedly reduced, and large areas have not burned since the late 1800's. This change has apparently been caused by the reduction of fine fuels by livestock, elimination of Indian ignitions, and efficient fire suppression (Gruell 1982). Where fires were frequent, the reduction of fire

has resulted in a dramatic increase in woody vegetation. In the Oregon Cascades and western Montana, for example, ponderosa pine is being successionally replaced by shade tolerant species (West 1969, Gruell and others 1982). On the Owyhee Plateau juniper has invaded the sagebrush and perennial bunchgrass type (Burkhart and Tisdale 1976). In the cool-dry regions of Yellowstone Park and southwestern Montana, Douglas-fir forests are now more densely stocked, and sagebrush/grasslands are being heavily invaded by trees (Houston 1973, Arno and Gruell 1983).

In general, fires have been less frequent in the moist regions of north Idaho and high-cold regions elsewhere (Loope and Gruell 1973, Arno and Davis 1980, Romme 1979, Barrett 1982). Fires were particularly prevalent during dry years 1910-1934. Since the early 1940's, the marked reduction in acres burned yearly has resulted in successional advances and reduced diversity (Gruell 1983).

Historical narratives documenting early fire occurrence provide an understanding of the past role of fire in shaping patterns of vegetation. These narratives and fire history studies demonstrate that fires have had a major influence on vegetation in the interior West. This knowledge can help land managers understand why vegetation has changed and aid in assessing the desired role of fire in the future.

Literature Cited

Alter, J. S., (ed.). 1928. Father Escalante and the Utah Indians. Utah Hist. Qua. 1(4):109-110.

Arno, .S F., and D. H. Davis. 1980. Fire history of western redcedar/hemlock forests in northern Idaho, pp. 21-26 *In* Proceedings, Fire History Workshop, Tucson, Arizona 1980. USDA Forest Service Rocky Mountain Forest and Range Exp. Sta. Gen. Tech. Rep. RM-81.

———, and T. D. Peterson. 1983. Variation in estimates of fire intervals: a closer look at fire history on the Bitterroot National Forest. USDA Forest Service Intermountain Forest and Range Exp. Sta. Res. Pap. INT-301.

———, and G. E. Gruell. 1983. Fire history of the forest grassland ecotone in southwestern Montana. J. Range Manage. 36:332-336.

Ayres, H. B. 1900. The Flathead Forest Reserve. 20th Annual Report, Part 5: 295-317. U.S. Dep. Inter., Geological Survey, Washington, D.C.

———. 1901. Lewis and Clark Forest Reserve, Montana. 21st Annual Report, Part 5:27-80. U.S. Dep. Inter., Geological Survey, Washington, D.C.

Baker, F. S. 1925. Aspen in the Central Rocky Mountain Region. U.S. Dept. Agric., Washington, D.C. Bull. 1291.

Barrett, S. W. 1981. Relationships of Indian-caused fires to the ecology of western Montana forests. University of Montana, Missoula. Thesis.

———. 1982. Fire's Influence on Ecosystems of the Clearwater National Forest—Cook Mountain Fire History Inventory. USDA Forest Service Clearwater National Forest, Orofino, Idaho.

Bradley, F. H. 1873. Report of Frank H. Bradley, Geologist, *In* Sixth Annual Report of the U.S. Geological Survey of the Territories for the year 1872. U.S. Government Printing Office, Washington, D.C.: 212-214.

Brandegee, T. S. 1899. Survey of Teton Forest Reserve and Yellowstone Park Forest Reserve (Southern part) made in the summer of 1897. Nineteenth Annual Rep., U.S. Geological Survey, Washington, D.C.

Burkhardt, J. W., and E. W. Tisdale. 1976. Causes of juniper invasion in southwestern Idaho. Ecology 57:472-484.

Catlin, G. 1891. *In* Catlin's Indians. Hubbard Bros. Book Co., Philadelphia, Pennsylvania, 1981: 425-433.

Davies, M. A., (ed.). 1961. *In* Peter Skene Ogden's Snake Country Journals 1826-27. The Hudson's Bay Record Society, London: 7, 9, 19, 118, 125-126, 133.

Ewers, J. C., (ed.). 1961. Five Indian Tribes of the Upper Missouri. University of Oklahoma Press, Norman.

Fremont, J. C. 1887. *In* Memoirs of my life. Volume 1. Belford, Clarke, & Company, Chicago and New York: 202-211, 221, 254, 263-267, 317.

Fryxell, F. 1943. Thomas Moran's journey to the Tetons in 1879. Annuals of Wyoming 15(1):76-82.

Griffiths, D. 1902. *In* Forage conditions on the northern border of the Great Basin. U.S. Government Printing Office, Washington, D.C.: 30-32.

Gruell, G. E. 1982. Fire's influence on vegetative succession-wildlife habitat implications and man-

agement opportunities. *In* Proceedings Montana Chapter, The Wildl. Society, February 1982: 43-50.
———, W. C. Schmidt, S. F. Arno, and W. J. Reich. 1982. Seventy years of vegetative change in a managed ponderosa pine forest in western Montana—implications for resource management. USDA Forest Service Intermountain Forest and Range Exp. Sta. Gen. Tech. Rep. INT-130.
———. 1983. Fire and vegetative trends in the northern Rockies: interpretations from 1871-1982 photographs. USDA Forest Service Intermountain Forest and Range Exp. Sta. Gen. Tech. Rep. INT 158.
———. In press. Indian fires in the interior West: A widespread influence, *In* Wilderness Fire Symposium. Missoula, Mont. USDA Forest Service Intermountain Forest and Range Exp. Sta.
Hafen, L. R., and A. N. Hafen, (ed.). 1961a. Account of the Connor Expedition. *In* Powder River Campaigns and Sawyers Expedition of 1865. The Far West and the Rockies Historical Series, 1820-1875. The Arthur H. Clark Co., Glendale, Calif.: 114, 116.
———, and ———, (ed.). 1961b. Report of Colonel Cole's Expedition. *In* Powder River Campaigns and Sawyers Expedition of 1865. The Far West and the Rockies Historical Series, 1820-1875. The Arthur H. Clark Co., Glendale, Calif.: 74.
Haines, A., (ed.). 1965. *In* Osborne Russell's Journal of a Trapper. University of Nebraska Press, Lincoln: 7, 30, 122.
Haines, F. D., Jr., (ed.). 1971. *In* The Snake Country Expedition of 1830-1831. John Work's Field Journal. University of Oklahoma Press, Norman: 16, 24, 28, 74.
Havard, V. 1878. *In* Botanical outlines of the country marched over by the 7th United States Cavalry, during the summer of 1877. Volume 2, No. 3, Annual Report of the Secretary of War. U.S. Government Printing Office, Washington, D.C.: 1687.
Hayden, F. V. 1873. *In* Sixth Annual Report of the U.S. Geological Survey of the Territories for the year 1872. U.S. Government Printing Office, Washington, D.C.: 126.
Hazlitt, R., (ed.). 1962. The journal of Francois Antoine Larocque from the Assiniboine River to the Yellowstone in 1805. (Translated from original in Ottawa, Canada 1911). *In* Frontier Omnibus. Montana State University, Bozeman: 25.
Hewitt, J. N. B., (ed.). 1969. *In* The journal of Rudolph Friederich Kurz—the life and work of this Swiss artist (translated by Myrtis Jarrell). Ye Galleon Press, Fairfield, Wash.: 229, 350.
Houston, D. B. 1973. Wildfires in northern Yellowstone National Park. Ecology 54: 1111-1117.
Keen, F. P. 1937. Climatic cycles in eastern Oregon as indicated by tree rings. Mon. Wea. Rev. 65: 175-188.
Kelly, C. 1930. A journey to California. The Salt Lake desert. Utah Hist. Qua. 3: 41, 44, 48.
Leiberg, J. B. 1899a. Priest River Forest Reserve. *In* Nineteenth Annual Rep. U.S. Geol. Surv. for 1897-98, Part V: 217-252.
———. 1899b. Present conditions of the forested areas in northern Idaho outside the limits of the Priest River Forest Reserve and north of the Clearwater River. *In* Nineteenth Annual Rep. U.S. Geol. Surv. for 1897-98, Part V: 373-83.
———. 1899c. Bitterroot Forest Reserve. *In* Nineteenth Annual Rep. U.S. Geol. Surv. for 1897-98 Part V: 253-282.
———. 1904a. *In* Forest conditions in the Little Belt Mountains forest reserve, Montana, and the Little Belt Mountains Quadrangle. U.S. Geological Survey. U.S. Government Printing Office, Washington, D.C.: 14, 23.
———. 1904b. *In* Forest conditions in the Absoroka division of the Yellowstone Forest Reserve, Montana and the Livingston and Big Timber quadrangles. U.S. Geol. Surv. Prof. Pap. 29: 1-148.
Lewis, W. S., and P. C. Phillips, (ed.). 1923. *In* The Journal of John Work, a Chief-Trader of the Hudson's Bay Co. during his 1831-32 Expedition from Vancouver to the Flatheads and Blackfeet of the Pacific Northwest. The Arthur H. Clark Co., Cleveland, Ohio: 80, 83, 147.
Loope, L. L., and G. E. Gruell. 1973. The ecological role of fire in the Jackson Hole area, northeastern Wyoming. Quaternary Res. 3: 425-443.
Maloney, A. B., (ed.,). 1945. *In* Fur Brigade to the Bonaventura, John Work's California Expedition 1832-1833 for the Hudson's Bay Company. California Historical Society, San Francisco: 7-8.
McKinstry, L., (ed.). 1975. *In* The California Gold Rush Overland Diary of Byron N. McKinstry 1850-1852. The Arthur H. Clark Co., Glendale, Calif.: 215.
Montana Historical Society. 1902a. *In* A trip up the south Snake River in 1863. Volume 1, No. 2. Independent Publishing Co. and Rocky Mountain Publishing Co.: 105, 122-133.
Montana Historical Society, 1902b. The Yellowstone Expedition of 1863. *In* Contributions to the Historical Society Montana. Volume 1, No. 2, second edition. Independent Publishing Co., Helena, Mont.: 162, 179, 198.
Moore, C. T. 1972. Man and fire in the central North American grassland 1835-1890; A documentary historical geography. University of California, Los Angeles. Dissertation.
Mullan, J. 1855a. Report of an exploration from Fort Benton to the Muscle Shell River, and thence by the southern Little Blackfoot River to the St. Mary's River. *In* Report of exploration of a route for the Pacific Railroad—Governor Stevens' Report to the Secretary of War. (I. I. Stevens, compiler.) Volume 1, Senate Executive Document 78, 33rd Congress, 2nd Session,

U.S. Government Printing Office. Washington, D.C.: 315.
———. 1855b. Report of a reconnaissance from the Bitter Root Valley to Fort Hall and back. *In* Volume 1. Report of exploration of a route for the Pacific railroad—Governor Stevens' report to the Secretary of War. (I. I. Stevens, compiler.) Senate Executive Document 78, 33rd Congress, 2nd Session, U.S. Government Printing Office. Washington, D. C.: 341-342.
———. 1861. *In* Report of Lieutenant Mullan, in charge of the construction of the military road from Fort Benton to Fort Walla Walla. 36th Congress, 2nd Session, House Executive Document 44, Washington, D.C.: 37.
———. 1863. Report of a reconnaissance from the Coeur d'Alene Mission to Thompson's prairie . . . thence across the mountain to the Bitter Root River . . . and over the high divide to the Ten-Mile prairie, of the Coeur d'Alene river. *In* Report on the Construction of a Military Road from Fort Walla Walla to Fort Benton. By Capt. John Mullan, USA. U.S. Government Printing Office, Washington, D.C.: 113-115.
Oregon Historical Society. 1901. *In* Reminiscences of Experiences on the Oregon Trail in 1844, The Quarterly of the Oregon Historical Society, 2:213, 219-220.
Pyne, S. J. 1982. Fire in America—A Cultural History of Wildland and Rural Fire. Princeton University Press, Princeton, N.J.
Phillips, P. C., (ed.). 1957. *In* Forty Years on the Frontier as Seen in the Journals and Reminiscences of Granville Stuart. Volume 1. The Arthur Clark Co., Glendale, Calif.: 183-186.
———, (ed.). 1940. *In* Life in the Rocky Mountains. A diary of the wanderings on the sources of the Missouri, Columbia and Colorado from February 1830 to November 1835. The Old West Publishing Co., Denver, Colo.: 103-107, 215.
Raynolds, W. F. 1868. *In* Report on the Exploration of the Yellowstone River. Senate Executive Document 77, 40th Congress, 2nd Session. U.S. Government Printing Office, Washington, D.C.: 54-59.
Rich, M. A., (ed.). 1950. *In* Peter Skene Ogden's Snake Country Journals 1824-25 and 1825-26. The Hudson's Bay Record Society, London: 156, 159, 165-166, 176.
Rollins, P. A., (ed.). 1935. *In* The Discovery of the Oregon Trail—Robert Stuart's Narratives of his Overland Trip Eastward from Astoria in 1812-13. Charles Scribner's Sons, New York: 129-131.
Romme, W. H. 1979. Fire and landscape diversity in subalpine fir forests of Yellowstone National Park. University of Wyoming. Dissertation.
Settle, R. W., (ed.). 1940. *In* The March of the Mounted Riflemen. First United States Military Expedition to Travel the Full Length of the Oregon Trail from Fort Leavenworth to Fort Vancouver, May to October, 1849, as Recorded in the Journals of Major Osborne Cross and George Gibbs and the Official Report of Colonel Loring. The Arthur H. Clark Co., Glendale, Calif.: 166-167.
Shinn, D. A. 1980. Historical perspective on range burning in the inland northwest. J. Range Manage. 33: 415-422.
Spaulding, R. A., (ed.). 1956. *In* The Fur Hunters of the Far West. University of Oklahoma Press, Norman: 241.
Stansbury, Howard, 1852. *In* Exploration and survey of the valley of the Great Salt Lake of Utah, including a reconnaissance of a new route through the Rocky Mountains. Lippincott, Grambo and Co., Philadelphia. Senate Executive Document 3, Special Session of Congress, March 1851: 81, 244.
Stevens, I. I. 1855. *In* Report of Governor I. I. Stevens upon the Route near the 47th Parallel. Volume 1. Report of the Secretary of War Communicating the several Pacific Railroad Explorations. House Executive Document 3, 33rd Congress, 1st Sess. Washington, D.C.: 97.
Stegner, W., (ed.). 1962. *In* Report on the Lands of the Arid Region of the United States, with a More Detailed Account of the Lands of Utah. The Belknap Press of Harvard University Press, Cambridge, Mass.: 25-29.
Stewart, O. C. 1951. Burning and natural vegetation in the United States. Geog. Rev. 41: 317-320.
———. 1963. Barriers to understanding the influence of use of fire by aborigines on vegetation. Proc. Tall Timbers Fire Ecol. Conf. 2: 117-126.
Thompson, E. M. S., and W. L. Thompson. 1982. *In* An Historical Biography of Richard Leigh-the Honor and the Heartbreak. Jelm Mountain Press, Laramie, Wyo.: 56-58, 63, 97-98.
Thwaites, R. G. (ed.). 1959. *In* Original Journals of the Lewis and Clark Expedition, 1804-1806. Volumes 2, 3, and 5. Antiquarian Press Ltd., New York: 252, 271, 309; 17, 38, 49; 159, 249, 276, 309.
———, (ed.). 1966a. *In* Narrative of a Journey Across the Rocky Mountains in 1834. Volume 21. Early Western Travels 1748-1846. AMS Press, Inc., New York: 246, 273, 356.
———, (ed.). 1966b. *In* Palmer's Journal of Travels over the Rocky Mountains, 1845-1846. Volume 30. Early Western Travels 1748-1846. AMS Press, Inc., New York: 244.
———, (ed.). 1966c. *In* Maximillan, Prince of Wied's Travels in the Interior of North America, 1832-1834. Volume 23. Early Western Travels 1748-1846. AMS Press, Inc., New York: 108, 162, 207.
Todd, E. W., (ed.). 1961. *In* The Adventures of Captain Bonneville in the Rocky Mountains and the Far West. Digested from his journal by Washington Irving. University of Oklahoma

Press, Norman: 27, 338-339.
Utah Historical Society. 1932. *In* Extracts from the Journal of Henry W. Bigler. Utah Historical Quarterly 5: 155.
Williams, G. W., (ed.). 1971. *In* Peter Skene Ogden's Snake Country Journals 1827-28 and 1828-29. The Hudson's Bay Record Society, London: 8, 143, 157, 161.
West, N. E. 1969. Successional changes in the montaine forest of the central Cascades. Amer. Midl. Naturalist 81: 265-271.
Wislizenus, F. A. 1912. *In* A Journey to the Rocky Mountains in the Year 1839. Missouri Historical Society, St. Louis: 64.
Young, F. G., (ed.). 1899. *In* The Correspondence and Journals of Captain Nathaniel J. Wyeth, 1831-36. Record of Two Expeditions for the Occupation of the Oregon Country. Sources of the History of Oregon. University Press, Eugene, Oregon: 228-229, 231.
Wyoming Historical Society. 1931. *In* Diary Kept by W. A. Richards in summer of 1873. Annals of Wyoming. Vol. 8 Cheyenne: 502.

Received 3 October 1983
Accepted for publication 8 May 1984