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FOREST SERVICE—BULLETIN 117.

HENRY S. GRAVES, Forester.

FOREST FIRES:

THEIR CAUSES, EXTENT
AND EFFECTS, WITH A
SUMMARY OF RECORDED
DESTRUCTION AND LOSS.

BY

FRED G. PLUMMER,
GEOGRAPHER.



WASHINGTON:
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1912.



FOREST FIRE ON SLEEPY RIDGE, WALLOWA NATIONAL FOREST, OREG., AUGUST, 1911.

U. S. DEPARTMENT OF AGRICULTURE,
FOREST SERVICE—BULLETIN 117.

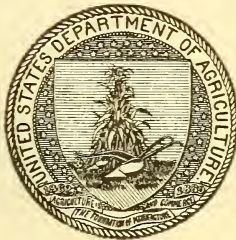
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LETTER OF TRANSMITTAL.

UNITED STATES DEPARTMENT OF AGRICULTURE,
FOREST SERVICE,
Washington, D. C., July 13, 1912.

SIR: I have the honor to transmit herewith a manuscript entitled "Forest Fires: Their Causes, Extent, and Effects, with a Summary of Recorded Destruction and Loss," by Fred G. Plummer, Geographer, and to recommend its publication as Bulletin 117 of the Forest Service.

Respectfully,

HENRY S. GRAVES,
Forester.

Hon. JAMES WILSON,
Secretary of Agriculture.

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FOREST FIRES.

SOURCES AND SCOPE OF INFORMATION.

Forest fires in the United States have caused an average annual loss of about 70 human lives,¹ the destruction of trees worth at the very least \$25,000,000, and the loss of stock, crops, buildings, and other improvements to the amount of many millions more. To these must be added enormous losses from the destruction of young tree growth, deterioration of the soil, damage to watercourses and adjacent property by low water and flood, interruption of business, and depreciation of property. By inquiry into the causes and extent of such fires we are able to realize in some degree the magnitude of these losses, even though their amount in dollars may not be appraised.

The first compilation of forest-fire statistics for the whole United States was by Prof. C. S. Sargent for the year 1880, published in the Tenth Census Report, Vol. IX. Data were given for 43 States and Territories, which, though necessarily incomplete, formed the best record then in existence. Unfortunately the Eleventh, Twelfth, and Thirteenth Censuses did not continue the compilation, and it is therefore not possible to compare data for different decades collected under similar conditions.

In 1891 the Division of Forestry of the Department of Agriculture collected statistics of forest, prairie, and crop fires. The data were incomplete and unsatisfactory, but they showed that during that year about 12,000,000 acres of forest had been burned and that property other than forest had been damaged to the extent of \$503,590. The loss from prairie fires to crops, tree growth, buildings, and other property was reported by the same correspondence at \$1,633,525. What proportion of the actual destruction these reports represented was not known.

The Chronicle Fire Tables for the year 1900 report a loss of \$2,246,000 from forest fires. This figure, compiled by insurance companies, covers principally the damage near or affecting insurable property.

In 1900 and 1901 the Division of Forestry made a second attempt to gather statistics upon which damage from forest fires might be

¹ Very incomplete data for the past 50 years show 2,938 persons burned to death in forest fires.

estimated. All available sources were searched, including the files of old newspapers and magazines. While the results covered the greater part of the United States and Canada and extended over 100 years of time, they were obviously not complete, nor is the extent of their incompleteness known.

These attempts to compile statistics were made at the end of the decades following 1880, and the present bulletin is prepared at the close of the third decade. In gathering the data not only have these former records been drawn upon, but data from every other available source, and for which it is impracticable to give due credit, have been freely used.

New data have been obtained from—

- (1) Reports of fires on National Forests.
- (2) Reports of State foresters from 17 States.
- (3) Supplemental reports of forest supervisors on fires outside of National Forests.
- (4) Reports of lumbermen's associations.
- (5) Newspaper accounts from press-clipping bureaus of recent fires.
- (6) The Forest Atlas. This is the central map system of the Forest Service and contains manuscript maps showing old and recent burns, statistics, reports, history, etc.
- (7) Investigations of Forest officers, particularly in even-aged forests, to determine by stem analysis the dates of old burns.

Before this mass of material could be used it was necessary to reduce the record of each event to a common standard, and a card system was devised, as shown below:

Sample of U. S. Forest Service fire record.

KIND OF FIRE: FOREST—BRUSH LAND—PRAIRIE (CHECK MARK PROPER TERM).	
LOCATION OF FIRE. { STATE, <i>New York.</i> { COUNTY, <i>Essex.</i> { NEAR <i>West Moriah P. O.</i>	DATE OF FIRE. { YEAR, <i>1845.</i> { MONTH, <i>June.</i> { DAY (OR DAYS), <i>10.</i>
Origin of fire, <i>unknown.</i> Area burned, <i>50,000</i> acres.	
Value of timber burned, <i>\$300,000.</i>	
Number of buildings burned: houses, barns, <i>11</i> mills, and others.	
Number of lives lost, Number stock lost: cattle, horses, sheep.	
Remarks: " <i>Immense quantities of boards, shingles, lumber of all kinds, produce, houses, barns, and sheds.</i> "	
The above information is furnished by <i>National Intelligencer</i> , page 3, col. 4. Date 6-30-1845.	

Even though these records do not include every fire that has occurred, some fair conclusions can be drawn from them. The causes and effects of fires at one period may be compared with the causes and effects at another period, notwithstanding that the total number and extent of fires are unknown. Moreover, the missing data for any decade may be interpolated and reasonable totals estimated. Such totals will, however, never represent the full damage.¹

ANCIENT FIRES.

It is probable that forest fires have occurred ever since there were forests. When wood has been reduced to charcoal, its structure may be preserved indefinitely. It is in the coal formations that some of the earliest evidences of fire may be found, while a substance resembling charred wood has been unearthed in a subcarboniferous sandstone, on the eastern side of the "Thumb" of Michigan. Wood found in the Pleistocene formation "showed the effect of fire, indicating the result of a forest fire."² The charcoal of peat bogs in North America and New Brunswick, some of which are estimated to be from 2,000 to 3,000 years old, also indicates the occurrence of forest fires in the far distant past. Thus, step by step, from the subcarboniferous sandstone to the quaternary peat, charcoal presents its evidence of fire, just as the unbroken record continues from trees older than the peats to those of the present day.

Fire-scarred California bigtrees indicate that great fires occurred there in the years 245, 1441, 1580, and 1797. Evidence has been found of forest fires that occurred in Colorado³ during 1676, 1707, 1722, 1753, and 1781, and also of numerous ancient fires in the Black Hills, S. Dak., the earliest of which is estimated to have occurred in 1730. So, too, in the region south of Mount Katahdin, Me., proofs were found that a forest fire covering an area of about 200 square miles occurred in about 1795.⁴

¹ As an example of this, Mr. W. T. Cox, Minnesota State forester, writes: "The old data regarding forest fires in Minnesota are apparently valueless, unless it is to show that during certain years fires were more prevalent than during others. We know, for instance, of certain fires which did millions of dollars' worth of damage no reports of which were included in these summaries. * * * Even the figures for 1910 are away off. I notice they are given at \$1,721,752. As a matter of fact, we had one fire in the fall of 1910 which did several times that amount of damage, in Beltrami County, and there were dozens of other large fires in northern Minnesota the same fall, none of which seems to have been reported. * * * These old reports did not give more than from 10 to 25 per cent of the loss in merchantable timber alone, and we have no way now of getting at the actual figures."

² Notes on Tertiary Plants from Canada and the United States, by D. P. Penhallow, Proceedings and Transactions of the Royal Society of Canada, p. 75, 1905.

³ Forest Service Bulletin No. 79.

⁴ In the several petrified forests the woody structure of the tree trunks has been entirely replaced by silica, the annual layers of growth, however, being clearly traceable. If carbon, indicating a fire scar, is present in any specimen, the fact has not been recorded.

It seems reasonable to assume, and the assumption is supported by some evidence, that fires destroyed the forests that probably once covered the great prairie region of the Middle States, some of the barrens of Canada, and the present extensive "parks" in the Appalachian and Rocky Mountain regions. This belief is held because trees will grow in these open areas when given encouragement and protection. Geologic evidences also support the view that the entire United States, below the Alpine summits, has, at one time or another, been forest land.

CAUSES OF FIRES.¹

At least two causes of fires operated in ancient times—lightning² and Indians. The practice of Indians in firing forests, prairies, or swamps was to permit the growth of berries, to drive game, and occasionally to impede an enemy. That this practice was continued long after the advent of the whites is shown by many accounts of such fires in the early history of America.

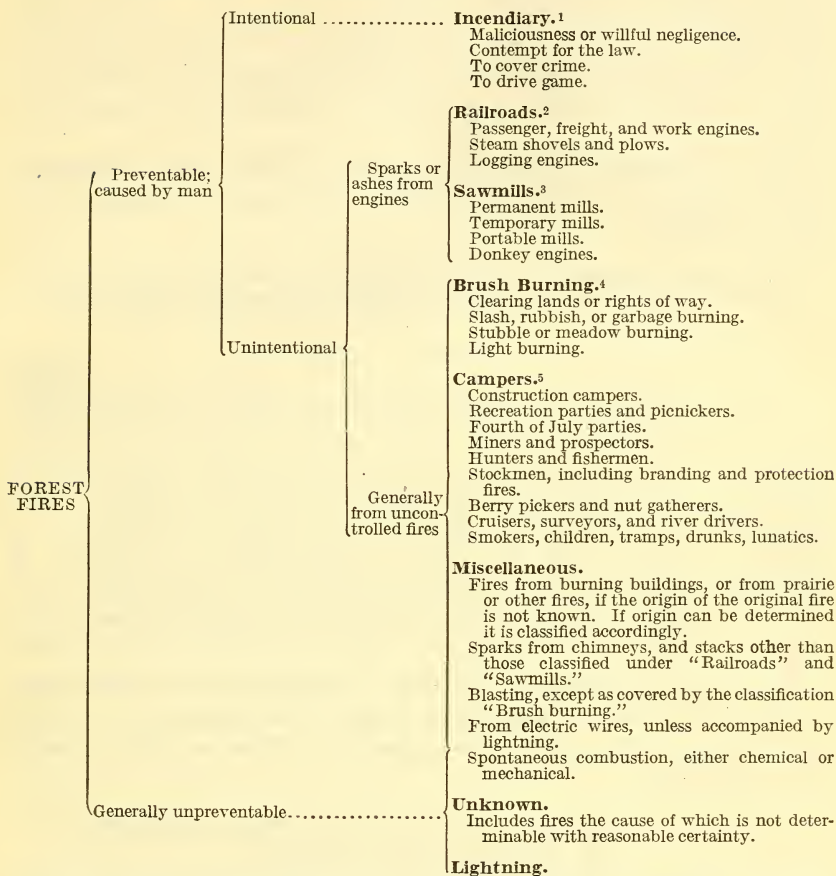
Forest fires may be divided into those caused by man and those caused by lightning. A natural division of the fires caused by man separates those which are intentional, or incendiary, from those which are unintentional. Since by far the greater number of forest fires are of unintentional origin, these latter have been further subdivided, as shown in the following classification:

¹ It is very desirable that all statistics of forest fires be kept in a uniform manner. Some States and organizations, in reporting the causes of fires, use terms which have practically the same meaning but which may be interpreted differently. As the value of a fire record depends upon the field report, it is necessary that there should be a uniform method of assigning the causes of fires. The scheme of classification in the Forest Service is both simple and logical and is recommended for general adoption.

² Forest Service Bulletin 111.

Classification of the causes of forest fires.

[The heavy-face type shows the terms used in reporting the causes of fires.



¹ Includes all fires that are intentionally set or due to willful negligence, but not those due to carelessness, mischief, or ignorance. "Intentional" however, does not include back-firing with good intent, which is classed according to the origin of the fire being fought.

² Includes all fires caused by sparks or ashes from traction locomotives, but not from clearing of rights of way, which are reported under "Brush burning."

³ Includes sparks from stationary engines, but not fires from logging locomotives nor from loggers while slashing, clearing, cooking, or river driving.

⁴ Includes all fires incidental to the removal of litter or undesirable growth, unless willful negligence is evident, in which case it is "Incendiary."

⁵ Includes fires due to carelessness, mischief, or ignorance and fires started by Indians, but not fires started to drive game or to increase the grazing area. Such are "Incendiary."

In order of their importance, the following are the chief known causes of fires on the National Forests: Railroads; lightning; campers; brush burning; incendiary; sawmills.

Lightning is responsible for about 17.5 per cent of the fires. Other natural causes are extremely rare, and are not entitled to special recognition, but are included in the classification among "Miscellaneous" when their nature is known, or among the "Unknown" when it can not be determined.

Municipal fire statistics contain many interesting cases of fires originating in unusual or seemingly impossible ways, many of which could operate in the forest as well as in the city. "Spontaneous combustion" is a rare cause, and though no one seems actually to have observed the phenomenon, the circumstances surrounding it are such as to leave no doubt that it may be responsible for some forest fires.

The most accurate data on the causes of forest fires are from the records kept on the National Forests. A summary of these data is given in Table 1.

TABLE 1.—Number of fires on the National Forests in 1906, 1907, 1908, 1909, 1910, and 1911, and reported causes; also percentage of causes to total number of fires.

Causes.	1906		1907		1908		1909		1910		1911		Average per cent to 1911, inclusive.
	Num-ber.	Per-cent.	Num-ber.	Per-cent.	Num-ber.	Per-cent.	Num-ber.	Per-cent.	Num-ber.	Per-cent.	Num-ber.	Per-cent.	
Railroads.....	303	26.7	273	20.1	603	22.1	1,186	37.8	1,704	32.8	442	13.1	26.7
Lightning.....	261	23.0	176	13.0	555	20.3	294	9.4	724	14.0	948	28.1	17.5
Incendiary.....	24	2.1	19	1.4	102	3.7	97	3.1	302	5.8	225	6.7	4.5
Brush burning..	15	1.3	34	2.5	68	2.5	181	5.8	307	5.8	199	5.9	4.8
Campers.....	312	27.5	361	26.7	493	18.1	431	13.7	688	13.2	574	17.0	16.9
Sawmills.....			65	4.8	5	.2	38	1.2	51	1.0	33	1.0	1.1
Unknown.....	196	17.3	367	27.1	263	9.7	758	24.1	1,184	22.8	743	22.1	20.7
Miscellaneous...	22	2.1	60	4.4	639	23.4	153	4.9	241	4.6	205	6.1	7.8
Total.....	1,133	100.0	1,355	100.0	2,728	100.0	3,138	100.0	5,201	100.0	3,369	100.0	100.0

The number of fires on the National Forests from two of the causes enumerated in Table 1 may be compared with similar data for property fires reported by insurance companies. These are "Incendiary" and "Lightning."

TABLE 2.—Property fires in the United States (including exposure fires).

[Compiled from the Chronicle Fire Tables.]

Year.	Number of fires.	Caused by—				Year.	Number of fires.	Caused by—			
		Incendiary.		Lightning.				Incendiary.		Lightning.	
		Num-ber.	Per-cent.	Num-ber.	Per-cent.			Num-ber.	Per-cent.	Num-ber.	Per-cent.
1885.....	14,114	3,135	22.21	380	2.69	1894.....	52,266	4,119	7.88	851	1.63
1886.....	15,222	3,474	22.82	405	2.66	1895.....	53,961	3,523	6.53	836	1.55
1887.....	18,163	3,712	20.43	409	2.25	1896.....	61,133	4,474	7.32	1,736	2.84
1888.....	26,528	3,267	12.32	396	1.49	1897.....	74,740	6,330	8.47	1,547	2.07
1889.....	29,965	3,721	12.42	348	1.17	1898.....	94,062	6,894	7.33	3,480	3.70
1890.....	35,411	4,700	13.28	711	2.01	1899.....	105,342	6,741	6.40	2,759	2.62
1891.....	37,282	4,558	12.23	521	1.40	1900.....	109,092	6,949	6.37	3,436	3.15
1892.....	44,141	3,068	6.95	839	1.90	1901.....	111,736	6,637	5.94	3,061	2.74
1893.....	54,035	4,068	7.53	659	1.22	1902.....	103,715	5,562	5.45	3,007	2.90

It will be seen that there is a decrease in the percentage of incendiary fires from 22.21 per cent in 1885 to 5.45 per cent in 1902. If this decrease has continued it should by now approximate the average percentage of incendiary fires upon the National Forests, which,

for the years 1906 to 1911, inclusive, is 4.5 per cent. The percentage of fires on National Forests reported as incendiary is increasing. This is due, however, to a larger and more efficient patrol force and an awakened and helpful public sentiment, enabling the causes of fire to be better ascertained, rather than to any increase in incendiarism.

The average percentage of forest fires caused by lightning, 17.5 per cent, is six or seven times as great as property fires caused by lightning, in spite of the fact that more thunderstorms are reported in the East, where the larger amount of property is situated. All of the available information on the relation of lightning to forest fires is presented in Forest Service Bulletin 111, "Lightning in Relation to Forest Fires," by Fred G. Plummer.

CONTRIBUTORY FOREST CAUSES.

A number of conditions in the forest contribute either to the inception or to the spread of fires. Some of these are natural forest conditions, while others result from the acts of man.

All forest fires start as small fires. Three kinds are distinguished—surface fires, which spread over the surface of the forest floor, fed by litter and undergrowth; ground fires, which smolder or burn only in the ground, consuming duff and humus and often the roots of trees; and crown fires, which consume the entire forest cover. All crown fires start from ground or surface fires, except when lightning ignites the tops of trees. In order for fire to get into the tree crowns the foliage must be close to the ground, or else the litter and undergrowth must be very heavy and inflammable. Both of these conditions obtain in many types of forests, and naturally increase the fire hazard.

Artificial litter on the forest floor, such as slash, is even more dangerous than natural litter. The refuse from bad logging becomes exceedingly inflammable as it dries out, and since it usually includes a large portion of the trees cut, burns long and fiercely. The history of logging in the United States shows that cut-over areas are in most cases so severely burned as to make their natural restocking with young growth exceedingly problematical. When a fire, instead of sweeping rapidly over the ground, burns long because of the large amount of fuel, it not only destroys the humus and duff, but the intense heat changes the chemical composition of the top soil. Forest fires may burn over the same area several times. If the first conflagration kills the stand without consuming it, the area within a few years will be covered with a large amount of dry, inflammable litter. Moreover, there will in all probability be a dense growth of young trees, which, if conifers, will not only contribute fuel to the next fire, but perhaps render it so hot as to consume everything, leaving no chances for further reproduction from natural seeding.

Insect depredations and forest fires are interrelated. Insect-killed timber furnishes dry fuel for the flames, and the damage is thereby increased. A forest fire in an insect-infected area will effectually destroy great quantities of the insects, but, on the other hand, insects may advance over a burned area and kill fire-injured trees which otherwise might have recovered. Dr. Hopkins believes, however, "that injuries by fire are not as a rule an important factor in contributing to subsequent depredations by bark beetles."¹

CONTRIBUTORY CLIMATIC CAUSES.

It needs no argument to prove that dry wood burns better than wet, nor that droughts, hot seasons, hot waves, and warm winds decrease the amount of moisture in a forest and thereby increase the fire hazard. Nevertheless, it is not true that every drought is coincident with great fires, nor is it strictly true that all great fires have followed hot seasons. Other factors, such as wind, topography, and the inflammability of the type of forest in which a fire occurs, bear upon the hazard. Moreover, its origin determines to some extent whether or not a fire will become a great conflagration. Lightning is usually accompanied by a downpour of rain; those who start a fire carelessly will usually make some attempt to extinguish it or give the alarm. Incendiaries, on the other hand, intend that the small fire which they start shall become a great fire, and are likely to take advantage of natural conditions. Thus climate must be considered with other variable factors as a contributory cause of fires.

Droughts are the most notable of the contributory climatic causes of forest fires. Although a single month of exceedingly dry and hot weather might bring a forest to a state of dryness which several months of the same weather would not practically increase, still the drought has an added menace in the fact that the probability of a serious fire starting is increased with the length of time a region is without rain.

The cause or causes of droughts are unknown. A planet like the earth presents seasons that necessarily might differ from year to year, because of its elliptical orbit and inclined axis, its high mountain barriers running in different directions, and its enveloping atmosphere of uneven density and transparency. While it would seem that these, taken singly or together, might well account for any phenomena of heat or cold, humidity or dryness, wind or calm, they have never been marshalled in explanation of the long-continued dryness known as drought.

¹ Hopkins, A. D., Some Insects Injurious to Forests, Bureau of Entomology, Bulletin No. 58, Pt. V, p. 68.

Years during which great droughts have occurred in the United States are as follows:

1662.....	Middle States.
1688.....	Middle States.
1694.....	Middle States.
1730.....	Middle States.
1763.....	Middle States.
1764.....	Middle States.
1773.....	Middle States.
1791.....	Middle States.
1854.....	Middle States.
1856.....	Iowa and Indiana.
1857.....	Iowa and Missouri.
1860.....	Middle States.
1863.....	Middle States.
1864.....	Middle States.
1870.....	Ohio, Wisconsin, and Missouri.
1874.....	Middle States.
1876.....	Northeast United States.
1881.....	East of Mississippi River.
1886.....	North Central States.
1887.....	North Central and Middle Atlantic States.
1894.....	Valleys of the Mississippi and Missouri Rivers.
1895.....	Lake Region and Atlantic Coast.
1910.....	Up to the latter part of August there was a deficiency of precipitation in every district of the United States, and it was exceptionally dry in the Northwest, where the percentage of the normal was only 26. The region most affected was the area drained by the Columbia River.

Hot seasons are summers of unusually high temperature. A hot season may be coincident with a drought, if there is a lack of precipitation. Since air at higher temperatures can absorb a great amount of moisture, part of which is withdrawn from vegetation, it is evident that this will contribute to inflammability of the forest cover.

A hot season which would be a contributory cause of forest fires would not necessarily be one which gave very high temperature with intermittent periods of cold weather or rain. Rather it would be a continued spell of warm weather in which the temperature would be above the normal, though not so high as to cause instability of the atmosphere.¹ Data are not at hand for making this distinction over

¹ Hot strata at lower elevations bring about an unstable condition of the atmosphere. The average rate of decrease in temperature with increase in altitude for unstable air in the lower part of the atmosphere is about 1° for each 330 feet of height. If the lower strata are very much warmer than normal, there will result an overturning of the air strata. This may occur gently, or with such violence as to create a storm, and then there will be a precipitation if the warm air, with a high moisture content, ascends to a higher and cooler altitude. This is what actually occurs when moisture-laden strata, moving against a barrier of mountains, are deflected upward and cooled.

the long periods for which records of hot seasons are available. In the United States hot seasons for the last 60 years were as follows:

- 1853.....Eastern United States.
- 1854.....South Central States.
- 1872.....Eastern States.
- 1877.....Eastern, Middle, and Southern States.
- 1879.....Central and Northeastern States.
- 1881.....General for the United States.
- 1882.....Eastern States.
- 1900.....General for the United States.

The records for European countries extend over much greater periods of time, but it is not always easy to separate droughts from dry seasons. The following record will be interesting as showing some of the extremes of weather conditions:

- 1186.....Western Europe; a year without a winter; apple trees blossomed in January, fruited in February, harvested in May, and the vintage was ready in August.
- 1303-4.....France; several of the principal rivers went dry.
- 1705.....France.
- 1718.....General in Europe.
- 1719.....France; very low water in the Seine.
- 1773.....General in Europe.
- 1778.....Italy.
- 1793.....General in Europe. In France very low water in the Seine.
- 1800.....Western Europe. The forests of Haguenaw and part of the Black Forest were burned.
- 1811.....Northern Europe.
- 1822.....France.
- 1826.....Western Europe. Forests were burned in Sweden and Denmark.
- 1834.....France.
- 1836.....Russia, Denmark, France, and Spain.
- 1842.....France.
- 1851.....Western Europe.
- 1852.....General in Europe.
- 1858.....Western Europe.

Hot waves are periods of three or more consecutive days in which the temperature is much above normal. These are common phenomena, and because of their heat and dryness may contribute to the fire hazard. They are caused by temporary suspension of the eastward movement of the atmosphere. Air strata, both upper and lower, have a general movement from west to east, and such a cessation, though it presents no phenomena at the surface of the earth, is actually a serious disturbance in the atmosphere. Hot waves are usually followed by a thunderstorm, and if there is much lightning, without a great downpour of rain, the chances for the ignition of trees is increased.

Warm winds, or "foehn" as they are sometimes known collectively, differ from the very local winds which come from a desert or other

heated area and make their influence felt over the adjoining country. Such are the hot winds known as the "Santa Ana" of southern California, the "sonora" of the Southwestern States, the hot winds of Texas or Kansas, and the so-called "northers"¹ of northern California, which, like the "sirocco" of Italy, may be both warm and damp.

The winds termed "foehn" appear to defy a law of physics, blowing from high altitudes to lower regions. These winds are warm, almost hot, and usually dry, in spite of the fact that they descend from cold or snow-covered slopes. The "foehn"² has been identified even in the Arctic regions, and is not uncommon in Iceland and Greenland. On one occasion a foehn in western Greenland lasted for nine days during November and December. In this country the best example of the foehn is the "chinook,"³ which is common in the Northwestern States, eastward as far as the Black Hills, sometimes into Colorado, northward into British Columbia, and sometimes into Alaska. Often it is welcomed as an agreeable change of weather, but sometimes it brings disaster in the swollen streams from quickly melted snow.

The foehn are a great menace to forests as a contributory cause of fires, not only because they may be hot and dry, but also because they are strong winds and may fan a flame into a terrible conflagration. Such winds increase the length of the fire season in localities where they occur. Ordinarily the fire hazard becomes very small with the advent of winter, attended by snow, rain, and decreased evaporation, but a foehn, such as the "chinook," is likely to occur at any season of the year, and its effect can not be disregarded.

SMOKE PHENOMENA OF FOREST FIRES.

It has already been pointed out that the damage resulting from forest fires is usually estimated in acres, quantity of timber, or in dollars, that these estimates are always too low, and that they do not include other losses due to the interruption of business, destruction of young growth, loss of soil fertility, and damage to water-courses, with the attendant depreciation of property. Even this is not all.

A thrifty forest purifies the air we breathe, and it is an irony of nature that when it goes up in smoke it causes a pollution of the

¹ This "norther" should not be confounded with the "northers" from Montana to the Gulf of Mexico, which are cold.

² Foehn in different countries differ slightly in characteristics, but they are all related. The word was originally applied to the warm winds which descended from the Alps in Switzerland. Local names are given in other countries; as the solano and leveche of Spain; the leste of Madeira Islands; the totenturm-wind in Hungary; the harmattan in northwestern Africa; the simoom in northeastern Africa; the kham-sin in Egypt; the zonda in Argentina; and the brickfielder in New South Wales.

³ For a discussion of the chinook as a foehn see *Descriptive Meteorology*, by Willis L. Moore, 1910, p. 186.

atmosphere. The mischief thus caused is by no means **trivial**, since a heavy pall of smoke interrupts business, interferes with navigation, and, turning night into day, compels the use of artificial light. Such conditions have obtained over an expanse of many thousands of miles, and the actual loss must be very great. In the vicinity of a great fire the atmosphere sometimes carries ashes and burning brands to a distance of several miles. The atmosphere in motion, flowing over the surface of the earth, has an enormous carrying capacity, very much greater than is generally supposed. It is analogous to flowing water in that matter can be carried to any distance, determined only by the sustained velocity of the wind and the size or weight of the particles of matter. Wind, like water, will deposit the particles "downstream," assorting them and carrying the lightest the greatest distance. It is probable that, for equal areas, the winds transport as much matter as the streams.

Forest fires are the most frequent causes of widespread pollution of the atmosphere, and the volume of the pollution is exceeded only in the case of violent volcanic eruptions. The forest fire not only causes an uprush of heated air, usually with a cyclonic movement, but it furnishes at the same time the material which is lifted to the higher atmospheric strata. Under such conditions it is not surprising that fires may jump several miles; in fact, as far as a live brand can be carried. The phenomena are analogous to those of local winds, which, sometimes assuming cyclonic form, can suck up water, sand, dust, and all kinds of small objects, which later "rain" down. The forms of wind which raise heavy matter are such centers of cyclonic action as whirlwinds, sand spouts, and waterspouts. These are the causes of many of the so-called prodigies, which have as surely been observed as they have reluctantly been believed. The shower of oranges which occurred near Naples in 1833 would have been discredited had it not been known that the fruit had been taken up by just such means. The waterspout is guilty, in a similar manner, of causing showers of living frogs, turtles, fish, and worms, and the sand spout or dust storm may fill the air with particles which must eventually fall.

A large forest fire has an appreciable effect upon the surrounding atmosphere, causing a movement of the air toward the fire. This effect is quite local, and is overbalanced if there is a strong wind blowing, which will drive the fire before it. Under such conditions a fire may advance with great rapidity, while blazing branches sail through the air and start other fires far ahead of the main conflagration. During the great forest and city fire at Fernie, British Columbia, August 1-8, 1908, which was accompanied by a high wind, flaming trees, timbers, lumber, and sections of buildings were carried.

This fire burned a strip 3 miles wide for a distance of about 20 miles. During the great Idaho fire of August 20–22, 1910, the same phenomena were observed. At some points the fire was actually blown out by the wind. In one case, while crossing a depression, the fire was lifted and carried ahead, leaving a belt of unburned forest three-fourths of a mile wide.

The tendency is for smoke to spread out and to be dissipated, but if the volume is great it may be identified for hundreds of miles, even when the cause of it is unknown. At greater distances, where the smoke is more attenuated, there is only a slight obscuration of light, though if the smoke has descended to the earth it may interfere with vision. At still greater distances from the fire, when the smoke has been further mixed with clear air, its presence can only be noted by a yellow or pearly haze about the horizon or by the discoloration of rain. These phenomena, observed from time immemorial, have been known by various names—in this country as dark days, dry fogs, Indian summers, and colored rains.



FIG. 1.—Phenomena caused by smoke from a forest fire.

Dark days have been recorded for centuries. Usually there is a gradually increasing gloom until it becomes so dark that artificial light is necessary. This darkness may last a few hours or several days and decrease as gradually as it came.

We are now able to show that dark days are due to dense smoke in the atmosphere, and that in this country forest and prairie fires have been the causes. In other countries peat fires and volcanic eruptions have also furnished smoke to produce dark days, but such cases are more rare. Theories advanced in olden times that dark days are caused by solar eclipses or by the transit of inferior planets across the solar disk are ridiculous, since a total solar eclipse seldom lasts over five minutes, and a transit of Venus, the largest and nearest of the inferior planets, is barely visible to the naked eye, and would not cause a diminution in light or heat that could be measured. If any consideration of such theories were necessary, it would be sufficient to point out that the dark days of modern history have not been coincident either with eclipses or transits.

The record for dark days in the United States and Canada is as follows:¹

1706.....	May 12, 10 a. m., New England.
1716.....	October 21, 11 a. m. to 11.30 a. m., New England.
1732.....	August 9, New England.
1762.....	October 19, Detroit.
1780.....	May 19, New England. (Black Friday. The Dark Day.)
1785.....	October 16, Canada.
1814.....	July 3, New England to Newfoundland.
1819.....	November 6-10, New England and Canada.
1836.....	July 8, New England.
1863.....	October 16, Canada. ("Brief duration.")
1868.....	September 15-October 20, western Oregon and Washington.
1881.....	September 6, New England. (The Yellow Day.)
1887.....	November 19, Ohio River Valley. ("Smoky Day.")
1894.....	September 2, New England.
1902.....	September 12, western Washington.
1903.....	June 5, Saratoga, N. Y.
1904.....	December 2, 10 a. m., for 15 minutes, Memphis, Tenn.
1910.....	August 20-25, northern United States, from Idaho and northern Utah eastward to St. Lawrence River.

Most dark days might more properly be called "yellow days."² Even "Black Friday," May 19, 1780, which was the most memorable of all the dark days of modern times, was preceded by a gradually increasing yellowness and an odor. The same was true of the dark days of 1819, 1881, 1894, and 1903. September 6, 1881, was so distinctly yellow that it is known as "The Yellow Day."

The evidence that dark days result from fires may be briefed as follows: In 1716 the air was very full of smoke. During the dark day of 1780 ashes of burnt leaves, soot, and cinders fell in some sections from forest fires in New York and Canada. In 1785 black rain fell during a thunder shower in the darkened area. In 1814 ashes of burnt wood fell and there was a strong smell of smoke. In 1819 a shower in the darkened area was discolored as if the water were impregnated with soot. The fires near Wissitaquik, Me., probably caused the darkness in 1836.³ In 1868 the smoke from the Coos and St. Helens fires was encountered on the Pacific Ocean. In 1881 dense smoke was noticed over a large area (fig. 2), chiefly from the Michigan forest fires. In 1887 the smoke from forest fires to the westward interfered with navigation, became painful to the eyes, and rendered breathing disagreeable. In 1894 the smoke came chiefly from the Hinckley fire in Minnesota. In 1902 the smoke came from numerous

¹ Notable dark days elsewhere occurred in Mediterranean B. C. 295, 44, A. D. 252, 746, 775, 1090, 1106, 1208, 1547; in England, January, 1807, May, 10, 1812, Dec. 27-29, 1813, Nov. 27, 1816; at Victoria, Australia (Black Thursday), Feb. 6, 1851. The long and widespread darkness of June, 1783, reported from Europe, Asia, Africa, and North America, was probably due to volcanic eruptions.

² A yellow tinge in the atmosphere is an indication of smoke from forest fires. A red glow sometimes indicates dust from volcanoes.

³ "Black Thursday" in Victoria, Australia, in 1851 was caused by terrible brush fires at the time.

fires, one of the largest being in the South Fork of Lewis River watershed. In 1903 the smoke was from fires in the Adirondacks. In 1910 the smoke was from the great Idaho fires. The area in which artificial light was used in daytime is shown in figure 3, but the area in which smoke was observed was very much greater. Indeed, the British ship *Dunfermline* reported that on the Pacific Ocean, 500 miles west of San Francisco, the smell of smoke was noticed, and the haze prevented observations for about 10 days. In connection with the 1910 phenomenon it was noted that a cool wave followed, passing eastwardly over the same area, but spreading farther southward,

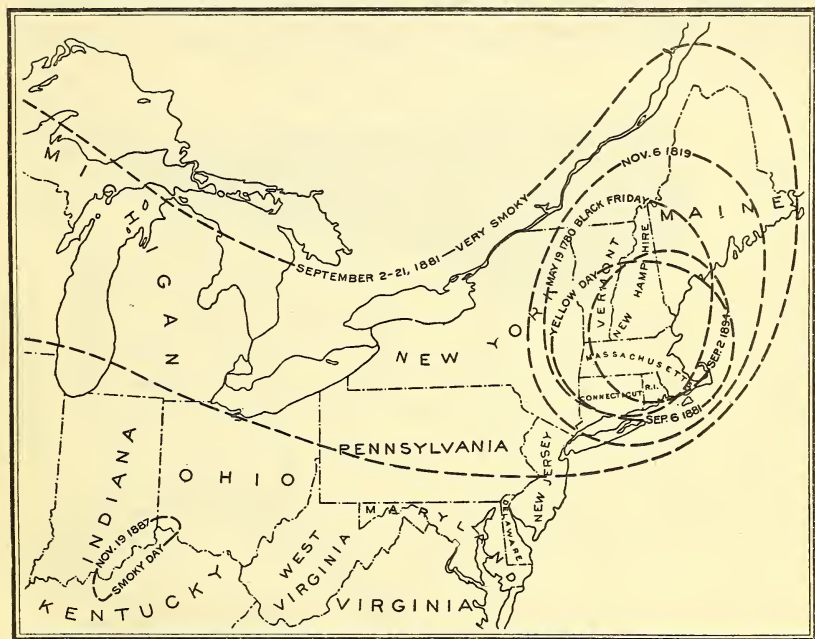


FIG. 2.—Areas in the northeastern States in which occurred the most important dark days since 1780.

which gave the lowest temperatures, with frosts, for the month of August.

New England easily leads in the phenomena of very dark days, and several of the most pronounced have affected practically the same area which is shown in figure 2. The tracks of many air currents and storm centers converge toward this area from all over the United States, and sometimes meet an opposing storm from the east or northeast. It therefore seems that dark days are caused by the banking up of smoke-laden air. The greatest forest fires have occurred in the Northern States, and the winds, transporting the smoke eastward, flow over the New England States. At such a time, if a "nor'easter"

flows in from the ocean and banks up a smoke-laden stratum, increasing its thickness and density, it is evident that obscurity, and perhaps darkness, will result.

Dry fogs.—On portions of the Pacific coast, particularly in the Puget Sound country, the smoke from forest fires is often so dense as to interfere with navigation. The same is true on the Great Lakes and on navigable rivers. Under such circumstances captains prefer to run slow or tie up until the danger has passed. At the time of the Hinckley fire, in 1894, it was estimated that the losses to lake vessels on account of the smoke exceeded \$40,000.

The smoke may last for days or weeks, until dispersed by a favorable wind. When there is no odor, it might be taken for fog, except

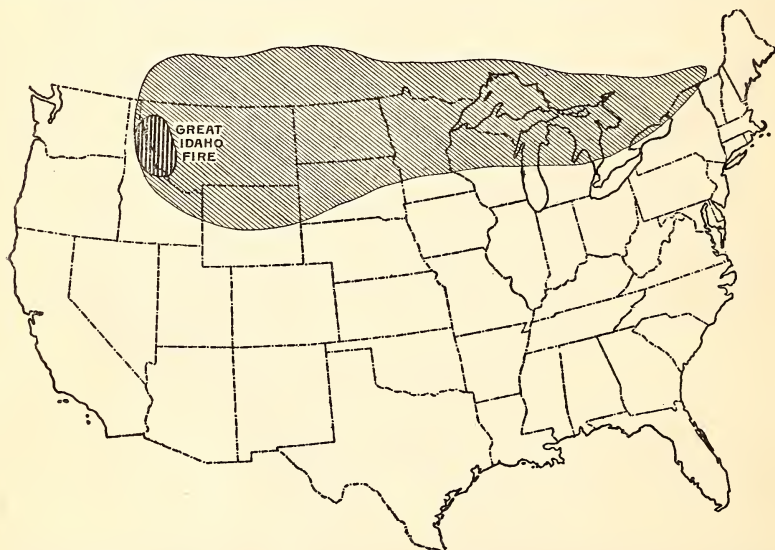


FIG. 3.—Area in which dark days occurred, caused by smoke from the great Idaho fire, August 19–25, 1910.

that it is dry. Although it is simply “smoke,” the phenomenon is also called “dry fog” in English-speaking countries. In Spain it is known as “callina”; in Germany as “hohrauch”; in Switzerland as “hale”; and in Russia as “mgla.” Prairie fires and the burning of peat or turf beds produce the same phenomena.

Several of such dry fogs have been noted in history. In 1783 the phenomenon lasted from May 9 until the latter part of June. It was first observed at Copenhagen and extended over France, Germany, and the Alps. At the same time a similar phenomenon existed over a large part of North America. On several of the days the sun was so obscured that they were recorded as “dark days.” In 1831 a dry fog extended generally over the Northern

Hemisphere. In May and July, 1834, there was a dry fog in central Europe, caused by the burning of peat beds in Germany and forest fires near Berlin and in Sweden and Russia. In 1881, in the north-eastern United States, a dry fog lasted from September 1 to September 10, culminating on September 6 in the "yellow day." Its limits were determined as between 40 and 45 degrees of latitude, and between 67 and 87 longitude. (See fig. 2.) This was caused by forest fires in Michigan, with contributions from fires in New Jersey, Pennsylvania, and Canada.

Indian summer is the name applied to periods during the months of October and November when the weather is unseasonably warm and there is a dry fog¹ of longer duration but of less intensity than the average. The air during Indian summer is saturated with impurities so fine that they are not precipitated unless a rain occurs. It is characterized by a smoky haze, sometimes of pearly or phosphorescent appearance, so attenuated that the zenith may be very blue, though the smoky appearance is very pronounced near the horizon.

Under different names Indian summer is recognized all over the world. In England it is called "St. Luke's summer" when it occurs in October, and "St. Martin's summer" if in November; in Wales, "St. Michael's summer"; in France, the "summer of St. Martin" and the "summer of St. Denis"; in Italy, the "summer of Santa Teresa"; in Sweden, "St. Bridget's summer"; in Russia and Germany, "old woman's summer"; in Argentina, "St. John's summer."

The phenomena vary in intensity in different years, or may be wholly lacking in some locality. On an average of one year in three Indian summer is marked, and about one year in three it is wholly lacking.

Colored rains, being so little known and understood, are considered as prodigies; nevertheless, they have been observed for many centuries. The phenomena are not difficult to understand. We say that "a shower of rain has cleared the atmosphere," meaning that the drops of water have carried to the earth such impurities as were held in suspension or solution. It is to be expected that under certain conditions, depending upon the quantity and nature of these impurities, the falling rain should be colored, and that in some cases the color should be so marked as to attract attention. Forest fires, as has been shown, are one of the principal agents by which the atmosphere is polluted, and are therefore related to the phenomena of colored rains. Usually such rains, noted in the daily press, are better described as discolored, being gray or muddy. It is not probable,

¹ American Weather, Gen. A. W. Greeley, 1888, p. 245.

however, that the most notable or highly colored rains mentioned in history can be attributed to smoke.¹

HISTORIC FIRES.

As a calamity a great forest fire ranks well with flood, pestilence, famine, or earthquake and, like them, is as soon forgotten. Some

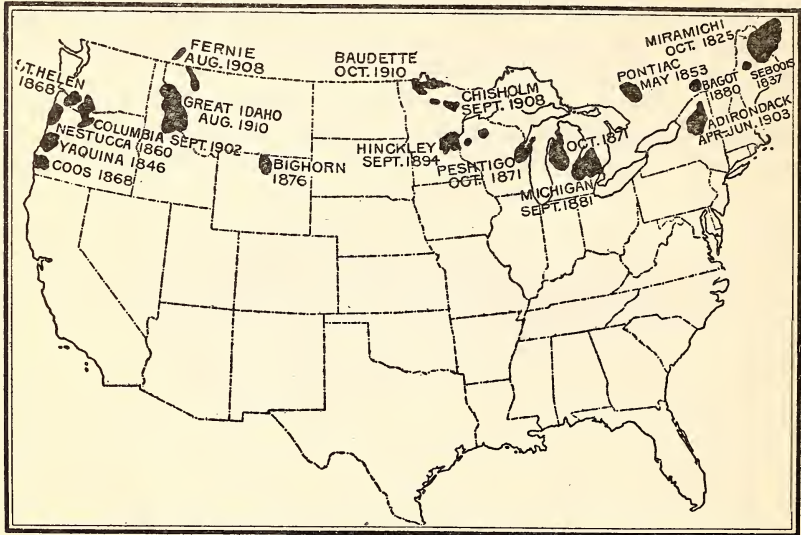


FIG. 4.—Diagram showing the location of the greatest forest fires in the United States since the year 1800.

fires, however, because of lives lost, property destroyed, or large areas burned, have become historic.

¹ Oct. 16, 1785, a black rain fell in Canada, and on Nov. 6, 1819, black rain and snow fell in the northern part of the United States and Canada. In the Middle Atlantic States, Apr. 11-13, 1902, there were showers of eolian dust, which, when accompanied by rain, fell as gray mud. Similar dust fell at Grantville, Pa., Feb. 10, 1896. On Apr. 12, 1902, a rain in the Middle Atlantic States was so loaded with dust from the dry western plains as to cause a mud shower.

Truly remarkable instances are: "Showers of milk or white rain" in Italy in the years 620, 629, and 643; yellow rains, May 16, 1646, at Copenhagen; May 19, 1665, Norway; Aug. 24, 1764, at Heidelberg, Germany. The causes of yellow rains have been assigned not only to dust, but to volcanic smoke and to the pollen of plants. A yellow rain in Italy, May 13, 1907, was attributed to Stromboli and Etna, but similar showers in the vicinity of Naples have been caused by pollen.

An exceptional occurrence of red rain was observed off the coast of Newfoundland in February, 1890.

In Europe red rains have been so numerous in history that several hundred have been catalogued. They are associated with the sirocco, a strong wind which carries dust from the desert regions of northern Africa over all of southern Europe and sometimes as far north as Russia.

During the last century notable red rains occurred:

1803—February.....	Italy.	1852—March.....	Lyons.
1813—March 14.....	Calabria.	1854—May.....	Horbourg, near Colmar.
1814—October.....	Oneglia, between Nice and Genoa.	1860—December 31...	Sienna.
1819—September....	Studein, Moravia.	1862—March.....	Beanan, near Lyons.
1821—May.....	Giessen.	1863—March.....	Rhodes.
1839—April.....	Philippeville, Algeria.	1863—April.....	Between Lyons and Aragon.
1841—February.....	Genoa, Parma, Canigon.	1868—April 26.....	Toulouse.
1842—March.....	Greece.	1869—March 10.....	Naples.
1846—May.....	Siam, Chambery.	1869—March 23.....	Sicily.
1846—October.....	Dauphine, Savoy, Vivarais.	1870—February 13...	Rome.
1847—March.....	Chambery.	1890—May 15.....	Oppide Mamertina, Italy.

Snow will also precipitate dust particles, which doubtless act as nuclei in the formation of snow crystals.

The first accounts of such great events are generally exaggerated and subsequent accounts are often conflicting. The best sources of information have been given preference in Table 3.

TABLE 3.—*Historic forest fires in the United States and Canada.*

Date.	Name of fire.	Location.	Area burned.	Lives lost.
			<i>Acres.</i>	<i>Number.</i>
1825—October.....	Miramichi.....	Maine and New Brunswick.....	3,000,000	160
1837—(?).....	Seboois.....	Maine.....	130,000	.....
1846—(?).....	Yaquina.....	Oregon.....	450,000	.....
1853—May.....	Pontiac.....	Quebec.....	1,600,000	.....
1860—(?).....	Nestucca.....	Oregon.....	320,000	.....
1868—September.....	Coos.....	do.....	300,000	.....
1868—September.....	St. Helen.....	Washington and Oregon.....	300,000	.....
1871—October.....	Peshtigo.....	Wisconsin.....	1,280,000	1,500
1871—October.....	.....	Michigan.....	2,000,000	.....
1876—(?).....	Big Horn.....	Wyoming.....	500,000	.....
1880—September.....	Bagot.....	Quebec.....	288,000	.....
1881—September.....	Michigan.....	Michigan.....	1,000,000	138
1891—May.....	Comstock.....	Wisconsin.....	64,000	.....
1894—July.....	Phillips.....	do.....	100,000	13
1894—September.....	Hinckley.....	Minnesota.....	160,000	418
1902—September.....	Columbia.....	Oregon and Washington.....	604,000	18
1903—April-June.....	Adirondack.....	New York.....	450,000	.....
1908—August.....	Fernie.....	British Columbia.....	64,000	9
1908—September.....	Chisholm.....	Minnesota.....	20,000	.....
1910—August.....	Great Idaho.....	Idaho and Montana.....	2,000,000	85
1910—October.....	Baudette.....	Minnesota and Ontario.....	300,000	42

STATISTICS OF DAMAGE AND LOSS.

Table 4 is a compilation of such data as can be expressed either in number of fires, area burned, thousands of board feet damaged, or the money value of the forest or forest products damaged. This last item sometimes includes the value of buildings, crops, or stock, though in the majority of cases it is not possible to segregate the amounts.

Many of the data in regard to fires collected by the Forest Service were found useless in the compilation of this table. A report that "a fire destroyed the crops and some stock belonging to Peter Swan and then spread into the adjoining woods where it did an immense amount of damage" has no value for the present purpose, except to prove that the statistical record is an underestimate of the damage done by forest fires, since it can not include these vague items.

In some cases the record seems complete, as indicated by the number of fires, their causes, etc.; in others it is clearly incomplete, since it shows the damage resulting from only one or a very few fires. Conclusions should not be drawn by interpolating from fragmentary data on the basis of complete data, since the causes and contributory causes are extremely variable for different years. Thus, although the forest fires reported in the census for 1880 are assumed to be a complete record for that year, they would not, in the case of a given State, serve as a basis upon which to estimate the number or extent of fires for any other year.

More data are needed before an estimate can be made of the probable fire hazard in each State under normal climatic conditions, since the States are of unequal size, with different amounts of forested land, and with forests of widely different types.

Figures do not convey an adequate expression of the prevalence of forest fires, nor can any general map do the subject full justice.

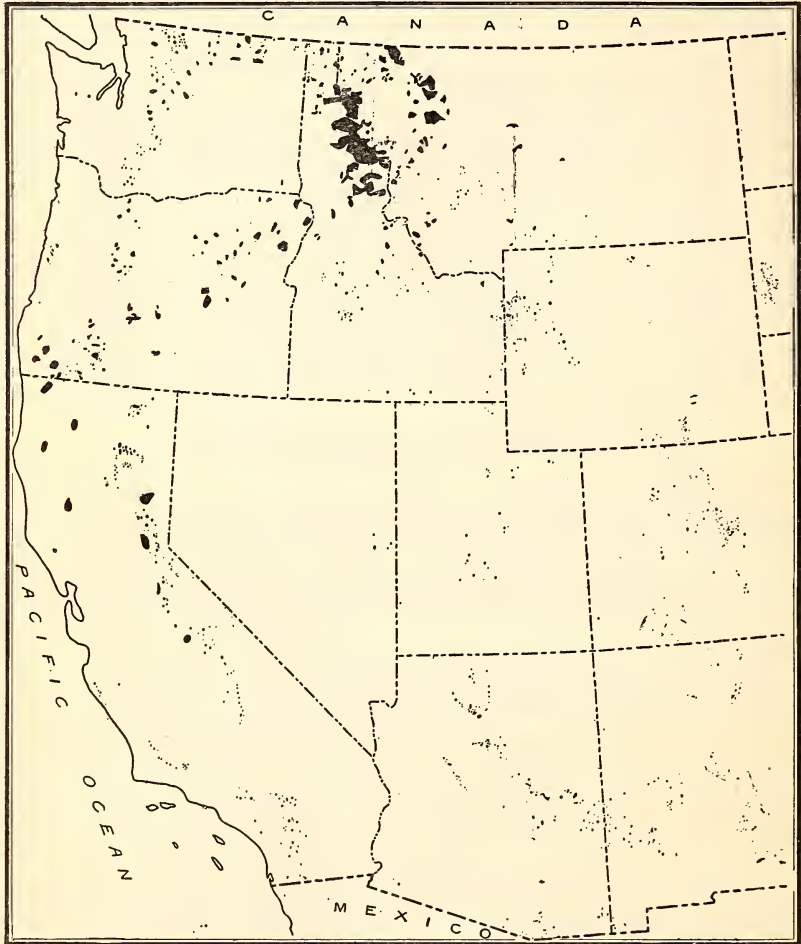


FIG. 5.—Fires of 1910 in the western United States.

Figure 5 shows the fires of 1910 only upon the National Forests in the western United States, but it is not possible to show upon it the locations of fires which occurred on private lands outside of the National Forests. In the State of Washington, for instance, there were 4,410 such fires, and a graphic record of them, on the scale used, would be impossible. Figure 6 shows, upon a larger scale,

the location of fires during 1910 in the timbered areas of Minnesota and Wisconsin and illustrates graphically what the statistics fail to convey.

While statistics are not sufficiently complete to justify a positive statement of the actual depletion of our forest resources through fire, they are more than sufficient to prove that this loss is appalling. In round figures the land area of the United States is 1,900 million acres, of which only about two-fifths is forested. Three-fourths

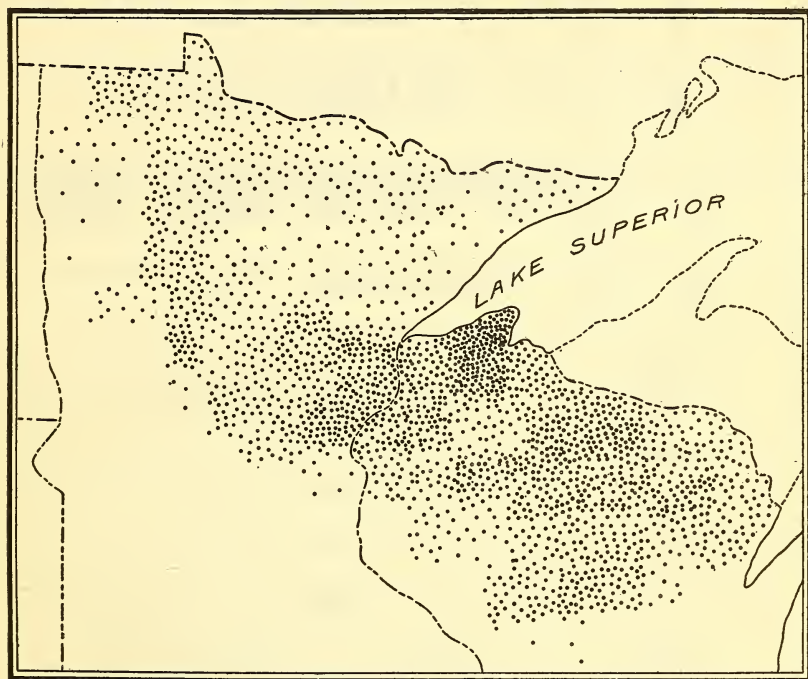


FIG. 6.—Location of fires of 1910 in northern Minnesota and Wisconsin.

of the original stand has been culled or cut and the present rate of destruction is three times that of the growth. At present the stand is about 2,800 billion board feet.¹ The annual cut is about 100 billion board feet, and the loss from fire, covering 10 million acres, varies according to whether the greater areas are virgin forest, cut lands, or reburns. We are prodigal of our heritage, both principal and interest. We cut each year $3\frac{1}{2}$ per cent of the stand, and burn almost all, if not all, of the growth.

¹ Forest Service Circulars 166 (1909) and 171 (1909) gave 2,500 billion board feet as the estimate. The Summary of the Report of the Commissioner of Corporations on the Lumber Industry, Part I, Standing Timber (1911), page 14, gives 2,800 billion feet.

FOREST FIRES.

TABLE 4.—Forest fires in the United States, Canada, and Newfoundland.

State.	Year.	Number of fires caused by—								Total fires.	Area burned.	Damage.		Remarks.	
		Railroads.	Lightning.	Incendary.	Brush burn- ing.	Campers.	Sawmills.	Unknown.	Miscella- neous.			Amount.	Value.		
Alabama.	1880	4			50	23				77	569,160	M. B. F.	\$121,225	Tenth Census record.	
	1875			1						1	10,000			Fragmentary record.	
	1880			2		5				7	10,240			Tenth Census record.	
	1886		1							1	5,000		20,000	Fragmentary record.	
	1900						2			2	10,000			Do.	
	1901									350	35,807			National Forest only.	
	1902									294	42,841			Do.	
	1903									191	3,120			Do.	
	1907		71	37		1	14		13	139	13,618		1,771	Do.	
	1908		49	38	1	21	1	1	24	142	14,624		2,459	Do.	
	1909		9	23		20	6	68	7	133	45,257		3,899	Do.	
	1910		13	51	1	21	21	69	28	185	126,299		20,154	Do.	
1911		5	70	1	2	44		32	170	57,470		146	Do.		
Arkansas.	1880			1	27	20			48	858,115			259,470	Tenth Census record.	
	1908	68		18	4	14			105	57,310		10,278	20,648	National Forest only.	
	1909	131	3	40	7	21	3	183	391	54,146		4,378	44,631	Do.	
	1910	8	2	161	13	21	1	207	415	501,262		23,470	38,562	Do.	
	1911	4		50	12	10		101	185	142,717		2,581	45,389	Do.	
	1869								1	1	23,000			10,000	Fragmentary record.
California.	1871								1	1				Do.	
	1877								1	1				Do.	
	1879					1			1	1				Do.	
	1880			5	9	55			69	356,835		440,750		Tenth Census record.	
	1881			1					3	70,000				Fragmentary record.	
	1884								2	16,000				Do.	
	1885								1	150,000				Do.	
	1886				2				1	1	109,200		4	3,000	Do.
	1887								6	8				Do.	
	1888								4	5				Do.	
	1889					1			5	6				Do.	
	1890								7	7				Do.	
	1891				1				3	5	32,000			Do.	
	1892								5	7	402,000			Do.	
1893								4	5	12,300			Do.		
1894								1	1	115,100			Do.		
1895								8	8	67,300			4,000	Do.	

1896	1						1	1,070	12,000	Do.
1897							7	56,000	Do.	
1898							3	20,000	Do.	
1899									No record.	
1900							2	6,500	Fragmentary record.	
1901							242	18,524	National Forest only.	
1902							7,895	15,000	Do.	
1903							1	21,000	Fragmentary record.	
1904							167	13,246	National Forest only.	
1905							1	600	Do.	
1906							2	12,000	Fragmentary record.	
1907									Do.	
1908							61	650,000	National Forest only.	
1909							129	8,601	Do.	
1910							37	75,060	Do.	
1911							124	163,259	Do.	
1912							117	4,107	Do.	
1913									Do.	
1914									Do.	
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2128										

TABLE 4.—Forest fires in the United States, Canada, and Newfoundland—Continued.

State.	Year.	Number of fires caused by—								Total fires.	Damage.		Remarks.
		Railroads.	Lightning.	Incendiary.	Brush burn- ing.	Campers.	Sawmills.	Unknown.	Miscellaneous.		Area burned.	Amount.		Value.
Delaware.	1880	6		2	6					Number	M. B. F.	\$15,675	Tenth Census record.
	1880			3	13	2			14	3,305		69,900	Do.
Florida.	1910		1	7	10	4			18	105,320	1,000		National Forest only.
	1911			5			6	27	38	10,000		7,701	Do.
Georgia.	1880	2			36	16			54	705,351		167,620	Tenth Census record.
	1878			1					21	46,000	250,000	500,000	Fragmentary record.
Idaho.	1880		2						21	21,000	4,000	202,000	Tenth Census record.
	1882				19		1		3	3,000	400,000	4,000	Fragmentary record.
1884	1884			1					1	58,000	200,000		Do.
	1888			1					1	13,000			Do.
1889	1889			1			1		2	27,500			Do.
	1890							1	1	10,000			Do.
1893	1893							1	1	13,000		50,000	Do.
	1895								1	7,000	40,000	80,000	Do.
1899	1899					1			1	3,000	10,000	20,000	Do.
	1900			1					177	2,000	10,000	30,000	Do.
1901	1901								91	3,301			National Forest only.
	1902								1	5,233		1,000,000	Do.
1903	1902							1	1	16,000			Fragmentary record.
	1903								26	330			Do.
1907	1907	1	25	2	10	114	21	3	176	4,629	3,712	6,638	National Forest only.
	1908	10	106	6	17	66	133	2	340	39,576	69,859	158,300	Do.
1909	1909								1,232	24,665	46,110	79,982	
	1910	189	162	16	76	90	7	161	744	1,761,106	4,021,196	11,399,651	
Illinois.	1877							1	62	48,691	2,500	45,775	Fragmentary record.
	1880			3	20	39			1			40,000	Tenth Census record.
1893	1893						1		1	1,200	15,000	40,000	Fragmentary record.
	1894						1		1	10,000		30,000	Do.
1871	1871					1			1				Do.
	1872					1			99			130,335	Tenth Census record.
1880	1880	20			52	23			11	58,000	235,000	470,000	Fragmentary record.
	1881								11				No record.
Indiana.	1897								11				
	1898								11				
1911								11					

Iowa.....	1870	1					1	100	30,000	Fragmentary record.
	1872	1					1	100	Do.	
	1879	1					1	10,000	Do.	
	1880	5	26	8			46	11,017	Tenth Census record.	
	1881-									
	1911									
Kansas.....	1879						1	19,200	No record.	
	1880	1	1	3			10	7,080	Mostly prairie; fragmentary record.	
	1884						1	1,300,000	Tenth Census record.	
	1890						1	12,800	Mostly prairie; fragmentary record.	
	1907			1			1	38,400	Do.	
	1908		1		1		3		Mostly prairie; National Forest only.	
	1909						4	3,300	Do.	87
	1910		4				9	640	Do.	
Kentucky	1880	12	51	33			106	556,647	Tenth Census record.	237,635
Louisiana	1880		4	2			6	64,410	Do.	6,800
Maine.....	1765-									
	1849						8	1,131,550	3,940,000	Fragmentary record.
	1850-									
	1879	2	1	2	1		46	237,610	759,000	Do.
	1880	14	3	39	20		76	35,230	1,721,000	Tenth Census record.
	1881-								123,315	
	1900	1	1	5	1		21	43,464	307,000	Fragmentary record.
	1901	3	1	7	3		22	6,918	8,465	No record.
	1902									
	1903	19	26	22			129	269,451	953,243	
	1904	3	1	10			31	6,958	12,655	
	1905	14	1	26	33		65	20,316	63,023	
	1906	6	3	2	8	9	33	7,528	20,919	
	1907	2	1	7	5		33	4,524	14,567	
	1908	31	10	32	28	2	231	142,130	618,816	
	1909	22	2	37	23	2	156	39,028	96,099	
	1910	5	1	11	6		34	848	2,841	
	1830-									
Maryland.....	1879	16	5	31	14		5	10,000	30,000	Fragmentary record.
	1880						66	41,076	37,425	Tenth Census record.
	1884						1	200		
	1889						1	38,400		Fragmentary record.
	1892						1	1,000	Do.	
	1907						1	3,873	Do.	
	1908						73	8,221	8,221	
	1909	34	13	12			73	29,001	56,817	
	1910	22	1	23	0	1	65	29,277	79,282	
	1911	17	17	18	6		85	17,530	96,294	
	1846-						85	70,050	223,801	
	1849		1	3	1		19	65,820	239,560	Do.
	1860-									
Massachusetts.....	1879	2					32	177,190	999,000	Do.

TABLE 4.—Forest fires in the United States, Canada, and Newfoundland—Continued.

State.	Year.	Number of fires caused by—								Total fires.	Area burned. Acres.	Damage.		Remarks.	
		Railroads.	Lighting.	Incendary.	Brush burning.	Campers.	Sawmills.	Unknown.	Miscellaneous.			Amount.	Value.		
Massachusetts	1880	52		8	40	56				3	159	13,899	M. B. F.	\$102,262	Tenth Census record.
	1881	1		1	3	1				20	26	98,530	327,000	756,400	Fragmentary record.
	1898											6,906		58,073	Fragmentary record.
	1899											51,807		140,456	Fragmentary record.
	1900											6,125		20,559	Fragmentary record.
	1901											51,578		26,526	Fragmentary record.
	1902											11,567		35,513	Fragmentary record.
	1903											1,339		14,764	Fragmentary record.
	1904											6,126		32,099	Fragmentary record.
	1905											11,025		7,300	Fragmentary record.
	1906											3,178		20,178	Fragmentary record.
	1907											39,672	25,000	205,152	Fragmentary record.
	1908	494	5	92	120	22	12	314	240	1,299	1,299	39,672	25,000	205,152	Fragmentary record.
	1909	149			149	232	5	360	253	1,496	1,496	35,083		189,482	Fragmentary record.
	1910	362			203	199	1	413	207	1,385	1,385	42,221		205,383	Fragmentary record.
	1871											2,000,000			Fragmentary record.
	1880	43			161	63				267	267	238,271		985,985	Tenth Census record.
1881											1,000,000		2,300,000	Fragmentary record.	
1882											228,000	600,000	1,250,000	Do.	
1896									9					No record.	
1897														No record.	
1903														No record.	
1904														No record.	
1905														No record.	
1906														No record.	
1907														No record.	
1908														No record.	
1909														No record.	
1910	16			3	36	3	1	4	21	1,830	1,830		2,570,446	Do.	
1911	33			5	40	22		88	192	161,617	161,617		3,340,018	Do.	
1870											40,000			Fragmentary record.	
1880	13			9	40				1	84	250,805			Tenth Census record.	
1894											190,000			Fragmentary record.	
1895	4										8,265			Fragmentary record.	
1896	5				5	4		0	27	8,265	14,912		3,125	Fragmentary record.	
1897	0				12	11		33	33	22	66,020			Fragmentary record.	
1897	3				27	11		21	70	8	66,020			Fragmentary record.	
1898	2				11	9		27	51	2	21,580			Fragmentary record.	

TABLE 4.—Forest fires in the United States, Canada, and Newfoundland—Continued.

State.	Year.	Number of fires caused by—								Total fires.	Area burned. Acres.	Damage.		Remarks.
		Railroads.	Lightning.	Incendary.	Brush burn- ing.	Campers.	Sawmills.	Unknown.	Miscella- neous.			Amount.	Value.	
New Hampshire	1880	12	1	7	7					Number 27	5,954	M. B. F.	\$83,610	Tenth Census report.
	1881	1								11	43,000	107,000	320,000	Fragmentary record.
	1907	1					10			399	22,700	21,758	114,605	
	1908	11		23	29	4	57	6		130	2,858	2,223	26,684	
	1910	32	6	17	41	44	6	58	10	214	11,004		55,505	
	1782									1	100,000			
	1834									1				
	1849				1	1				7	290,000	900,000	1,800,000	Do.
	1850									7	100,000	600,000	1,200,000	Do.
	1871				2	1				7	100,000		1,000,000	
1872										100,000				
1873														
1879									2	25,000	300,000	600,000	Do.	
1880		28	7	7	6				54	71,074	252,240	252,240	Tenth Census report.	
1881									5	57,000	200,000	400,000	Fragmentary record.	
1884										128,000		1,128,000		
1885														
1886														
1894		1	1						18	150,000	500,000	1,000,000	Do.	
1895		24	4	6	4				49	66,126	600,000	600,000	Do.	
1896									4	21,000	75,000	130,000		
1897														
1901									65	98,850		169,323	No record.	
1902		21	2	22	4				4	12		305,744		
1903		26	3	21	7				8	14		198,413		
1904		25	6	13	5				11	21				
1905														
1906														
1907		60	10	7					70	19		11,647	Do.	
1908		149	7	39	21				38	533		64,536		
1909		145	14	62	55				279	30		133,944		
1910		146	8	64	19				348	26		127,850		
1878			1						2	2		5,000	Fragmentary record.	
1880		1	2	37	5				2	64,034		142,075	Tenth Census record.	
1883									47	250,000	200,000	200,000	Indians on warpath.	

1880	133	102	129	17		381	685, 738	1, 500, 000	3, 043, 723	Tenth Census record.
1881	2	1		2	48	53	417, 000	121, 752	2, 400, 000	Fragmentary record.
1886							178, 982		587, 056	
1887							191, 029		394, 327	
1888							22, 853	147, 000	735, 000	
1889							214, 061	81, 000	400, 000	
1900							206, 027		834, 203	
1901	235	9	99	37	324	23	73, 005		238, 374	
1902	84	25	22	20	84		138, 572		620, 573	
1903	84	28	23	48	116	3	64, 186		241, 240	
1904	92	28	23	48	116	3	63, 211		135, 873	
1905	78	25	18	28	20	70	18, 642		63, 915	
1906	78	36	36	80	9	80	44, 465		70, 070	
1907	69	11	19	8	6	52	19, 389		73, 623	
1908	588	152	145	224	20	835	398, 855		688, 980	
1909	64	44	25	69	8	187	82, 152		176, 885	
1910	222	3	73	106	24	45	98, 548	19, 165	381, 215	Total loss, \$391, 034.
1862			1		2		75		50	
1866			1	1		3	2, 300			
1869			1		1	2	54		120, 000	
1883			1	2		2	400		2, 500	
1891					1	1	100		12, 000	
1909									291, 225	Tenth Census record.
1880	1	2	39	25		67	431, 730			Numerous fires.
1878										Tenth Census record.
1880			4	4		9	100, 000		250, 000	Fragmentary record.
1885			1	1	1	2	23, 600	470	1, 800	Do
1886	1			1		85	13, 116			Do
1900	20	35	7	3	17	1	16, 732			Do
1901							1, 121			Do
1902	28		2	50	3		1, 655			Do
1903	29	1	1	1	6	1	622			Do
1904	43	1	42	14		32	7, 474			Do
1905	17	1		6	1	94	1, 742			Do
1906	56	3	2	6	35	2	8, 472	237	735	Do
1907	133	6	2	11		176	8, 472	2, 610	15, 475	Do
1908	35	2	2	5	115	152	3, 761	4, 443	4, 331	Do
1909	24	3	2	5	31	69	12, 346	7, 452	23, 101	Do
1910	143	17	2	2	24	206	8, 964			Do
1911	61	69	2	13	54	12	985, 430			Tenth Census record.
1880	6		14	38	15	73	300, 000		5, 254, 980	Fragmentary record.
1910		4	16	22	9	51	509, 359		100, 000	Tenth Census record.
1880						1	8, 000		273, 900	Fragmentary record.
1885						1	125, 000		20, 000	Do
1886						2	20, 000			Do
1887						1				Do
1889						1	5, 000			Do

Rhode Island.

South Carolina.
South Dakota.

Tennessee.

Texas.

TABLE 4.—Forest fires in the United States, Canada, and Newfoundland—Continued.

State.	Year.	Number of fires caused by—								Total fires.	Area burned.	Damage.		Remarks.
		Railroads.	Lightning.	Incendiary.	Brush burn- ing.	Campers.	Sawmills.	Unknown.	Miscella- neous.			Amount.	Value.	
Wyoming	1888							1		1	Number	M. B. F.		Fragmentary record.
	1889							1		1	10,000	26,500	\$26,500	Do.
	1890							1		1	8,920			Do.
	1891							1		1	10,000			Do.
	1892					1		1		1	20,000	6,400	6,400	Do.
	1893							3		3	3,200			Do.
	1897							2		2	114,400			Do.
	1898							1		1	257,500			Several fires.
	1899					1		1		1	76,000			Fragmentary record.
	1900							5		5	30,000			National Forest only.
	1901							55		55	137,000			Do.
	1902							71		71	25,505			Do.
	1903							4		4	93,546			Do.
	1907			2		2	18	11	1	34	379	1,027	632	Do.
	1908		1	5		1	3	3		20	2,289	2,121	4,721	Do.
1909		3	1		2	15	4	3	28	2,028	3,828	3,866	Do.	
1910		31	39	2	4	50	1	27	157	33,104	15,829	27,654	Do.	
1911			15		4	41	3	18	83	3,464	3	21,656	Do.	
1902							1		1	1,000,000			Fragmentary record.	
1910							2		3	72,500			Do.	
1911							1		1	100,000			Do.	
1912							1		1	1,000,000	500,000		Do.	
CANADA.														
	British Columbia	1885						1		1	1		40,000	Fragmentary record.
		1886						1		1	1		1,000,000	Includes town of Vancouver.
		1908						1		1	1	900,000	1,920,000	Fragmentary record.
		1909									64,000		25,000,000	Canadian forestry journal.
	Dominion Lands.	1890								489	70,000		18,400	Mostly prairie; fragmentary record.
		1909	70	22	1	142	1	244	7	487	11,520		45,000	
		1910	188	55	33	400		343	208	1,227	251,000			
		1825						1		1	2,500,000			Miramichi fire.
	New Brunswick.	1858						1		1	1			25,600	Fragmentary record.
	1891						1		1	1			6,400	Do.
	1894						1		1	1			10,000	Do.
	1909						1		1	103,000				Do.

Nova Scotia.....	1901				1			4	7	14,000	50,000	100,000	Do.
	1902								7	315,000		500,000	
	1903									200,000		2,000,000	
	1908								93	10,000		10,000	Do.
	1909						1	1	1	64,000			Do.
	1845						1	1	1	130,000			Do.
	1855						1	1	1	1,250,000			Do.
	1867						1	1	1	1,250,000			Do.
	1868						1	1	1	100,000			Do.
	1870						1	1	1	1,250,000			Do.
	1871						1	1	1	6,400			Do.
	1874						2	2	2				Do.
	1881						1	1	466				Do.
	1883	86	37	184	153	2	1	1	1	28,100			Do.
	1884						1	1	1				Do.
	1887						2	2	2				Do.
	1888						1	1	1				Do.
	1898				1				1	10,000	20,000	1,000,000	Do.
	1901								8				Do.
	1902								50				Do.
	1909								1				Do.
	1825								1	3,200			Do.
	1853								1	1,600,000			Do.
	1858								1				Do.
	1868								1				Do.
	1870								1	96,000			Do.
	1871								1				Do.
	1875								1				Do.
	1880								2	300,000	6,000	600,000	Do.
	1881								2		3,000	62,000	Do.
	1894								1			80,000	Do.
	1906	2	16		15	10	27	1,000	1				Do.
	1907	4			21	10	10	2,000	70	1,000			Do.
	1908	12	2		24	20	72	15,000	45	2,000			Do.
	1909	12			25	10	50	3,000	130	15,000			Do.
	1910	20	5	1	30	15	80	3,000	100	3,000			Do.
	1911	35	7		25	20	115	5,000	150	5,000			Do.
							33		285				Do.
NEWFOUNDLAND.													
Newfoundland.....	1911	2					3		5	22,923	100,973		

Includes 6 villages.
Fragmentary record.

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