



U. S. DEPARTMENT OF AGRICULTURE

FOREST SERVICE

PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION

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Research Note



Number 176

Portland, Oregon

November 1959

FOREST FIRE WEATHER AND COMPUTED FIRE OCCURRENCE

IN WESTERN OREGON AND WESTERN WASHINGTON

IN 1959

by

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Severity of the 1959 fire season varied from well below normal in western Washington to a record-setting high in southwestern Oregon. The season was characterized by well-distributed, short rainy periods separated by comparatively short dry spells that frequently included days of high fire danger. July was the only month with markedly above-normal temperatures, and April and October were the only months with predominantly below-normal rainfall. Temperatures were substantially below normal in May and September, and considerably more than the normal amount of rain fell in September. Otherwise, temperature and precipitation were near normal in most areas. Despite the comparatively frequent rains, windy days with low humidities were surprisingly numerous, reaching a near-record level in southern Oregon.

In comparison with 1958, overall severity of the 1959 fire season was considerably lower in western Washington and slightly higher in western Oregon. In western Washington, spring and summer were slightly below normal severity and fall was far less severe than normal. In western Oregon, spring and fall were near normal and summer was more severe than normal, particularly in southern areas.

Weather conditions during the 1959 fire season are compared with those of previous years through use of three indexes that provide a measure of ease with which fires start, speed with which they

spread, and depth to which they burn. These indexes are: (1) total number of days when no rain fell, (2) average number of days since a wetting rain of one-fourth inch or more, and (3) burning index, a rating of the combined effect of fuel moisture and wind speed on rate of fire spread. High burning index means high rate of spread.

Each index is an average of separate measurements from a number of widely distributed Weather Bureau stations.^{1/} Admittedly, the most desirable arrangement would be to base this analysis of fire weather on observations taken within forest areas. This has not been possible because of the short, irregular fire season and the lack of continuity in records from most fire danger stations. In order to make comparisons with past seasons, it has been necessary to use stations that operate continuously during the time of year when fire seasons occur and that have been in operation for a number of years.

That an accurate indication of fire season severity in forest areas is given by the three indexes has been demonstrated by statistical analysis. Close correlations were found to exist between three measures of fire occurrence and fire-weather conditions as indicated by the three indexes. This enabled derivation of equations for computing "expected" fire occurrence from the season weather indexes. A new section, in which the actual fire occurrence is compared with the computed occurrence, has been added to this report.

Supplementary information on other features of fire weather during 1959 is also presented to show number of days with (1) relative humidity of 30 percent or lower, (2) burning index greater than 28, and (3) lightning storms over the national forests.

Fire-Weather Indexes for Western Oregon

In terms of burning index and spacing of wetting rains, the 1959 fire season was more severe than both those of 1958 and the average of the past 10 seasons (table 1). Rainless days, however,

^{1/} Although all days in the April-through-October fire season were used in the calculation of rainless days and number of days since a wetting rain, the burning index rating is based on only the 50 percent of days with highest burning index, according to the Forest Service scale used in the Pacific Northwest Region. Fuel moisture is based on relative humidity.

Table 1.--1959 fire-weather indexes and comparative data
for western Oregon^{1/}

Item	Cur-	Pre-	10-year	Record ^{2/}	
	rent year (1959)	vious year (1958)	average (1949-58)	Low	High
Spring (April 1-June 30):					
Burning index	26.3	22.1	25.1	15.9 (1953)	33.7 (1951)
Average days since wetting rain	12.0	9.4	13.0	5.5 (1933)	22.9 (1935)
Total rainless days	61.0	59.0	60.5	46.2 (1948)	75.8 (1924)
Summer (July 1-Sept. 15): ^{3/}					
Burning index	39.4	33.1	32.4	25.3 (1954)	37.8 (1945)
Average days since wetting rain	46.8	33.7	39.1	15.9 (1947)	75.5 (1935)
Total rainless days	67.2	70.5	68.4	59.3 (1954, 1947)	74.8 (1929)
Fall (Sept. 16-Oct. 31):					
Burning index	17.4	25.5	18.2	10.0 (1940)	26.4 (1936)
Average days since wetting rain	20.6	44.7	20.2	5.3 (1955)	94.4 (1932)
Total rainless days	30.2	34.8	31.4	22.2 (1950)	42.5 (1936)
Season (April 1-Oct. 31):					
Burning index	29.0	26.8	26.2	18.5 (1953)	31.3 (1951)
Average days since wetting rain	26.4	25.8	23.9	13.5 (1941)	48.8 (1932)
Total rainless days	158.5	164.2	160.3	139.5 (1948)	176.0 (1952)

^{1/} Indexes based on observations at the following Weather Bureau stations: Burning index--Portland (International Airport), Eugene, Sexton Summit, and Medford. Rainfall indexes--Portland, Eugene, North Bend, and Medford.

^{2/} Burning index computed 1932-58 except for 1933, 1934, 1937, and 1939. Average days since wetting rain and total number of rainless days computed 1922-58, except for 1923 and 1927.

^{3/} New record high.

were fewer than in both the preceding season and the 10-year average. Rainfall was below normal in April, June, August, and October and above normal in September. Despite below-normal temperatures in May, June, August, and September, burning index was the second highest of the 38-year record, exceeded only by that of 1951. East winds with accompanying low humidity were observed in all months except June and August. Although these winds blew most often in May and October, the most prolonged and severe occurred from April 7 through April 9.

Near-normal fire weather was indicated by the spring indexes, though all were higher than in 1958. Burning index and average time since wetting rain were both the highest since 1955. At Eugene and Medford, total number of rainless days was greatest since the record dry spring of 1951. Of the three spring months, highest fire danger was in April.

Summer indexes indicated the most severe conditions since 1951. Burning index was at a new record high, having surpassed the mark set in 1945. This was due to unusually severe burning conditions, particularly in southwest Oregon. Average time since wetting rain was greatest since 1951, though there were fewer rainless days than usual. No wetting rains fell between June 4 and October 7 at Eugene, though several rains of less than a quarter inch occurred.

Fall was slightly below normal in severity and was considerably less severe than in 1958. Eugene registered the greatest spacing of wetting rains since 1932. North Bend had the most rainless days since 1952, whereas Portland and Medford had the fewest since 1950.

Fire-Weather Indexes for Western Washington

The April-October fire season was the least severe since the 1956 season, to which it was similar. All indexes were below the averages of the previous 10 years, though burning index was only slightly so (table 2). Only 1941 and 1956 had fewer rainless days during the 24 years of record. In average time since a wetting rain, the 1959 season was fifth lowest since 1936. Except for June and August, east winds occurred in all months, with the most prolonged and severe occurrence April 7 to April 9. Temperature averaged normal or below and precipitation normal or above in all months except July, which was warmer and drier than normal in most localities. April rainfall was below normal until the last 5 days. With the

Table 2.--1959 fire-weather indexes and comparative data
for western Washington^{1/}

Item	:	:	:	:	Record ^{2/}	
	: Cur-	: Pre-	: 10-year	:		
	: rent	: vious:	: average	:	Low	High
	: year	: year	: (1949-58)	:		
	: (1959)	: (1958)	:	:		
	:	:	:	:		
Spring (April 1-June 30):						
Burning index	17.0	19.4	17.4	11.6 (1953)	24.3 (1951)	
Average days since wetting rain	6.0	9.6	9.8	4.0 (1942)	15.7 (1938)	
Total rainless days	50.0	58.3	54.3	43.7 (1953)	69.7 (1938)	
Summer (July 1-Sept. 15):						
Burning index	19.5	23.2	18.5	10.0 (1954)	24.8 (1945)	
Average days since wetting rain	18.1	27.0	22.7	8.3 (1943)	60.5 (1951)	
Total rainless days	53.0	64.0	61.8	49.3 (1948)	67.5 (1951)	
Fall (Sept. 16-Oct. 31):						
Burning index	6.4	11.8	10.2	5.1 (1955)	15.6 (1952)	
Average days since wetting rain	2.8	4.7	8.1	2.7 (1956)	28.3 (1942)	
Total rainless days	23.3	28.3	25.2	15.7 (1956)	38.0 (1936)	
Season (April 1-Oct. 31):						
Burning index	15.6	19.1	16.2	11.8 (1955)	21.4 (1951)	
Average days since wetting rain	9.7	14.8	14.1	7.0 (1948)	28.9 (1951)	
Total rainless days	126.3	150.7	141.2	122.7 (1941)	162.3 (1938)	

^{1/} Indexes based on observations at the following Weather Bureau stations: Burning index--Toledo, Seattle (Boeing Field), Bellingham, and Stammede Pass. Rainfall indexes--Toledo, Hoquiam, and Bellingham.

^{2/} Burning index computed 1944-1958. Average time since wetting rain and total number of rainless days computed 1936-1958.

exception of 1958, burning index was the highest since 1952 and surprisingly high for the rainy character of the season. At Boeing Field, burning index was very nearly equal to that of 1958.

Spring fire weather was below average severity and below 1958 spring values for each of the three indexes. Despite the generally damp weather, there were periods of high fire danger between rains. These seemed more in evidence at Boeing Field, where average burning index was equal to that of 1958.

Summer rainfall indexes were both below the average of the 10 previous summers, but the burning index was slightly above the average. All indexes were substantially below 1958 levels. Rainless days were fewer only in 1948, though the same number occurred in 1954.

The fall part of the season was below the average severity of the 10 previous years. Though total number of rainless days was only slightly below normal, burning index was the lowest since 1956 and average time since a wetting rain very nearly equaled the alltime low. Fall and the summer-fall combination of indexes are among the least severe of record.

1959 Computed Fire Potential

The principal reason for rating the severity of fire-season weather is to establish a basis for comparing fire occurrence between years. We recognize that fewer fires will occur during a damp season and that their average size is likely to be smaller than during a dry and windy season. Similarly, an intensive fire-prevention campaign may result in fewer fires, and faster and stronger initial attack may result in smaller fires. It is impossible to identify the effects of prevention and suppression action without determining what fire occurrence would be reasonable to expect under any given weather conditions. Consequently, equations have been developed for computing occurrence from given weather indexes. These equations are based on the relation between fire occurrence and weather indexes in recent years.^{2/} The fire occurrence that would be expected in western Oregon and western Washington under the weather conditions of the 1959 season has been computed from these equations (table 3).

^{2/} Cramer, Owen P. Relation of number and size of fires to fire-season weather indexes in western Washington and western Oregon. U.S. Forest Serv. Pac. NW. Forest and Range Expt. Sta. Res. Note 175, 11 pp., illus. 1959. (Processed.)

Table 3.--Computed and actual fire occurrence in 1959:
western Oregon and western Washington^{1/}

Measure of occurrence and area	1959 occur- rence		Actual occurrence as percentage of computed		
	Com- puted	Actual to 10/31	1959	1958	10-year average (1949-58)
					----- <u>Percent</u> -----
Man-caused fires (number):					
State and private:					
Western Oregon	443	372	84.0	96.5	93.5
Western Washington	664	428	64.4	80.4	106.6
National forest:					
Western Oregon	132	152	115.5	107.2	105.0
Western Washington	34	102	302.7	187.5	132.9
Fires 1/4 acre and less (percentage of all fires):					
State and private:					
Western Oregon	52.4	52.7	100.6	114.9	101.1
Western Washington	70.4	72.6	103.1	125.4	109.8
National forest:					
Western Oregon	71.2	78.9	110.8	105.0	99.5
Western Washington	81.0	88.8	109.7	113.6	100.2
Fires 10 acres and larger (percentage of all fires):					
State and private:					
Western Oregon	13.5	14.9	110.4	83.7	94.0
Western Washington	2.4	1.8	75.0	29.8	67.0
Fires 100 acres and larger (percentage of all fires):					
National forest:					
Western Oregon	2.8	1.8	65.4	21.8	^{2/} 103.3
Western Washington	1.6	.9	58.1	22.9	^{3/} 92.1

^{1/} Computed fire occurrence is derived from equations expressing the relation between season fire-weather indexes and occurrence, 1940-56 in western Oregon and 1944-56 in western Washington.

^{2/} Average for 8 years. Computed occurrence was zero in 1953, and actual occurrence was zero in 1954.

^{3/} For only the 5 years in which fires 100 acres and larger occurred. None occurred 1953-57.

Three indexes of fire occurrence have been used, each to indicate different occurrence conditions likely to be of importance to fire control agencies. These indexes are (1) the total number of man-caused fires, (2) the percentage of all fires that do not exceed 1/4 acre, and (3) the percentage of all fires that reach 10 acres and larger on State and privately protected lands and 100 acres and larger on national-forest protected lands. The first may be useful in evaluating changes in man-caused risk or in the effectiveness of prevention efforts. Changes in the second index may indicate change in effectiveness of initial attack. Adequacy of followup on larger fires may be reflected in the third index.

Actual occurrence expressed as a percentage of computed is convenient for analyzing factors other than weather. When actual is more than 100 percent of the computed, occurrence has been greater than the experience of recent years would lead us to expect under the given weather conditions. Percentage trends would indicate changes in fire occurrence or in fire control practices. Such a trend exists in number of man-caused fires on the national forests of western Washington. What would seem to be a favorable trend has been developing for the past three seasons on State and privately protected lands in western Washington, where the number of man-caused fires has continued to be increasingly fewer than the expected. This reverses the 1944-56 trend in this area. No other trends are indicated in the half-State occurrence figures, though some of the year-to-year variations may be meaningful to persons familiar with the local situation. Not all variation should be attributed to changing conditions, however; most year-to-year variations are attributable to chance.

Supplementary Fire-Weather Data

Low relative humidity. -- Afternoon humidities of 30 percent or lower were frequent in western Oregon. This was particularly true in the southern part of the area, where the greatest number on record was observed at Sexton Summit (table 4). Low humidities occurred much less often in western Washington, where--with one exception--frequencies were similar to those of 1958: at Boeing Field, low humidities were much less numerous this year. For the most part, the lowest humidities accompanied east winds.

Low humidities in western Washington were most frequent in the spring months and were absent during the fall. In western Oregon,

Table 4.--Number of days between April 1 and October 31
with relative humidity 30 percent or lower:
western Oregon and western Washington^{1/}

	:	:	:	Record ^{2/}	
	:	:	:		
Station	:	1959	:	1958	:
	:	:	:	Low	:
	:	:	:		High
Western Oregon:					
Portland		19		22	8 (1941, 1948)
Eugene		42		58	12 (1941)
Sexton Summit	<u>3/</u>	58		37	4 (1955)
Medford		117		119	46 (1948)
•					
Western Washington:					
Toledo		8		8	1 (1948)
Stampede Pass		14		12	1 (1948)
Seattle (Boeing Field)		22		42	2 (1948)
Bellingham		2		3	0 (1945, 1948
					1952, 1953)

^{1/} Relative humidity observed at 4:30 p.m. until June 1, 1957; at 4 p.m. thereafter.

^{2/} Same period of record as burning index (footnote 2, tables 1 and 2).

^{3/} New record high.

they were most frequent during the summer. A record number occurred at Sexton Summit, and the number at Eugene was second only to that in 1958. Low humidities were generally absent in this area during fall, except at Medford.

High burning index. -- In the northern half of western Oregon, days with extreme burning conditions were the most frequent since 1951. The greatest increase in frequency during recent years occurred at Sexton Summit. Here, the number of extreme days jumped to 40 (table 5), the greatest number since 1936.

Table 5.--Number of days between April 1 and October 31

with burning index greater than 28: western

Oregon and western Washington^{1/ 2/}

Station	1959	1958	Record ^{3/}	
			Low	High
Western Oregon:				
Portland	17	11	7 (1935, 1953)	27 (1944, 1945)
Eugene	55	52	14 (1942)	76 (1951)
Sexton Summit	40	13	8 (1947)	47 (1936)
Medford	62	60	17 (1953)	97 (1957)
Western Washington:				
Toledo	2	10	0 (1955)	12 (1951)
Stampede Pass	19	27	4 (1955)	34 (1951)
Seattle (Boeing Field)	26	26	4 (1953)	44 (1951)
Bellingham	1	2	0 (1945, 1948)	7 (1951)

^{1/} Burning index observed at 4:30 p.m. until June 1, 1957; at 4 p.m. thereafter.

^{2/} Burning index greater than 28 is equivalent to class 6 or greater on the Forest Service Region 6 burning index scale.

^{3/} Same period of record as in tables 1 and 2 (footnote 2).

Throughout most of western Washington, fewer high-burning-index days occurred than in 1958. At Boeing Field, however, there were as many as in 1958. In both States, these worst days were nearly always related to dry easterly winds, except in southwestern Oregon. In this area, high-burning-index days were also associated with very hot weather.

Lightning storms. --Comparatively few lightning storms occurred west of the Cascades during the summer (table 6), and occurrence was below that of 1958. Frequency was generally the lowest since 1957 in western Oregon and the lowest since 1955 in western Washington. Storms were reported by most national forests on July 23, August 20, and September 11.

Table 6.--Number of days with lightning storms

between July 1 and September 15: western

Oregon and western Washington^{1/}

National forest	: 1954	: 1955	: 1956	: 1957	: 1958	: 1959
Western Oregon:						
Rogue River	3	2	22	9	25	$\frac{7}{2/3}$
Umpqua	2	2	15	4	18	$\frac{5}{2/0}$
Willamette	1	1	16	3	6	$\frac{1}{2/1}$
Mt. Hood	2	8	21	4	9	
Siskiyou	0	2	13	1	8	
Siuslaw	1	1	8	0	2	
Average	1.5	2.7	15.8	3.5	11.3	--
Western Washington:						
Gifford Pinchot	2	9	13	11	9	6
Snoqualmie	5	6	19	7	12	5
Mt. Baker	3	1	4	8	11	8
Olympic	0	1	8	7	6	1
Average	2.5	4.2	11.0	8.2	9.5	5.0

^{1/} Based on daily reports to U.S. Weather Bureau and on ranger district field records (R6-F49).

^{2/} Complete field records not yet available.