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FOREST FIRE WEATHER AND COMPUTED FIRE OCCURRENCE IN WESTERN OREGON AND WESTERN WASHINGTON IN 1960

by

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Fire season severity in 1960 was about average in western Washington but was very high in western Oregon. Severity of the entire season in both States was slightly greater than in 1959. Although spring was less severe, both summer and fall were slightly more severe than comparable parts of the previous fire season. Spring fire danger in western Washington was as low as any in the 17 years of record but was near normal in western Oregon. Summer in Oregon was as severe as any in the past 30 years, while in western Washington the summer was only slightly more severe than normal. The western Oregon fall was among the more severe, while below normal fire danger prevailed over western Washington. The combined summer-fall period was the most severe since 1932 in western Oregon but was about normal in western Washington.

The season was marked by abrupt transitions--from very wet and cool in the spring to hot and dry in early summer, and then to alternating dry and rainy periods in late summer and fall. The spring rains stopped May 26 in western Oregon and June 20 in western Washington. The summer drought ended on August 16 with rain in western Washington and on August 21 in northwestern Oregon. During the rest of the season in western Washington, rains came at relatively short intervals. In northwestern Oregon, these rainless intervals were somewhat longer, grading into continued drought in interior southwest Oregon.

Severity of weather conditions during the 1960 forest-fire season is compared with that in previous years by the use of three indexes of weather conditions that are closely related to the ease with which fires start, the speed with which they spread, and the depth to which they burn. These weather 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. General severity of the season is judged by considering all three indexes.

Each index is an average of separate measurements from a number of widely distributed Weather Bureau stations.[1/] These valley and mountain stations provide an unbroken record for the 7-month season both for the current year and many previous years, thus permitting valid comparisons of the present with the past.

The real significance of indexes of fire season severity is the fire occurrence that they imply. High correlations found between the three season weather indexes and measures of fire occurrence validated the regression equations. These equations have been used to compute the "expected" fire occurrence that is compared with actual fire occurrence later in this note. Differences between computed and actual fire occurrence help to point out any changes in fire occurrence patterns since the period on which the equations were based.

Supplementary information on other features of fire weather during 1960 is also presented to show number of days with (1) 4 p.m. relative humidity of 30 percent or lower, (2) 4 p.m. burning index greater than 28, and (3) lightning storms over the national forests.

FIRE-WEATHER INDEXES FOR WESTERN OREGON

The 1960 fire season is one of the most severe of the 39-year record (table 1) having the second highest burning index and the fourth

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[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.--1960 fire-weather indexes and comparative data for western Oregon[1/]

Item	Current year (1960)	Previous year (1959)	10-year average (1950-59)	Record[2/] Low	Record[2/] High
Spring (April 1-June 30):					
Burning index	26.2	26.3	24.7	15.9 (1953)	33.7 (1951)
Average days since wetting rain	9.1	12.0	12.8	5.5 (1933)	22.9 (1935)
Total rainless days	53.2	61.0	59.5	46.2 (1948)	75.8 (1924)
Summer (July 1-Sept. 15):					
Burning index	[3/]40.5	39.4	33.0	25.3 (1954)	39.4 (1959)
Average days since wetting rain	61.5	46.8	38.7	15.9 (1947)	75.5 (1935)
Total rainless days	67.2	67.2	68.7	59.3 (1954, 1947)	74.8 (1929)
Fall (Sept. 16-Oct. 31):					
Burning index	22.2	17.4	18.1	10.0 (1940)	26.4 (1936)
Average days since wetting rain	55.9	20.6	20.2	5.3 (1955)	94.4 (1932)
Total rainless days	34.5	30.2	31.1	22.2 (1950)	42.5 (1936)
Season (April 1-Oct. 31):					
Burning index	30.5	29.0	26.3	18.5 (1953)	31.3 (1951)
Average days since wetting rain	38.0	26.4	23.7	13.5 (1941)	48.8 (1932)
Total rainless days	154.9	158.5	159.0	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 1932-60 except for 1933, 1934, 1937, and 1939. Average days since wetting rain and total number of rainless days computed 1922-60, except for 1923 and 1927.

[3/] New record high.

greatest spacing of wetting rains. Season burning index, although only slightly higher than 1959, was the highest since 1951. Spacing of wetting rain also was the highest since 1951, the summer drought period lasting from May 26 to August 21 except in southern portions where no general wetting rains were reported before November. Very rainy weather early in the spring and occasional rainy periods in late summer and fall resulted in a normal number of rainless days for the entire season. The combined summer and fall portions of the season had the highest burning index of record and second greatest spacing of wetting rains.

After unusually rainy weather from March through May, precipitation remained below normal in each month through October. Greatest deficiency was in the southern portions, Medford having been 158 days without a wetting rain when the nominal fire season ended on October 31. Temperature was near normal except for a cool May and a hot July. Below normal temperatures prevailed along the coast. On August 8, parching east winds and 100° temperatures created extreme danger. Other east winds occurred July 5 and 29, September 7-9 and 26-29, and October 14-18. Portland recorded a surprisingly low humidity of 8 percent on June 4.

Predominately rainy weather through May caused both spring rainfall indexes to be below normal, while the higher than normal burning index in June raised the spring burning index to slightly above average. Burning index was the same as in 1959, time since a wetting rain was the lowest since 1953, and the total number of rainless days was the least since 1956.

Summer burning index broke previous records for the second year in a row. Eugene reported a record high, Portland was second highest to 1945, and Sexton Summit second highest to 1959. Number of days since a wetting rain was the highest since 1951 for western Oregon and also for Portland and North Bend. However, with rains in mid-August and early September, total rainless days was normal. Had the summer continued its usual dry course through August and into September instead of becoming cool and rainy after August 21, severity of the summer portion of the season would have been much greater than any summer within the 39-year period of record. This respite held the summer severity down to the level of the two previous worst summers: 1951 and 1959. Even so, Eugene had 99 days between wetting rains and Portland 80.

Although total number of rainless days in the fall was only slightly greater than average, rains that did not reach the southern end of the State reduced the average time since a wetting rain at Portland to 7.2 days compared with Medford's 135.5 days. Not since 1933 has there been a longer average spacing of wetting rains at Medford. North Bend with 53 days had the greatest spacing of wetting rains since 1936. Fall burning index averaged well above the 1959 level and above the 10-year average, and Sexton Summit in southern Oregon had the highest fall burning index since 1952. Except in the southern portion where the forests remained too dry, the alternating dry and rainy periods were ideal for slash burning.

FIRE-WEATHER INDEXES FOR WESTERN WASHINGTON

The 1960 fire season can be separated into three distinct portions in western Washington--the rainy period that ended June 20, the rainless period from June 21 to August 14, and the off-and-on rains from August 15 to October 31. The fire weather for the entire April-October season was somewhat below average severity in each of the three indexes (table 2).

Rainfall and temperature were normal in April, May was quite cool with twice normal rainfall, and June rainfall was half normal with normal temperature. There was no rain in July which was also warmer than normal. August was cooler than normal and had well above normal rainfall. September rainfall and temperature were below normal, while October had normal temperature and above normal rainfall. East winds occurred July 5, August 7-9, and September 8-9.

Spring burning index was only slightly below the 10-year average, but Toledo set a new record low. Average number of days between rains of a quarter inch or more was the lowest since 1953, with a record low of 3.1 days at Hoquiam. Western Washington had the fewest rainless days of record and Bellingham, too, established a record low number. The three indexes showed that spring fire danger was the lowest since 1955.

Summer fire weather was slightly more severe than the average of the preceding 10 years in each of the three indexes. Each indicated slightly worse conditions than in 1959, but easier than in 1958. Severity was greater in the southern portion of the State where number of days since a wetting rain at Toledo was greatest since 1951, and Hoquiam reported total rainless days second only to 1951.

Table 2.--1960 fire-weather indexes and comparative data for western Washington[1/]

Item	Current year (1960)	Previous year (1959)	10-year average (1950-59)	Record[2/] Low	Record[2/] High
Spring (April 1-June 30):					
Burning index	14.3	17.0	16.9	11.6 (1953)	24.3 (1951)
Average days since wetting rain	4.5	6.0	8.8	4.0 (1942)	15.7 (1938)
Total rainless days	41.3	50.0	53.3	43.7 (1953)	69.7 (1938)
Summer (July 1-Sept. 15):					
Burning index	20.5	19.5	18.4	10.0 (1954)	24.8 (1945)
Average days since wetting rain	24.8	18.1	21.2	8.3 (1943)	60.5 (1951)
Total rainless days	62.0	53.0	61.4	49.3 (1948)	67.5 (1951)
Fall (Sept. 16-Oct. 31):					
Burning index	8.3	6.4	9.9	5.1 (1955)	15.6 (1952)
Average days since wetting rain	4.5	2.8	7.8	2.7 (1956)	28.3 (1942)
Total rainless days	25.3	23.3	24.6	15.7 (1956)	38.0 (1936)
Season (April 1-Oct. 31):					
Burning index	15.2	15.6	16.0	11.8 (1955)	21.4 (1951)
Average days since wetting rain	11.8	9.7	21.8	7.0 (1948)	28.9 (1951)
Total rainless days	128.6	126.3	139.1	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 Stampede Pass. Rainfall indexes--Toledo, Hoquiam, and Bellingham.

[2/] Burning index computed 1944-1960. Average time since wetting rain and total number of rainless days computed 1936-1960.

Below normal fire weather prevailed in the fall. Burning index and average number of days since a wetting rain were both below average while total rainless days was normal. Burning index at Boeing Field equalled the 1955 low record. Although wetting rains started earlier than usual, dry periods between rains provided good slash burning weather in most areas.

COMPUTED 1960 FIRE OCCURRENCE

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, however, without knowledge of the effect of weather on fire occurrence. In a separate study,[2/] high correlations were found between the season weather indexes and three measures of fire occurrence, permitting regression equations to be developed. These equations define the relations between fire occurrence and weather during 13- and 17-year base periods ending with 1956. Since the fire occurrence computed with these equations represents what would have been expected during the base period, differences between the computed and observed occurrence indicate changes in patterns of fire occurrence since the base period. The fire occurrence that would have been expected in western Oregon and western Washington under the 1960 weather conditions has been computed from these equations (table 3).

Three indexes of fire occurrence have been used, each to indicate different 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 one-fourth 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

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[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 1960: western Oregon and western Washington[1/]

Measure of occurrence and area	1960 occurrence		Actual occurrence as percentage of computed		
	Computed	Actual to 10/31	1960	1959	10-year average (1950-59)
			Percent		
Man-caused fires (number):					
State and private:					
Western Oregon	401	486	121.2	84.0	97.5
Western Washington	686	590	85.9	64.4	101.9
National forest:					
Western Oregon	165	203	123.0	116.3	105.3
Western Washington	37	101	273.0	302.7	152.4
Fires 1/4 acre and less (percentage of all fires):					
State and private:					
Western Oregon	44.5	62.0	[2/]139.3	100.6	100.3
Western Washington	69.0	78.3	113.4	103.1	110.8
National forest:					
Western Oregon	68.5	82.8	[2/]120.9	110.8	101.0
Western Washington	81.8	72.8	89.0	109.7	102.4
Fires 10 acres and larger (percentage of all fires):					
State and private:					
Western Oregon	17.7	10.0	56.5	110.4	94.7
Western Washington	2.9	2.3	79.3	75.0	64.1
Fires 100 acres and larger (percentage of all fires):					
National forest:					
Western Oregon	4.3	.5	12.3	65.4	[3/]93.0
Western Washington	1.3	.7	53.8	58.1	[4/]92.9

[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/]Highest of record.

[3/]Average for 8 years. Computed occurrence was zero in 1953, and actual occurrence was zero in 1954.

[4/]For only the 5 years in which fires 100 acres and larger occurred. None occurred 1953-57.

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.

Fire Occurrence in Western Oregon

Considerably more man-caused fires were reported by all protection agencies than might have been expected on the basis of the fire-weather conditions. Fortunately, a considerably greater than expected proportion of all fires was held to a size of one-fourth acre or less. Also, a much smaller than expected proportion of all fires became large. These results might be interpreted as a greater than usual incidence of man-caused fires and more than usually successful initial attack and followup action although a thorough study might reveal other causes for these differences.

Fire Occurrence in Western Washington

There is a distinct difference in trends of occurrence of man-caused fires between national forests and State and private protected lands in western Washington. This year the actual number of man-caused fires on national forests was 273 percent of the expected. In 17 years this is second only to the 302 percent of 1959. The trend has been fairly steady since 1944 with the rate of increase averaging five fires per year. On State and private lands, the number of man-caused fires was well below the expected number for the fourth consecutive season.

Another indication of the difficulty with fire in 1960 in the western Washington national forests is the smaller than expected proportion of all fires remaining in the smallest size class. The proportion of all fires that reached 100 acres or more was also much less than expected. These figures might indicate for national forests steadily increasing man-caused risk, less effective than usual initial attack, and more effective than usual followup action.

On State and privately protected lands more fires remained small, and fewer fires reached large size than would be expected in similar weather in the base period. The record on State and private lands may indicate good control of man-caused risks, effective initial attack, and good followup.

SUPPLEMENTARY FIRE-WEATHER DATA

Low Relative Humidity

In western Oregon, humidities frequently reached 30 percent and below, particularly in southwest Oregon (table 4). There were about as many low-humidity days as in 1959, with a few less in the spring and a few more in the summer. At Portland the 15 summer days with low humidities were the most numerous since 1952 when there were 16. For the entire season, Medford had 122 low-humidity days, the most since 1951.

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

Station	1960	1959	Record[2/] Low	Record[2/] High
Western Oregon:				
Portland	20	19	8 (1941, 1948)	37 (1938)
Eugene	43	42	12 (1941)	65 (1951)
Sexton Summit	46	58	4 (1955)	58 (1959)
Medford	122	117	46 (1948)	135 (1951)
Western Washington:				
Toledo	13	8	1 (1948)	26 (1951)
Stampede Pass	11	14	1 (1948)	20 (1951)
Seattle (Boeing Field)	15	22	2 (1948)	42 (1958)
Bellingham	3	2	0 (1945, 1948, 1952, 1953)	6 (1946)

[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).

In western Washington, during both spring and fall there were few days with humidity below 30 percent. There were more in the summer, equalling previous records at Toledo and Bellingham.

High Burning Index

In 39 years, 1960 was second only to 1951 in number of high fire-danger days in western Oregon (table 5). Extreme days were particularly frequent in the higher country of southern Oregon with a new record of 58 days reported at Sexton Summit. Portland's season total of 20 was the greatest since 1949. Most of these days occurred during the summer, Portland having the greatest number since 1946 and Eugene the second greatest number of record, equalling the 38 occurrences of 1959. Sexton Summit's 36 high-burning-index days was a new summer record.

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	1960	1959	Record[3/]	
			Low	High
Western Oregon:				
Portland	20	17	7 (1935, 1953)	27 (1944, 1945)
Eugene	52	55	14 (1942)	76 (1951)
Sexton Summit	[4/]58	40	8 (1947)	47 (1936)
Medford	52	62	17 (1953)	97 (1957)
Western Washington:				
Toledo	1	2	0 (1955)	12 (1951)
Stampede Pass	20	19	4 (1955)	34 (1951)
Seattle (Boeing Field)	16	26	4 (1953)	44 (1951)
Bellingham	0	1	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).

[4/] New record high.

In western Washington, about the same number of extreme days occurred as in 1959, except at Boeing Field where there were 10 fewer. The number of severe days was about normal and was the least since 1957.

Lightning Storms

Near normal numbers of lightning storms occurred in the western portions of Oregon and Washington during the 1960 summer with a few more storm days reported than in 1959 (table 6). Greatest increase was in the northern Cascades of Oregon and the central and southern Cascades of Washington. Storms were reported by most forests on July 26 and 27, August 3, September 3 and 4, and 1 or 2 days in the September 9-13 interval.

Table 6.-- Number of days with lightning storms between July 1 and September 15: western Oregon and western Washington[1/]

National forest	1955	1956	1957	1958	1959	1960
Western Oregon:						
Rogue River	2	22	9	25	7	9
Umpqua	2	15	4	18	3	11
Willamette	1	16	3	6	5	8
Mt. Hood	8	21	4	9	5	12
Siskiyou	2	13	1	8	3	4
Siuslaw	1	8	0	2	1	4
Average	2.7	15.8	3.5	11.3	4.0	8.0
Western Washington:						
Gifford Pinchot	9	13	11	9	6	10
Snoqualmie	6	19	7	12	5	13
Mt. Baker	1	4	8	11	8	2/7
Olympic	1	8	7	6	1	5
Average	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.