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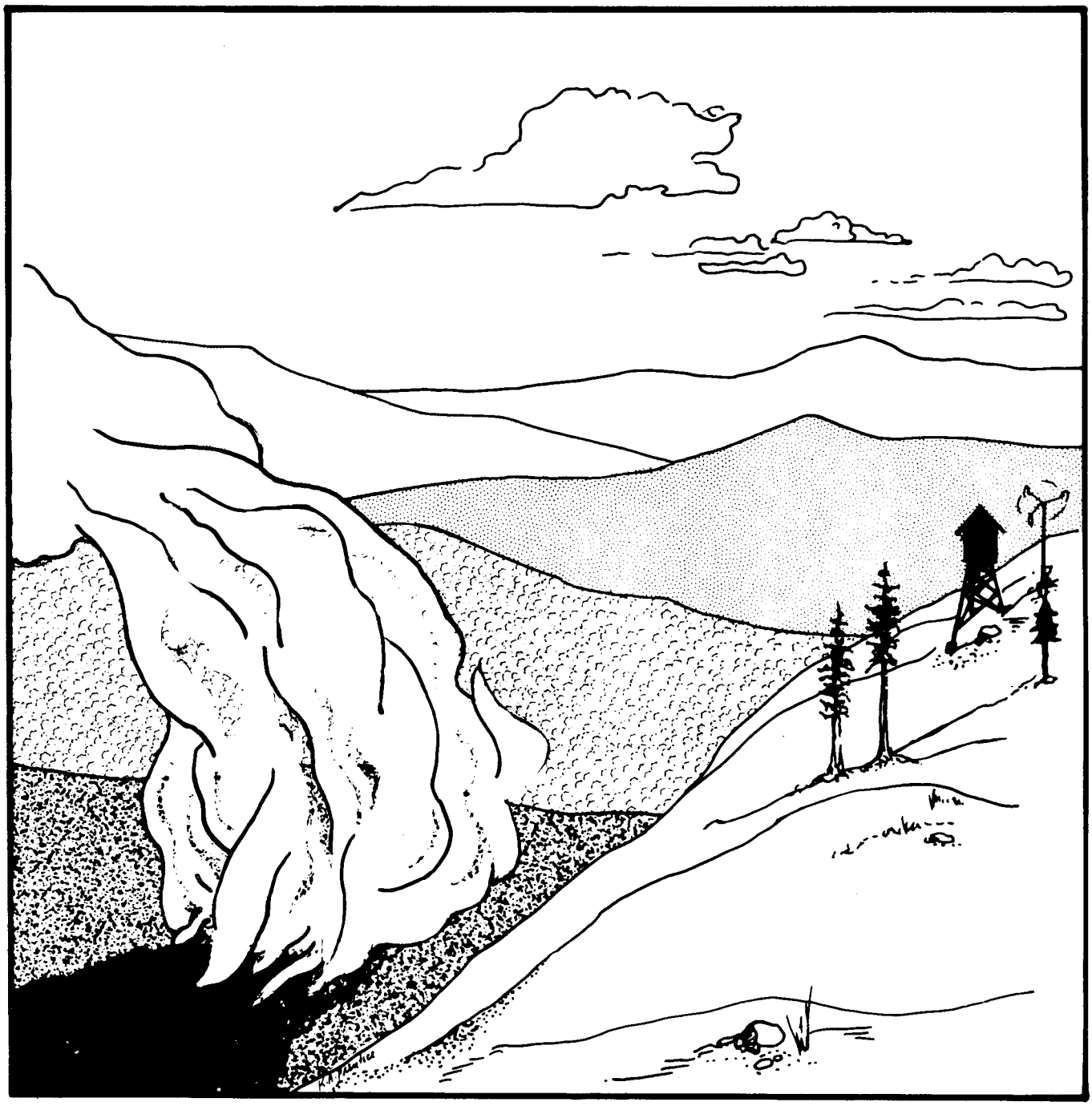
Potential Fire Behavior in California: an atlas and guide for forest and brushland managers

Bill C. Ryan



The Author:

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Bill C. Ryan

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Knowledge of potential fire-behavior characteristics is needed by forest and brushland managers. They need to know the most probable dates or periods of dangerous fire conditions and probable fire intensities and spread rates. For prescribed fires, they need to know probable dates and lengths of time the burns can be continued within prescription limits. They need to know when weather and fuel conditions will allow accumulated debris and fuel to burn, but not burn so intensely that desirable vegetation is killed or the fire becomes wild. They also need information to estimate whether or not the wind will take smoke into populated areas and cause problems.

At the National Fire Weather Data Library, Fort Collins, Colorado, the Forest Service, U.S. Department of Agriculture, maintains on magnetic tapes a mass of data on weather and fuel moisture. These data are collected from fire-danger rating stations throughout the United States (Furman and Brink 1975). With these data and techniques developed by Deeming and others (1977) potential fire characteristics can be estimated.

This report describes an Atlas that provides statistical analyses of potential fire behavior in California's wildlands. Charts and information from the fire-danger rating station at Mount Hebron in northern California serve as an example of the information provided by the Atlas.

THE ATLAS

The Atlas includes 10 volumes. Volume 1 lists the contents and describes the data used to derive the statistics and information in the Atlas. The other nine volumes include one volume for each of the nine sections of California *(fig. 1)*.

Maps of each section *(appendix A:figs. 2 to 10; appendix B: tables I to 18)* show locations of observation stations whose fire weather statistics are included in the Atlas. The maps are accompanied by a list of the stations in each section showing each station name, number, number of years of observation, and the total number of observations. Stations on the maps are identified by the last four digits of the station number. Because some areas overlap two sections, some station locations are plotted in two sections. When that occurs, information and statistics for that station are included in only one section. The section is indicated by a number next to the station number.

Application

The information contained in the Atlas can help managers in ...

Prescribed burning:

• Estimating the probable number of days available with spread component (SC), burning index (BI), and ignition component (IC) within prescription limits.

- Determining probable length of time that weather and fuel variables will remain within prescription limits and burns can be continued.
- Estimating potential fire characteristics between observations at danger-rating stations.
- Determining dates or periods when prescription conditions will probably occur.
- Providing data to facilitate estimating number of acres that can be burned within prescription each month.

Fire suppression:

- Estimating probable number of days in, above, or below specific ranges of fire intensity or spread rates.
- Estimating probable maximum fire intensities and spread rates.
- Estimating probability of fire intensities or spread rates within specific ranges.
- Estimating most probable dates or periods of dangerous fire conditions.

General purposes:

- Estimating probability of occurrence of specific weather conditions and fuel moisture.
- Estimating probability of specific ranges of windspeed and direction during a given month.

Because the information in the Atlas is based on the National Fire-Danger Rating System--1978 (NFDRS), the four basic principles of the System should be considered when using the Atlas:

"1. The NFDRS relates only to the potential of the initiating fire. An initiating fire is one that does not behave erratically; it spreads without spotting through continuous

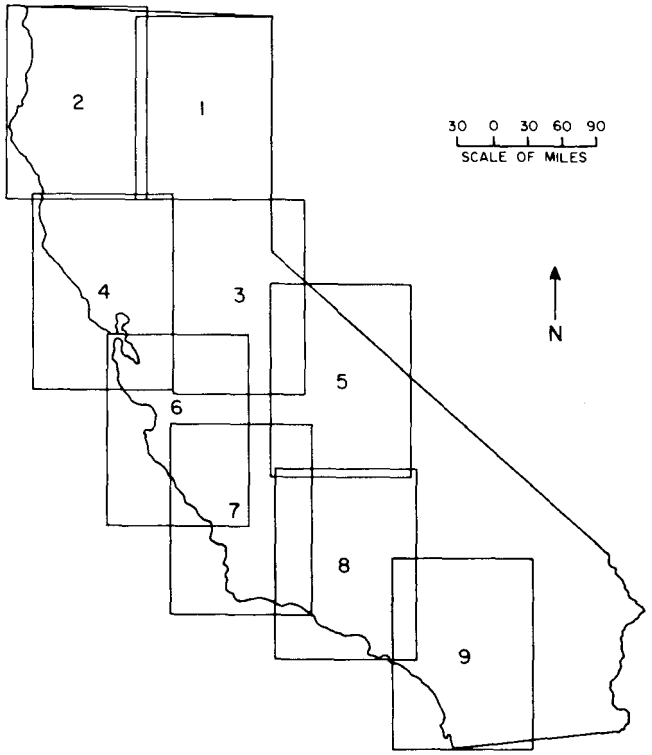

Figure 1--Areas of California are outlined into nine sections. Each section contains fire-danger observation stations, as indicated on maps *(appendix A: figs. 2-10)*.

ground fuels. Crowning and spotting are not now addressed. However, experience with the NFDRS will enable users to identify the critical levels of fire danger when such behavior is highly probable.

"2. The System only addresses those aspects of fire control strategy affected by fire occurrence and behavior. The concept of containment, as opposed to extinguishment, is basic because it allows us to limit the scope of the rating problem to the behavior potential of the headfire. Other aspects of the containment job such as accessibility, soil condition, and resistance to line construction must be evaluated by other means.

"3. The ratings are relative, not absolute. Wherever possible, we have structured the component or index so that it is linearly related to the particular aspect of the fire problem being rated. Thus, when the value of a component or index doubles, the fire manager should expect a doubling of the rated activity relative to what has been recently observed. *The BI is an exception that will be addressed later.*

"4. Fire danger is rated from a *worst case* approach. Fire weather is measured at the time of day when fire danger is normally the highest; and, wherever possible, in the open at midslope on southerly or westerly exposures. This important principle must be understood if fire-danger ratings are to be properly interpreted."

Derivation

To develop the Atlas, data from the National Fire Weather Data Library were used. Data were processed from magnetic tapes with FORTRAN code modified from the National Fire-Danger Rating System's (Deeming and others 1977) FIREDAT routine (Main and others 1982). Necessary variables such as 1-hour timelag fuel moisture (TLFM), 10-hour TLFM (if necessary), 100-hour TLFM, 1000-hour TLFM, herbaceous and woody fuel moisture, spread component, burning index, and ignition component were computed.

Spread component, BI, and IC were calculated with current (summer 1981) fuel models, slope, and herbaceous types, as recorded on the 10-day Fire Danger and Fire Weather Record for the stations. The date of greenup--when the spring flush of growth becomes generally apparent--is needed for calculations of live fuel moisture. The dates stored in the Administrative Forest Fire Information Retrieval and Management System (AFFIRMS)--for 1981 and 1982 were used. When the greenup date was not cataloged in AFFIRMS, dates were obtained from the agency responsible for the observations or were estimated on the basis of elevation and dates given for surrounding stations. The potential fire characteristics in or near the month in which greenup begins may vary greatly. If greenup during a particular year is earlier than the date used to produce the tables, fuel moisture will tend to be greater and fire severity potential will tend to be less between the two dates. If greenup is later, fuel moisture will tend to be less and fire severity potential greater.

Information about each observation station's fuel models, location, elevation, length of record, agency affiliation and protection unit are given. The information for Mount Hebron Ranger Station *(fig. 11)* is included as an example, along with statistics of weather and potential fire characteristics *(tables 1-18)*. Inventories of observations each year of record for fire-danger observation stations can also be obtained from the National Fire Weather Data Library (Furman and Brink 1975).

INTERPRETING THE DATA

Fire weather observations, except for minimum and maximum temperatures and relative humidities, are recorded for 1300 P.s.t. only. Statistics derived from observations taken at one time of the day cannot be assumed to be representative of conditions at other times of the day. This fact must be considered when using the statistics.

Length of record of observations taken at a location is significant because the longer the record, the more confidence that can be placed in the statistics of that record. In California, records vary from only a few months to more than 20 years. The confidence that can be placed in the statistics, therefore, varies greatly from station to station. In the Atlas, statistics were computed for only those stations with at least 4 years of data for 1 or more months of the year after 1972. The number of observations and years of record have been included with the other statistics to help users evaluate the reliability of the information and establish confidence levels. For example, in April 1973 through December 1981, at Mount Hebron Ranger Station, the SC, BI, and IC indicated potentially severe fire conditions compared with other months *(tables 2, 4, 6)*. Only 11 observations were recorded in April during the 9-year period, however. Therefore, these statistics are not reliable indicators of potential fire conditions to be expected in April.

Persistence of Potential Fire Characteristics

The persistence of the spread component was analyzed by dividing its range into 10 intervals *(table 1)*. Class intervals were chosen subjectively on the basis of ranges of spread rates for different fuels. The number of consecutive days from the initial day (0) to runs of nine (9) days, was calculated. The percentages of time, according to records, that the SC calculated on day 0 lasted 1, 2, 3, and up to 9 days, were tabulated. The number 29 (circled in *table 1*)

indicates that 29 percent of the time during periods of record when an SC of between 6 and 10 occurred, it remained 6 or more for 4 days. The number of occurrences of SC in each class is in the column labeled "Obs." (for observations). For example, the number of occurrences of SC between 6 and 10 during the period of record was 673. (The SC is scaled so that it is numerically equal to the theoretical rate of spread in feet per minute.)

The persistence of the BI *(table 3)* and IC *(table 5)* were also determined; these tables are similar to *table 1.* Class intervals for BI were based on the adjective classes used by the Pacific Southwest Region and the California Department of Forestry. Those for IC were obtained by dividing the range (0-100) into 10 equal parts.

Persistence of SC, BI, and IC was considered broken if a 3-day or greater break in sequence of observations occurred; that is, if 3 or more days in a row of observations were missing, persistence of all classes (except the lower class) was considered broken. Calculations were made only after 1972 because records of minimum and maximum temperatures and relative humidities were not available for earlier years.

Frequency Distribution

Spread component, BI, IC, fuel moisture variables, and weather variables were divided into 10 classes each. An empirical distribution (survival) function

$$F_m(x) = \frac{N(\{x_i : \quad x_i \geq X\})}{n} \bullet 100$$

was calculated for each of the 10 lower class boundaries X for each month in which

$$N(\{x_i: \ x_i \geq X\})$$

is the number of observed values x_i that are greater than or equal to X, and n is the total number of observations for the month. The function was computed to give the frequency of occurrence for each variable for each month in *tables 2, 4, 6, 7,* 9, and *11* through *16.* The total number of observations for each class, for each month and for the total periods of record are given for each variable.

Class intervals for SC were chosen subjectively on the basis of ranges of spread rates for different fuels. Class intervals for BI were determined on the basis of the adjective classes used by the Pacific Southwest Region and the California Department of Forestry. The class intervals for the other variables were obtained by dividing the estimated maximum ranges of the variables into 10 equal parts.

Table 7 gives the empirical distribution function as defined above for temperature for each month. The number circled in *table 7,* for example, indicates that 74 percent of the time in June the temperature at 1300 P.s.t. reaches at least 65° F (18.3° C). The percentage of temperature in each specific class can be found by subtracting the percentage on the line below. For example, the percentage of days with temperatures at 1300 P.s.t. from 65° F (18.3° C) to 77° F (25° C) in June is 43 (74 percent minus 31 percent). The number of days with temperature from 65° F (18.3° C) to 77° F (25° C) in June is 263 (43 percent of 612)-an average of about 12 $^1/_2$ days each June, for the 21-year period.

Maximum and minimum magnitudes and number of observations for each variable for the months of record are also included in the tables.

Statistics of 100-hour TLFM, 1000-hour TLFM, herbaceous-fuel moisture, and woody-fuel moisture content were calculated only for the years after 1972, when records of maximum and minimum temperatures and relative humidities were generally available.

Minimum and Maximum Temperatures and Relative Humidities

Records of maximum and minimum temperatures and relative humidities were not taken until 1973 at fire weather stations. Thus, *tables 8* and *10* are based on data taken after 1972. The record highs, record lows, mean maximums, mean minimums, and means for each month are given in degrees Fahrenheit.

Precipitation

Precipitation amounts and means in inches are given for all months and years of record when possible *(table 17).* Often, records for months or years are incomplete, so monthly or annual precipitation cannot be determined. For example, no complete year's record was made for Mt. Hebron Ranger Station.

Windspeed and Direction

The percent of joint occurrences of windspeeds and directions for each month were computed (for example, *table 18*). Windspeeds are divided into 10 classes as shown on the left side of the table. Directions are given to eight points of the compass (eight direction classes). The tables list the percent of joint occurrences of windspeeds in 3 mi/ h (1.3 m/s) classes, and directions in eight points of the compass. For example, in *table 18,* the circled number 2 indicates that in the 21-year period in the month of May, SE winds from 10 to 12 mi/h (4.5 to 5.4 m/s) occurred 2 percent of the time at 1300 P.s.t. at Mt. Hebron Ranger Station.

Because of their similarity to other tables, several tables included in the Atlas for Mount Hebron are not included here. They are the tables that show joint occurrences of windspeed and direction for Mount Hebron for other months of record, June-November, and tables of SC, BI, and IC for fuel model T, which are similar to *tables 1-6* in this report for fuel model G.

APPENDIX A-Figures 2 to 10

Figures 2 through *10* each contain a map of a section of California. Each map is accompanied by a list of the stations in the section showing station name and number, number of years of observations, and total number of observations. Stations on the maps are identified by the last four digits of the station number. Because some areas overlap two sections, some station locations are plotted in two sections. A number (superscript) after a station number indicates the section in which information and statistics are given for that station. The following abbreviations are used in the lists of stations:

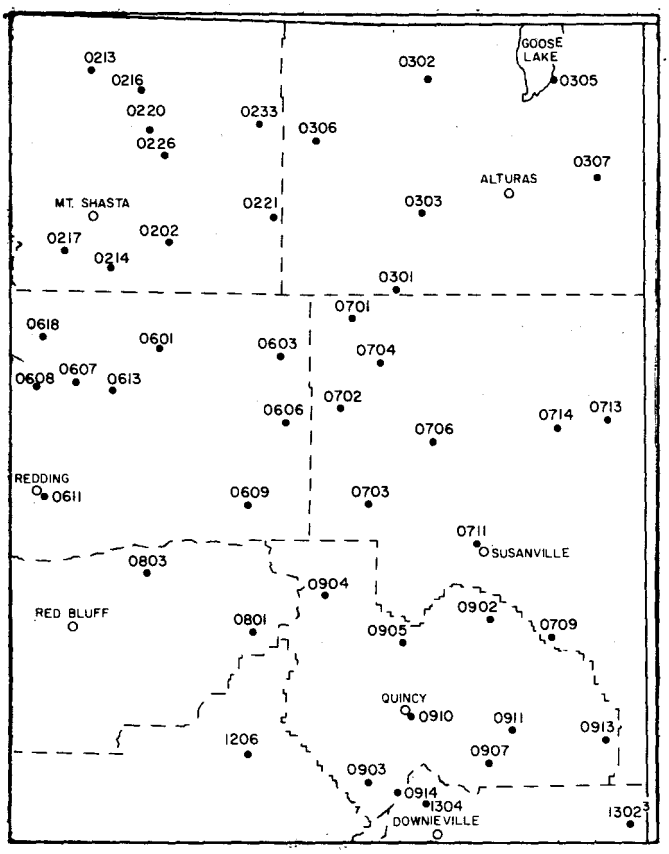

Figure 2--Section 1. 4

BRKRDG = Breckenridge
FFS = Forest Fire Station
FS = Fire Station
GS = Guard Station
HQ = Headquarters
LAVBDS = Lava Beds
LO = Lookout
MLKRCH = Milk Ranch
RD = Ranger District
RS = Ranger Station
SAWMPK = Saw Mill Peak
WBO = Weather Bureau Office
WHSHQD = Whiskeytown

Stations in Section 1:

Station	No.	Years	Observations
Black Fox Mountain LO	40202	19	2460
Lodge Pole GS	40213	12	1213
McCloud RS	40214	9	1453
Mt. Hebron RS	40216	21	3679
Mt. Shasta WBO	40217	20	5248
Orr Mountain LO	40220	18	2390
Round Mountain LO	40221	19	2536
Tennant GS	40226	18	1857
LAVBDS	40233	6	525
Adin RS	40301	11	1755
Blue Mountain LO	40302	18	2120
Canby RS	40303	21	5386
Sugar Hill LO	40305	11	1430
Timber Mountain LO	40306	18	2558
Cedarville	40307	12	1263
Big Bend GS	40601	19	2745
Fall River Mills RS	40603	20	4636
Hat Creek Rim LO	40606	11	1541
Hirz Mountain LO	40607	19	2279
Lakeshore GS	40608	19	2957
Manzanita Lake	40609	19	2487
Redding	40611	6	922
Squaw Creek GS	40613	8	924
Sims	40618	10	1284
Bieber FFS	40701	8	1170
Blacks Ridge LO	40702	19	2512
Bogard RS	40703	20	2939
Boyd Hill LO	40704	9	1150
Dow Butte LO	40706	20	2876
Laufman RS	40709	19	2989
Susanville RS	40711	15	2428
Observation Mountain	40713	12	1352
Ravendale	40714	12	1434
Colby Mountain LO	40801	20	2611
Inskip	40803	6	849
Boulder Creek GS	40902	18	2161
Camel Peak LO	40903	14	1733
Almanor RS	40904	20	3868
Greenville RS	40905	16	2581
Mohawk GS	40907	16	2541
Quincy HQ	40910	19	5091
Smith Peak LO	40911	18	2276
Chilcoot	40913	19	2520
Lexington	40914	5	525
SAWMPK	41206	6	817
Saddleback LO	41304	17	1954

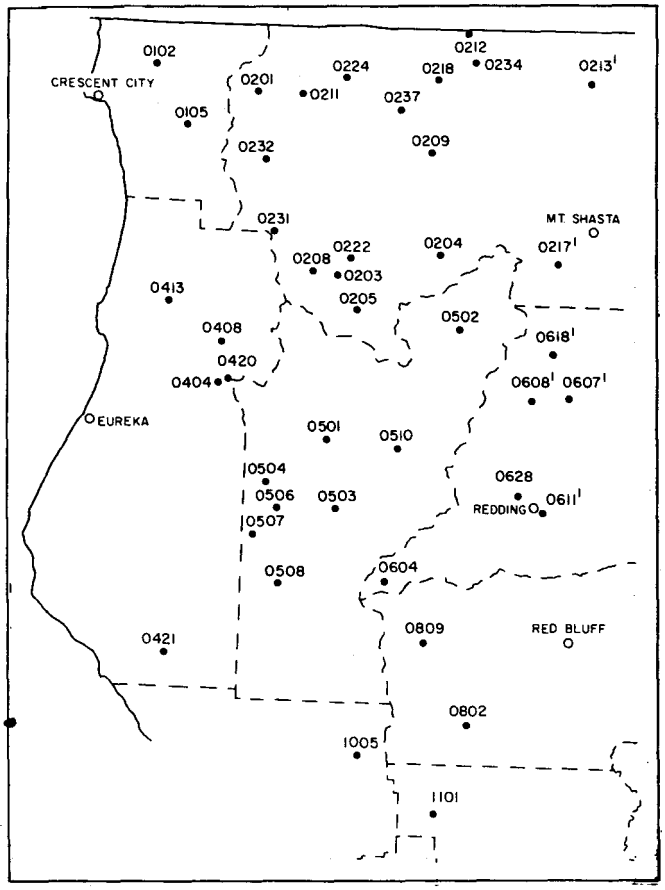

Figure 3--Section 2.

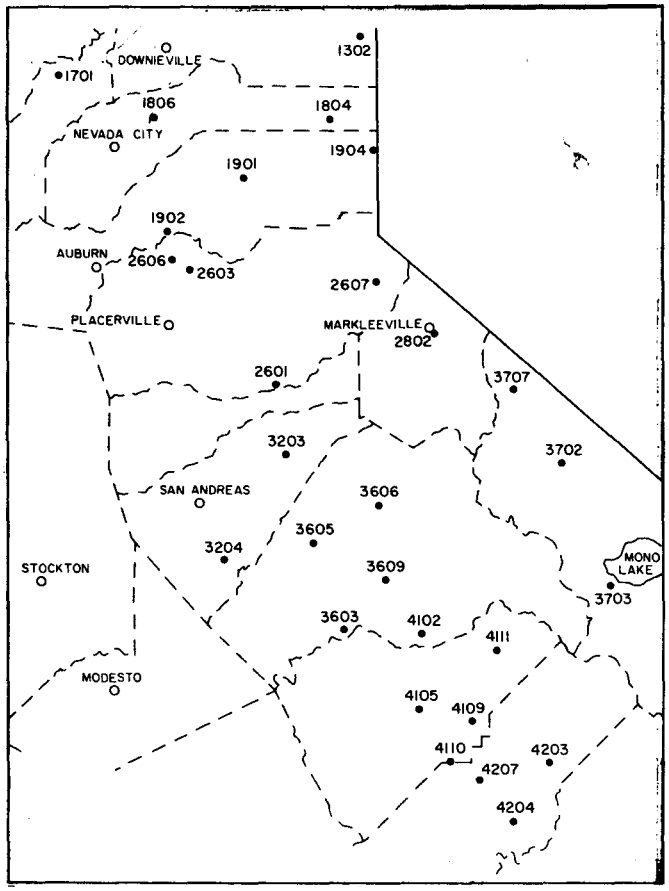

Figure 4--Section 3.

Stations in Section 2:

Station	No.	Years	Observations
Gasquet RS	40102	20	2811
Ship Mountain	40105	7	787
Bald Mountain	40201	5	642
Blue Ridge LO	40203	19	2452
Callahan RS	40204	20	3747
Crawford Creek GS	40205	17	2221
Forks of Salmon GS	40208	17	2288
Fort Jones RS	40209	16	4592
Happy Camp RS	40211	11	1763
Oak Knoll RS	40218	20	4718
Sawyers Bar	40222	21	4288
Seiad RS	40224	18	3761
Somesbar	40231	16	2838
Okonom Lookout	40232	15	1742
Parcgy	40234	6	809
Collins Creek Baldy LO	40237	9	1202
Brush Mountain LO	40404	20	2691
Hoopa	40408	8	1197
Schoolhouse Peak LO	40413	15	1765
Willow Creek	40420	13	2629
Eel River	40421	8	1108
Big Bar RS	40501	20	3310
Coffee Creek RS	40502	20	3110
Hayfork RS	40503	20	3404
Hyampom GS	40504	18	2428
Limedyke LO	40506	19	2714
Mad River RS	40507	20	3062
Ruth RS	40508	18	2301
Weaverville RS	40510	20	5030
Harrison Gulch RS	40604	20	3420
WHSHQD	40628	9	1439
Eagle Peak LO	40802	20	2634
Saddle Camp GS	40809	10	1151
Eel River RS	41005	20	2833
Alder Springs	41101	20	2827

Stations in Section 3:

Station	No.	Years	Observations
Dog Valley	41302	18	2460
Challenge RS	41701	19	2997
Truckee RS	41804	20	4343
White Cloud	41806	7	1025
Duncan Peak GS	41901	18	2059
Forest Hill FS	41902	20	4080
Stateline LO	41904	20	2583
Armstrong Hill LO	42601	18	2491
Bald Mountain LO	42603	19	2892
Georgetown RS	42606	20	5837
Meyers RS	42607	20	4582
Markleeville	42802	18	2831
Blue Mountain LO	43203	14	1792
Fowler	43204	13	1631
Groveland RS	43603	20	5343
Mt. Elizabeth LO	43605	20	2862
Pine Crest RS	43606	20	3091
Woods Ridge LO	43609	17	2281
Bridgeport RS	43702	18	3436
Lee Vining	43703	20	5426
Walker	43707	7	936
Crane	44102	9	1335
Jerseydale FFS	44105	18	3454
Wawona	44109	9	1329
Miami	44110	10	1453
Valley	44111	4	621
Minarets RS	44203	20	2795
North Fork RS	44204	20	6034
Batterson RS	44207	10	1991

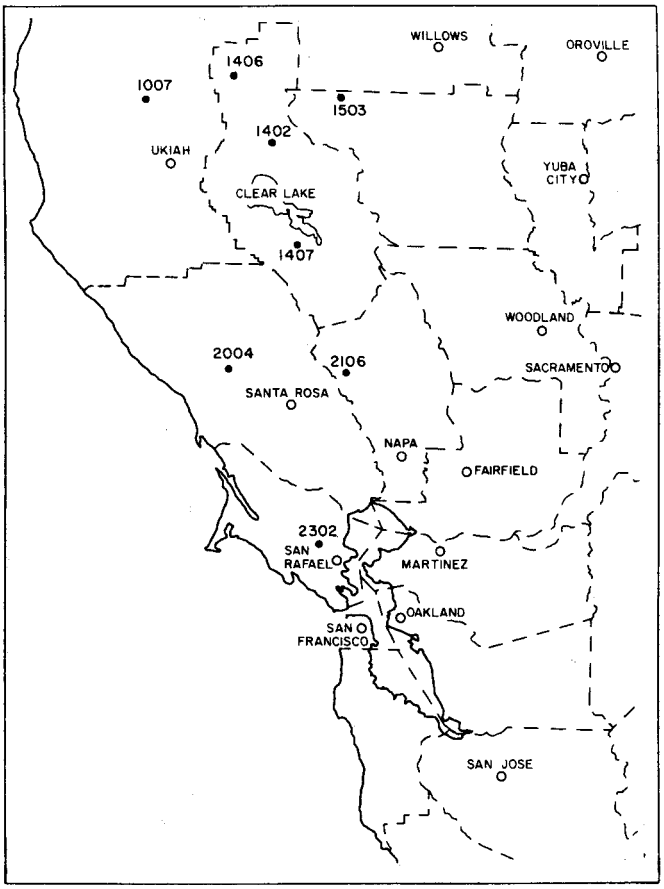

Figure 5--Section 4.

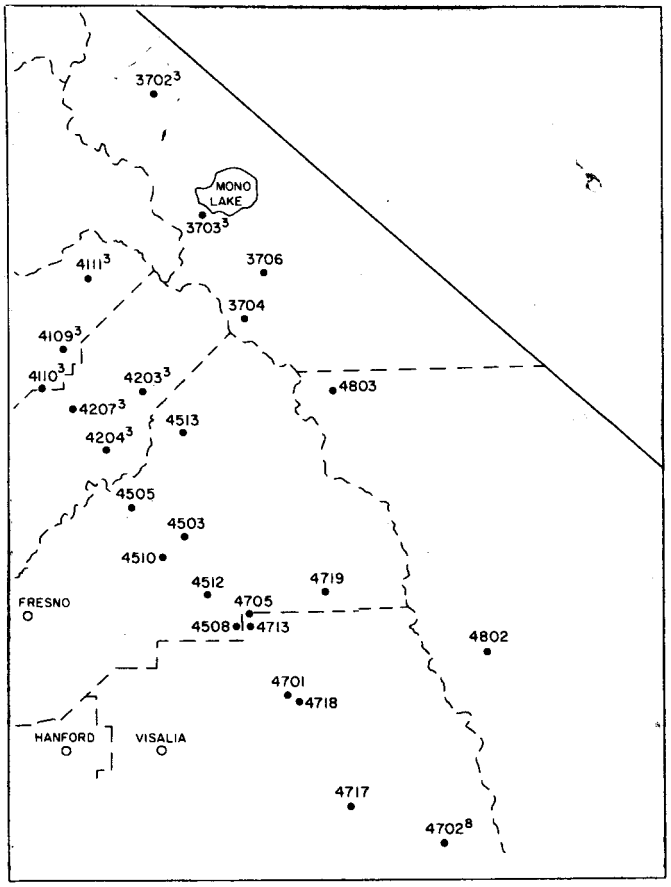

Figure 6--Section 5.

Stations in Section 4:

Station	No.	Years	Observations
Howard Forest FFS	41007	15	1928
High Glade LO	41402	17	2245
Soda Creek GS	41406	20	2918
Konocti	41407	9	1240
Stonyfork RS	41503	20	6066
Mt. Jackson LO	42004	8	992
St. Helena	42106	8	1087
Woodacre FS	42302	8	1056

Stations in Section 5:

Station	No.	Years	Observations
Mammoth RS	43704	20	3831
Bald Mountain LO	43706	8	1039
Fence Meadow GS	44503	20	3068
Mountain Rest	44505	10	1630
Pinehurst RS	44508	20	4076
Trimmer	44510	10	2273
Delilah LO	44512	10	1425
Kaiser	44513	5	573
Ash Mountain	44701	21	3398
Grant	44705	5	669
Park Ridge	44713	14	1605
Wishon	44717	10	1309
MLKRCH	44718	6	731
Cedar	44719	6	892
Lone Pine RS	44802	20	3863
Round Valley	44803	18	4835

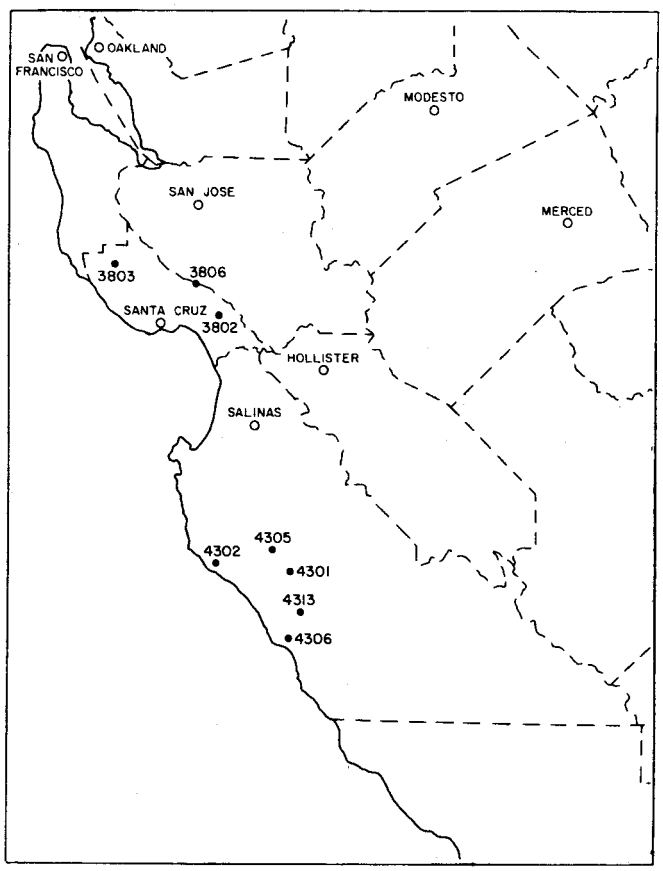

Figure 7--Section 6.

Stations in Section 6:

Station	No.	Years	Observations
Corralitos	43802	6	899
Eagle Rock	43803	13	1807
Burrell	43806	5	550
Arroyo Seco GS	44301	20	5265
Big Sur GS	44302	19	3577
Chews Ridge LO	44305	19	2789
Cone Peak LO	44306	19	2754
The Indians	44313	19	2517

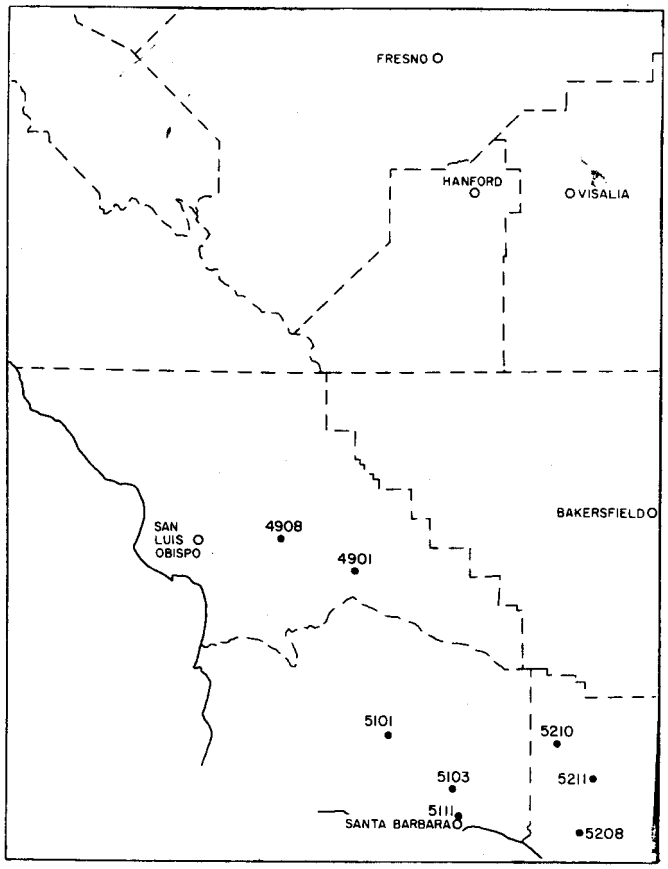

Figure 8--Section 7.

Stations in Section 7:

Station	No.	Years	Observations
Branch Mountain LO	44901	19	2829
Pozo GS	44908	19	3703
Figueroa GS	45101	19	3746
Los Prietos RS	45103	19	5730
Monastery	45111	5	939
Casitas	45208	16	2417
Ozena	45210	10	1718
Rose Valley	45211	9	1613

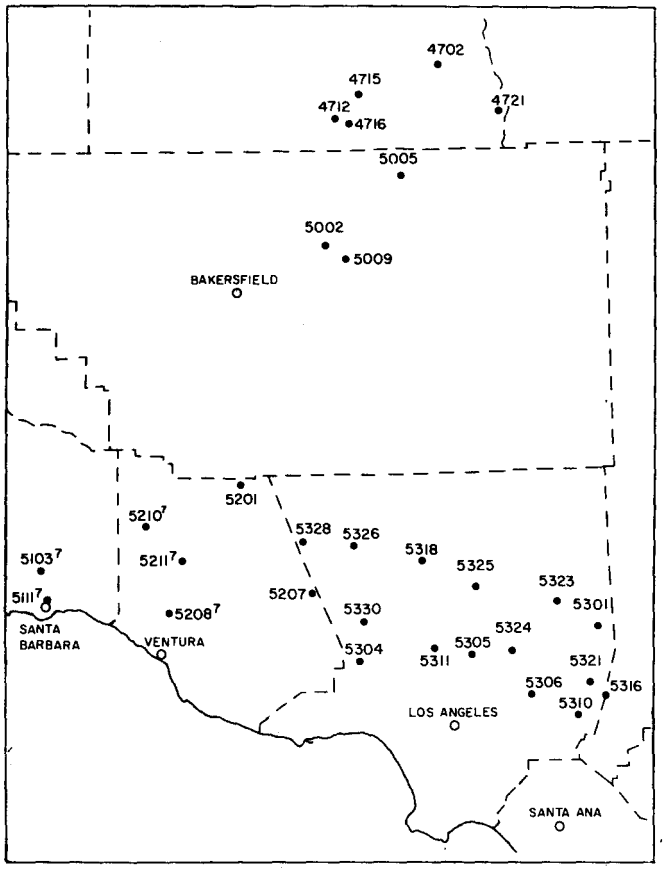

Figure 9--Section 8.

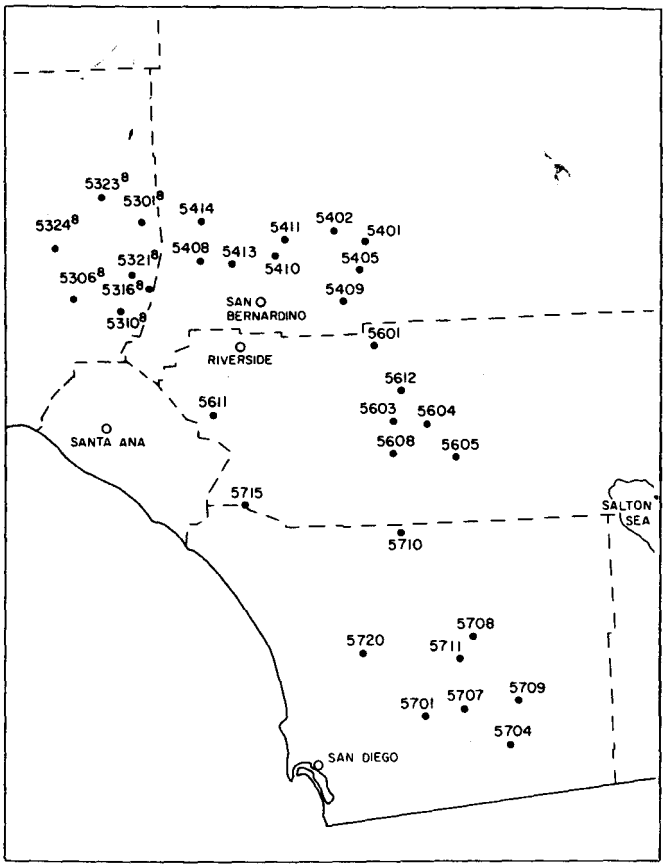

Figure 10--Section 9.

Stations in Section 8:

Station	No.	Years	Observations
Bald Mountain	44702	18	2629
Uhl	44712	16	4346
Camp Whitsett	44715	8	921
Tobias	44716	10	1322
Chimny	44721	4	512
Democrat Springs	45002	19	3050
Kernville FS	45005	20	4286
BRKRDG	45009	5	611
Chuchupate	45201	19	6055
Temescal RS	45207	20	3859
Big Pines	45301	19	4501
Chatsworth FS	45304	8	1338
Clear Creek FS	45305	10	2092
Duarte FS	45306	13	2325
Lechuza FS	45310	8	1166
Little Tujunga GS	45311	19	3913
Padua Hills FS	45316	17	4124
Sierra Pelona LO	45318	19	2982
Tanbark	45321	10	1415
Vallyermo RS	45323	20	4793
Vetter LO	45324	19	2546
Vincent FS	45325	17	4389
Warm Springs LO	45326	20	3401
Slide Mountain	45328	8	994
Newhall	45330	8	1274

Stations in Section 9:

Station	No.	Years	Observations
Fawnskin	45401	20	6162
Big Pine Flats GS	45402	18	2937
Converse GS	45405	19	3646
Lytle Creek RS	45408	20	6304
Mill Creek RS	45409	20	6388
Strawberry Peak LO	45410	19	3362
Rock Camp RS	45411	18	3037
Devore	45413	9	2445
Mormon Rocks	45414	10	1948
Banning GS	45601	18	3394
Cranston GS	45603	19	3645
Keenwild GS	45604	20	5392
Kenworthy GS	45605	19	3241
Red Mountain LO	45608	19	2855
Temescal GS	45611	20	4652
Vista Grande GS	45612	16	2776
Alpine GS	45701	20	4085
Cameron GS	45704	20	4071
Descanso RS	45707	20	6273
Julian FFS	45708	16	3292
Laguna GS	45709	20	3645
Oak Grove RS	45710	20	5732
Pine Hills GS	45711	20	3588
Tenaja GS	45715	20	3819
Ramona	45720	9	2357

APPPENDIX B—Figure 11, Tables 1 to 18

MT HEBRON RS 40216

AGENCY / PROTECTION UNIT:	USFS/ KLAMATH
LOCATION	
COUNTY:	SISKIYOU
LATITUDE / LONGITUDE:	41.80N/122.00W
SECTION:	32
TOWNSHIP / RANGE:	46N / 1W
ELEVATION:	4250 FT.
CLIMATE CLASS:	2
GREEN-UP DATE USED FOR COMPUTATIONS:*	05/17
FUEL MODEL 1/SLOPE CLASS / HERB TYPE:	G /2/ P
FUEL MODEL 2/SLOPE CLASS / HERB TYPE:	T /1/ P
NUMBER OF YEARS:	21
TOTAL NUMBER OF OBSERVATIONS:	3679

* THIS GREEN-UP DATE IS EITHER THE DATE STORED IN AFFIRMS IN 1981 OR 1982, OBTAINED FROM THE PROTECTION AGENCY, OR INTERPOLATED FROM SURROUNDING STATIONS IF NO DATE WAS STORED.

Figure 11--Information for Mount Hebron Ranger Station.

Table 1 --*Percent probability of n consecutive days of spread component remaining in or becoming greater than initial range for 1300 P.s.t.*

Mount Hebron RS 40216 Model: G Slope class: 2 Vegetation type: P
Observations: 1374 Years of record: 9

Spread component	Length of run (days)										Obs.
	0	1	2	3	4	5	6	7	8	9	
0-5	100	100	100	100	100	100	100	100	100	100	398
6-10	100	68	51	38	(29)	22	19	18	16	14	673
11-20	100	34	13	2	1	1	0	0	0	0	242
21-40	100	12	4	0	0	0	0	0	0	0	57
41-80	100	0	0	0	0	0	0	0	0	0	4
81-160	0	0	0	0	0	0	0	0	0	0	0
161-320	0	0	0	0	0	0	0	0	0	0	0
321-640	0	0	0	0	0	0	0	0	0	0	0
641-1000	0	0	0	0	0	0	0	0	0	0	0
1001+	0	0	0	0	0	0	0	0	0	0	0

Table 2--*Cumulative percent probability of spread component occurrence by class and month and minimum and maximum by month for 1300 P.s.t.*

Mount Hebron RS 40216 Years of record: 9

Spread component	Month												Obs.
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
0-5	-	-	-	100	100	100	100	100	100	100	100	-	398
6-10	-	-	-	100	83	63	72	68	68	80	55	-	673
11-20	-	-	-	73	40	18	18	20	24	17	9	-	242
21-40	-	-	-	55	9	2	1	4	6	5	0	-	57
41-80	-	-	-	9	0	0	0	0	0	1	0	-	4
81-160	-	-	-	0	0	0	0	0	0	0	0	-	0
161-320	-	-	-	0	0	0	0	0	0	0	0	-	0
321-640	-	-	-	0	0	0	0	0	0	0	0	-	0
641-1000	-	-	-	0	0	0	0	0	0	0	0	-	0
1001+	-	-	-	0	0	0	0	0	0	0	0	-	0
Maximum	-	-	-	60	34	31	29	41	39	49	12	-	
Minimum	-	-	-	6	3	0	1	1	0	3	3	-	
Observations	0	0	0	11	149	263	272	271	254	143	11	0	1374

Table 3--*Percent probability of n consecutive days of burning index remaining in or becoming greater than initial range for 1300 P.s.t.*

Mount Hebron RS 40216 Model: G Slope class: 2 Vegetation type: P
Observations: 1374 Years of record: 9

Burning index	Length of run (days)										Obs.
	0	1	2	3	4	5	6	7	8	9	
0-15	100	100	100	100	100	100	100	100	100	100	16
16-30	100	95	90	86	81	81	76	71	71	71	220
31-35	100	74	63	51	45	38	32	27	24	23	220
36-40	100	65	49	36	26	21	19	17	16	15	260
41-50	100	48	33	22	16	11	8	7	6	5	372
51-60	100	29	16	9	5	3	2	1	0	0	171
61-70	100	24	5	2	0	0	0	0	0	0	66
71-80	100	26	0	0	0	0	0	0	0	0	23
81-90	100	5	0	0	0	0	0	0	0	0	19
91+	100	17	0	0	0	0	0	0	0	0	7

Table 4--*Cumulative percent probability of burning index occurrence by class and month and minimum and maximum by month for 1300 P.s.t.*

Mount Hebron RS 40216 Years of record: 9

Burning index	Month												Obs.
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
0-15	-	-	-	100	100	100	100	100	100	100	100	-	16
16-30	-	-	-	100	99	99	100	97	99	100	100	-	220
31-35	-	-	-	100	81	76	91	86	77	87	55	-	220
36-40	-	-	-	100	62	56	83	71	61	61	36	-	260
41-50	-	-	-	91	44	40	60	59	45	28	9	-	372
51-60	-	-	-	64	19	15	21	33	19	10	0	-	171
61-70	-	-	-	64	5	5	8	13	7	6	0	-	66
71-80	-	-	-	55	1	3	2	6	4	3	0	-	23
81-90	-	-	-	27	0	2	1	3	2	1	0	-	19
91+	-	-	-	18	0	0	0	1	1	0	0	-	7
Maximum	-	-	-	114	78	90	90	94	97	85	45	-	-
Minimum	-	-	-	38	15	0	12	1	0	19	20	-	-
Observations	0	0	0	11	149	263	272	271	254	143	11	0	1374

Table 5-- *Percent probability of n consecutive days of ignition component remaining in or becoming greater than initial range for 1300 P.s.t.*

Mount Hebron RS 40216 Model: G Slope class : 2 Vegetation type: P
Observations: 1374 Years of record: 9

Ignition component	Length of run (days)										
	0	1	2	3	4	5	6	7	8	9	Obs.
0-10	100	100	100	100	100	10	100	10	100	10	175
11-20	100	81	65	61	54	48	44	44	40	38	295
21-30	100	70	56	42	35	30	25	21	19	16	456
31-40	100	48	34	21	12	7	5	4	3	3	285
41-50	100	31	13	6	4	1	0	0	0	0	101
51-60	100	16	6	0	0	0	0	0	0	0	34
61-70	100	27	0	0	0	0	0	0	0	0	17
71-80	100	0	0	0	0	0	0	0	0	0	8
81-90	100	0	0	0	0	0	0	0	0	0	3
91-100	100	0	0	0	0	0	0	0	0	0	0

Table 6--*Cumulative percent probability of ignition component occurrence by class and month and minimum and maximum by month for 1300 P.s.t.*

Mount Hebron RS 40216 Years of record: 9

Ignition component	Month												
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug	Sept.	Oct.	Nov.	Dec.	Obs.
0-10	-	-	-	100	100	100	100	100	100	100	100	-	175
11-20	-	-	-	100	80	82	94	89	87	89	64	-	295
21-30	-	-	-	100	48	57	75	73	67	69	18	-	456
3140	-	-	-	82	19	22	42	40	37	25	0	-	285
41-50	-	-	-	36	5	7	15	18	13	6	0	-	101
51-60	-	-	-	27	2	3	4	8	5	3	0	-	34
61-70	-	-	-	9	1	1	1	4	3	1	0	-	17
71-80	-	-	-	0	0	0	1	1	1	1	0	-	8
81-90	-	-	-	0	0	0	0	0	0	0	0	-	3
91-100	-	-	-	0	0	0	0	0	0	0	0	-	0
Maximum	-	-	-	67	64	84	84	89	78	72	28	-	0
Minimum	-	-	-	22	0	0	0	0	0	0	2	-	0
Observations	0	0	0	11	149	263	272	271	254	143	11	0	1374

Table 7--*Cumulative percent probability of temperature occurrence by class and month and minimum and maximum by month for 1300 P.s.t.*

Mount Hebron RS 40216 Years of record: 21

Temperature (° F)	Month												
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Obs.
< 0	100	100	100	100	100	100	100	100	100	100	100	100	0
0-12	100	100	100	100	100	100	100	100	100	100	100	100	0
13-25	100	100	100	100	100	100	100	100	100	100	100	100	1
26-38	96	100	100	100	100	100	100	100	100	100	100	100	40
39-51	71	93	83	95	99	100	100	100	100	99	92	97	330
52-64	11	28	42	67	82	96	100	100	97	85	50	10	755
65-77	0	0	4	23	44	(74)	97	91	78	49	6	0	1257
78-90	0	0	0	0	7	31	69	61	35	7	0	0	1221
91-103	0	0	0	0	0	0	6	4	0	0	0	0	74
104+	0	0	0	0	0	0	0	0	0	0	0	0	0
Maximum	54	63	69	76	85	96	95	97	91	86	68	54	
Minimum	20	35	32	34	33	41	51	45	40	32	33	37	
Observations	28	29	52	113	389	612	644	638	614	421	108	30	3678

Table 8--*Temperature means and record highs and lows for the period of record after 1972*

Mount Hebron RS 40216 Years of record: 9

Temperature (° F)	Month											
	Jan.	Feb.	Mar	Apr.	May	Jun	July	Aug.	Sept	Oct	Nov	Dec.
Record high	-	-	-	76	84	92	97	102	92	88	69	-
Mean maximum	-	-	-	66	65	75	83	81	77	70	55	-
Mean	-	-	-	47	49	57	64	61	56	48	32	-
Mean minimum	-	-	-	29	32	39	44	41	36	27	10	-
Record low	-	-	-	14	11	19	13	27	17	9	-4	-
Observations	0	0	0	11	149	263	272	271	254	143	11	0

Table 9--*Cumulative percent probability of relative humidity occurrence by class and month and minimum and maximum by month for 1300 P.s.t.*

Mount Hebron RS 40216 Years of record: 21

Relative humidity (pct)	Month												
	Jan.	Feb.	Mar.	Apr	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Obs.
0-9	100	100	100	100	100	100	100	100	100	100	100	100	20
10-19	100	100	100	99	99	100	99	99	100	100	100	100	640
20-29	100	100	96	79	88	90	75	75	77	85	98	100	1292
30-39	93	93	79	48	60	55	28	35	40	56	88	97	815
40-49	82	86	60	30	33	29	8	14	19	32	70	87	379
50-59	71	59	44	19	19	15	4	8	9	18	52	67	243
60-69	68	38	23	14	8	9	1	4	5	9	28	37	117
70-79	46	28	15	8	5	5	0	2	3	5	18	13	88
80-89	18	10	8	5	2	2	0	1	2	2	8	3	67
90-100	0	0	0	1	1	0	0	0	0	1	3	3	17
Maximum	88	88	84	92	100	100	89	90	100	100	100	93	
Minimum	25	26	14	9	5	8	5	6	6	9	13	28	
Observations	28	29	52	113	389	612	644	638	614	421	108	30	3678

Table 10--*Relative humidity means and record highs and lows for the period of record after 1972*

Mount Hebron RS 40216 Years of record: 9

Relative humidity (pct)	Month											
	Jan.	Feb.	Mar	Apr.	May	June	July	Aug.	Sept.	Oct .	Nov	Dec.
Record high	-	-	-	100	100	100	100	100	100	100	100	-
Mean maximum	-	-	-	69	93	91	88	91	94	96	94	-
Mean	-	-	-	43	63	61	57	58	61	61	66	-
Mean minimum	-	-	-	17	33	30	25	26	28	27	37	-
Record low	-	-	-	8	8	8	7	6	5	9	11	-
Observations	0	0	0	11	149	266	273	272	254	142	11	0

Table 11-- *Cumulative percent probability of 1-h TLFM occurrence by class and month and minimum and maximum by month for 1300 P.s.t.*

Mount Hebron RS 40216 Years of record: 21

1-h TFLM (pct)	Month												
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Obs.
0-1	100	100	100	100	100	100	100	100	100	100	100	100	0
2-3	100	100	100	100	100	100	100	100	100	100	100	100	543
4-5	100	100	98	88	94	93	76	75	78	91	99	100	1487
6-7	86	97	85	49	60	51	22	27	32	52	91	97	718
8-9	79	76	46	27	36	27	7	12	14	26	65	73	338
10-II	57	48	27	18	19	16	3	7	8	14	38	43	192
12-13	32	31	21	12	11	9	1	4	5	8	22	10	101
14-15	21	24	12	8	5	6	1	2	3	5	15	7	36
16-17	18	21	8	5	3	5	0	2	2	4	12	7	37
18+	7	14	2	4	2	4	0	1	1	3	7	7	82
Maximum	26	19	18	26	26	28	21	26	28	31	32	26	
Minimum	5	5	3	2	2	2	2	2	2	2	3	5	
Observations	28	29	52	113	389	582	613	605	584	401	108	30	3534

Table 12--*Cumulative percent probability of 10-h TLFM occurrence hr class and month and minimum and maximum by month for 1300 P.s.t.*

Mount Hebron RS 40216 Years of record: 21

10-h TLFM (pct)	Month												
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Obs.
0-1	-	-	-	100	100	100	100	100	100	100	100	100	0
2-3	-	-	-	100	100	100	100	100	100	100	100	100	47
4-5	-	-	-	100	99	100	98	97	99	99	100	100	766
6-7	-	-	-	100	94	92	65	59	64	86	98	100	937
8-9	-	-	-	91	78	64	27	28	37	64	97	100	599
10-11	-	-	-	64	51	41	15	18	21	42	88	97	435
12-13	-	-	-	27	32	26	7	10	12	27	69	77	271
14-15	-	-	-	0	22	17	3	7	8	17	41	60	147
16-17	-	-	-	0	15	13	2	5	6	10	30	33	94
18+	-	-	-	0	11	10	1	4	5	6	19	10	238
Maximum	-	-	-	12	46	50	35	50	50	50	50	38	
Minimum	-	-	-	7	3	3	3	2	2	3	5	9	
Observations	0	0	0	11	389	582	613	605	584	401	108	30	3534

Table 13--*Cumulative percent probability of 100-h TLFM occurrence by class and month and minimum and maximum by month for 1300 P.s.t.*

Mount Hebron RS 40216 Years of record: 9

100-h TLFM (pct)	Month												
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Obs.
0-1	-	-	-	100	100	100	100	100	100	100	100	100	0
2-3	-	-	-	100	100	100	100	100	100	100	100	100	0
4-5	-	-	-	100	100	100	100	100	100	100	100	100	0
6-7	-	-	-	100	100	100	100	100	100	100	100	100	11
8-9	-	-	-	91	100	100	99	98	100	100	100	100	89
10-11	-	-	-	64	100	93	88	84	100	100	100	-	177
12-13	-	-	-	27	95	76	62	71	95	100	100	-	330
14-15	-	-	-	0	70	41	24	50	83	97	100	-	364
16-17	-	-	-	0	31	17	4	20	46	85	100	-	246
18+	-	-	-	0	14	5	1	7	19	36	64	-	162
Maximum	-	-	-	12	25	22	20	36	32	23	20	-	
Minimum	-	-	-	7	10	7	7	7	9	12	16	-	
Observations	0	0	0	11	149	266	273	272	254	143	11	0	1379

Table 14--*Cumulative percent probability of 1000-h TLFM occurrence by class and month and minimum and maximum by month for 1300 P.s. t.*

Mount Hebron RS 40216 Years of record: 9

1000-h TLFM (PC)	Method												
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug	Sept	Oct	Nov.	Dec	Obs.
0-1	-	-	-	100	100	100	100	100	100	100	100	-	0
2-3	-	-	-	100	100	100	100	100	100	100	100	-	0
4-5	-	-	-	100	100	100	100	100	100	100	100	-	0
6-7	-	-	-	100	100	100	100	100	100	100	100	-	0
8-9	-	-	-	100	100	100	100	100	100	100	100	-	0
10-11	-	-	-	100	100	100	100	100	100	100	100	-	112
12-13	-	-	-	100	100	100	93	66	100	100	100	-	285
14-15	-	-	-	100	100	88	50	38	76	100	100	-	359
16-17	-	-	-	100	99	52	12	17	48	79	100	-	272
18+	-	-	-	36	68	26	3	10	28	42	91	-	351
Maximum	-	-	-	19	22	20	18	28	25	22	18	-	
Minimum	-	-	-	16	15	11	11	10	12	15	17		
Observations	0	0	0	11	149	266	273	272	254	143	11	0	1379

Table 15--*Cumulative percent probability of woody fuel moisture occurrence by class and month and minimum and maximum by month for 1300 P.s.t.*

Mount Hebron RS 40216 Years of record: 9

Moisture (pct)	Month												
	Jan.	Feb	Mar	Apr	May	June	July	Aug.	Sept	Oct	Nov	Dec.	Obs.
0-29	-	-	-	100	100	100	100	100	100	100	100	-	0
30-59	-	-	-	100	100	100	100	100	100	100	100	-	0
60-89	-	-	-	100	100	100	100	100	100	100	100	-	443
90-119	-	-	-	0	46	99	93	66	64	5	0	-	580
120-149	-	-	-	0	17	57	14	19	33	5	0	-	299
150-179	-	-	-	0	3	3	0	7	10	0	0	-	39
180-209	-	-	-	0	0	0	0	6	0	0	0	-	18
210-239	-	-	-	0	0	0	0	0	0	0	0	-	0
240-269	-	-	-	0	0	0	0	0	0	0	0	-	0
270+	-	-	-	0	0	0	0	0	0	0	0	-	0
Maximum	-	-	-	60	160	158	145	200	180	140	60	-	
Minimum	-	-	-	60	60	89	82	74	60	60	60	-	
Observations	0	0	0	11	149	266	273	272	254	143	11	0	1379

Table 16--*Cumulative percent probability of herbaceous fuel moisture occurrence by class and month and minimum and maximum by month for 1300 P.s.t.*

Mount Hebron RS 40216 Years of record: 9

Moisture (pct)	Month												
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov	Dec.	Obs.
0-29	-	-	-	100	100	100	100	100	100	100	100	-	308
30-59	-	-	-	0	61	100	100	100	64	5	0	-	25
60-89	-	-	-	0	45	100	100	100	64	5	0	-	319
90-119	-	-	-	0	29	100	78	38	39	5	0	-	529
120-149	-	-	-	0	15	53	1	7	6	0	0	-	141
150-179	-	-	-	0	5	11	0	6	1	0	0	-	56
180-209	-	-	-	0	1	0	0	0	0	0	0	-	1
210-239	-	-	-	0	0	0	0	0	0	0	0	-	0
240-269	-	-	-	0	0	0	0	0	0	0	0	-	0
270+	-	-	-	0	0	0	0	0	0	0	0	-	0
Maximum	-	-	-	9	180	176	121	150	150	100	15	-	
Minimum	-	-	-	3	4	89	73	59	3	2	4		
Observations	0	0	0	11	149	266	273	272	254	143	11	0	1379

Table 17--*Precipitation (inches)*

Mount Hebron RS 40216

Year	Month												Total
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov	Dec.	
							inches						
1961	-	-	-	-	-	1.65	0.14	-	0.69	-	-	-	-
1962	-	-	-	-	-	0.56	-	0.53	0.30	-	-	-	-
1963	-	-	-	-	-	0.78	0.31	0.25	0.08	-	-	-	-
1964	-	-	-	-	-	-	0.33	0.11	0.12	0.10	-	-	-
1965	-	-	-	-	-	1.63	0.26	-	0.02	0.00	-	-	-
1966	-	-	-	-	1.00	0.69	0.11	0.93	0.55	0.17	-	-	-
1967	-	-	-	-	-	2.02	0.01	0.00	0.16	0.88	-	-	-
1968	-	-	-	-	-	0.83	0.00	-	0.08	-	-	-	-
1969	-	-	-	-	-	1.14	0.33	0.00	0.17	1.65	-	-	-
1970	-	-	-	-	-	1.52	0.22	0.00	0.00	-	-	-	-
1971	-	-	-	-	-	-	0.07	0.11	0.64	-	-	-	-
1972	-	-	-	-	-	0.39	0.02	0.13	0.47	-	-	-	-
1973	-	-	-	-	-	0.00	1.06	0.11		-	-	-	-
1974	-	-	-	-	-	0.05	0.13	-	0.00	-	-	-	-
1975	-	-	-	-	-	-	-	-	-	-	-	-	-
1976	-	-	-	-	-	0.77	0.78	3.05	-	-	-	-	-
1977	-	-	-	-	-	1.24	0.07	-	-	-	-	-	-
1978	-	-	-	-	-	-	0.58	-	-	-	-	-	-
1979	-	-	-	-	-	0.25	0.13	1.40	-	-	-	-	-
1980	-	-	-	-	-	1.30	-	0.00	0.48	-	-	-	-
1981	-	-	-	-	-	0.22	-	0.18	-	-	-	-	-
Mean	-	-	-	-	1.00	0.88	0.27	0.49	0.27	0.56	-	-	-

Table 18--*Percent probability of joint occurrence of windspeed and direction at 1300 P.s.t.*

Mount Hebron RS 40216 Total observations: 149
Years of record: 21 May Calm: 0 percent

Windspeed (mi/h)	Wind direction								Total (pct)[1]	Obser-vations
	NE	E	SE	S	SW	W	NW	N		
1-3	0	0	1	0	1	0	0	1	3	5
4-6	3	0	1	3	3	1	7	9	28	41
7-9	3	0	0	1	4	2	9	5	25	37
10-12	0	0	2	1	1	1	6	3	15	22
13-15	1	0	0	1	5	1	5	1	15	22
16-18	0	0	0	1	4	1	4	1	11	16
19-21	1	0	0	0	0	0	1	0	2	3
22-24	0	0	0	0	0	0	1	0	1	1
25-27	0	0	0	1	0	0	1	0	1	2
28+	0	0	0	0	0	0	0	0	0	0
Total percent[1]	9	0	5	7	18	6	34	21	100	
Observations	13	0	7	11	27	9	51	31		

[1]Total percentages may not agree with sums of individual percentages because of rounding.

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Potential fire characteristics can be estimated as functions of weather, fuel, and terrain slope. Such information is needed by forest and other land managers--especially for anticipating fire suppression needs and planning prescribed burns. To provide this information, an Atlas has been developed for California. The Atlas includes statistical analyses of spread component, burning index, ignition component, temperature, relative humidity, dead fuel moisture, live woody fuel moisture, live herbaceous fuel moisture, precipitation, windspeed and direction for 200 fire-danger rating stations in California. Charts and information for one of the stations included in the Atlas--Mount Hebron in northern California--serve as an example of this application.

Retrieval Terms: fire management, prescribed burning, fuel moisture, forest climatology, potential fire characteristics