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The Moisture Content of Ponderosa Pine and Whiteleaf Manzanita Foliage in the Central Sierra Nevada

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ABSTRACT: In the first year of studies of moisture in living fuels, pine and manzanita had dissimilar moisture trends, the moisture content of brush varied with elevation during the growing season, and soil moisture was correlated with brush foliage moisture.

The moisture content of living vegetation, a major factor in its flammability, is the most difficult component of a fire danger rating system to measure directly. But with more information on the variability and characteristics of moisture in living fuels, we should be able to estimate such fuel moisture accurately. With this purpose in mind, studies of moisture in vegetation were started in the central Sierra Nevada in May 1962. These studies supplemented similar ones already begun in the north coastal and southern sections of California.

Most past studies in this field have dealt with the distribution of moisture in tree boles and were usually related to insect or wood-use problems (2, 3, 4, 6, 7, 9, 14). Some studies have been published on the annual variation of foliage moisture, but most of these were carried out in climates not characteristic of California (7, 8, 12, 13, 15).

This study was designed to find out how moisture in vegetation is related to weather variables, soil moisture, elevation, and time. We set up three plots, with 2 sub-plots each--at 3,200, 4,200, and 5,200 feet--near Sonora, California. All three plots have slopes ranging from 5 to 15 percent and a south aspect. Ponderosa pine (*Pinus ponderosa*

Laws.) and whiteleaf manzanita (Arctostaphylos viscida Parry) make up most of the vegetation. The pine is from 10 to 30 feet high, and the shrubs average 4 feet.

METHODS

Each plot is divided into two sub-plots which are 100 feet apart and contain 18 trees and 9 shrubs apiece. The trees were randomly tagged with the letters A through F, three trees on each sub-plot having the same letter. Each of the three trees having the same letter was sampled at the same height and exposure as determined by the following randomized sampling system:

Sample location		Sampling period, weeks					
Exposure	Height	2	4	6	8	10	12
South	Upper 1/3	F	E	C	B	A	D
South	Middle 1/3	A	B	E	C	D	F
South	Lower 1/3	B	A	F	D	C	D
North	Upper 1/3	F	C	D	F	B	A
North	Middle 1/3	D	F	B	A	E	C
North	Lower 1/3	C	D	A	E	F	B

This system, repeated every 12 weeks, helps reduce the effects of the variability of moisture with height and exposure in the trees. Small branches were cut from the various groups of trees at the predetermined locations. All the needles along one side of a branch were removed, including new growth, with relatively high moisture content, as well as the old growth. Twig samples consisted of 1-inch segments up to one-half inch in diameter cut from the branch just behind the oldest needles. The total twig sample from one location was 6 to 8 inches long. The samples from each of the three trees in one height group were combined and placed in a plastic box of known weight.

Some branches were cut from all nine shrubs on a sub-plot and the resulting pile put into three sample boxes. No attempt was made to sample brush by height or exposure.

All vegetation was cut between noon and 4:00 p.m. in order to reduce the effects of diurnal variability. The samples were sealed and weighed within three hours after cutting.

Sampling was done every 14 days. Moisture content on a dry weight basis was determined by xylene distillation (1) in the laboratory in Berkeley.

Soil samples were taken at the time of each vegetation sampling at 12, 30, and 48 inches depth with an auger. (Soil moisture content was determined later by oven drying.) Wind speed, precipitation, temperature, and relative humidity were recorded continuously throughout this study.

RESULTS

Moisture contents of pine needles and twigs were fairly constant during the first year. The range in pine needle moisture was from 103 to 125 percent and in twig moisture from 86 to 100 percent (fig. 1). However, these differences were not statistically significant with time. There was no correlation between soil moisture and pine moisture (fig. 3). Moisture content of needles increased with height in the crown, and the mid-crown represented the average moisture content of the entire crown.

Manzanita moisture showed a definite seasonal trend, peaking during the period of new growth. After new growth ceased, very rapid drying occurred until the middle of August, at which time the moisture content leveled off and remained constant throughout the winter months (fig. 1). An elevational effect is apparent in that the peak moisture content was higher and earlier at the lower elevation (fig. 2). This difference is probably due to the fact that soil moisture is higher when budding out occurs at the lower elevations. Manzanita moisture content seemed to be related to soil moisture at the 30- and 48-inch depth during the drying period from May through September (fig. 3).

One preliminary conclusion to be drawn from the first year of this study is that moisture trends differ in ponderosa pine and whiteleaf manzanita. Pine remained fairly constant, but manzanita reached a peak during new growth and then declined until a minimum was reached. Neither species gained moisture during the winter months. The moisture content of manzanita varied with elevation. This elevational difference was not evident in pine. If a correlation between soil moisture and manzanita moisture content is confirmed by further study, it may

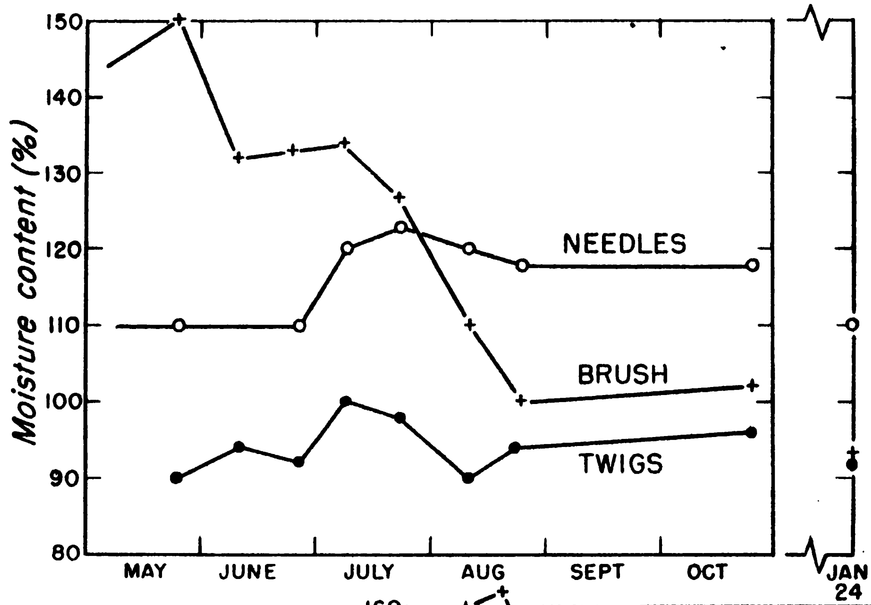

Figure 1.--Average moisture content of manzanita and ponderosa pine foliage, May 1962-January 1963.

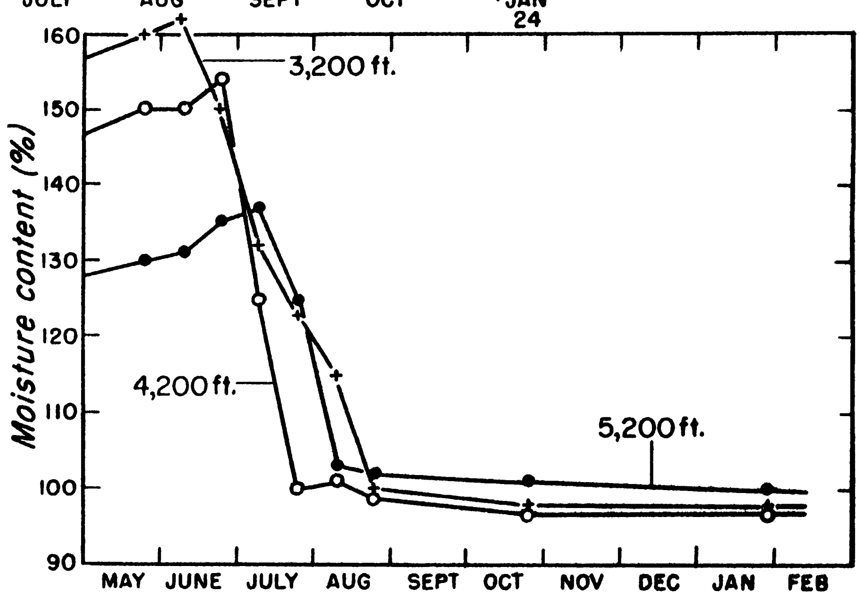

Figure 2.--Moisture content of manzanita foliage, by elevation, May 1962-February 1963.

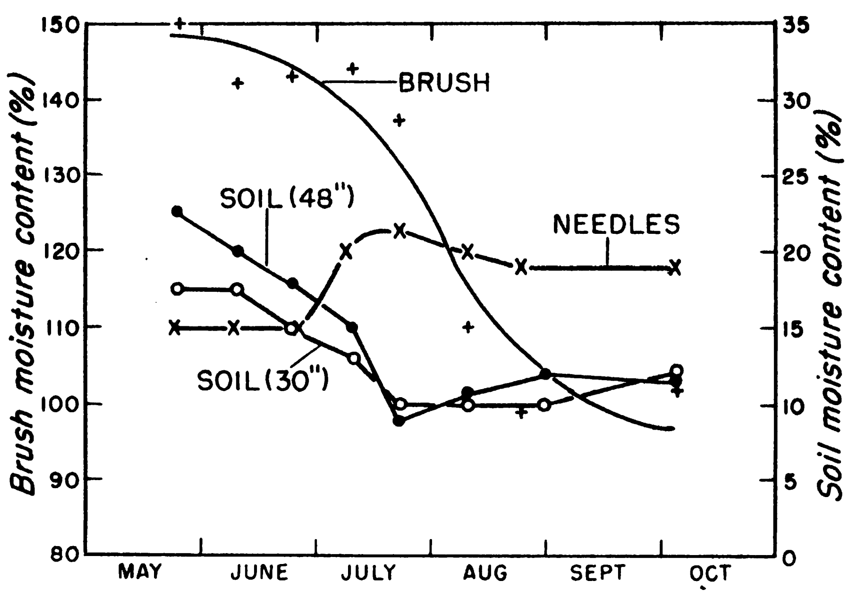

Figure 3.--Moisture content of manzanita brush and ponderosa pine needles, and soil moisture at 30 and 48 inches, depth, May to October 1962.

be possible to predict brush moisture content from soil moisture, the easier of the two variables to measure.

This study is being continued to check these findings and to determine the relationship between daily weather and moisture in living fuels. Day-to-day and diurnal changes in fuel moisture will be investigated.

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