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ESTIMATING LIGHT INTENSITY BENEATH CONIFEROUS FOREST CANOPIES: SIMPLE FIELD METHOD

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ABSTRACT

Intensity of light under canopies of coniferous forest can be estimated easily without instruments but with accuracy adequate for numerous administrative and research studies.

KEYWORDS: light intensity estimations, coniferous forests, forest canopies, field method

Field workers on administrative and research projects frequently need a simple but reasonably accurate method for estimating intensity of sunlight under forest canopies. Many years ago during an instrumental study of light intensity under coniferous forest canopies in northern Idaho, the author[2] developed a simple ocular method that has proved useful many times. Because this method does not require instruments and is easy to use, other workers may find it handy.

The method is based on the observed fact that crowns of coniferous trees exert little filtering effect on the passage of light; that is, most sun rays either penetrate openings in the canopy unimpeded or else are almost entirely obstructed by foliage.

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[2]Wellner, Charles A. 1946. Estimating light intensity in residual stands in advance of cutting. USDA For. Serv., North. Rocky Mt. For. and Range Exp. Stn. Res. Note 47, 4 pp.

As a result, the light pattern beneath the canopy is essentially a mosaic of patches of full sunlight and deep shade. Measurements of light intensities beneath the canopy are primarily of very high or very low intensity and the mean light intensity is an average mainly of extreme values.[3] The problem in any field method of measurement or estimation is largely one of classifying the light pattern into two parts, full sunlight and deep shade, and obtaining the proportion of each. It was found that this classification could be done satisfactorily by direct visual observation.

The method consists of two processes: (1) making ocular observations of light intensity at regular intervals throughout the area studied, listing these as "full sun" or "shade" intensities, and determining the proportion of each, and (2) computing average light intensity for the area by substituting these proportions into a simple formula for calculation.

The individual observation is made by glancing upward at the sun. If the observer's view of the sun is entirely unobstructed or less than half obstructed, he tallies the observation as "full sun." If his view is more than half obstructed, he records the observation as "shade." Most observations can be judged definitely in one class or the other. The observer classifies borderline observations at his discretion. The practice of classifying first one as "full sun," the next as "shade," the next as "full sun," etc. is satisfactory.

An alternative method is to hold a small, light-colored card or page of a pocket notebook horizontally in the hand. The light on the card is tallied as "shade" or "full sun."

The method of selecting observation points may be varied according to the area studied. Any method is satisfactory which obtains good distribution of observation points throughout the given area, an adequate number of points, and the choice of these so that they are either random or systematic, i.e., not influenced by personal selection. At least 100 observations should be made on each study area.

As with all direct-reading methods, observations should be made during June or July, as near midday as possible, and on days when the sun is clearly visible. They should not be made before 10:00 a.m. or after 2:00 p.m. Though a cloudless day is not necessary, the sun must be visible to the observer.

When the proportion of "full sun" and "shade" observations is known, the observer can compute the mean light intensity. The computation consists of multiplying the proportion (percentage) of "full sun" measurements by 100 (the intensity of full sunlight) and the percentage of "shade" measurements by the average intensity of shade, summing the two results and dividing by 100.

$$\text{Mean light intensity} = \frac{A(y) + B(x)}{100}$$

Where mean light intensity is in percentage of full sunlight

A = percentage of "full sun" observations
B = percentage of "shade" observations
x = average intensity of shade
y = intensity of full sunlight (100)

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[3] In the instrumental study mentioned, 83 percent of a total of 6,621 direct measurements having an average intensity of 48 percent of full sunlight, were in the 0-20 and 81-100 percent of full sunlight classes.

A value of 7 as an average intensity of shade (x) is used in stands where 10 percent or more of the observations are "full sun," and a value of 3 is used where less than 10 percent are "full sun." A value of 100 is always used for full sunlight intensity.

Use of the formula is illustrated by the following example. Suppose 35 percent of the observations are "full sun" and 65 percent are "shade." Then:

$$\text{Mean light intensity} = \frac{35 \times 100 + 65 \times 7}{100} =$$

$$\frac{3500 + 455}{100} = 39.55 \text{ or } 40 \text{ (percent of full sunlight)}$$

Accuracy of this ocular method is indicated by comparison of estimates made by this ocular method with measurements made by a Shirley radiometer[4] on 18 sample plots, each 0.4 acre (0.16 ha) in area, distributed over a wide range of canopy densities. No comparison showed a difference greater than 6 percent of full sunlight; only one comparison showed a difference greater than 5 percent; 15 of the differences were less than 3 percent, and 6 were less than 1 percent.

From these comparisons it is concluded that for most field studies in which discontinuous measurements of light intensity beneath the canopy are adequate, the method described here can produce satisfactorily accurate estimates.

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[4]Shirley, H. L. 1930. A thermoelectric radiometer for ecological use on land and in water. Ecology 11:61-71.

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