*Spectrophotometric Analysis of Foliage of some British Columbia Conifers**

EARLE HINDLEY†, AND J. HARRY G. SMITH‡

ABSTRACT: *Reflectance of 9 species of conifers from Southern British Columbia was assessed with a Beckman model DU spectrophotometer. Wide variations in reflectance within a species, relatively small differences among species, and limited tonal contrast in infra red film make it likely that improved species-identification will come from better knowledge of tree shape and habitat rather than from emphasis of tonal differences through varying film-filter combinations.*

AT THE present time difficulties of identifying individual tree-species seriously limit wider application of photo-mensurational techniques. Could the tonal differences among conifers be accentuated by optimum combinations of film and filter, species-identification would be much easier and more accurate. Since the tone of an object as shown on an aerial photograph is directly affected by the amount and wavelength of the light reflected from it, reflectance of the foliage of some British Columbia conifers was studied. A Beckman model DU spectrophotometer with a reflectance attachment was used in attempts to determine the wave-lengths in which the greatest differences in reflection occurred among species in various forest types.

Branch samples were collected from typical trees in 9 collection areas in forest types found in the southern interior of British Columbia. Branches were placed in plastic bags and refrigerated until analysis was completed. No significant changes in reflectance characteristics were noted in materials that had been stored in this way for three weeks. Reflectance measurements were made in a standard fashion on the leaf surfaces that would be seen when the standing trees were viewed from above. Most measurements of reflectance were taken at intervals of 50 millimicrons from 450 to 1,100.

The maximum differences in reflectance among species were noted in the infrared light range, from 750 to 1,100 millimicrons. Smaller and less consistent differences among species were found in the green to red portion of the spectrum from 500 to 700 millimicrons. There was a very strong tendency for reflection of infrared light to decrease with increase in altitude of the collection area. For example, percentage of reflectance of infrared light ranged for alpine fir from 55 per cent near Galloway (4,600 feet) to 82 per cent near Clearwater (2,100 feet). The influence of elevation was so pronounced that potential correlations of reflectance with aspect of collection area, and age, diameter, height, and crown class of sample trees may have been masked. The influence of species on reflectance is shown in Table I.

The green-red portion of Table I represents averaged estimates of the per cent of light reflected in the portion of the spectrum to which the conventional combination of Kodak aerographic film with a minus blue filter is sensitive. Kodak infrared aerographic film, which is sensitized to infrared light in the range from 700 to 900 millimicrons, could be used to record differences indicated in the second part of Table 1. The range in the amount of infrared light that is reflected is nearly three times that of green-red light, but available

* Research Note No. 16, Faculty of Forestry, The University of British Columbia. A University Research grant, help and loan of equipment from Dr. O. Bluh of the Physics Department, and collection of samples by J. G. N. Davidson, F. Hartman, B. Devitt, and D. Hamilton are gratefully acknowledged.

† B.S.F. 1957. Mr. Hindley is employed now by T&H Engineering and Forestry Ltd.

‡ Assistant Professor, Faculty of Forestry.

TABLE I

PER CENT OF LIGHT REFLECTED FROM NEEDLES OF SOME B. C. CONIFERS

Species	Localities sampled	Per cent of light reflected	
		Green-red	Infrared
Lodgepole pine	5	13.5 (4)[1]	74.3 (6)
Yellow pine	3	16.3 (2)	85.4 (1)
Alpine fir	3	9.4 (9)	77.3 (5)
Interior D. fir	5	11.1 (8)	64.6 (8)
Engelmann spruce	2	11.6 (7)	77.5 (4)
White pine	1	13.5 (4)	80.9 (3)
Larch	1	18.1 (1)	82.2 (2)
Coast hemlock	2	15.7 (3)	61.4 (9)
Coast cedar	2	12.6 (6)	67.3 (7)

[1] Order of reflectance from high to low.

infrared films have too short a tonal range to capitalize fully on these differences. When improved infrared films with a long tonal-range have been developed, it may be possible to use them to discriminate more effectively among these conifers. Even then infrared might not always be helpful because, for example, differences between Engelmann spruce and alpine fir which occur frequently in mixtures are larger in green-red than in infrared light.

Other difficulties in using the percentages given in Table I must be mentioned. Although species that reflect greater amounts of light should be represented on the average by lighter toned images on aerial photographs, the range in reflectance within a species can be very great. The reflectance of blue-green light from samples of Douglas fir ranges from 8.8 per cent at Clearwater to 18.6 per cent at Cranbrook and for lodgepole pine from 8.6 per cent at Grand Forks to 20.8 per cent at Cranbrook. The per cent of infrared light reflected from Douglas fir ranged from 61.2 at Allison Pass to 73.0 at Clearwater, and for lodgepole pine it varied from 62.5 at Grand Forks to 84.0 at Clearwater. Probably much of this variation is associated with the large differences in elevation among localities, but residual variations may be very great.

Because species-identification is so often incidental to other purposes of photography, there does not seem to be much chance that very narrow bands of light in which differences between species or species groups are maximized can be utilized commercially. The possibilities of using special filters to capture peak or low reflection of light around 550 or 650 millimicrons would be worth investigating although their use may also be limited by the total amount of light energy required to "expose" film without excessive image movement.

As a result of this study it may be concluded that until an infrared film with a longer tonal-range becomes available, it would be best to concentrate research efforts on other approaches to identification of the species studied here. Knowledge of inherent differences in tone attributable to species and other factors must be supplemented by information on the typical range in size, shape, branch habit, and ecological characteristics of species and species groups. Such information may be presented most effectively in the form of a dichotomous key.