Therefore, direct volume estimates would save us very little. We must usually go into the field in connection with our surveys to complete the forest classification as to species composition, to secure log grade information, to secure stand structure, etc.

2. We need estimates by species, and, in complex mixtures such as occur in the Douglas-fir subregion especially in southern Oregon, the various species cannot be successfully identified on photography which is mostly on a scale of 1:20,000.

3. Net volumes are needed as a result of our surveys. In many locations we have defect and cull factors which sometimes amount to as high as 50% of the gross volume. We cannot judge cull and defect from photos.

4. The crowns of some sawtimber size trees are below the general canopy of the forest; therefore we cannot secure reliable tree counts from aerial photos.

5. Our stands are so dense, especially on the west side, that we cannot see the base of trees; therefore we cannot reliably determine tree heights by measuring shadows or by using the parallax wedge method. A complicating factor in this regard is the fact that most of our area involves mountainous terrain which in turn results in tremendous changes in photographic scale within short distances on a photo.

6. We have no evidence that there is a close correlation between crown width and tree volume in most of our conifers.

7. We are a far-flung organization employing hundreds of men who must do their work in extremely variable conditions. Training in photo mensuration techniques would be a big job.

CONCLUSION

In closing I wish to say that for us the possibilities of estimating volume per acre for photo delineations of stand size density classifications seem to offer more opportunity than attempting to secure the volume of individual trees. We regard this as a possibility only for types which are comprised of one species of low uniform defect. Lodgepole pine stands may be susceptible to this kind of treatment.

USE OF AERIAL PHOTOGRAPHS IN THE INVENTORY PHASE OF THE FOREST MANAGEMENT JOB*

H. K. Trobitz, Forestry Department, Simpson Logging Company

IN THE past ten years there have been tremendous advances made in the use of aerial photographs in the forestry and engineering fields on the West Coast. At first, aerial photos of forested areas were a curiosity, but soon their utility for reconnaissance purposes was recognized. Foresters then began using them for forest typing and topographic mapping; and before long we probably shall see them used in what may well be their most intensive forestry use, photo-cruising.

The theme of this meeting has been particularly interesting and encouraging. Speakers have stressed what has been and is being done with the aerials, rather than relating nebulous thoughts of what is supposed can be done with them. This approach is especially valuable in establishing faith among the industry, and should lead to greater use of aerials in connection with forest properties.

* Paper read at Annual Meeting of Columbia River Section of the Society, Portland, Oregon, December 7, 1949

Industry (which controls the purse strings) must be presented the advantages of the use of aerial photos in solving the problems of forest management on a cost-benefit ratio. The costs of photography are well established but the balancing benefits, on the other hand, must be evaluated on a time-saving basis.

In the Simpson Logging Company operations around Shelton, Washington, we have been using aerial photographs in our forest management job on an ever-increasing basis. In 1929, Fairchild Aerial Surveys furnished the Company with a set of 7″×9″ panchromatic pictures on a 1:14,400 scale. These photos were, for the most part, of the Olympic National Forest area which is now a part of the Cooperative Sustained Yield Unit. Very limited use was made of these aerials. In 1946, approximately 1,500 square miles (embracing the scattered Simpson ownership and the portion of the Olympic National Forest falling within the Cooperative Sustained Yield Unit) were flown by Fairchild. After considerable study it was decided to use infrared photography on a 1:14,400 scale taken with a 12″ lens. This combination, it was felt, would be most suitable for the multipurpose forestry job. To date this photography has proved satisfactory in all respects. As part of the Fairchild contract, controlled aerial mosaics, scale 1:14,400, were prepared on a township basis, covering the entire flown area.

Our specialized photogrammetric equipment includes a Multiscope, used primarily for adjusting photo scales to base map scales for detail transfer; a stereocomparagraph for making local form line topographic maps; and binocular stereoscopes.

Using the controlled mosaics as a base, a land net has been superimposed. This land net has been built up from picture-pointed corners, about twelve per township, and from the U. S. General Land Office field notes.

Tracings of these mosaics were made and now furnish us with a set of base maps showing the main planimetric detail, land net, and ownership. These base maps will serve as the official base maps for the operation, and will show all information concerning forest types, road plans, cutting records, fire plans, etc.

We have found the land net projection to be of such accuracy that in the field we seldom search over 150 to 200 feet from the projected corner location. This saves considerable time in looking for a corner, evidence of which may have been lost. A further saving in time results from not having to chain and run compass line to locate the corner approximately. One can travel to the projected corner location in the field by dead-reckoning oneself from readily discernible features in the photo.

In the actual inventory job, the aerial photos furnish many short cuts which result not only in a saving of time but often in an increase in accuracy of results. Before going to the field, the cruiser can prepare his maps and have an excellent mind's-eye view of the lay of the land. Camp locations and trails, if needed, can be strategically located.

The greatest single aid which aerial photos furnish to the cruising job is to serve as a basis for stratifying forest stands of similar characteristics. Forest stands may be segregated on a basis of age, stocking, tree size, volume, or species. Which stand characteristics should be stratified depends upon the information desired, the variability of the stand, or a combination of factors. Thus a stratified area represents a group of individual homogeneous stands, as opposed to an unsegregated heterogeneous mass of forest growth.

In the end-result, stratification serves a threefold purpose. First, it gives a map showing the location of stands of various characteristics, depending upon

the basis of stratification. Second, it gives a basis upon which to vary the intensity of cruise, depending upon the degree of accuracy desired or timber values at stake. Finally, by reducing stand variation, stratification reduces sampling errors so that for the same number of plots a greater accuracy results. Stratification may reduce sampling errors by as much as 40%, depending upon the variation in the stand. This reduction in sampling error then means that the same degrees of accuracy may be obtained by taking fewer plots, which in turn means a saving in the job cost.

The use of stratification can best be exemplified by a case, in a recently completed .6% cruise in the Shelton Working Circle old growth timber. The sampling error for Douglas fir (which comprises 50% of the stand) was ±13% on 9,700 acres. The area was later stratified into stands in which Douglas fir 40″-and-over predominated, and into stands of less than 40″ D.B.H.* Recalculation of the sampling error indicated that it had declined to 8%. By way of interest, the accuracy of stratification was as follows:

For Douglas fir:

Over 40″ DBH strata 92% of volume in trees over 40″
Over 40″ DBH strata 8% of volume in trees under 40″
Under 40″ DBH strata 26% of volume in trees over 40″
Under 40″ DBH strata 74% of volume in trees under 40″

In the above-mentioned cruise, which covered a gross of 80,000 acres, about 60% of the area was unsurveyed. The necessary control was obtained by placing a one-mile grid on the controlled mosaics, transferring cruise line crossings with trails, stream crossings, and other prominent landmarks to contact prints, and then locating these points in the field. The cruise-line crossings in the field, once located on the ground, were marked and numbered. This control cost about $600, and was established in ten days by a two-man party. The adequacy of this plan can best be indicated by saying that the cruisers, who had never been in the country before, were satisfied, and encountered no difficulties with the control.

The aerial photos are useful even during the actual cruising operation. Prestudy of the day's run can tell the cruiser the best way to get to the cruise line, what difficulties will be encountered, where to end the strip, and how best to return to camp. The cruiser can tell where to expect brush or rock outcrops which may be impassable. Further intensive study will reveal whether there is any timber worth cruising beyond the rock or brush, or which way to bypass the obstacle. Otherwise this information could be obtained only on the ground by time-taking reconnaissance.

No attempt has been made to determine the amount of money saved by using aerial photos in the cruising operation as there are too many variables. It can readily be seen, however, that if properly used there is a real saving of time. With labor at $1.50 to $2.00 per hour this can amount to a sizable sum.

Several months ago we completed our inventory of Simpson holdings in the Shelton Working Circle. About 166,000 acres of land were classified, of which 142,000 acres are immature stands less than 100 years old. Stands were delineated on the contact prints by species, economic size class, stocking, age in 10-year groups, and site. The classification system we used is the same as that of the U. S. Forest Service.[1] Stand boundaries were transferred to the base maps, and finally township tracings of the type map were made.

* Diameter at Breast Height.

[1] Forest type classification of the Pacific Northwest Region, Pacific Northwest Forest and Range Experiment Station, and U. S. Forest Service Pacific NW Region, Portland, Oregon, March 1949.

Stands were classified on the basis of photo interpretation. Such factors as crown density, crown color, picture-tone, crown-size, relative stand-height, and slope and exposure were used to name the individual stands. The accuracy of photo interpretation was checked wherever possible by known field classification of old typing jobs. So far a good correlation has existed between photo classification and ground classification. Further ground checks will be made as time goes on.

Stands of down to three acres were delineated in this job as the type map must serve a twofold purpose: that is an inventory and a management plan. It is interesting to note that over 2,000 acres of mature timber were inventoried on the aerials, which were missed on a previous 10% ground cruise.

The cost of the photo inventory was 3.8 cents per acre, which is about ¼ the cost of a 10% cruise. This cost includes stand delineation, transfer to base map, tracing preparation, and summarization of stands by section, township and total holdings.

We feel that we have a forest type map of our holdings with very accurate stand boundaries. All previous accurate field information has been incorporated; and the only changes we expect to have to make are in stand classification resulting from field checking. Our inventory at present is probably at least as good as a 20% ground cruise.

We are also making our aerial photos pay in other ways. Logging settings are being laid out on contact prints, and intensively studied prior to marking setting boundaries in the field.

Preliminary road locations are roughly located on the aerials by studying terrain features. Some difficulties are encountered in the Olympics due to the heavy ground cover concealing outcropping rocks, etc., which are important from the road-building aspect.

In the case of land acquisition, the photos and mosaics have been a big help. Hardly a day goes by that some person does not come in with land for sale. Descriptions of the property are vague and usually a tax slip gives the best information. In a matter of minutes, the parcel can be plotted and a fair estimate made of land conditions—enough to say whether we are interested or not. Without the pictures it would mean a trip for a "land examiner," and mileage costs for what too often amounts to a "wild goose chase."

In conclusion, we at Simpson feel that the aerial photographs have already paid their way. We are finding new time-saving uses for them right along, and with the investment written off we still have all the basic data available for further use.

NEWS NOTE

BAUSCH & LOMB ACQUIRES CHICAGO COMPANY

Acquisition of the Riggs Optical Company of Chicago, an affiliated distributor for many years, was announced April 21, 1950 by Bausch & Lomb Optical Company. The Chicago firm will be known as Bausch & Lomb Optical Company, Central Division, with headquarters at 18 South Michigan Avenue, Chicago. The new sales and service organization is designed to provide better customer service through a more centralized control of production, distribution and inventory activities.

Merger of two other Bausch & Lomb affiliates, the Colonial Optical Company, of New York City, and McIntire, Magee & Brown Optical Company of Philadelphia, to form Bausch & Lomb's Northeastern Division was announced last December. In October of 1948, another affiliate, the Riggs Optical Company of San Francisco, was merged to form Bausch & Lomb's Pacific Division.