THE APPLICATION OF PHOTOGRAMMETRY TO FORESTRY*

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IT HAS been said that "nothing is quite so difficult as an explanation of the obvious." But, that is what is necessary in this instance, for there is nothing technical in the correlation or the application of the uses of aerial maps to the practice of forestry. For the most part, it is elementary: the only requisite being a knowledge of the forester's problems and a realization of the advantages and limitations of aerial maps.

During the course of this paper, I shall refer to different forms of aerial maps. So that there will be no misunderstanding, I should like to briefly explain these maps and their uses at the outset.

First, I have in hand the more or less standard 7 by 9 inch contact print of the photographed area. It is scaled at 1:20,000 and is satisfactory for all general purposes at that scale. These photographs are used for detailed study of all forest areas.

From the assembly of the 7 by 9 prints, we form two different maps: the county index map which is used only as a guide to the position and number of the contact prints, and whose scale is as small as possible without losing the photo numbers and all detail, and the fractional county map which is composed of 7 by 9 prints which have been rectified to correct for any tilt and change in scale, and then assembled by mechanical means into a precise map. These fractional county maps make the best general map for the forester—they may be reduced or enlarged to meet the needs of the particular unit, and in most cases eight fractional county maps will be needed to cover a county of 1,000 square miles assuming a scale of 1:32,000 to 1:20,000 is desired.

The only other equipment necessary for using aerial photographs and photographic maps is a hand stereoscope and standard drafting materials.

Aerial photographic maps find a great use in forestry when applied to the preliminary inspection of any forest unit. Determining the spots for fire towers and lookouts becomes a simple matter when suitable control exists in the form of USC&GS, USGS and USED bench marks, and the photographs are contoured accurately. From observation the highest points in the unit are located, and by closer observation with a stereoscope the points narrowed down so that with a small amount of field survey work, the tower locations may be selected with accuracy. The planning of roads, trails, and fire lanes are facilitated and probably half of the expense of extensive surveying is eliminated. They are invaluable in determining the acreage in timber, the area in pasture, under cultivation, tax delinquent, submarginal, and so on. It enables the forester to have a picture of his entire unit with reference to the area covered with vegetation—and without these photos, much time is spent in covering the unit to obtain just this information.

With photographic maps he has a base sheet with which he may record ownership and assessed valuation of all the land in his unit. In this connection, it is suggested that an overlay be made for the fractional county maps, and the ownership of the various tracts be numbered and placed thereon. The overlay then acts as a key to the file of general information assembled for each owner's tract. This to help in recording fire reports and for valuation purposes.

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With a minimum of time in the field, he may determine the location and number of all houses and farms in the unit, the extent of power and telephone lines, and the exceedingly important knowledge of all trails, and the classification of roads. With only a preliminary study of his photographs, he can divide his unit into their forest types, that is, softwoods, hardwoods, mixed hardwoods, etc., and determine the percentage of each. This is all information necessary for the records of any district forester or lumber company, and requires considerable time and expense to collect. However, with aerial maps this material is collected in the office with a minimum of effort thereby eliminating much costly ground survey and cruises.

Another important use of aerial maps to the forester is in fire prevention. Aerial photographs give a clear picture of the wealth of any area measured in its forests. Individuals or groups who disregard fire prevention posters and literature, are as interested in photographs of their communities as you and I, and explanations and illustrated talks with photographs, both the plain verticals and motion picture, have proved extremely effective in developing the relations of the forester with the public and in forest education in the schools. When individuals realize that the forester has pictures of their property close at hand, they tend to be more restrained in their actions, particularly regarding burning brush and setting fires.

In addition, the district ranger or forester finds the photographs of great use in fire prevention because the forest types are clearly shown. During the fire seasons they may know definitely their areas of greatest hazard since they can distinguish from the photographs the area in dry pasture, in thick brush, the areas through which travel is greatest and where campers, hunters and fishermen are apt to be. This knowledge saves a considerable amount in forest burning thru the prevention of fires by realizing the areas of greatest fire hazard.

Probably the greatest single use aerial maps have in forestry lies in fire detection and suppression work. Fractional county maps at a 1:32,000 scale should be standard equipment in every fire tower. These maps should cover the entire range of the area covered by any lookout, so that in spotting a fire or smoke, the lookout may have information regarding the terrain and the type in which the fire is burning. Where the lookout must fight his own fires, the aerial maps show accurately and clearly all roads, trails, all lakes and streams, and hills and valleys that he can put to use in traveling to and suppressing the fire.

In the dispatch office, fractional county maps at 1:20,000 of the entire forest district should be on hand. The dispatcher then, by cross shots from adjacent towers, may plot on the aerial photographic map the exact position of any fire, and from this photograph determine the forest type in which the fire is burning. That is, whether it is in pasture, scrub timber, or heavy forest. Also important to the dispatcher is a knowledge of the terrain or topography of the area that is fired. If the fire is sweeping up a watershed or hill, or if it is creeping down hill, whether there are natural barriers to the progress of the fire, whether there is water in the vicinity, whether pack trails must be used or whether the roads are such that automobiles may go into the area. Knowledge of the best and quickest route the suppression crew must take to reach the fire is noted, and the amount of equipment and the number of men necessary to fight the fire can accurately be figured when all this information is tabulated. Thus we see that aerial maps in almost all instances save valuable time when fires are reported. Guess work in the dispatch office as regards fire position, forest type in burning areas, topography of the area, and quickest route to the fire is hardly justified when aerial maps are used in the fire dispatcher's office. A gain of 10 minutes time in reaching

a fire of any consequence can easily save many times over the cost of aerial maps and these maps can be made a great time-saver.

In the district forester's office, it becomes an easy matter to establish the acreage burned, and if low percentage cruises have been made in the unit prior to the fire, the valuation of the burned area can be reached in short order.

The ownership of the land and the number of previous fires over the land has already been recorded during the unit inspection and with this information, mop-up and post inspection of the fire becomes only a matter of detail.

Finally, we should mention the uses of aerial photographs in the work of timber estimation and forest valuation.

The use of aerial maps in this phase of forest work has developed slowly, principally in former years because of the cost. However, with enormous areas of our country photographed by various government agencies during the past few years, and now available to the public and state at a nominal cost, this factor can be disregarded in many instances. Indeed, the cost of the original photography has decreased to such an extent in the past few years that this cost is not prohibitive to their use even in economical forest operations. The greatest cause at present for this slow development is in the absence of elementary literature and statistics on the subject.

Mr. F. R. Wilcox of the Canadian International Paper Company has figures showing the comparison in labor costs in cruising forest areas with and without aerial photographs. These figures are based on a cruise of 1%, and on original photography for the unit.

Class of Work	*Man Days Required*	
	With Photos	*Without Photos*
Preliminary office	$ .23	—
Cruising	1.33	$ 2.15
Base lines	—	2.80
Exploring	.25	.19
Field office	1.02	.52
Miscellaneous	.72	2.21
Final office	.11	3.46
Man days for each 1% of estimate	3.66	11.33
Labor cost (@$3.00 per day average)	10.98	33.99
Percentage of labor of total cost	68.2%	74.6%
Total cost per sq. mi. per 1% of estimate	16.10	45.43
Cost of aerial photography and map	20.00	—
	$36.10	$45.43

Mr. Wilcox points out that this is a saving of $9.33 or 26% in a 1% timber estimate. These figures are accurate I am sure, though the savings should be greater at this time due to the lower cost of obtaining the aerial photographs. For areas where the photographs are obtainable from the government photographic laboratories, the savings will amount to 50 or 60%. It is safe to say then that if the cost of the estimate can be reduced by from 25 to 60%, a saving should result in the cost of the valuation of the forest through a similar procedure.

Briefly then, may I summarize the uses of aerial photographs which tend to reduce the costs of forest operations: first, in unit inspection for determining acreage in forest, ownership and valuation of land, road classifications, telephone and power lines, houses and farms, and forest types; second, fire prevention with particular reference to public relations and forest education, and to the district ranger and forester; third, fire detection and suppression, with their

great use and savings when furnished in the lookout tower, in the dispatch office, and in the district ranger's office. And finally, in timber estimation and forest valuation, where savings of 25 to 60% may be obtained through the use of aerial photographs.

Before closing, one more item should be taken up. That is the estimated cost of making these maps available to the foresters unit. Where aerial photographs may be supplied by the government photo laboratories, the following costs might prevail: all figures based on obtaining complete coverage for a typical county of 1000 square miles:

(1) County index map	1	@	$4.00	$ 4.00
(2) Fractional county maps	8	@	3.00	24.00
(3) Contact prints	600	@	.20	120.00
(4) Stereoscope	1	@	7.50	7.50
				$155.50

Approximately 16¢ per square mile. This figure will vary in nearly all cases, but the results should be between 15 and 20 cents per mile.