SURVEYS AND WORKING PLANS FOR OPERATING COMPANIES¹

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INTRODUCTION

This is a very broad subject and cannot be dealt with in much detail in a short paper. My remarks, therefore, will deal with the general requirements of a Working Plan and will show what type of survey can be used to supply the necessary information. The extent to which aerial photos can be used in this work will be stressed, with particular reference to the methods employed by the Forestry Department of Brompton Pulp and Paper Co. Ltd.

WORKING PLANS AND OPERATING PLANS

The greater part of our timber is owned by the Crown and is only under lease to the operating companies. The managers of this timber may be considered to be the Departments of Timber Management of the provinces or the Dominion, with the companies operating the limits for these owners through their managers. A Working Plan is thus required by the Crown managers so that they will know in what manner their limit is to be operated. The operating companies also require a Working Plan for the same reason and to show how much wood the limit will yield throughout the first and succeeding rotations.

The various governments require specific information in their Working Plans. The companies must supply this and in addition may require additional data for their operations. Therefore, the surveys should be made and the data compiled in such a manner that both the government and the companies will obtain maximum information at minimum cost.

A Working Plan essentially shows how much wood a limit now carries, the allowable annual cut over a period of years, and the probable inventory at various periods during and at the end of one or more rotations. It also must show where the wood is to be cut each year, or period of years, in order to ensure the success of the plan. All major data included in a Working Plan are therefore used as a basis for calculating the above-mentioned information.

The Working Plan proper deals with the question of inventory, rotations, allowable cut, etc., and indicates the general order of cutting. Operating Plans are often made separately from the Working Plan and show in detail the areas to be cut each year, accompanied by necessary data. This paper will discuss separately the surveys required for these two types of plans.

MAJOR DATA REQUIRED FOR WORKING PLAN

The important basic data required in connection with Working Plans may be summarized as follows:

1. Area classification of limit into productive, non-productive and waste areas.

¹ Paper presented at the fortieth annual meeting of the Canadian Society of Forest Engineers, Fredericton, N.B., October 4 to 7, 1948.

2. Inventory of existing stands by value and species for various types.
3. Classification of stands into age classes.
4. Stand tables for each major type and age class showing distribution of diameters for each species.
5. Growth Study data with yield tables for different site-types.
6. Regeneration data indicating degree of stocking in stands reproducing after being cut-over or burned, and species distribution.

There are, of course, various other data included in a Working Plan, but the above provides the basis for the essential part of the plan.

PROCEDURE FOR OBTAINING DATA FOR WORKING PLAN

Our Company has attempted to make full use of aerial photographs in our surveys. Vertical photographs at a scale of 1" = 20 chs. have been used. Ground surveys have been a necessary adjunct of the aerial photo interpretation, but they have been considered more as an aid to the photos rather than the reverse. The outline which follows will show our general method of obtaining maps and volumetric estimates using aerial photographs in combination with ground surveys.

On the photos are marked in sequence—photo centres and tie points (where required) type boundaries and classification, topographical features. A base map is purchased if available; if not we make our own using the slotted templet method. Photo data are transferred to the base map using a Sketch-master (a Duoscope was used originally). The map is then traced and the type areas measured using the dot system. The areas are recorded and the volume of the mature stands computed using the average cordage figures obtained by ground crew sampling. Summaries of area and volume can then be made for each compartment, map sheet, water-shed, limit or for any desired unit.

The system of types used will not be explained in detail here, as I believe this subject will be dealt with in another paper to be presented at this meeting. Also, Reg Loomis who originated this method at Brompton has written a paper on the subject.

In general our *type classification* is based on cover types, tree height, stand density, species distribution and age class. To date we have encountered some 90 sub-types, exclusive of young stands, representing various combinations of these factors. The characteristics are largely determined from the photographs with occasional ground checks.

In order to determine volume, sample plots are taken in the various types by ground crews and average cordage figures and diameter distribution obtained for each sub-type. Rectangular plots five chains by one-half chain are used. Plot locations are selected from the photographs and so placed as to be representative of all the type area. The plots are located in the field by reference to topographic features visible on the photo. Plots represent 1 per cent or less of the area of the types sampled. Over a whole limit certain representative areas are selected for sampling and then these results are applied to the whole area. This represents approximately .07 per cent cruise or less than 1/10 of 1 per cent. This may sound very low but with the detailed

system of typing used it apparently is more accurate than a more intensive cruise where broad types, or no types at all, are used.

Classification of area can be done to a large extent from aerial photos. Waste areas such as swamp, barren, exposed rock, cut-over and burn are, of course, easily distinguished. Sandy plains are often discernible from the photos, as are spruce flats and slopes. The stand composition usually gives a good indication of the soil, especially when compared with field examination. Steep, rocky slopes and other "non-operable" areas can be delineated under the stereoscope. Thus, the aerial photos can be used to a large extent to classify the areas into productive, non-productive and waste.

Broad *age classes* can be fairly well determined from the photos if it be assumed that height is proportional to age for a given site class. Occasionally, of course, some stands are encountered which have been suppressed for long periods and although of mature age they would be classified as immature stands from the photos. But as these have not reached "merchantable maturity", the error is more technical than actual. Growth studies are required in order to determine the age at which various stands reach maturity, also merchantability and corresponding heights and diameters. This can be done in conjunction with the volume cruise. On this basis we have divided the age classes into five classes—zero to one-third maturity, one-third to two-thirds maturity, two-thirds maturity to maturity, mature stands, overmature stands. Overmature stands can't always be detected from the photos, but open stands with many tall trees, two-storey stands, etc. are usually an indication. The use of obliques would be useful in judging these stands. Age classes of young stands are based on the height of the stand.

Growth Studies are required in order to produce Yield Curves and Tables. Permanent plots are the best medium for studying growth and we have established about 150 plots this year, with more planned for next year. This is being done in coöperation with the Dominion Forest Service, using their forms. The Stand Density Index system will be used with remeasurement being made after five years and possibly in succeeding five-year periods. This will indicate what happens to stands in various types. For a preliminary Working Plan, such a system cannot be used because of the time element. What we have done is to measure the age and yield of several plots in different age classes in the various types. The results are plotted and yield curves drawn for the different site-types encountered. This indicates what yield can be expected from undisturbed stands, and when each type of stand is best cut. These results will later be checked by the permanent sample plot study.

Regeneration Surveys are valuable for indicating the degree of stocking of stands reproducing after cut-over and burn, the species coming in, and the period between the disturbance and the establishment of the seedlings. These must be ground surveys, but areas are selected for possible aerial photos thus saving much needless exploration. We carried out a survey using the same forms and system as were developed by the Dominion Forest Service.

The results of the survey are used in conjunction with the growth study to fix the rotation age and to predict the type of stands which will be available

for cutting during the second rotation. Only an estimate can be made but the regeneration survey is a valuable basis on which to predict the future crop.

SURVEYS REQUIRED FOR OPERATING PLANS

An operating plan for a watershed or block will include the following data:

1. Area, volume by species and product, and estimated average annual cut from the operating area.
2. Stand tables for operable stands for each camp area.
3. Camp location and cutting area.
4. Tote road and main haul road location.
5. River improvements—(dams, side piers, etc.)

Aerial photos can be used in connection with all these items, with the possible exception of stand tables. The same maps and types are used as for inventory purposes. More plots must be taken and the types are checked and corrected where necessary. We have used a 1 per cent cruise or less and the estimates have averaged within 5 per cent of the actual cut. Even applying our inventory cordage figures, without additional plots, our estimate has been just as close in many instances. This is particularly true of the spruce stands, while in the mixedwood stands there is often considerable variation between stands in the same sub-type. The use of low obliques would probably reduce still further the ground work required.

Cutting areas can be layed out from the maps and the aerial photos, using natural boundaries where possible which are quite evident on the photos. The approximate camp location can be chosen by referring to the map and photos, although the exact location may differ slightly due to soil conditions and ground irregularities not discernible from the photos.

The general *location of truck roads* to camps and main haul roads can be layed out on the photos. Examination of the route on the ground is essential, especially for summer truck roads, but much needless exploration is eliminated by preliminary examination of the photos. Possible bridge sites can also be picked from the photographs.

The character of potential driving streams can be determined in a general way from the photos. Rapids, falls, deadwaters, false channels, low banks, islands, shallow areas in lakes, are all readily discernible on the photos. Possible damsites can also be determined. Ground examination is also required but the field work is substantially reduced.

REVISION OF MAPS AND ESTIMATES

A forest stand is not static and thus any inventory is theoretically obsolete the day after it is made. A running inventory of the remaining stand is essential and disturbances but cut, fire, wind, insects and fungi must be kept track of. Aerial surveys have a wide field of application in this connection.

We photograph our cut-over areas every year, using our own camera and a rented plane. A K-20 camera is used to take vertical photographs of the cuts at a scale of 20 chs. to the inch. We have found this more accurate and

cheaper than ground traversing of the cut-over areas. Burned areas are also photographed or sketched from the air. In the event of large blowdowns occurring, these can be easily photographed. It is also possible to sketch the extent of severe budworm attacks or other causes of defoliation, birch dieback etc., from the air.

INCREASED USES OF AERIAL SURVEYS

It is admitted that our company could make even more use of aerial photos than they are now doing. Volumetric measurement of stands is possible from the photos accompanied by limited ground correlation, and our efforts can be extended in this direction.

The use of low oblique photographs should provide a better means of identifying species and determining heights, stand density, volume and age classes. This type of photography may be of particular value for re-photographing areas for purposes of Working Plan revision.

New devices are being produced from time to time for measurement of various details on an aerial photograph. It can be expected that the use of some of the simpler of these will prove useful to company photogrammetrists in obtaining more accurate results and possibly reducing the field work required.

The helicopter no doubt has an application in survey work. To date the cost would appear too high for anything but specialized uses. However, the future may see the helicopter being used for close examination of stands from the air for a variety of purposes.

CONCLUSION

Forest management must of necessity change from high-sounding phrase, glibly uttered by high dignitaries at public functions, to an actuality if our forests are to be put on a sustained yield basis. The factors involved are legion, but not the least of these are the surveys required for preparation of a practical Working Plan. The data so collected form the foundation of any management plan. Few of us can expect to see the final results of any plan we may formulate, but we should keep in mind that the surveys and plans we make today affect the forests of tomorrow.