forest inventories

Forest inventories incorporate studies of the distribution of tree species and tree densities in forest stands, together with a determination of the quality and size (height, top diameter, diameter at breast height (DBH), basal area etc.) of representative trees. One of the aims of a forest inventory is the establishment of standard tree volume tables which give cubic content — the volume of marketable timber available in a given area. Armed with this knowledge, specialists in forest management plan experiments involving the thinning and spacing of trees to ensure optimal growth. They can detect the stunting effect of competition or disease on valuable species and take remedial action. Most important, forest managers can plan the exploitation of a given stand keeping its future development and subsequent regeneration uppermost in mind. Lastly, through close analysis of these data, the most economic use of labor, logging equipment and forest-based industries can be projected.

Large-scale aerial photography caught the attention of forest managers only about 10 years ago. Before that surveyors hauled dendrometers of various kinds on treks through dense forest to measure individual trees. At most they covered small areas usually at the periphery of a forest where access was easiest. Despite the advent of snowmobiles, seaplanes and helicopters, much of the drudgery and expense of ground sampling methods persisted.

Aerial photographs of forests were initially used to help forest inventory-takers to find their location and to plan their itinerary on the ground. Later they were used to assist in the production of topographical, hydrographic and route maps.

One obstacle, however, prevented forest managers from applying aerial photographs to forest inventory work. Photographs cannot be accurately related to forest areas unless their scale is established. This in turn cannot be determined without knowing the plane's altitude at the time the photographs were taken.

The development of the NRC radar altimeter provides an accurate, simple, rapid and convenient method for solving this problem. Lightweight, easily installed on an aircraft and versatile, the radar altimeter gives an accurate reading of the distance between an aircraft and actual ground level. The radar signal penetrates all intervening vegetation. In contrast to previous altimeters, no radar pulses are reflected from forest cover and therefore no inaccuracy in height is introduced. At its upper range of 2,300 to 3,800 feet, the altimeter functions accurately even over rough terrain with extreme slopes surpassing 40 per cent.

The antenna of the altimeter is mounted on the underside of the aircraft. Each radar pulse reflected from the ground is converted into voltage which is proportional to the distance the pulse travels to the ground and back. This voltage, converted into a height reading in feet is displayed on a digital meter placed beside an aerial camera. By means of a special lens system the height reading appears on the edge of each photograph of the forest below. The photographs, taken with 60 per cent overlap and viewed stereoscopically can yield information on the quantity and kinds of trees and on tree height and crown diameter over areas of known size.

Both private industry and university are cooperating with René Rinfret, Director of the Forest Inventory Service of the Quebec Department of Lands and Forests, and his staff in Quebec's large-scale forest inventory program. La compagnie Hauts-Monts, whose president, W. F. Grenier, was one of the first to realize the advantages of applying aerial photography to forest inventory work, is responsible for the camera work and altimeter readings. Photointerpreters under Dr. Gilles Ladouceur of the Department of Photogrammetry at Laval University, Quebec City, will aid in compiling volume tables and other information from the photographs.

The inventory program will cover all 400,000 square miles of forest in Quebec, some 275,000 square miles of it commercial timberland. The forested area of Quebec will be divided into 30 regions, three being investigated each year. This year the inventory will focus on the Eastern Townships from Charlevoix and Eastman to just east of James Bay. Photographic work will also start this year for inventories in 1971 in the lower Gatineau and Mistassini regions.

Trials conducted over square one-tenth acre plots in black spruce-fir stands have been eminently successful. The areas were photographed with a camera with a focal length of 24 inches (610 millimeters) installed on a twin-engine aircraft and coupled to the radar altimeter. The plane at a height of approximately 1,500 feet was put on automatic pilot. From photographs measuring nine inches by nine inches and scaled 66 feet to the inch, tree heights were stereoscopically determined and results for 50 foot trees differed on the average from field measurements by less than 5 per cent. The total census of merchantable timber (DBH exceeding four inches) as derived from the photographs was only slightly below that obtained from ground measurements.

"These tests conclusively show the potential of the NRC radar altimeter with aerial photography for forest inventory programs," Mr. Rinfret says.

Mr. Rinfret and Dr. Ladouceur point out that these excellent results have been obtained from a method still under development. With further refinements they expect that average height measurements from photographs could come within two per cent of ground measurements. In addition, they expect that the slight error in tree census studies will shrink still more.

The NRC radar altimeter's impact on forest inventories can be summed up as follows: Once the aerial photographs are available, work on accurately evaluating forest stands in Quebec can continue 24 hours a day if necessary. Key areas can be sampled more intensively and the data checked and rechecked — all in the relative comfort of the laboratory. *S/D*