Resource Inventory Notes

BLM-3 January 1977

INVENTORYING THE URBAN FOREST

By: James R. Geiger 1/

ABSTRACT

Wood utilization alternatives are currently being investigated in the city of Chicago. Analysis of available resources, i.e., waste wood resulting from diseased and/or storm-damaged trees, will determine optimum marketability. A phase of the project was to isolate the forested areas of the city. The city was divided into 10-acre plots which were classified photogrammetrically into forested and treeless plots. Further subsampling will be used to determine volumes and growth on the forested areas.

INTRODUCTION

The Chicago Bureau of Forestry, Parkways and Beautification is charged with the establishment, protection, maintenance, and replacement of trees that are present in the public ways, parkways and medians. The responsibility encompasses 218 square miles, 3,800 miles of streets and approximately 600,000 trees at a stocking density of 4.3 trees per acre or 21 trees per block. Removals presently average one (1) tree per block or 28,000 trees per year. This amounts to approximately 4,000,000 cubic feet or 100,000 tons of wood fiber. Prior to intervention by the Environmental Protection Agency, tree debris was eliminated by open burning. It was simple and inexpensive. Alternative use of land fills and air curtain destruction proved effective but was expensive and only a short term or limited solution. It soon became evident that the program needed a shift from one of disposal to one of wood fiber recovery to develop a long-term solution to the problem that would be acceptable to environmentalists and economists. One solution may be to engage in a wood utilization program in the metropolitan area.

Basic to the project is an assessment of resource availability to answer the questions:

1/ Project Director, City of Chicago, Bureau of Forestry, Parkways and Beautification, Chicago, Illinois. Paper presented at the Forest Products Research Society Annual Meeting, Toronto, Ontario, 1976.

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Denver, Colorado, 80225

- *What can be supplied to the existing markets?*
- *How much can be supplied the markets?*
- *How long can the markets be supplied?*
- *Will the resource supply several markets or only one market?*

When availability has been defined and proven, potential markets can consider purchasing options and substitution possibilities. Without an idea of availability, it will be difficult to obtain a long-term commitment from the markets.

To answer the availability question in Chicago, it is necessary to know:

1. *Area of forested land.*
2. *Gross cubic foot volume of trees expected to be removed in the next ten years, i.e., trees causing maintenance problems or hazardous situations.*
3. *Estimate of growht,*

The answers to these questions will provide the necessary data to accurately assess what is presently available and what can be expected to be present for the duration of a utilization system.

AREA INVENTORY

Analysis began with two basic assumptions:

1. *Homogenous population existed, i.e., that the forest is the same in the north part of the city as it is in the south.*
2. *Distinct boundaries existed or could be defined, i.e., distinct city limits and distinct plot boundaries.*

The first step in the area inventory was to identify sample units. Chicago is mapped on a system of grids or quarter sections of 160 acres each. Each quarter section is divided into 32 five-acre blocks. The inventory design described the most convenient sample unit as a subgrid or two five-acre blocks. Subgrids were either rectangular or various irregular shapes, but all were one-sixteenth of a quarter section or ten (10) acres. (Refer to Figure 1). The subgrids or sample units were located on aerial photos, maps and on the ground.

The next step was to photogrammetrically stratify the subgrids into treeless or forested categories.

Aerial photographs utilized had a scale of 1:250. Resolution would not allow detection of small crowns, i.e., trees with less than one cubic foot solid wood. These trees represent an insignificant portion of future wood fiber and were disregarded. The photo survey was only concerned with street trees. Parks, forest preserves, and privately owned trees were considered to be treeless areas. They were not included in the initial resource assessment but will be part of the final analysis of available resources in Metropolitan

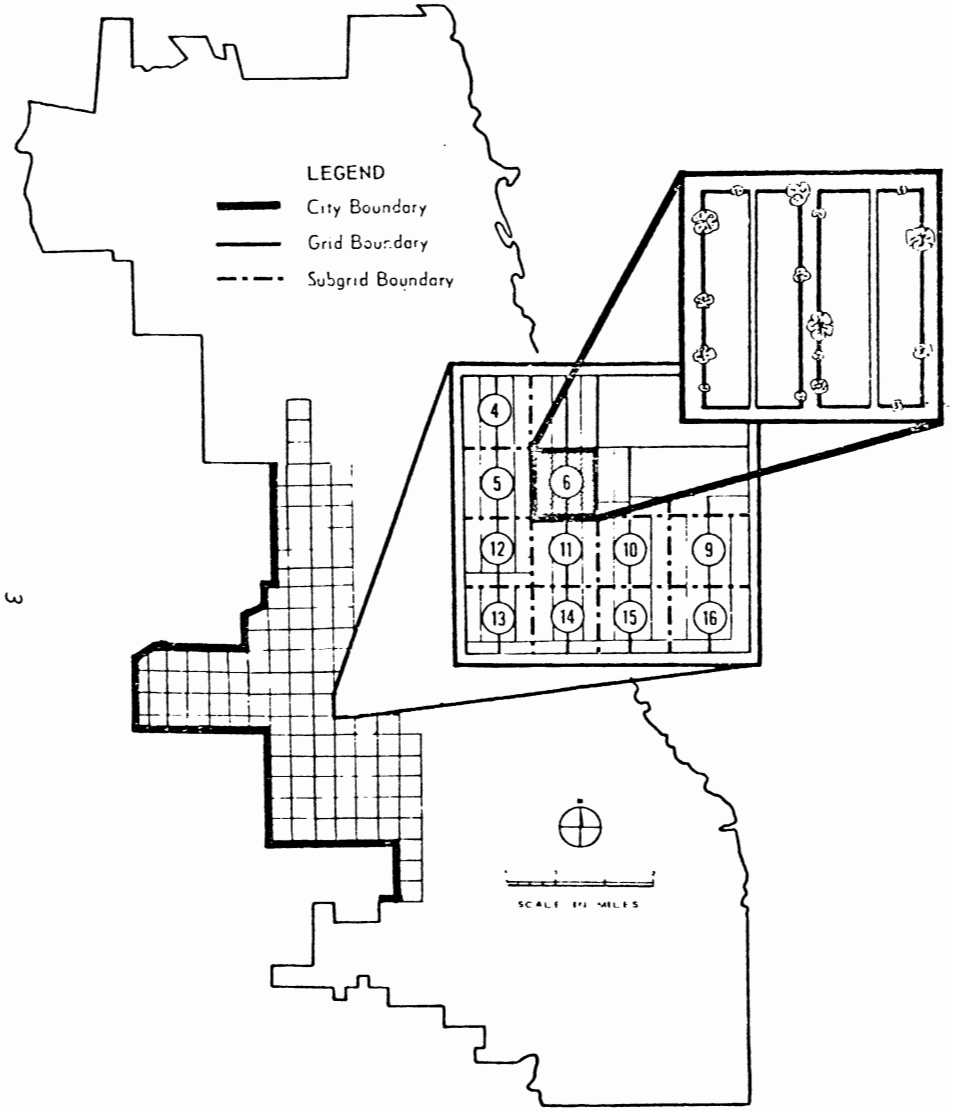

Figure 1. Subgrid or Sample Unit Identification as a 10 acre unit, 1/16 of a quarter section.

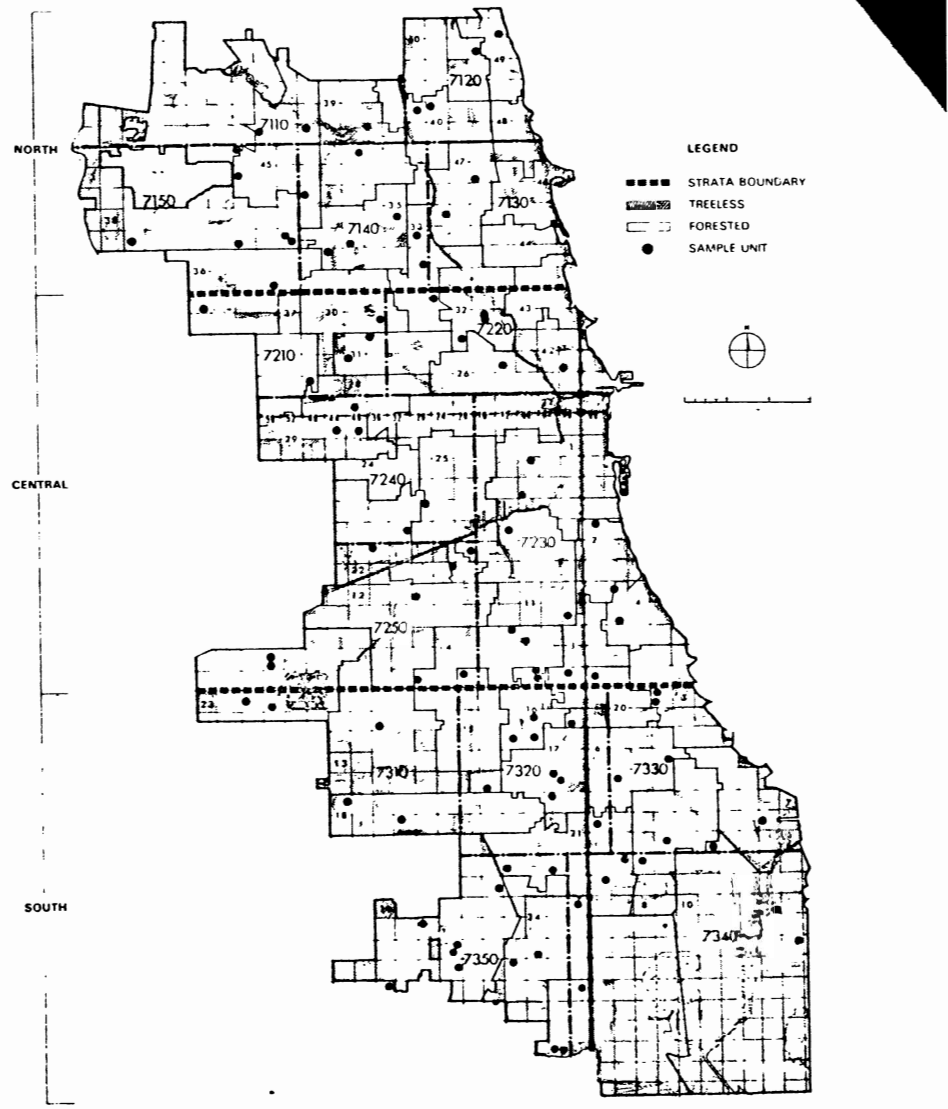

Figure 2. Treeless Areas, Forested Areas, and Sample Plot distribution, Chicago, Illinois, 1976.

Chicago. A treeless subgrid was defined as a subgrid with less than three street trees. Industrial-commercial, recreational, and all major transportation corridors predominated the treeless category. Virtually all residential areas were forested. Treeless subgrids represented 33% of the city or 47,000 acres. Forested subgrids represented 93,120 acres of 67% of the total area of the City (Refer to Figure 2).

VOLUME SAMPLING

In order to determine the sampling intensity needed for volume estimates, it was necessary to take a minimum number of randomly selected trial plots.

Irregular City boundaries would not permit unbiased random selection of sample units. A regular universe was necessary to give each subgrid equal probability of being selected as a sample unit. Irregular City boundaries were compensated for by delineation of a rectangular grid pattern enclosing the largest strata of the City. This universe included grids outside the City limits and was used separately in each strata for sample unit selection.

The universe was defined as X = 28, Y = 20, S = 16, where

X = Grid West, Y = Grid North, S = Subgrid within Grid XY

Three management areas, North, Central, and South, provided a convenient method of stratification to reduce sampling intensity. Each management area or strata operates independently, and stratified data collection will provide unique information about each area.

One hundred (100) subgrids were randomly selected from the universe in each strata, i.e., North, Central and South. Random number tables were used to obtain three two-digit numbers to select the subgrid. The selection subgrids were then categorized as outside City limits, treeless, or forested. Only forested subgrids were accepted as sampling units (Figure 2).

A subsample of 10 forested plots were randomly selected in each strata. The random selection of only forested units reduced anticipated plot variability and decreased sampling intensity. These plots were visited in the field. The sum of the diameters of each plot was used to obtain variance and standard deviation. The following data is applicable to each strata:

Strata	Forested Area	Mean Total Diameter	Standard Deviation of Total Diameter
North	27,370	515	360
Central	31,530	433	331
South	34,220	475	232

The overall coefficient of variation was 64%. If a total of 100 field plots were established in the City, an overall sampling error of 6.5% at one standard deviation may be expected.

The City of Chicago is now in the process of measuring these plots.

SUMMARY

The completed area inventory and future estimates of gross cubic foot volume of trees expected to be removed in the next ten (10) years will allow compilation of volume tables applicable to Metropolitan Chicago. This will standardize assessment of park, forest preserve, private, and suburban trees. Projections can then be made and a determination of resource availability established. With a knowledge of resource availability in Metropolitan Chicago, markets can be intelligently approached and salable products determined. Once products are determined, a wood utilization system can be designed and feasibility of implementation studied.

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CURRENT LITERATURE

FORESTRY

The following publications are available from the Forest Management Institute, Department of the Environment, Majestic Bldg., 396 Cooper Street, Ottawa, Ontario, Canada:

- *"Can Tropical Forest Inventories Benefit from Recent Development in Aerial Photography" by Nielsen and Aldred*
- *"Automation of Thematic Mapping Based on Remote Sensing and Computerized Image Interpretation" by Kalensky*
- *"Accuracy of Forest Mapping from Landsat Computer Campatible Tapes" by Kalensky and Scherk*
- *"Automatic Forest Mapping Using Remotely Sensed Data" by Kalensky and Wightman*
- *"Spectral Signatures of Forest Trees" by Kalensky and Wilson*
- *"Environmental Monitoring: The Role of Remote Sensing" by Sayn-Wittgenstein and Aldred*

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Res. Paper INT-183, "Assessing the Timber Resource Situation on a Working Circle Using Inventory Data"; Res. Note INT-207, "Number of Plots Required for Measuring Productivity on Mountain Grasslands in Montana"; and Res. Note INT-208, "Forest Area and Timber Volume Statistics for Western South Dakota", can be ordered from the Intermountain Forest and Range Experiment Station, 507 25th Street, Ogden, Utah 84401.

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Copies of "Bayesian Estimation Methodology for Forest Inventory" by Ek and Issos are available upon request from Department of Forestry, School of Natural Resources, Russell Laboratories, 1630 Linden Drive, University of Wisconsin, Madison, Wisconsin 53706.

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Res. Bull. PNW-66, "Timber Resources of Douglas County, Oregon," by Colin Maclean is available from the Pacific Northwest Forest and Range Experiment Station, P.O. Box 3141, Portland, Oregon 97208. The report summarizes the 1973 timber inventory of the county. Also ask for Gen Tech. Report PNW-46, "Northwest Plant Names and Symbols for Ecosystem Inventory and Analysis".

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"Forest Assessment" by D. Heinsdijte, 1976, can be purchased from International Scholarly Book Service, Inc., P.O. Box 555, Forest Grove, Oregon 97116 for $29.50. Also available is "Soil Mapping by Color Aerial Photography" by M. S. Simakova, 1964, for $6.50.

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Purdue University Research Bulletin No. 934, "Line Sampling for Forest Inventory", 1976, by Beers and Miller, provides background, guidelines, formulas, and research results for accurate, intelligent, and efficient application of horizontal and vertical line sampling. This bulletin is a companion piece to Beers and Miller's two bulletins on horizontal point sampling (Purdue University Research Bulletins 786 and 808). Obtain your copy from Mailing Room, Purdue University Agricultural Experiment Station, Agricultural Administration Building, West Lafayette, Indiana 47907.

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"3-P Cruising" is a manual designed to assist the technician or practicing forester in learning the basic concepts, field procedure, data calculations and advantages and disadvantages of 3P cruising. Copies are available from Tom Hicks, Central Oregon Community College, College Way, Bend, Oregon 97701.

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Copies of a report on "Computer Programs for Forest Management Planning and Small Ownerships" by Jim Space, Bill Balmer and Gyde Lund are available from the U.S. Forest Service, State and Private Forestry, Washington, D.C. 20250. Thirteen inventory processing and financial analysis programs are discussed.

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WILDLIFE

Guidelines and standards for conducting transect and ocular aquatic habitat surveys are available in Tech. Note 283, "Techniques for Conducting Stream Habitat Survey on National Resource Land," by Duff and Cooper. Drop us a line and we'll send you a copy.

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FWS 4-75, "Recreational Fisheries Management and Ecosystem Modeling," is available from the Division of Forestry and Wildlife Resources, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061.

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RECREATION

"Measuring Scenic Beauty: The Scenic Beauty Estimation Method", by Daniel and Booster is available from the Rocky Mountain Forest and Range Experiment Station, 240 West Prospect Street, Fort Collins, Colorado 80521. Ask for Research Paper RM 167-FR8.

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Order Res. Paper NC-49, "Wilderness Ecology: A Method of Sampling and Summarizing Data for Plant Community Classification", from North Central Forest Experiment Station, Fowell Avenue, St. Paul, Minnesota 55101.

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REMOTE SENSING

LARS Information Note 060176, "Computer-Aided Analysis of Skylab Scanner Data for Land Use Mapping, Forestry and Water Resource Applications"; Information Note 062276, "Techniques and Applications for Computer-Aided Analysis of Multispectral Scanner Data"; and "Remote Sensing of Agriculture, Earth Resources, and Man's Environment" may be ordered from L.A.R.S., Purdue University, 1220 Potter Drive, West Lafayette, Indiana 47906.

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"Studying the Earth from Space", (25¢), is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20244.

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"The EROS Data Center - Its Activities and Services" can be obtained from the U.S. Geological Survey, Branch of Distribution, 1200 South Eads Street, Arlington, Virginia 22202. The classic "A Land Use and Land Cover Classification System for Use with Remote Sensor Data" (1976) may be purchased for 75¢ from the same address.

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"The Usefulness of Skylab/EREP X-190 and S-192 Imagery in Multistage Forest Surveys" by Langley and Van Roessel can be purchased from NTIS, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, Virginia 22161. Ask for #76-10197, $6 - paper, $2.25 - microfiche.

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Res. Pap. PSW-113, "Evaluation of Skylab (EREP) for Forest and Rangeland Surveys" can be obtained from the Pacific Southwest Forest and Range Experiment Station, 1960 Addison Street, P.O. Box 245, Berkeley, California 94701.

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R-2752, "Rural Landscape Assessment - A Comparative Evaluation of High Platform Remote Sensors" is available from the Department of Landscape Architecture, Environmental Awareness Center, College of Agricultural and Life Sciences, University of Wisconsin, Madison, Wisconsis 53706, for $10.0(

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"An Introduction to Aerial Photography for Natural Resource Management" by David Paine may be purchased from the Oregon State University Bookstores, Inc., 97331. Write the Bookstore for the price.

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Coming Soon! The new third edition of "Interpretation of Aerial Photographs' by Thomas Eugene Avery. Write the Burgess Publishing Company, 7108 Ohms Lane Minneapolis, Minnesota 55435 for publication date and price.

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OTHER

Howell and Osborne have compiled "A Selected and Annotated Environmental Education Bibliography for Elementary, Secondary and Post-Secondary Schools.' Copies are available @ $3.25 each from: Dr. Jerry F. Howell, Jr., Director, Center for Environmental Studies, UPO 780, Morehead State University, Morehead, Kentucky 40351.

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2166 "Sampling Lawn and Garden Soils" is available for 10¢ from the Extensior Service, University of Wisconsin, Madison, Wisconsis 53706.

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"Soil Resource Inventory Handbook" by Garwin Carlson may be obtained from the Malheur National Forest, 139 NE Dayton Street, John Day, Oregon 97845.

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MEETINGS

The 43rd Annual Meeting of the American Society of Photogrammetry will be held in Washington D.C., February 27th - March 5, 1977. The theme is "Modern Land Data Systems - A National Objective".

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The 6th Annual Remote Sensing of Earth Resources Conference will be held March 28-30, 1977 at the University of Tennesses Space Institute, Tullahoma, Tennessee.

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Remote Sensing - The Fourth Canadian Symposium on Remote Sensing will be held May 16-18, 1977. Contact D. J. Kruus, Canada Centre on Remote Sensing, 2464 Sheffield Road, Ottawa, Ontario K1A 0E4 for details.

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REM-BLM-3
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Integrated Inventories - The "Integrated Inventories of Renewable Natural Resources" Workshop is now scheduled for January 9-12, 1978. This national meeting will be sponsored by the SAF Inventory Work Group and the University of Arizona, School of Renewable Natural Resources. We'll keep you posted as the program develops.

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Coming in 1978 - "National Forest Inventory: Why it is Needed and How to Best Conduct It." Sponsored by IUFRO Subject Groups S4.02 and S4.04 to be held in Bucharest, Romania, June 18-24, 1978. For further information contact Tiberius (Mike) Cunia, SUNY College of Environmental Science and Forestry, Syracuse, New York 13210, USA.

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MISCELLANEOUS

Comment by Alan R. Ek, Associate Professor, Department of Forestry, University of Wisconsin on "3P or Not 3P". (See Resource Inventory Notes BLM-1, September 1976).

"The article seems to imply that in many cases the 3P estimator is by far the most precise approach - at least in comparison to the implied simple expansion estimators for the random sample and systematic sample. While this is correct, it is important to mention other estimators that, like 3P, usually have much smaller sampling errors than the single expansion estimator. A linear regression or ratio of means estimate (based on Dbh^2, volume guesses or a similar concomitant variable) using random of systematic sampling could also have a much smaller variance than the simple expansion estimator. This would be likely if the sample size was greater than, say 10 trees.

"These estimators are biased, but like 3P the bias is small relative to the standard error. The real question is then of choosing among estimators that are all much more precise than the simple expansion estimator. It is easy to choose an estimator that is, say 10 times better than the simple expansion estimator. It is less important and more difficult to discriminate

among those that are all, say 8-10 times more efficient. For more background on this point see "A Comparison of Some Estimators in Forest Sampling" by Alan R. Ek in Forest Science 17 (1): 2-13, March 1971."

Thanks Alan, you brought up some good points!

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Do you know that Resource Inventory Notes are received at nearly 1300 addresses including over 220 in some 76 different countries? Got an inventory technique you want to tell the world about? Send it in to the "Notes".

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