INFO an item of interest
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Resource Inventory Notes

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A COMPUTER 3P GAME

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Probability proportional to prediction of size sampling (3P sampling) was introduced to foresters by Grosenbaugh (1) in 1963. Foresters using 3P sampling select a higher proportion of the larger and more valuable trees in a forest inventory than is selected in traditional techniques. The technique is capable of yielding more precise estimates of volume and value than most other sampling techniques.

The purpose of the 3P game is to give a quick introduction to the process of one-stage 3P sampling. The game is not a substitute for field experience. Since 3P sampling has been described in detail (1,2,3,4), we only briefly deal with the technique in illustrating our computer game.

Field Operations

Before examining the game, let's briefly review the field operations involved in applying 3P sampling to a small timber sale.

1. We mark each tree in the timber sale.

2. As each tree is marked and numbered, we make a quick prediction of the tree's cubic foot volume. (Other measures of size or value could be used.)

The authors are research associates and professor, respectively, Institute of Natural and Environmental Resources, University of New Hampshire. Published with the approval of the Director of New Hampshire Agriculture Experiment Station as Sci. Contribution No. 744.

3. Volume can be predicted by using a crutch table based on d.b.h., height, and Girard form class. We determine whether the tree is to be sampled for careful measurement by comparing the prediction with a computer generated random number. Grosenbaugh (1) and Space (3) give the procedures for estimating sample size and for determining the trees to be sampled.

4. We obtain precise measurements on the sample trees. These measurements can be taken by climbing each tree, felling each tree, or by the use of optical equipment.

We now have all the information required to estimate the total volume, the coefficient of variation, and the sample error for the timber sale.

Running the 3P Game

The computer game simulates those procedures used in actual field work. It is written in the BASIC computer language and is meant to be played on terminals.

The computer game has been developed for a small timber sale of 36 trees. These trees are chosen from the data bank of 100 trees, this being done so that each run will yield a different sale. We plan to sample 12 trees for careful, precise measurement, but by chance, we may not obtain exactly 12 sample trees as planned. The largest tree in the sale does not exceed 66 cubic feet of volume.

The following crutch table is given by the computer, if needed, to help estimate tree cubic volumes.

This is a Table of Cubic Volume for FORM Class 80

		HEIGHT		
DBH	:	40	60	80
	:			
9	:	8	11	15
12	:	13	19	25
15	:	20	29	35
18	:	29	42	56

The computer prints the d.b.h. (nearest inch), height (nearest 5 feet), and form class (nearest 5 percent). Based on this information, we make a quick estimate of volume and enter the estimate on the terminal beside the heading called PREDICTION. In the following example, we estimate 10 cubic feet of volume.

```
TREE 10   DBH = 9   HT. = 45   GFC = 80   PREDICTION = ? 10
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Now a random number is printed, and we compare the number with the prediction to decide if the tree must be sampled. If the random number is -999 or if the prediction is less than the random number, we do not sample the tree. If the prediction is equal to or greater than the random number, we sample the tree. In this case, a "YES" or "NO" is all that is required to answer the question, "SAMPLE TREE?" An example run of the program for three trees is shown below.

```
TREE 10   DBH = 9   HT. = 45   GFC = 80   PREDICTION = ? 10
        RANDOM NO. = 8      SAMPLE TREE   ?YES

TREE 11   DBH = 17   HT. = 80   GFC = 75   PREDICTION = ? 48
        RANDOM NO. = 57     SAMPLE TREE   ?NO

TREE 12   DBH = 17   HT. = 75   GFC = 85   PREDICTION = ? 50
        RANDOM NO. = 20     SAMPLE TREE    ?YES
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After the last tree is encountered, the computer prints a complete list of all 36 trees and gives the volume of the sample trees. A partial list of the printout, showing the tree volume for two of our nine sample trees, is as follows:

DBH	HT.	GFC	PREDICTION	RAN NO.	SAMPLE TREE	TREE VOL.
13	65	85	23	43	NO	
9	45	80	9	-999	NO	
10	50	85	13	-999	NO	
19	85	85	65	20	YES	65.6
12	50	75	15	10	YES	15.6
15	80	85	37	52	NO	
14	70	80	31	-999	NO	
12	50	70	14	30	NO	

Upon completion of the simulated field work, the computer prints a summary section for the run.

```
NO. OF SAMPLE TREES = 9
          3P VOLUME = 1145 + or - 109.9
    SUM PREDICTIONS = 1097
      COEF. OF VAR. = 12.2%
       SAMPLE ERROR =  4.1%

        TRUE VOLUME = 1113

SIMPLE RANDOM VALUE = 950 + or - 226.9
       SAMPLE ERROR = 10.7%
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The first entry in the printout is the number of trees sampled. By chance, we sampled 9 rather than the 12 trees we had planned to sample.

The 3P estimate of volume for the sale is given with a 95% confidence interval. We estimate a total volume of 1145 cubic feet with a 95% confidence interval of plus or minus 109.9 cubic feet. The sum of PREDICTIONS entry, 1097 cubic feet, is the total of all estimated volumes given the trees in the sale. The coefficient of variation for this sale, 12.2%, shows the variation in the sample based on the estimates. The sample error, 4.1%, shows the statistical precision of the inventory. The true volume, 1113 cubic feet, for this sale is also given for comparison.

A simple random sample of 12 trees was also taken (because we plan on sampling 12 trees by 3P) and its volume estimate with a 95% confidence interval is given. We estimate 950 cubic feet with a 95% confidence interval of plus or minus 226.9 cubic feet, and a sample error of 10.7%. Thus, in the example run, the 3P estimate of total volume was decidedly more precise than the simple random estimate.

A listing of the computer game can be obtained from the Institute of Natural and Environmental Resources, University of New Hampshire, Durham, N. H. 03824. The game is written in elementary BASIC to run on the IBM 360 Model 50 computer. Some minor changes might be required to run the game on other systems.

Literature Cited

1. Grosenbaugh, L.R. 1963. Some Suggestions for Better Sample-Tree Measurement. Proceedings, Society of American Foresters, Boston, Mass. 36-42.

2. Grosenbaugh, L.R. 1967. The Gains from Sample-Tree Selection with Unequal Probabilities. Journal of Forestry. 65:203-206.

3. Space, J.C. 1973. Three-P Cruise Your Next Timber Sale. The Consultant 18:64-68.

4. Space, J.C. 1973. 3-P Forest Inventory. State and Private Forestry - Southeastern Area. 55 pp.

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CURRENT LITERATURE

Forestry

"Forest Modeling and Inventory" is available from the Department of Forestry, School of Natural Resources, College of Agriculture and Life Sciences, University of Wisconsin at Madison, Wisconsin, 53706. This contains selected papers from the 1973 and 1974 meetings of the Midwest Mensurationists.

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FAO (Food and Agricultural Organization of the United Nations) has two new publications on Forest Inventory - "Manual of Forest Inventory with Special Reference to Mixed Tropical Forests" and "Report on the Second FAO/SIDA Training Course on Forest Inventory." Both texts provide a very complete treatment of the subject matter and would be of interest even in any area. The manual costs $7.50 and the training course, $10.95, including postage and handling. Both are available from UNIPUB, Box 433, Murray Hill Station, New York, N. Y., 10016.

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Two very excellent and complete texts on inventory and sampling are "Forest Inventory, Vol. I and Vol. II." These books were written by the German authors, F. Loetsch, F. Zohrer, and K. E. Haller. The English editions are quite costly but are a welcome addition to a library. For further information, write: BLV Verlagsgesellschaft, Munchen Bern Wien, Federal Republic of Germany.

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The Pacific Northwest Forest and Range Experiment Station, P. O. Box 3141, Portland, Oregon, 97208, has recently released several resource bulletins, including PNW-56, "Timber Resource Statistics for Oregon, January 1, 1973"; PNW-58, "Timber Resources and the Timber Economy of Okanogan County, Washington"; and PNW-59, "Timber Resource Statistics for the Fairbanks Block, Tanana Inventory Unit, Alaska, 1970". While you're writing to the PNW Station, ask for a copy of General Technical Report PNW-34 by Keith Hutchison and Jim LaBau. This report describes the timber inventory, harvesting, marketing, and trends of the forest ecosystem of Southeast Alaska.

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USDA Forest Service General Technical Report FPL-1 entitled, "A Collection of Log Rules", will be of interest to those involved in timber surveys. Frank Freese of the Forest Products Lab in Madison, Wisconsin, provides descriptions and comparisons of over 70 log rules in this booklet. This publication is for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C., 20402, as Stock #0101-00367.

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Ralph Nyland and Jean Fisher give "Short-Cut Prism Estimates of Cordwood Successful in Pole Hardwoods" in Research Note No. 19. Write Applied Forestry Research Institute, State University of New York, Syracuse, N. Y., 13210. While writing AFRI, ask for a copy of Research Report No. 25, "Forest Resource and Wood-Using Industries of the Catskill Region", by H. W. Burry and J. E. Fisher.

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Mike Bonnor describes "Cluster Sampling with Large-Scale Aerial Photography in Forest Inventories" in Information Report FMR-X-80. Mike presents a sampling design in which large-scale aerial photos provide a major source of inventory data. Copies of this report may be obtained from the Forest Management Institute, Canadian Forestry Service, 396 Cooper Street, Ottawa, K1A 0W2, Ontario.

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The North Central Forest Experiment Station, Folwell Avenue, St. Paul, Minn., 55101, has just released Resource Note NC-195, "Forest Area in Iowa Counties, 1974", by Burt Essex. This note lists the commercial forest land and noncommercial forest land acreage for each Iowa county, based on the 1974 forest survey.

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Another publication from the North Central Forest Experiment Station that will be of interest is Research Paper NC-82, entitled "Improve Forest Inventory with Access Data -- Measure Transport Distance and Cost to Market", by Dennis Bradley. The technique outlined is ideal for a stratified double sampling design. By the way, the Bureau of Land Management is exploring Bradley's procedure in an inventory in Idaho.

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Resource Bulletin NE-39, "The Forest Land-Owners of New Jersey", by Neal Kingsley, describes the results of a mail canvass conducted in conjunction with the second forest survey of the State. The appendix contains the procedure for conducting such a survey.

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James A. Johnson and Gary L. Willis give the results of a test in "Estimating Form Class in Standing Trees" in Research Note No. 14. This is available from Michigan Technological University, Ford Forestry Center, L'Anse, Michigan, 49946.

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Recreation

Want a good example of a recreation inventory system? Write the U. S. Forest Service, Northern Region, Federal Building, Missoula, Montana, 59801, and ask for a copy of R-1 74 006, "Recreation Opportunity Inventory and Evaluation". It's an excellent publication and a welcome addition to any inventory specialist's library.

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Another publication that you may be interested in is No. R-74-1, entitled "Perception and Measurement of Scenic Resources in the Southern Connecticut River Valley". The publication is available from the Institute for Man and his Environment, University of Massachusetts, Amherst, Mass., 01002.

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P. A. Murtha and M. Greco have assembled Information Report FMR-X-79, "Appraisal of Forest Aesthetic Values: An Annotated Bibliography". This report is available from the Forest Management Institute, Canadian Forestry Service, Department of the Environment, Ottawa, K1A 0H3, Ontario.

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Remote Sensing

Novices in remote sensing will want to get a copy of Publication No. 1345 entitled, "Photographic Image-Enhancement", by A. Nielsen. This publication is also available from the Forest Management Institute, Canadian Forestry Service. The principles of photographic image-enhancement are described. Special emphasis is given to the Agfacontour technique, which is illustrated with imagery from ERTS-1.

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P. E. T. Allen, FAO cartography expert, has recently written, "The Effect of Instrument Errors and Stability of Materials in Area Determination", and "The Uses of Sidelooking Airborne Radar Imagery for Tropical Forest Surveys". Both are available from FAO of the United Nations, Via delle Terme di Caracalla, 00100 - Rome, Italy.

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The South Dakota State Planning Bureau, Pierre, S. D., 57501, is developing a land use and natural resource inventory program based on remote sensing. Information on the program is contained in "Introduction to the South Dakota Land Use Inventory System" and in "Innovative Methods for the Generalization of State and Regional Land Use Information, an Operational LANDSAT Demonstration Project", both by Paul Tesser.

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L. Jobin and J. Beaubien have recently written "Capability of ERTS-1 Imagery for Mapping Forest Cover Types of Anticosti Island". The reprint is available from Bibliogheque, Centre de Recherches Forestieres des Laurentides, C. P. 3800, Ste-Foy, Quebec, Canada, G1V 4C7.

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Research Paper PSW-112, "Evaluation of ERTS-1 Data for Forest and Rangeland Surveys", describes experimental uses of ERTS-1 imagery for inventorying forests and rangelands and for detecting areas of forest disturbance or stress. Various levels of success that a resource manager might expect with ERTS-1 are given. Write the Pacific Southwest Forest and Range Experiment Station, P. O. Box 245, Berkeley, California, 94701.

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Special Report 233, "Land Use/Vegetation Mapping in Resevoir Management", is available from the Corps of Engineers, U. S. Army Cold Regions Research and Engineering Laboratory, Hanover, N. H., 03755. This report demonstrates the extent to which ERTS-1 imagery, Skylab S190A and S190B photography and RB57 photography can be utilized for the preparation of land use/vegetation maps.

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A reprint of "A Preliminary Evaluation of ERTS Imagery for Forest Land Management in British Columbia" by Lee, Oswald, and Harris is available from the Pacific Forest Research Centre, 506 W. Burnside Road, Victoria, British Columbia V8Z 1M5.

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Other Publications of Interest

AGR-41, "Sampling Surface-Mined Coal Spoils", by R. I. Barnhisel, Cooperative Extension Service, University of Kentucky, Lexington, Ky., 40506.

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General Technical Report INT-22, "SCREEN: A Computer Program to Identify Predictors of Dichotomous Dependent Variables", by David Hamilton and Donna Wendt, and reprint, "Eliminating Biases in the Planar Intersect Method for Estimating Volume of Small Fuels", by James K. Brown and Peter J. Roussopoulos, are both available from Intermountain Forest and Range Experiment Station, 507 - 25th Street, Ogden, Utah, 84401.

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Research Note PSW-300, "Number of Pins in Two-Stage Stratified Sampling for Estimating Herbage Yield", by William G. O'Regan and C. Eugene Conrad and General Technical Report PSW-12, "RAMP: A Computer System for Mapping Regional Areas", by Bradley B. Nickey, are both available from Pacific Southwest Forest and Range Experiment Station, P. O. Box 245, Berkeley, California, 94701.

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The Division of Forestry, Fisheries and Wildlife Development of the Tennessee Valley Authority at Norvis, Tenn., 37828, has released several publications that are of interest. These include:

- Forestry Bulletin 72, "Forest Inventory Statistics, Fannin-Gilmer County Unit, North Georgia".
- Technical Note B9, "Land Analysis Systems", by F. P. Baxter, T. L. Cox, and R. P. Gregory.
- Technical Note B10, "Universal Map Code (A 7½ Minute Quadrangle Identification System)", by Steve Weber and Bob Gregory.
- Technical Note B12, "WRAP - A Multiple Resource Model for Allocation of Wildland Resources", by Larry N. Hamner.

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"Land Systems Inventory - Boise National Forest, Idaho" by Wendt, Thompson, and Larson. USDA Forest Service, Region 4, 324 25th Street, Ogden, Utah, 84401.

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Research Note RM-301, "A Sturdy Probe for Measuring Deep Snowdrifts", by Robert L. Jairell and General Technical Report RM-16, "Selected Bibliography of Wildlife and Habitats for the Southwest", by David R. Patton and Peter F. Ffolliott, are available from the Rocky Mountain Forest and Range Experiment Station, 240 W. Prospect Street, Fort Collins, Colorado, 80521.

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"MDPLOT: A Program for Plotting Multi-Dimensional Data", by Nance, Polmer and Keith is available from the Southern Forest Experiment Station, T-10210, Federal Building, 701 Loyola Avenue, New Orleans, La., 70113. Ask for General Technical Report SO-7.

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MP-1185, "Techniques for Sampling the Dynamics of Southern Pine Beetle Populations", by Coulson, Hain, Foltz, and Mayyasi, is available from the Texas Agricultural Experiment Station, College Station, Tex., 77843.

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MEETINGS

Remote Sensing

The Laboratory for Applications of Remote Sensing will be holding the Third Symposium on Machine Processing of Remotely Sensed Data from June 29 through July 1, 1976, at Purdue University. Papers written about all areas of theory, implementation and applications of machine processing of remotely sensed data will be presented. For further information, contact Professor Philip H. Swain, LARS, Purdue University, West Lafayette, Indiana, 47907.

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3P Workshop

A 3P Sampling Workshop will be held May 11, 12 and 13, 1976, at West Virginia University in Morgantown. This workshop is sponsored by the West Virginia University Division of Forestry and Center for Extension and Continuing Education; USDA Forest Service, State & Private Forestry; and the Society of American Foresters Inventory Working Group. Class size will be limited. For further information, write WVU Conference Office, 389 Birch Street, Attention: William E. Kidd, Jr., Morgantown, West Virginia, 26506.

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Sampling and Data Processing

A Forest Inventory Workshop, sponsored by the University of New Hampshire, the SAF Inventory Working Group, and the USDA Forest Service will be held November 8 through 12, 1976, at Durham, New Hampshire.

The Workshop will consist of two concurrent sessions. Session A (Sampling Designs) will include random sampling, stratified sampling, systematic sampling, list sampling, sampling with partial replacement, probability proportional to size and 3P sampling. Some basic knowledge of statistics will be helpful, but is not required. Session B (Data Processing) will cover discussions of data processing systems for large and small inventories and cruises. Among those to be discussed will be the INDIANA system, CRUISE, CFI programs, STX, SURVEY and FINSYS. A knowledge of FORTRAN will be helpful, but not required.

Registration for either of the sessions will be between $25. and $50. Registration will be limited and will be filled on a first-come-first-served basis. For further information, contact Professor James Barrett, James Hall, Institute of Natural Resources, University of New Hampshire, Durham, N. H., 03824.

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MISCELLANEOUS

Visual Resource Inventory

Red Hanna and Phil Delucchi of the Siuslaw National Forest have designed and developed a computer program called VISRSINV. The program can summarize visual resource inventory acreages for variables included in the National Visual Management System, such as distance zone, sensitivity level, variety class, and quality objectives.

The program uses BASIC language and is currently on the Wang 2200 with a disc storage system. The advantages of the system are numerous. Briefly, it has the ability to:

- Summarize acreage by travel corridor, scene area, TRI compartment, drainages, planning units, district or forest or other formats, depending on user needs.

- Provide retrievable in-place visual resource data.

- Provide a system that can be revised and updated by adding, deleting or changing information when needed in a minimum amount of time.

.Provide a printout of total acreage tables for distance zones, sensitivity levels, variety class and quality objectives.

.Provide a matrix relating acreage to the visual quality objectives by distance zones.

The system can be utilized with any mapping scale, size of map or areas. Further information on the program, as well as copies of the program listing, may be obtained by writing the Forest Supervisor, Siuslaw National Forest, P. O. Box 1148, Corvallis, Oregon, 97330.

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Regeneration Surveys

I. E. Bella of the Canadian Forestry Service is interested in hearing from anyone doing work in the assessment of regeneration stocking. He is particularly interested in basic information on the relationship between seedling spatial pattern, quadrat size, and sampling error for different sampling schemes. If you have any information for Mr. Bella, please contact him at the Northern Forest Research Centre, 5320 - 122 Street, Edmonton, Alberta, Canada, T6H 3S5.

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Alaska National Forest Inventories

Kerry Martin has written in describing the continous forestry inventory program he is involved in on the Tongass and Chugach National Forests in Alaska. A double-stratified sampling system, based on area and volume strata, is being used. Previously established growth plots are being remeasured and the 10-point variable radius prism plots are being established. For further details, contact Kerry in care of Forest Inventory, Chugach National Forest, Post Office Box 275, Seward, Alaska, 99664.

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Please address all correspondence regarding Resource Inventory Notes to:

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State & Private Forestry
6816 Market Street
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ATTN: Resource Inventory Notes

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