TREE NURSERY INVENTORY: AN ANNOTATED BIBLIOGRAPHY

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An annotated bibliography on Tree Nursery Inventory procedures. The publications are listed alphabetically, by the author's last name.

Forest tree nursery inventories have been going on since the late 1930's, beginning with Chapman in 1939. Since that time, procedures have been refined to include stratified sampling, permanent history plots, and computer programs.

We have researched the literature as thoroughly as possible. Some material probably has been left out inadvertently. Should this be the case, our readers are invited to send additional references to the authors so that the list may be kept current.

Aldhous, John R.
1972. Nursery Practice. [British] For. Comm. Bull. 43, Appendix 1:129-143.

A rather complete explanation with examples of forms and calculations is given. The British procedure for inventorying of nurserystock, both seedlings and transplants, was designed in 1964. It covers uniformity of nurserybeds and sampling methods (including helpful indices of variation and numbers of samples) required to remain within acceptable limits of error.

Armson, K.A., and V. Sadreika.
1974. Chapter eight: Inventory Sampling and Assessment of Nursery Soils and Stock Experimentation. *In* Forest Tree Nursery Soil Management and Related Practices. p. 120126. Ontario Min. of Nat. Resources, Toronto, Ontario.

Authors give a step-by-step review of formulas and sample calculations, together with a discussion of sampling procedures, size, and soils.

Barton, William W., and Charles M. Clements.
1961. A systematic sampling nursery inventory procedure. Tree Planters' Notes 46:19-25. (Originally presented as paper before the Reg. 7, State Nurserymen's Conf., Trenton, N.J 1961.

The authors describe a sampling system for total tree count, plantability, and seed bed inventory. Example formulas and computations for checking the adequacy of the samples are given, plus sample forms for recording data.

Belcher, Earl W., Jr.
1964a. Nursery seedling and seedling history plots. p. 166-171: Proc. Reg. 8 For. Nurserymen's Conf. Oklahoma.

The author describes randomly located permanent plots to determine germination, survival factor, grading, and inventorying. Example data-collection forms are given. Plots are located prior to planting and established immediately after planting. Time and expense are saved over conventional methods.

Belcher, Earl W., Jr.
1964b. The use of history plots in the nursery. Tree Planters' Notes 64:27-31.

This publication is the same essentially as the paper listed above by Belcher.

Belcher, Earl W., Jr.
1972. Life history plots and inventories. p. 157-159. Proc. Southeast. Area For. Tree Nurserymen's Conf., Wilmington, N. C.

Belcher provides some guidelines for statistically testing whether or not history plots should be used in lieu of temporary plots. He recommends establishing both randomly selected history plots and systematic temporary plots, then testing to see if there is any difference between the two.

Chapman, R.A.
1939. A method for inventorying planting stock in forest nurseries. U.S. Dep. Agric., For. Serv., South. For Exp. Stn., Occas. Pap. 86. 10 p.

In one of the first works on nursery inventory in the United States, Chapman suggests using a 1- by 4-foot sampling frame as a sample unit. Units may be either randomly or systematically located throughout the beds. Procedures are given for estimating the total number of seedlings, estimating the percentage of plantable seedlings, and calculating the total number of plantable seedlings. An appendix deals with curve fitting. Chapman's summary of his procedure is as follows:

1. Obtain from one set of samples an estimate of the average number of all seedlings per sampling unit (a convenient unit is 1 by 4 feet).
2. Obtain from another set of samples the relation of percent-plantable-seedlings per sampling

unit to the total number of seedlings per unit. Express the relationship by means of a curve.

3. From the curve obtained in step 2, determine the percent plantable seedlings that corresponds to the average number of seedlings found in step 1.

4. Multiply the average number of seedlings (step 1) and divide by 100 to find the estimated plantable seedlings per sampling unit.

5. Multiply this estimated number by the total number of sampling units in the group of beds.

Clements, Charles M.
1961. Nursery inventory procedures. p. 37. Proc. Reg. 7 State Nurserymen's Conf., Trenton, N.J.

Clements briefly discusses the formula employed to determine the number of sample counts necessary for various degrees of accuracy. No examples are given.

Duffield, John W.
1963. Inventory procedure for small or specialized forest nurseries. Tree Planters' Notes 58:22-25.

A stratified systematic sampling procedure is described to help a nurseryman find out how many seedlings he has and which beds he should lift to fill a specific order. Data cards for each seedbed and a measuring wheel are used to inventory the seedlings. Stratification is based on light and heavy stocking and is left to the judgment of the counter. A sample form is given.

Eliason, E.J.
1959. Simplified tree inventory counting frame. Tree Planters' Notes 38:9-10.

Eliason describes an open-end counting frame used to define the sampling area for taking tree inventories in nursery seedbeds. The new frame is adjusted from the side by sliding it through the seedlings at ground level. The frame works faster than most, and in-and-out tree stems are differentiated automatically.

Frederick, David M.
1969. A computerized inventory for Indiana's forest tree nurseries. Master's thesis. Purdue Univ., Lafayette, Ind. 78 p.

See description of program below.

Frederick, David M. and John W. Moser, Jr.
1970. Inventory processing for Indiana's forest tree nurseries. Purdue Univ., Dep. For. and Conserv. Res. Prog. Rep. 380. 8 p.

The authors describe a system of computer programs to (1) calculate an estimate of total and shippable seedlings for each bed from which a sample has been collected, (2) summarize this bed information by various categories of interest to the nursery manager, and (3) present the summarized information in tabular form. The program is coded in FORTRAN IV for the CDC 6500 computer. The sampling technique used is a systematic sample. Example printouts are shown.

Hamilton, David A., and Kenneth D. Ware.
1966. Sampling efficiency for inventory of a forest tree nursery. Unpubl. Pap. Iowa State Univ., Ames, Iowa. 29 p.

The authors are concerned with selecting the most efficient sampling method. Standard errors are evaluated for the estimates obtained: By systematic sampling, by simple random sampling, and by stratified random sampling. The stratified sample is recommended. An inventory work plan is presented discussing the sampling unit, stratification, selection of sampling units, number of units to be selected, variables to be measured, and computations.

Johnson, Floyd Alfred.
1941. A statistical study of sampling methods for tree nursery inventories. M.S. thesis. Iowa State Univ., Ames, Iowa. 25 p.

See description below.

Johnson, Floyd Alfred.
1943. A statistical study of sampling methods for tree nursery inventories. J. For. 41(9):674-679.

Johnson attempts to answer three questions: What type of sampling unit should be used; how many sampling units should be taken; how should they be selected? In hardwood seedbeds, the 1-foot row, 2-foot row, and 1-foot bed-width units appeared to be most efficient. In coniferous seedbeds, 1-foot or 2-foot row units are not recommended. A method is given for determining the size of a random sample consistent with the accuracy desired for the estimated total number of trees. Systematic samples proved to be more accurate than stratified random samples in seedbed stock. In transplant beds, however, neither method was consistently more accurate than the other. Stratified random sampling was superior to completely random sampling.

McNeel, W.D.
1969. Computer method of establishing inventory samples. p. 178-180. Proc. 1968 Southeast. Area For. Nurserymen's Conf., Alexandria, La.

McNeel briefly describes a computer program for the 1130 IBM computer to determine the number of samples required to meet a given accuracy. McNeel uses a stratified sampling technique with randomly selected plot locations.

Mugford, Delbert C.
1962. Nursery stock inventory procedures. p. 9-16. Proc. Reg. 9 For. Nurserymen's Conf. Marietta, Ohio.

The author describes Missouri's forest nursery inventory procedure which uses a systematic sample. He compares the procedure used by Barton and Clements (1961) with that in Ontario (Mullin, Morrison, and Schweitzer, 1955). Because of the high intensity of sampling, the Ontario method produced the most accurate inventory. Example forms and computations are given.

Mullin, R.E.
1964. Comparisons of sampling methods for inventory of nursery stock. Tree Planters' Notes 67:3-8.

Mullin tested 2-foot frames versus 4-foot frames and fully random sampling, stratified random samplings, and systematic sampling with random starts. He found that the 2-foot frame is more satisfactory than the 4-foot because there is less tendency to miss seedlings in the smaller frames. Sampling method did not have a significant effect on the average number of trees per frame. Error percentage analysis determined that fully random sampling was the least reliable; systematic intermediary and stratified sampling were the most reliable. An excellent literature review is provided.

Mullin, R.E., L.M. Morrison and T.T. Schweitzer,
1955. Inventory of nursery stock. Ontario Dep. of Lands and For. Res. Rep. 33. 64 p.

The authors provide a very thorough discussion of considerations in inventorying nursery stock. The recommended sampling units (frames), the number of observations needed, and sampling designs are discussed for a variety of transplant and seedbed situations. All sampling designs discussed use a random or stratified random manner of placing the frame.

Peaslee, Alan R.
1968. A useful homemade plastic tree caliper for seedling inventories. Tree Planters' Notes 19(2):20-21.

Peaslee briefly describes how to construct a caliper for measuring seedling diameters for nursery seedbed inventories. Illustrations are given.

Province of Ontario.
1956. Seedbed inventory. Tree Planters' Notes 25:25.

"Inventory of Nursery Stock" by Mullin, Morrison and Schweitzer (1955) is reviewed briefly.

Schumacher, F.X., and R.A. Chapman
1954. Sampling methods in forestry and range management. Duke Univ School of For. Bull 7 rev 222 p

This is a general text on statistical sampling as it applies to forestry and range. Nursery

inventories are discussed briefly as examples of various types of sampling.

Seidel, Kenneth W., and
Nelson F. Rogers.
1966. Shortleaf pine seedling inventory methods on broadcast-seeded areas in the Missouri Ozarks. U.S. Dep. Agric., For. Serv. Res. Note NC-19. 2 p.

While this particular paper does not address itself specifically to nursery inventories, the procedures discussed can be applied. To estimate the total number of seedlings per acre and distribution, the authors recommend using circular milacre plots (radius 3.72 feet) total stocking method with a stocked milacre method. They conclude that a more precise estimate of the number of seedlings per acre is obtained by the total stocking method.

Space, James C., and Earl W. Belcher, Jr.
1972. Design and computer processing of nursery stock inventories. 27 p. U.S. Dep. Agric., For. Serv. Southeast. Area State & Priv. For., Atlanta, Ga.

Systematic and random sampling, permanent history plots and temporary plots, and spring and fall inventories are discussed in this publication. A computer program is presented, called NURINV, to compile the data collected. Sample data collection forms and printouts are given for the various types of inventories.

Space, James E., and
Stephen E. McDonald.
1973. Tree inventory program saves time. Tree Planters' Notes 24(1):8-9.

The authors describe a computer program, TREINV, which computes present inventory and projected inventory based on mortality estimates. TREINV also indicates to the nurseryman whether there will be too many or too few trees to meet anticipated needs. A sample data form and printout are given.

Stoeckeler, J.H. and G.W. Jones.
1957. Forest nursery practice in the Lake States. U.S. Dep. Agric., For. Serv. Agric. Handb. 110. 124 p.

The authors consider both seedbed and transplant inventories. Tables are given to determine the number of sample or counting plots needed to meet a given sampling error. They suggest using a stratified random sampling system for seedbed. Where more than five counts are required per seedbed, however, they imply that a modified systematic sample is as accurate as a random scatter.

Thomas, Philip B.
1963. Nursery stock inventory using IBM compilation. 4 p. Proc. Reg. 9 State Nurserymen's Meet., Rolla, Mo.

Thomas follows the same transplant inventory procedure recommended by Mullin, Morrison, and Schweitzer and uses history plots for the seedling inventory. Data recorded on mark-sense IBM card include species, block number, age class, source, bed feet, and season. Outputs include reports on number of trees for each-block, species, age class, and sources, as well as calculated confidence limits. The reports are also used to determine how many feet to lift.

Thomas, Philip B.
1964. Nursery stock inventory using IBM compilation. Tree Planters' Notes 64:1-3.

Thomas describes the use of the computer for compiling data from transplant inventories and seedling inventories. IBM mark-sense cards are used and examples are shown. A stratified random sample is used for the transplant inventory, and a systematic sample for the seedbed. The computer produces a report showing number of trees for each block, species, age class,

and source, plus a listing of the confidence limits on the estimates. A short description on the use of the inventory in filling orders is also given.

Turner, Eugene E.
1964. Seedling inventory. p. 163-165. Proc. Reg. 8 For. Nurserymen's Conf., Oklahoma City, Okla.

Turner briefly describes an inventory system used in the South for pine and hardwood seedlings. A random sampling scheme is used for the spring and fall inventories of the pine. Sampling of the hardwoods is more intense than that of pine because of the hardwood's diversity of species. A sample data collection form is given.

Wakeley, Philip C.
1951a. Planting the Southern Pines. U.S. Dep. Agric., For. Serv., South, For. Exp. Stn. Occas. Pap. 122, 2:261-264.

Wakeley describes the seedling inventory system being used in the South. Costs should be kept to a minimum of a few cents per thousand trees, yet accuracy of ± 5 percent should be obtained. The inventories serve as a safeguard against accepting more orders than can be filled. Two inventories are recommended: one in July, the other in the fall. The July inventory is needed for preliminary planning of stock shipments and field planting. The fall inventory gives an up-to-date estimate of the total number of living seedlings and a closer estimate of plantable seedlings at lifting time. Wakeley briefly outlines a sampling procedure to follow to insure that information is obtained for a given level of accuracy.

Wakeley, Philip C.
1951b. Planting the southern pines, U.S. Dep. Agric., For. Ser. South. For. Exp. Stn. Occas. Pap. 122, 3:556-559.

Wakeley gives step-by-step directions for seedling inventories. Equipment and materials required, preparation for sampling, making the sample counts, and calculation procedures are discussed.

Wakeley, Philip C.
1954. Planting the southern pines. U.S. Dep. Agric., For. Serv. Agric. Monog. 18. 223 p.

Wakeley briefly describes a random sampling method to inventory plantable seedlings. Step-by-step procedures are given for determining sampling intensity, counting the seedlings, and calculating the totals of living and plantable seedlings.

Ware, Kenneth D., Gerald Grebasch, and David A. Hamilton, Jr.
1967. Sampling design and computer processing for efficient nursery inventories. p. 27-42. Proc. Northeast. Area Nurserymen's Conf. Point Pleasant, W. Va.

The authors present a very thorough historical review of nursery inventory. Comparisons are made between older sampling systems and double-sampling techniques. They find that stratified sampling with a mean-of-ratio estimator gives the estimate with the smallest standard error. The basis of stratification is accomplished as the nurseryman prepares a map while walking through the nursery. Areas of the same species with relatively uniform stands of seedlings and similar quality fall within one stratum. Differing areas fall into other strata. The authors calculate an estimate of the standard error as well as the normally obtained totals. The authors discuss the need for using computers, keeping inventory plans up to date, and the advantages of using permanent plots with partial replacement.