FO-2213 Forest Measurements
Topic 32: Inventory Design

Bottom-Up Approach

Inventory design requires a bottom-up approach because the designer must first decide the desired outputs first and then choose the processing procedures available, then move to the data collection and statistical analysis procedures that will yield the desired results.

Desired Outputs

- Products to be inventoried
  - Pulpwood - pine and hardwood
  - Chip'n Saw - pine only
  - Sawtimber - pine and hardwood (mixed)
- Species differentiation
  - Pine or by species of pine
  - Hardwood: hard and soft, or by species
- Product volume/weights; i.e desired units of measure
  - Cords
  - Tons
  - Board feet (log rule?)
- Dollar values
  - Current prices; source?
- Required statistical precision limits
  - AE% $\leq$ 10% at the 95% confidence level for combined volume.
- Printed output results; i.e. what types of tables and computations are needed
  - Volume/weights per acre and total tract
  - Stand and stock tables

Methods of Computational Analyses

- Hand vs. computer (software availability)
- Availability of volume equations and functions to produce desired units of measure for each desired species-product class.
- Sample tree input variables for the volume functions
  - dbh, 1 or 2 inch classes
  - merchantable height in feet, bolt, logs to X-inch top diameter
  - total height (1.0 ft)
  - tree form; M&G form class, taper function, etc.
  - X year radial growth, 1X-bark thickness; nearest 0.1 inches
  - age; at breast height, add x years from seedling.
- Input of tree/field data to the computation process; keyboard, data transfer, pencil, etc.
  - From Excel spreadsheet in ASCII format
  - From field computer in proprietary, binary format

Sample Tree Specifications

DBH classes; 1 or 2 inch classes?

Pulpwood - pine and hardwood; 6" class (5.1+ or 5.6+)and larger to 3" top;

Chip'n Saw - pine only (8" class+) to 6" top diameter

Sawtimber - pine 10" class and larger to 6" top and hardwood 12" class to 10" top

Height; what kind? Measure each tree or subsample? Volume function compatibility.

Height to what top diameter or merchantability limit?

Pulpwood to 3" top, ob.

Chip'n saw to 6" top, ob.

Sawtimber; pine to 6" top and hardwood to 10" top

Tree form measure (related to the volume function used); how attained in the field?

Sub-sample form class on 3 trees per encountered dbh-product class

Product specifications; i.e. acceptable characteristics by species and dbh class

For sub-sample variables; how many and how distributed?

2 trees per encountered dbh -product class closest to plot center

Estimates of Population Attributes and Variability for sample size determination

Average tree size

Average tree frequency distribution; i.e. trees per acre by species-product class

Defined sample strata; species and product timber types

Population variation measure available; observed/sampled CV%

Take 5-10 sample plots and computer coefficient of variation

Attainable allowable error? Or, what are required statistical precision limits?

±AE% at the stand, tract, or type level on combined product volumes

Required Sample Size (relatively independent of tract or plot size)

Finite or infinite population; fixed area plots = finite with fixed plots size (ps) in acres, point/prism = infinite; for specified acres (A)

Calculation of sample size from appropriate equation

$$n = \frac{1}{\frac{1}{N} + \left(\frac{AE\%}{t\ CV\%}\right)^2} \qquad where\ N = \left(\frac{A}{ps}\right)$$

Given the required sample size, what plot size by product class:

a. will obtain adequate tree numbers for the population to be sampled; i.e. 6-15 trees per sample plot/point.

Less than 6 trees will cause within-plot variation to mask between-plot variation; statistical constraint.

More than 15 trees is a logistical constraint in keeping up with tally trees to avoid errors of omission/commission.

b. can be efficiently handled with available manpower; 1 or 2 person crew

c. can be defined with boundaries and marked for location or check cruising.

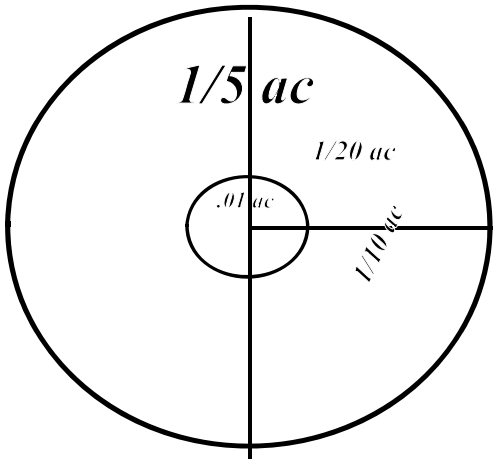
d. can be established with the available equipment; DME, laser, tape, etc.

Plot radius (ft) = {plot size(acres) * 43,560/ ÷ Π }$^{0.5}$

e. estimated time/cost per sample; sample per day, per project.

f. can be best utilized for different products; i.e. can the plot be split?

primary merchantable plot = 0.2 acre for all products except pulpwood
secondary merchantable plot = 0.1 acre for pulpwood only; right half
pre-merchantable plot =0.05 acre for pre-merchantable trees only; ne quad
reproduction plot = 0.01 for seedlings iff utilized in future management



Distribution and Location of Samples

How will the desired number of samples be distributed? Random or systematic?

Random = random by timber type or stand
Systematic = 2 x 5 chain grid, 4 x 5 chain grid, etc.

Method of navigation to the sample location? GPS, compass and pacing, etc.

GPS = UTM coordinates of waypoints

Limits of navigation; within ± x feet/meters, etc.

GPS = ± 3 m for plot center

Availability of current imagery, GIS maps, or GIS shape files.

Locate plots on imagery or in GIS shape file

Tree/field Tally Methods

Paper vs computerized tally procedures
Every plot receives a unique number; i.e. 1....n
Required data items; plot#, product, species, dbh, height, form, defect, #trees
Sub-sampling procedures; 2 trees per encounter dbh class selected as the closest to plot center for which the requirement has not been filled.
Tally/cruise procedures on the plot; i.e. clockwise from the travel direction.
Plot tally verification procedure before leaving the plot.
Plot marking procedure.