## 3P Sampling

**3P - probability proportional to prediction**

- designed when a highly precise estimate of volume or value is required
- not a replacement for operational cruises
- variation of list sampling
- exploits cruisers ability to ESTIMATE volume

## 3P Sampling

- If you estimate volume on every tree, total volume will be either higher or lower than actual value
- Select a few sample trees to measure
- Compute average ratio measured:estimated and adjust total estimated volume

## 3P Sampling

Components

- selection process
- measurement protocol
- computation

## 3P Selection process

- unequal probability selection rule
- use estimated volume and random number (RN)
- RN range from 1 to max size (+ little more)
- usually based on volume, but have used dbh
- if estimate ≥ RN, than measure tree
- rule makes probability of inclusion proportional to predicted value
- also forces some of largest trees to be measured

## 3P Measurement protocol

- Estimation of tree volume
  - experienced cruiser - estimate volume directly
  - inexperienced cruiser - estimate dbh and lookup volume in local volume table
- Measurement of tree volume
  - obtain detailed upper stem measurements and derive volume measurement
  - measure dbh and merch.ht and use standard volume table

## 3P Computations

- total volume based on two sets of trees, sample group and sure-to-measure group

Total volume = $T_y$ + sure-to-measure

## 3P Computations

$$\frac{\hat{T}_y}{T_x} = \frac{\sum \frac{Y_i}{X_i}}{n}$$

$$\hat{T}_y = T_x \cdot \frac{\left(\sum \frac{Y_i}{X_i}\right)}{n}$$

where

$T_y$ = measured volume on all trees

$T_x$ = estimated volume on all trees

$Y_i$ = measured volume on sample tree 'i'

$X_i$ = estimated volume on sample tree 'i'

## 3P - simple example

- population of 10 trees, expected max volume per tree 350 bdft
- generate set of RN from 1 to 425
- if RN > 350, set as 'sure-to-measure'
- total volume based on two sets of trees, sample group and sure-to-measure group

## 3P - simple example

| Tree | $X_i$ | RN | $Y_i$ | Sure-to-measure | $Y_i/X_i$ | $X_i$ |
|---|---|---|---|---|---|---|
| 1 | 180 | 112 | 200 | | | |
| 2 | 90 | 327 | .. | | | |
| 3 | 300 | 311 | .. | | | |
| 4 | 60 | (389)M | .. | | | |
| 5 | 380 | (412)M | .. | | | |
| 6 | 150 | 266 | .. | | | |
| 7 | 100 | 100 | 110 | | | |
| 8 | 50 | 287 | .. | | | |
| 9 | 80 | 261 | .. | | | |
| 10 | 300 | 81 | 250 | | | |

## 3P - simple example

$$\hat{T}_y = T_x \cdot \frac{\left(\sum \frac{Y_i}{X_i}\right)}{n}$$

$$= 1310 \cdot \frac{3.044}{3}$$

$$= 1310 \cdot (1.015)$$

$$= 1330$$

Total volume
= $T_y$ + sure-to-measure
= 1330 + 400
= 1730

## Extension of basic 3P

- Can be combined with other sampling designs as a multistage sampling design
  - e.g., point sampling (1st stage) and 3P sampling (2nd stage)

## Summary

- best applied in situations where
  - relatively few stems per unit area, & individual trees is of relatively high value
  - several different products from each tree
  - no time during harvesting to scale using conventional methods
- not very useful when
  - numerous stems per unit area to be tallied
  - relatively low value stems