


FORESTRY 1001
2010



Quote of the Day

*“All effort is in the last analysis sustained by the faith that it is worth making.” - **Ordway Tead***



ORDWAY TEAD

Housekeeping Items

- Tree ID Test Oct 28
- Tuesday Nov 2 – MIDTERM!!!
 - Map Scale, Map Area, North Arrow
 - Height calculations from Suunto measurements
 - Mean, standard deviation, standard error
 - Stand and stock tables from tally data
 - Interpretation of Stand-level parameters
 - General familiarity with reading assignments in Forest Mensuration Book

- Trees/ha = 1275
- BA/ha = 65 m²
- Vol/ha = 97.5 m³

Elements of Sample Design

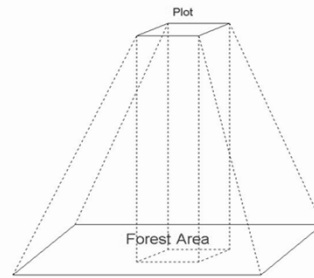
- Sampling Units
- Sampling Layout
- Number of Samples

Sampling Units

- Fixed Area Plots
 - Sample with probability proportional to frequency
 - Fixed Tree Factor
- PPS points (prism points, angle count sampling)
 - Sample with probability proportional to size
 - Fixed BAF when using horizontal point sampling
- Distance Methods
- Transect Methods

What is a sample?

- A subset, generally small, of the population of interest used to represent the whole population



A Sample is a collection of sampling units

Beer's Hypothesis

“The most efficient sample design is one which samples proportionally to the variance of the parameter of interest.”

- Tom Beers

Why Sample?

- Hard to measure without error
- Populations are large or even infinite
- Measurements are costly

Sampling

- Selecting a subset of elements from the sampling frame according to the rules of probability

Sample Layout

- Random Sampling
 - With replacement
 - Without Replacement
- Systematic Sampling
- Cluster Sampling

Random Sampling

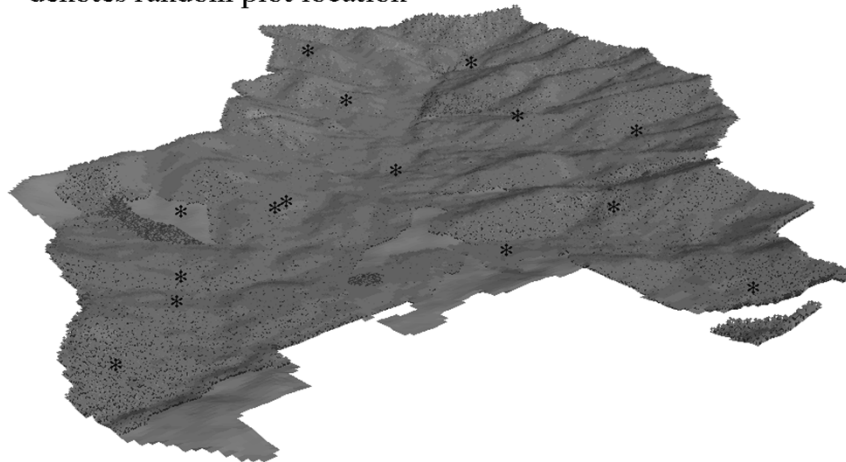
- Statistically the most efficient
 - Mean and standard error unbiased with single sample
- Can be logistically very hard to implement
- Hard to develop truly random samples

Methods of random sampling

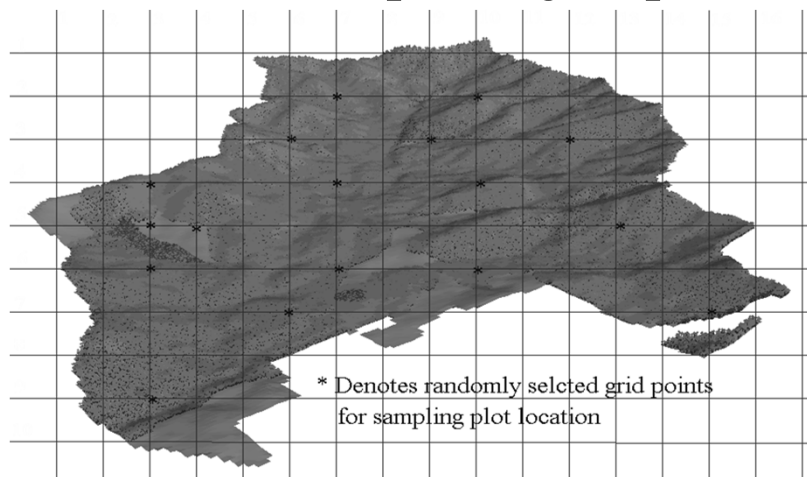
- Generate a random bearing and distance between each plot
- randomly drop pen on map
- randomly place grid on map and then randomly select points from grid to sample

The “pen” Drop Method

* denotes random plot location



Random sample of grid points



Generating Random Numbers

- Grid locations can be “randomly” selected by generating random {x,y} pairs
- You can generate a random integer between 1 and N in a spreadsheet:

$$= \text{INT}(N * \text{RAND}()) + 1$$

Takehome message

$$S_{\bar{x}} = \frac{s}{\sqrt{n}}$$

Elements of Sample Design

- Sampling Units
- Sampling Layout
- Number of Samples

Confidence Interval

$$\text{C.I.} = \bar{x} \pm t \cdot s_{\bar{x}}$$

Minimum Sample Size

Systematic Sampling

- samples laid out along a systematic grid
- logistically the easiest
- unbiased mean
- biased standard deviation

Systematic Sample of our population

Column # Row #	1	2	3	4
1	8	16	27	3
2	13	5	29	4
3	7	24	27	10
4	13	12	2	8

Sampling Frame?

Questions

- How many independent systematic samples of size 4 are there?
- For the sample illustrated, how many independent choices were made?

Why a Biased Standard Deviation?

- Consider the following example:
 - We measure a single sample plot (ie, 1 sample unit)
 - We measure the dbh of every tree on the sampling unit
- How many individual choices of sampling units did you make?
- Can we calculate the standard error for mean basal area per hectare?
 - Why?
- Can we calculate the standard error for mean dbh?
 - Why?
 - Any limits to this estimate?

Why a Biased Standard Deviation?

- Now consider a systematic sample of 4 sample plots
 - Plots are located 200 m apart on a 2 by 2 grid
 - Start point randomly selected
- How many individual choices did you make?
- You have 4 sample plots, so you “CAN” calculate a standard error of mean basal area per ha, but what is it analogous to?

All Systematic samples of size 4

Column # Row #	1	2	3	4
1	8	16	27	3
2	15	5	22	4
3	7	24	27	10
4	14	12	19	8

Properties of systematic samples

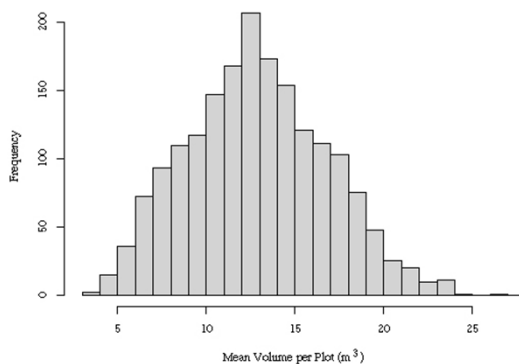
- ♣ Unbiased mean
- ♣ One sample selection (once 1 plot is located, all others are fixed)
- ♣ Sampling units are not independent
- ♣ Need at least two independent selections to calculate unbiased estimate of standard deviation (remember the $n-1$)
- ♣ s , as estimated from systematic sample, tends to be too large

Why is s too large?

- How many random samples of size 4?
- What is range of random samples of size 4?
- How many systematic samples of size 4?
- What is range of systematic samples of size 4?
- So what does systematic sampling do for us?

Distribution of Means of size 4

1820 samples
Possible!



Range of means: 3.5 – 26.75

[Figure 3-2]

Systematic Sample of Size 4

- Only 4 samples possible
 - 7.25, 13.25, 16.25, 17.25
- Clearly not as much variance possible
- “True” standard error would be the standard deviation of these 4 means

So Why use Systematic
Sampling?

Implementing a systematic sample

- ♣ Choose intensity
- ♣ Choose layout (square/rectangular)
- ♣ Determine plot and line spacing
- ♣ Choose start point and grid orientation
(these should be random – If not sampling method degenerates into haphazard sampling which is non-probabilistic)

Grid Spacing: Plots arranged in square

$$\text{Spacing (m)} = \sqrt{\frac{\text{Area (m}^2\text{)}}{\text{Number of plots}}}$$

- ♣ Distance between plots and lines equal
- ♣ Grid drawn to scale is randomly placed over area
- ♣ Grid drawn to scale is systematically placed over area

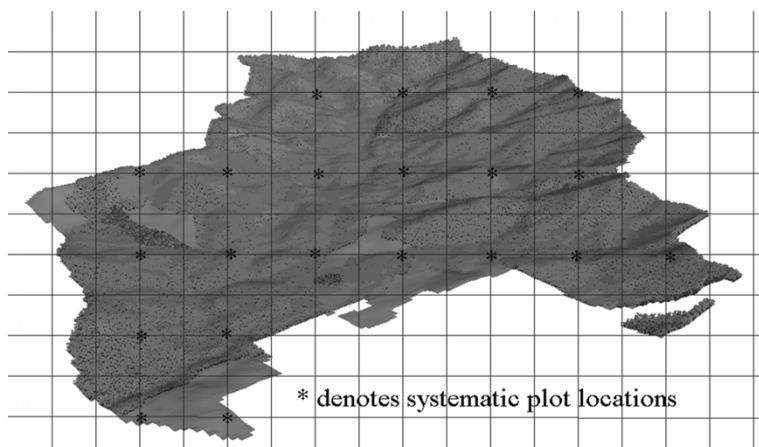
Grid spacing: rectangular grid

$$\text{Lines pacing (m)} = \frac{\text{Average Area width(m)}}{\text{Number of lines}}$$

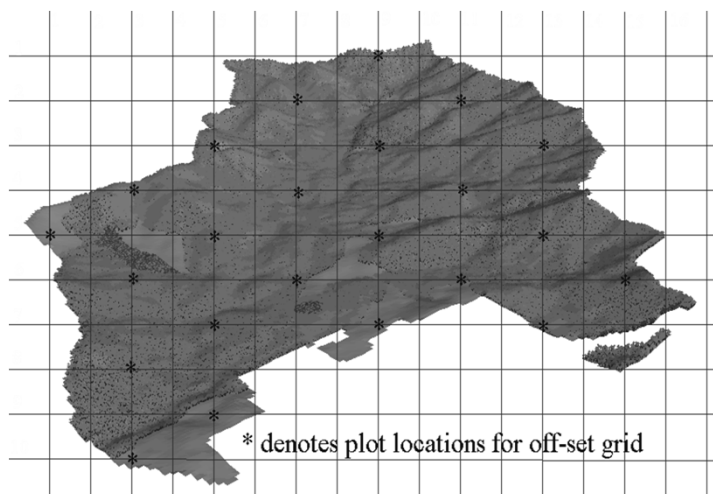
$$\text{Plot Spacing (m)} = \frac{\text{Average line length(m)}}{\text{Number of plots} / \text{Number of lines}}$$

- ♣ Space between lines and space between plots along lines are not equal
- ♣ Well suited to areas not regularly shaped

Uniform Grid



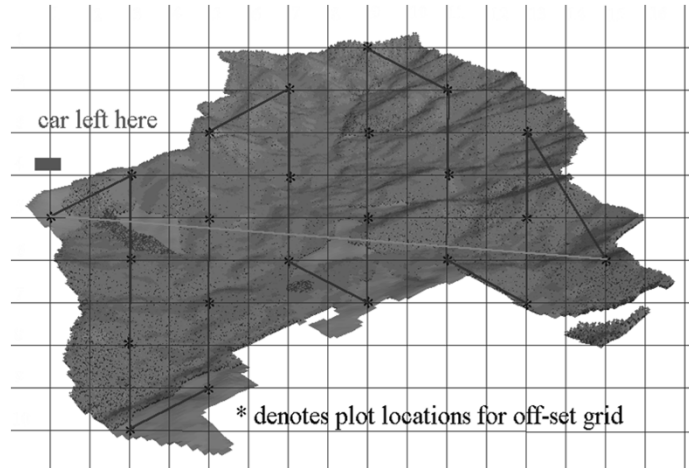
Off-set Grid



Designing for Implementation

- All plots should be located prior to entering the field
- Map showing location and list of distances and bearings to each plot
- Tally sheets prepared

Route Design



Route Design

