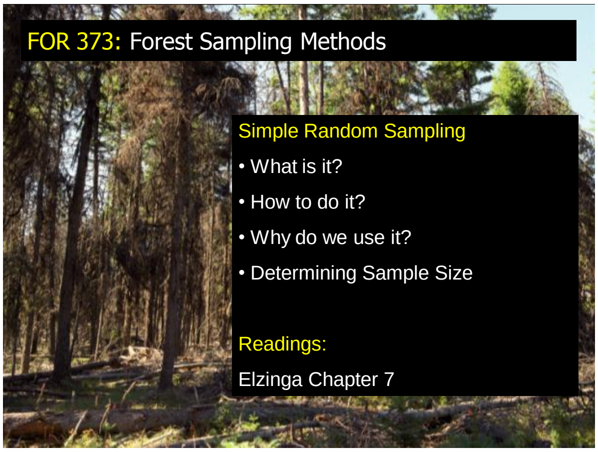


FOR 373: Forest Sampling Methods

Simple Random Sampling

- What is it?
- How to do it?
- Why do we use it?
- Determining Sample Size

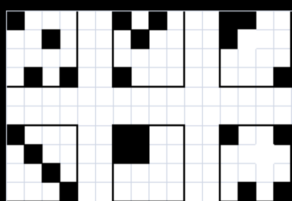
Readings:

Elzinga Chapter 7

Simple Random Sampling: What is it

"In simple random sampling every possible combination of sampling units has an equal and independent chance of being selected"

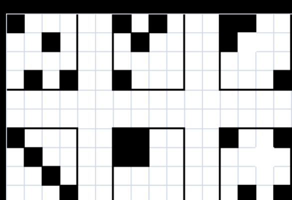
Avery and Burkhart



Simple Random Sampling: What is it

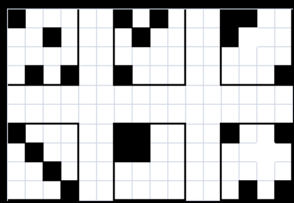
This does not mean that each sample has an equal probability of being selected.

For example, these stands may have 80% PIPO and 20% ABGR



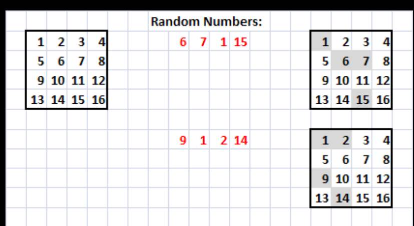
Simple Random Sampling: What is it

A random sample is one in which the selection of a particular sample does not depend on whether another sample has been chosen: Independent Samples



Simple Random Sampling: How to do it

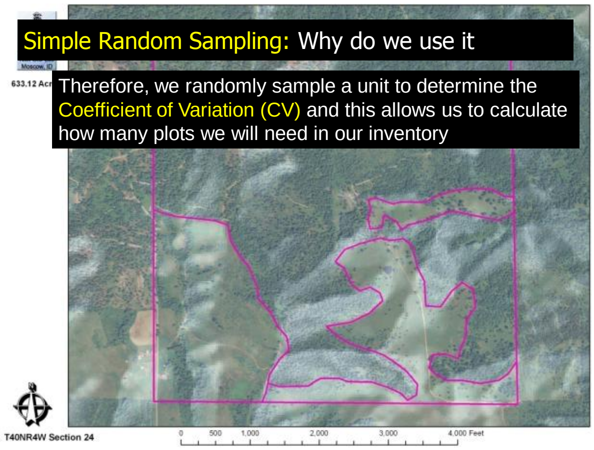
Random Number Generation: Assign each square a number and make a random number generator select them. Then sample them in that order.



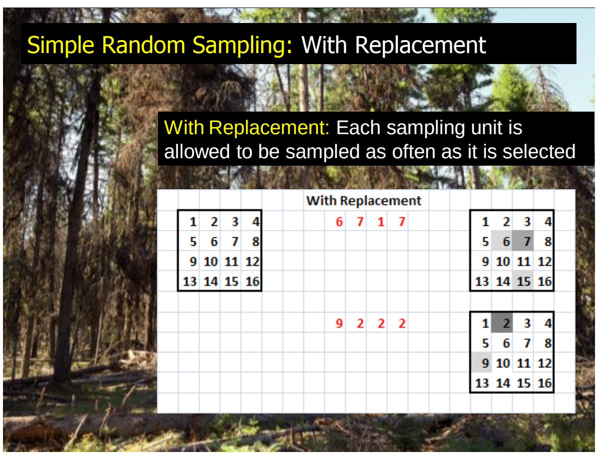
Simple Random Sampling: Why do we use it

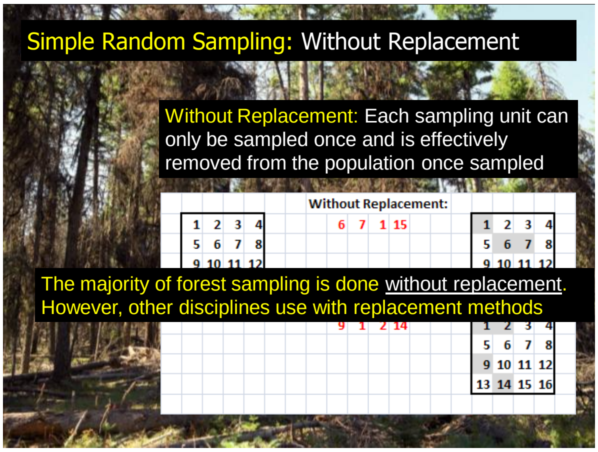
Simple Random Sampling is often used to evaluate the variance of a unit when we do not know either what the stand boundaries are or what underlying environmental variables may influence the variability.

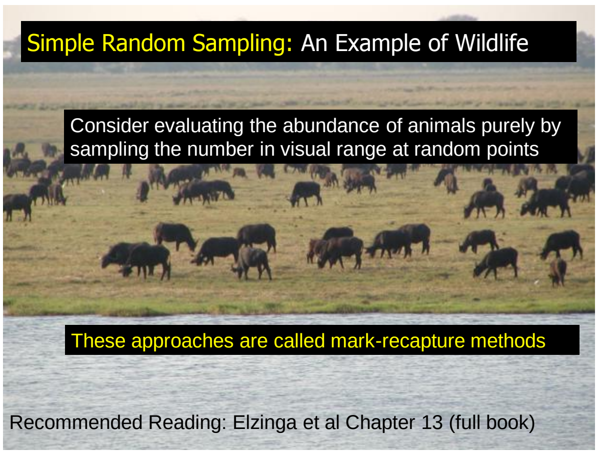
Simply put: When we do not know enough to stratify the unit and before we can plan a proper sampling design we need to collect some preliminary data

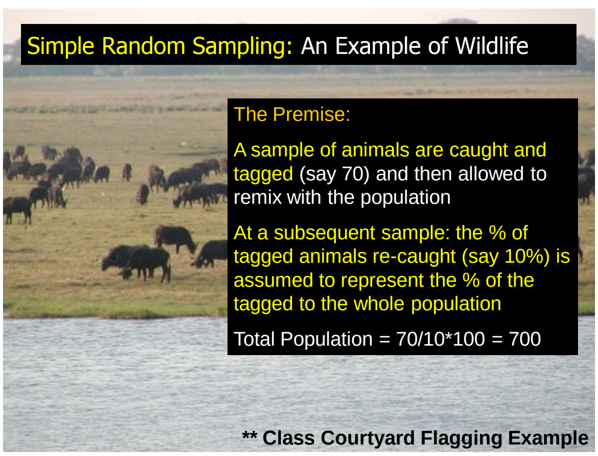

Simple Random Sampling: Why do we use it
Therefore, we randomly sample a unit to determine the Coefficient of Variation (CV) and this allows us to calculate how many plots we will need in our inventory
633.12 Acr
T40NR4W Section 24
0 500 1,000 2,000 3,000 4,000 Feet

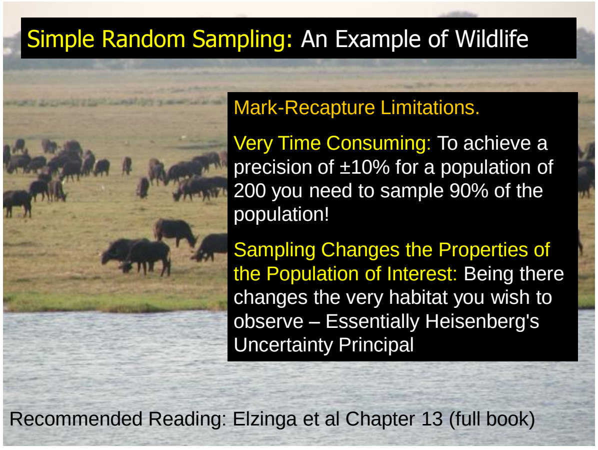

Simple Random Sampling: The two main kinds
Two main kinds of simple random sampling are used in forestry:
1. With Replacement
2. Without Replacement

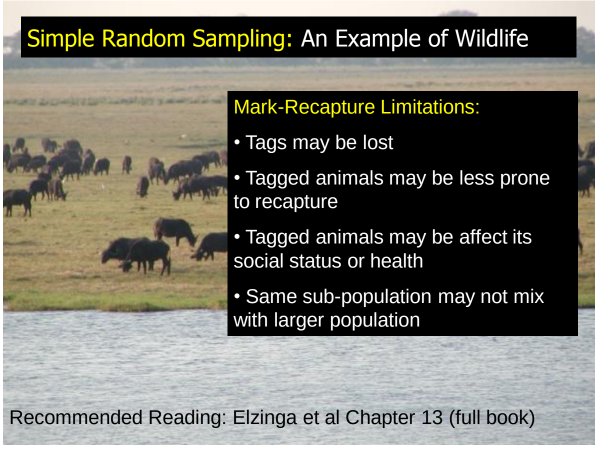

Simple Random Sampling: With Replacement
With Replacement: Each sampling unit is allowed to be sampled as often as it is selected
With Replacement
1 2 3 4
5 6 7 8
9 10 11 12
13 14 15 16
6 7 1 7
1 2 3 4
5 6 7 8
9 10 11 12
13 14 15 16
9 2 2 2
1 2 3 4
5 6 7 8
9 10 11 12
13 14 15 16


Simple Random Sampling: Without Replacement
Without Replacement: Each sampling unit can only be sampled once and is effectively removed from the population once sampled
Without Replacement:
The majority of forest sampling is done without replacement. However, other disciplines use with replacement methods


Simple Random Sampling: An Example of Wildlife
Consider evaluating the abundance of animals purely by sampling the number in visual range at random points
These approaches are called mark-recapture methods
Recommended Reading: Elzinga et al Chapter 13 (full book)


Simple Random Sampling: An Example of Wildlife
The Premise:
A sample of animals are caught and tagged (say 70) and then allowed to remix with the population
At a subsequent sample: the % of tagged animals re-caught (say 10%) is assumed to represent the % of the tagged to the whole population
Total Population = 70/10*100 = 700
** Class Courtyard Flagging Example





Simple Random Sampling: Getting Information

For both with and without replacement methods, the population mean is calculated using this equation:

$$\bar{y} = \frac{\sum y}{N}$$

Simple Random Sampling: Getting Information

The With Replacement (or infinite population) Standard Error:

$$s_{\bar{y}} = \sqrt{\frac{s^2}{n}}$$

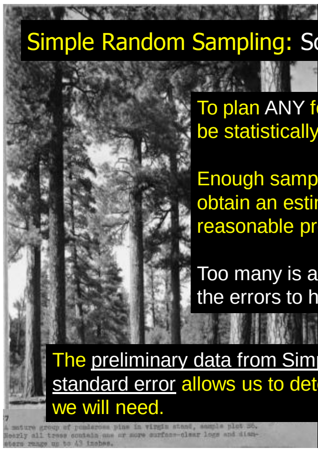
The Without Replacement (or finite population N) Standard Error:

$$s_{\bar{y}} = \sqrt{\frac{s^2}{n}\left(1 - \frac{n}{N}\right)}$$

The difference is called the finite population term:

$$\left(1 - \frac{n}{N}\right)$$

Simple Random Sampling: So Why do We Care?



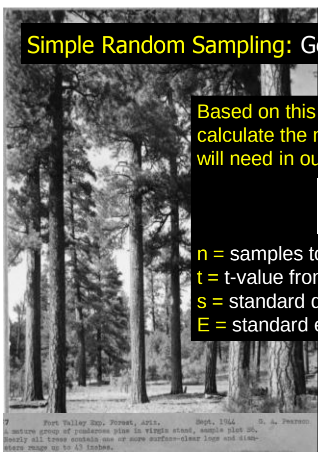
To plan ANY forest inventory its needs to be statistically valid while practical.

Enough samples must be collected to obtain an estimate of the inventory to a reasonable precision.

Too many is a waste. Too few will make the errors to high.

The preliminary data from Simple Random Sampling and the standard error allows us to determine exactly how many plots we will need.

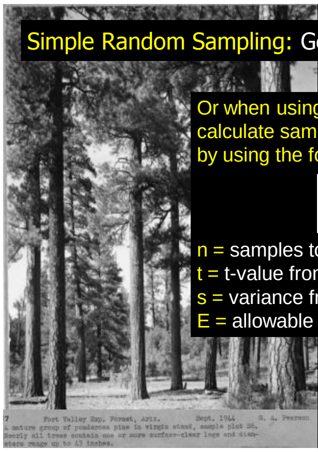
Simple Random Sampling: Getting Information



Based on this information we can now calculate the number of sampling plots we will need in our inventory:

$$n_0 = \frac{t^2 \times s^2}{E^2}$$

n = samples to estimate mean to ± E
t = t-value from students t-test table
s = standard deviation from a prior work
E = standard error of the mean

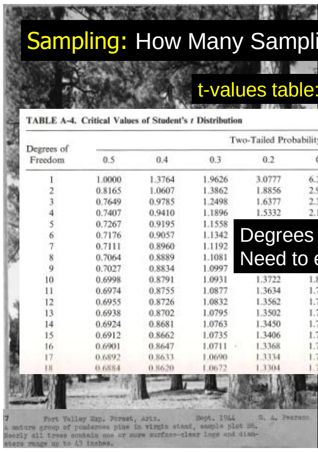


Simple Random Sampling: Getting Information

Or when using percentage error we could calculate sample size or number of plots by using the following equation:

$$n_0 = \frac{t^2 \times CV^2}{E(\%)^2}$$

n = samples to estimate mean to ± E
t = t-value from students t-test table
s = variance from a prior work
E = allowable % error



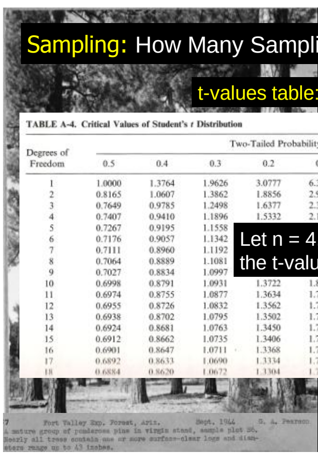
Sampling: How Many Sampling Units

t-values table: A Work Through Example

TABLE A-4. Critical Values of Student's *t* Distribution

Degrees of Freedom	Two-Tailed Probability of Obtaining a Larger Value								
	0.5	0.4	0.3	0.2	0.1	0.05	0.02	0.01	0.001
1	1.0000	1.3764	1.9626	3.0777	6.3137	12.7062	31.8210	63.6559	636.5776
2	0.8165	1.0607	1.3862	1.8856	2.9200	4.3027	6.9645	9.9250	31.5998
3	0.7649	0.9785	1.2498	1.6377	2.3534	3.1824	4.5407	5.8408	12.9244
4	0.7407	0.9410	1.1896	1.5332	2.1318	2.7765	3.7469	4.6041	8.6101
5	0.7267	0.9195	1.1558						
6	0.7176	0.9057	1.1342						
7	0.7111	0.8960	1.1192						
8	0.7064	0.8889	1.1081						
9	0.7027	0.8834	1.0997						
10	0.6998	0.8791	1.0931	1.3722	1.8125	2.2281	2.7638	3.1693	4.5868
11	0.6974	0.8755	1.0877	1.3634	1.7959	2.2010	2.7181	3.1058	4.4369
12	0.6955	0.8726	1.0832	1.3562	1.7823	2.1788	2.6810	3.0545	4.3178
13	0.6938	0.8702	1.0795	1.3502	1.7709	2.1604	2.6503	3.0123	4.2209
14	0.6924	0.8681	1.0763	1.3450	1.7613	2.1448	2.6245	2.9768	4.1403
15	0.6912	0.8662	1.0735	1.3406	1.7531	2.1315	2.6025	2.9467	4.0728
16	0.6901	0.8647	1.0711	1.3368	1.7459	2.1199	2.5835	2.9208	4.0149
17	0.6892	0.8633	1.0690	1.3334	1.7396	2.1098	2.5669	2.8982	3.9651
18	0.6884	0.8620	1.0672	1.3304	1.7341	2.1009	2.5524	2.8784	3.9217

Degrees of Freedom = n-1
Need to estimate n to get t-value



Sampling: How Many Sampling Units

t-values table: A Work Through Example

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18	0.6884	0.8620	1.0672	1.3304	1.7341	2.1009	2.5524	2.8784	3.9217

Let n = 4, then for 80% probability the t-value = 1.6377

Sampling: How Many Sampling Units

t-values table: A Work Through Example

TABLE A-4. Critical Values of Student's *t* Distribution

Degrees of Freedom	Two-Tailed Probability of Obtaining a Larger Value								
	0.5	0.4	0.3	0.2	0.1	0.05	0.02	0.01	0.001
1									
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5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									

We have: n = 4, t-value = 1.6377

Calculate sample size using E= 10% and a CV of 30

$$n_0 = \frac{t^2 \times CV^2}{E(\%)^2} = \frac{1.6377^2 \times 30^2}{10^2} = 24$$

Then you recalculate your degrees of freedom with the new *n* value until *n* repeats (changing your t-value).

DF= 23 (t= 1.3195) DF= 15 (t= 1.3406)

$$n_0 = \frac{1.3195^2 \times 30^2}{10^2} = 16 = \frac{1.3406^2 \times 30^2}{10^2} = 16$$

Sampling: How Many Sampling Units

t-values from Excel

	A	B	C	D	E	F
1						
2		n =	4			
3		Confidence	80%			
4						
5		t =	1.6377	=TINV(0.20,(C4-1))		
6						