

Statistical Consulting Report for
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June 19, 2009

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Objective:

To compare the accuracies and efficiencies of different sampling methods for inventory of residual woody debris on a typical forest harvest area in North Carolina.

Method:

50 plots were established on a recently harvested site in Johnston County, North Carolina. 20 of these plots were randomly chosen from two harvest areas (13 hardwood and 7 pine). On these plots line intersect, prism sweep and 100% tally sampling designs were applied to estimate the volume of residual woody biomass remaining after typical forest harvesting. The null hypothesis is that sampling methods are not significantly different from each other ($H_0: X_1=X_2=X_3$) where X_1 , X_2 , and X_3 are the means of 100% tally sampling, line intersect sampling and prism sweep sampling respectively. The main contrast would be comparing line intersect and prism sweep sampling designs to 100% tally sampling. The response variable is the residual woody biomass left on the site.

COMMENTS:

1. Check data for possible typos, outliers and summarize data. Producing charts and plots will help to visualize the data. For example, producing bar charts (one bar for each sampling method) and scatter plots (%Tally x LI, %Tally x VPR) will show their volume means (with standard deviations) the relationships between methods.
2. The null hypothesis can be tested using one-way ANOVA approach. During ANOVA, specific contrast can be used to compare two sampling methods against 100% Tally.
3. Depending on the trends in the data, a type of regression can be fit to data (e.g., 100% Tally as independent variable, LI as dependent variable). Assuming the relationship is linear (which should be obvious in the plot) a simple linear regression can be fit. Such analysis tests whether the relationship between two sampling methods is significant (the slope parameter b is significantly different from zero or not). It will also show how much bias there is between methods. A similar regression analysis can be done between VPR and 100% Tally.
4. Since this is an undergraduate student project, I suggest practicing with SAS and/or with R statistics package (freely available from the internet) would be extremely helpful to learn basic statistics with software.

I simulated some data to show how F-test can be constructed for the effects as follows:

```

data a;
length Treat plot 4. ;
retain Seed_1 0 residue;
  do treat=1 to 3;
    do plot=1 to 20;
      call ranuni (Seed_1,residue);
      output;
    end;
  end;
drop seed_1 ;
run;

```

```

data a;
length sampling $6. plot 4. residue 6.4 ;
set a;
if treat=1 then sampling='Total ';
if treat=2 then sampling='Prism';
if treat=3 then sampling='Line';
  if treat=1 then residue=residue+0.8 ;
  if treat=2 then residue=residue+0.84;
drop treat ;
run;

```

```

proc print data=a ; run;

```

The SAS System

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Obs	sampling	plot	residue
1	Total	1	1.63323
2	Total	2	1.29887
3	Total	3	1.60301
57	Line	17	0.95512
58	Line	18	0.91506
59	Line	19	0.30112
60	Line	20	0.41355

```

proc glm data=a ;
class sampling ;
model residue = sampling ;
means sampling /waller ;
*contrast 'Total versus Prism' sampling 0 -1 1;
*contrast 'Total versus Line' sampling -1 0 1;
run; quit ;

```

The GLM Procedure

Class Level Information

Class	Levels	Values
sampling	3	Line Prism Total

Number of Observations Used 60

Dependent Variable: residue

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	9.94601496	4.97300748	50.71	<.0001
Error	57	5.59026029	0.09807474		
Corrected Total	59	15.53627526			

R-Square	Coeff Var	Root MSE	residue Mean
0.640180	29.19179	0.313169	1.072798

Source	DF	Type III SS	Mean Square	F Value	Pr > F
sampling	2	9.94601496	4.97300748	50.71	<.0001

The ANOVA results shows that at least one sampling method is significantly different at <0.0001 level. This is the probability of F Value.

Waller-Duncan K-ratio t Test for residue

NOTE: This test minimizes the Bayes risk under additive loss and certain other assumptions.

Kratio	100
Error Degrees of Freedom	57
Error Mean Square	0.098075
F Value	50.71
Critical Value of t	1.78647
Minimum Significant Difference	0.1769

Means with the same letter are not significantly different.

Waller Grouping	Mean	N	sampling
A	1.41725	20	Prism
A	1.30016	20	Total
B	0.50099	20	Line

The multiple range test (Waller) shows that Total tally and the Prism methods are not different but Line method is significantly different from other two. The residue mean for Line was 0.5099 where as the mean for Total was 1.3.

residue Mean

