Comparison of Canopy Cover Estimation Using Densiometer and Photo Analysis Software  
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Introduction
Canopy cover can heavily influence the understory and other biological components of ecosystems, such as productivity, composition and structure. The densiometer has been viewed as an acceptable measurement tool by the US Department of Agriculture since the 1950’s. However, advancements in technology have led to new methods of canopy cover assessment that are less expensive, and less time consuming, while maintaining precision and decreasing observer bias. One such method involves capturing photos of the canopy with a digital camera with a basic lens and then using photo analysis software to determine proportion canopy. The program CanopyDigi yields results that are consistent between camera types and produces results that are correlated with the estimates produced by a moosehorn, ocular estimations, and a sighting tube. There are currently no studies that report on the relationship between regular photo estimates like those from CanopyDigi and those of the densiometer.

The CanopyDigi Software takes the black and white bitmap and assigns pixels a greyscale value between 1 and 255 before converting the bitmap into the false color image based on a given threshold.

Objectives
• To estimate the canopy cover for 220 plots using both the densiometer data and the canopy photographs
• To determine if there is a difference between the densiometer estimates and the photo estimates
• If there is a difference, determine the relationship between the methods and if conversion is possible

Hypotheses
Null: There is not a linear relationship between the densiometer estimates of canopy cover and the photo analysis software estimates of canopy cover
Alternative: There is a linear relationship between the densiometer estimates of canopy cover and the photo analysis software estimates of canopy cover

Analytical Methods
Run dbetas to determine if outliers existed
Wilcoxon signed rank test to determine if means were equal
Run Pearson’s product-moment correlation
Determined if data met assumptions of linear regression
Determined if transformation was appropriate based on qq plots and Shapiro-Wilk normality test
Run offset model and 95% confidence interval on slope to determine in relationship significantly different than 1 to 1 given non zero intercept

Results
No outliers were found using the dbetas
Pearson’s product moment correlation
T = 23.3147, p-value<2.2e-16, cor. = .8789
The correlation was not equal to zero and the data had strong positive linear relationship
Wilcoxon signed rank test
W = 22708, p-value = 2.16e-16
The means for densiometer estimates and photo estimates were not equal
Offset Anova
Fail to reject that the slope was different than 1
Intercept was different than 0

Discussion
As a result of the linear relationship and the high correlation between the densiometer and photo estimates, it was possible to estimate a conversion equation between the two methods. The equation that best fit the data was
Densiometer estimate = 17.216 + Photo estimate.
There was no significant difference between the slope and 1, however, there was a significant difference between the intercept and zero. This suggests that the difference between the densiometer estimates and the estimates produced from the photos is relatively constant over the range of canopy cover measured. The need for an intercept different than zero suggests that the photo estimates are underestimating canopy cover when compared to the densiometer. It was expected that the photo estimates would underestimate canopy cover as methods it is correlated with, such as the moosehorn, also produce lower estimates of canopy cover than a densimeter. While there was slight departure from normality, the robust sample of 220 comes from an approximately normal distribution because of the Central Limit Theorem. However, if the sample size was below 50, normality can not have been assumed and the conversion equation may not have been valid. As a result of the large sample size and the other assumptions of a linear relationship met, conversion between the two methods is possible. Thus, canopy photos may replace the densimeter in the field and reduce time spent collecting canopy data. Conversion between methods allows for the photo estimates to be converted to densiometer estimates that are more holistic, less variable and more similar to animal perspectives.