Comparison of three canopy cover estimation techniques in Long Island Central Pine Barrens

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Abstract

Light availability controlled by forest canopy openness has a causal relationship with understory plant growth and tree species recruitment, thus plant and forest community composition. Understanding changes in light availability is important for forest managers to produce appropriate management strategies. At a subset of 29 permanent forest health monitoring (FHM) plots established in 2005-2006, we characterized canopy cover in 2019 using the following three independent methods that varied in complexity, time required for each measurement, and cost: (1) hemispherical photography (HP), (2) spherical crown densiometer (convex mirror), and (3) the AccuPAR ceptometer. We conducted a two-way ANOVA and simple regression analyses to determine no significant difference amongst canopy openness measurements provided by the three different tools. The results of this study support the accuracy of these widely-used methods, allowing researchers to choose the most appropriate and cost-effective tool and allowing forest stewards to develop the best management plans for the sustainability of natural resources in pine barren forests.

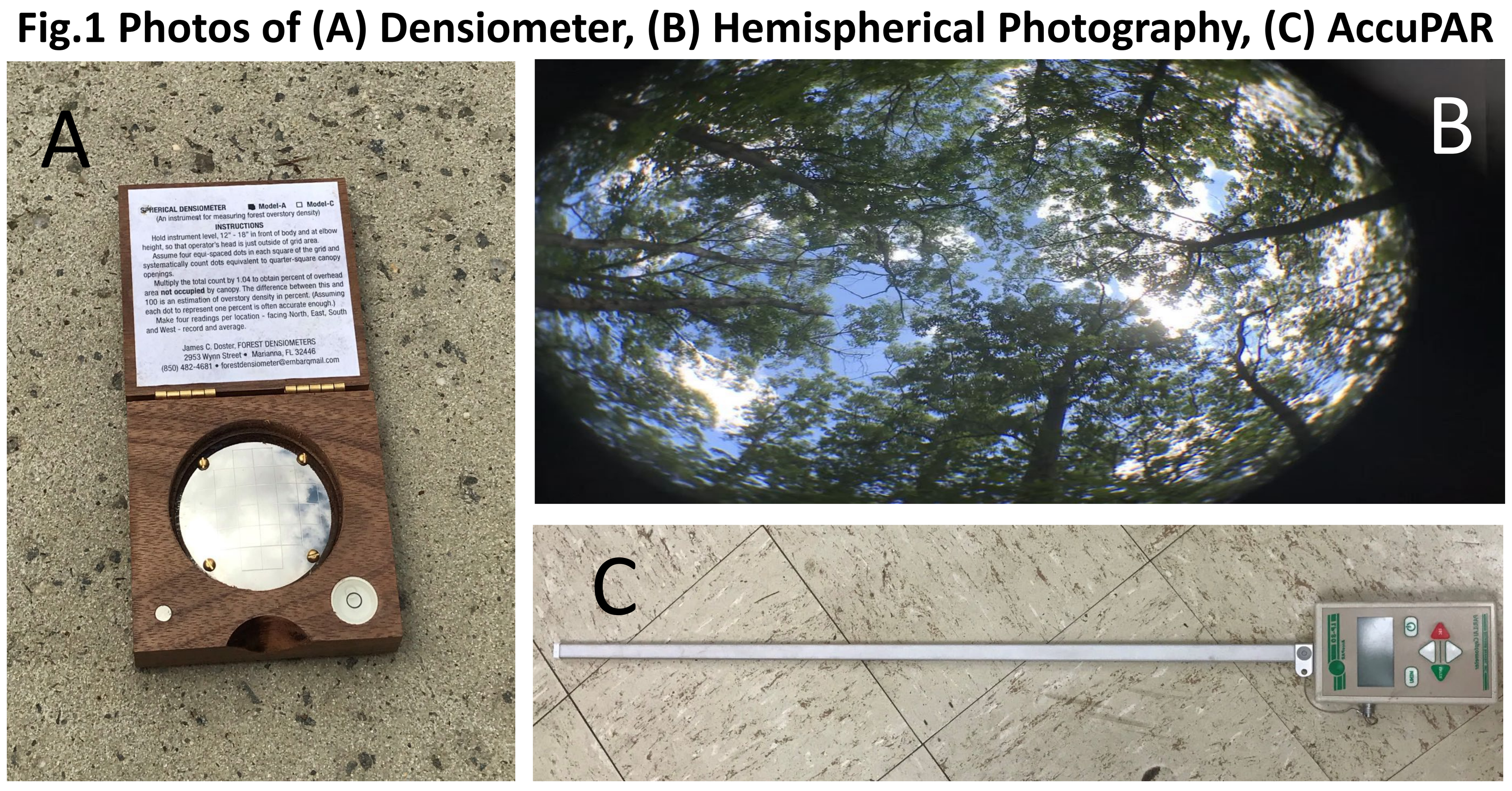
Introduction

Light availability has a causal relationship with understory plant growth and tree recruitment and it often dictates forest composition. The primary driver of light availability is canopy openness (CO), i.e. the amount of sky unobstructed by tree parts. Proper CO data collection and analysis can often inform about the health of a forest and aid foresters and ecologists in creating effective forest management plans. There are many tools and techniques available to measure CO, many differ in cost, required time to take measurements, and appropriateness for different forest types, hence choosing the best tool for a certain forest is key.

Hypothesis

We expected that canopy cover measurements using (1) spherical crown densiometer, (2) hemispherical photography, and (3) AccuPAR LP-80 ceptometer (**Fig.1**) will provide varying levels of accuracy. We hypothesized that HP and AccuPAR sensor would overestimate CO, but the densiometer would be less susceptible to effects of "clumping" (spatial aggregation of leaves).

Fig.1 Photos of (A) Densiometer, (B) Hemispherical Photography, (C) AccuPAR



Methods

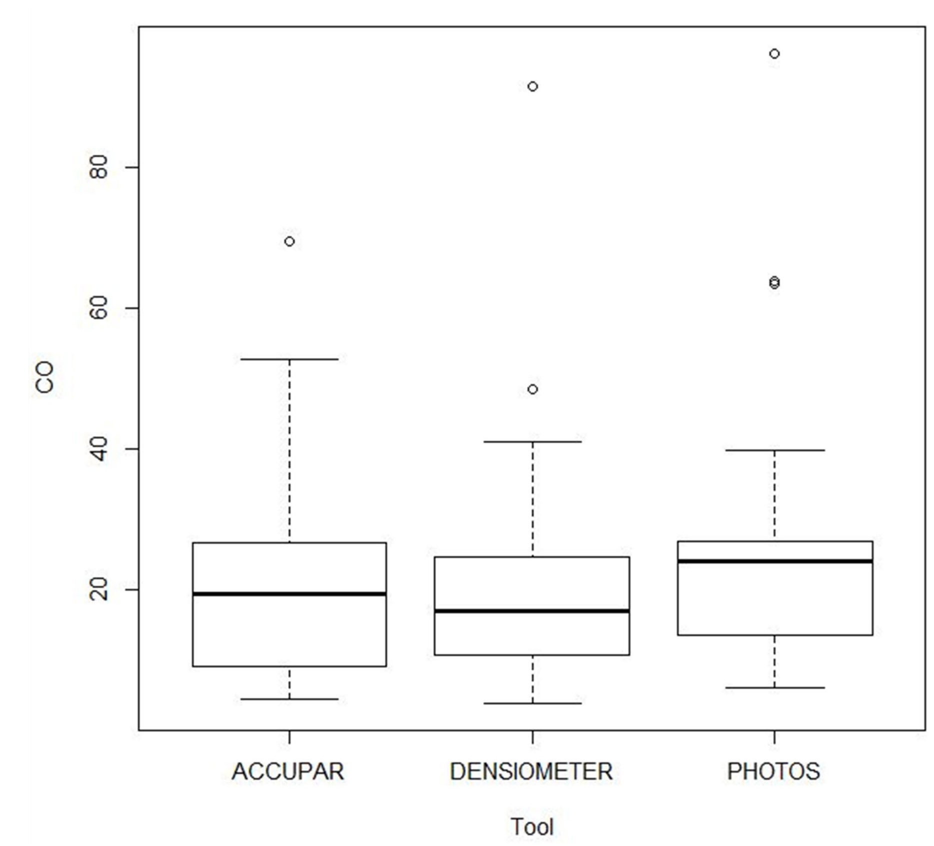
Plots

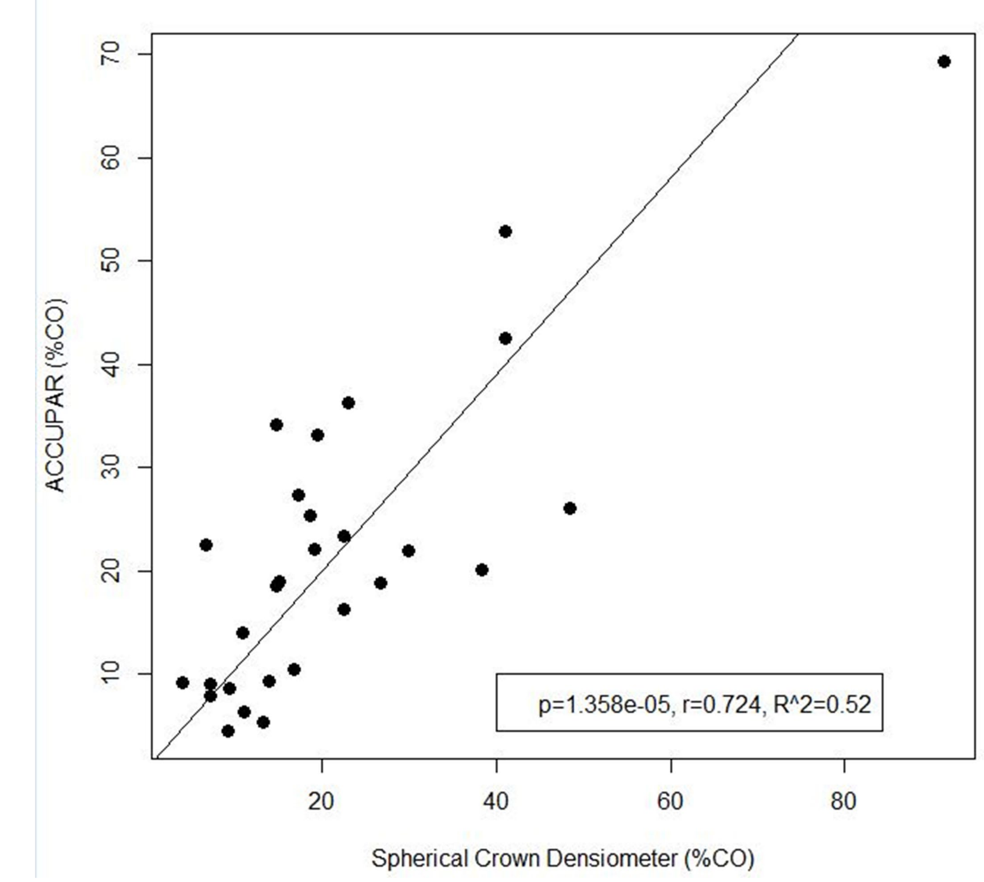
In 2019, 28 of the permanent FHM plots in the Long Island Central Pine Barrens were visited to take measurements of CO with the three instruments (HP, CD, AP, Fig. 1). Each 16x25 m plot had five points for canopy openness measurements (at the center of the plot, two points 4 m towards the 25 m edge, and two points 6 m towards the 16 m edge).

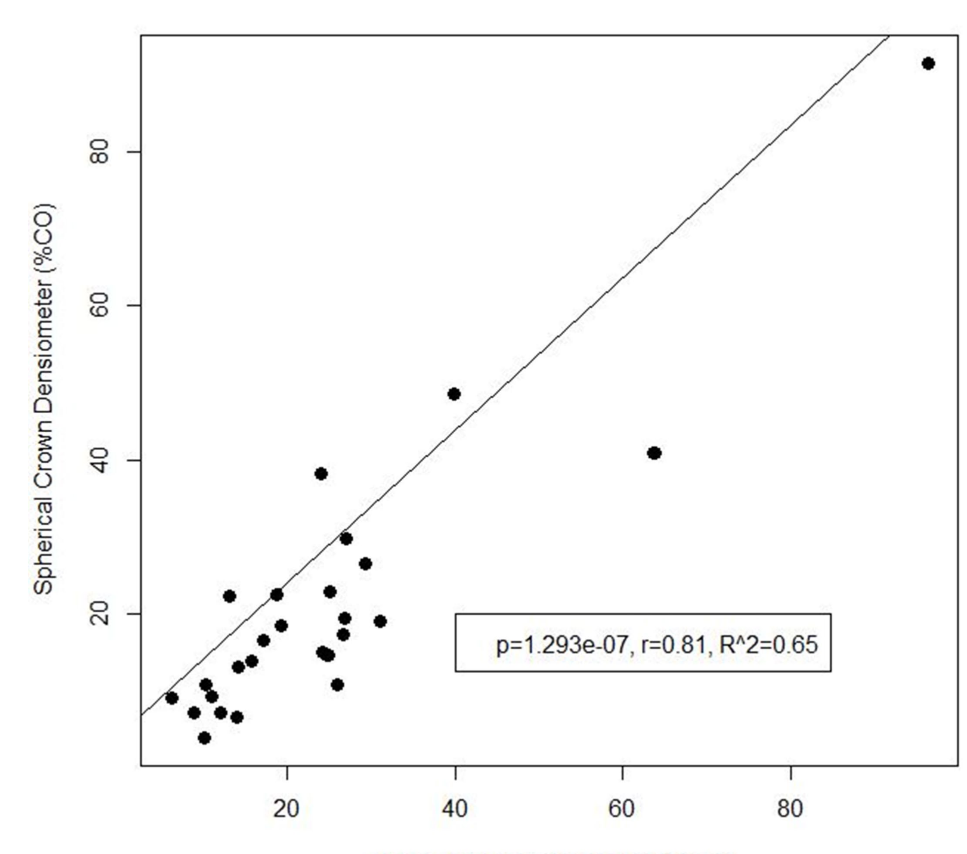
Statistical Analyses

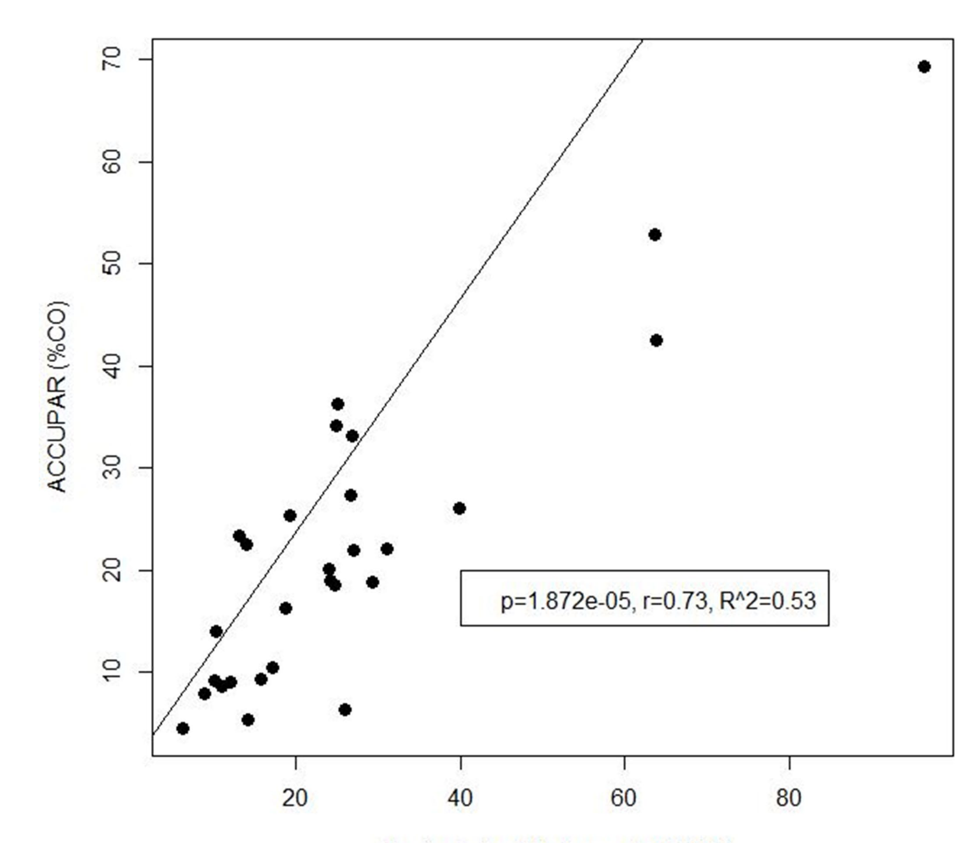
HP were analyzed with ImageJ (Schneider et al, 2012) and statistical analysis was conducted with R (R Core Team, 2017). Simple linear regression and ANOVA analyses were used to determine correlation coefficients and significant differences between the measurements taken by the three different CO tools.

Results









Bartlett's Test for Equal Variance:

Bartlett's K-squared = 1.8092, df = 2, p-value = 0.4047

ANOVA:

F-statistic: 0.4838, p-value: 0.6182

Our results show that tools are ***NOT*** significantly different from one another when measuring CO in Pine Barrens ecosystem.

Discussion

Although we expected HP and AP to measure larger values of CO with respect to CD, we found that there was no significant difference. This may be due to small sample size (n=28) with different forest types (broadleaf vs pine needle). Some differences amongst measurements may be caused by operator bias with CD and different thresholding of HP images. Future studies should increase sample size for each forest type.

Acknowledgements

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