NOT ALL BASAL AREA IS CREATED EQUAL: THE INFLUENCE OF SPECIES AND STAND DEVELOPMENT ON CANOPY COVER OF FOUR COMMON SOUTHERN PINES

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Abstract—Restoring natural fire regimes and diverse ground cover to planted or old-field origin southern pine stands typically requires a substantial reduction in overstory density. While maintaining full canopy cover (CC) is consistent with maximizing fiber production, this approach does not allow sufficient light to reach the forest floor to accomplish a broader set of objectives. The relationship between stand basal area (BA) and CC has been used to regulate the overwood in shelterwood seed cuttings and is worth exploring for other purposes. Two factors potentially complicating the use of BA as a proxy for CC are: (1) the dynamic relationship between stem diameter and crown size and (2) species-level differences. Data collected as part of a regional inventory (Forest Inventory and Analysis Forest Health Monitoring plots) were used to construct regression models of crown projection area (CPA) for the four most common southern pines (*Pinus taeda*, PITA; *P. elliottii*, PIEL; *P. echinata*, PIEC; *P. palustris*, PIPA). Species, stem diameter, and live-crown ratio were all identified as important predictor variables ($P < 0.05$). Relative to a stated objective of achieving 50 percent CC there were some substantial differences in the amount of BA suggested for retention in stands of different average diameter (5- to 18-inch d.b.h, PITA 46 to 70 square feet per acre; PIEL 46 to 64; PIEC 47 to 71; PIPA 50 to 74); the differences among species were somewhat less dramatic. There was a clear tendency for relatively small stems, e.g., <10 inch d.b.h., to have larger crowns per unit stem diameter, implying a given CC could be achieved with less BA. Species shade tolerance also appeared to influence crown-stem allometry, with the more shade-tolerant species tending to provide a given amount of CC with less BA. Both factors, species, and average tree size appear worthy of consideration when attempting to meet residual canopy cover goals.

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Not all Basal Area is Created Equal: The Influence of Species and Stand Development on Canopy Cover of Four Common Southern Pines

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BACKGROUND

•Densely stocked pine plantations lack many of the attributes associated with fully functioning upland pine ecosystems (Mitchell et al. 2007).

•There is growing interest in converting existing plantations to a more natural state (Masters et al. 2007, Stanturf et al. 2004).

•Frequent low intensity fires are an integral component of upland-pine ecosystems in the Southeast (Komarek 1974).

•Using structure provided by an existing overstory, even if a less preferred species, may be preferable to starting over from scratch (Kirkman et al. 2007).

•Reducing overstory stocking (canopy cover) to levels that allow the development of diverse ground cover is an initial step in the restoration process.

•Knowledge of differences in canopy cover related to species and stage of development can be used to customize restoration treatments.

Table 1. Characteristics of the FHM sample, means and standard errors.

Species	Common	Code	Count (n)		Dbh (in)		LCR (%)		MCD (ft)	
			Nat	Plant	Nat	Plant	Nat	Plant	Nat	Plant
P. taeda	loblolly	PITA	1,640	3,379	7.7 (*0.2*)	6.6 (*0.2*)	37 (*1.2*)	41 (*1.5*)	11.6 (*0.4*)	10.4 (*0.3*)
P. palustris	longleaf	PIPA	194	13	8.6 (*0.3*)	7.8 (*0.1*)	39 (*1.1*)	58 (*0.9*)	12.3 (*0.4*)	12.7 (*0.2*)
P. echinata	shortleaf	PIEC	568	32	7.4 (*0.2*)	7.6 (*0.2*)	33 (*1.3*)	36 (*1.1*)	10.2 (*0.4*)	9.8 (*0.5*)
P. elliottii	slash	PIEL	284	473	7.4 (*0.2*)	6.5 (*0.2*)	28 (*1.2*)	39 (*1.0*)	11.1 (*0.4*)	10.4 (*0.3*)

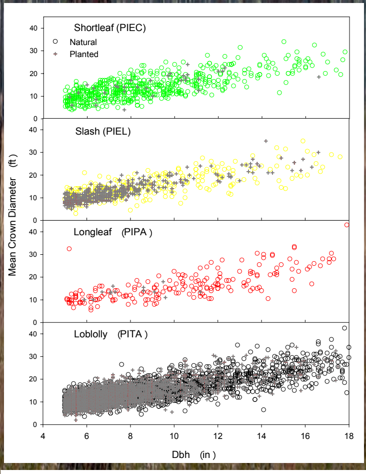

Fig 1. Relationship between stem diameter and mean crown diameter by species and stand origin.

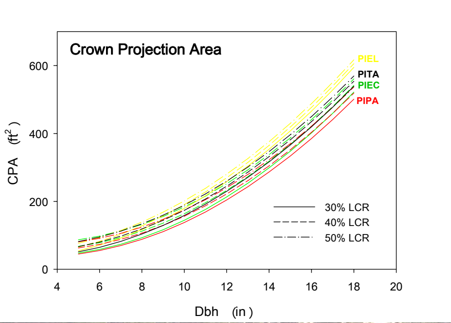

Fig 2. Species-specific crown projection area models of the form: CPA = Dbh + Dbh^2 + LCR.

METHODS

•Data from the FIA Forest Health Monitoring Program was used to develop species-specific models of crown projection area for four widely distributed southern pines (Bechtold 2003) (Fig 2).

•Analysis of covariance was used to test for differences in crown-stem allometry related to stand origin and species, with live crown ratio (LCR) as a covariate.

•The basal area (BA, ft^2/ac) associated with a given level of canopy cover was determined by scaling individual tree crown projection area (CPA) up to the stand level.

Table 2. Regression parameters and standard errors for CPA models.

Species Code	n	b1 (Dbh)	b2 (Dbh2)	b3 (LCR)	R^2
PITA	5,019	-8.809 (0.547)	2.014 (0.043)	1.505 (0.048)	0.56
PIPA	207	-12.215 (3.823)	2.057 (0.243)	1.808 (0.378)	0.56
PIEC	600	-12.938 (1.59)	2.148 (0.121)	1.959 (0.181)	0.58
PIEL	757	-6.163 (1.437)	2.075 (0.112)	1.11 (0.145)	0.60

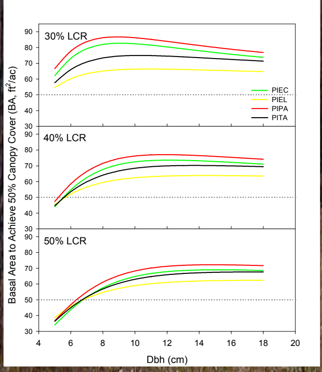

Fig 3. Estimates of stand level BA required to provide 50% CC.

KEY FINDINGS

•Crown-stem allometry was independent of stand origin (P=0.750) yet differed among species (P=0.039) (Fig 1).

•Live crown ratios were positively related to crown projection areas, i.e. trees with relatively longer crowns tended to have larger CPAs' at a given DBH (Fig 2).

•CPA was positively linked to species shade tolerance, where very shade-intolerant PITA had relatively smaller crowns than shade intolerant PIEC and PITA, which were somewhat smaller than those of shade-intermediate PIEL (Fig 2).This finding is consistent with field measurements of canopy gap fraction indicating PIPA provides less canopy cover per unit BA than PIEL (Kirkman et al. 2007).

•The amount of residual basal area required to provide 50% canopy cover increased with stem diameter, perhaps up to 10-in Dbh, indicating younger/smaller trees have larger CPAs per unit BA than older/larger ones (Fig 3).

Fig 4. Juvenile (top) and mature (bottom) pine stands containing 60 ft^2/ac of BA.

CONCLUSION

•The relatively large differences in the amount of stand BA to provide 50% CC revealed in this study (34-87 ft^2/ac) indicates species, tree size, and LCR, are worthy of consideration when formulating restoration prescriptions involving these southern pines. Perhaps most notably, that relatively lower BAs' should be retained in younger, i.e. smaller average diameter stands, and in particular those with lower LCRs'.

REFERENCES

Bechtold, W.A. 2003. Crown-diameter prediction models for 87species of stand-grown trees in the Eastern US. South. J. Appl. For. 27(4): 269-278.

Kirkman, L.K., et al. 2007. The perpetual forest: using undesirable species to bridge restoration. J. Appl. Ecol. 44: 604-614.

Komarek, E.V. 1974. Effects of fire on temperate forests and related ecosystems: Southeastern United States. In: Lozlowski, T.T., Ahlgren, C.E., Eds. Fire and Ecosystems. Academic Press, NY: 251-277.

Masters, R.E., et al. 2007. Red Hills Forest Stewardship Guide. Tall Timbers Research Station & Land Conservancy. 78 p.

Mitchell, et al. 2007. Silviculture that sustains: the nexus between silviculture, frequent prescribed fire, and conservation of biodiversity in longleaf pine forests of the Southeastern U.S. Can. J. For. Res., Vol. 36: 2724-2736.

Stanturf, J.A. et al. 2004. Restoration of Southern Ecosystems. In: Southern Forest Science: Past, Present and Future. Ch. 13: 123-131.