

Site Preparation Techniques for the Establishment of Mixed Pine-Hardwood Stands: 22-Year Results

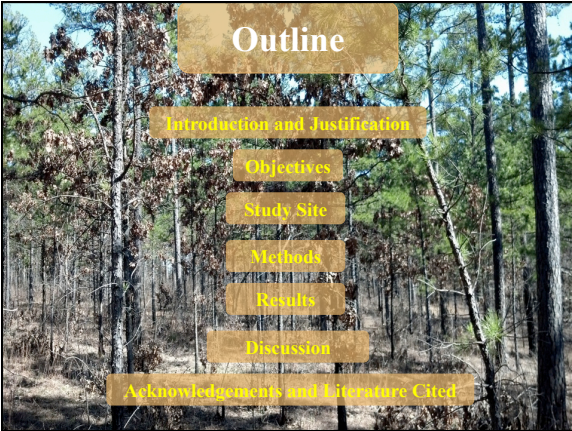


David Clabo
M.S. Candidate
University of Tennessee
Dept of Forestry, Wildlife and Fisheries
April 17, 2013 12:20 PM Room 160 PBB





Outline

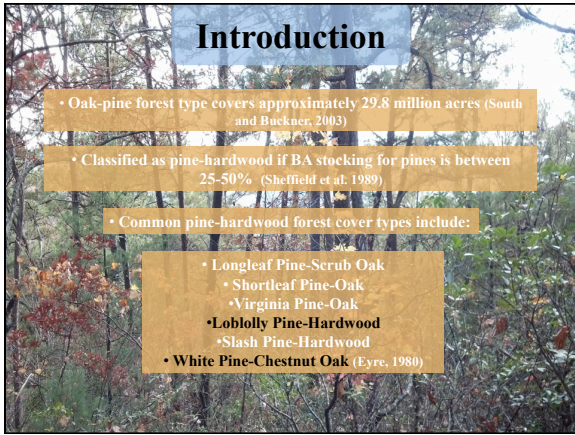
- Introduction and Justification
- Objectives
- Study Site
- Methods
- Results
- Discussion
- Acknowledgments and Literature Cited



Introduction

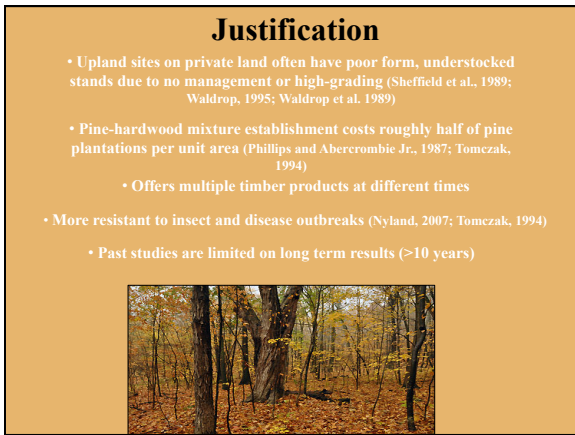
- Transitional forest type (Braun, 2001; Cooper, 1989)
- Site productivity, past land use practices, disturbances, and topography (Nicholas and White, 1984; Vose et al., 1997)
- Pine numbers increase as site productivity decreases
- Fire often necessary (Vose et al., 1997; Brose and Waldrop, 2006)





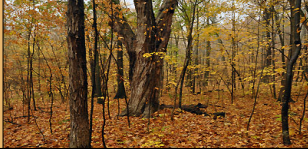
Introduction

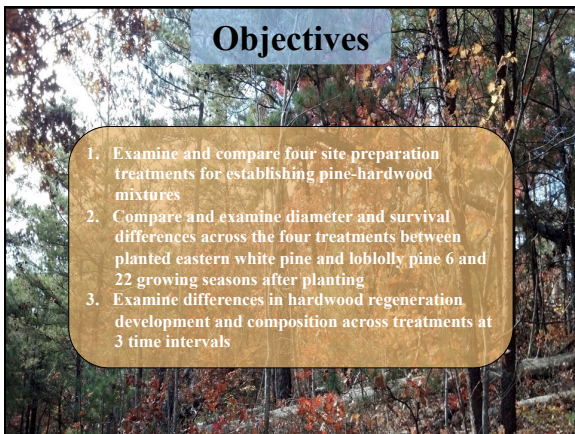
- Oak-pine forest type covers approximately 29.8 million acres (South and Buckner, 2003)
- Classified as pine-hardwood if BA stocking for pines is between 25-50% (Sheffield et al. 1989)
- Common pine-hardwood forest cover types include:
 - Longleaf Pine-Scrub Oak
 - Shortleaf Pine-Oak
 - Virginia Pine-Oak
 - **Loblolly Pine-Hardwood**
 - Slash Pine-Hardwood
 - White Pine-Chestnut Oak (Eyre, 1980)



Justification

- Upland sites on private land often have poor form, understocked stands due to no management or high-grading (Sheffield et al., 1989; Waldrop, 1995; Waldrop et al. 1989)
- Pine-hardwood mixture establishment costs roughly half of pine plantations per unit area (Phillips and Abercrombie Jr., 1987; Tomczak, 1994)
 - Offers multiple timber products at different times
- More resistant to insect and disease outbreaks (Nyland, 2007; Tomczak, 1994)
 - Past studies are limited on long term results (>10 years)







Objectives

1. Examine and compare four site preparation treatments for establishing pine-hardwood mixtures
2. Compare and examine diameter and survival differences across the four treatments between planted eastern white pine and loblolly pine 6 and 22 growing seasons after planting
3. Examine differences in hardwood regeneration development and composition across treatments at 3 time intervals

Study Site

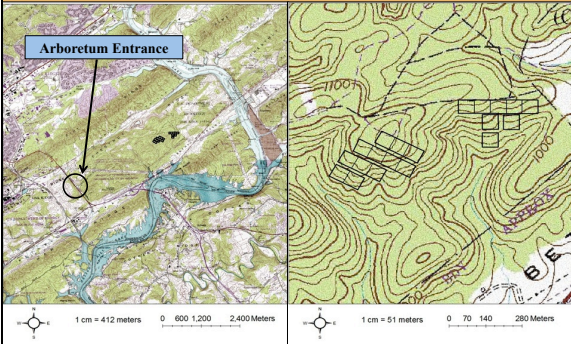


UT Oak Ridge Forest Resources Research and Education Center, Anderson County, Tennessee (36°00' N 84°19' W)



Study Site

Sites dominated by white oak (SI=21.3 m), chestnut oak (SI=21.3 m), yellow-poplar (SI=27.4 m), shortleaf pine (SI=20.4 m), blackgum, and red maple (Moneymaker, 1981)




Arboretum Entrance

1 cm = 412 meters 0 600 1,200 2,400 Meters

1 cm = 51 meters 0 70 140 280 Meters

Methods: Commercial Clearcut

- Late spring 1989, all stems ≥ 12.7 cm felled
- Winter 1990, 50 1-0 stock loblolly pines planted on half a square 0.4 h plot while 50 2-0 stock white pine planted on opposite half
- Planted perpendicular to slope on 6.1x6.1 m spacing
- 3 m buffer around pines to account for edge effects (Andrews, Jr., 1995)



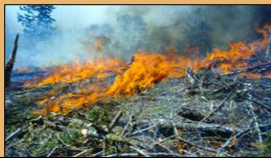
Methods: Silvicultural Clearcut

- Same commercial clearcut procedures
- After full leaf out, all stems ≥ 1.8 m tall felled
- Same pine planting procedures (Andrews, Jr., 1995)



Methods: Fell-and-Burn Site Preparation

- Fell-and-burn: low-cost site preparation technique pioneered in the Piedmont region on upland sites (Abercrombie, Jr., and Sims, 1986; Tomczak, 1994; Waldrop, 1997)
- Silvicultural clearcut applied
- Plots burned in September of 1989 using backing and flanking fires
- Same pine planting procedures (Andrews, Jr., 1995)



Methods: Brown-and-Burn Site Preparation

- Common on industry lands (Carter and Foster, 2004; Shiver and Martin, 2002)
- Same commercial clearcut treatment procedures
- Herbicide application in late summer of 1989 (prior to burning) of Arsenal®, Roundup®, ionic surfactant, and water at a mixed rate of 95.54 liters per 0.4 ha
- Foliar application: elevated spraying apparatus
- Same burn procedures as the fell-and-burn method
- Same pine planting procedures (Andrews, Jr., 1995)



Methods

- During 1996, Mullins et al. (1997) collected pine survival, and diameter data
- Collection of hardwood regeneration data on each plot half on 20.1x2.0 m transects; species determined and diameter class in 2.5 cm classes (largest sprout in clumps)
- Yangbao (2004) collected hardwood regeneration data following Mullins et al. (1997) (no pine data collected).
- Pine and hardwood data collected in 2012 following Mullins et al. (1997) methodology

Statistical Methods

- All pine analyses used a randomized complete block experimental design with a split-plot treatment design
- Regeneration analyses used a RBD with repeated measures treatment design
- Natural regeneration analysis split into potential overstory species (e.g. oaks, hickories, yellow-poplar, sweetgum, etc) and all species categories (e.g. dogwood, red bud, beech, sourwood, sassafras, etc.)
- Proc Mixed SAS 9.3 $\alpha=0.05$

Results: Species Composition

1996: 27 hardwood species 3 conifer species
2004: 28 hardwood species 3 conifer species
2012: 28 hardwood species 2 conifer species



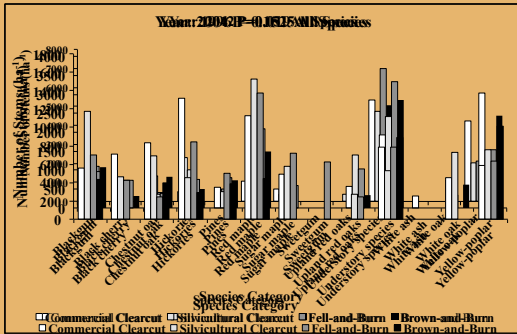
Results: Pines

Treatment by year and species by year effects significant.

Loblolly pine	Year:1996		Year: 2012	
	Survival (%)	DBH (cm)	Survival (%)	DBH (cm)
Commercial Clearcut	26 a*	4.3 a	18 a	29.7 a
Silvicultural Clearcut	23 a	4.8 a	15 a	31.8 ab
Fell-and-burn	63 b	7.4 b	55 b	35.1 b
Brown-and-burn	68 b	8.4 b	65 b	35.8 b
White Pine				
Commercial Clearcut	27 a	1.0 a	9.0 a	11.4 a
Silvicultural Clearcut	30 a	1.0 a	8.0 a	10.7 a
Fell-and-burn	72 b	2.5 ab	59 b	19.6 b
Brown-and-burn	76 b	3.3 b	65 b	22.6 b

* Different letters in the same column indicate significant differences at P=0.05.

Results: Hardwoods

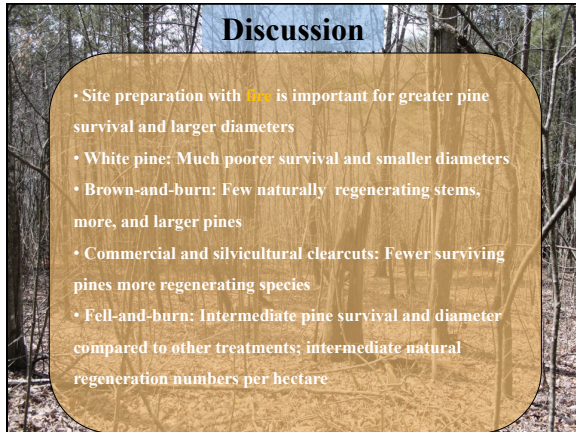


Results: Natural Regeneration

Treatment: P=0.014 Year: P<0.0001, Potential Overstory Interaction P=0.04 All Species= Insignificant

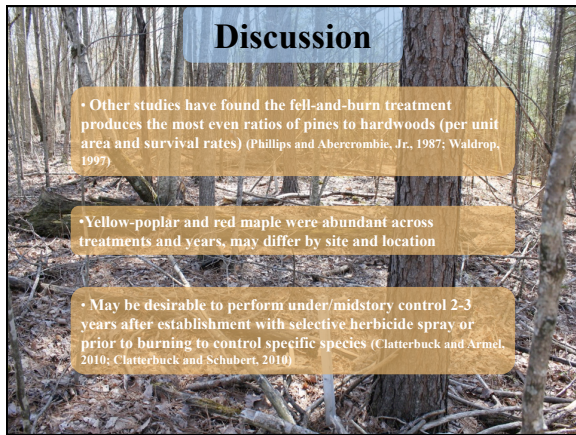
Treatment	Year: 1996		Year: 2004		Year: 2012	
	Potential Overstory	All Species	Potential Overstory	All Species	Potential Overstory	All Species
Commercial Clearcut	9009 a*	15226 a	8328 a	10667 a	3963 a	4932 a
Silvicultural Clearcut	9313 a	18329 a	9528 a	14188 a	5191 a	7015 a
Fell-and-Burn	4215 b	10318 a	9147 a	9644 a	3523 a	3716 a
Brown-and-Burn	3508 b	9382 a	6278 a	10899 a	1971 b	3424 a

* Different letters in the same column indicate significant differences at P=0.05.



Discussion

- Site preparation with **fire** is important for greater pine survival and larger diameters
- White pine: Much poorer survival and smaller diameters
- Brown-and-burn: Few naturally regenerating stems, more, and larger pines
- Commercial and silvicultural clearcuts: Fewer surviving pines more regenerating species
- Fell-and-burn: Intermediate pine survival and diameter compared to other treatments; intermediate natural regeneration numbers per hectare



Discussion

- Other studies have found the fell-and-burn treatment produces the most even ratios of pines to hardwoods (per unit area and survival rates) (Phillips and Abercrombie, Jr., 1987; Waldrop, 1997)
- Yellow-poplar and red maple were abundant across treatments and years, may differ by site and location
- May be desirable to perform under/midstory control 2-3 years after establishment with selective herbicide spray or prior to burning to control specific species (Clatterbuck and Arnel, 2010; Clatterbuck and Schubert, 2010)

Photo Citations

- www.mhhe.com
- www.natl.ifas.ufl.edu
- www.wisconsinbirds.org
- www.forestry.tennessee.edu
- www.apbrwww5.apsu.edu
- www.tillthelastthemlockdies.blogspot.com
- www.humboldt.edu
- <http://www.forestryimages.org/browse/detail.cfm?imgnum=5389174>

Literature Cited

- Abercrombie, Jr., J.A.; D.H. Sims. 1986. Fell and burn for low-cost site preparation. *For. Farmer*. 46(1): 14-17.
- Andrews, Jr., V.L. 1995. Effects of four pine-hardwood regeneration techniques on first year regeneration and wildlife habitat. M.S. Thesis. Knoxville TN: The University of Tennessee, Knoxville. 141 p.
- Braun, E.L. 2001. *Deciduous Forests of Eastern North America*. Caldwell, New Jersey. Blackburn Press. 596 p.
- Brose, P.H. and T.A. Waldrop. 2006. Fire and the origin of table mountain pine – pitch pine communities in the southern Appalachian Mountains, USA. *Can. J. of For. Res.* 36: 710-718.
- Carter, M.C. and C.D. Foster. 2004. Prescribed burning and productivity in southern pine forests: a review. *For. Ecol. and Manag.* 191(1-3): 93-109.
- Clatterbuck, W.K. and G.R. Arnel. 2010. Site preparation for natural regeneration of hardwoods. *Professional Hardwood Notes*. Publication PB1799. Knoxville, TN: University of Tennessee Extension, Institute of Agriculture. 12 p.
- Clatterbuck, W.K. and M.R. Schubert. 2010. Effects of pre- and post-harvest site preparation treatments on natural regeneration success in a mixed hardwood stand after 10 years. In *Proceedings of the 14th Biennial Southern Silviculture Research Conference*. USDA, Forest Service. Gen. Tech. Rep. SRS-121. 614 p.
- Cooper, A.W. 1989. Ecology of the pine-hardwood type. In *Proceedings of Pine-Hardwood Mixtures: A Symposium on Management and Ecology of the Type*. USDA For. Serv. Gen. Tech. Rep. SE-58. 3-8 pp.
- Eyre, F.H. 1980. Forest cover types of the United States and Canada. *Soc. Am. For.*, Bethesda, MD. 148 p.
- Moneymaker, R.H. 1981. *Soil Survey of Anderson County, Tennessee*. Washington, DC: USDA, Soil Conservation Service. 165 p.

Literature Cited

- Mullins, J.A., E.R. Buckner, T.A. Waldrop, and R.M. Evans. 1997. Site preparation methods for establishing mixed pine-hardwood stands in the southern Appalachians. In *Proceedings of the Ninth Biennial Southern Silviculture Research Conference*. USDA For. Serv. Gen. Tech. Rep. SRS-20. 22-25 pp.
- Nicholas, N.S. and P.S. White. 1984. The effects of the southern pine beetle on fuel loading in yellow pine forests of Great Smoky Mountains National Park. U.S. Department of the Interior, National Park Service. *Research/Resources Management Report SER-73*. 31 p.
- Nyland, R.D. 2007. *Silviculture concepts and applications*, second edition. Waveland Press. Long Grove, Illinois. 682 p.
- Phillips, D.R. and J.A. Abercrombie, Jr. 1987. Pine-hardwood mixtures- a new concept in regeneration. *South. J. of Appl. For.* 11(4): 192-197.
- Shiver, B.D. and S.W. Martin. 2002. Twelve-year results of a loblolly pine site preparation study in the Piedmont and Upper Coastal Plain of South Carolina, Georgia, and Alabama. *South. J. of Appl. For.* 26(1): 32-36.
- South, D.B. and E.R. Buckner. 2003. The decline of southern yellow pine timberland. *J. of For.* 101(1): 30-35.
- Sheffield, R.M., T.W. Birch, E.C. Leatherberry, and W.H. McWilliams. 1989. The pine-hardwood resource in the eastern United States. In *Proceedings of Pine-Hardwood Mixtures: A Symposium on Management and Ecology of the Type*. USDA For. Serv. Gen. Tech. Rep. SE-58. 9-19 pp.
- Tomczak, D.J. 1994. The mixed stand alternative. *For. Farmer*. 53(2): 15-17

Literature Cited

- Vose, J.M., W.T. Swank, B.D. Clinton, R.L. Hendrick, and A.E. Majors. 1997. Using fire to restore pine/hardwood in the southern Appalachians of North Carolina. In *Proc. First Conference on Fire Effects on Rare and Endangered Species Habitats Conference*. International Association of Wildland Fire. 149-154 pp.
- Waldrop, T.A. 1995. Variations in the fell-and-burn system to regenerate pine-hardwood mixtures in the Piedmont. P. 401-405. In *Proc. Eighth Bienn. South. Silv. Res. Conf.* U.S. Department of Agriculture, Forest Service. Gen. Tech. Rep. SRS-1. 401-405 pp.
- Waldrop, T.A. 1997. Four site-preparation techniques for regenerating pine-hardwood mixtures in the Piedmont. *South. J. of Appl. For.* 21(3): 116-122.
- Waldrop, T.A., E.T. Lloyd, and J.A. Abercrombie, Jr. 1989. Fell and burn to regenerate mixed pine-hardwood stands: An overview of research on stand development. In *Proceedings of Pine-Hardwood Mixtures: A Symposium on Management and Ecology of the Type*. USDA For. Serv. Gen. Tech. Rep. SE-58. 75-82 pp.
- Yangbao, S. 2004. Unpublished Data. University of Tennessee Forestry, Wildlife, and Fisheries Department.

