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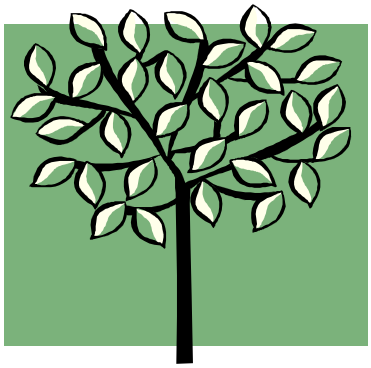
Stand Manager

Technical Development, Planning and Utilization Unit Newsletter
NC Forest Service (NCFS) - NCDA & CS



Tech Update:

By Barry New

In this issue, we provide technical information and research results targeted toward two tree species that the NC Forest Service is devoting increased efforts, namely longleaf pine and shortleaf pine. These efforts will help to provide activities toward our strategic objectives in the NC Forest Action Plan. They include objective 4.3— To advocate and promote markets for forest derived ecosystem services and non-timber products, and objective 5.3—Promote the restoration and conservation of declining tree species and forest ecosystems. "Maintain and Restore Forests in Decline" is a key Departmental Initiative that has been incorporated into the NCDA & CS Strategic Plan.

Also in this issue is cooperative research results with NC State University regarding an Agroforestry trial that was established on NCDA & CS land along with forest economic analysis of conservation payments for off-base RCW mitigation on private land. Our nursery and tree improvement program continues to support both federal & state initiatives to develop future capacity for tree species of concern. The last article provides a summary on growing hardwood tree species to meet a projected increased demand for woody biomass from emerging bioenergy markets in the southern US.

Inside this issue:

Pine Silviculture

By Ron Myers

Site Evaluation For Shortleaf Pine Restoration

Shortleaf pine is an important but declining tree species in the southeastern US. Compared to the widely planted loblolly pine, restoration of shortleaf pine deserves an increased consideration for future management because of desirable traits that make it resilient to climate change, tolerant to drought conditions, and management acceptance of prescribed fire to provide multiple benefits for wildlife habitat and ecosystem benefits. To be successful with any shortleaf pine restoration efforts, it will be important to properly evaluate the site potential or site index (SI) for potential management.

Several methods have been developed for predicting site index for a species when it cannot be directly measured, and may be determined using either: (1) association of site quality classes with soil series, soil mapping unit, or some other soil physical properties, (2) prediction of SI from a mathematical equation using measured soil and site characteristics.

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Pine Silviculture Continued:

Early work in the Piedmont region examined the relation of soil characteristics and properties to site index of loblolly and shortleaf pines (Coile 1948, Coile and Schumacher 1953). Soil features most often correlated with shortleaf pine site quality are surface soil thickness, depth to a restricting, mottled, or less permeable horizon; surface soil texture, subsoil texture, and subsoil consistency. Both texture and structure are correlated with consistence that can be grouped into subsoil classes. These variables can influence soil aeration, internal drainage, moisture holding capacity, and ultimately the growth of tree roots important for long-term tree productivity and health.

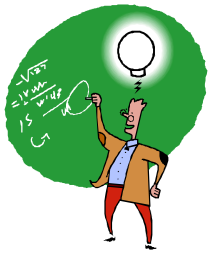
Table 1: Site Index values for Shortleaf pine in the Piedmont Plateau by Subsoil class.

	Depth to Subsoil (inches)						
Subsoil Consistence	**2**	**4**	**6**	**8**	**10**	**12**	**18**
Very Friable	51	62	66	68	69	70	71
Friable	47	59	62	64	65	66	67
Semi-Plastic	43	54	58	60	61	62	63
Plastic	38	49	53	55	56	57	58
Very Plastic	33	44	48	50	51	52	53

[1]Coile and Schumacher 1953

The best shortleaf pine sites are usually on well-drained, medium textured soils, with a good depth of A horizon (> 6”). Medium-textured soils make good sites because they have adequate available soil moisture and nutrient levels, good soil structure, internal drainage and aeration, all of which favor tree root development. Fine-textured soils generally have adequate soil moisture, but they are often of lower site quality because of dense clay subsoil with poor structure, internal drainage and aeration, or lack of A horizon from erosion. Sites where soils are composed of alluvium present a special situation where drainage class, the depth of the slope, and distance to the drainage channel may have equal or greater effects on site quality than properties of the soil profile alone. In the western part of the range of shortleaf pine, topographic features affecting site quality are aspect, slope steepness, slope position, slope shape, and elevation. The best sites are generally on N to E facing, gently sloping, concave, or lower slope positions, while poor sites are on narrow ridges and S to W facing, steep, convex upper slopes (Graney 1986).

Site Index Relationships



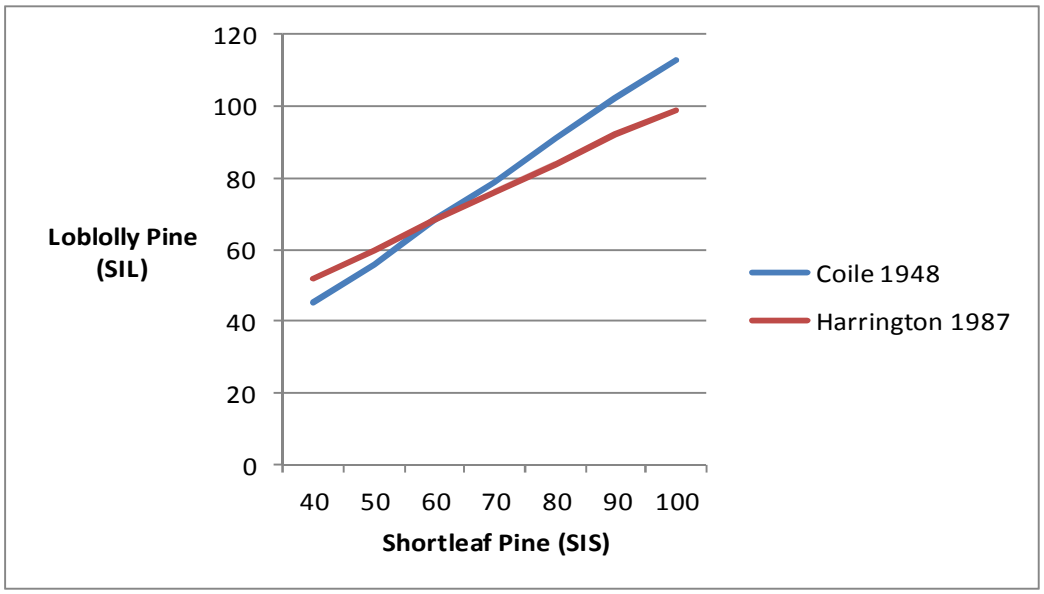
Although site index can be predicted using soil characteristics, another approach has been to use the measured site index of a commonly associated species. Site index comparisons between loblolly and shortleaf pine indicate that the SI of either species can be predicted using the SI of the other. The relationship between site index values for both **loblolly pine (SIL) and shortleaf pine (SIS)** appear to be linear, with the mean difference in SI greatest on poor sites and decreasing as site quality improves. Early research by T.S. Coile on shortleaf pine in the Piedmont region of NC found that loblolly pine site index was always higher than that of shortleaf with no significant differences attributed to topographic position class alone. Coile’s simple regression equations using SI alone and no site/soil variables produced the following: **SIS = 0.885(SIL) and SIL = 1.13(SIS)**, using a zero intercept method.

Harrington's research included a larger sample of plots (190) between the two species in nine southern states and examined geographical difference between plots located in the east vs. west along with effects from elevation and mean slope percent. He found that simple regression equations predicting the SI of one species using only the SI of the other species were not significantly different for plots in the east and west and that the correlation coefficients and standard errors were higher in eastern plots.

His simple regression equations for SI for both species were as follows **SIS = 0.963(SIL) – 1.62** with standard error of 5.70 and **SIL = 0.791(SIS) + 20.68** with standard error of 5.17 The correlation coefficient was the same for both equations with (R^2)=0.872 Using these simple regression equations from Harrington and Coile, a site index comparison graph can be produced for graphical interpretation of SI for both species on the same land (Figure 1).

Site index differences between shortleaf and loblolly pine in mixed stands are usually 10-15 feet on better sites in the Carolina Piedmont and 0-10 feet, depending on the soil and site conditions in the western part of the range. However, Harrington's research suggests that contrary to past perceptions that shortleaf pine would be most competitive with that of loblolly pine on poor sites, site index of shortleaf pine was most comparable to loblolly pine on the better sites.

Figure 1: SI Comparison for Loblolly pine and Shortleaf pine on the same land.



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AgroForestry

By Fred Cubbage and Ron Myers

Early Tree Growth, Crop Yields, and Estimated Returns for an Agroforestry Trial In Goldsboro, North Carolina

The NC Forest Service cooperated with researchers at NC State University on an agroforestry project that was established at the Center for Environmental Farming Systems in Goldsboro, North Carolina in January 2007. The NC Forest Service provided technical field assistance with species/site evaluation, forest tree seedlings, and tree planting recommendations. Below is a short abstract summary of the results that have been published in the above scientific paper.

Abstract: A 17 acre (6.9 ha) agroforestry research and extension alley cropping trial was established at the Center for Environmental Farming Systems in Goldsboro, North Carolina in January 2007, with a randomized block design with five replications. Loblolly pine (*Pinus taeda)*, longleaf pine (*Pinus palustris)*, and cherrybark oak (*Quercus pagoda*) were planted in staggered rows, with each species planted for 140 ft (43 m) per Replication. Crop land alleys of 40 ft or 80 ft (12.2 to 24.4 m) wide were left between the tree rows. Crops of soybeans (*Glycine max*) and corn (*Zea mays*) were planted in alternating years since establishment.

Agroforestry Trial on NCDA land in Goldsboro, NC

As of 2011, survival rates were 93% for cherrybark oak, 88% for longleaf pine, and 97% for loblolly pine. Average tree diameter at ground level was 1.0 in (2.5 cm) for cherrybark oak, 2.1 in (5.3 cm) for longleaf, and 3.2 in (8.1 cm) for loblolly. Heights averaged 4.6 ft (1.4 m) for cherrybark oak, 5.2 ft (1.6 m) for longleaf pine, and 10.4 ft (3.2 m) for loblolly pine. Growth, yield, and economic projections for traditional timber production indicated that species volumes and values tracked the height and diameter relationships measured on the site. Loblolly pine had the largest projected internal rate of return, at 7.2%, followed by longleaf pine with pine straw harvests at 5.5%, longleaf without pine straw at 3.5%, and cherrybark oak at 1.9%. Their discounted land expectation values (and annual equivalent values) per acre at a 4% discount rate were $789 ($32) for loblolly; $346 ($11) for longleaf with pine straw; -$49 (-$2) for longleaf; and -$376 (-$15) for cherrybark oak.

There might be more loss in crop and silvopasture production from shade and root competition with loblolly, however, and production of pine straw for longleaf or acorn mast from cherrybark oak may offer other benefits. Crop yields on the sandy soils on the site were very poor during the four years observed, which had a series of droughts and floods. These led to net financial losses averaging about $150 per acre per year for those four years at the demonstration site, but state-wide average farm budget returns did show moderate profits of about $80 per acre per year. The results support the merits of agroforestry systems in the upper South to diversify income and reduce financial risks.

A summary of the financial returns for tree species is presented in Table 2. These results do not include cost-share payments in the analysis and would represent a baseline minimum that could be expected with the potential for higher returns if cost-share payments were utilized to reduce establishment costs.

Table 2: Growth and Capital Budgeting Results for Three Species for Timber Production Management Regimes at a Discount Rate of 4%

Species	Rotation Age (yrs)	Harvest Years (Thin/ Final)	Total Projected Volume Cut / MAI (ft^3/ac)	Net Present Value ($/ac)	Land Expectation Value ($/ac)	Annual Equivalent Value ($/ac)	Internal Rate of Return (%)
Cherrybark Oak	80	55&80	4,846 61	-360	-376	-15	1.9
Longleaf Pine *Timber Only	40	25&40	2,826 71	-49	-61	-2	3.7
Longleaf Pine *Timber and Pine Straw	40	25&40	2,826 71	274	346	11	5.5
Loblolly Pine	25	17&25	2,700 108	493	789	32	7.2

Over the 5 year study period, the forest tree species prospered more than the crops, which were almost failures two out of the four years. Between the periods of 2007-2010 alternate years of either soybeans or corn resulted in negative returns/acre. If indeed climate change does occur and is associated with decreased summer rainfall and higher temperatures, agroforestry systems with crops, or particularly livestock, do appear to be more viable to diversify farm risk and ensure that at least some timber returns are produced to offset any frequent years of crop losses.

NCDA Forester David Schnake next to planted oak trees in agroforestry trial.

Early results from this research trial indicate that each of these tree systems could survive and provide some growth and modest financial returns for an agroforestry system—perhaps as much of more than pure crop systems on poor sites. As more time progresses, the alley crop and livestock interactions will make this agroforestry trial and financial returns more complex.

Additional agroforestry information in the form of fact sheets and power point presentations can be found at the **USDA National Agroforestry Center's website at www.unl.edu/nac**

Reference:

Cubbage, Frederick, Viola Glenn, J. Paul Mueller, Daniel Robison, Russell Myers, Jean-Marie Luginbuhl, and Ron Myers. 2012. Early Tree Growth, Crop Yields, and Estimated Returns For an Agroforestry Trial in Goldsboro, North Carolina. Agroforestry Systems. Agroforest Syst DOI 10.1007/s10457-012-9481-0.

Forest Economics

By Fred Cubbage and Ron Myers

Economic Analysis of Payments Required to Promote Increased Longleaf Pine Habitat on Private Lands in NC for Off-Base RCW Mitigation

In 2012, the North Carolina Forest Service collaborated with researchers at NC State University to help develop and analyze stand-level management regimes that are used to manage both Longleaf pine and Loblolly pine for economic comparisons and to determine economic incentives in the form of conservation payments that would be required to promote a change in landowner management preferences. Below is a abstract summary of a presentation of the research that was presented at the Ecosystem Services Conference, December 10-14th, 2012 in Fort Lauderdale, FL.

Abstract: Military bases are central to the Endangered Species Act (ESA) recovery plan for the red- cockaded woodpecker (RCW) in North Carolina. A key strategy proposed for meeting the on base requirements of the ESA is the development of economic incentives to encourage cooperative conservation of RCW habitat between federal military and nonindustrial private agricultural and forest landowners (NIPAFs). **Longleaf pine management regimes were analyzed for three primary goals that included (1) timber maximization, (2) multiple products, and (3) ecological services focused on developing RCW habitat.** Capital budgeting models for land management options consistent with RCW habitat requirements were analyzed and compared with traditional pine management options and agricultural alternatives, using discounted cash flow measures of net present value (NPV) and soil expectation value (SEV) as criteria at a **4% discount rate.** The difference between the base loblolly pine management options and the longleaf pine alternatives provided a baseline opportunity cost for conversion to RCW habitat.

Longleaf pine managed for ecosystem services had lower financial returns than conventional loblolly pine and only yielded a positive NPV with the addition of moderate pine straw revenues. Depending on the site quality and management regime, **the opportunity costs of conversion of loblolly pine to longleaf pine managed for ecosystem services ranged from $485 to $698 per acre with no pine straw income to $56 to $255 per acre with moderate income from pine straw.** These results were highly sensitive to changes in both stumpage price and cost share rate. **The opportunity cost associated with transitioning average agriculture sites to longleaf ranged from $1,612 to $4,655 per acre dependent on the crop,** indicating that any future incentives for habitat creating programs should focus on lands that favor forestry or on poor agriculture lands.

These loblolly and crop opportunity cost estimates could be used as a basis to support conservation payments to provide an economic incentive for NIPAFs to manage for RCW habitat. **The 10 year annual conservation payment that would be required to make longleaf pine financial returns equal to loblolly pine ranged from $58 to $83 per acre per year with no pine straw income and $7 to $50 per acre per year with moderate income from pine straw.**

These conservation payment rates are reasonable, and suggest payments for ecosystem services offer potential to establish longleaf pine ecosystems and create additional RCW habitat on nonindustrial private agriculture and forest lands. Other possible RCW ecosystem payments that could be investigated could include paying much of the costs for longleaf stand establishment, or paying landowners to extend the harvest of old loblolly pine or longleaf stands for up to 30 years.

RCW tree in LL stand at BLSF

Reference:

Glenn, Viola, Fred Cubbage, and Ron Myers. 2012. Using private lands to mitigate public Endangered Species Act requirements: Opportunity costs for managing for red-cockaded woodpecker habitat on private lands in North Carolina. In: Proceedings, Southern Forest Economics Workers Annual Meeting. In prep. Access at: http://sofew.cfr.msstate.edu/.

Nursery & Tree Improvement News

By Ken Roeder—NCFS Forest Geneticist

NCFS Nursery & Tree Improvement Program Working on Genetically Improved 2nd Generation Shortleaf Pine

In November 2011, a Memorandum of Agreement was signed by the NC Forest Service and the US Forest Service, National Forest System, Southern Region to facilitate Shortleaf Pine nursery and tree improvement projects in NC. In the agreement, both parties agree to work collaboratively, including exchange of personnel and other resources, in matters relating to the genetic improvement and use of shortleaf pine germplasm for the development of new genetic material and orchards for future ecosystem restoration in the south.

Retired USFS Silviculturist John Blanton (L), and current USFS Silviculturist Jason Rodrique (R), standing in a Shortleaf Pine progeny planting in the Nantahalla, NF

NC Forest Service coordinated with USFS Silviculturists and National Forest field personnel to visit and document the location/condition of **10 Shortleaf Pine progeny tests that were established in NC between the years of 1982-1986.** NC Forest Service personnel from TDP, FIA, and Nursery programs measured 6 Shortleaf Pine progeny tests in the Fall 2012 to collect tree and family data on planted Shortleaf pine. Data from these 26-30 year old shortleaf progeny tests are being analyzed by our Forest Geneticist to make future selections in these full sib crosses to create new 2nd generation improved shortleaf pine seed orchards.

Field Notes: Special Projects & FM Activities submitted by County personnel or Foresters

Ranger Training Class Pictures 2012

Ranger Training Level I

Ranger Training Level II

Hardwood Silviculture

By Jeff Wright and Ron Myers

Growing Populus Sp. in the Southern US for Short Rotation Woody Crops (SRWC)

Demand for hardwood from plantation-grown stands for pulp and bioenergy in the southern US is more than 90 million tons/year and is increasing. Several fast growing hardwood species are being evaluated for planting to fill this potential demand. The genus *Populus*, with more than 30 species, has some of the fastest growing trees in the world. The native range of *Populus* is primarily North America, Europe, North Africa and parts of Asia. *Populus sp.* is currently important for pulp production in the western US, Europe and China as well as for certain lumber applications in China and Europe. The reasons are rapid growth rates, as well as highly desirable wood properties for multiple forest processing industries.

In parts of the US, *Populus sp.* has the potential to substantially increase forest productivity for a wide variety of forest product uses. The United States Department of Energy has identified *Populus sp.* as being an important woody biomass feedstock. *Populus sp.* offers multiple advantages as a biomass crop including high productivity on short rotations, potential for planting on marginal lands, multiple crops from a single planting (coppicing ability), high bulk density, excellent fiber properties and high carbon storage. *Populus sp.* commonly planted in the US and worldwide includes cottonwood and hybrid poplar.

Best plantation growth will be realized when timely and adequate silvicultural management is practiced. Actual yields will vary due to climate, site conditions, and management inputs. Future success of any hardwood plantation project will depend on several important factors that include proper site selection, adequate site preparation, quality seedlings and tree planting, and appropriate cultural treatments for follow-up care.

Site Selection - Site selection should be made at least one year before the planned planting date to permit time for chemical and mechanical site preparation treatments. Moderately well to well drained soils with some degree of clay content for water retention are desirable. Avoid excessively well drained or poorly drained sites and soils with pH less than 5.0 or greater than 8.0. Somewhat poorly drained soils that have good internal drainage can be used if bedding is conducted.

Site Preparation - Beginning chemical site preparation treatments at least one year earlier than the planned planting date will usually provide the flexibility needed to get hard-to-kill pine, hardwood and grass species under control prior to planting. Ensure that appropriately labeled herbicides are used for hardwood planting purposes to ensure no herbicide carryover issues. Mechanical site preparation should consist of bedding or subsoiling that is completed between mid-summer and early fall. *Populus sp.* requires a combination of both chemical and mechanical site preparation for best growth. Old-field sites may need to be subsoiled for improved site conditions following cultivation.

General guidelines as to the geographic areas various hardwood species are adapted to in the eastern US.

Tree Planting - Normally with cottonwood and hybrid poplar planting is accomplished by pushing 12-18" long sticks into the soil leaving only the upper 1-2 buds above the soil surface. Spring planting is preferred. Best survival and growth will occur with cottonwood if planting is done about 3 weeks before the expected last frost date. Hand planting is the norm but mechanical planting is possible depending on equipment and contractor experience with sticks and/or container stock. Tree planting for pulpwood regimes should plant between 450-600 TPA while a bioenergy regime may plant between 800-1,200 TPA on shorter rotations. The upper limit to plant may depend on the water holding capacity of the soil.

Table 3: Suggested Rotation Length and Yields for Populus sp.

Species	Bioenergy Rotation (3-5 Yrs.)	Pulpwood Rotation (8 -10 Yrs.)
Cottonwood	**MAI** 8-12 Tons/Acre/Yr.	**MAI** 14-18 Tons/Acre/Yr
Populus	**MAI** 12-16 Tons/Acre/Yr	**MAI** 14-18 Tons/Acre/Yr

Weed control - After planting, follow-up herbaceous weed control is a must. Complete weed control for the first 1.5 years will be needed on most sites. Once the trees have closed canopy, no additional weed control is necessary. Note that pine site preparation or release tank mixes will result in *Populus sp.* mortality or stunted growth. All label and safety instructions should be adhered to during herbicide applications to prevent seedling damage or loss.

Fertilization - Nutrient management is also essential. A soil analysis should be done before planting or application. Any macro and micro nutrient deficiencies should be corrected with a base fertilization before planting occurs. After crown closure at age 2-3 years, broadcast application of 150-200 lbs/acre urea may be needed on some soils. Weed control must be adequate before any nitrogen application. Once the stand is fully established and the site is fully captured, no additional fertilization is usually required.

3 Yr. old hybrid Poplar near Roxboro, NC

Insect Control - Cottonwood leaf beetle can be a serious insect pest. Plantations should be monitored for signs of infestation. A systemic insecticide such as Admire Pro could be injected in the soil at each tree early in the growing season for control. Later in the season, a foliar application of Sevin could be applied as an effective means of control.

2 Yr. old hybrid Poplar near Columbia, SC

Hardwood plantations may offer landowners an attractive rate of return if an increased demand for biomass feedstock develops along with higher stumpage prices for the end use products. They often have high upfront costs from establishment practices and cultural treatments, however a coppice rotation can be utilized in successive years to lower future costs. Lesser upfront costs means greater returns from similar harvest values.

For more information about growing Populus sp. Contact **ArborGen** at www.ArborGen.com or 1-843-991-2911 or jawright@arborgen.com

References:

Jeff Wright. Growing Populus sp. in the southeastern US. Internal Arborgen Technical publication.

Dougherty & Wright. 2012. Eucalyptus for US south. BioResources 7(2), 1994-2001.