Forestry and Tree Planting in North Carolina

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Abstract

North Carolina's forests cover more than 18.6 million acres (7.5 million hectares), equaling more than 59 percent of the State's land area. Nearly 97 percent of this forest land is capable of timber production. Forestry contributes more than $6 billion annually to the State's economy. The State's forests are genetically and commercially diverse and support more than 60 major tree species. Many other species are also important to the State's native forest ecosystems. Major forest types are oak and hickory; loblolly and shortleaf pine; oak, gum, and cypress; oak and pine; and longleaf pine. State forestry programs support these species, other important species, and ecosystem restoration efforts. More than 50 million tree seedlings are planted annually, 16 million of which are produced by State nurseries. While most of these seedlings are softwoods, local hardwood seed is also collected and expansion of container seedling operations continues. Inroads have been made in growing more specialty species for wetland and streambank restoration needs. Understory herbaceous plants are also being grown for longleaf pine ecosystem restoration projects. Support for the State nursery is still strong, and landowners are encouraged to plant and reforest lands as part of their long-term forest management.

Introduction

Forestry in North Carolina has a long history, beginning with the naval stores industry of colonial times. From 1720 to 1860, North Carolina's pine forests were plentiful, and the resin extracted from longleaf pine was used for tar, pitch, and turpentine. This use was unsustainable, however, and partially led to the industry's demise. The State is considered the birthplace of professional forestry in America. In 1892, Gifford Pinchot, who later became the first Chief of the Federal agency that would become the Forest Service, served as the first Forest Manager for George W. Vanderbilt's Biltmore Estate where he developed and implemented a forest management plan (Goodwin 1969). Subsequently, in 1895, German forester Dr. Carl A. Schenck went to North Carolina to succeed Gifford Pinchot as manager, and 3 years later, in 1898, Schenck founded the Biltmore Forest School. About 300 students attended the school during Schenck's tenure, including Fredrick Weyerhaeuser. The students managed a nursery at Brevard that produced a wide variety of tree species. During this time, the first North Carolina (and possibly the United States) commercial forest tree plantings occurred.

In 1891, W.W. Ashe became the first State employee to carry out timber assessments for the North Carolina Geologic Survey. Ashe became the first forestry expert in 1908 when a separate State Forestry Division was created as part of the N.C. Geological and Economic Survey. In 1909, J.S. Holmes was appointed as the first State employed graduate forester. The early establishment of the State forestry agency occurred in 1921 when forest protection from pests and wildfires was the driving public concern in North Carolina.

The founding of the Civilian Conservation Corps (CCC) ushered in a period of extensive tree planting in the State. CCC crews within North Carolina planted about 15 million seedlings from 1933 to 1938. The Soil Bank days of the 1950s increased the amount of tree planting and, by the 1960s, private forestry companies began plantation management on a large scale in the State. Georgia-Pacific, Weyerhaeuser, and Federal Paperboard, among other companies, planted millions of seedlings on their land holdings. The North Carolina State nurseries produced the bulk of these seedlings by supplying more than 100 million annually. Within a short time period, Weyerhaeuser and Federal Paperboard began operating their own nurseries and the planting of genetically improved seedlings became common in the State. In 1977, the State Forest Development cost-share program was authorized by the North Carolina General Assembly and, in 2004, the one-millionth acre was planted in the State using this program.

Forestry has developed and been recognized for its outreach into management of other natural resources in addition to the scientific management of forest ecosystems. Forestry, logging, wood products manufacturing, and forest recreation contribute more than $6 billion annually to the North Carolina economy (Brown 2007, NCDFR 2009a).

North Carolina's Environment

North Carolina is one of the most physiographically diverse States in the Eastern United States. Three distinct physiographic provinces exist: the Coastal Plain, the Piedmont, and the Mountains (figure 1). Elevations range from sea level to 6,684 ft

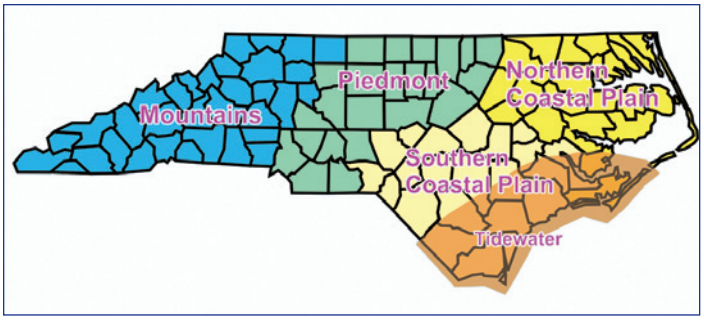

Figure 1. The three physiographic regions of North Carolina based on survey unit (county) boundaries. The tidewater area in the coastal plain is a poorly drained area adjacent to the coast (Source: Unpublished North Carolina Division of Forest Resources, 2011).

(2,037 m), the highest point east of the Rocky Mountains. The State also has more peaks higher than 6,000 ft (1,830 m) than any State east of the Mississippi River (SCONC 2011) and possesses the most extensive system of barrier islands in the United States. These islands extend east into the Atlantic Ocean and are subject to frequent exposure to Atlantic Ocean storms, including hurricanes and nor'easters. Not far inland are pocosins and Carolina bays, more concentrated in North Carolina than in any other State (NCDSS 2011). Deep swamp areas are also common in the eastern one-third of the State.

The climate in North Carolina is also diverse and varies from the Atlantic coast in the east to the Appalachian Mountain range in the west. The mountains often act as a shield by blocking cold temperatures and storms from the Midwest from entering the Piedmont region of North Carolina (SCONC 2011). Temperatures rarely go above 100 °F (38 °C) or fall below 10 °F (-12 °C), but differences in altitude and proximity to the ocean create significant local variations. Rainfall ranges from 35 to 40 in (89 to 102 cm) annually in the Piedmont region, to larger amounts along the coast (70 to 80 in [178 to 203 cm]), to greater than 100 in (254 cm) in the Great Smoky Mountains in the southwest of the State (C-DC 2010). The Mountains are as likely to experience the effects of tropical storms originating from the Gulf of Mexico as the Coastal Plain is likely to experience the effects of tropical storms originating from the Atlantic.

Natural Areas

North Carolina occupies 31.2 million acres (12.6 million hectares) (figure 2). Of this area, 59 percent is forested (Bardon and others 2010). The remaining land consists of urban and industrial development, farmland, and inland water. Of the forested areas, 2 percent are classified as reserved forest land. These forest lands extend across the 17 major river basins in North Carolina (figure 3) (NCDWR 2011).

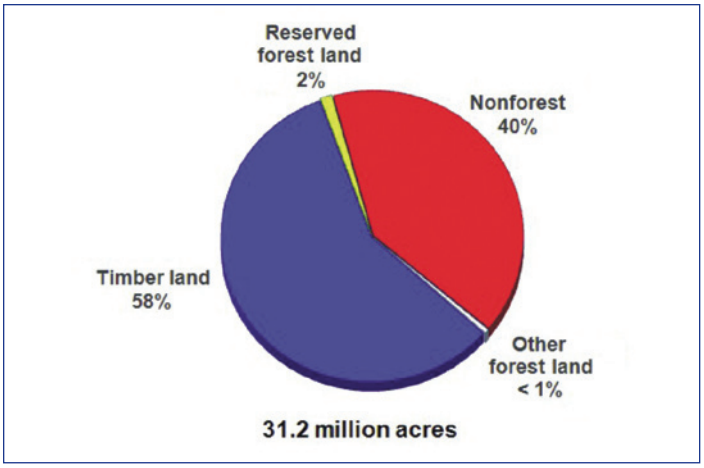

Figure 2. Classification of land area in North Carolina (Source: Bardon and others, 2010).

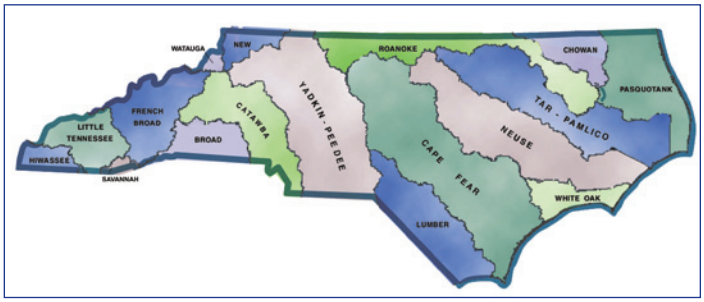

Figure 3. North Carolina river basins (Source: North Carolina Department of Environment and Natural Resources, 2011 available on Web: http://www.ee.enr.state.nc.us/public/ecoaddress/riverbasins/riverbasinmapinteractive.htm).

The North Carolina Division of Forest Resources (NCDFR) recognizes 13 major forest types; 5 are softwood types and 8 are hardwood types (table 1). The oak/hickory (upland hardwood type) and the loblolly/shortleaf pine (upland softwood type) are the most abundant forest types in the State. Planted stands account for about one-half of the loblolly/shortleaf area (figure 4). Planted oak/pine stands usually result from significant hardwood competition and pine stocking levels that precluded classification as a pine type. Many of these stands originated as pine plantations. Over time and due to natural succession, hardwood species have invaded and thrived, and the distribution of species has changed to a mixed stand.

The 13 forest types are more practically consolidated into six management units based on species, stocking, and stand origin. The six management units are upland hardwood, natural pine, plantation pine, lowland hardwood, oak-pine, and nonstocked (table 2).

Coastal Plain

The land and inland water areas of the Coastal Plain comprise nearly one-half of the State's land area and are divided into northern and southern subregions (figure 1). It can be further

subdivided into two sections based on drainage: the tidewater area, which is along the coast and in large part low, flat, and swampy; and the interior portion, which is gently sloping and, for the most part, naturally well drained. Throughout the Coastal Plain, soils consist of soft sediment, with little or no underlying hard rock near the surface. The elevation ranges from about 200 ft (60 m) at the fall line, or western boundary, to less than 50 ft (15 m) higher than the tidewater area (SCONC 2011).

The Coastal Plain is 59 percent forested and contains almost 49 percent of the State's timber land (tables 1 and 2). Because the Coastal Plain contains the State's lowest elevations and has the smallest gradients in elevation, this area contains most of North Carolina's swamps and pocosins. Riverine systems are typically slow, more meandering, and of blackwater type if originating from within the region. Because of these features, most North Carolina bottomland hardwood and cypress forests (a combined 84 percent) are found in the Coastal Plain. Loblolly pine (*Pinus taeda* L.) is the most prevalent softwood type in the region, and nearly all of the State's longleaf pine (*Pinus palustris* Mill.) and pond pine (*Pinus serotina* Michx.) are found there. Unique to this region of the State, Atlantic white cedar (sometimes referred to as AWC or juniper) (*Chamaecyparis thyoides* L. [B.S. & P.]) once covered

Table 1. North Carolina timber land area by forest plant community type and survey unit (2007 survey data).

Forest plant community type	North Carolina physiographic province			
	Coastal Plain	Piedmont	Mountains	Total
	Acres (hectares)			
Hardwoods				
Aspen/birch	0 (0)	0 (0)	1,508 (610)	1,508 (610)
Elm/ash/cottonwood	253,448 (102,567)	250,686 (101,450)	12,164 (4,923)	516,298 (208,938)
Exotic hardwoods	3,775 (1,528)	0 (0)	2,948 (1,993)	6,723 (2,721)
Maple/beech/birch	0 (0)	0 (0)	56,895 (23,025)	56,895 (23,025)
Oak/gum/cypress	1,763,321 (713,590)	123,951 (50,161)	0 (0)	1,887,272 (763,752)
Oak/hickory	1,388,073 (561,733)	2,790,366 (1,129,221)	3,110,179 (1,258,645)	7,288,618 (2,949,600)
Oak/pine	1,141,857 (462,093)	792,957 (320,898)	380,836 (154,119)	2,315,650 (937,110)
Other hardwoods	5,810 (2,351)	0 (0)	109,279 (44,224)	115,089 (46,575)
Hardwoods total	4,556,284 (1,843,863)	3,957,960 (1,601,729)	3,673,809 (1,486,738)	12,188,053 (4,932,330)
Softwoods				
Loblolly/shortleaf	3,807,672 (1,540,910)	1,305,697 (528,397)	115,707 (46,825)	5,229,076 (2,116,132)
Longleaf	289,850 (117,298)	257 (104)	0 (0)	290,107 (117,402)
Other eastern softwoods	1,453 (588)	26,769 (10,833)	1,518 (614)	29,740 (12,035)
Spruce/fir	0 (0)	0 (0)	12,063 (4,882)	12,063 (4,882)
White/red/jack pine	0 (0)	1,025 (414)	134,085 (54,262)	135,110 (54,677)
Softwoods total	4,098,975 (1,658,796)	1,333,748 (539,749)	263,373 (106,583)	5,696,096 (2,305,128)
Nonstocked	111,287 (45,036)	35,978 (14,560)	11,644 (4,712)	158,909 (64,308)
Total	8,776,546 (3,551,742)	5,327,686 (2,156,038)	3,948,826 (1,598,033)	18,043,058 (7,301,766)
Total percent	49%	30%	21%	100%

Source: U.S. Department of Agriculture, Forest Service, Forest Inventory and Analysis, 2010.

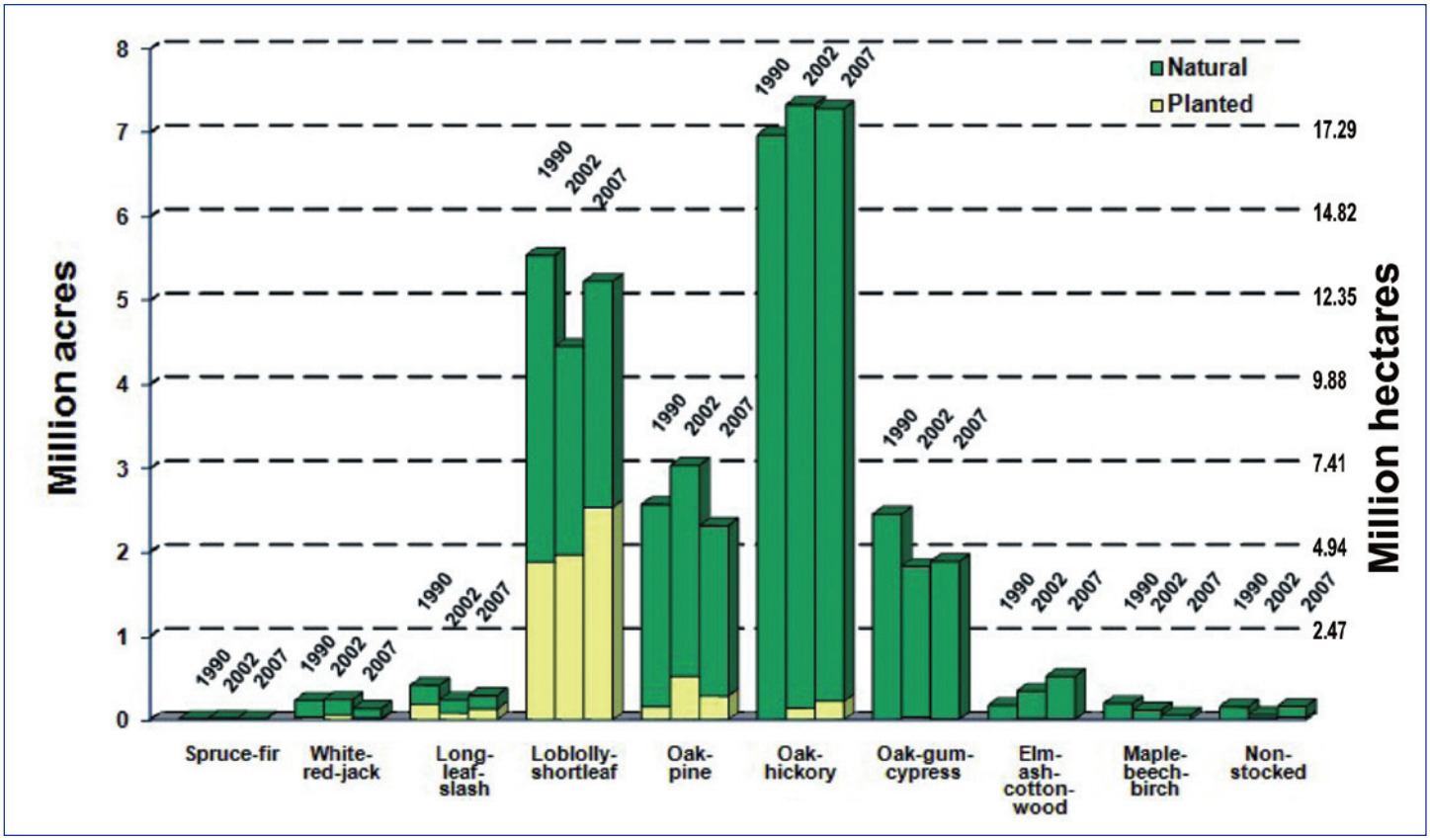

Figure 4. Trends in timber land area by seedling type and forest community type (Source: Bardon and others, 2010).

Table 2. Timber land area by North Carolina physiographic province and forest management type.

Forest management type	North Carolina physiographic province			
	Coastal Plain	Piedmont	Mountains	Total
	Acres (hectares)			
Upland hardwoods	1,397,658 (565,612)	2,790,366 (1,129,221)	3,280,809 (1,327,696)	7,468,833 (3,022,530)
Natural pine	1,956,414 (791,733)	830,384 (336,044)	229,487 (92,870)	3,016,285 (1,220,647)
Planted pine	2,142,560 (867,063)	503,365 (203,705)	33,886 (13,713)	2,679,811 (1,084,481)
Lowland hardwoods	2,016,769 (816,157)	374,637 (151,610)	12,164 (4,923)	2,403,570 (972,690)
Oak-pine	1,141,857 (462,093)	792,957 (320,898)	380,836 (154,119)	2,315,650 (937,110)
Nonstocked	111,287 (45,036)	35,978 (14,560)	11,644 (4,712)	158,909 (64,308)
Total	8,766,545 (3,547,695)	5,327,687 (2,156,038)	3,948,826 (1,598,074)	18,043,058 (7,301,766)

Source: U.S. Department of Agriculture, Forest Service, Forest Inventory and Analysis, 2010.

large expanses but is now confined to small areas. Many of the ecosystems found here are fire dependent and will change when fire is excluded.

Piedmont

The Piedmont province is 51 percent forests and represents 30 percent of the State's timber land. The Piedmont province contains the State's largest metropolitan areas, the highest population concentrations, and the most nonforested areas of all the regions in North Carolina. The Piedmont province terrain is much more varied than the Coastal Plain terrain and includes a wide range of tree species. Hardwoods predominate, but mixed stands are common, with loblolly pine the most abundant softwood type and Virginia pine (*Pinus virginiana* Mill.) second (tables 1 and 2). The most common hardwood

stands are the white oak-red oak-hickory forest type followed closely by the yellow poplar-oak and the sweetgum-yellow poplar. Riverine systems encounter more gradient here; because of the higher clay mineral content of the soils and movement of these minerals into the drainages, they are referred to as the red river bottom type.

Mountains

The Mountains are 76 percent forested and contain 21 percent of the State's timber land. The region contains most of the State's reserved timber land, primarily in the Great Smoky Mountains National Park. The Mountains have the highest proportion of publicly owned timber land in the State, mainly because the Pisgah and Nantahala National Forests are located here. The Mountains have fewer large cities and urban development than the State's other regions and contain the State's highest elevations and most rugged terrain. Because of the topography, the Mountains are where the headwaters of many streams occur. Waters here are often whitewater in nature, and most are classed as freestone streams—those formed from rainfall and snowmelt. The Mountains are dominated by upland hardwoods, which account for 80 percent of the region's timber land. Chestnut oak, black oak, and scarlet oak stands dominate the region, followed by white oak, red oak, and hickory stands and then by yellow poplar, white oak, and northern red oak stands, in terms of abundance (tables 1 and 2).

The Mountains' highest elevations also contain tree genera typically occurring at more northern latitudes, such as spruce (*Picea*), fir *(Abies*), and birch *(Betula*). Eastern white pine (*Pinus strobus* L.) is the most common softwood type found here.

Forest Land Ownership

Approximately 14.1 million acres (5.7 million hectares), or about 78 percent of the State's timber land, is owned by non-industrial private forest (NIPF) landowners (figure 5). The proportion of NIPF ownership is 91 percent in the Piedmont, 74 percent across the Coastal Plain, and 70 percent in the Mountains. Ownership by timber investment management organizations has been increasing in the past decade. Forest industry timber land ownership accounts for 8 percent of all timber land (14 percent of Coastal Plain, 3 percent of the Piedmont, and 1 percent of the Mountains).

Timber land ownership by public agencies accounts for 14 percent of all timber land in the State. Public ownership of timber land has increased by about 10 percent since 2002. Public ownership is highest in the mountains, largely due to National Forest System holdings there.

Challenges Facing the State's Forests

Urbanization

As the North Carolina population grows, so does the rural-urban interface. This expanding interface increases demand on forests for water, recreation, and aesthetics, as well as for traditional wood products. Incoming residents in these areas are typically unfamiliar with North Carolina's native forest ecosystems, management practices, and wildfire danger. Green corridors are becoming narrower and disjointed and some forests are becoming smaller. Many of the ownerships in this interface are only a few acres (hectares) in size.

Insects and Diseases

The southern pine beetle (*Dendroctonus frontalis* Zimmermann) is the most destructive forest insect in North Carolina, attacking trees of all age classes. Populations are cyclical; a beetle population-monitoring program is in place. Ips engraver beetle (*Ips* spp.) is the second most destructive insect pest in the State.

Young loblolly pine seedlings are susceptible to pine tip moth (*Rhyacionia* spp.) and to fusiform rust (*Cronartium quercuum* f. sp. *fusiforme* [Hedgc. & N. Hunt] Burdsall & G. Snow), especially when the alternate host is present. Genetic improvement of loblolly pine has made great strides in finding resistant families. These families are now recommended for high rust hazard sites.

Shortleaf pine (*Pinus echinata* Mill.) is susceptible to fusiform rust, pitch canker (*Fusarium subglutinans* (Wollenweb. & Reinking) P.E. Nelson, Toussoun & Marasas f. sp. pini), and littleleaf disease (*Phytophthora cinnamomi* Rands).

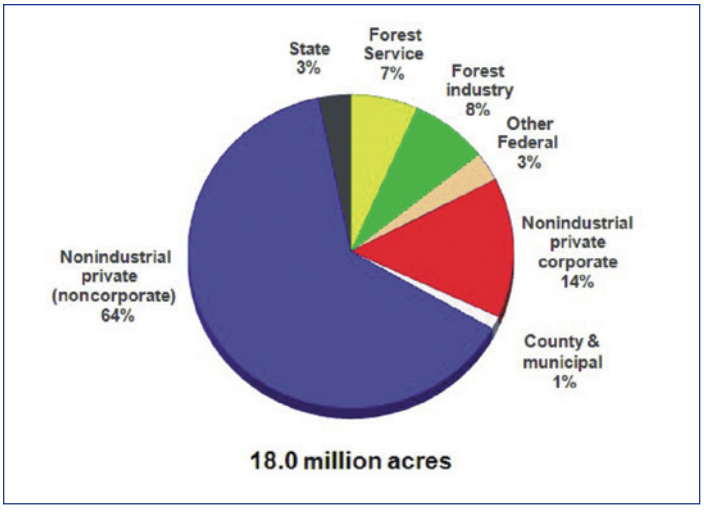

Figure 5. Area of timber land ownership in North Carolina (Source: Bardon and others, 2010).

Phytophthora is becoming endemic and also kills Fraser fir (*Abies fraseri* [Pursh.] Poir.). Eastern white pine is resistant and is recommended as an alternative species to Fraser fir on those sites, which are infected with Phytophthora. Eastern white pine, however, is susceptible to white pine blister rust, (*Cronartium ribicola* J.C.Fisch.) and white pine weevil (*Pissodes strobi* Peck). Combined, these pests reduce the value of white pine in the State.

Longleaf pine shows a high resistance to fusiform rust, tip moth, and fire (Barnard and Mayfield 2009) but is susceptible to pitch canker. Brown-spot needle blight (*Scirrhia acicola* [Dearn.] Siggers.) is also a problem.

More details regarding North Carolina's current forest health are available in the 2010 Forestry Assessment (Bardon and others 2010).

Drought

Currently, most of the North Carolina Piedmont is in a severe drought (NCDMAC 2011). Surrounding areas are designated as being in moderate drought. In recent years, drought has played a significant role in the occurrence and severity of forest fires.

Wildfire

North Carolina has a distinct forest fire season. This season has been extended due to the recent drought conditions affecting the State. In addition, fires have become more serious due to the increase in the number of residents living in the rural-urban interface. This situation is problematic due to the extent of fire-dependent ecosystems that are present.

North Carolina's State Forestry Agency

After preparation of this article, the North Carolina Division of Forest Resources that was under the North Carolina Department of Environment and Natural Resources is now the North Carolina Forest Service as of July 1, 2011, and is now part of the North Carolina Department of Agriculture and Consumer Services.

Founding legislation for NCDFR directs the forest agency to provide the State with forest protection (from wildfires and pests). NCDFR operates out of a Central Office located in the State capital in Raleigh. Forestry operations are organized under three regional offices, one located in each of the physiographic regions of the State (Region 1–Coastal Plain, Region 2–Piedmont, and Region 3–Mountains). Within each region are several districts, each covering several adjacent counties. Regional and district staff provide support to the county level programs.

The agency owns and operates very little public land but does manage two operational State forests, seven educational State forests, three training facilities, and three forestry centers. The agency also operates two State nurseries to make forest tree seedlings available to landowners and other citizens across the State. A forest tree improvement program supports the nursery operations to provide the most genetically appropriate seedlings for planting in North Carolina. NCDFR also maintains an aviation program to provide reconnaissance for forest protection efforts and suppression resources for wildland firefighting. Other programs include law enforcement, forest management, forest health, water quality, urban forestry, and other public outreach programs. NCDFR is currently involved in developing a strategic plan to better serve North Carolina citizens. This effort will also evaluate the success and role of tree planting in the State.

The largest State forest NCDFR manages is Bladen Lakes State Forest (BLSF) covering about 32,700 acres (13,233 hectares). BLSF is a working forest that is regularly harvested for timber and reforested, mostly with longleaf pine and AWC. Longleaf pine stand management goals also include pine straw, timber, poles, and charcoal. BLSF typically plants more than 200,000 seedlings annually.

Tree Production and Planting in North Carolina

Across the State, trees are typically planted for traditional forest products such as poles, timber, pulpwood, pine straw, watershed, wildlife, aesthetics, as well as for ecosystem restoration, biomass production, landscape plants, and Christmas trees. Older, natural hardwood stands are usually harvested to supply lumber to the furniture industry and pulpwood.

The most planted species in North Carolina is loblolly pine, which is the economic forestry giant in the State. Essentially all of these seedlings are genetically improved. The next most planted species is longleaf pine. More than 50 million forest tree seedlings are typically planted in North Carolina each year (table 3). These quantities are expected to remain at this level during the next few years.

For stand establishment, weed control is one of the most important cultural practices undertaken before planting (site preparation) and during early stand establishment. If weed control is not vigorously undertaken, an entire young stand can be lost.

Stand spacing depends on site and species. Pine stand spacing ranges from 400 to 600 trees per acre (tpa), while hardwoods are typically planted at 350 to 500 tpa. AWC seedlings are

Table 3. Area of pine and hardwood trees planted in North Carolina for 2004 through 2008. Number of trees planted estimated from areas of trees planted.

	2008		2007		2006		2005		2004	
	Pine	Hardwood	Pine	Hardwood	Pine	Hardwood	Pine	Hardwood	Pine	Hardwood
	Acres (Hectares)									
Non-cost-share	26,883 (10,879)	7,116 (2,879)	28,788 (11,650)	7,337 (2,969)	42,084 (17,030)	10,984 (4,445)	40,859 (16,535)	10,825 (4,380)	32,661 (13,217)	11,468 (4,641)
Cost-share	47,598 (19,262)	438 (177)	50,389 (20,392)	452 (183)	48,351 (19,567)	1,057 (428)	46,397 (18,776)	2,201 (890)	66,746 (27,011)	1,463 (592)
Total NIPFO	74,481 (30,141)	7,552 (3,056)	79,177 (3,204)	7,789 (3,152)	90,435 (36,598)	12,041 (4,872)	87,256 (35,311)	13,026 (5,271)	99,407 (40,228)	12,931 (5,233)
Forest industry	24,000 (9,712)	0 (0)	20,000 (8,094)	0 (0)	21,000 (8,498)	0 (0)	20,000 (8,094)	0 (0)	19,000 (7,689)	0 (0)
Government	411 (166)	0 (0)	642 (260)	0 (0)	599 (242)	0 (0)	879 (356)	0 (0)	426 (172)	0 (0)
Total acres (hectares)	98,892 (40,020)	7,552 (3,056)	99,819 (40,395)	7,789 (3,152)	93,134 (37,690)	12,041 (4,872)	108,135 (43,760)	13,026 (5,271)	118,833 (48,090)	12,931 (5,233)
Total number of trees (estimated)	51,425,000	3,250,000	51,910,000	3,350,000	48,500,000	5,200,000	56,250,000	5,600,000	61,800,000	5,500,000
	54,675,000		55,260,000		53,700,000		61,850,000		67,300,000	

NIPFO = nonindustrial private forest ownership.

Note: Numbers are likely to be underreported.

Source: Georgia Forestry Commission's Annual Reforestation Survey (2009).

typically planted at closer spacings (1,500 to 1,700 tpa). Third cycle loblolly pine require wider spacing to allow the trees to grow more freely.

North Carolina State Nurseries

NCDFR operates two public-sector nurseries. Linville River Nursery (Newland, NC) produces more than 300,000 improved Fraser fir greenhouse container seedlings and 1 million improved bareroot eastern white pine seedlings annually. Claridge Nursery (Goldsboro, NC) is located in the mid-Coastal Plain near the center of the State. This nursery grows several species of southern yellow pine and other conifers, hardwoods, and a few specialty species for forestry, reclamation, and restoration plantings. This includes 12 longleaf ecosystem herbaceous species grown for the Longleaf Pine Ecosystem Restoration Program. In all, NCDFR nurseries collect seed and grow more than 16 million seedlings of more than 40 to 50 species annually, most of which are planted as 1-year-old plants.

Both of the State nurseries grow bareroot and container seedlings (figure 6). New U.S. Environmental Protection Agency regulations for pest management chemicals are expected to severely restrict bareroot seedling production in the near future. This will likely result in a shift to container operations and possible increased seedling costs.

Seed sown in these State nurseries are usually collected and processed internally by NCDFR. Seeds are collected from wild stands, seed production areas, and genetically improved seed orchards and clone banks. Seedlings produced from these seed at these nurseries can be certified as local source material for various restoration projects. Seed production areas of the longleaf understory herbaceous species, like wire grass (*Aristida stricta* Michx.), have also been established to supply additional seed. Seedlings of other species may be grown on request as needed. Rare and hard-to-find species can also be produced if sufficient quantities are required. Claridge Nursery typically contract grows seedlings for the North Carolina Department of Transportation, local military bases, and the USDA Forest Service.

Linville River Nursery produces second generation Fraser fir as field-plantable, greenhouse-bench seedlings in 2 years (figure 7). This is a big change from 5-year-old, 3-2 transplants that the Christmas tree industry has used in the past. These field-plantable seedlings make it possible for NCDFR to move commercial quantities of genetically improved seedling to growers' fields 3 years sooner. Eastern white pine is grown and sold as a 2-year-old seedling.

Figure 6. Claridge Nursery container operation showing longleaf and Atlantic white cedar seedlings (Photo source: Brad Stevens, North Carolina Division of Forest Resources, 2008).

Figure 7. North Carolina Division of Forest Resources 2-year-old field plantable greenhouse-bench Fraser fir seedling; shearing knife is shown for scale (Photo source: Ken Roeder, North Carolina Division of Forest Resources, 2009).

Seedling sales via the Internet are increasing. Sales of seedlings have been helped by offering smaller tree quantities that cater to North Carolina residents owning only a few acres (hectares) in the rural-urban interface.

In addition to the two State nurseries, a few major, and many small nurseries are located in the State that produce about 50 million forest seedlings annually for private and industrial tree planting in North Carolina and other nearby States.

Forest Tree Improvement Program

The forest tree improvement program operates in conjunction with the nursery operation to ensure that seedlings being produced are of the best genetic quality for deployment in North Carolina. The tree improvement program's goals are to maximize forest production on the decreasing number of acres in commercial forests in the State. This set of goals means that, in addition to growth rate and wood quality, disease resistance (i.e., fusiform rust) is also being assessed in selection of improved trees. This selection process will increase stand yields of higher quality products across the State. Species being actively improved under this program are loblolly pine, longleaf pine, shortleaf pine, eastern white pine, Virginia pine, AWC, Fraser fir, and sycamore. The tree improvement program is currently producing open pollinated (half-sib from mother trees) and full-sib crossed seed from NCDFR seed orchards. The full-sib loblolly pine seed is from Mass Controlled Pollination, which produces commercial quantities of the best parental crosses (figure 8).

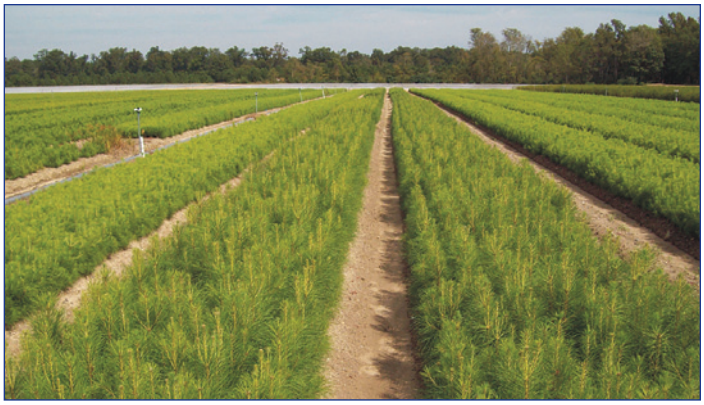

Figure 8. Third Cycle Mass Controlled Pollination seedlings are being grown at Claridge Nursery and are available for planting (Photo source: Ken Roeder, North Carolina Division of Forest Resources, 2009).

Programs Involving Tree Planting

Conservation

Two primary Federal conservation programs are administered in the State by NCDFR. The Forest Stewardship Program provides technical assistance to NIPF landowners to encourage and enable active long-term forest management including reforestation. The primary focus of the program is the development of comprehensive, multiresource management plans that provide landowners with the information they need to manage their forests for a variety of products and services. The Forest Legacy Program is a working forest conservation easement that protects habitat and provides forest products, opportunities for recreation, protection of water quality, and other public benefits.

Cost-Share Programs

Several cost-share tree-planting programs are available through NCDFR and other agencies (table 3). The Forest Development Program (FDP) is one of several cost-share programs providing funding and technical support to promote reforestation and forest improvement activities (NCDFR 2010). More than 1.5 million acres (0.6 million hectares) have been planted under this program. Under current funding levels, this program involves more than 1,500 landowners annually with an average ownership of 37 acres (15.0 hectares) (NCDFR 2009a). These cost-share programs have a large effect on the number of acres (hectares) planted (table 4).

Table 4. Forestry cost-share programs in North Carolina and longleaf pine acres planted under several of these programs.

Short title	Cost-share program title	Program agency	Longleaf pine areas planted under these programs (1997–2007)
			Acres (hectares)
CRP	Conservation Reserve Program	FSA	11,694 (4,732)
FDP	Forest Development Program	NCDFR	25,012 (10,122)
NCA	North Carolina Agricultural Cost-Share Program	NCDSWC	1,779 (720)
CREP	Conservation Reserve Enhancement Program	FSA	1,220 (494)
WRP	Wetland Reserves Program	NRCS	0 (0)
FIP	Forestry Incentive Program	NRCS	244 (99)
EQUIP	Environmental Quality Incentives Program	NRCS	NA
SIP	Stewardship Incentives Program	FS	NA
FLEP	Forest Land Enhancement Program	NCDFR—no longer available	869 (352)
FRRP	Forest Recovery and Rehabilitation Program	NCDFR—no longer available	4,481 (1,813)
FRP	Forest Recovery Program	NCDFR—no longer available	NA
—	No cost-share program	—	13,983 (5,659)

FS = USDA Forest Service. FSA = USDA Farm Service Agency. NA = data not available. NCDSWC = North Carolina Division of Sewer and Water Quality. NCDFR = North Carolina Division of Forest Resources. NRCS = USDA Natural Resources Conservation Service.

Source: NCDFR 2010.

Restoration Projects

Longleaf Pine Restoration

Recognizing the declining longleaf forest acreage, the NCDFR implemented the Longleaf Pine Restoration Initiative. The initiative focuses on artificial forest regeneration as the primary means to restore longleaf pine to sites where it was historically found and adapted to, especially in the southern Piedmont and Coastal Plain (figure 9). An average of 5,000 acres (2,023 hectares) of longleaf pine seedlings are now planted annually (NCDFR 2009b). Longleaf pine ecosystem restoration has also gained importance in recent years with increased production of seedlings and seeds of understory species.

Figure 9. New longleaf pine plantation during summer of second growing season (Photo source: Ken Roeder, North Carolina Division of Forest Resources, 2008).

Shortleaf Pine Restoration

For a variety of reasons, artificial regeneration of shortleaf pine has lagged behind other species. An average of 110 acres (44.5 hectares) of shortleaf was planted each year between 2005 and 2009 on NIPF land (NCDFR 2009a). A number of cost-share assistance programs support shortleaf pine establishment on private lands. North Carolina's FDP is the primary State-administered financial assistance program supporting shortleaf establishment, although the federally funded Environmental Quality Incentives Program, a program of the U.S. Department of Agriculture, Natural Resources Conservation Service, also funds the planting of shortleaf pine. NCDFR helps to develop management plans and provide technical expertise for these programs.

Atlantic White Cedar Restoration

Atlantic white cedar (AWC) was once a common forest type in North Carolina coastal wetlands, but has decreased to less than 10 percent of its original range. Most of the estimated 10,583 acres (4,283 hectares) remaining in North Carolina are on public lands. Exploitive logging, natural regeneration failure, absence of artificial regeneration, drainage effects, fire exclusion, and lack of competition control are cited as reasons behind the decline of AWC forests. North Carolina has identified AWC as a species of concern. NCDFR promotes conservation, restoration, and planting of AWC by providing forest management advice, conducting applied forest management research, and providing workshops and inhouse training.

Future Outlook for Tree Planting in North Carolina

As in most Southern States, urbanization is reducing the land area available for producing traditional forestry products in North Carolina. The acreage of the rural-urban interface is also growing resulting in more people living within native fire ecosystems. Risks to these residents from wildfire have increased. Demand for forest resources is also changing. While the demand for traditional products like pulp, timber, and poles is increasing, more residents also believe more forests are needed to provide clean water, wildlife, aesthetic value, and recreational environments.

More efficient use of North Carolina's forest land base is required. Use of more productive and disease-resistant, genetically improved trees is necessary. The best forest lands must be planted with the best trees and intensively managed with the most appropriate cultural practices. The number of acres planted annually has declined during the past few years. Productivity on every acre has increased, however. Potential productivity of forest land in the State is lost when a site is planted without using appropriate long-term stand management practices.

Some Southern States have closed their nurseries, but support in North Carolina is still strong. In fact, demand for seedlings from the two State nurseries appears to be increasing.

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