Chapter 2. Conserving Working Forest

2.a.

North Carolina's Forests in 2007

Key Findings

- In 2007, North Carolina had 18 million acres of timberland—a gain of 362,000 acres since 2002. The gain reverses a declining timberland trend.
- Hardwood management types on timberland decreased by 489,000 acres, while softwood management types increased by 733,000 acres between 2002 and 2007. The biggest changes were in planted pine, which gained 573,000 acres, and the oak–pine management type, which lost 719,000 acres. Lowland hardwoods and natural pine also gained acreage.
- Ownership of North Carolina's timberland has shifted. Individual private ownership decreased 353,000 acres between 2002 and 2007, while private corporate ownership increased by 249,000 acres. Overall, the nonindustrial private forest (NIPF) class of ownership increased 250,000 acres and accounted for 78 percent of timberland ownership as of 2007. Forest industry ownership decreased 110,000 acres, accounting for 8 percent of timberland ownership. Public ownership of timberland increased 222,000 acres, 14 percent of timberland ownership. The National Forest System manages 46 percent of the publicly owned timberland.
- The volume of live softwood trees increased by nearly 1 billion cubic feet from 2002 to 2007. In 2007 loblolly pine accounted for 62 percent of the softwood volume and remained the predominant softwood species.
- The volume of live hardwood trees increased by nearly 2 billion cubic feet during the period from 2002 to 2007 and accounted for 66 percent of North Carolina's total wood volume. Yellow poplar was the predominant hardwood species, second only to loblolly pine in volume of all species for North Carolina.
- From 2002 to 2007, the average annual growth of softwoods exceeded annual removals by 96 million cubic feet per year. Softwood growth averaged 703 million cubic feet per year, a 13 percent increase over the period from 1990 to 2001. Planted softwoods made up 50 percent of the net annual growth, an increase of 47 percent from the 1990 to 2001 period. Softwood removals declined to 608 million cubic feet per year during 2002 to 2007. Planted softwoods accounted for 43 percent of the removals, an increase from the 1990 to 2001 period.
- From 2002 to 2007, the average annual growth of hardwoods exceeded annual removals by 218 million cubic feet per year. Hardwood growth averaged 748 million cubic feet per year, a 24 percent increase over the period from 1990 to 2001. Hardwood removals increased to 530 million cubic feet per year during 2002 to 2007.

Introduction

Information in this chapter draws heavily on the publication *North Carolina's Forests, 2002* by Brown, New, Oswalt, Johnson, and Rudis. Many of the figures were borrowed from a presentation given by Mark J. Brown at the North Carolina Forestry Association Annual Meeting, October 8, 2009 in Myrtle Beach, SC. All facts and figures for 2007 were derived from the USDA Forest Service EVALIDatorPC Version 4.0. Survey data for North Carolina was downloaded February 3, 2010 and consisted of the 370701 data set for 2003, 2004, 2005, 2006 and 2007.

Overview

North Carolina has 31.2 million acres of land (FIGURE 2*a*-1). The 2007 forest survey

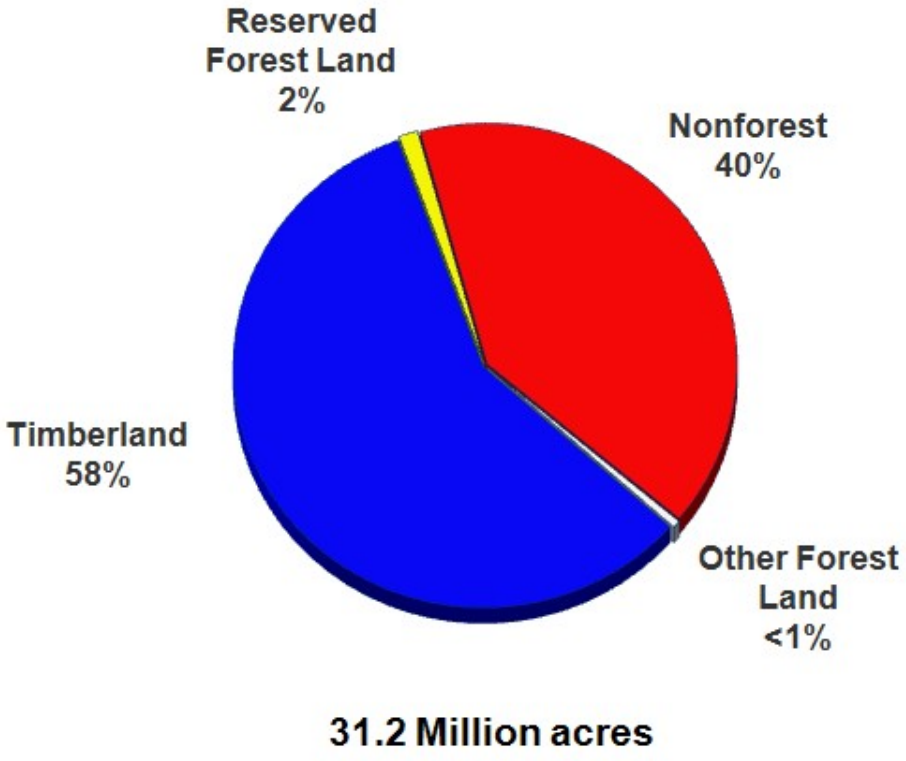
found 18.6 million acres, or 60 percent of the land, to be forested. The remaining 12.6 million nonforested acres consisted of urban and industrial developments, farmland, and inland water.

Two percent of the 18.6 million forest acres were classified as reserved forestland. The 384,500 acres in this reserved status were located mostly in the Great Smoky Mountains National Park, national forest wilderness areas, and state parks. Another 156,000 forest acres were classed as unproductive because of adverse site conditions, such as rock outcrops, cliffs, or deep water.

After deduction of the reserved and other forestland acres, 18 million acres of North Carolina's forests (97 percent) are classified as timberland. Timberland is forestland capable of growing 20 cubic feet of wood per acre per year and not reserved from cutting.

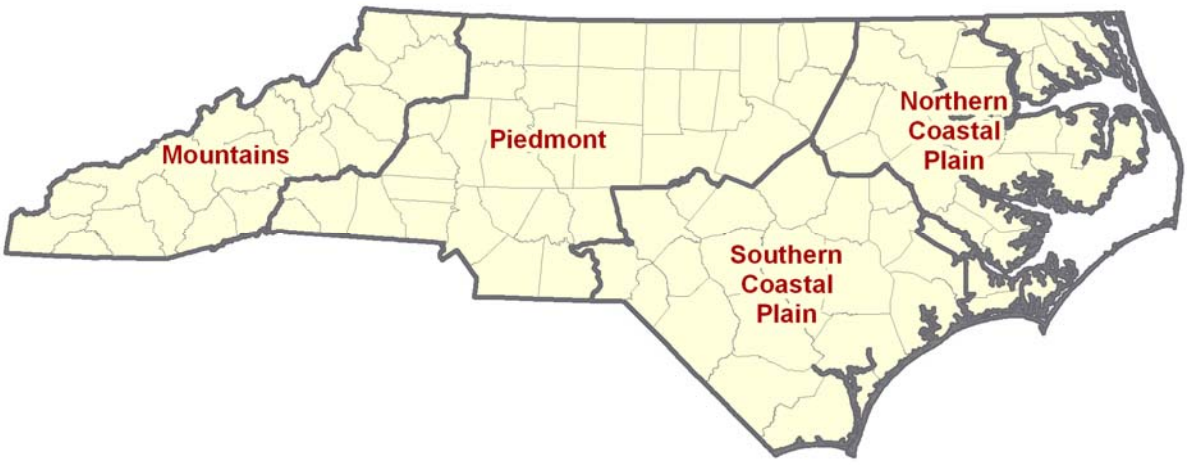
North Carolina is one of the most physiographically diverse states in the Eastern United States. Elevations range from sea level to 6,684 feet, the highest point east of the Rocky Mountains. North Carolina has more peaks over 6,000 feet than any state east of the Mississippi River. In contrast, it also has the most extensive system of barrier islands in the United States. Not far inland are pocosins and Carolina Bays, more concentrated here than in any other State. Areas of deep swamps are common in the eastern third of the state as well. North Carolina is located in three distinct physiographic provinces recognized by the U.S. Geological Survey as the Coastal Plain, the Piedmont, and the Blue Ridge. For this report, we use the designations developed by the USDA Forest Service Forest Inventory and Analysis Program (FIA) to describe North Carolina's physiographic regions: northern and southern coastal plain, piedmont, and mountains (FIGURE 2*a*-2).

FIGURE 2*a*-1. Classification of land area in North Carolina, 2007.



Source: Brown, M. J., 2009 and USDA Forest Service, Forest Inventory and Analysis (FIA), 2010

FIGURE 2*a*-2. Physiographic regions of North Carolina based upon survey unit (county) boundaries (data collected in the coastal plain units is cumulative throughout this section).



Created by: A. Bailey, NC DFR, 2010

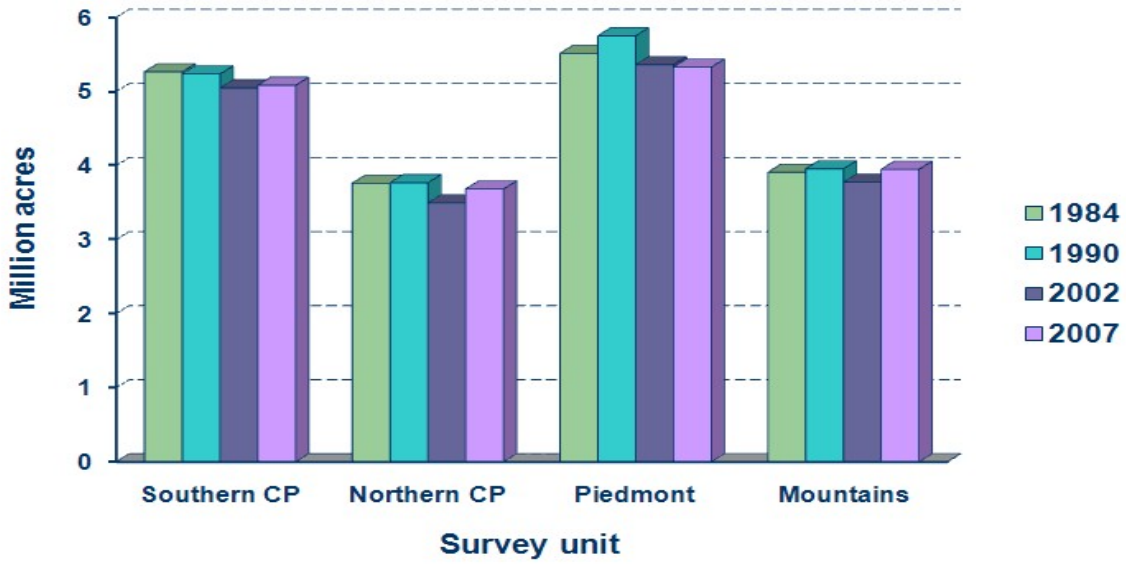
Not only are there topographic differences among these regions, but also varying are land use, ownership, demographics, and tree species occurrence. Primary forest

management issues differ among the regions as well. In the coastal plain, loss of longleaf pine is a concern. In the piedmont, the loss of shortleaf pine is a concern. In the mountains, oak regeneration and retention is a concern, along with the amount of older, overly mature stands.

The coastal plain is 59 percent forested and contains almost 49 percent of the state's timberland (FIGURE 2*a*-3) (TABLE 2*a*-1). In addition, sizable areas exist in agricultural production. Metropolitan areas are widely dispersed. Most of the state's softwood forest types, 72 percent, are found in this region as well. The coastal plain accounts for 80 percent of the state's pine plantations. In fact, the majority of forest industry holdings in the state, 87 percent, are found in this region. Because the coastal plain contains the state's lowest elevations as well as the smallest gradients in elevation, it contains most of North Carolina's swamps and pocosins. Riverine systems are slower, more meandering, and typically of blackwater type if originating within the region. As a result of these features, most of the state's bottomland hardwoods and cypress (a combined 84 percent) are found in the coastal plain. Loblolly pine is the most prevalent softwood type in the region, and nearly all of the state's longleaf pine and pond pine are found there. Unique to this region of the state, Atlantic white cedar once covered large expanses but is now confined to small areas.

The piedmont has the least proportion of forest, 51 percent. Only 30 percent of the state's timberland is found here. The piedmont contains the state's largest metropolitan areas and the highest concentrations of people and nonforested areas (FIGURE 2*a*-4). Nonindustrial private forest (NIPF) landowners control a higher proportion of the timberland, 92 percent, than in the coastal plain and mountains. The terrain in the piedmont is much more varied than that of the coastal plain and includes a wide range of tree species. Hardwoods predominate, but mixed stands are common, with loblolly pine the most abundant

FIGURE 2*a*-3. Trends in timberland area in North Carolina by survey unit.



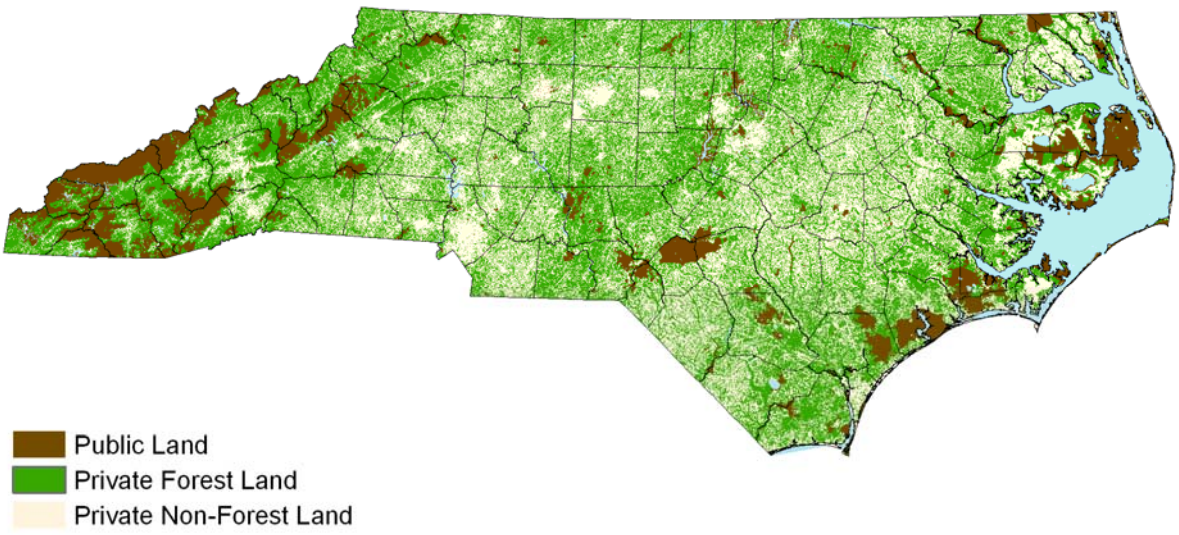
Source: Brown, M. J., 2009 and USDA Forest Service, Forest Inventory and Analysis (FIA), 2010

TABLE 2*a*-1.—Timberland area by major species groups, forest type groups and survey unit, 2007

	Coastal Plain (Acres)	Piedmont (Acres)	Mountains (Acres)	North Carolina (Acres)
Hardwoods	**4,556,284**	**3,957,960**	**3,673,809**	**12,188,053**
Aspen / birch group	0	0	1,508	1,508
Elm / ash / cottonwood group	253,448	250,686	12,164	516,298
Exotic hardwoods group	3,775	0	2,948	6,723
Maple / beech / birch group	0	0	56,895	56,895
Oak / gum / cypress group	1,763,321	123,951	0	1,887,272
Oak / hickory group	1,388,073	2,790,366	3,110,179	7,288,618
Oak / pine group	1,141,857	792,957	380,836	2,315,650
Other hardwoods group	5,810	0	109,279	115,089
Softwoods	**4,098,975**	**1,333,748**	**263,373**	**5,696,096**
Loblolly / shortleaf pine group	3,807,672	1,305,697	115,707	5,229,076
Longleaf / slash pine group	289,850	257	0	290,107
Other eastern softwoods group	1,453	26,769	1,518	29,740
Spruce / fir group	0	0	12,063	12,063
White / red / jack pine group	0	1,025	134,085	135,110
Nonstocked	**111,287**	**35,978**	**11,644**	**158,909**
TOTAL	**8,766,546**	**5,327,686**	**3,948,826**	**18,043,058**

Source: USDA Forest Service, Forest Inventory and Analysis (FIA), 2010

FIGURE 2*a*-4. Public land, private forest land, and private non-forest land in North Carolina, 2006.



Created by: A. Bailey, NC DFR, 2010

softwood type and Virginia pine second. The most common hardwood types are the white oak–red oak–hickory forest type followed closely by the yellow poplar–oak and the *sweetgum–yellow poplar* forest types. Riverine systems encounter more gradient; and because of the less organic soils, they are of red river bottom type.

The mountains are 76 percent forested—the highest percentage of forestland among all of North Carolina's regions. The region contains most of the state's reserved timberland, primarily in the Great Smoky Mountains National Park. The mountains have the highest proportion of publicly owned timberland in the state, mainly because this region includes the Pisgah and Nantahala National Forests. The mountains have fewer large cities and urban development than the state's other regions. The mountains 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 timberland. Chestnut oak–black oak–scarlet oak forest-type stands dominate, followed by white oak–red oak–hickory forest types and then the yellow poplar–white oak–northern red oak forest type in terms of abundance. The highest elevations of the mountains also contain tree species typically occurring at more northern latitudes, such as spruce, fir, and yellow birch. White pine is the most common soft-wood type in the mountains, whereas the Virginia pine type is the most common yellow pine type present.

Historical Trends

The 2007 inventory was the eighth forest survey of North Carolina. The first one was completed in 1938 (Cruikshank, 1944). Forest surveys were repeated in 1956 (Larson, 1957), 1964 (Knight and McClure, 1966), 1974 (Knight and McClure, 1975), 1984 (Sheffield and Knight, 1986), 1990 (Brown, 1993) and 2002 (Brown, 2004). The 1938 survey recorded 18.1 million acres of timberland (FIGURE 2*a*-5). The late 1930s was a time of widespread family farms and part of the Great Depression era. Most of the agricultural land was in subsistence farming.

The 1956 survey recorded 19.3 million acres of timberland. The 1.2-million-acre increase since 1938 largely occurred from the reversion of many old fields to forestland as a result of industrial expansion after World War II. During this time, much of America's population left farming for work in factories, for which many relocated to urban areas (Healy, 1985).

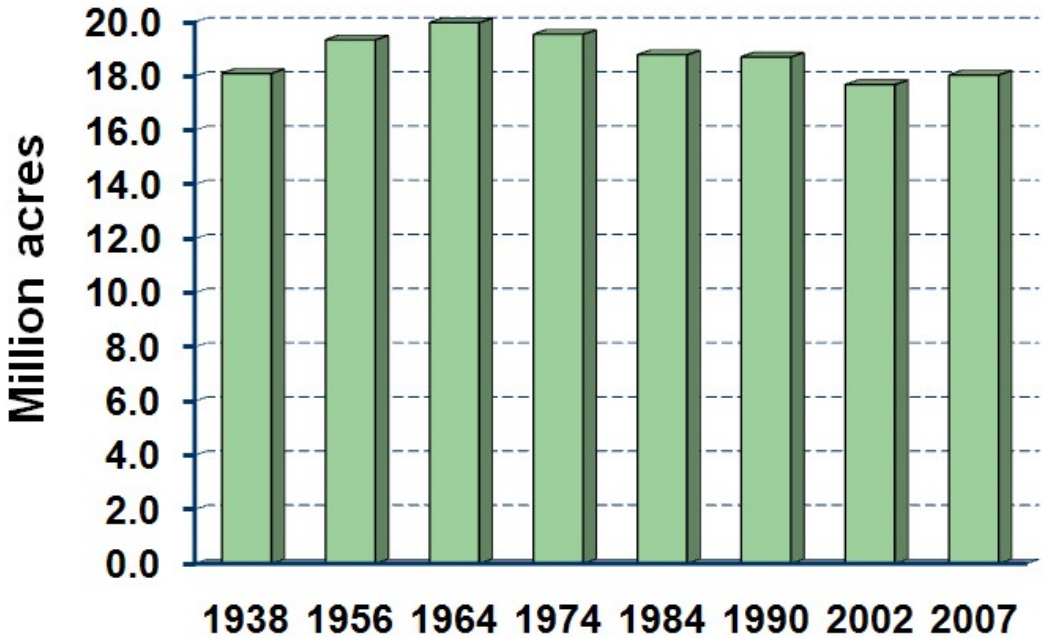
The trend of old fields reverting to forestland continued into the 1964 survey, when timberland totaled nearly 20 million acres. This was the largest area of timberland recorded in any of the state's seven surveys. The 700,000-acre increase since the previous survey was also augmented by government programs and incentives for the planting of pines on many of the old fields instigated by the U.S. Department of Agriculture (USDA) Soil Bank Act of 1956.

By 1974, however, the increases in timberland measured by the forest survey had ended. The 1974 survey recorded 19.5 million acres of timberland in the state. Increased agricultural activity and the beginning of corporate farming largely drove the nearly 500,000-acre decline. Much of this activity occurred in the state's coastal

plain because of its flat terrain and soils high in organic matter.

By the 1984 survey, another 800,000 acres of timberland were removed from the state's forests, leaving 18.8 million acres in

FIGURE 2*a*-5. Trends in area of timberland in North Carolina for surveys completed in 1938, 1956, 1964, 1974, 1984, 1990, 2002, and 2007.



Source: Brown, M. J., 2009 and USDA Forest Service, Forest Inventory and Analysis (FIA), 2010

timberland. In this decade, about half of the loss went to agriculture and half to urban development. Most of the loss to urban development took place in the piedmont, where populations and cities were beginning to grow at higher rates than elsewhere in North Carolina.

In the 1990 survey, timberland totaled 18.7 million acres, a decline of less than 100,000 acres. This was the shortest interval, however, between all seven surveys to date. Again, half the loss resulted from urban development and half from agricultural uses.

In 2002, the area of timberland had fallen to 17.7 million acres, the smallest amount in North Carolina since the surveys began in 1938. This was the fourth consecutive survey to record a decrease in timberland area. The decline was 1 million acres, a 5 percent decrease from the 1990 survey. Timberland accounted for 97 percent of North Carolina's forests in 2002.

In 2007, the area of timberland increased by nearly 360,000 acres to 18 million acres, a 2 percent increase from the 2002 survey. Timberland still accounts for 97 percent of North Carolina's forests in 2007.

Between 1990 and 2002, urban and other related land uses accounted for most of the diversions of timberland. Agricultural uses, a major cause of such forest diversions in past decades, were a distant second in losses in the 1990 – 2002 survey period. Population increases, primarily resulting from immigration to the state, were responsible for most of the increase in

urbanization. The associated increases in urban infrastructure (such as transportation and power line rights-of-way, offices and industrial parks, shopping centers and malls, schools, and subdivisions) cumulatively consumed sizable areas formerly classed as timberland. Although timberland declined in all the state's physiographic regions from 1990 to 2002, the piedmont suffered the highest percentage loss, despite already being the least forested region. Timberland declined 7 percent in the piedmont, 5 percent across the coastal plain, and 4 percent in the mountains. This is understandable because the piedmont contains more miles of interstate and more cities with populations greater than 100,000 than the other regions. Altogether, between 1990 and 2002 in North Carolina, diversions totaled 1.6 million acres and outpaced total additions of 0.6 million acres for a net loss of 1 million acres. Urban and related uses accounted for 63 percent of these diversions. Agricultural uses accounted for 35 percent of the diverted acreage. New water impoundments accounted for 1 percent, and timberland transferred to a reserved status made up the final 1 percent.

From 2002 to 2007, North Carolina's timberlands increased in all the state's physiographic regions except the piedmont. The mountains showed the greatest increase, gaining nearly 5 percent, followed by the coastal plain with a gain of nearly 3 percent. The piedmont lost 0.6 percent. Overall, the net change in North Carolina's timberland increased by nearly 362 thousand acres. Additions to timberland from nonforestland were about 966 thousand acres while approximately 667 thousand acres of timberland were diverted to non-timberland uses. Urbanization and agriculture accounted for 92 percent of the diversions. Losses to urbanization were more than double the losses to agriculture. Timberland transferred to a reserved status accounted for 7 percent and new water impoundments accounted for the remaining 1 percent.

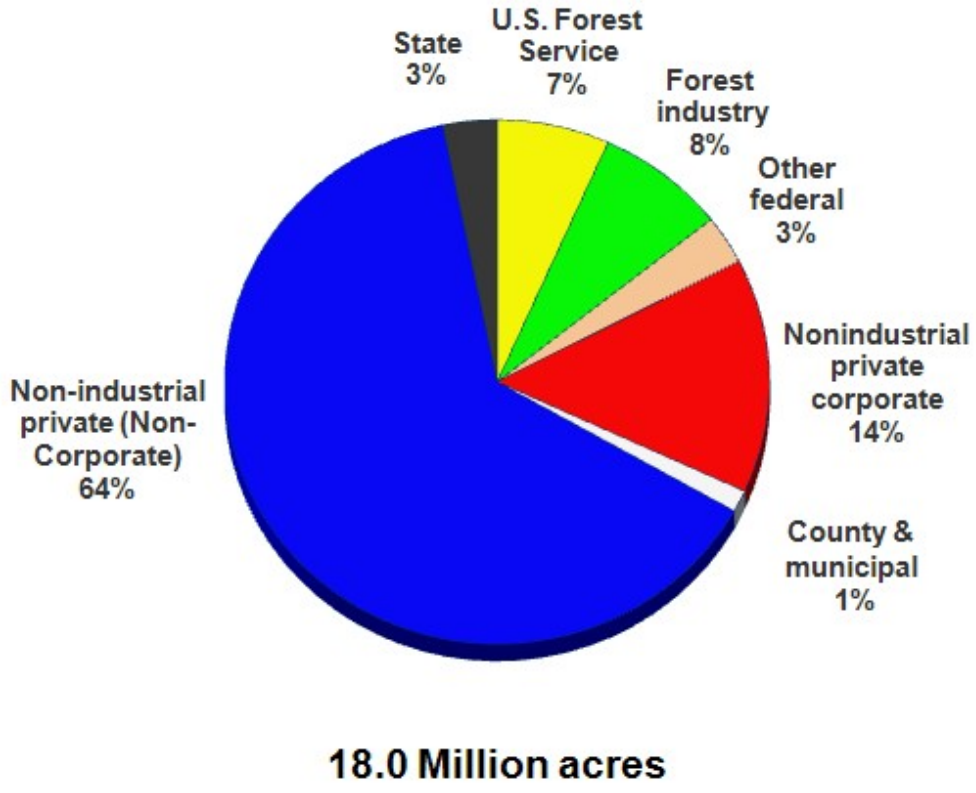
Ownership

In 2007, timberland owned by noncorporate, nonindustrial private landowners totaled 11.5 million acres and accounted for 64 percent of all timberland in the state (FIGURE 2*a*-6). Timberland owned by private nonindustrial corporations totaled 2.6 million acres and accounted for 14 percent of all timberland. Together, these individual and corporate timberlands comprise the NIPF landowner category. NIPF timberland totaled 14.1 million acres, or about 78 percent of the state's timberland.

Overall, the NIPF category increased by 250,000 acres, representing an increase of 2 percent since 2002. In 2007, private individual ownership totaled 11.5 million acres, the same area reported in the 2002 survey (FIGURE 2*a*-7). Although private ownership has remained nearly flat since the 2002 survey, the overall trend has been declining for several decades. In contrast, the 2.6 million acres in the private corporate group increased by 11 percent since 2002 and has been increasing for decades. This signifies either a real change in ownership from private individuals to entities like timber investment management organizations (TIMOs), or a trend toward incorporation by private landowners, or both.

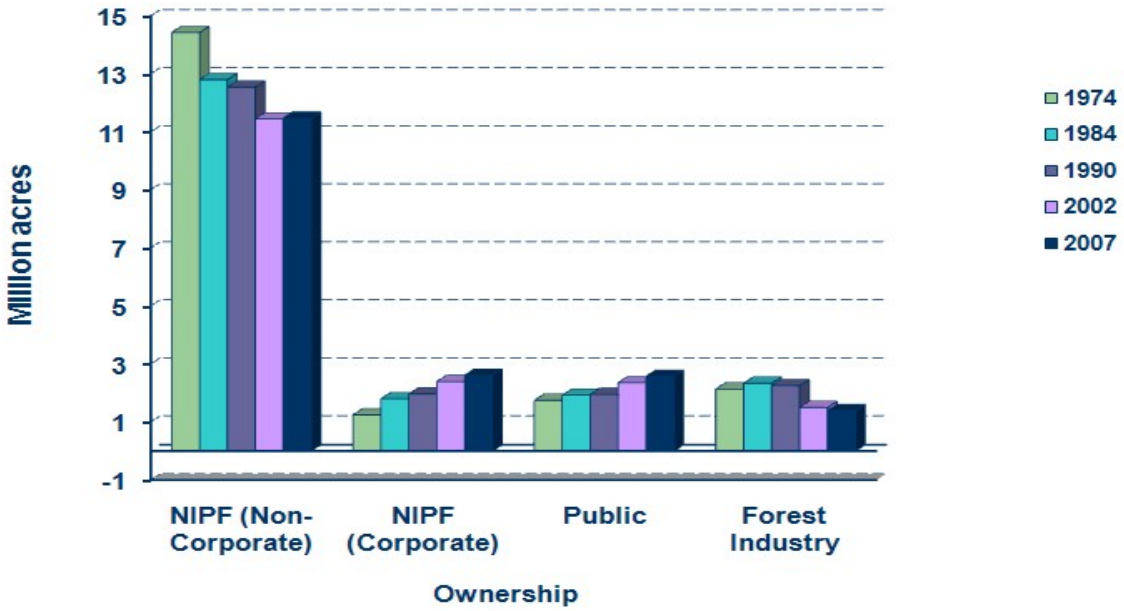
NIPF ownership varied among the state's regions. The proportion of a region's timberland under NIPF ownership was highest in the piedmont: NIPF landowners

FIGURE 2*a*-6. Area of timberland by ownership in North Carolina for the 2007 survey.



Source: Brown, M. J., 2009 and USDA Forest Service, Forest Inventory and Analysis (FIA), 2010

FIGURE 2*a*-7: Ownership trends for timberland in North Carolina.



Source: Brown, M. J., 2009 and USDA Forest Service, Forest Inventory and Analysis (FIA), 2010

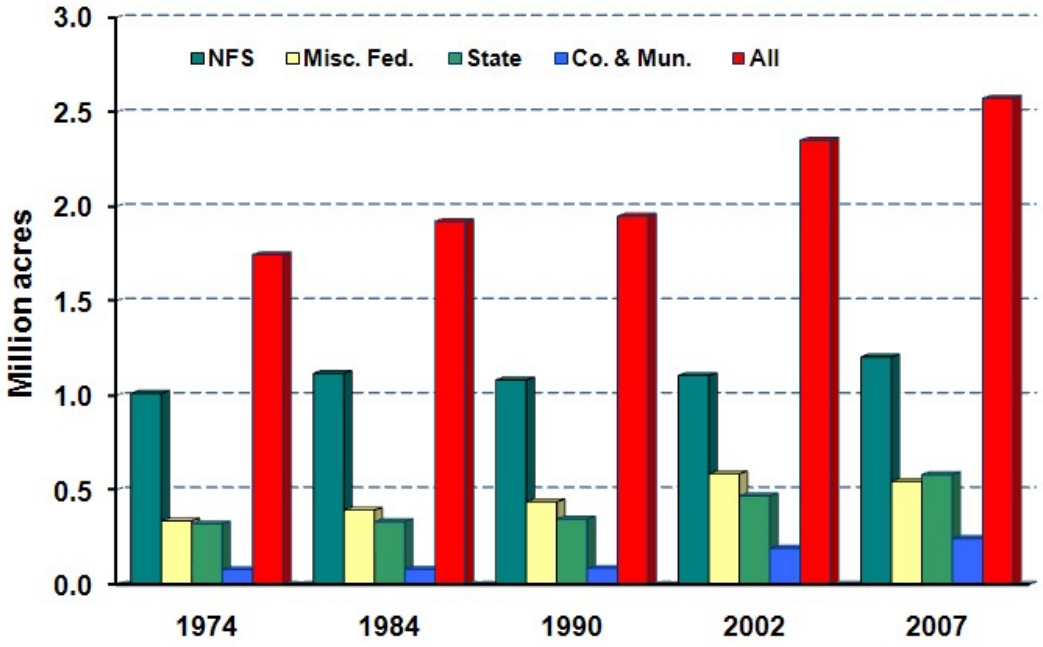
controlled 91 percent of the timberland in that region. The proportion under NIPF ownership was 74 percent across the coastal plain and 70 percent in the mountains.

Timberland owned by the forest industry totaled 1.4 million acres and accounted for 8 percent of all timberland in the state. From 2002 to 2007, forest industry holdings in the state have decreased by 7 percent, a continuation of the declining trend North Carolina has been witnessing since the 1980s, when industry holdings peaked at 2.3 million acres. In 2007, forest industry ownership was concentrated in the coastal plain. Forest industry ownership accounted for 14 percent of coastal plain timberland. Forest industry owned only 3 percent of piedmont timberland and just 1 percent of the timberland in the mountains.

Timberland owned by all public agencies totaled nearly 2.6 million acres and accounted for 14 percent of all timberland in the state. Public ownership of timberland has continued to increase by about 10 percent since 2002.

National forest system (NFS) lands comprised almost a half (47 percent) of the state's publicly owned timberland (FIGURE 2*a*-8) with 1.2 million acres. Miscellaneous federal lands, accounted for 545,000 acres, slightly more than a fifth of the total public timberland. State ownership of timberland accounted for 581,000 acres or about 23 percent of all public timberland. Local governments made up the remaining 243,000 acres of public timberland. The area of NFS lands has remained somewhat stable for decades, but did show a 9 percent increase in timberland from 2002 to 2007. Most NFS lands (85 percent) are located in the mountains. Publicly owned timberland was not equally distributed among the regions. Public ownership was highest in the mountains—29 percent of the timberland—largely due to NFS holdings. Public ownership accounted for 12 percent of coastal plain timberland, largely a combination of military, national forest, and state forest holdings. The lowest proportion and the fewest acres were found in the piedmont, where just 7 percent of the timberland was under public ownership.

FIGURE 2*a*-8: Ownership trends for public agencies in North Carolina.



Source: Brown, M. J., 2009 and USDA Forest Service, Forest Inventory and Analysis (FIA), 2010

Public Land Ownership

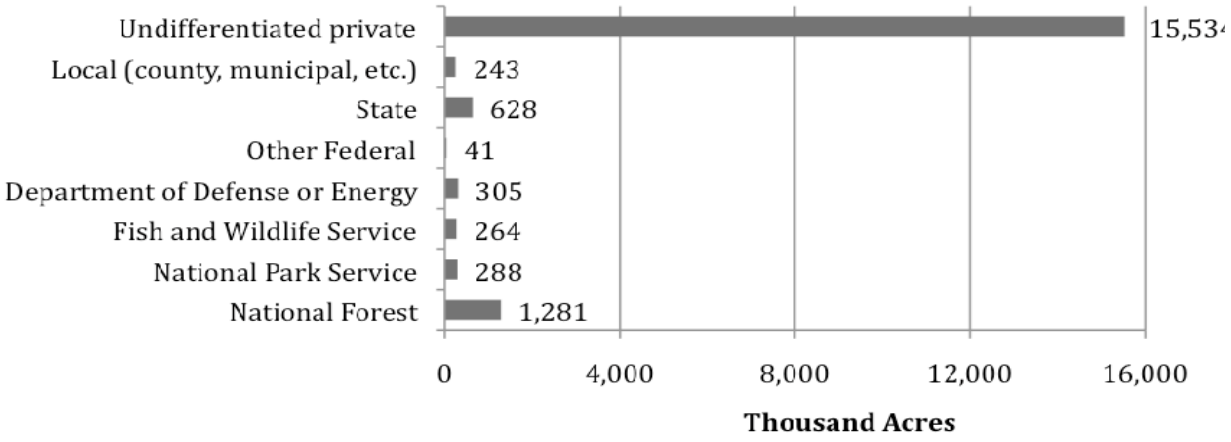
The state of North Carolina is fortunate to have many land management agencies that provide a diversity of public and social benefits to its citizens. Of the total forestland in NC, approximately 83 percent of is privately owned and 17 percent is publically owned (FIGURE 2*a*-4). State and local governments own approximately 29 percent of the public land and 71 percent is owned and managed by Federal agencies (FIGURE 2*a*-9).

The NC Division of Forest Resources (NCDFR) has a long history of collaborative efforts with public land management agencies on projects regarding forest management, forest health, fire suppression, prescribed burning, endangered species management, and forest fuel mitigation. NCDFR works with partners to provide technical assistance, training workshops and emergency response resources.

Over the years, NCDFR has collaborated on many ecological and silvicultural research studies for both pine and hardwood silviculture on several National Forests and state owned land. These research partnerships help to transfer new technology and management techniques to private landowners regarding forest management in North Carolina. NCDFR works very closely with the NC Wildlife Resources Commission with management activities beneficial to wildlife habitat or to ensure public access is available for hunting, nature enjoyment, and recreation.

NCDFR along other public land management agencies has been very active in promoting and providing assistance for prescribed burning. The NCDFR actively conducts prescribed burning on state owned land to manage for Red-cockaded Woodpecker (RCW) habitat and provides assistance on National Forests and Department of Defense land that is actively managed for RCW. The Fire Environment

FIGURE 2a-9. Acres of forestland by ownership class in North Carolina.



Source: USDA Forest Service, Forest Inventory and Analysis (FIA), 2010

Branch of NCDFR has partnered with the Nature Conservancy and USDA Forest Service (USFS) to study the smoldering combustion limits of organic soils in NC. One factor limiting the use and acceptance of prescribed fire in these wetland communities is a lack of knowledge about conditions leading to sustained organic soil consumption. The USFWS is an active partner participating in prescribed burning activities and cooperative research that will be ongoing and applied to more sites for operational burning.

The NCDFR is involved in Community Protection Plans (CPP's). The USFS Community Protection Grant Program (also known as the Steven's Amendment Grant Program) provides funding to states through the National Fire Plan to proactively prevent and mitigate wildland fire hazards that have the potential to threaten communities surrounding national forests. The program emphasizes collaborative planning to maximize mitigation and prevention efficiency.

Under this program NCDFR, USFS, local communities and other cooperators have been working together to develop a mitigation and prevention plan for each national forest in North Carolina (TABLE 2*a*-2). These plans serve as a guide for the public to identify and mitigate wildland fire hazards that threaten the communities and privately owned land surrounding National Forests.

TABLE 2*a*-2.—Summary of NC CPP Activity by Fiscal Year and National Forestland

North Carolina CPP Activity Report	FY 2007-08	FY 2008-09
Total Acres Treated	1891	2873
Acres Treated by National Forest Location		
Uwharrie NF	1891	1924
Croatan NF		348
Nantahala NF		420
Pisgah NF		181

Source: NCDFR CPP Accomplishment Data 2009

Work is currently being performed in districts where national forestland is located and includes NCDFR districts 1, 2, 3, 4, 9, and 10. The criteria for areas to be included in the plan and receive grant funding are; 1) the area must be within three miles of a national forest boundary and 2) be considered a community at risk from wildfire. As long as the area meets these

conditions, work can be performed on both private and public lands. The overall goal of the Community Protection Grant Program is to maximize acreage treated in the wildland-urban interface (WUI) that share boundaries with national forestland. Sites within WUI areas receive top funding priority for potential grant projects.

The Department Defense has a strong presence in North Carolina with bases and facilities operated by the US Army, US Marine Corp, US Air Force, and NC National Guard. The major installations of Fort Bragg (Army), Camp Lejeune (Marines), Pope Air Force Base, MCAS Cherry Point (Marines), Dare County Range (Air Force), and Camp Butner (NC National Guard) own and manage large areas of forestland used primarily for training purposes (TABLE 2*a*-3). The military's forestlands contain significant natural areas as well as threatened and endangered species. NCDFR provides technical assistance for forest management as requested and has cooperative agreements with the military services for wildfire suppression response.

TABLE 2*a*-3.—Acres of land owned by major military installations in NC

Major Military Installation	Acres owned (includes non-forestland)
Pope AFB	1,947
Seymour Johnson AFB	4,107
Fort Bragg	160,700
Camp Lejeune	114,801
MCAS Cherry Point	13,190
Dare County Range	46,595
Camp Butner	4,800

Source: DoD Base Structure Report FY 2008

Development encroachment adjacent to military lands and operational areas threatens our military's ability to train. Farming, ranching, and forestry are compatible with military land use. North Carolina has established the NC Working Lands Group as a collaborative means to protect farm, forest and ranch lands around military installations while resulting in net agricultural, environmental, natural resource, and economic and military readiness benefits.

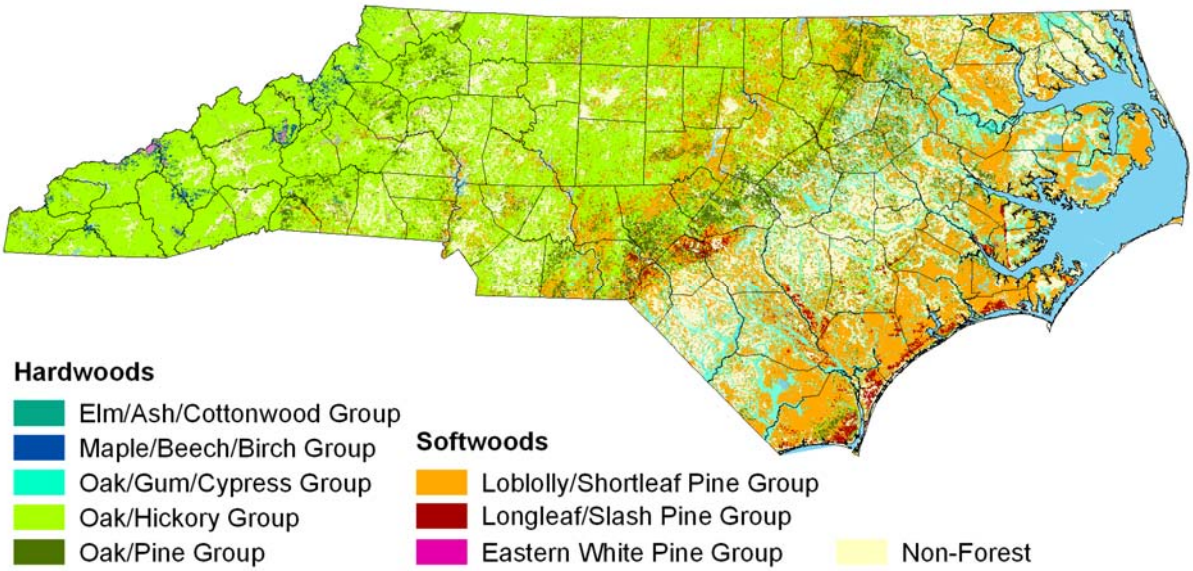
The Southeast Regional Partnership for Planning and Sustainability (SERPPAS) is multistate collaborative partnership between the Department of Defense, other federal agencies, and state environmental and natural resource agencies. SERPPAS works to prevent encroachment around military lands, to encourage compatible resource-use decisions, and to improve coordination among regions, states, communities, and military services. The region covered by SERPPAS includes the states of North Carolina, South Carolina, Georgia, Alabama, and Florida. NCDFR supports SERPASS objectives and participates in its Longleaf program.

The NCDFR is actively involved in many other collaborative projects and activities with public land management agencies within the state. The NCDFR Urban and Community Forestry Program cooperates with municipal and county governments on open space and green infrastructure planning. NCDFR also assists local governments with forest and water quality management on public water supply watersheds.

Forest-Type Groups

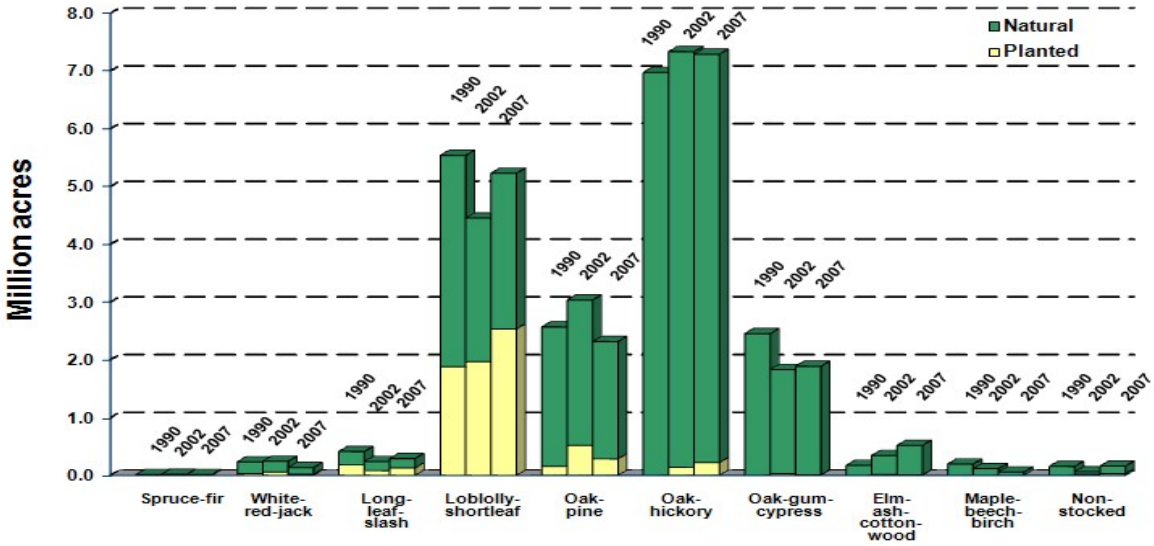
Due to the numerous and diverse forest types across North Carolina, groupings were used to portray the composition of forests (FIGURE 2*a*-10) and the recent trends in their area (FIGURE 2*a*-11). Oak–hickory types were clearly the state's predominant forest-type group, covering some 7.3 million acres. The oak–hickory type group decreased in area by less than 1 percent

FIGURE 2*a*-10. Forest-type groups of North Carolina.



Created by: A. Bailey, NC DFR, 2010

FIGURE 2*a*-11. Trends in area of timberland by forest-type groups and stand origin for North Carolina.



Source: Brown, M. J., 2009 and USDA Forest Service, Forest Inventory and Analysis (FIA), 2010

since 2002 and accounted for 40 percent of the state's timberland in 2007.

The loblolly–shortleaf pine type group was second in abundance and covered 5.2 million acres. This group included Virginia-pine and pond pine types as well. The loblolly–shortleaf group increased in area by 17 percent during 2002 to 2007 and accounted for 29 percent of all timberland in 2007. Planted stands accounted for 49 percent of the loblolly–shortleaf group (fig. 10), or nearly 2.5 million acres. The increase in planted pine in the loblolly–shortleaf group accounted for 73 percent of the group's total increase.

The total area of the oak–pine type group decreased 24 percent to 2.3 million acres in 2007. The area of planted oak–pine decreased 45 percent below the 2002 level; and in the 2007 survey, 12 percent of the oak–pine stands had evidence of planting. Planted oak–pine stands have usually resulted from significant hardwood competition and stocking ratios that precluded classification as a pine type. Many of these stands originated as pine plantations. Over time and due to natural succession, hardwoods invaded and thrived, and the distribution of species changed to a mixed stand. Planting without site preparation or lack of other stand treatments would expedite the change in type.

The area of the oak–gum–cypress type group increased 3 percent to 1.9 million acres in 2007, following a 25 percent decrease from 1990 to 2002. The reasons for the large decrease from 2002 to 1990 are unclear. Possibly reclassification to oak–hickory or oak–pine types captured some of these acres. Slight changes in stocking, particularly for samples located in transition zones, can alter type classification. Another possible explanation may reside in the change of sample designs between surveys.

After nearly two decades of decreases in planting for the longleaf–slash pine forest-type group, the period from 2002 to 2007 saw a 55 percent increase. Natural stands experienced a 5 percent increase during the same period. Total acreage increased by 52,000 acres to 290,000 acres (FIGURE 2*a*-12).

All regions were dominated by hardwood types (TABLE 2*a*-1). However, their dominance differed by region. Hardwood types accounted for 93 percent of the mountains timberland, 74 percent of the piedmont, and 52 percent of the coastal plain. As one might expect, hardwood types were mostly upland in the mountains and lowland in the coastal plain.

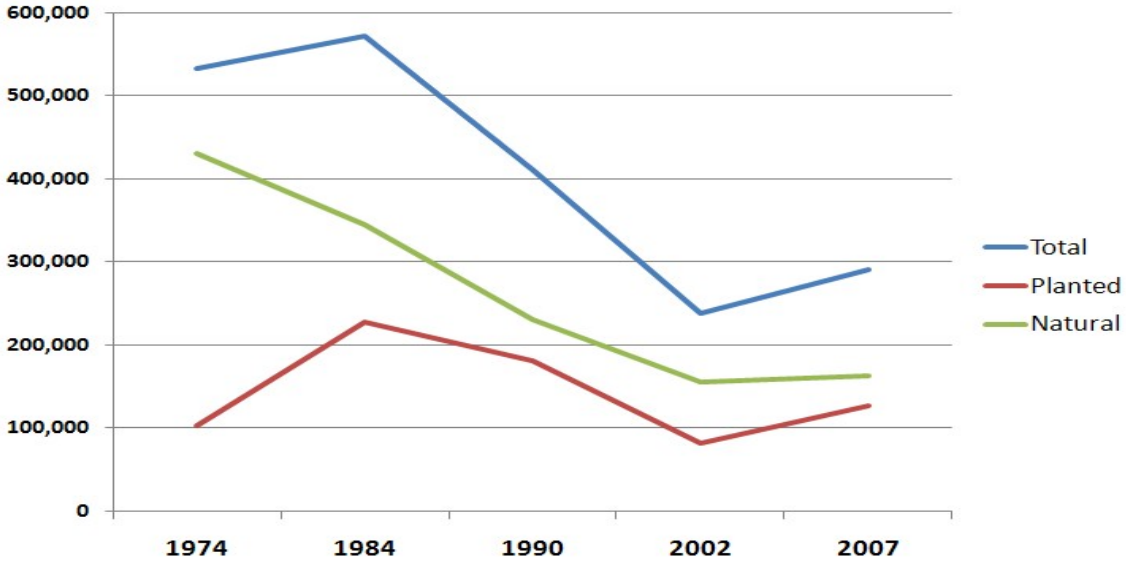
Forest-Management Types

Timberland in the preceding forest-type groups was consolidated into fewer categories, namely six forest-management types, based on a combination of stocking and stand origin. The six management types are pine plantation, natural pine, oak–pine, upland hardwood, lowland hardwood, and nonstocked. This consolidation was made to simplify portrayal of the state's timber resources.

Statewide, the area classified as pine plantation increased by 27 percent, from 2.1 to 2.7 million acres between 2002 and 2007 (FIGURE 2*a*-13), and accounted for 15 percent of the state's timberland. However, this timberland was not evenly distributed across the state. Pine plantations decreased in the mountains by 41,000 acres (TABLES 2*a*-4 and 2*a*-5). The piedmont gained 30,000 acres of pine plantations, and the coastal plain gained 583,000 acres. Eighty percent of all pine plantations in the state occurred in the coastal plain, where 24 percent of the timberland was in pine plantations. Pine plantations made up 9 percent of the piedmont timberland and less than 1 percent of the mountains timberland.

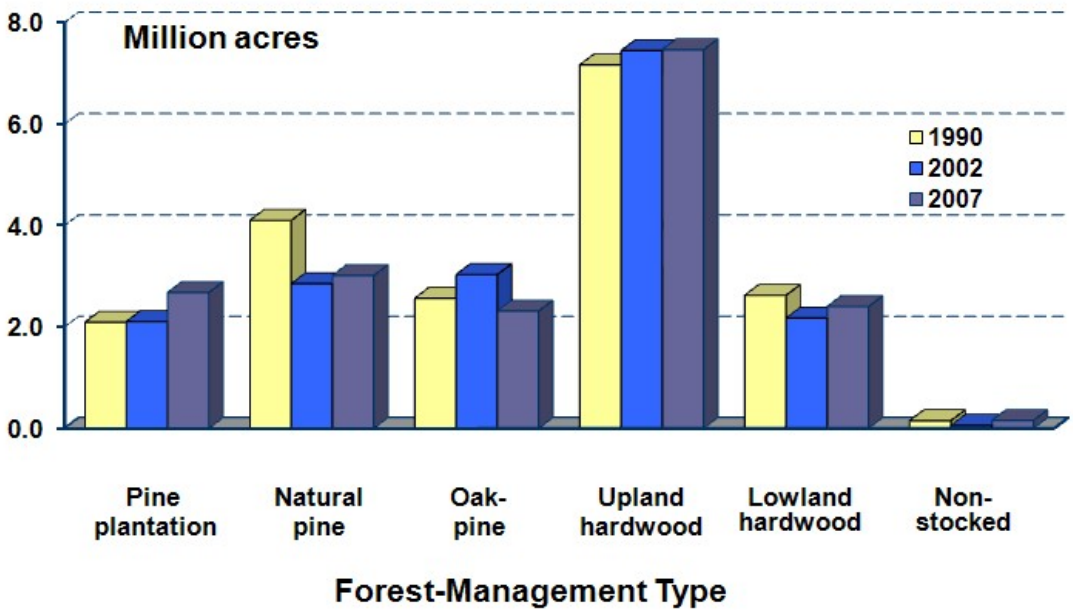
Between 2002 and 2007, the area of natural pine stands decreased by 7 percent in the piedmont and 24 percent in the mountains. The decrease was offset by a 293,000-acre increase in the coastal plain, resulting in an overall increase for North Carolina of 6 percent. Natural pine stands made up 17 percent of all timberland in 2007, compared with 16 percent in 2002 and 22 percent in 1990. Timberland classified as oak–pine forest-management type decreased by 719,000 acres in 2007, an overall decrease of 24 percent. The overall percentage of timberland represented by the oak–pine

FIGURE 2*a*-12: Timberland trends for the longleaf–slash pine type group.



Source: USDA Forest Service, Forest Inventory and Analysis (FIA), 2010

FIGURE 2*a*-13. Area of timberland by forest-management type.



Source: Brown, M. J., 2009 and USDA Forest Service, Forest Inventory and Analysis (FIA), 2010

TABLE 2a-4.—Timberland acres by survey unit and forest management type for survey years 2002 and 2007.

Timberland Acres	Coastal Plain	Piedmont	Mountains	Total
2002	**8,270,029**	**5,492,040**	**4,036,702**	**17,798,771**
Lowland Hardwoods	1,922,677	247,801	2,789	2,173,267
Natural Pine	1,663,746	891,763	300,751	2,856,260
Nonstocked	111,287	35,978	11,644	158,909
Oak-Pine	1,615,413	1,053,210	365,878	3,034,501
Planted Pine	1,559,248	472,922	74,831	2,107,001
Upland Hardwoods	1,397,658	2,790,366	3,280,809	7,468,833
2007	**8,766,545**	**5,327,687**	**3,948,826**	**18,043,058**
Lowland Hardwoods	2,016,769	374,637	12,164	2,403,570
Natural Pine	1,956,414	830,384	229,487	3,016,285
Nonstocked	111,287	35,978	11,644	158,909
Oak-Pine	1,141,857	792,957	380,836	2,315,650
Planted Pine	2,142,560	503,365	33,886	2,679,811
Upland Hardwoods	1,397,658	2,790,366	3,280,809	7,468,833

Source: USDA Forest Service, Forest Inventory and Analysis (FIA), 2010

TABLE 2*a*-5.—Change and percent change in timberland acres by survey unit and forest management type for survey years 2002 and 2007.

Change in Timberland Acres	Coastal Plain	Piedmont	Mountains	Total
2002 to 2007	**496,516**	**-164,353**	**-87,876**	**244,287**
Lowland Hardwoods	94,092	126,836	9,375	230,303
Natural Pine	292,668	-61,379	-71,264	160,025
Nonstocked	0	0	0	0
Oak-Pine	-473,556	-260,253	14,958	-718,851
Planted Pine	583,312	30,443	-40,945	572,810
Upland Hardwoods	0	0	0	0

Percent Change in Timberland Acres	Coastal Plain	Piedmont	Mountains	Total
2002 to 2007	**6.0%**	**-3.0%**	**-2.2%**	**1.4%**
Lowland Hardwoods	4.9%	51.2%	336.1%	10.6%
Natural Pine	17.6%	-6.9%	-23.7%	5.6%
Nonstocked	0.0%	0.0%	0.0%	0.0%
Oak-Pine	-29.3%	-24.7%	4.1%	-23.7%
Planted Pine	37.4%	6.4%	-54.7%	27.2%
Upland Hardwoods	0.0%	0.0%	0.0%	0.0%

Source: USDA Forest Service, Forest Inventory and Analysis (FIA), 2010

group dropped from 17 percent to 13 percent. Losses of 474,000 acres in the coastal plain and 260,000 acres in the piedmont were largely responsible for the overall decrease. The mountains gained 15,000 acres in the oak-pine forest management type between 2002 and 2007. Part of the overall decrease in the oak–pine forest-management type can be explained by increases in the pine component. Stands in which the pine component constituted a plurality of the stocking would have caused the reclassification of oak–pine type to either the pine plantation or natural pine management type.

According to the 2007 survey, the area classified as upland hardwood type did not change from 2002 and remains at 7.5 million

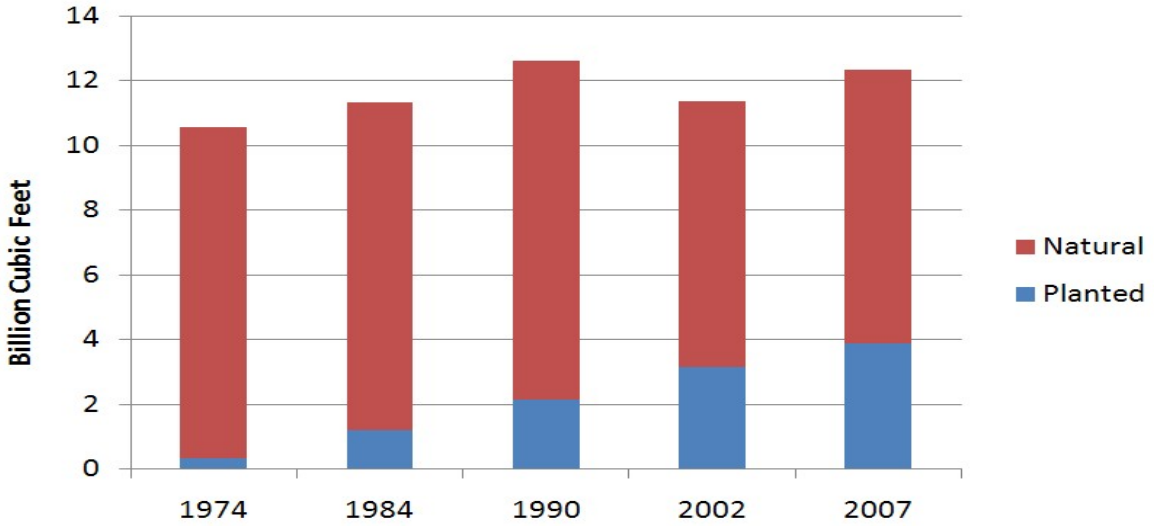
acres. Upland hardwood stands accounted for 41 percent of the state's timberland in 2007. The area classified as lowland-hardwood forest-management type increased 11 percent to 2.4 million acres. Lowland hardwood stands comprised 13 percent of the timberland in the state. Notable was a 336 percent increase in lowland hardwoods in the mountain region, bringing the total area from 2,789 acres to 12,164 acres. Lowland hardwoods in the piedmont were also significant with a 51 percent increase to 375,000 acres.

Volume

Softwood Volume

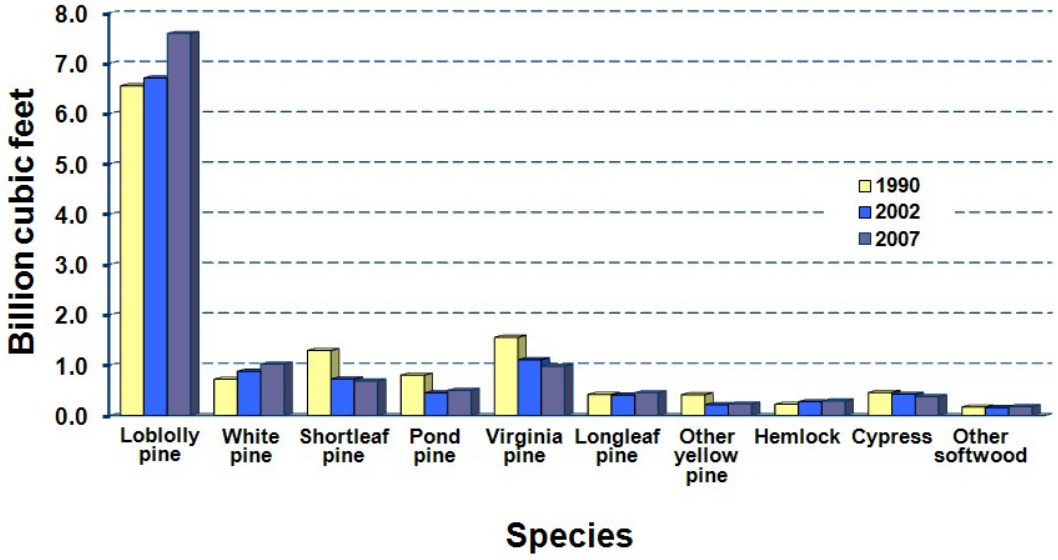
Softwood species made up 34 percent of the state's wood volume in 2007. The volume of softwood trees increased 9 percent since 2002 to 12.3 billion cubic feet (FIGURE 2*a*-14). Planted softwoods accounted for 32 percent or 3.9 billion cubic feet of the total softwood volume. This was a 23 percent increase from the 3.2 billion cubic feet of planted softwoods accounted for in 2002. Loblolly pine remains the predominant softwood species (FIGURE 2*a*-15). In addition, loblolly pine also accounted for the most volume of any single species in North Carolina, whether softwood or hardwood—7.6 billion cubic feet or 62 percent of all softwood volume. Loblolly, longleaf, pond, and slash pine all increased in volume. Shortleaf and Virginia pine continued to decrease in volume. White pine volume increased, as did hemlock. Most softwood volume was in the 8-, 10-, and 12-inch diameter classes (FIGURE 2*a*-16). Softwood volume increased in every diameter class during 2002 to 2007 and peaked in the 10-inch diameter class.

FIGURE 2*a*-14. Volume of live softwood trees on timberland by stand origin and survey year.



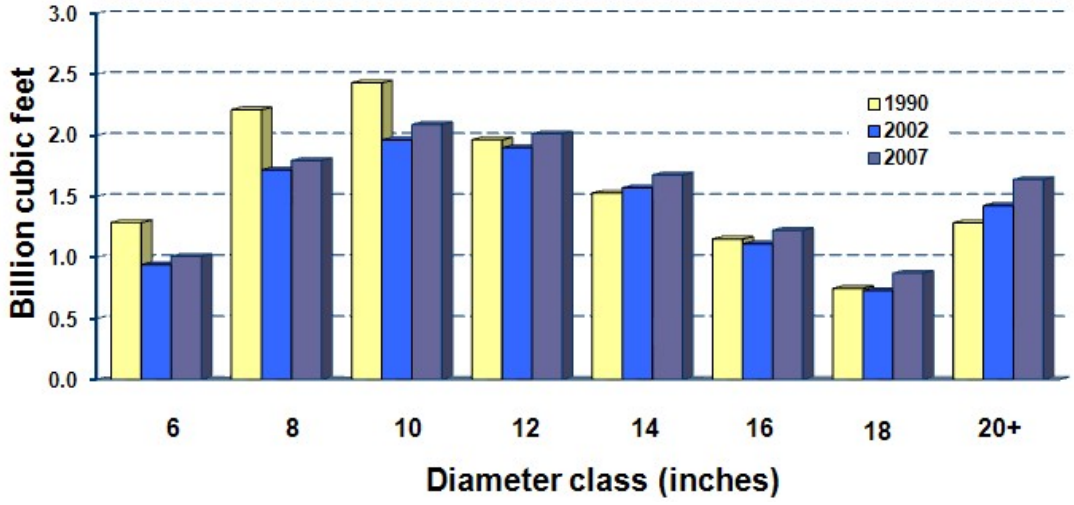
Source: USDA Forest Service, Forest Inventory and Analysis (FIA), 2010

FIGURE 2*a*-15. Volume of live trees on timberland by species and survey year.



Source: Brown, M. J., 2009 and USDA Forest Service, Forest Inventory and Analysis (FIA), 2010

FIGURE 2*a*-16. Volume of live softwood trees on timberland by diameter class.



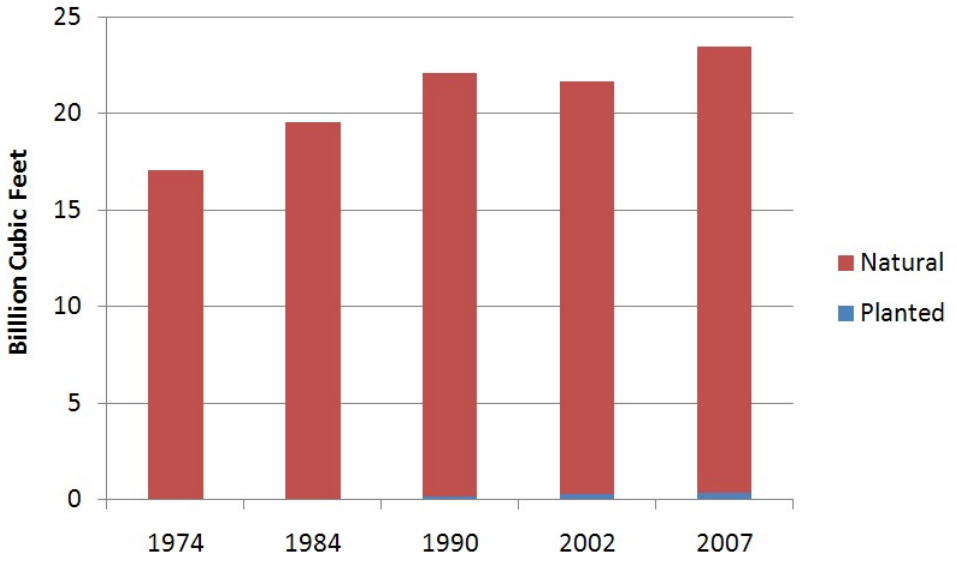
Source: Brown, M. J., 2009 and USDA Forest Service, Forest Inventory and Analysis (FIA), 2010

Hardwood Volume

Hardwood species made up 66 percent of the state's wood volume in 2007: no change since 2002. This occurred despite an 8 percent increase in volume to 23.5 billion cubic feet (FIGURE 2*a*-17). As expected, only 1 percent of hardwood volume came from planted stands; about the same as in 2002. Yellow poplar was the predominant hardwood species, second only to loblolly pine in volume of all species in the state. Yellow poplar volume increased by 14 percent, to 4.7 billion cubic feet (FIGURE 2*a*-18). Soft maple and sweetgum were second and third in hardwood species volume. Soft maple increased in volume by 10 percent to 2.7 billion cubic feet in 2007, while sweetgum increased almost 5 percent to 2.2

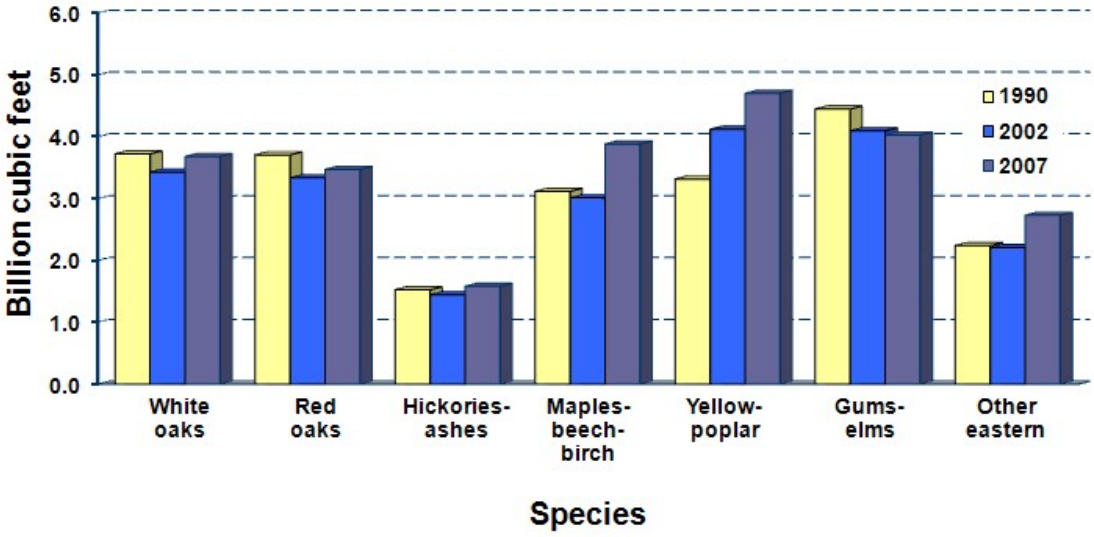
billion cubic feet. Collectively, the white oaks and the red oaks increased in volume, led by increases in chestnut oak, northern red oak, scarlet oak, and white oak. Southern red oak decreased in volume. By diameter class, hardwood volume was fairly evenly distributed compared with that of softwoods (FIGURE 2*a*-19). Hardwood volume was highest in the14-inch diameter class. Hardwood volume increased in all diameter classes between the 2002 and 2007 surveys.

FIGURE 2*a*-17. Volume of live hardwood trees on timberland by stand origin and survey year.



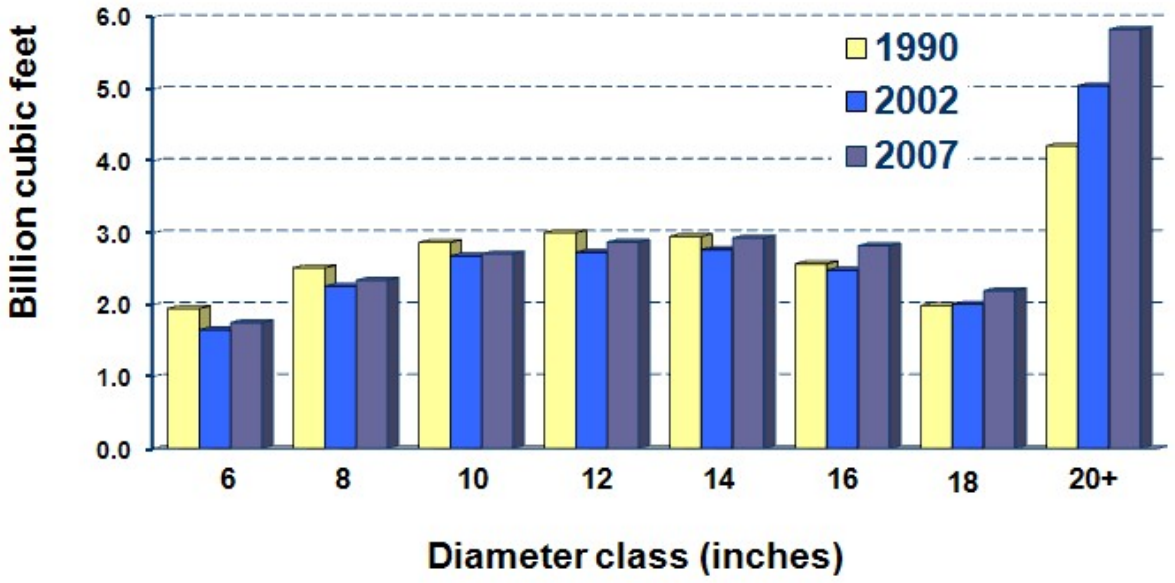
Source: USDA Forest Service, Forest Inventory and Analysis (FIA), 2010

FIGURE 2*a*-18. Volume of live trees on timberland by species and survey year.



Source: Brown, M. J., 2009 and USDA Forest Service, Forest Inventory and Analysis (FIA), 2010

FIGURE 2*a*-19. Volume of live hardwood trees on timberland by diameter class.



Source: Brown, M. J., 2009 and USDA Forest Service, Forest Inventory and Analysis (FIA), 2010

Growth, Removals, and Change

The following two sections involve components of change surrounding the state's softwood and hardwood resources. Each section begins with a computed average total for growth during the remeasurement period referred to as *gross growth*. Gross growth includes growth on trees that survived since the previous survey, ingrowth, growth on new ingrowth, growth on mortality trees up until the time they died during the period, and growth on removal trees up until the time they were removed. It should be noted here that removals for FIA purposes include not only harvested trees but trees removed from timberland for other reasons, such as land clearing, conversion to urban uses, and transfer to reserved status. In addition to gross growth, the other components of change are mortality and removals. Mortality reduces gross growth to determine net annual growth, and removals reduce net annual growth to determine net change.

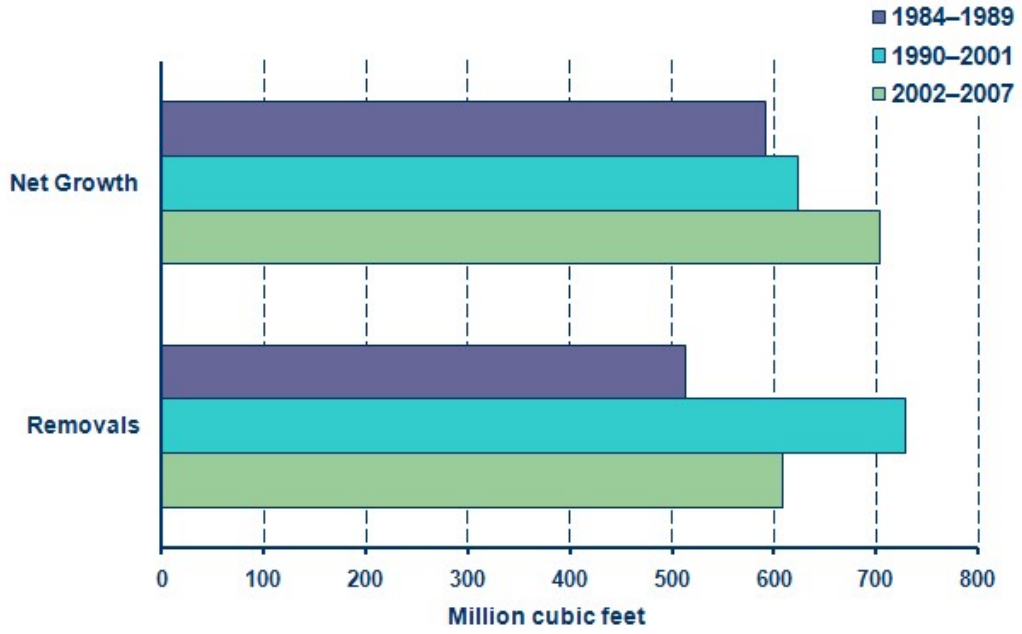
Softwood Growth, Removals, and Change

Softwoods provided 48 percent of the state's total net annual growth in tree resources. From 2002 to 2007, softwood growth averaged 703 million cubic feet annually (FIGURE 2*a*-20), an increase of 13 percent. Planted softwoods made up 50 percent or 353 million cubic feet of the softwood net annual growth during the 2002 to 2007 period. This was an increase from 47 percent or 296 million cubic feet from the 1990 to 2001 period.

Softwoods made up 53 percent of the state's total annual removals. During the 2002 to 2007 period, softwood removals averaged 608 million cubic feet annually (FIGURE 2*a*-20), a decline of 17 percent from the removals in the 1990 to 2001 period.

Planted softwoods provided 43 percent or 262 million cubic feet of the state's average annual softwood removals during 2002 to 2007. This is an increase from the removals in the 1990 to 2001 period, when planted

FIGURE 2*a*-20. Average net annual growth and removals of softwood live trees by survey period.



Source: Brown, M. J., 2009 and USDA Forest Service, Forest Inventory and Analysis (FIA), 2010

softwoods accounted for 31 percent or 223 million cubic feet of total softwood removals.

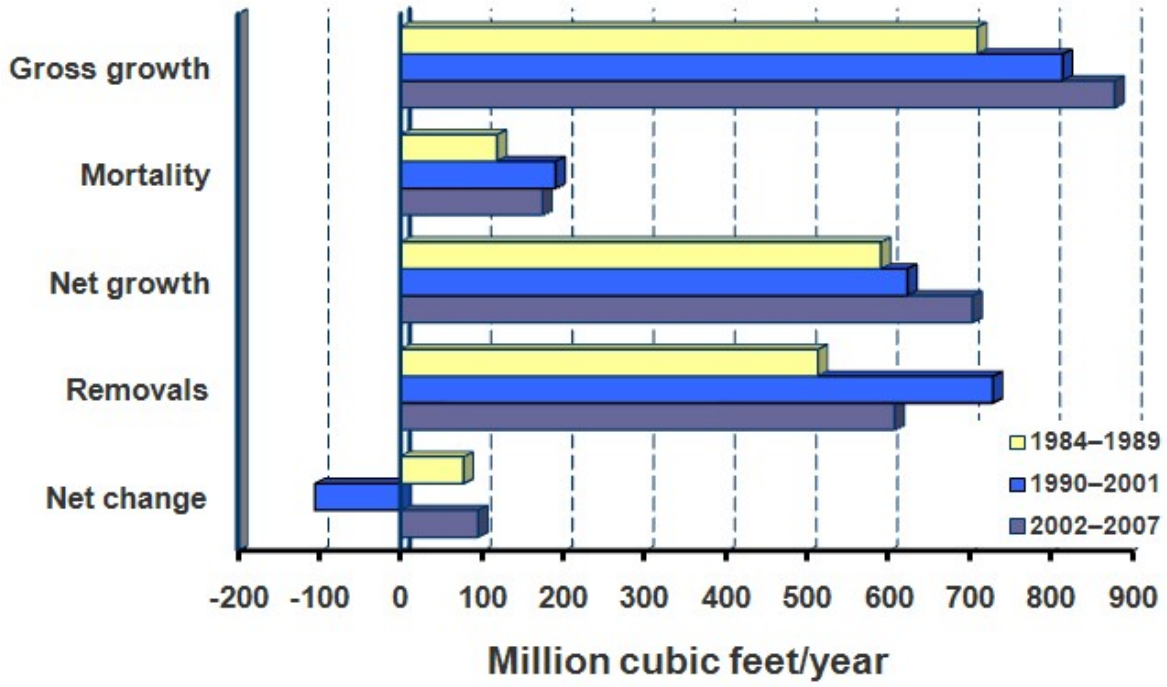
Between 2002 and 2007, annual softwood net growth exceeded net annual softwood removals by 16 percent or 96 million cubic feet. The growth and removals figures above reflect the changes that took place in the softwood resource from 2002 to 2007. A more complete look leading to net change observations in the softwood resource includes the impact of varying mortality rates and the ratio of growth to removals. FIGURE 2*a*-21 portrays how gross growth is reduced by mortality to yield net growth. Then net growth is reduced by removals to yield net change.

The impact of mortality on net change is often overlooked. Mortality is virtually uncontrollable in most cases, and largely unpredictable. The most significant mortality resulted from weather (drought, flooding, ice storms, tornados, and hurricanes), fires, and insect outbreaks. Mortality can even be species specific. From 2002 to 2007, the state's softwood resource accumulated 878 million cubic feet of gross growth per year. However, softwood mortality averaged 175 million cubic feet annually during the same timeframe. Thus, mortality reduced gross growth to 703 million cubic feet of net growth. Then the net growth was reduced by removals of 608 million cubic feet, which yielded an average net change in the softwood resource of 96 million cubic feet per year. This change reversed the negative net change of 105 million cubic feet per year experienced from 1990 to 2001.

Hardwood Growth, Removals, and Change

Hardwoods contributed 52 percent of the state's total net annual growth in tree resources. From 2002 to 2007, hardwood growth averaged 748 million cubic feet

FIGURE 2*a*-21. Components of change for softwoods by survey period.



Source: Brown, M. J., 2009 and USDA Forest Service, Forest Inventory and Analysis (FIA), 2010

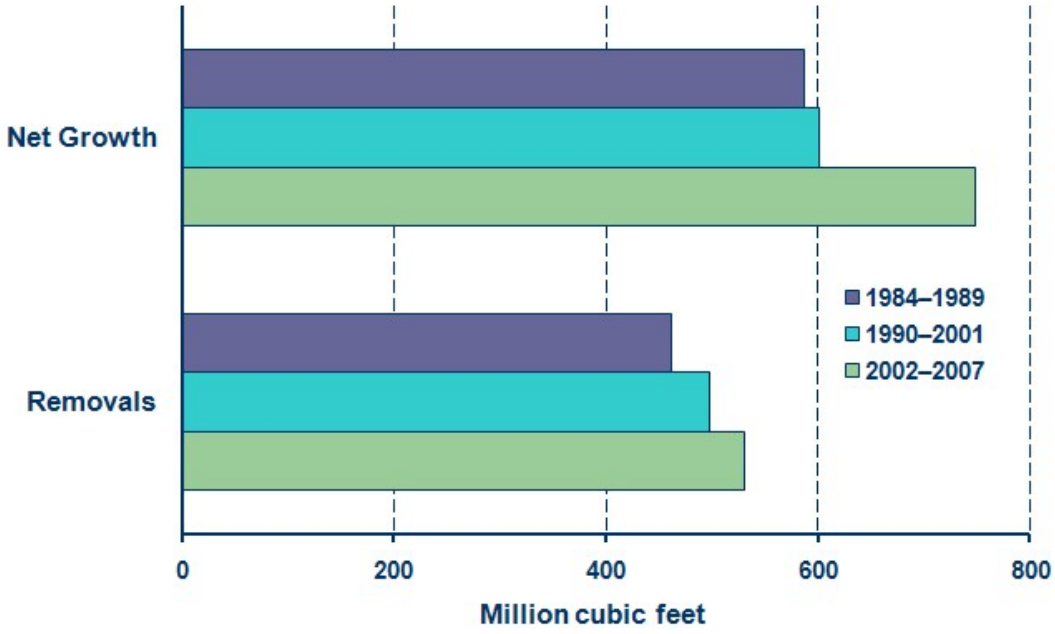
annually (FIGURE 2*a*-22) and increased 24 percent over that in the 1990 to 2001 period. Planted stands provided 4 percent of hardwood growth during the 2002 to 2007 period, an increase from that in the 1990 to 2001 period. Hardwoods made up 47 percent of the state's total annual removals. During the 2002 to 2007 period, hardwood removals averaged 530 million cubic feet annually (FIGURE 2*a*-22), a 6 percent increase from removals in the 1990 to 2001 period. Planted sources contributed 13 percent of hardwood removals during the 2002 to 2007 period.

From 2002 to 2007, net annual hardwood growth exceeded annual hardwood removals by 41 percent or 218 million cubic feet. Gross growth of hardwoods averaged 976 million cubic feet annually (FIGURE 2*a*-23). Average annual hardwood mortality of 228 million cubic feet reduced hardwood gross growth to 748 million cubic feet of net annual growth. Because hardwood removals of 530 million cubic annually were less than the net annual growth, a positive change of 218 million cubic feet annually occurred in the hardwood resource. This change follows another positive change in hardwoods recorded in the 1990 to 2001 period as well.

Summary

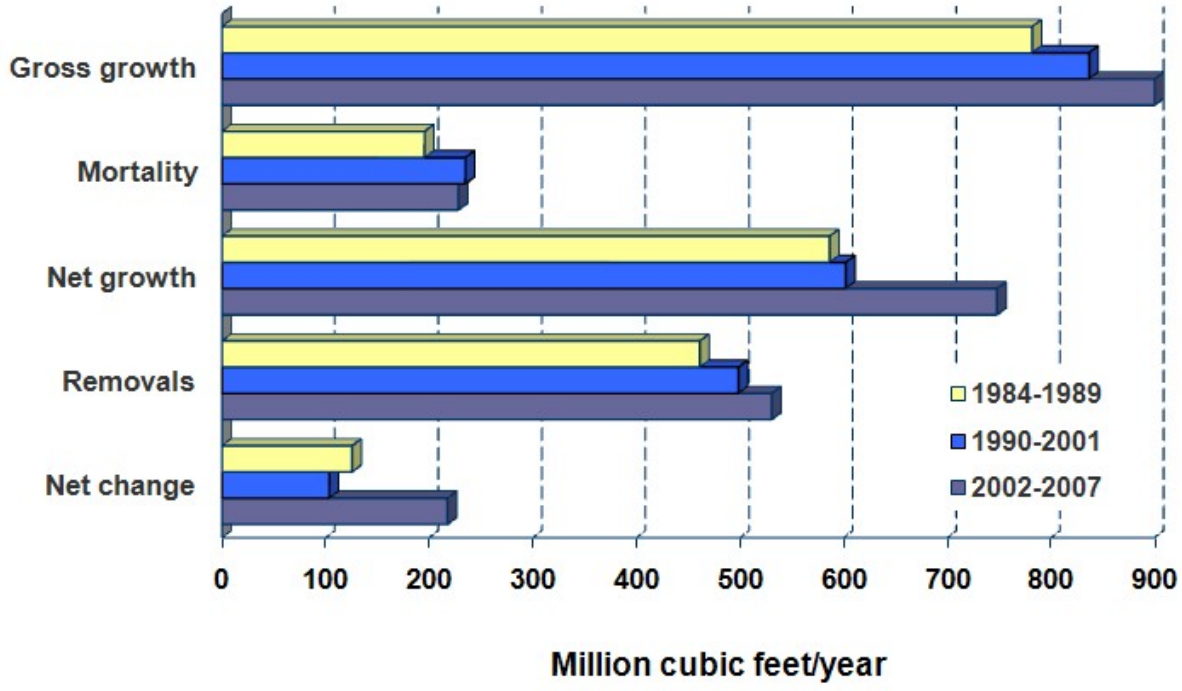
In 2007, forests covered 18.6 million acres in North Carolina, of which 18 million acres were classified as timberland. Hardwood forest types prevailed on 68 percent of timberland and planted pine stands occupied 15 percent. Nonindustrial private forest landowners controlled 78 percent of timberland, forest industry holdings declined in acreage but held at 8 percent, and publicly owned timberland totaled 14 percent. The volume of all live trees on timberland

FIGURE 2*a*-22. Average net annual growth and removals of hardwood live trees by survey period.



Source: Brown, M. J., 2009 and USDA Forest Service, Forest Inventory and Analysis (FIA), 2010

FIGURE 2*a*-23. Components of change for hardwoods by survey period.



Source: Brown, M. J., 2009 and USDA Forest Service, Forest Inventory and Analysis (FIA), 2010

totaled 36 billion cubic feet, 66 percent of which consisted of hardwood. Planted pines made up 3.9 billion cubic feet of the total. Loblolly pine was the dominant individual species with 7.6 billion cubic feet. Net annual growth of all live trees averaged 1.4 billion cubic feet, and annual removals averaged 1.1 billion cubic feet. Softwoods made up 48 percent of the growth and 53 percent of the removals. Softwood growth exceeded softwood removals by 96 million cubic feet. Hardwood growth exceeded hardwood removals by 218 million cubic feet.

Map Data Sources

FIGURE 2a-2: USDA Forest Service

FIGURE 2a-4: National Land Cover Dataset 2001, NC DENR Managed Areas dataset

FIGURE 2a-10: USDA Forest Service FIA, Reufenacht et al 2008.

References and Sources Cited

Brown, M. J. 2009. Forest survey of North Carolina 2007. Presentation at North Carolina Forestry Association Annual Meeting, October 8, 2009, Myrtle Beach, SC.

Brown, M. J.; New, B. D.; Oswalt, S. N.; Johnson, T. G.; and Rudis, V. A. . 2006. *North Carolina's Forests, 2002*. Resource Bulletin SRS-113. Asheville, NC: U.S. Department of Agriculture—Forest Service, Southern Research Station.

Brown, M.J. 1993. North Carolina's forests, 1990. Resour. Bull. SE–142. Asheville, NC: U.S. Department of Agriculture Forest Service, Southeastern Forest Experiment Station. 101 p.

Brown, M.J. 2004. Forest statistics for North Carolina, 2002. Resour. Bull. SRS–88. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station. 78 p.

Cruikshank, J.W. 1944. North Carolina forest resources and industries. Misc. Publ. 533. Washington, DC: U.S. Department of Agriculture Forest Service. 76 p.

Healy, R.G. 1985. Competition for land in the American South: agriculture, human settlement, and the environment. Washington, DC: The Conservation Foundation. 333 p.

Knight, H.A.; McClure, J.P. 1975. North Carolina's timber, 1974. Resour. Bull. SE–33. Asheville, NC: U.S. Department of Agriculture Forest Service, Southeastern Forest Experiment Station. 52 p.

Knight, H.A.; McClure, J.P. 1966. North Carolina's timber. Resour. Bull. SE–5. Asheville, NC: U.S. Department of Agriculture Forest Service, Southeastern Forest Experiment Station. 47 p.

Larson, R.W. 1957. North Carolina's timber supply, 1955. For. Surv. Rel. 49. Asheville, NC: U.S. Department of Agriculture Forest Service, Southeastern Forest Experiment Station. 71 p.

NC Division of Forest Resources (NCDFR). 2009. Accomplishment data from the NC Community Protection Plan Program. Raleigh: NC Dept. of Environment and Natural Resources (NCDENR), Unpublished.

Ruefenacht, M.V., et al. 2008. Conterminous U.S. and Alaska Forest Type Mapping using forest Inventory and Analysis Data, Photogrammetric Engineering and Remote Sensing 74(11):1379-1388.; or http://svinetfc4.fs.fed.us/rastergateway/Forest_type/

Sheffield, R.M.; Knight, H.A. 1986. North Carolina's forests. Resour. Bull. SE–88. Asheville, NC: U.S. Department of Agriculture Forest Service, Southeastern Forest Experiment Station. 97 p.

U.S. Dept. of Agriculture (USDA) Forest Service, Forest Inventory and Analysis (FIA), 2010. EVALIDatorPC software, Version 4. Reference files and NC data files downloaded February 3, 2010. Online: http://199.128.173.17/fiadb4-downloads/datamart.html

U.S. Department of Agriculture (USDA) Forest Service. Soil Bank Act, 1956. Title 1 of the Agricultural Act of 1956 (P.L. 84–850).

U.S. Dept. of Defense (USDOD). 2009. Base structure report fiscal year 2008 baseline. U.S. Department of Defense, Washington DC. Report downloaded May 14, 2010. Online:http://www.acq.osd.mil/ie/download/bsr/BSR2008Baseline.pdf.

Glossary

average annual mortality. Average annual volume of trees 5.0 inches diameter at breast height (d.b.h.) and larger that died from natural causes during the intersurvey period.

average annual removals. Average annual volume of trees 5.0 inches d.b.h. and larger removed from the inventory by harvesting, cultural operations (such as timber-stand improvement), land clearing, or changes in land use during the intersurvey period.

average net annual growth. Average annual net change in volume of trees 5.0 inches d.b.h. and larger in the absence of cutting (gross growth minus mortality) during the intersurvey period.

census water. Streams, sloughs, estuaries, canals, and other moving bodies of water 200 feet wide and greater, and lakes, reservoirs, ponds, and other permanent bodies of water 4.5 acres in area and greater.

diameter class. A classification of trees based on tree d.b.h. Two-inch diameter classes are commonly used by USDA Forest Service FIA, with the even inch as the approximate midpoint for a class. For example, the 6-inch class includes trees 5 through 6.9 inches d.b.h.

d.o.b. (diameter outside bark). Stem diameter including bark.

forestland. Land at least 10 percent stocked by forest trees of any size, or formerly having had such tree cover, and not currently developed for nonforest use. The minimum area considered for classification is 1 acre. Forested strips must be at least 120 feet wide. Forest land includes three sub-categories: timberland, reserved forestland, and other forest land.

forest-management type. A classification of timberland based on forest type and stand origin:

Pine plantation. Stands that (1) have been artificially regenerated by planting or direct seeding, (2) are classed as a pine or other softwood forest type, and (3) have at least 10 percent stocking.

Natural pine. Stands that (1) have not been artificially regenerated, (2) are classed as a pine or other softwood forest type, and (3) have at least 10 percent stocking.

Oak–pine. Stands that have at least 10 percent stocking and classed as a forest type of oak-pine.

Upland hardwood. Stands that have at least 10 percent stocking and classed as an oak–hickory or maple–beech–birch forest type.

Lowland hardwood. Stands that have at least 10 percent stocking with a forest type of oak–gum–cypress, elm–ash–cottonwood, palm, or other tropical.

Nonstocked stands. Stands that are less than 10 percent stocked with live trees.

forest type. A classification of forestland based on the species forming a plurality of live-tree stocking. Major eastern forest-type groups are as follows:

white–red jack pine. Forests in which eastern white pine, red pine, or jack pine, singly or in combination, constitute a plurality of the stocking. (Common associates include hemlock, birch, and maple.)

spruce–fir. Forests in which spruce or true firs, singly or in combination, constitute a plurality of the stocking. (Common associates include maple, birch, and hemlock.)

longleaf–slash pine. Forests in which longleaf or slash pine, singly or in combination, constitute a plurality of the stocking. (Common associates include oak, hickory, and gum.)

loblolly–shortleaf pine. Forests in which loblolly pine, shortleaf pine, or other southern yellow pines, except longleaf or slash pine, singly or in combination, constitute a plurality of the stocking. (Common associates include oak, hickory, and gum.)

oak–pine. Forests in which hardwoods (usually upland oaks) constitute a plurality of the stocking but in which pines account for 25 to 50 percent of the stocking. (Common associates include gum, hickory, and yellow poplar.)

oak–hickory. Forests in which upland oaks or hickory, singly or in combination, constitute a plurality of the stocking, except where pines account for 25 to 50 percent, in which case the stand would be classified oak-pine. (Common associates include yellow poplar, elm, maple, and black walnut.)

oak–gum–cypress. Bottomland forests in which tupelo, blackgum, sweetgum, oaks, or southern cypress, singly or in combination, constitute a plurality of the stocking, except where pines account for 25 to 50 percent, in which case the stand would be classified as oak–pine. (Common associates include cottonwood, willow, ash, elm, hackberry, and maple.)

elm–ash–cottonwood. Forests in which elm, ash, or cottonwood, singly or in combination, constitute a plurality of the stocking. (Common associates include willow, sycamore, beech, and maple.)

maple–beech–birch. Forests in which maple, beech, or yellow birch, singly or in combination, constitute a plurality of the stocking. (Common associates include hemlock, elm, basswood, and white pine.)

Nonstocked stands. Stands less than 10 percent stocked with live trees.

gross growth. Annual increase in volume of trees 5.0 inches d.b.h. and larger in the absence of cutting and mortality. (Gross growth includes survivor growth, ingrowth, growth on ingrowth, growth on removals before removal, and growth on mortality before death.)

hardwoods. Dicotyledonous trees, usually broadleaf and deciduous.

Soft hardwoods. Hardwood species with an average specific gravity of 0.50 or less, such as gums, yellow-poplar, cottonwoods, red maple, basswoods, and willows.

Hard hardwoods. Hardwood species with an average specific gravity greater than 0.50, such as oaks, hard maples, hickories, and beech.

ingrowth. The net volume or number of trees that grow large enough during a specified year to qualify as saplings, poletimber, or sawtimber.

land area. The area of dry land and land temporarily or partly covered by water, such as marshes, swamps, and river floodplains (omitting tidal flats below mean high tide), streams, sloughs, estuaries, and canals < 200 feet wide, and lakes, reservoirs, and ponds < 4.5 acres in area.

net annual change. Increase or decrease in volume of live trees at least 5.0 inches d.b.h. Net annual change is equal to net annual growth minus average annual removals.

nonforestland. Land that has never supported forests and land formerly forested where timber production is precluded by development for other uses.

nonstocked stands. Stands less than 10 percent stocked with live trees.

other forestland. Forestland other than timberland and productive reserved forestland. It includes available and reserved forestland that is incapable of producing annually 20 cubic feet per acre of industrial wood under natural conditions, because of adverse site conditions such as sterile soils, dry climate, poor drainage, high elevation, steepness, or rockiness.

other removals. The growing-stock volume of trees removed from the inventory by cultural operations, such as timber stand improvement, land clearing, and other changes in land use, resulting in the removal of the trees from timberland.

ownership. The property owned by one ownership unit, including all parcels of land in the United States.

national forestland. Federal land that has been legally designated as national forests or purchase units, and other land under the administration of the Forest Service, including experimental areas and Bankhead-Jones Title III land.

forest industry land. Land owned by companies or individuals operating primary wood-using plants.

nonindustrial private forest (NIPF) land. Privately owned land excluding forest industry land.

Corporate. Owned by corporations, including incorporated farm ownerships.

Individual. All lands owned by individuals, including farm operators.

other public. An ownership class that includes all public lands except national forests.

Miscellaneous federal land. Federal land other than national forests.

State, county, and municipal land. Land owned by states, counties, and local public agencies or municipalities or land leased to these governmental units for 50 years or more.

reserved forestland. Land permanently reserved from wood products utilization through statute or administrative designation.

softwoods. Coniferous trees, usually evergreen, having leaves that are needles or scalelike.

yellow pines. Loblolly, longleaf, slash, pond, shortleaf, pitch, Virginia, sand, spruce, and Table Mountain pines.

other softwoods. Cypress, eastern red cedar, white cedar, eastern white pine, eastern hemlock, spruce, and fir.

stand age. The average age of dominant and co-dominant trees in the stand.

stand origin. A classification of forest stands describing their means of origin.

Planted. Planted or artificially seeded.

Natural. No evidence of artificial regeneration.

timberland. Forestland capable of producing 20 cubic feet of industrial wood per acre per year and not withdrawn from timber utilization.

tree. A woody plant having one erect perennial stem or trunk at least 3 inches d.b.h., a more or less definitely formed crown of foliage, and a height of at least 13 feet (at maturity).

2.b.

Declining Forest Types

Key Findings

- The volume and extent of longleaf pine, Atlantic white cedar, and shortleaf pine, species with ecological and economic importance, has significantly declined in North Carolina.

Introduction

The mission of the North Carolina Division of Forest Resources (NCDFR) is "to develop, manage, and protect the multiple resources of North Carolina's forests." Many of North Carolina's tree species are declining because of a multitude of pressures. NCDFR recognizes the need to initiate efforts to maintain and restore declining forest types. One of the major goals for the Forest Management Section states

> "NCDFR will maintain a leadership role in promoting the restoration and enhancement of declining forest tree species and forest ecosystems."

In the face of the many threats to our state's forest resources, a need to direct more efforts towards these species and ecosystems becomes even more important.

NCDFR efforts have focused on three conifers; longleaf pine, Atlantic white cedar, and shortleaf pine. Many other species are in decline or threatened, including spruce–fir types, Table Mountain pine, hemlock, and bottomland hardwoods. Resource professionals across the state have an obligation to conserve these communities when an opportunity arises. Conditions and threats for many threatened natural communities are discussed in detail in the *North Carolina Wildlife Action Plan* and in Chapter 4, section f, of this assessment.

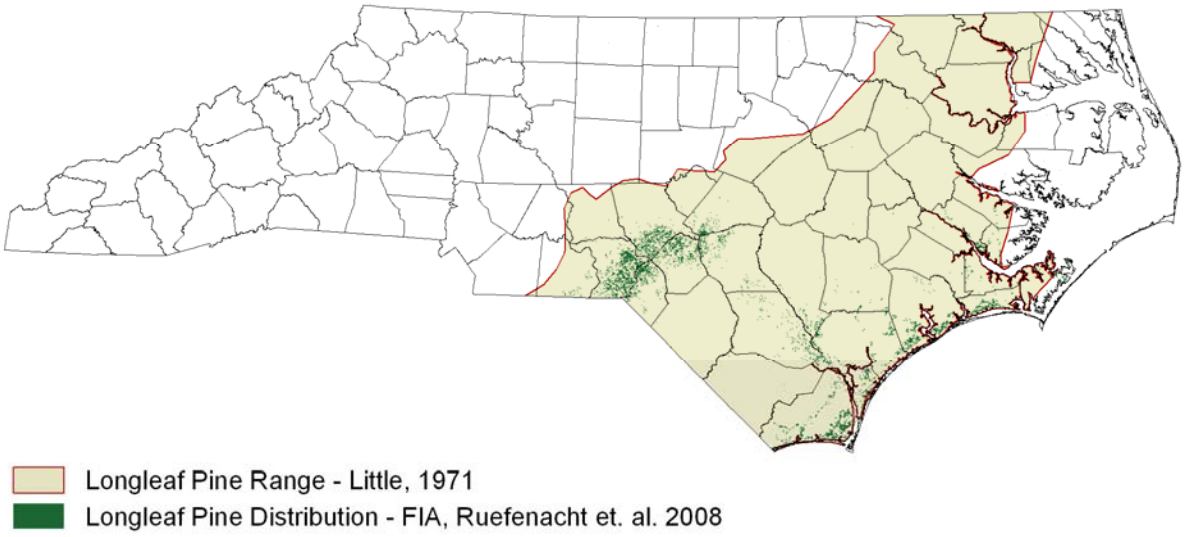
Longleaf Pine Forests

Historic Extent

Prior to European settlement, longleaf pine forests dominated the landscape of North Carolina's coastal plain and lower piedmont. Today longleaf occurs on less than 3 percent of its original range (FIGURE 2*b*-1). Longleaf pine forest is one of the most endangered ecosystems in the country. The decline of longleaf pine forests is attributed to a variety of factors, including a lack of planned management for regeneration, urbanization, harvesting, livestock grazing, and fire exclusion. USDA Forest Service FIA data reveal that North Carolina lost about 73,000 acres of longleaf pine forests between 1990 and 2007 with the majority of the loss occurring between 1990 and 2002 in the longleaf forest type and between 2002 and 2007 in the longleaf–scrub oak type (TABLE 2*b*-1).

Longleaf pine is a valuable timber species for sawtimber and pole markets. Its long needles generate a profitable landscaping mulch market. Longleaf pine is also valued for its rich and diverse ecosystem. Many rare and endangered species, including the red-cockaded woodpecker, are associated with the longleaf pine community. Longleaf ecosystems are recognized as one of the most diverse in the world. The *NC Wildlife Action Plan* provides a thorough assessment of the condition and threats to the natural

FIGURE 2*b*-1. North Carolina longleaf pine forest distribution in 2008 versus historic range.



Created by: D. Jones and A. Bailey, NC DFR, 2010

TABLE 2*b*-1.—Total area (acre) for longleaf pine type (141) and longleaf–scrub oak type (403) and ownership of combined forest types, 1990 – 2007

Survey Year	Longleaf Forest Type	Longleaf–Scrub Oak Type	Combined Total	Ownership of Combined Total			
				Public (acre, %)		Private (acre, %)	
1990	255,304	109,997	365,301	167,119	46%	198,182	54%
2002	177,461	114,605	292,066	136,046	47%	156,020	53%
2007	231,433	62,244	293,676	122,219	42%	171,457	58%

Source: USDA Forest Service, FIA

plant communities where longleaf pine is a key component (NC Wildlife Resources Commission, 2005). More efforts are needed to restore this valuable species to the landscape of North Carolina.

North Carolina Longleaf Forests Today

Based on the 2007 forest inventory of North Carolina (USDA 2010 data), the number of acres where longleaf pine is more than 50 percent of the stand stocking has increased since the 2002 survey (Brown et al., 2006). Currently, about 231,000 acres occur of the longleaf forest type. An additional 62,000 acres occur of the longleaf –scrub oak type (where longleaf pine comprises between 25 and 49 percent of the stocking, with scrub oaks, primarily turkey, blackjack, and dwarf post oaks, occupying 50 percent or more of the stand) (TABLE 2*b*-1). These two forest types combined account for about 293,000 acres of longleaf pine in North Carolina as of 2007. Fifty-eight percent of these forest types are privately owned, and 42 percent are in public ownership.

Fire exclusion has contributed to the decline in longleaf forest acreage. Of the 352 longleaf pine remnants examined by Frost (1993), only 91 stands (26 percent) were being maintained by fire. Typically, when fire is excluded from longleaf forests, these stands transition to other forest types. The best examples of remaining natural longleaf

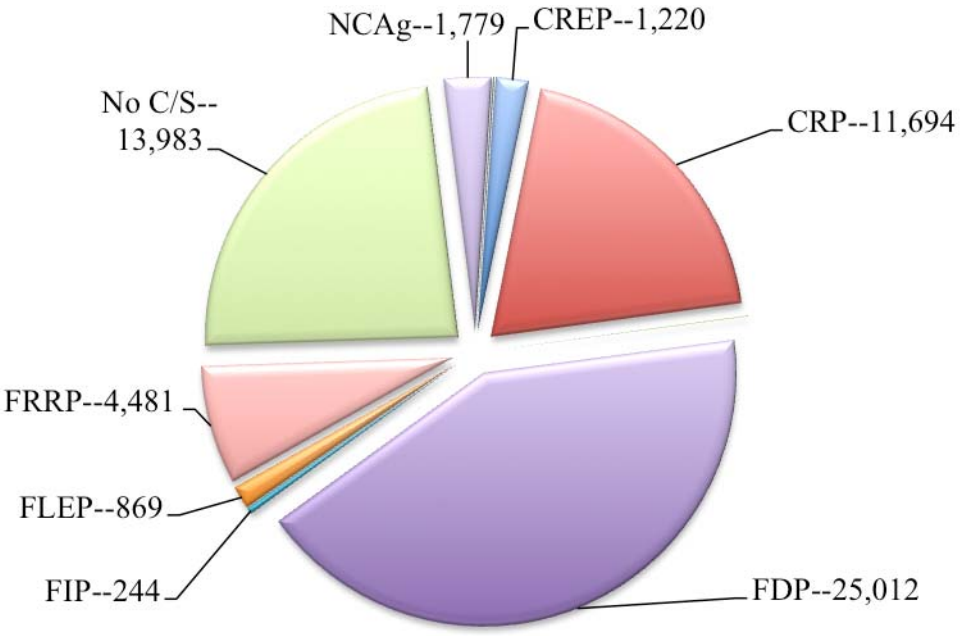
communities in North Carolina occur on Fort Bragg, the Croatan National Forest, and Sandhills Game Lands, and are maintained with regular prescribed burns.

Longleaf Restoration Efforts

According to NCDFR reports, an average of 5,642 acres of longleaf seedlings were planted between 2005 to 2009, a modest increase from an average of 5,200 acres per year from 1993 to 2004 (NCDFR, 2009). A number of cost-share assistance programs support longleaf pine establishment on private lands. North Carolina's Forest Development Program (FDP) is the primary state-administered financial assistance program supporting longleaf pine establishment. NCDFR foresters and rangers provide technical expertise and write management plans for these programs. The FDP provides an extra incentive to landowners who plant longleaf pine seedlings by reimbursing up to 60 percent of the establishment costs, a higher premium over the 40 percent cost-share rate for loblolly pine. More than 59,000 acres of longleaf pine have been established with NCDFR involvement since 1997. Of the total forestland established using cost-share funding between 1997 and 2007 (with NCDFR involvement), federal programs combined accounted for 24 percent, FDP accounted for 42 percent, and 24 percent was established with no cost-share funding (FIGURE 2*b*-2).

Recognizing the declining numbers for longleaf forests, the NCDFR implemented a Longleaf Pine Restoration Initiative in 1993. The initiative focused on artificial regeneration as the primary means to restore longleaf pine to sites where it was

FIGURE 2b-2. Acres of longleaf establishment by federal and state cost-share programs, 1997 – 2007.



Source: NCDFR 4220 database, 2010

historically found and adapted to, especially in the lower piedmont and coastal plain. A goal to double the annual number of acres planted to longleaf was proposed. Generally, the goals of the 1993 Longleaf Pine Restoration Initiative were met.

Beginning in 2006, NCDFR revised and expanded the objectives of the original initiative giving it new direction. The overall objective of the 2006 – 2010 NCDFR Longleaf Pine Restoration Initiative is to "Sustain and promote restoration of longleaf forests in North Carolina through efforts to establish new stands, conserve existing stands, and promote total resource management" (NCDFR, 2006). Specific objectives support actions in reforestation, outreach and education, research, restoration management, conservation, and collaboration.

The Longleaf Alliance (LLA) was established in 1995 with the express purpose of coordinating a partnership between private landowners, forest industries, state and federal agencies, conservation groups, researchers, and other enthusiasts interested in managing and restoring longleaf pine forests for ecological and economic benefits. North Carolina land managers and owners benefit from the LLA outreach and research efforts. NCDFR is a member of the LLA. A range-wide restoration initiative, Americas Longleaf, has recently completed a Longleaf Range-wide Conservation Plan with a goal to increase longleaf from 3.1 to 8 million acres. Another regional effort, the Southeastern Regional Partnership for Planning and Sustainability (SERPPAS), a partnership of state and federal environmental agencies and the U.S. Department of Defense, has pledged support for longleaf restoration. Numerous conservation partnerships are active in North Carolina with an interest in longleaf restoration, including Onslow Bight Conservation Forum, Cape Fear Arch, Greater Uwharrie Conservation Partnership, NC Prescribed Fire Council, Chatham Conservation Partnership**,** and Sandhills Conservation Partnership.

Recently, numerous restoration projects were funded by grants secured from the USDA Forest Service State and Private Forestry Redesign Program. In 2009 additional support was provided by the American Reinvestment and Recovery Act (ARRA). Funds from ARRA are targeted to increase longleaf seedling production, restore longleaf ecosystems, promote an education and outreach effort, and assist in the formation of a North Carolina Longleaf Coalition.

Atlantic White Cedar Forests

Historic Extent

Once a common forest type in NC coastal wetlands and waterways, the area of Atlantic white cedar has decreased to less than 10 percent of its original range. Exploitive logging, natural regeneration failure, absence of artificial regeneration, drainage impacts, fire exclusion, and lack of competition control are cited as reasons behind the decline. NCDFR has identified Atlantic white cedar as a species of concern. NCDFR supports and participates in an Atlantic White Cedar Alliance formed in 1995 by a group of researchers and land managers, including universities, state and federal government, forest industry, environmental and forest consultants, and private landowners. This informal cooperative research effort advocates for the conservation, restoration, management, and use of Atlantic white cedar across its range.

Atlantic White Cedar in North Carolina

Because of large sampling errors, attributed to the small population and limited

distribution of the species, USDA Forest Service FIA data provides only an estimation of forest area of Atlantic white cedar. It does point to a continuing decline in area occupied by this species in North Carolina from 1990 to 2007 (TABLE 2*b*-2).

In 1997 an extensive inventory of remnant Atlantic white cedar stands was commissioned by the U.S. Air Force (Davis and Daniels, 1997). No plantations and only natural stands whose diameter at breast height (4.5 feet above ground line) exceeds six inches were inventoried. Of the 10,583 acres of mature Atlantic white cedar stands identified, 77 percent were publicly owned and 23 percent privately owned. A vast majority (88 percent) of the acres occur in the northern counties of the coastal plain: Dare, Tyrrell, Camden, Hyde, and Washington. The U.S. Fish and Wildlife Service (USFWS) Alligator River National Wildlife Refuge holds the largest stand at 4,152 acres, with the U.S. Air Force Dare County Bombing Range holding the second largest at 2,242 acres. Other populations of note are found in the Great Dismal Swamp, Sandhills, Green Swamp, and Bladen County. Hurricane Isabel and two wildfires have damaged or destroyed a significant portion of the Atlantic white cedar stands in the Great Dismal Swamp.

Shortleaf Pine Forests

Shortleaf pine, valued commercially for superior sawtimber and ecologically for its habitat diversity and integrity, has declined since European settlement. Historically periodic fire maintained shortleaf pine forests throughout North Carolina. Agricultural land clearing prior to the Civil War destroyed many shortleaf forests in the coastal plain and piedmont. When the fields were abandoned in the early 1900s, loblolly pine trees (left along waterways and poorly drained soils) replaced what was once occupied by shortleaf. In the piedmont, the removal of the valued shortleaf pine allowed hardwoods to dominate in what were formerly mixed shortleaf–hardwood stands.

Today, shortleaf pine is most prevalent in two forest types, shortleaf and shortleaf–oak, and is associated with many other hardwood and pine stands. According to the last several forest inventories, the forested area of shortleaf pine and the number of shortleaf trees occupying each acre has sharply dropped in North Carolina (Brown 2004, USDA 2010). Reasons for this decline include urbanization, especially in the piedmont, lack of management for regeneration, fire exclusion, forest conversion, and harvesting. Interest in restoration efforts is growing among state and federal agencies across the Southeast.

TABLE 2*b*-2.—Area (acres) of Atlantic white cedar forestland, 1990 – 2007

		Stand-age			
Survey Year	Total Acres*	0 - 20 yrs	21 - 40 yrs	41 - 60 yrs	61 - 80 yrs
1990	33,615 (28)	5,693	7,922	14,084	5,915
2002	15,215 (56)	11,603	3,613		-
2007	10,341 (72)	-	5,937	4,403	-

**value in parenthesis = percent sampling error*

Source: USDA Forest Service, FIA data, 1990 – 2007

Shortleaf Pine in North Carolina

Based on USDA Forest Service FIA data, the combined area of shortleaf pine and shortleaf pine–oak forest types has declined by 59 percent since 1990 (USDA 2010). The shortleaf pine forest type had the sharpest decline, losing almost 70 percent of its area. In 1990 the shortleaf pine forest type accounted for almost 60 percent of the total shortleaf pine area; by 2007 it dropped to 44 percent (FIGURE 2*b*-5). The basal area of the shortleaf pine stems across all forest types declined by 47 percent during that same period (Hopkins, 2006). Moser et al. (2007) found that the amount of shortleaf pine regeneration in most states was in decline, along with the overstory basal areas containing shortleaf pine. The smaller proportion of shortleaf regeneration versus overstory basal area point to a potential absence of shortleaf pine in future forests (Moser, 2007). Three-fourths of the shortleaf stands are found in the piedmont region (FIGURE 2*b*-3). In the mountains, all of the 51,458 acres with shortleaf pines were a mixed shortleaf pine–oak type suggesting pure shortleaf stands are rare there. A vast majority of the shortleaf forest type (94%) and shortleaf pine–oak forest type (79 percent) is privately owned. The bulk of the shortleaf growing stock is found in large-diameter trees. Since 1990 the age class distribution has shifted towards a predominance of older aged stands (FIGURE 2*b*-6). This decline in area of young stands reflects an overall lack of regeneration. Declining area, decreasing basal area, and lack of regeneration have discouraging implications for the future of shortleaf pine.

Shortleaf Pine Restoration Efforts

For a variety of reasons, including slow growth, susceptibility to littleleaf disease, and lack of regeneration success, artificial regeneration of shortleaf pine has lagged behind other species. According to NCDFR, an average of 110 acres of shortleaf were planted each year between 2005 and 2009 on NIPF land (NCDFR, 2009). 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 (EQIP), a program of the USDA Natural Resources Conservation Service, will also fund the planting of shortleaf pine. NCDFR foresters and rangers develop management plans and provide technical expertise for these programs. The FDP provides additional incentives by reimbursing landowners for up to 60 percent of establishment costs to plant shortleaf pine seedlings compared to the standard cost-share rate of 40 percent for loblolly pine.

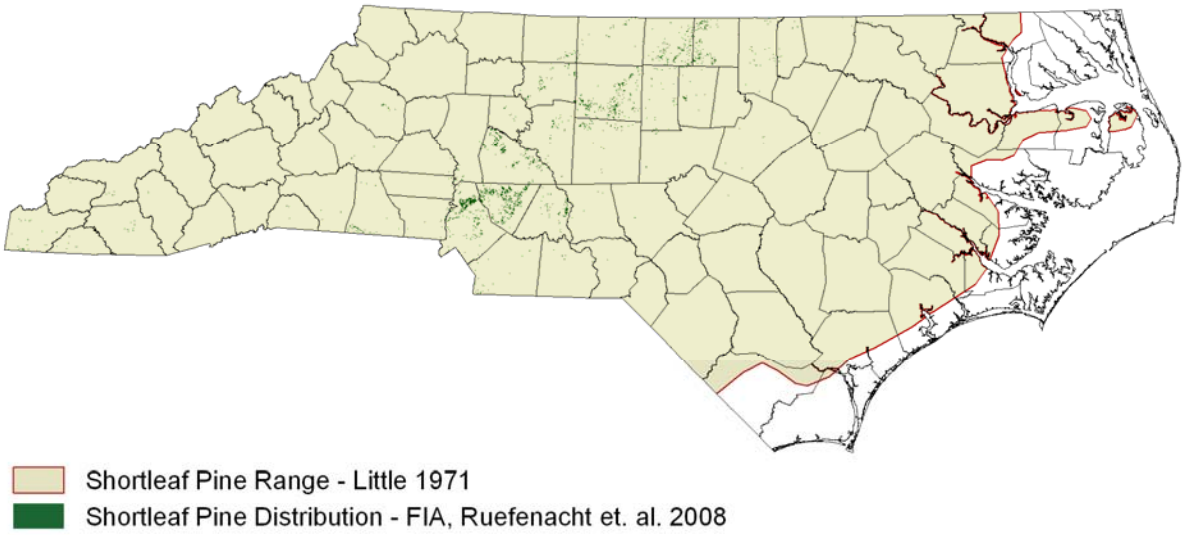
Summary

NCDFR recognizes the need to initiate efforts that maintain and restore declining forest types. In the face of the many threats to North Carolina's forest resources, the need to spotlight these species and ecosystems becomes even more important. NCDFR efforts have focused on three conifers: longleaf pine, Atlantic white cedar, and shortleaf pine.

Longleaf pine once covered a vast area of North Carolina's piedmont and coastal plain. At this writing in 2010, only a small portion of those forests remain. Numerous state agencies, federal agencies, nongovernmental organizations, resource professionals, and owners of forestland support restoration efforts and practice longleaf forest management in NC. Thanks to their efforts, the decline in longleaf pine acreage has begun to slow down and longleaf pine acreage increased between 2002 and 2007.

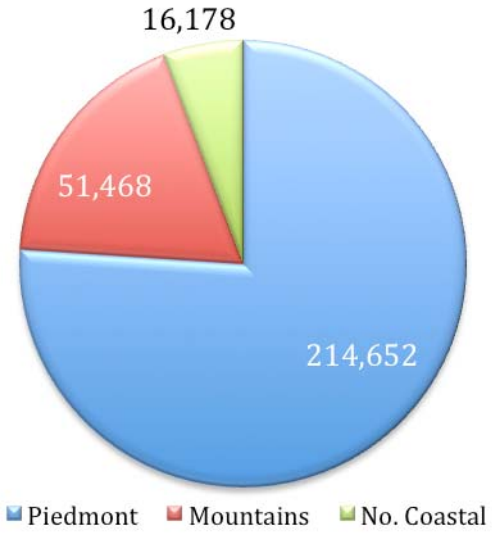
b. Declining Forest Types

FIGURE 2*b*-3. North Carolina shortleaf pine forest distribution in 2008 versus historic range.



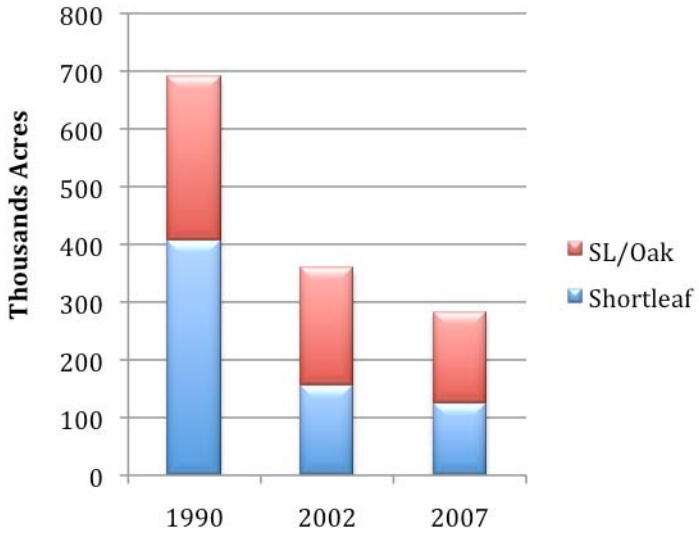
Created by: D. Jones and A. Bailey, NC DFR, 2010

FIGURE 2*b*-4. Area of shortleaf pine in acres for geographical regions of North Carolina from analysis of the 2007 forest inventory data.



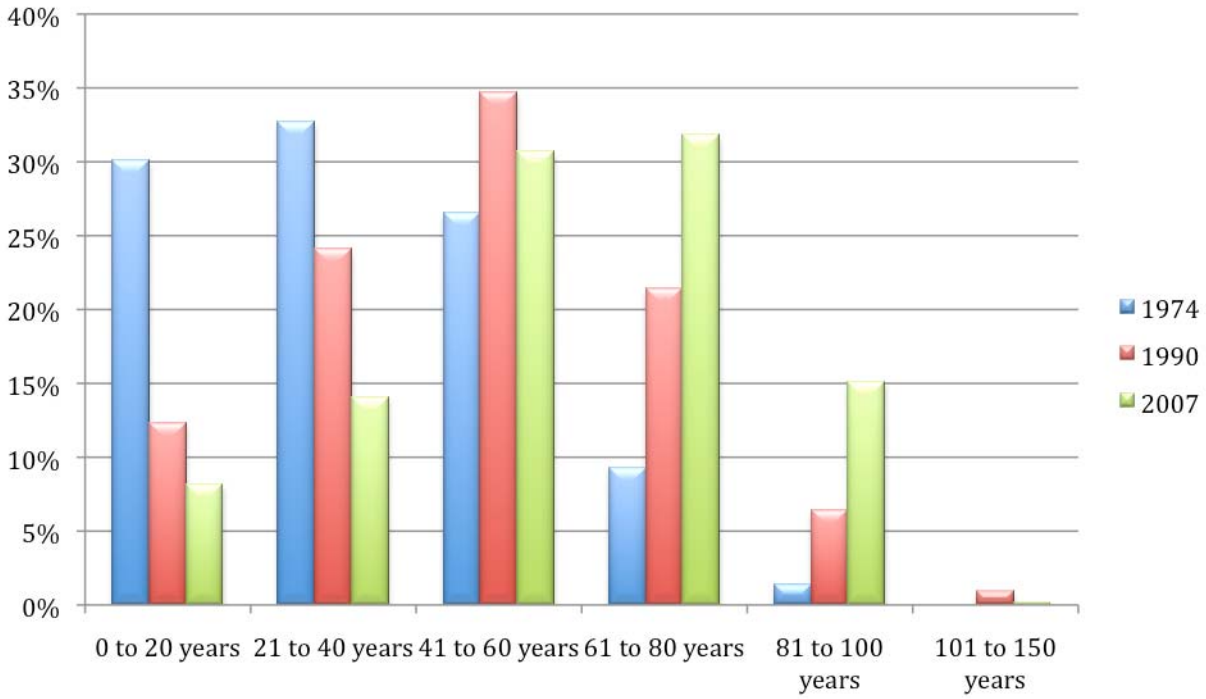
Source: USDA Forest Service, FIA data, 1990 – 2007

FIGURE 2*b*-5. Area of shortleaf pine from 1990, 2002, 2007 forest inventory data for the shortleaf pine and shortleaf pine–oak forest types.



Source: USDA Forest Service, FIA data, 1990 – 2007

FIGURE 2*b*-6. Percentage of total shortleaf pine area that shifted to older stands from analysis of the 2007 Forest Inventory Analysis data for North Carolina.



Source: USDA Forest Service, FIA data, 1974 – 2007.

Atlantic white cedar, an economically and ecologically valued tree, once occupied a significant portion of North Carolina's inner coastal plain. Today it is found on a small portion of its historic range. According to FIA data, Atlantic white cedar acreage A growing number of conservation partnerships have formed to bring longleaf pine forests back to North Carolina's landscape. continues to decline. Because of its small distribution, an accurate assessment of Atlantic white cedar status and trends is not available. More than 75 percent of the remaining stands are publically owned. An informal group—consisting of researchers, land managers, and private landowners—advocates for the conservation, restoration, management, and use of Atlantic white cedar across its range.

Shortleaf pine was once found across most of North Carolina. It has not received the same focus commercially as loblolly pine or ecologically as longleaf pine, and has significantly diminished. According to FIA data, acreage of the two forest types most commonly associated with the species, shortleaf pine and shortleaf pine–oak forest types, declined by 60 percent from 1990 to 2007. Shortleaf pine forest acreage has dropped by almost 70 percent. The data show that North Carolina's growing stock is getting older and is not being replaced by artificial or natural regeneration.

Many tree species and forest types have declined from their historic distribution. For some, the decline continues. Efforts are needed to quantify the extent of the loss, evaluate the health of the remnants, improve management, increase awareness, and instigate restoration action. New threats continue to pressure our state's forests. We are obligated to constantly monitor their numbers and assess their condition and health so we don't lose these valuable species.

Map Data Sources

FIGURE 2b-1: Little 1971, USDA Forest Service FIA, Reufenacht et al 2008.

FIGURE 2b-3: Little 1971, USDA Forest Service FIA, Reufenacht et al 2008.

References and Sources Cited

Brown, M. J. 2004. *Forest statistics for North Carolina: 2002*. Resource Bulletin SRS-88. Asheville, NC: USDA Forest Service, Southern Research Station.

Brown, M. J.; New, B. D;, Oswalt, S. N.; Johnson, T. G.; and Rudis, V. A. 2006. *North Carolina's Forests, 2002*. Resource Bulletin SRS-113. Asheville, NC: USDA Forest Service, Southern Research Station.

Frost,C. C. 1993. Four centuries of changing landscapes patterns in the longleaf pine ecosystem. In *Proceedings of the Tall Timbers Fire Ecology Conference*, No. 18 (pp. 17-43). Tallahassee, FL: Tall Timbers Research Station.

Davis, K.N., and Daniels, S.M. 1997. *Inventory of Atlantic white-cedar remnant stands in North Carolina*. Prepared for the U.S. Department of Defense, Air Force, 4CES/CEV. Goldsboro, NC: Seymour Johnson AFB.

Hopkins, C. 2005, June. Shortleaf pine symposium background document. Presented at the Society of American Foresters, NC Chapter Summer Meeting, Statesville, NC. Unpublished.

Moser, K.W.; Hansen, M.; McWilliams, W.H.; and Sheffield, R.M. 2007. Shortleaf composition and structure in the United States. In Kabick, J. M. et al. (Eds.), *Shortleaf Pine restoration and Ecology in the Ozarks: Proceedings of a Symposium* (pp. 19-27). Gen. Tech. Rep. NRS-P-15. Newton Square, PA: USDA Forest Service, Northern Research Station.

NC Wildlife Resources Commission. 2005. *NC Wildlife Action Plan*. Raleigh, NC: Author.

NC Division of Forest Resources (NCDFR). 2006. *NC Division of Forest Resources Longleaf Initiative for 2005-2010*. Raleigh: NC Dept. of Environment and Natural Resources (NCDENR), Unpublished.

NC Division of Forest Resources (NCDFR). 2009. *Total Accomplishment Reports, 2005 – 2009*. Raleigh: NC Dept. of Environment and Natural Resources (NCDENR), Unpublished.

NC Division of Forest Resources (NCDFR). 2010. 4220 Database. Raleigh: NC Dept. of Environment and Natural Resources (NCDENR), Unpublished.

USDA Forest Service. 2010. EVALIDatorPC software, Version 4. Reference files and NC data files downloaded February 3, 2010. Online: http://199.128.173.17/fiadb4-downloads/datamart.html

2.c.

Family and Minority Forests Ownership

Key Findings

- A 2006 survey of North Carolina landowners identified the following as the top reasons for owning forestland: passing land on to heirs, land investment, beauty or scenery, part of farm or ranch, and nature protection. Owning forestland for commercial timber production is typically not a primary reason for owning forestland.
- The majority of family forests and farms are small. Almost 90 percent of family forests are less than 50 acres with the majority less than 10 acres. Nearly seven of 10 family farms are less than 100 acres, while most are less than 50 acres.
- The size of forest and family farm holdings in North Carolina will continue to decrease from development, land use change, and generational transfer of property. This may lead to a decrease in traditional resource management activities.

Introduction

Family forests accounted for 11.19 million acres or almost 61 percent of the 18.4 million acres of North Carolina's forestland in 2006 (Butler, 2008) (TABLE 2*c*-1). About 469,000 family forest owners control family forests. More than half of family forest ownerships are small in size (less than 10 acres). Nearly 9 in 10 family forest owners have tracts that are less than 50 acres in size, yet in sum total these small-acreage owners control about 38.3 percent or 4.38 million forested acres. The proportion of timberland that is privately owned is greatest in the piedmont at 93 percent, compared to 72 percent in the coastal plain and 71 percent in the mountains.

Diverse Landowner Objectives

The recent National Woodland Owner Survey indicates that family forest owners have many different management objectives, values, and reasons for ownership (Butler, 2008). The top reasons for owning family forestland in North Carolina include the following:

- Pass land on to heirs
- Land investment
- Enjoy beauty or scenery
- Part of farm or ranch
- Protect nature and biologic diversity

These reasons were more commonly expressed by owners of smaller properties (less than 50 acres) than owners of larger properties. Owners of larger properties are more likely to own land for monetary reasons, such as investment or the

TABLE 2c-1.—Area of family-owned, private, and public forests in North Carolina, 2006

Ownership Category	Area (acres)
Family	11,194,000
Other Private	4,303,000
Total Private	15,497,000
Federal	2,090,000
State	601,000
Local	258,000

Total Public	2,949,000

Source: North Carolina's Forests, 2002 (Brown et al., 2006)

production of timber products. Given the historic decrease in size of forest holdings and the socioeconomic status of new owners (higher income, highly educated), social amenities will likely take precedence over management objectives that emphasize timber production.

Natural resources professionals who educate and serve these new forest owners will need to apply different approaches to meet the changing resource management needs of family forest landowners. Ongoing social marketing efforts, and addressing needs by type have been proposed as new approaches to addressing the needs of current and future owners with their diverse management and ownership objectives (Hermansen-Baez, 2008; Butler et al., 2007).

The Link Between Family Forests and Farms

North Carolina working forests include land that is primarily forested but may include a significant component of pasture and cropland. These working forests have the potential to produce economic benefits to the landowners. When actively managed in a sustainable manner, working forests can provide social and environmental benefits to the public.

Many farm properties are forested to some degree; thus, the fate of rural forests is directly linked to that of farms. The conservation of working forests in North Carolina will become increasingly more important for the long-term sustainability of open space, forest productivity and health, and wildlife habitat. The most obvious landscape effects of human activities from our state's increased urbanization are the reduction of open space (forestland and cropland) and the fragmentation of our remaining working forests and farms into smaller, isolated parcels.

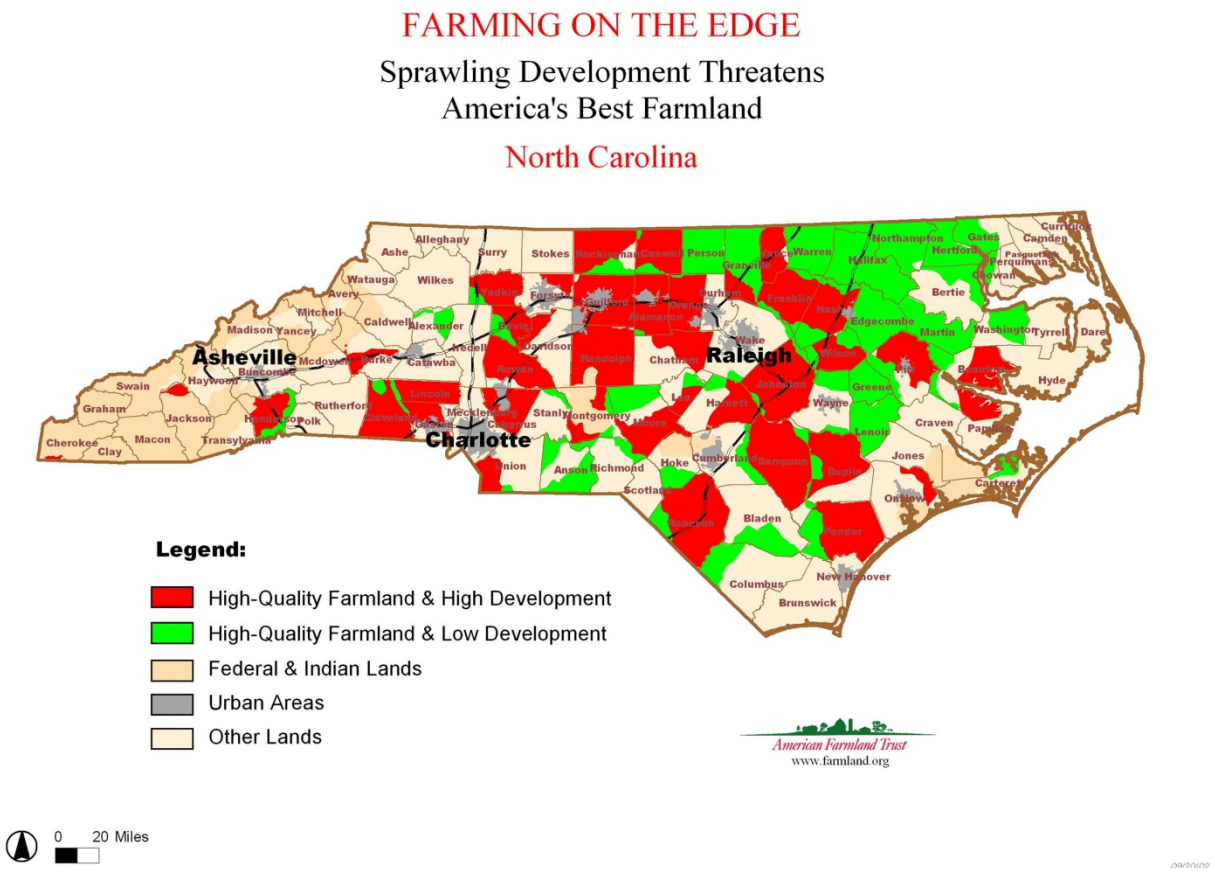
Between 1987 and 2007, North Carolina lost a total of 1,270,100 acres or 20 percent of its cropland, while losing a total of 1,104,200 acres or 7 percent of its forestland. Over this same 20-year period, a greater percentage loss of cropland acres occurred in the mountains compared to the piedmont, even though more total acres were lost in the piedmont (Ouzts 2007).

Open space losses in the coastal plain are projected to be below the statewide averages. The mountains will experience similar rates of open space losses when compared to the statewide projections, except for projected losses in cropland acres. Based on projections by Ouzts (2007), the mountains could lose about 69,100 cropland acres (31 percent of total cropland acreage) during 2007 to 2027, while some rural mountain counties could lose about 45,500 cropland acres (45 percent). Across all three regions, the loss of open space will likely continue, with the greatest loss occurring in cropland acres (Ouzts, 2007). This cropland and open space is very important for providing the early successional habitat that benefits many wildlife species.

In a report by the American Farmland Trust, sprawling development has the potential to threaten North Carolina's best farmland (FIGURE 2*c*-1). Between 1992 and 1997, North Carolina ranked fourth among the 20 states losing the most prime farmland. High-quality farmland areas have relatively large amounts of prime or unique farmland at risk to development. Future conservation and management efforts should be prioritized and directed to landowners who have working forests and family farms that are most at risk of potential conversion and fragmentation from development.

Heavy land-use pressures will likely continue and increase most rapidly in the

FIGURE 2*c*-1. North Carolina farmland at risk of development.



Source: American Farmland Trust, 2002

piedmont's urban and exurban areas. Piedmont counties near metropolitan areas will see the greatest losses in forestland, but most notable is the rate of cropland loss. Future conservation measures should include increased funding for land and water conservation measures, increased partnerships and collaborative projects with land trusts, and financial incentives for local land conservation.

Family Farms

The *2007 Census of Agriculture* (USDA, 2009) estimates the majority of family farms in North Carolina are small, with seven of 10 farms comprising less than 100 acres. With small farm size comes poor economies of scale; this is especially true considering that nearly half of farms comprise less than 50 acres. The percent of total farmland in cropland is now 57.8 percent, while 6.9 percent is in pasture.

There were an estimated 52,913 farm entitites in 2007; about 9 in 10 were owned through individuals, families, or sole proprietorships. The average age of the farm operator was 57.3 years, mirroring the aging of most forest landowners. The majority of

the total number of farms are owned by persons of White or Causasian (95.4 percent) ethnic background, while 2.8 percent of farms are owned by African Americans (TABLE 2*c*-2).

TABLE 2c-2.—North Carolina Farm Demographic Summary, 2007

Race	Total Number of Farms	Percent Total
White or Caucasian	50,503	95.4%
African American	1,491	2.8%
American Indian and Alaska Native	603	1.1%
Asian	122	0.2%
Spanish, Hispanic or Latino origin	478	0.9%
More than one race	185	0.3%

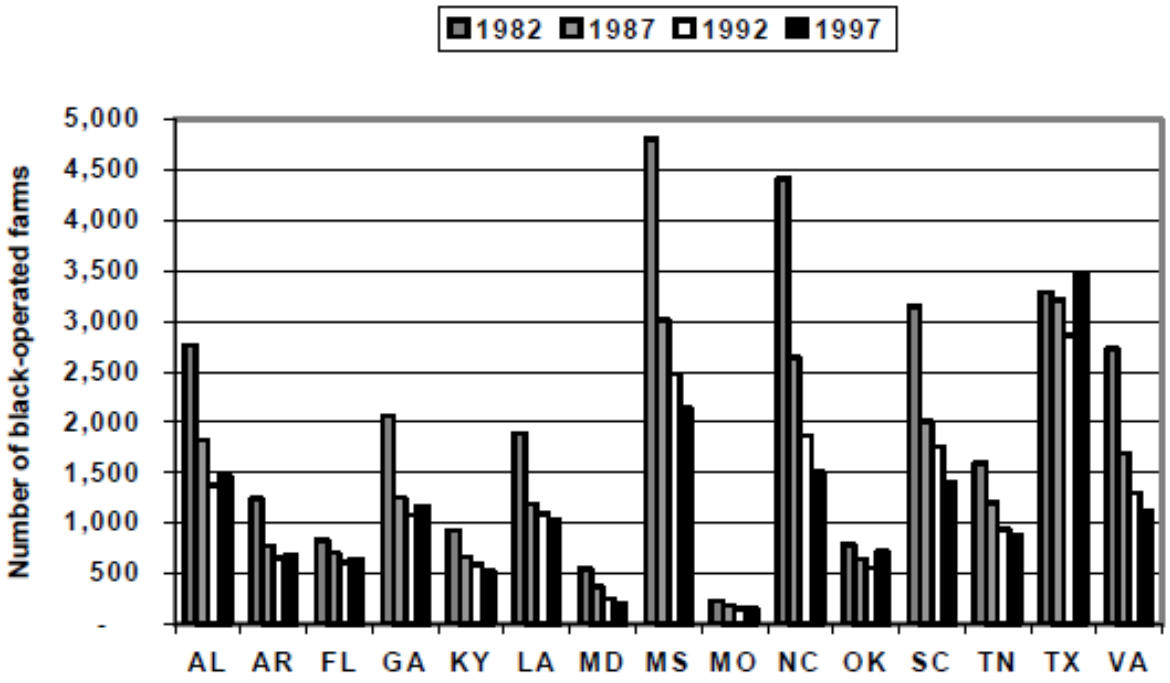
Source: *U.S. Census of Agriculture 2007* (USDA, 2009)

In the 10-year period from 1997 to 2007, total farmland acres decreased from 9,444,867 to 8,474,671 acres, while cropland acres decreased from 5,701,023 to 4,895,204. In 2005, the state lost 1,000 farms; and between the period from 2002 to 2005, North Carolina lost roughly 6,000 farms and more than 300,000 acres of farmland (Wilson, 2007).

Since 1982 and earlier, the number of African American owned farms among rural populations has been declining in North Carolina and across the South (FIGURE 2*c*-2). The number of African Americans owning or operating farms in the U.S. has declined by 98 percent, compared to a 66 percent drop among all other farm operators since farm ownership peaked in 1920 (USDA, 1997). In 1920, there were 926,000 African American farmers in the United States. In the 2002 Census, African Americans operated only 29,000 farms.

In 1950, African American farmers in North Carolina owned about 500,000 acres and by 1982, the total acreage was 40,000. This was a 92 percent reduction over this period.

FIGURE 2c-2. Minority landholders and working forests in the South.



Source: Warren, Williamson, and Sills (2003).

Reaching the Limited-Resource Audience

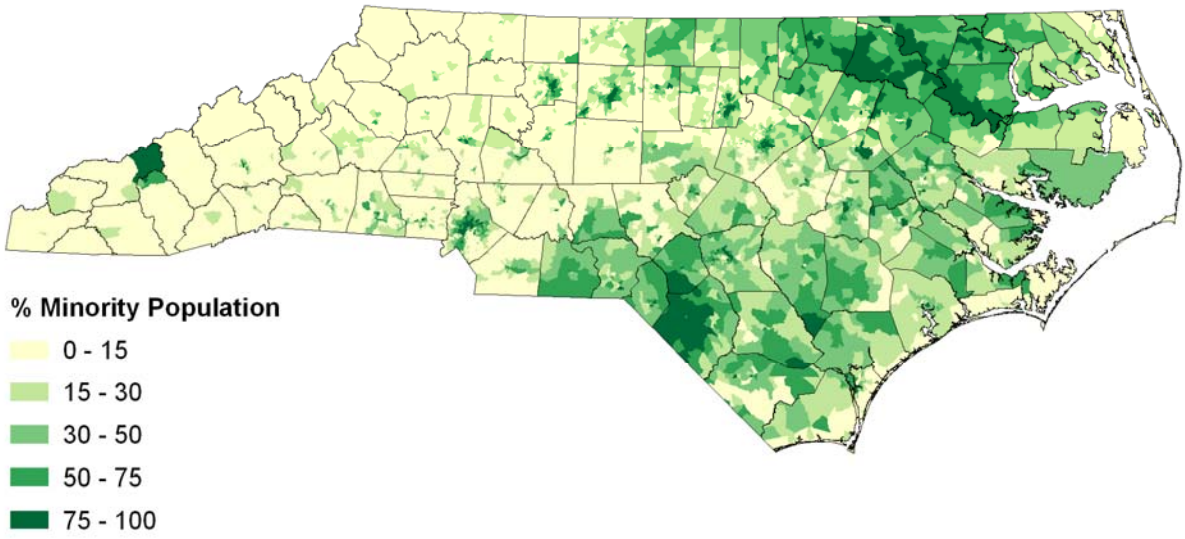
Many African American farmers and forest landholders can also be categorized as "limited resource" (Warren, Williamson, and Sills, 2003). African American farms are typically small acreage and located on poor soils in economically depressed areas. Within the coastal plain, there are higher rural populations of minority or limited-resource landowners than in the mountains or piedmont. These farmers own land at risk to potential fragmentation and parcelization from economic constraints and heir property transfer events (FIGURE 2*c*-3).

There has been a systematic failure to provide education and technical assistance to minority owners regarding estate planning to secure their property for future generations. The lack of detailed wills has resulted in generations of divided ownership and fractured heir transfer that can contribute to highly fragmented land ownership and uncertainty about long-term decision-making. This geographical and decision-making constraint may further compound management difficulties, especially for absentee landowners.

Minority and other limited-resource landholders often have small farm and forest acreages; they typically have limited access to capital and lower education, lower literacy levels, and lower annual incomes than other farmers. Increased financial incentives along with new outreach efforts are needed to provide targeted technical assistance to minority and underserved landowners to assist them in the conservation and management of these smaller working forests.

Family farms and ownerships will continue to change as a result of intergenerational transfer and sales. Nationally, a fourth of these family forestland owners intend to sell or transfer their land soon, owing largely to the fact that a fifth of those owners are 75 years or older (Butler, 2008).

FIGURE 2*c*-3. Minority population density in North Carolina by Census block group.



Created by: B. Vaughn, Conservation Fund, 2009

Summary

Family forest owners account for almost 61 percent of the total forestland in North Carolina. More than half of these family forest and farm ownerships are small (less than 50 acres). Family forest landowners have diverse management objectives for owning land that include aesthetics, social amenities, investment, and leaving a family legacy. Natural resource professionals who educate and serve these forest owners will need to apply different management approaches to meet these changing resource management needs.

Forest and farms are becoming more fragmented for a variety of reasons. The conservation of working forests will become increasingly more important for the long-term sustainability of open space, forest productivity and health, and wildlife habitat. Future conservation and management efforts should be prioritized and directed to landowners who have working forests and family farms that are most at risk of fragmentation and potential conversion from development within both rural and urban priority landscapes.

Limited-resource landowners are often not aware of available programs and services to assist them with managing their farms or forestland. Family forest ownership will continue to change as a result of intergenerational transfer or property sales because of tax constraints. Family forest and minority landowners will need increased outreach efforts, financial incentives, help with conservation measures, and other technical assistance to conserve working forests for future benefits.

Map Data Sources

FIGURE 2c-1: Map is from the publication: American Farmland Trust. 2002. Farming on the Edge: Sprawling Development Threatens America's Best Farmland.

FIGURE 2c-3: US Census Bureau

References and Sources Cited

Brown, M. J.; New, B. D;, Oswalt, S. N.; Johnson, T. G.; and Rudis, V. A. 2006. *North Carolina's Forests, 2002.* Resource Bulletin SRS-113. Asheville, NC: USDA Forest Service, Southern Research Station.

Butler, B. J. 2008. *Family Forest Owners of the United States, 2006*. Gen. Tech. Rep. NRS-27. Newtown Square, PA: USDA Forest Service, Northern Research Station.

Butler, B. J.; Tyrrell, M.; Feinberg, G.; VanManen, S.,; Wiseman, L.; and Wallinger, S. 2007. *Understanding and reaching family forest owners: Lessons from social marketing research. J. For. 107*(7): 348-357.

Hermansen-Baez, L. A. 2008. *Changing Roles in the Southern United States*. For. Res. Inf. Paper 172. Gainesville, FL: University of Florida.

Ouzts, E. 2007. *Losing Our Natural Heritage: Development and Open Space Loss in North Carolina*. Raleigh, NC: Environment North Carolina Research and Policy Center. Online: http://www.environmentnorthcarolina.org/uploads/r4/nc/r4nciI0ZGc4rXhq_XM9_TQ/Losing_Our_Natural_Heritage.pdf

Sustainable Agriculture Research and Education (SARE). 2000. A program supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, DC. Online: http://www.sare.org/USDA National Agricultural Statistics Service. 1997. Cited in fourth paragraph under Family Farms. Reference needed.

U.S. Department of Agriculture (USDA). 1997. *1997 Census of Agriculture North Carolina State and County Data*. Publication AC97-A-33. Washington D.C.: USDA National Agricultural Statistical Service. Online: http://www.agcensus.usda.gov/Publications/1997/Vol_1_National,_State_and_County_Tables/North_Carolina/index.asp

U.S. Department of Agriculture (USDA). 2009. *2007 Census of Agriculture United States Summary and State Data*. Publication AC-07-A-51. Washington D.C.: USDA National Agricultural Statistical Service. Online: http://www.agcensus.usda.gov/Publications/2007/Full_Report/usv1.pdf

Warren, S.; Williamson, R.; and Sills, E. 2003. Minority landholders and working forests in the South. In *Proceedings of the 2002 National Convention*, Society of American Foresters (pp. 292-295). Bethesda, MD: Society of American Foresters.

Wilson, R. 2007. *From Rural to Suburban in Less than a Century: Changes in Housing Density in North Carolina from 1940 – 2030*. Raleigh, NC: Conservation Trust for North Carolina.

Glossary

limited-resource landowners. Traditionally under-served landholders. This group includes those who have smaller-than-average land holdings with no or limited access to substantial amounts of capital or off-farm income. This group may include beginning farmers; farmers producing for emerging or alternative markets; and certain individuals or groups, such as minority farmers who are traditionally under-served by credit and other farm service institutions (SARE, 2000).

2.d.

Population Growth and Land-Use Change Impacts

Key Findings

- North Carolina is one of the fastest growing regions in the Southern United States with approximately 70 percent of the state's population classified as urban.
- By 2030, North Carolina's population is expected to increase by more than 50 percent since 2000, adding approximately 4 million people.
- Developed land in the state has grown by 1.86 million acres in the two decades following 1987. The majority of land-use change occurred in the piedmont (77 percent) compared to the coastal plain (52 percent) and the mountains (44 percent).
- 1.1 million acres of North Carolina forest was lost to land-use change between 1987 and 2007.
- If current population growth, development, and land-use trends continue, North Carolina may lose approximately 0.9 million acres of forestland and 1.1 million acres of cropland by 2027.

Population Changes

North Carolina is one of the fastest growing regions in the Southern United States in terms of population growth, economic activity, land-use changes from development, and wildland urban interface pressures. From the period of 1990 to 2000, North Carolina was among the fastest growing states in the country, with the sixth highest numeric population change—adding more than 1.4 million people.

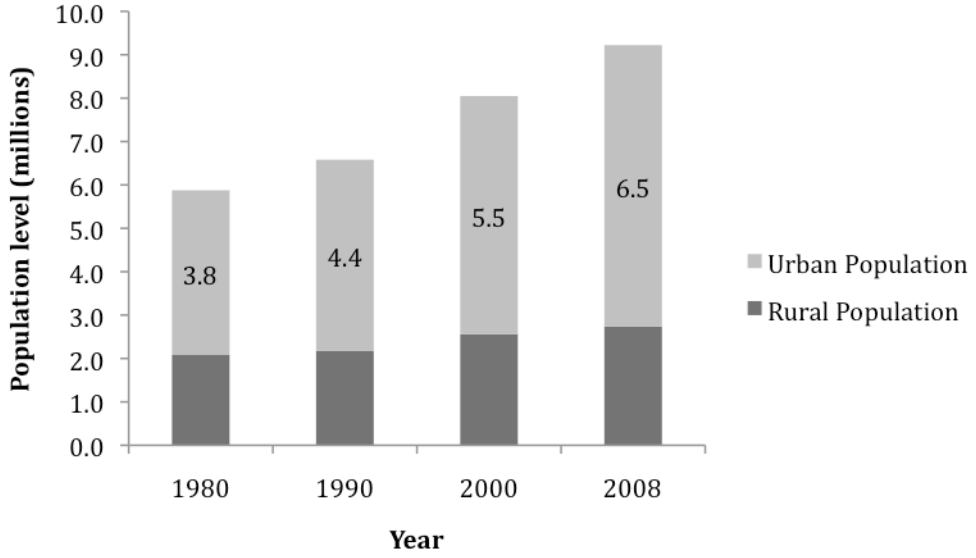
In 2008, North Carolina ranked as the 10th most populated state in the country with a population of approximately 9.2 million people, of which 70 percent were classified as urban (FIGURE 2*d*-1).

From April 1, 2000 to July 1, 2008, the state has experienced a population growth rate of 14.6 percent compared to 8 percent for the entire United States. By 2030, North Carolina's population is expected to increase by more than 50 percent from the 2000 census, adding approximately 4 million people to reach more than 12 million (FIGURE 2*d*-2) (Stuart 2006). Over 60 percent of this population growth is projected to come from new migration into the state.

North Carolina's current population is comprised primarily of 67.2 percent White persons not Hispanic, 21.6 percent African American persons, 7.4 percent Hispanic or Latino origin, 1.9 percent Asian persons, and 1.3 percent American Indian or Native persons. Our state population has almost double the national average of African American persons, who comprise a significant ethnic component of both our rural and urban populations.

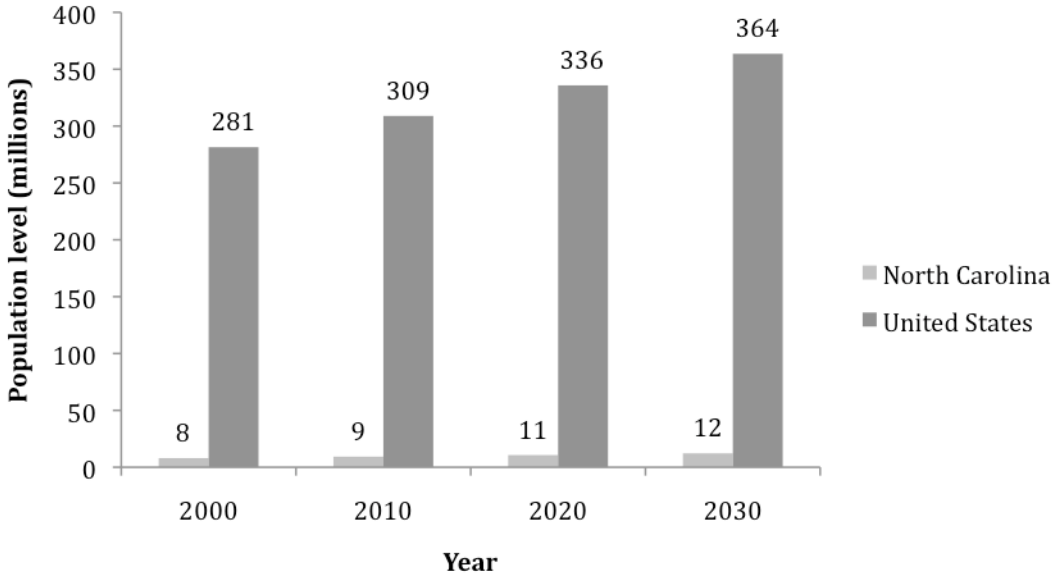
North Carolina's economic transformation is ongoing and has brought many benefits, including new jobs and opportunities, international recognition as a business location, and rapid population growth and development across many regions of the state.

FIGURE 2*d*-1. North Carolina population level for urban and rural populations from 1980 to 2008.



Source: U.S. Census Bureau data, 2008

FIGURE 2*d*-2. Population projections by 10-year period for North Carolina and the United States from April 2000 to July 2030.



Source: U.S. Census Bureau, Population Division, Interim State Population Projections, 2005

Our state is beginning to experience significant losses from development due to housing and associated infrastructure (roads, schools, business offices, commercial retail businesses, and industrial construction) that support a robust economy and an increasing population (TABLE 2*d*-1). A USDA Forest Service report, *Forests on the Edge*, indicates that private forests, particularly in the Eastern United States where most private forests occur, are likely to see dramatic increases in housing development in the next three decades, with consequent impacts on ecological, economic, and social services (Stein, et al., 2005).

The 2000 Census estimated that 36 out of 100 counties in North Carolina had population densities greater than 150 per square mile (FIGURE 2*d*-3). In 2000, North Carolina had 165.2 people per square mile and 3,132,013 households with 2.49 people per household. Based on the 2008 population estimate, North Carolina now has 189.3 people per square mile.

In 2000 there were approximately 72.3 housing units per square mile compared to 32.8 units per square mile for the United States. For the period of 2010 to 2030, a gain of 1,050,365 housing units is expected with an average gain of 525,182 units projected for each decade. This increased projection results in a 25 percent gain over 20 years (TABLE 2*d*-1).

If current population and development patterns continue to 2030, roughly half the state will be settled at a density equivalent to being urban, suburban, or sprawling exurban (Wilson, 2007) (FIGURE 2*d*-4, 2*d*-5, 2*d*-6). Population density increases in North Carolina's urban-rural interface will present new challenges to many landowners wanting to conduct traditional forest management. A study conducted in the Virginia piedmont concluded that the probability of conducting traditional forest management for timber production approaches zero at population densities of 150 people per square mile (Wear et al., 1999).

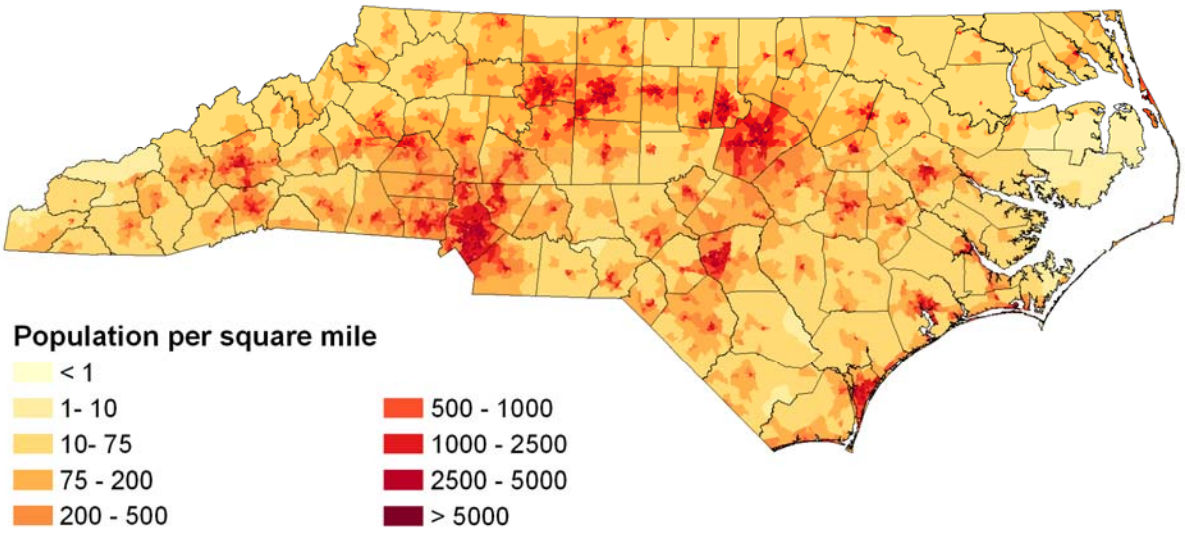
Increasing urbanization in fast growing rural areas has the potential to negatively impact water quality from the loss of forestland or conversion of open space to development. Research by the USDA Forest Service (Stein et al., 2005) has identified watersheds across the nation that would be impacted most by increased housing density during the next two decades (by 2030). Two of those projected watersheds occur in North Carolina, the Deep River and the Pee Dee River (including South Carolina).

TABLE 2*d*-1.—Growth in number of housing units in North Carolina

Year	No. Housing Units Statewide	Numeric Gain	Percentage Gain
1980	2,274,196	632,181	38.50%
1990	2,818,193	543,997	23.92%
2000	3,523,944	705,751	25.04%
2010	4,152,147	628,203	17.83%
2020	4,716,944	564,797	13.60%
2030	5,202,512	485,568	10.29%

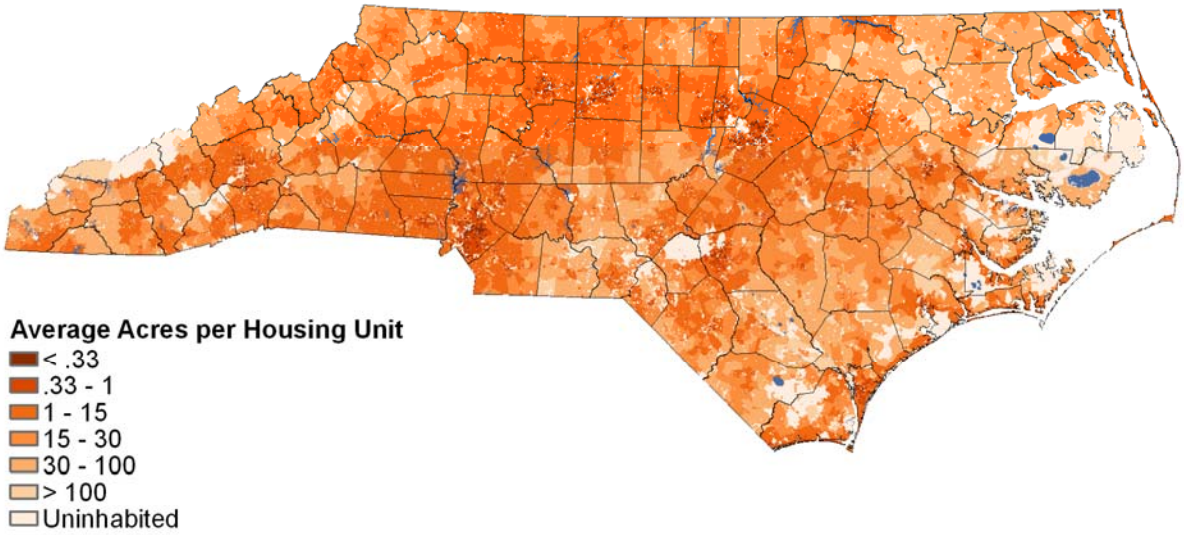
Source: Wilson, R. 2007.

FIGURE 2*d*-3. Population by census tract (square mile) in North Carolina.



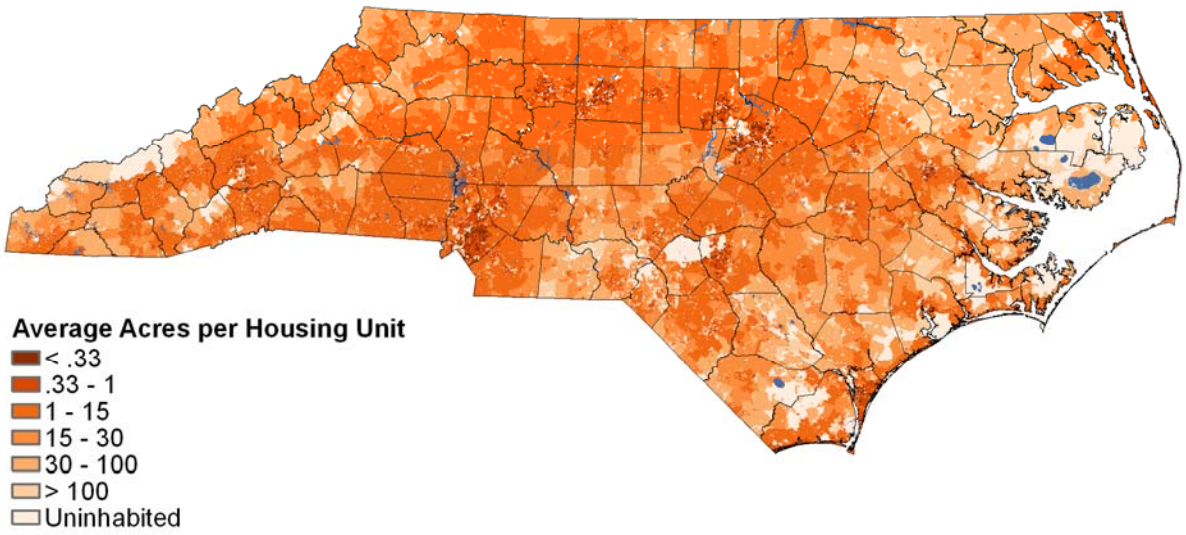
Created by: A. Bailey, NC DFR, 2010

FIGURE 2*d*-4. Average number of acres per housing units in North Carolina in 2010.



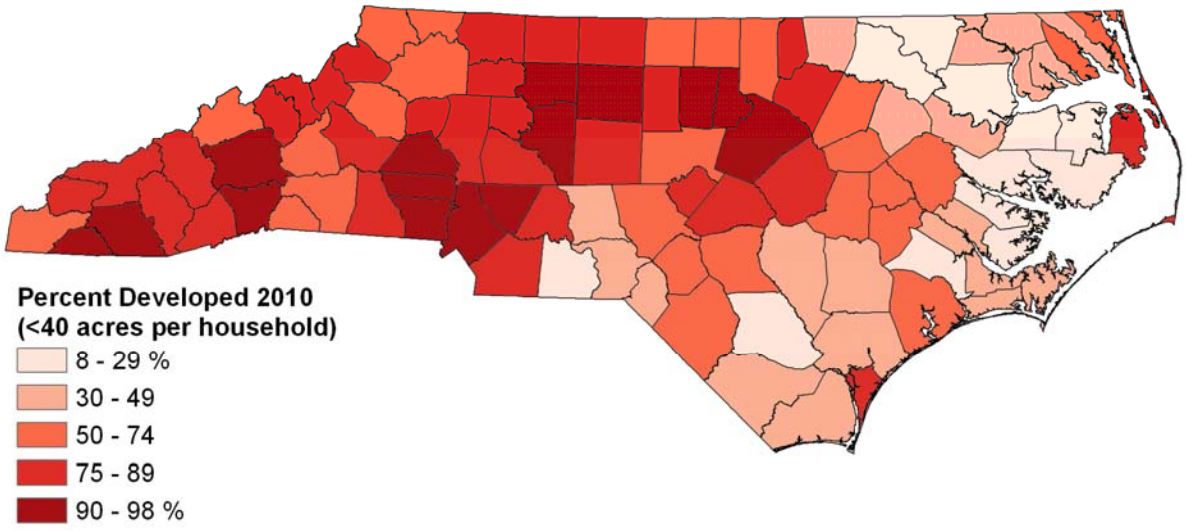
Created by: A. Bailey, NCDFR, 2010.

FIGURE 2*d*-5. Average number of acres per housing units in North Carolina in 2030.



Created by: A. Bailey, NCDFR, 2010.

FIGURE 2*d*-6. Percent of land developed in North Carolina, 2010.



Created by: A. Bailey, NCDFR, 2010.

Land-use Changes

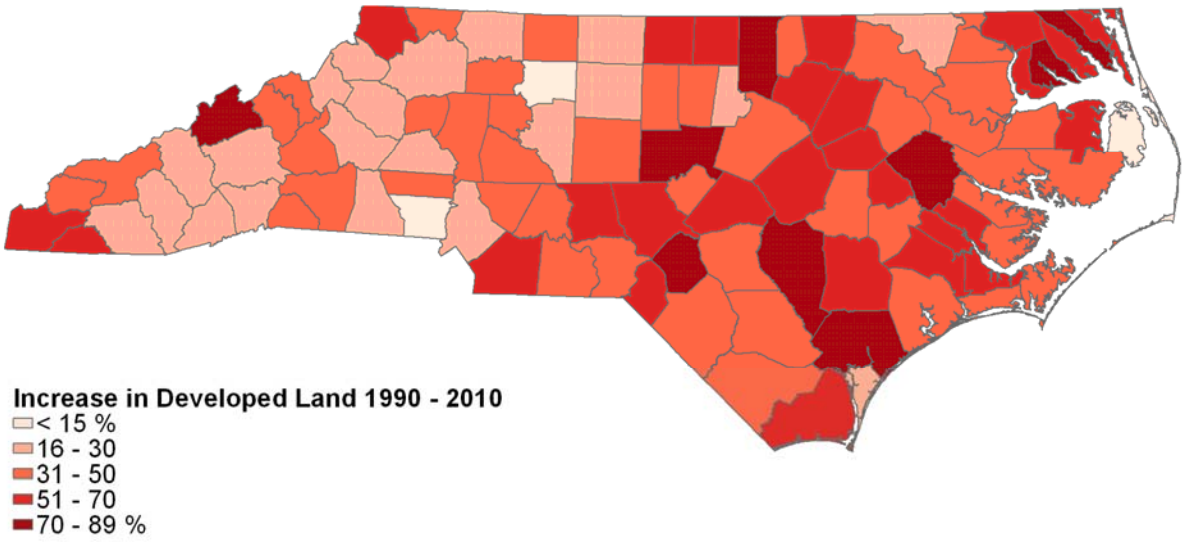
Housing development, along with its accompanying infrastructure, commercial, and industrial development, has been recognized as a primary cause of anthropogenic landscape change (Hammer et al., 2004). In North Carolina land-use change is occurring at unprecedented rates (FIGURE 2*d*-7 and 2*d*-8, TABLE 2*d*-2 and 2*d*-3). The rate of increase in developed acres is even higher than the state's population growth. Over a 20-year period, from 1987 to 2007, the state's population grew by 40 percent, but the number of developed acres increased by 65 percent (Ouzts, 2007).

Developed land in the state has grown by 1.86 million acres, with the majority of land-use change occurring in the piedmont (TABLE 2*d*-2). During the last 20 years, the piedmont has lost 638,000 acres of forestland, a decrease of 8 percent (Ouzts 2007). During this same period, the piedmont developed 1.38 million acres of land, a 77 percent increase in developed land area (TABLE 2*d*-2).

In an overall national ranking of the most sprawling metropolitan regions in the United States, the Triad (Greensboro, Winston-Salem, High Point) was ranked second, while the Triangle (Raleigh, Durham, Chapel Hill) was ranked third. The counties that comprise these metropolitan areas contain approximately 59 percent of the state's population. It is estimated that 70 percent of the state's new residents that migrated to North Carolina from 1987 to 2007 are living in the counties surrounding the piedmont's major cities (Ouzts 2007).

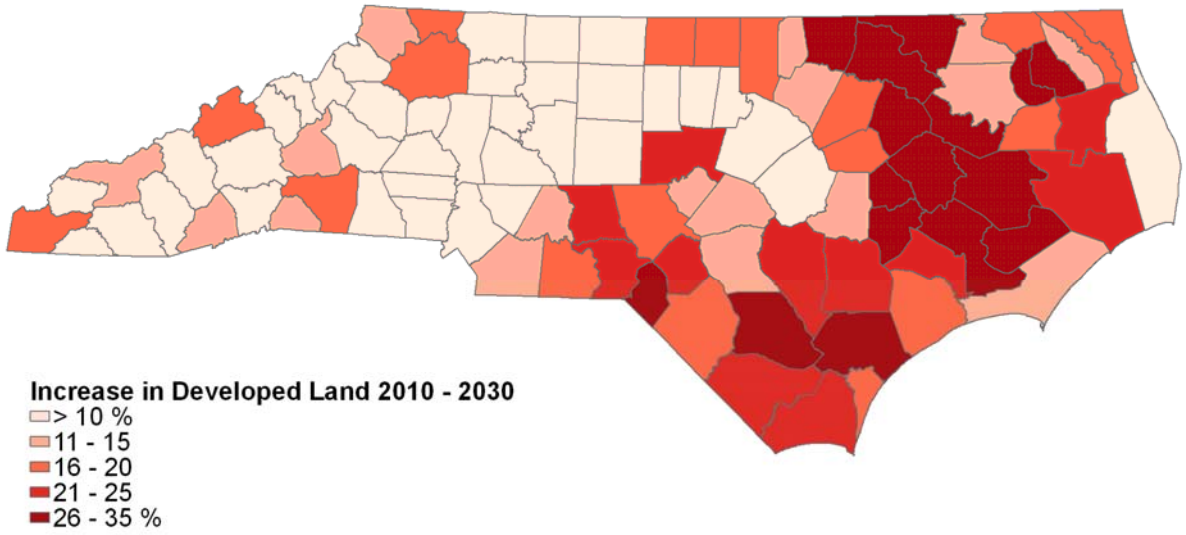
Between 1987 and 2007, the coastal counties of North Carolina lost more than 262,000 acres of forestland. During this same period, coastal counties also experienced a 52 percent increase in developed land or 248,000 acres of development. The Wilmington-Jacksonville metropolitan area counties added 109,000

FIGURE 2*d*-7. Development changes in North Carolina, 1990 – 2010.



Created by: A. Bailey, NCDFR, 2010.

FIGURE 2*d*-8. Estimated changes in development in North Carolina, 2010 to 2030.



Created by: A. Bailey, NCDFR, 2010.

TABLE 2d-2. National Resources Inventory (NRI) data for change in developed area by geographical region, 1987-2007

	1987 Developed Land Area	2007 Developed Land Area	Total Acres Developed 1987-2007	Percent Change in Developed Area
Piedmont Total	1,784,800	3,161,900	1,377,100	77%
Charlotte	364,900	685,400	320,500	88%
Fayetteville	154,400	236,300	81,900	53%
Rocky Mt.-Greenville	94,200	169,700	75,500	80%
Triangle	320,600	647,100	326,500	102%
Triad	364,600	583,800	219,200	60%
Piedmont Rural	486,100	808,500	322,400	66%
Coastal Total	478,700	726,700	248,000	52%
Wilmington-Jacksonville	185,300	294,600	109,300	59%
Coastal Rural	293,400	428,700	135,300	46%
Mountains Total	591,100	851,500	260,400	44%
Asheville	106,900	166,600	59,700	56%
Hickory-Morganton	180,700	248,600	67,900	38%
Mountains Rural	303,500	433,800	130,300	43%
Rural Total	1,083,000	1,671,000	588,000	54%
Urban Total	1,771,600	3,045,800	1,274,200	72%
State Total	2,854,600	4,716,800	1,862,200	65%

Source: Losing Our Heritage: Development and Open Space Loss in North Carolina (Ouzts, 2007)

TABLE 2d-3. Development projections by county groupings, 2007-2027

Region	Projected Increase in Developed Acres	Percent Change
Piedmont Total	1,400,700	44%
Coastal Total	207,000	28%
Mountains Total	184,800	22%
Rural	461,600	28%
Urban	1,272,200	42%
Total	1,733,900	38%

Source: Ouzts, 2007

acres of developed land, a 59 percent increase since 1987, while the rural coastal counties added 136,000 during this same time period—a 46 percent increase (Ouzts, 2007).

Development in the mountains occurred at an almost equal rate in both urban and rural counties, with development increasing 43 percent in rural areas and 45 percent in mountain urban counties near the Asheville and Hickory-Morganton metro areas (Ouzts, 2007).

In the next 20 years, development will continue to increase very rapidly in North Carolina, particularly around urban areas in the piedmont (TABLE 2*d*-3). The Triangle area is projected to be developed the most rapidly, with its developed land increasing by 58 percent, followed by the Charlotte area at 48 percent, the Rocky Mount-Greenville area at 35 percent, and other piedmont rural counties at 35 percent (TABLE 2*d*-3).

The state's mountains and coastal plain will also experience increased land-use pressures from new residents and retirees moving into these parts of the state. The western mountain region is projected to have a development rate of 22 percent, while the coastal plain is projected to develop at a slightly higher rate of 28 percent from 2007 to 2027.

In the mid 1980s, land was developed at a rate of 1.13 acres for each new person entering the state; five years later it was 1.0 acre per new resident; and by the mid 1990s, that rate had fallen to 0.65 of an acre per new resident. If the U.S. Census projections for the next 20-year period from 2007 to 2027 predict an increase of 30 percent, or 2.7 million people, North Carolina could potentially lose another 1.75 million acres to development using the same rate of 0.65 acres per new resident.

Several metropolitan areas within the piedmont will likely experience development rates that have the potential to influence the management of rural working forests located in close proximity of these rapidly developing areas. Often times these new residents do not have the same connection to the land, their management objectives are not based on generating revenue from traditional agricultural or forest management practices, and they have other conservation objectives for ownership.

Impact on Forest Resources

The increase in population density and land-use change will have an important influence on the conservation and management of working forests and on the future benefits they provide (Wear and Greis, 2002; Stein et al., 2005). Consequential changes to forests could result in the following:

- Changes in traditional uses of forests
- Decreases in the production of timber and other forest products
- Continued increase in forest fragmentation and parcelization in specific regions of the state
- Forest health changes
- Loss of opportunities for outdoor recreation
- Declines in native fish and wildlife and their habitats

- Water quality declines and altered hydrology

Urbanization combined with emerging environmental policies is predicted to result in as much as a 32 percent decrease in available timber supply with accessible commercial timber acres (NC Office of the Governor, 1996). The 2003 release of the Southern Forest Resources Assessment (SFRA) identified urbanization as a critical threat to forest sustainability in the Southeast (Wear and Greis, 2002). This report indicated that North Carolina led the nation in loss of commercial forest to urban uses from 1982 to 1997, losing over 1 million acres, 5.9 percent of the state's total forest area. Several recommendations to ensure forest sustainability in North Carolina were previously outlined in the report of the governor's Task Force on Forest Sustainability (1996).

Impact on Urban Forests

Rapid urbanization and associated land-use change is putting increasing pressure on the sustainability of trees and forests in NC communities. For an in-depth discussion of these impacts, refer to Chapter 4, Section k, of this document, "Maintaining Viable Urban Forests."

Local land-use planning processes often do not integrate strategies to conserve a connected green infrastructure alongside new growth. The loss of connectivity between urban green spaces leads to a loss of biodiversity and reduced ecosystem function in North Carolina's urban forest.

Traditional development patterns will continue to result in habitat fragmentation, loss of biodiversity across the landscape, decreased air and water quality, and loss of connection between people and the natural surroundings. Continued fragmentation of North Carolina's urban forests may result in decline in habitat for some priority species in the *NC Wildlife Action Plan* (2005) and a reduction in wildlife corridors.

Community planners, local governments, land trust organizations, and resource management agencies will need to work together to plan for future projects that can accommodate new development while minimizing the impacts to both urban and rural priority landscapes.

Summary

North Carolina has undergone changes taking it from a predominately rural state in the 1950s to an urban one. Almost 70 percent of the state's population can be classified as urban. It is expected that North Carolina will continue this trend of increasing population and development, especially around metropolitan areas in several regions of the state.

Increasing population densities in the state are contributing to increase housing densities and detrimental land-use impacts to our natural resources. Within the state, there are regional differences in how this increased development is affecting both forestland and cropland. Population density increases within the urban-rural interface will present new challenges to many landowners wanting to conduct traditional forest management. Increasing urbanization in fast growing rural areas has the potential to negatively impact water quality from the loss of forestland or conversion of open space to development.

Changes at the urban-rural interface will likely have an increasingly important influence on the conservation and management of working forests, the future supply of timber in North Carolina, and the multiple benefits that forests may be able to provide in the future.

Map Data Sources

FIGURE 2d-4: US Census Bureau

FIGURE 2d-4: Hammer et al. 2004

FIGURE 2d-5: Hammer et al. 2004

FIGURE 2d-6: Forests on the Edge: David Theobald

FIGURE 2d-7: Forests on the Edge: David Theobald

FIGURE 2d-8: Forests on the Edge: David Theobald

References and Sources Cited

Hammer, R. B.; Stewart, S. I.; Winkler, R. L.; Radeloff, V. C.; and Voss, P. R. 2004. Characterizing dynamic spatial and temporal residential density patterns from 1940 – 1990 across the North Central United States. *Landscape and Urban Planning 69*: 183-199.

NC Office of the Governor. 1996. *Report of the Governor's Task Force on Forest Sustainability*. Raleigh, NC: Author.

NC Office of State Budget and Management. 2008. *The North Carolina Financial and Population Quarterly Report*. Raleigh, NC: Author. Online: http://www.osbm.state.nc.us/files/pdf_files/January08_Econ.pdf

NC Wildlife Resources Commission. 2005. *NC Wildlife Action Plan*. Raleigh, NC: Author.

Ouzts, E. 2007. *Losing Our Natural Heritage: Development and Open Space Loss in North Carolina*. Raleigh, NC: Environment North Carolina Research and Policy Center. Online: http://www.environmentnorthcarolina.org/uploads/r4/nc/r4nciI0ZGc4rXhq_XM9_TQ/Losing_Our_Natural_Heritage.pdf

Stein, S.; McRoberts, R.; Alig, R.; Nelson, M.; Theobald, D.; Eley, M.; Dechter, M.; and Carr, M. 2005. *Forests on the Edge: Housing Development on America's Private Forests*. Gen. Tech. Rept. PNW GTR-636. Portland, OR: USDA Forest Service, Pacific Northwest Research Station. Online: http://www.fs.fed.us/openspace/fote/fote-6-9-05.pdf

Stuart, A. 2006, Spring. Recent population change in North Carolina. *Tar Heel Junior Historian 45*:2. Raleigh: NC Museum of History. Online: http://www.ncmuseumofhistory.org/collateral/articles/S06.recent.population.change.pdf

U.S. Census Bureau. 2005. *Interim State Population Projections*. Washington, DC: Author, Population Division.

Wear, D. N. and Greis, J. G. 2002. *Southern Forest Resource Assessment*. Gen. Tech. Rept. GTR-SRS-053. Asheville, NC: USDA Forest Service, Southern Research Station. Online: http://www.treesearch.fs.fed.us/pubs/4833

Wear, D. N.; Liu, R.; Foreman, J. M.; and Sheffield, R. M. 1999. The effects of population growth on timber management and inventories in Virginia. *Forest Ecology and Management 118*: 107-115.

Wilson, R. 2007. From Rural to Suburban in Less than a Century: Changes in Housing Density in North Carolina from 1940 – 2030. Raleigh, NC: Conservation Trust for North Carolina.

Glossary

exurban. Private forest lands with 16 to 64 housing units per square mile. Lands with these higher housing densities can still support many wildlife species and other ecological functions, although perhaps at a reduced level. However, management for commercial timber may be less likely.

open space. An area of land that is valued for natural processes and wildlife, for agricultural and sylvan production, for active and passive recreation, for providing other public benefits, or for any combination of these uses. Open space may be either open, forested, cropland, or pastureland that has not been converted or used to support development.

private forest. For this project, private forest includes tribal, forest industry, and nonindustrial private ownerships; it excludes public lands and private lands protected through conservation easements.

rural. Private forest lands with 16 or fewer housing units per square mile. Forest lands with this housing density can generally support a diversity of economic and ecological functions commonly associated with private forests, such as management for timber, most wildlife species, and water quality.

sustainable development. Development that integrates environmental protection, economic development, and social equity.

sustainable forestry. The practice of meeting the forest resource needs and values of the present without compromising the ability of future generations to meet their own needs.

urban. Private forestland with 64 or more housing units per square mile. Such lands are less likely to be used for timber production or to contribute to wildlife habitat and water quality because of increased road density, infrastructure, and human population levels. Such forest patches, however, are often highly valued for their aesthetics, noise abatement properties, and positive effect on property values.

2.e.

Management Practices for Forestry and Wildlife

Key Findings

- Very few NC family forest landowners have a written management plan, or have received professional assistance or financial incentives, to actively manage their forestland.
- Pine plantations account for 12 percent of the total forestland in North Carolina, with 9 percent of nonindustrial private forestlands classified as pine plantations.
- Continued support and funding for state and federal cost-share programs and initiatives are needed to provide financial and management incentives to NC landowners.
- Intensive forest management practices have the potential to enhance productivity in managed forests on fewer acres. Actively managed forests may reduce pressure to harvest natural forests while sustaining a long-term timber supply.
- Forest management practices in planted pine forests have intensified in North Carolina over the last few decades. This trend is expected to increase for forest industry owners, real estate investment trusts (REITs), and TIMOs, but not for NIPF landowners As forested parcels get smaller they typically become more difficult, both operationally and economically, to mange intensively.
- A state forest nursery and tree improvement program is important to provide a diverse and stable supply of forest seedlings that meet current and future needs for reforestation, ecological restoration, wildlife habitat, and urban tree plantings
- Forest management practices and activities are effective methods to enhance forest wildlife habitat conditions for both game and nongame species.
- Prescribed fire is an effective management activity to enhance and maintain many NC forest habitat types and fire-dependent ecosystems.
- Between 2004 and 2009, approximately 95 to 97 percent of the forestry sites inspected statewide were documented to be in compliance with the NC Forest Practices Guidelines Related to Water Quality (FPGs).
- Forestry research support and funding is decreasing for traditional growth and productivity topics in favor of social and environmental issues, sustainability topics, and ecosystem services. This trend is expected to continue.

Introduction

Forest management in North Carolina is practiced by several ownership classes and agencies across many diverse forest types and geographic regions. The NC Division of Forest Resources (NCDFR) supports and helps landowners and other natural resource professionals implement a wide variety of resource management practices that contribute to forest management, forest protection, forest health, and conservation

programs. This section's assessment is not a complete analysis or summary of forest management accomplishments in North Carolina, but presents an overview of accomplishments by NIPFs, who own 78 percent of North Carolina's forestland. Forest Inventory Analysis (FIA) data found in "Forest Statistics for North Carolina, 2002" (Brown 2004) was used to assess the current status of forest management practices in this chapter. Trends were identified by comparing the change in status between the 2002 FIA survey and the 1990 FIA survey for North Carolina (Johnson 1991, Brown 2004). Promoting sustainable forest management practices to the NIPF ownership class, will be important to enhance public benefits from trees, protect forests from threats, and conserve working forests for the future.

Family Forests Owners' Attitudes Toward Management

Family forest landowners in North Carolina have varying reasons for owning their land and differing levels of engagement with it. The numbers of NC landowners enrolled in forest certification programs, conservation easements, and cost-share programs, and who have a written management or stewardship plan, are very low.

Only 4 percent of family forest owners in North Carolina currently have a management plan for their forestland (Butler, 2008). NC family forest owners' future plans (next 5 years) for their forestland included either "leave it as is—no activity" (32 percent), "minimal activity to maintain forestland" (14 percent), or "have no current plans" (10 percent). Harvesting timber for sawlogs, pulpwood, or firewood was listed as a planned activity by less than 10 percent of family forest landowners. Only 6 percent of family forest owners in North Carolina have participated in cost-share programs in the past 5 years (Butler, 2008).

This low participation in active forest management may reflect the desires and attitudes of forest owners. It may also be caused, however, by other factors, such as economy of scale on smaller parcels, lack of information on the benefits or associated costs from various management practices, and less than optimal outreach efforts by conservation program administrators (GfK NOP, 2006).

Just 15 percent of NC family forest owners who responded to the *2006 National Woodland Owner Survey* indicated that they had received technical advice about the management of their property. The majority of family forest owners who responded indicated that their primary sources for obtaining forestry advice included state forestry agencies (55 percent), private forestry consultants (14 percent), university extension agencies (8 percent), loggers (7 percent), other landowners (6 percent), and federal agencies (5 percent). Forest management activities implemented in the last 5 years by family forest owners by resource activity have included planting trees (18 percent), fire hazard reduction (15 percent), wildlife habitat improvement (10 percent), herbicide application (9 percent), and site preparation (10 percent) (Butler, 2008; GfK NOP, 2006).

Status and Trends of Forest Management Practices in North Carolina

USDA Forest Service FIA data and analysis (Brown 2004) and other reports (Moffat 1998, Snider 1999, Siry 2002) indicate that while forest industry managers of forestland apply intensive forest management to a majority of their land, only a small portion of NIPF landowners are actively managing

their forestlands. Pine plantations account for 12 percent of the total forestland in North Carolina with a majority located in the coastal plain.

Pine plantations represent 51 percent of the land managed by forest industry and TIMOs. Pine plantations are typically managed more intensively than other forest types (Siry and Cubbage, 2001a). In contrast, only 9 percent of the NIPF in North Carolina consists of pine plantations. The amount of land managed by TIMOs is expected to increase, and the intensity of management is projected to increase for both industry-owned and TIMO forestlands (Siry and Cubbage, 2001a). Forests owned by industry are managed more intensively for fiber production than NIPFs, although there is growing interest from NIPF landowners within the piedmont and coastal plain in better managing pine forests for future income potential.

FIA survey data indicates that a final harvest occurred on an average of 246,400 acres per year in North Carolina from 1990 to 2002. The number of acres of NC forests harvested by a clear-cut method has decreased by 20 percent across all ownership types during 1990 to 2002. Partial cutting or harvests increased 33 percent between the 1990 and 2002 survey periods and occurred on 79,000 acres per year.

The number of acres artificially regenerated annually for all forest types decreased slightly from 1990 to 2002 by about 3,200 acres or 3 percent. A total of 100,000 acres were artificially regenerated annually, with 63 percent of this artificial regeneration conducted by NIPF landowners and 33 percent by forest industry landowners (TABLE 2*e*-1). Pine plantations represent 62 percent of the artificially regenerated acres. The total number of acres of natural regeneration also experienced a decrease of 19 percent during this same period. This decrease was reported across all forest types, but was more significant for upland hardwoods (13.5 percent) and oak–pine forest types (23.4 percent) than for pines (Brown 2004).

NC Division of Forest Resources Accomplishments

The NC Division of Forest Resources (NCDFR) compiles a Total Accomplishment Report (TAR) annually for statewide and individual county activities, projects, and associated accomplishments that have NCDFR involvement and participation. The NCDFR also works closely with other partnering resource management agencies and professionals to record accomplishments, provide technical assistance, and recommend services to NIPF landowners. The TAR shows the diversity of activities and projects that NCDFR is able to provide to NC landowners, natural resource management agencies, municipalities, and local communities. These reports are not a complete summary of all forest management that occurs in North Carolina, and further work would be needed to compile additional information from various agencies and companies.

In North Carolina there are approximately 469,000 family forest landowners and another 56,000 “other private ownership” entities in the state. Family forest landowners own about 11.2 million acres or 61 percent of the total area of forestland (Butler 2008). NCDFR is responsible for assisting NC forest landowners interested in managing their forestland for urban benefits, water quality, forest protection, forest improvement, non-timber resource improvement, and traditional forest management.

TABLE 2e-1.—Status and trend of NC forest management practices by ownership group, 1990 – 2002, in annual acres treated and percent change over survey period

Forest Management Practice	Public	Forest Industry	Nonindustrial private	Total	% Change Between 1990 and 2002 FIA Surveys
	thousand acres per year				percent
Final Harvest	6.6	40.3	199.5	246.4	-19.7
Partial Cut	2.9	4.7	71.1	78.8	32.9
Thinning	3.8	26.7	20.8	51.3	0.4
Timber Stand Improvement	1.9	3.0	9.9	14.8	23.6
Site Preparation	3.4	29.6	45.0	78.0	-24.1
Other Treatment	4.7	4.7	43.2	52.6	-51.1
Artificial Regeneration	4.6	32.9	63.0	100.5	-2.8
Natural Regeneration	8.7	10.8	193.9	213.5	-18.6

Between 2004-2009, the NCDFR, consulting foresters, and other natural resource professionals have developed 35,932 management plans for NIPF landowners impacting 1,799,634 acres (TABLE 2*e*-2). This total, when combined with the acres impacted from urban forest management assistance, represents that management direction or assistance occurs on 17 percent of family forests in North Carolina. From 2004 to 2009 an average of 7,186 management plans impacting 359,926 acres were written each year. This total also includes the assistance and accomplishments of NIPF landowners who use the professional services of a consulting forester and other resource professionals. As of 2009 there were approximately 239 active consulting foresters providing management services within North Carolina.

There has been a decrease in the number of urban plans and assists from 5 years ago because of a recent shift in program delivery to the municipal and community level versus individual urban homeowners. During this same time, there was a change in the federal funding allocation formula to support urban forestry programs that can have the biggest impacts on more people living within urban areas. Going forward, there is increased opportunity for urban forestry programs to partner with the NCDFR Forest Stewardship Program to reach more landowners and accomplish more activities for aesthetic or scenic benefits within the urban-rural interface.

Reforestation and Cost Share

The 1977 North Carolina General Assembly passed the Forest Development Act (NCGS 113A-176), which established a voluntary cost-sharing program to "provide financial assistance to eligible landowners to increase the productivity of the privately-owned forests of the State." The Forest Development Program (FDP) is designed to encourage NIPF landowners to reforest their land after harvest, and to put idle or unproductive land into forests.

The Primary Forest Product Assessment Act (NCGS 113-189) of 1977 prompted the evaluation of the primary forest products processed by North Carolina sawmills and other timber industries. This assessment (typically $2 million per year) along with legislative appropriations (often $589,500 per year), provides funding for reforestation and forest stand improvement work cost shared under the FDP. This partnership successfully leverages state money with

TABLE 2*e*-2.—5-year summary of urban and forest management plans developed and acres impacted by management or assistance

State Fiscal Year	Management Plans Developed [1]		Urban Forest Management Assistance [2]	
	No. of Plans	Acres Impacted	No. of Plans/Assists	Acres Impacted
2004 – 05	7,982	396,360	876	23,726
2005 – 06	6,791	358,342	670	37,938
2006 – 07	7,357	350,177	479	17,620
2007 – 08	6,723	332,534	494	14,633
2008 – 09	7,079	362,221	387	11,463
Totals	35,932	1,799,634	2,906	105,380
Average	7,186	359,926	581	21,076

Source: Data retrieved from NCDFR's 4220 Forest Management & Urban Forestry Accomplishment Records Program
[1]Includes Forest Management, Practice, Pre-Harvest, Regeneration, Rehabilitation, Replant and Stewardship plans written by NCDFR foresters and rangers as well as others (typically private consulting foresters or wildlife biologists).
[2]Includes Municipal Area Assists, Shade Tree Assists, Urban Assists, Urban Plan,s and Urban Tree Planting by Landowners.

funds from private citizens and timber industry. Landowners usually pay 60 percent of expenses, and FDP funds typically reimburse the other 40 percent, up to a prevailing rate. Of that 40 percent, 71 percent has historically come from assessments paid by the timber industry, 25 percent from appropriations, and 4 percent from earned interest on the account (Brogan 2009). The actual assessment rate being paid by the primary processors (timber industry) has not changed since the original rate was established in 1977.

State and federal cost-share programs are important resources to provide financial incentives and assistance to family forest landowners to conduct a variety of management practices in North Carolina. Records of North Carolina's statewide reforestation accomplishments from 1999 to 2008 indicate that 75,000 to 100,000 acres are typically planted each year. The state's cost share program, the FDP, has accounted for the planting of approximately 50,000 of those acres annually. The number of acres planted using state financial incentives represents about 50 to 75 percent of the total reforestation being carried out by NIPF (Brogan 2009).

On average, FDP has provided direct financial assistance to over 1,500 forest owners each year (Brogan 2009). NIPF landowners have planted nearly 1.2 million acres of forestland under the FDP since 1978. The majority was planted to loblolly pine, but this figure also includes 3,057 acres of hardwood species and 44,601 acres of longleaf pine. A review of NC longleaf planting accomplished under various cost-share programs from 1997 to 2006 revealed that 25,000 acres of the 60,000 total longleaf pine acres planted were funded and accomplished using the state FDP cost-share program. TABLE *D*-1 in Appendix D provides a detailed summary of total acres reforested annually by state and federal cost-share programs in North Carolina since 1970.

FIGURE 2*e*-1 summarizes the cumulative number of acres established under the various cost-share programs available in North Carolina from 1970 to 2008 (Brogan 2009). The largest total number of acres planted was funded under the state's FDP program. Funding levels and support for some of the federal cost-share programs

since 1970 have varied considerably, and only six viable forestry cost-share programs are available today.

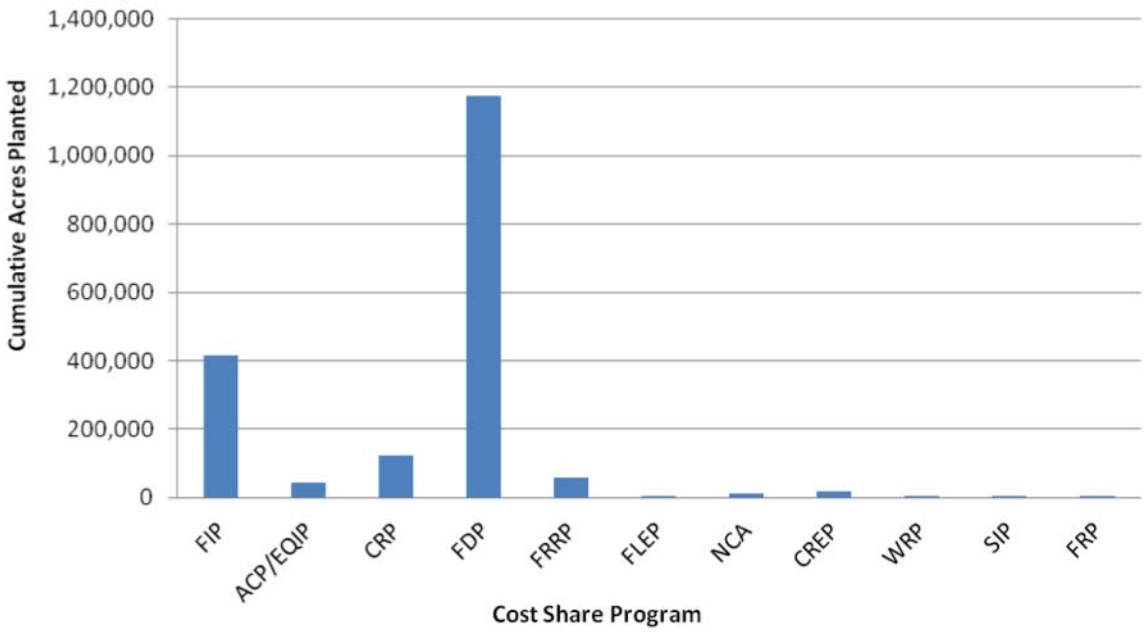
Each year the FDP program provides financial assistance for about 23,247 acres of site preparation, 51,048 acres of reforestation, and 2,021 acres of forest stand improvement (TABLE 2*e*-3). It has been called a "gateway" program that allows field personnel to interface with more landowners and potentially provide value-added services in addition to assisting them with financial incentives.

Site Preparation Practices

Approximately 78,000 acres were site prepared in North Carolina annually from 1990 to 2002, indicating a decline of 24 percent across all ownerships compared with the previous FIA survey period of 1984-1990 (Johnson 1991, Brown 2004). About two-thirds of these acres were site prepared for planting pine. The trend shows an increase in site preparation for planted pine, but decreases for natural pine, oak–pine, and both lowland and upland hardwoods. Forest industry and NIPF landowners account for 40 percent and 57 percent of the total acres that were site prepared, respectively.

Site preparation conducted by NIPF landowners with FDP cost share funding averaged 23,247 acres annually from 1999 to 2008. This represents about 52 percent of the average acres that were annually site prepared during 1990 to 2002. A survey conducted by the NC Division of Forest Resources found that 65 percent of landowners planting pine in 1998 did not prepare the site (Pickens, 2002). Some

FIGURE 2*e*-1. Acres reforested in North Carolina by cost-share programs (1970 – 2008).



Source: S. Brogan, NCDFR, 2009

NOTE: FIP = Forestry Incentives Program; ACP/EQIP = Agricultural Conservation Program/Environmental Quality Incentives Program; CRP = Conservation Reserve Program; FDP = Forest Development Program; FRRP = Fran Reforestation and Rehabilitation Program; FLEP = Forest Land Enhancement Program; NCA = NC Agricultural Cost-share Program: CREP = Conservation Reserve Enhancement Program; WRP = Wetland Reserves Program; SIP = Stewardship Incentives Program; FRP = Forest Recovery Program

TABLE 2*e*-3.—Summary of FDP acres accomplished by management practice (1999 – 2008)

Fiscal Year	Site Preparation	Reforestation	Forest Stand Improvement
1999 – 2000	23,753	46,972	2,449
2000 – 2001	31,908	58,595	1,905
2001 – 2002	38,157	61,286	2,914
2002 – 2003	24,473	54,445	850
2003 – 2004	20,633	52,826	1,553
2004 – 2005	17,703	50,272	2,322
2005 – 2006	20,371	44,597	2,029
2006 – 2007	15,745	47,563	2,665
2007 – 2008	16,476	42,877	1,500
Totals	209,219	459,433	18,187
Average Acres	23,247	51,048	2,021

Source: NC Division of Forest Resources, Forest Development Program

common factors that have resulted in NIPF landowners not conducting site preparation include high initial costs of practices, lack of professional advice, and increased use during harvest operation. Genetically improved pine seedlings have now become the standard in many pine planting projects and do not always represent an intensive management objective by the landowner but rather a decision to plant the best genetic material that is currently available.

Specific data for North Carolina on fertilizer application during site preparation is not always readily available or shared by various forest ownerships. However, reports by the NC State University (NCSU) Forest Nutrition Cooperative (FNC) showed fertilized acres by forest industry and TIMOS increased from about 200,000 acres in 1990 to about 1.2 million acres in 2004(Albaugh, 2007). Fertilizer use among FNC members at tree establishment averaged about 200,000 acres per year since 1995, while mid-rotation fertilization fluctuated between 1 million and 1.3 million acres per year for the same period. Applications were largely on loblolly pine plantations (91 percent). New research information along with market fluctuations in fertilizer prices will likely influence fertilizer application rates and acres applied in the future.

Forest Stand Improvement Practices

The 2005 NC Legislature authorized new forest stand improvement practices for the FDP program to “improve tree growth and overall forest health.” These new practices were specified and approved in Administrative Code in November 2006. As of July 1, 2007, NIPF landowners could apply for FDP cost-share assistance for forest stand improvement practices such as prescribed burning, density release treatments, fertilization, crop-tree crown release, and cull-tree removal.

In recent years the overall number of forested acres thinned in North Carolina has remained relatively constant at about 50,000 acres per year. A majority of the thinning occurred on pine stands with forest industry accounting for 52 percent and NIPFs for 41 percent of the acres. Timber stand improvement is practiced on about 14,800 acres annually. TSI practices increased 24 percent between the 1990 and 2002 FIA

surveys. This occurred primarily on NIPF lands, which account for 67 percent of the total.

In the past, most of the TSI practices were focused on pine management, primarily for improved timber production. Recently, the *term timber stand improvement* has been replaced with *forest stand improvement* to reflect an increased effort to manage and improve forest stands for multiple benefits. Family forest landowners are interested in conducting management practices with less intensive objectives and greater ecological benefits, such as biodiversity, water quality protection, recreation, and forest habitat enhancement.

Future opportunity exists to provide more forest stand improvement practices to natural stands, especially hardwood stands that may be overstocked, or have less than ideal stocking levels of desirable species, for improved productivity and forest health benefits. Hardwood stands that have been mismanaged in the past may need some type of intermediate treatment to improve the stand productivity for both timber and wildlife habitat benefits.

Many landowners that live within the urban-rural interface landscape no longer prefer typical silviculture and harvesting methods associated with traditional forest management. To assist more forest landowners, resource professionals will need to apply adaptive management strategies and be willing to provide and implement silviculture practices that are tree-oriented rather than acre-oriented and focus on the production of quality rather than quantity. Forest stand improvement practices can be used to accomplish scenic and aesthetic benefits along with forest wildlife habitat improvement.

Between 2004-2009, 2,793 forest stand improvement practices have been implemented on 132,957 acres of NIPF (TABLE 2*e*-4). On average, about 559 projects are conducted on 26,591 acres annually. The majority of the forest stand improvement practices are conducted for the purposes of pre-commercial thinning, prescribed burning for silviculture benefits, and herbicide or mechanical release treatments.

An opportunity exists to increase forest stand improvement practices on more acres for improved forest habitat in overstocked forest stands, improved forest health and productivity in natural or degraded hardwood stands, and increased scenic amenities. A continuation review and legislative report on the Forest Development Program (FDP) concluded that funding levels are not adequate to meet the current and future FDP demands by NC landowners seeking financial assistance (Brogan, 2009). The FDP maintains a waiting list of fully qualified but unfunded landowners each year due to a lack of full funding for the cost-share program. The work on this waiting list averages over $2.2 million annually and represents another 25,000-plus acres per year that could be reforested. Future increases in FDP funding and support are necessary to address the current and future demands for financial incentives.

Within the last few years, an increased number of federal and state cost-share practices have become available to NC landowners for ecosystem restoration, wildlife habitat enhancement, forest stand improvement, riparian and wetland restoration, and conservation benefits. The long-term acceptance, application, and sustainability of these practices will depend on future funding commitment levels, collaborative administration and record keeping by cooperating agencies, and increased outreach efforts by resource professionals to forest landowners.

TABLE 2*e*-4.—5-year summary of forest stand improvement accomplishments [1] by NIPF

Fiscal Year	No. of Projects/ Activities	Acres Treated
2004 – 2005	486	26,691
2005 – 2006	507	25,614
2006 – 2007	582	31,420
2007 – 2008	533	20,812
2008 – 2009	685	28,420
Totals	2,793	132,957
5-year Average	559	26,591

[1] Forest stand improvement practices recorded include prescribed burning for silviculture purposes, precommercial thinning, release treatments, fertilization, crop-tree release treatments, and other.Future Cost-share Support and Capacity

Forest Management Practices for Enhancing Forest Productivity

Over the past several decades, the Southeast has become a major source of timber products. Increased growth and yield from planting of genetically improved seedlings, controlling competitive vegetation, applying fertilizer, and other intensive management techniques have the potential to increase the available timber supply to meet an increasing demand. As the demand increases for ecosystem services and the amount of available forestland for timber production decreases, the importance of producing more volume on less land will continue to become increasingly critical.

Substantial productivity gains from pine plantations have occurred due to a broader acceptance of intensive management practices including genetic tree improvement, site preparation, herbicide application, thinning and fertilization. From 1952 to 2007, wood volumes harvested from planted pine plantations have doubled and rotation lengths have decreased by 50 percent (Fox et al., 2007a).

Although hardwood forests occur on 72 percent of the forestland in North Carolina, few landowners practice intensive forest management on hardwood forests since significant volume increases are difficult to achieve for many hardwood species and few hardwood plantations exist in the state. Hardwood forests are often managed by landowners for objectives other than financial gain.

Potential Productivity Gains

Productivity projections in this section refer to intensive forest management in pine plantations, generally in the coastal plain or piedmont. To quantify the impact of intensive management practices on productivity, Professor Jacek P. Siry, with the Warnell School of Forestry and Natural Resources, University of Georgia (Siry 2001b) developed five management intensity levels, ranging from traditional planted pine practices (site preparation and planting) to increasingly more intensive practices that use genetically improved seedlings, vegetative control, and fertilization. He used the TAUYIELD growth and yield model (Amateis et al., 1995) to project volume gains for each management intensity level in TABLE 2*e*-5.

Increased productivity gains can be realized with each increase in management intensity. By applying the most intensive management regime, a 70 percent volume increase is predicted (Siry, 2001b). Although up-front investment costs are high for these practices, published literature has documented improved net present value (NPV) and internal rate return (IRR) across many sites.

Herbicide and Fertilizer Use

The use of silvicultural herbicides is an important tool to increase forest productivity and enhance wildlife habitat in the South (Wagner et al., 2004). Herbicides have been found to be beneficial for improving forest wildlife habitat and biodiversity in Southern

TABLE 2*e*-5.—Projected growth and yield data for unthinned pine management intensities levels

	Stand Age			
Management Intensity Level[1]	15	20	25	30
		cubic feet of growth per acre		
SP	1121	2004	2716	3158
SP + G	1353	2355	3135	3605
SP + G + F	1353	2637	3433	3912
SP + G + F + H	1670	3139	4033	4502
SP + G + F + H(x2)	2170	3645	4587	5057

[1] SP = Site Preparation, G = Genetics, F = Fertilization, H = Herbicide
[2]TAUYIELD assumes a Site Index 60 at base age 25 and planting density of 600 trees per acre.

Source: Siry, 2001b

U.S. forests via manipulation of forest structure, creation of snags, and control of invasive plant species (Miller and Miller, 2004). The use of herbicides by NIPF owners in North Carolina has shown a slow but steady increase in application since 1996, averaging 14,625 acres per year from 2000 to 2006 (FIGURE 2*e*-2).

A similar trend is believed to apply to forest industry lands, although comprehensive data on herbicide application and use by forestry industry and other resource management agencies is difficult to compile. Increased herbicide use is likely due to a shift away from more costly mechanical methods, price reductions, and scientific studies showing greater effectiveness of herbicides for increasing early pine productivity rates and survival.

Herbicide use for site preparation is the most common objective (68 percent), followed by vegetative release (30 percent) (Pickens 2007). Control of undesirable hardwoods and herbaceous competition in pine plantations can significantly increase early pine seedling growth. First-year weed control has shown to increase the site quality index by 4 feet at age 25 (Siry, 2001b). Mid-rotation vegetative control, often applied after a thinning, has shown volume increases of 300 cubic feet per acre (Siry, 2002).

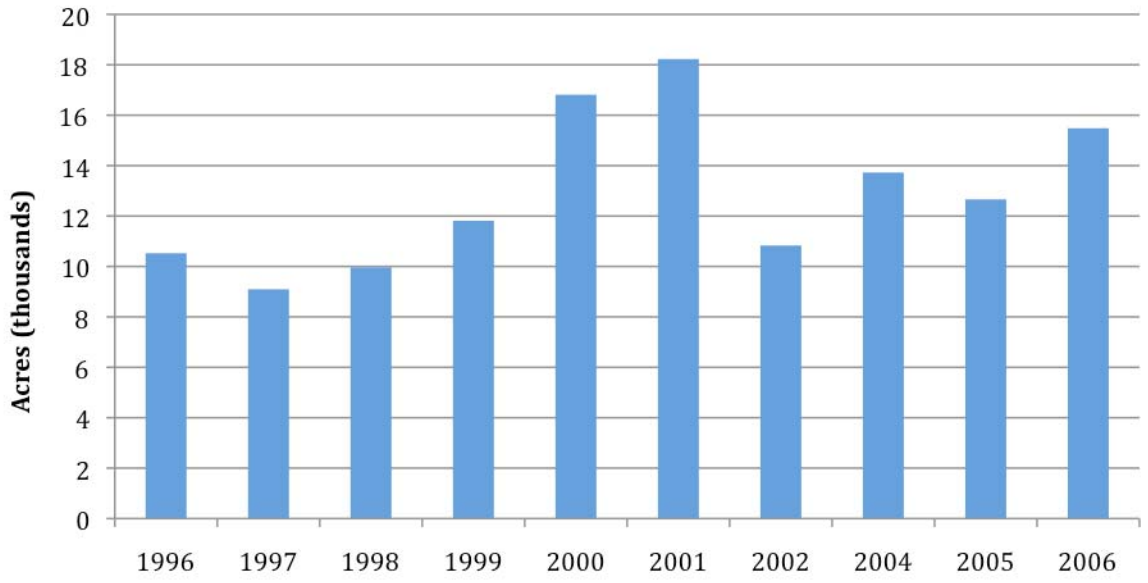
In the Southeastern United States, it is estimated that herbicides are applied annually on 1 percent of the forestland, primarily in pine plantations (Michael, 2000). Among NIPF landowners whose ownership was less than 500 acres, herbicides, pesticides, and fertilizers were applied on less than 5 percent of their property. Landowners with more than 500 acres applied herbicides, pesticides, or fertilizers on 32 percent of their forestland (USDA Forest Service, 2008).

Fertilization is becoming increasingly popular on forest industry lands as knowledge of sites that consistently respond to fertilization increases. Dramatic and significant gains are possible on nutrient deficient soils. Fertilizer applied at planting on phosphorous-deficient soils increases volume growth by 40 cubic feet per year throughout the rotation (Fox et al, 2007a) and a one-time application of 200 pounds of nitrogen and 25 pounds of phosphorous at mid-rotation increases growth by an average of 400 cubic feet per acre over an 8-year period (Fox et. al, 2007a).

Forest Tree Improvement and Genetics

For more than 50 years, tree improvement programs in the south have focused on

FIGURE 2*e*-2. Total number of acres treated with herbicides for forestry purposes involving NCDFR, 1996 – 2006.



[1]Source: B. Pickens, NCDFR, 2007. No data were reported for 2003.

improving several traits important for southern pine plantation forestry. Among these traits are height and volume growth, stem form, wood quality, and disease resistance. Nearly all of the loblolly pine plantations that have been established in recent years were planted using genetically improved seedlings (McKeand, 2006). Currently, the major forest tree seedling nurseries in North Carolina are producing second- and third-generation improved loblolly pine. Improvement of other southern pine species, such as longleaf, shortleaf, pond, and Virginia pines, has not been developed beyond rogued first-generation populations.

Across the south, second-generation loblolly pine seedlings can produce volume growth estimated to be greater, on average, than unimproved seed by 17 percent for coastal plain sources and 21 percent for piedmont sources (McKeand, 2006). These mixed-seed orchard seedlots have been mostly replaced by single-family seed collections. Plantations established from the best single-family parents can produce gains of about 26 to 50 percent over unimproved seed, with volume gains as much as 400 cubic feet per acre. In North Carolina, these expected gains are even greater due to the highly rated families selected for placement in improved seed and breeding orchards, and the planting of any of the top single families from these orchards (Roeder, 2010).

Third-generation and mass control pollinated (MCP) breeding in North Carolina is starting to produce commercial quantities of seed. Until seed supplies increase further, third-generation and MCP seedlings will be available only on a limited basis to North Carolina landowners. Wood volumes produced by these genetically improved third-generation families are estimated to surpass unimproved families by 40 to 60 percent or more. Volume improvement by MCP breeding will be even greater (Roeder, 2010). Improvement in stem quality and rust resistance results in higher yields per acre of higher quality trees. Some high production clones are also

available across the south, but are more expensive.

Since 1957, the NC State University Cooperative Tree Improvement Program (NCSUCTIP) has provided technical guidance, direction, and technical outreach to genetically improve loblolly pine. NCDFR is an active member of this program. Other members include five state forestry organizations and several different classes of private members. Members share breeding and testing efforts. Initially, the NCSUCTIP developed selected populations of all the southern pines and some other species. NCDFR is one of the few members that has maintained the selected germplasm of these other species and continues to work with them. All loblolly pine germplasm and data analyses developed by the cooperative are available to members. Seedlings grown from this germplasm are available to the nonindustrial private landowner.

Many landowners are currently not aware of the genetic differences and options available for planting seedlings from improved loblolly pine families. Planting contractors are frequently the individuals who make purchase decisions for landowners regarding nursery source and genetic family. More effort is needed to educate forest landowners regarding species, genetics, and appropriate management practices to enhance productivity. To help in this effort, the NCSUCTIP has developed a rating system that allows seedling consumers to evaluate the genetic potential of improved loblolly pine seedlings that they are about to obtain. The *Loblolly Pine Productivity Rating System* (PRS) is available for use by all cooperative members. NCDFR is the only producer of loblolly pine seedlings for planting in North Carolina that actively makes these PRS ratings available to their seedling customers.

The NCDFR genetic tree improvement program remains active with longleaf pine, shortleaf pine, Virginia pine, Atlantic white cedar, eastern white pine, and Fraser fir. Hardwood species under improvement include sweetgum, yellow poplar, sycamore, and white oak. Cooperative work is also being conducted by NCDFR, other state forest services, and the USDA Forest Service. In general, most hardwood species available from NCDFR's nurseries are unimproved and have undergone little or no genetic improvement. Seed production areas of these unimproved species are being established for seed collection purposes. There has also been an increased interest in the genetics improvement of American chestnut and butternut for disease resistance.

Forest Nursery and Seedling Capacity

North Carolina currently has only 2 major nurseries selling forest seedlings to the general public. These include NCDFR nursery in Goldsboro, North Carolina and the Weyerhaeuser Company nursery in Washington, North Carolina. In addition, there are two additional private forest seedling nurseries in the state.

Over 40 species of tree seedlings are produced and sold in North Carolina for reforestation, afforestation, wetland and stream mitigation projects, wildlife plantings and urban tree planting. The majority of nursery production is bare-root loblolly pine seedlings for reforestation purposes. In the 2008-2009 planting season over 62 million seedlings were produced in North Carolina. Of this total, the forest industry nursery sold about 49 million seedlings while the state forestry nursery sold 13 million seedlings. Total seedling production in the state declined by 9% from 2005 to 2009 while total seedling production across the South declined 4 percent. The NCDFR state

forestry nursery is the only large producer of bare-root hardwood seedlings in North Carolina.

Weyerhaeuser Company, NCDFR, and at least one private nursery have the capacity to produce containerized longleaf pine seedlings. For the past several years, public demand has exceeded the available supply of longleaf pine containerized seedlings. North Carolina has ranked 7th in the South in seedling production for each year from 2005 to 2009. An adequate supply of longleaf seedlings is critical to meet the restoration goals proposed in North Carolina's and America's Longleaf initiatives.

The NCDFR has been producing tree seedlings for sale to North Carolina landowners since about 1925. Nursery production is authorized by NC General Statute 113-35, which allowed the Department to "establish and operate forest tree nurseries and forest tree seed orchards". The law assures that an adequate supply of forest tree seedlings, of the highest quality, is available so the State will continue to maintain a strong forest-based economy.

State forestry nurseries are important to maintain a reliable and stable supply of forest seedlings to meet current and new demands to increase productivity, improve wildlife habitat, restore wetlands and streams, supply biomass or carbon markets, and establish tree species of concern. In 1996 a special commission of consulting foresters, representatives from forest industry, forestry associations, landowners and private citizens was formed to study the effects of privatization of the nursery program in the state of Georgia. This commission study concluded that the private sector could not procure all the state's seedling needs alone. They recommended the state continue to operate a nursery program to insure a stable and adequate supply of quality seedlings. In 1996 the Southern Group of State Foresters agreed that maintaining viable state nursery programs was in the best interest of sustainable forestry in the South.

In 1978 the Southern Forest Nursery Management Coop (SFNMC) was founded to research and develop effective weed and disease control technologies for nursery production, and to transfer this knowledge to members. The SFNMC represents the forest tree nursery community on issues where the Environmental Protection Agency (EPA) and the U.S. Department of Agriculture are involved (USDA). The NCDFR and Weyerhaeuser Company nurseries are members of the SFNMC along with seven other southern state forestry agencies, seven private firms, and the U.S. Forest Service (USFS).

Proposed changes by the EPA regarding the use of soil fumigants could drastically affect future nursery operations for forest seedling nurseries. If the proposed regulations are implemented, nurseries will have to make significant modifications that will impact production and seedling costs shift toward growing more containerized stock vs. bare-root stock, or close operations. A reduction in the production of bare-root seedlings in favor of containerized seedlings is one option being considered by many nurseries. A shift toward more containerized seedlings would require a significant investment in added infrastructure.

Forest Management Practices to Enhance Forest Habitat and Ecosystems

Active forest management can be used to replicate the disturbance regimes from natural forces and create forest habitat needed by many wildlife species. To meet the needs of a variety of wildlife species and habitat, land managers will need to create a

mosaic of plant communities and forest habitat in various age groups across the landscape. Forest practices such as harvesting methods, prescribed burning, thinning, forest stand improvement practices, and herbicides can be applied to alter forest structure and composition to meet the habitat needs of many game and non-game wildlife species.

Prescribed Burning

Based on data compiled from NCDFR Total Accomplishments Reports, the statewide average annual acres prescribed burned for hazard reduction, wildlife, or silviculture objectives was 118,779 acres during 2000-05. About two -thirds of the prescribed burning was for hazard reduction burning, mostly by federal, state, and non-government entities. Prescribed burning for wildlife habitat and silvicultural purpose averaged 32,492 and 7,422 respectively. Seventy percent of the prescribed burning is conducted in the Coastal Plain region (Table 2*e*-6). No clear trends are noted from the data, with the exception of a decrease in prescribed burning carried out by forest industry ownerships.

Yearly fluctuations in accomplishments do occur because opportunities to conduct prescribed burning are greatly influenced by variations in weather, and other barriers. Other barriers attributed to the ability to conduct more prescribed burning include the reduced capacity of fully trained or qualified personnel, reduced capacity of fire control equipment and smoke management limitations and public attitudes toward prescribed fire.

The North Carolina Prescribed Burn Act was passed in 1999 to help mitigate and overcome some of the barriers to prescribed burning. The NC Prescribed Burn Act limits the prescribed burner's liability for damage or injury resulting from impacts of smoke due to prescribed burning. This act also acknowledges the benefits of prescribe burning and establishes burning requirements.

North Carolina is experiencing an increased level of interest in prescribed burning by a wide variety of groups. This increased interest resulted in the formation of the NC Prescribed Fire Council (NCPFC) in 2003. The mission of the NCPFC is to foster cooperation among all partners in North Carolina with an interested in prescribed fire. Currently the NCPFC has 188 members representing approximately 35 entities. Another effort to promote prescribed burning is the Governor's proclamation that the second week in February be declared Prescribed Fire Awareness Week for North Carolina.

TABLE 2*e*-6.—Summary of prescribed burning acres in North Carolina by region and purpose, 2000 – 2005

	HRB by LO[1]	HRB by Other [2]	HRB by Industry	Silviculture Burn [3]	Wildlife Burn [4]
Coastal Plain	6,136	47,680	8,282	3,311	17,258
Piedmont	8,307	7,404	537	3,809	14,871
Mountain	62	468	0	292	362
Statewide Average	14,505	55,552	8,819	7,411	32,492

[1] HRB = Hazard reduction prescribed burn where the primary objective is to reduce fuel loads to reduce the threat from wildfire.
[2] HRB by Other = Hazard reduction prescribed burn conducted by all other state, federal, local government agencies or nongovernment organization.
[3] Silviculture Burn = Acres of post-establishment, in-stand burning where silvicultural or ecosystem restoration objectives are primary over HRB objectives.
[4] Wildlife Burn = Acres of post-establishment, in-stand burning where wildlife habitat enhancement objectives are primary over HRB objectives.

Fire Exclusion and Fire Dependent Ecosystems

Changes in land use and fire exclusion have the potential to alter the structure and composition of our current forests and associated wildlife communities. Many forests and natural communities have evolved from disturbance events such as fire ignited by lightning, severe storm events, and landscape manipulation. Many plants and animals depend on fire to flourish. Examples include animals such as bobwhite quail, red-cocked woodpecker, fox squirrel, pine snake and many birds and plants such as wiregrass, Venus flytrap, pitcher plant, and other rare or threatened species. Prescribed burning helps to reduce vegetation competition, releases seeds, promotes flowering or fruiting, and creates enhanced cover for these species.

Fire exclusion threatens the health and existence of many native plant communities and the wildlife they support. The use of prescribed fire in North Carolina is an important wildlife and forest management tool to maintain fire-dependent ecosystems. The use of prescribed fire and herbicides in mid-rotation plantations can also be used to develop pine savanna vegetation typical of older, natural fire-maintained pine stands (Miller and Miller, 2004). These two silvicultural prescriptions are especially important tools in the management and sustainability of both longleaf pine and shortleaf pine ecosystems.

Non-Timber Resource Protection and Enhancement

Many landowners in North Carolina are interested in managing their forestland to protect water quality, improve recreation, protect important archaeological sites, or enhance wildlife habitat. The Forest Stewardship Program (FSP) coordinates various public and private technical assistance programs available to forest landowners to help develop and implement a multi-resource management plan. From 2001 – 2007 an average of 43,000 acres per year were enrolled in the Forest Stewardship Program in North Carolina.

The NCDFR provides technical assistance to assist landowners with activities and projects that provide non-timber benefits (TABLE 2*e*-7). Over the last 5 years, approximately 151,442 thousand acres were managed for non-timber values, with an average of 30,288 acres treated annually. The majority of these projects and activities were for wildlife enhancement.

Soil and Water Quality Protection Measures to Benefit Forests

In North Carolina, forestry related site-disturbing activities must comply with the performance standards described in the state regulation entitled the Forest Practices Guidelines Related to Water Quality (FPGs). The statewide FPGs are incorporated as part of the state's Sedimentation Pollution Control Act, and cover the full spectrum of forestry activities; refer to the NCDFR's Website for citations of the FPGs. The NCDFR is delegated the authority to inspect forestry sites for compliance with the FPGs. FPG inspection results from 2004 through 2009 are presented in Table 2E-8.

In addition to the FPGs, the state has a comprehensive set of forestry Best Management Practices (BMPs) that often are the primary means to promote compliance with the FPGs and other water quality regulations. While the implementation of forestry BMPs is voluntary in North Carolina, the NCDFR conducts periodic site survey assessments to determine the degree of BMP implementation. More information about these BMP surveys can be found in the

TABLE 2*e*-7: 5-year Summary of Non-Timber Resource Protection and Enhancement[1] projects conducted by NIPF owners involving NCDFR personnel or programs

	Soil & Water Protection[2]		Recreation Enhancement[3]		Wildlife Enhancement[4]	
Fiscal Year	No. Projects/ Activities	Acres Treated	No. Projects/ Activities	Acres Treated	No. Projects/ Activities	Acres Treated
2004-05	223	7434	13	118	372	26,577
2005-06	170	5070	21	505	384	33,146
2006-07	212	4938	14	928	428	31,438
2007-08	112	1638	27	690	266	12,259
2008-09	86	3100	30	606	325	22,995
Totals	803	22,180	105	2,847	1,775	126,415
Average	161	4,436	21	569	355	25,283

[1] Non-Timber Resource Protection and Enhancement projects are for benefits other than wood production, including wildlife and fisheries, recreational and archeological, and soil and water projects.
[2] Soil & Water Protection projects and activities may include stabilization or re-vegetation to prevent erosion, bridges, culverts, or rock fords.
[3] Recreation Enhancement also includes archeological projects and activities that may include trails construction, vista clearings, understory clearing, and recreational area development and structures.
[4] Wildlife Enhancement projects and activities include prescribed burning, food plots, mast tree plantings, wildlife habitat practices, and nest boxes.

Water Quality Section of the NCDFR website.

Ongoing efforts of education, training, and on-site technical assistance are employed to reach landowners, loggers, and others who may need to understand FPG's, BMP's and the multitude of water quality regulations that affect forestry operations in North Carolina.

From 2004 to 2009, approximately 18,346 forestry sites were inspected for FPG compliance. Between 95 to 97 percent of the forestry sites inspected were documented to be in compliance over this same period (TABLE 2*e*-8). Forestry BMP implementation continues to be very high in North Carolina. Three-year BMP implementation results from 2000 to 2003 are summarized in a *Final Report for the NC Forestry BMP Implementation Survey* (Raval, 2005). In North Carolina the average statewide BMP implementation over this 3-year survey period was 82 percent. The level of BMP implementation varied regionally, and the level of BMP implementation was based on the review of more than 5,000 individual practices indentified on 565 sample harvest sites. From 1997 to 2007, 25 statewide BMP implementation monitoring surveys were conducted throughout the South. Combining all BMP categories in all states, and using only the most recent survey data, the average BMP implementation for the South was 87 percent. The range of overall implementation reported by individual states for all surveys during this same period was from 68 percent to 99 percent (SGSF, 2008).

All inspections of any forestry operation are documented at the local level and summarized in a statewide database. More detailed information on forestry sites not in compliance with FPGs is maintained in a violation tracking database. This database can provide summary information to forest industry to review quarterly compliance reports and utilize this information for Sustainable Forstry Initiative (SFI) purposes. Many of the forestry sites not in compliance are brought back into

TABLE 2*e*-8.—Summary of forestry site inspections[1] for *NC Forest Practices Guidelines* (FPG) related to water quality

	Forestry Sites			
Fiscal Year	Inspected[2]	In Compliance	Not in Compliance	In Compliance (%)
2004-05	4241	4012	229	95
2005-06	3903	3722	181	95
2006-07	3914	3747	167	96
2007-08	3070	2952	118	96
2008-09	3218	3115	103	97
Totals	18,346	17,548	798	96

[1]This is the total number of forestry sites inspected for FPG compliance, not including re-inspections.

[2] Sites include active and inactive harvest operations, reforestation activities, precommercial thinning, release treatments, and forest road construction not associated with a harvest.

compliance through recommendations and technical assistance provided by NCDFR personnel. Only a small number of sites are referred to other agencies for further assistance (TABLE 2*e*-9). Referrals are violations that will involve additional follow-up action or expertise or may be violations that fall outside of NCDFR jurisdictional responsibility.

Streamside Management Zones

In North Carolina forestry activities must establish and maintain a streamside management zone (SMZ) alongside certain types of streams and bodies of water. Forested buffers are an effective measure to protect water quality during harvesting, road construction, herbicide or fertilizer applications, and site preparation activities.

The width of SMZ's vary according to site specific factors such as soils, slope, type of water body,overall site disturbance, and landowner objectives. The forestry BMP Manual contains recommendations for establishing SMZ's. While the primary objective of establishing a SMZ is for water quality protection, a well-managed SMZ can provide multiple benefits, including wildlife cover and habitat; recreation; aesthetic visual screens; and windbreaks. Generally, harvesting is allowed within a SMZ, but should occur in a low-impact manner that maintains the integrity of the soil and water resources.

Forest Certification in North Carolina

Forest certification is a relatively new development since the 1990's, and deals not with the final product, but the practice of forestry, growth of the product, harvesting of the product, and ecological impacts associated with the harvesting of the product (Klingberg 2003). Forest certification is gaining widespread attention by a variety of stakeholders including state agencies, forest industry, environmental organizations, professional foresters, loggers, government policy makers, social activists, and the general public (Viana et al. 1996; Mater 1999).

Forest certification has been promoted as a tool for broader public acceptance of forest management and for achieving environmental, social, and economic benefits on certified forests (Moore and Cubbage, 2008). The concept of forest certification has emerged as a management tool to attain sustainable forestry using a voluntary market approach rather than a regulatory approach. Four major certification systems are active in North Carolina. These organizations are Sustainable Forestry Initiative (SFI), Forest Stewardship Council (FSC), Green Tag, and American Tree Farm System (ATFS). Of the four, SFI and ATFS fall under the Program for the Endorsement of Forest Certification (PEFC), the world's largest forest

TABLE 2*e*-9.—Summary of NC forest practices guidelines (FPG) referrals[1]

	Fiscal Year				
Agency	2004 – 05	2005 – 06	2006 – 07	2007 – 08	2008 – 09
DFR—LE	1	2	2	0	2
DLR	7	4	3	2	2
DWQ	6	4	4	1	0
DACS	0	0	0	0	0
Totals	14	10	9	3	4

[1] Agencies include NC Division of Forest Resources-Law Enforcement(DFR—LE), NC Division of Land Resources (DLR), NC Division of Water Quality (DWQ), and NC Department of Agriculture and Consumer Services (DACS).
[2]Total is the actual number of tracts referred. Some tracts may have been referred to more than one agency.

certification umbrella organization endorsing national and/or regional forest certification standards that meet its rigorous sustainable forest management criteria.

Very few family forest landowners are aware of forest certification programs. In the U.S., only 12 percent of the family forest owners, who own 24 percent of the family forest land, have heard of forest certification with very few family forest landowners (<1 percent by ownership) currently enrolled in a forest certification program (Butler 2008). By comparison, less than 5 percent of NC family forest landowners who responded to a 2006 NWO survey were familiar with forest certification programs or have land currently enrolled (Butler 2008).

Forest Stewardship Council (FSC) certified forestlands currently amount to about 12,000 acres in NC, all of which are privately owned. Comparatively, the Sustainable Forestry Initiative (SFI) and American Tree Farm System (ATFS) certify about 352,000 and 1.1 million acres respectively. Over 65 percent of the forestland enrolled under the ATFS is owned by NIPF landowners making the ATFS the most accessible forestland certification system for this ownership group in NC. Recently, the ATFS has modernized its standards and guidelines in order to reach PEFC sustainability benchmarks. In 2009, ATFS was audited at the National level and received third party certification from PEFC.

Forest industry forestlands are certified by both the SFI and the ATFS, with SFI accounting for nearly 90 percent of the certifications. North Carolina has a very active statewide SFI implementation committee. The primary certification alternatives at the present time work best for larger NIPF's, but are currently difficult and costly for the average NIPF landowner to implement (Mercker 2006).

Other studies conducted in SE states have found that very few landowners are familiar with certification requirements and were reluctant to outlay cash for direct or indirect costs associated with certification expenses (Vlosky 2000, Newsome et al. 2003). Mercker (2006) found that NIPF landowners most likely to consider forest certification were typically well educated, professionals that were new at forest land ownership, had received advice or information about their forestland, and desired to stay up-to-date with new forestry practices and programs.

Newsome et al (2003) results showed that there was a positive relationship between landowner's awareness of certification and the following:

- Landowner's who have participated in government programs in the past,
- Landowner's who receive a higher proportion of their income from forestry

- Landowner's who interact more frequently with professional foresters or county extension agents
- Landowner's who belong to associations

North Carolina NIPF landowners share many of the common socio-demographics of the prospective landowners that would indicate a willingness to consider forest certification if given the appropriate information and technical assistance. Educational focus should be with those landowners having the characteristics most favorable toward considering certification. Five sociodemographic variables were identified by Mercker (2007) as significantly related to landowner's willingness to certify, including landowners who: 1) were well educated, 2) were new at land ownership, 3) were professionals, 4) have received forestry advice or information, and 5) desired to stay up to date with new forestry practices and programs.

Increased enrollment in forest certification systems by North Carolina NIPF landowners will require future efforts to assess their awareness and acceptance of current programs available to them and target educational programs to landowners with characteristics favorable toward certification. Additional training on the process and benefits of forest certification will be needed for natural resource professionals that can assist NIPF landowners willing to consider certification for their forests as well as third party assessment opportunities.

Having a good knowledge of forest certification is a precondition for NIPF landowner participation. Lindstrom (1999) found that without adequate knowledge of forest certification, private forest landowners are not likely to participate, no matter how good the certification system. Mercker (2006) found that the top reasons landowners chose for certifying their forests were if certification 1) made their forest healthy, 2) improved wildlife habitat, or 3) saved money by reducing the likelihood of future regulation. Future opportunities may also exist to expand forest certification systems that incorporate emerging markets in ecosystems services and demand for export timber products. Group certification opportunities through third party organizations may also develop in the future.

Regardless of the reasons for NC landowners to enroll in forest certification systems, increased future efforts will be needed in education, outreach, training, and a collaborative effort between resource management agencies, forest industry, NGO's, and natural resource professionals to promote forest certification in North Carolina.

Forest Certification may become a more important tool to many forest landowners in NC to demonstrate a commitment to forest sustainability and a long-term dedication to proper management and stewardship of our forest resources.

Building Research Capacity

Currently, North Carolina has a variety of forestry research organizations or centers that are capable of addressing a broad range of forestry issues (TABLE 2*e*-10). For the purposes of this assessment, a narrow definition of forestry research is used and those institutions engaged in broader natural resource management research are not included. These forestry research centers tend to be clustered in the center of the state. Universities are the focus for forestry research and provide a consortium of information for the other research centers both in and out of state. Several of the research centers have research forests associated with them.

TABLE 2*e*-10.—Primary organizations conducting forestry research in North Carolina

Research Institutions	Location	Type of work
NC State University Department of Forestry and Environmental Resources	Raleigh	Full spectrum research, undergraduate and graduate programs
Duke University Nicholas School of the Environment	Durham	Full spectrum research, graduate programs
US Forest Service—Southern Research Station	Asheville	Full spectrum
NC Division of Forest Resources	Raleigh	Urban forestry, water quality; applied forest management
Weyerhaeuser	New Bern	Pine silviculture
National Council for Air and Stream Improvements (NCASI)	Research Triangle Park	Forestry and pulp and paper

Both public and privately operated forestry-related cooperatives exist in North Carolina (TABLE 2*e*-11). The proprietary nature of their research limits the dissemination of their findings to their members only. However, the existence of multiple such organizations in the state underscores the investment in research and development in the forest products sector in North Carolina.

Forestry research cooperatives are important to investigate and assess future research areas, such as forest management and sustainability, forest tree improvement and productivity, and forest modeling. These cooperatives are the joint efforts of the USDA Forest Service, state forestry agencies, forestry programs at southern universities, and forest industry. In recent years funding for these cooperatives has declined due to consolidation in forest industry and declining research budgets from other agencies.

A major concern associated with the transition in forestland ownership in the South has been the decreasing support of forestry research. Both internal proprietary research and external cooperative research programs have declined substantially or have been eliminated by forest industry (Clutter et al., 2005). Consequently, several of the research cooperatives in the South have been terminated in the last 10 years, and the support for some of the remaining programs has declined to the point where their long-term survival is questionable (SIFRC, 2000; Clutter et al., 2005).

Emerging areas that are gaining increased research interest and subsequent funding includes declining ecosystems and species restoration, climate change mitigation, biofuels for energy, carbon management and sequestration, and invasive species.

TABLE 2*e*-11.—Forestry-related cooperatives in North Carolina

Name	Location	Type of work
Forest Nutrition Cooperative	Raleigh NC State/VA Tech	Forest productivity
NC State Cooperative Tree Improvement Program	Raleigh NC State University	Tree Improvement
Southern Forest Resources Assessment Consortium	Raleigh NC State University	Modeling of forest biological, economic, and social information
Southern Center For Sustainable Forests	Duke/NC State/NCDFR	Forestry Certification, Chip Mill Study

Summary

Few family forest landowners in North Carolina have a written forest management

plan or received professional advice or financial assistance to actively manage their property. Nearly 30 percent of forest landowners list “leave as is” as their plan for management activities in the next five years. Harvesting timber is listed as a planned activity by less than 10 percent of forest landowners. Of the forest landowners that do seek management advice, the majority of them indicate that the state forestry service is one of their primary sources of information.

Demand for timber products is increasing, while available forestland is decreasing through conversion to other uses (Wear, 2002). Intensive forest management practices have the potential to increase productivity in managed forests on fewer acres. Actively managed forests may reduce pressure to harvest natural stands while sustaining a long-term timber supply. The area of pine plantations in North Carolina, currently accounting for 12 percent of the total forested area, is expected to double in the next 30 years (Prestemon and Abt, 2002). Most of these plantations will be established using practices such as the planting of genetically improved seedlings and application of herbicides, which should improve productivity. Productivity gains will range from 10 to 70 percent over traditional plantations with the highest quality sites exhibiting the best response. Forest industry owners, REITs, and TIMOs will practice even more intensive management.

Few NIPF landowners, even those who own large tracts, practice intensive forestry. An increase in the number of small NIPF tracts (which are difficult operationally and economically to manage intensively) is predicted.

Forest nurseries in North Carolina produce a sufficient supply of forest seedlings to meet the reforestation needs of the state. The NCDFR nursery program produces 45 different species of native forest seedlings for timber, wildlife habitat, wetland mitigation, and ecosystem restoration. A state nursery and tree improvement program is important to provide a diverse and stable supply of forest seedlings. Volume gains realized from genetically improved seedlings benefit landowners economically and help meet the demand for wood products on fewer acres.

North Carolina has funded a strong cost share program, the FDP, to improve productivity for nonindustrial private landowners. The FDP provides funding for about half to three-fourths of all the acres artificially reforested each year. A higher funding rate is available for the planting of longleaf pine, shortleaf pine, Atlantic white cedar, and hardwood species. Other federal cost-share programs and initiatives are available for establishing forests to benefit wildlife habitat, threatened and endangered species, and water quality. Continued support and funding for state and federal cost-share programs and initiatives are important to provide financial and management incentives to family forest landowners.

Changes in land use and fire exclusion have altered the structure and composition of our forests and associated wildlife communities. Forest management practices and activities—such as prescribed burning, thinning, timberstand improvement, and herbicide use—are effectively used to enhance forest habitat for game and nongame wildlife species. The use of prescribed fire in North Carolina is an important wildlife and forest management tool to maintain fire-dependent ecosystems and as an effective technique for reducing the risk from wildfire.

Soil and water quality protection measures will continue to be important to monitor and

implement during any forestry operation to prevent nonpoint source pollution and to maintain favorable public opinion about forestry practices in the future. The trend in forestry research appears to be away from traditional growth and productivity topics towards more sustainability topics, such as ecosystem services.

References and Sources Cited

Albaugh, T. J.; Allen, H. L.; and Fox, T. R. 2007. Historical patterns of forest fertilization in the southeastern United States. *South. J. Appl. For. 31*(3):129-137.

Amateis, R.; Radtke, P.; and Burkhart, H. 1995. TAUYIELD: *A Stand Growth and Yield Model for Thinned and Unthinned Loblolly Pine Plantations.* Rep. 92. Blacksburg, VA: Virginia Polytechnic Institute and State University, Loblolly Pine Growth and Research Cooperative. Baker, J. C.; and Hunter, W. C. 2002. Effects of forest management on terrestrial ecosystems. In Wear, D. Nand Greis, J. G. (Eds.).2002 *Southern Forest Resource Assessment*, Gen. Tech. Rep. SRS-53 (pp. 91-112). Asheville, NC: USDA Forest Service, Southern Research Station. Brogan, 2009. Cited on page 12.

Brown, M. J. 2004. *Forest Statistics for North Carolina, 2002*. Resource Bulletin SRS-88. Asheville, NC: USDA Forest Service, Southern Research Station. Butler, B. J. 2008. *Family Forest Owners of the United States, 2006*. Gen. Tech. Rep. NRS-27. Newtown Square, PA: USDA Forest Service, Northern Research Station.

Brogan, S. 2009. A continuation review and legislative report on the Forest Development Program. NC Division Forest Resources internal document. Raleigh, NC. Unpublished.

Butler, Brett J. 2008. *Family forest owners of the United States, 2006*. Gen. Tech. Rep. NRS-27. Newton Square, PA: USDA Forest Service, Northern Research Station. 72 p.

Clutter, M.; Mendell, B.; Newmand, D.; Wear, D.; and Greis, J. 2005. Strategic factors driving timberland ownership change in the U.S. South. Asheville, NC: USDA Forest Service, Southern Research Station, and Southern Group of State Foresters. Online: http://www.srs.fs.usda.gov/econ/pubs/southernmarkets/strategic-factors-and-ownership-v1.pdf.

Fox, T. R.; Allen H. L.; Albaugh T. J.; Rubilar R.; and Carlson C. A. 2007a. Tree nutrition and forest fertilization of pine plantations in the southern United States. *South. J. Appl. For. 31*(1):5–11.

GfK NOP, Roper Public Affairs. 2006. *Family Forest owners: An In-depth Profile*. New Haven, CT: The Sustaining Family Forests Institute, Yale School of Forestry. Online: http://www.sustainingfamilyforests.org/pdfs/report_fullreport.pdf.

Johnson, Tony G., 1991. Forest statistics for North Carolina, 1990. Resour. Bull. SE-120. USDA Forest Service, Southeastern Forest Experiment Station. Asheville, NC. 63 p.

Klingberg, T. 2003. Certification of Forestry: A Small-scale Forester Perspective. In Small-scale Forest Economics, Management and Policy. 2(3): 409-421.

Lindström, T.; Hansen, E.; and Juslin, H. . 1999. Forest Certification: the view from Europe's NIPFs. *J. For*. 97 (3): 25-30.

Mater, C. 1999. Understanding Forest Certification: Answers to Key Questions. Pinchot Institute for Conservation. 50p.

McKeand, S.; Abt, R. ; Allen, H. L; Li, B.; and Catts, G. P. 2006, Oct./Nov. What are the best loblolly pine genotypes worth to landowners? *J. For. 104*(7): 352-358.

Mercker, David. 2006. Forest Certification and Nonindustrial Private Forest Landowners: assessing awareness, acceptance, and educational preferences. PhD Dissertation. The University of Tennessee, Knoxville. 57pp.

Mercker, D.C.; and Hodges, D. 2007. How Do Forest Landowners Desire to Learn About Forest Certification? *Journal of Extension*. [On-line], 45(5) Article 5RIB4. Available at: http://www.joe.org/joe/2007october/rb4.php

Michael, J. 2000. Pesticides used in forestry and their impacts on water quality. *Proceedings of Southern Weed Science Society 53*: 81-91.

Miller, K.V. and Miller, H. 2004. Forestry herbicide influences on biodiversity and wildlife habitat in southern forests. *Wildlife Society Bulletin 32*(4): 1049-1060

Moffat, S.O. ,Cubbage, F.,Cascio, A., and Sheffield, R.. 1998. Estimations of future forest management intensity on NIPF lands in the South: Results of the southern State Forester's survey. SOFAC Report No. 14. Southern Forest Assessment Consortium, Working Paper Series. 7 p. + appendices.

Moore, S. E. and Cubbage, F. 2008. Forest Stewardship Council Resource Manager Certification: Program Impacts and Prospects. Poster presented at the 6th Association of Natural Resource Extension Professionals Conference, May 19-23, 2008, Madison, WI (abstract published).

Newsom, D., B. Cashore, G. Auld, and J. E. Granskog. 2003. Forest Certification in the Heart of Dixie: a Survey of Alabama Landowners. Yale Program on Forest Certification. www.cabi-publishing.org/bookshop/ReadingRoom/0851995993.asp Date of retrieval 2003.

NC Division of Forest Resources (NCDFR). *Total Accomplishment Reports 2001-2007*. Raleigh: NC Dept. of Environment and Natural Resources. Unpublished.

NCDFR. 2006. *North Carolina Forestry Best Management Practices Manual to Protect Water Quality*. Pub. FM-08-01. Raleigh: NC Dept. of Environment & Natural Resources.Pickens, B. 2002. An evaluation of loblolly pine planted in 1998 by non-industrial private landowners in North Carolina. Raleigh: NC Division of Forest Resources, NC Dept. of Environment and Natural Resources. Unpublished.

Pickens, B. 2007. Results of a 10-year survey of herbicide use in North Carolina by non-industrial private landowners. Raleigh: NC Division of Forest Resources. Unpublished.

Prestemon, J. P. and Abt, R. C. 2002, Oct./Nov. The southern timber market to 2040. *J. For. 100*(7):16-22

Raval, S. 2005. *Final Report for the North Carolina Forestry BMP Implementation Survey, 2000-2003*. Raleigh: NC Division of Forest Resources, Forestry NPS Unit..

Roeder, K. 2010. Data analysis from NCDFR tree improvement program. Goldsboro: NCDFR, NC Dept. of Environment and Natural Resources. Unpublished

Southern Industrial Forestry Research Council (SIFRC). 2000. *A Review of Cooperative Forestry Research in the South*. Report No. 7. Washington, DC: SIFRC, American Forest and Paper Association.

Siry, J. and Cubbage, F. 2001a. *A survey of timberland investment management organizations forestland management in the South.* Work. Pap. Research Triangle Park, NC: Southern Forest Resource Assessment Consortium.

Siry, J.; Cubbage, F.; and Malmquist, A. 2001b. Potential impact of increased management intensities on planted pine growth and yield and timber supply in the South. *Forest Products Journal 51*(3): 42–48.

Siry, J. 2002. Intensive timber management practices. In *Southern Forest Resource Assessment* (pp. 327-340). Gen. Tech. Rep. SRS-53. Asheville, NC: USDA Forest Service, Southern Research Station.

Snider, A. and Cubbage, F. 1999. *Nonindustrial private forests: a review of selected studies.* Prepared for NCDivision of Forest Resources and USDA Forest Service Region 8, State and Private Forestry. NC State University, Forestry Department, Raleigh, NC. Unpublished.

Southern Group of State Foresters (SGSF). 2008. *Implementation of Forestry Best Management Practices—A Southern Region Report*. Asheville, NC: USDA Forest Service, Southern Research Station.

USDA Forest Service. 2008. National Woodland Owner Survey, Table Maker Ver1.0. Amherst, MA: Forest Inventory and Analysis Program, USDA Forest Service. Online: http://www.fia.fs.fed.us/nwos/results/.

Wagner, R. G.; Newton, M.; Cole, E. C.; Miller, J. H.; and Shiver, B. D. 2004. The role of herbicides for enhancing forest productivity and conserving land for biodiversity in North America. *Wildlife Society Bulletin 32*(4): 1028-1041

Viana, V. M.; Jamison, E.; Donovan, R. Z.; Elliot, C.; and Gholz, H. 1996. Certification of Forest Products: Issues and Perspectives. Island Press, Washington, D.C. 261p.

Vlosky, R. P. 2000. Certification: Perceptions of Non-industrial Private Forestland Owners in Louisiana. Louisiana Forest Products Laboratory. Louisiana State University Agricultural Center. Working Paper #41. 15p.

Wear, D. and Gries, J. 2002. *Southern Forest Resources Assessment*. SRS-53. Asheville, NC: USDA Forest Service, Southern Research Station.

Glossary

clone. A vegetatively propagated organism, or a group of such organisms consisting of an ortet and its ramets.

family forest owners. Families, individuals, trusts, estates, family partnerships, and other unincorporated groups of individuals that own forest land. This group is a subset of nonindustrial private forest owners.

forest certification. The stewardship and use of forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality, and potential to fulfill, now and in the future relevant ecological, economic, and social functions at local, national, and global levels, and that does not cause damage to other ecosystems"

germplasm. (1) Within an individual or group, the collective hereditary materials that are the physical basis for inheritance; the hereditary stream. (2) The genotype, with particular reference to its transmission to the next generation.

mass controlled pollinations (MCP). A method of tree breeding where large numbers of pollen parentage are completely controlled, eliminating pollen contamination and allowing for positive assortative mating among seed orchard parents to maximize genetic gains or specific genetic traits.

roguing. A systematic removal of individuals not desired for the perpetuation of a population, e.g., from a seed stand, nursery, or genetic test.

Sustainable Forestry Initiative (SFI). A voluntary, third-party organization that develops standards of good forest management and certifies that forests are well-managed as defined by a particular standard ensuring that certain wood and paper products come from responsibly managed forests.

timber investment management organization (TIMO). A management group that aids institutional investors in managing their timberland investments. A TIMO acts as a broker for institutional clients.

timber stand improvement. An intermediate treatment made to improve the composition, structure, condition, health, and growth of evenly or unevenly aged forest stands.

urban-rural interface. The area or zone where infrastructure and other associated development from human populations meet or intermingle with rural forests and farms.

2.f.

Emerging Markets in Ecosystem Services

Key Findings

- Ecosystem markets are available to landowners in North Carolina, but are primarily on a case-by-case basis, with the majority of markets focusing on mitigating impacts upon water quality.
- Best estimates are that approximately 19 stream and/or wetland compensatory mitigation banks exist in North Carolina, indicating that landowners in this state may be in an advanced position, relative to other southern states, to capitalize on the projected needs for future water-resource ecosystem markets.
- Based upon anecdotal evaluation of the components that could drive the creation and implementation of forestry-based strategies to offset carbon dioxide (CO_2), it would appear that managing forests for CO_2 could be successful in North Carolina, thus offering a potential source of continued support for working forests.

Introduction

Ecosystem services are the benefits people obtain from ecosystems. Examples of the type of services include: provisioning (food, water, timber, and fiber); regulating (climate, floods, disease, wastes, and water quality); cultural (recreational, aesthetic, and spiritual); and supporting (soil formation, photosynthesis, and nutrient cycling). While the intrinsic values of the ecosystem services provided by forests have long been recognized, only recently have there been efforts to monetize ecosystem services in a manner that could benefit private landowners.

Status and Examples of Ecosystem Markets

Current markets for ecosystem services range from nonexistent to highly developed and vary by geographic location. The most well-known markets are those for provisioning services, which include timber, fiber, food, and water. In North Carolina there may be opportunities for landowners to benefit from several nontraditional ecosystem markets:

1. Wetland and stream compensatory mitigation banking
2. Nutrient offset banking and credit trading
3. Riparian buffer mitigation banking
4. Endangered species conservation banking
5. Carbon credit trading

The information outlined in this document for each ecosystem market is simply a brief overview and not a full description of eligibility, benefits, risks, or regulatory requirements needed to participate in these markets. A landowner needs to obtain the professional services of an environmental consultant who can describe the extensive regulations that govern these ecosystem

markets and assess their respective market opportunities for the landowner.

Overview of Mitigation Banking

The term *mitigation banking* refers to the restoration, enhancement, preservation, or creation of wetlands, streams, riparian buffers, or endangered species habitat conservation areas that off set expected adverse impacts to these ecosystems from land development, roadway construction, and related disturbance activities. Mitigation banks are highly regulated by numerous federal and state agencies. Once a mitigation bank has been approved by the appropriate regulatory agencies, the credits from the mitigation services conducted on the mitigation bank are available for sale to an entity that is proposing impacts to wetlands, streams, or endangered species habitats. Recent changes in federal and state laws give a preference to private-sector mitigation banks for offsetting impacts from development projects. This new guidance may prove to be an opportunity for private landowners to realize revenue from mitigation banking activities.

Wetland and Stream Compensatory Mitigation Banking

Impacts to wetlands and streams are mitigated by any of three methods (in order of preference): avoiding; minimizing; and then as a last resort, compensating for the impacts. Compensatory mitigation can, in turn, be achieved through one or more of the following: restoration, enhancement, preservation, and creation. From 1995, when the federal mitigation policy was established, until 2008, when new federal and state laws revised how mitigation should be conducted, approximately 19 wetland or stream mitigation banks existed in North Carolina. Since the 2008 revisions, at least 5 mitigation bank proposals in North Carolina have been submitted to the U.S. Army Corps of Engineers, with 3 having been approved. The rapid increase in mitigation banking proposals since April 2008 indicates that this ecosystem market is growing and opportunities may exist for forestland owners across the state. Extensive information about the rules, policies, and requirements for compensatory wetland and stream mitigation are available on these Web sites:

- U.S. Army Corps of Engineers: www.saw.usace.army.mil/WETLANDS/Mitigation/index.html
- NC Ecosystem Enhancement Program: www.nceep.net
- U.S. Environmental Protection Agency: www.epa.gov/wetlandsmitigation

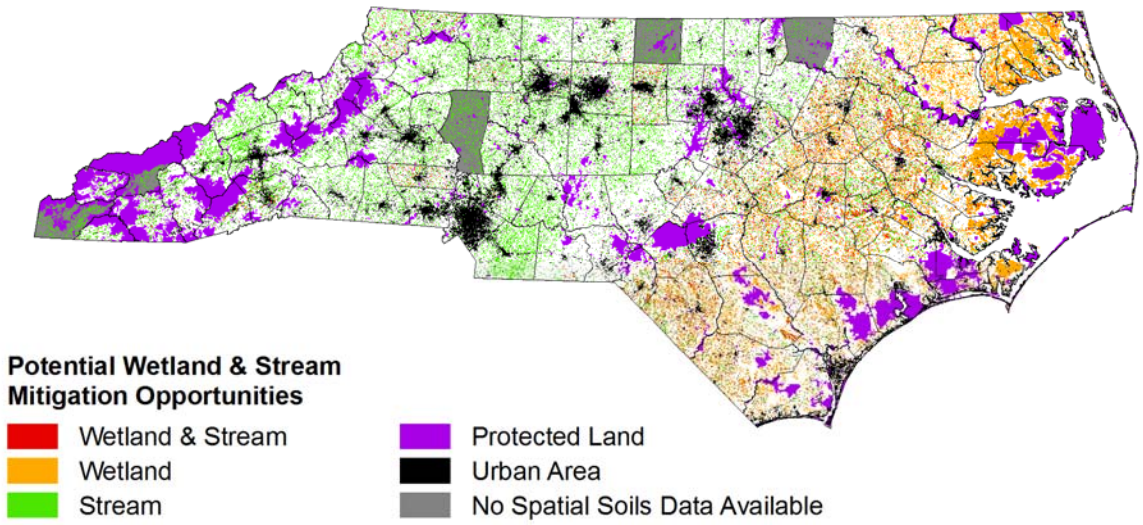
FIGURE 2*f*-1 depicts approximate locations of potential wetland and stream mitigation site opportunities for private landowner participation.

Nutrient Offset Banking and Credit Trading

The NC Nutrient Offset Program was developed in 2001 to assist wastewater dischargers and land developers in the Neuse River basin and Tar-Pamlico River basin with compliance of strategies to manage these nutrient-sensitive waters. Developers in these river basins must work with local municipalities to reduce the nutrient contributions associated with their land development activities. If developers are unable to meet the requirements associated with the nutrient rules, they must develop strategies to offset their nutrient contribution, one of which is to pay into the NC Riparian Buffer Restoration Fund. Land that has been converted from forestland to agriculture, pasture, and other disturbed land

use may qualify for providing nutrient offsets through forest restoration and

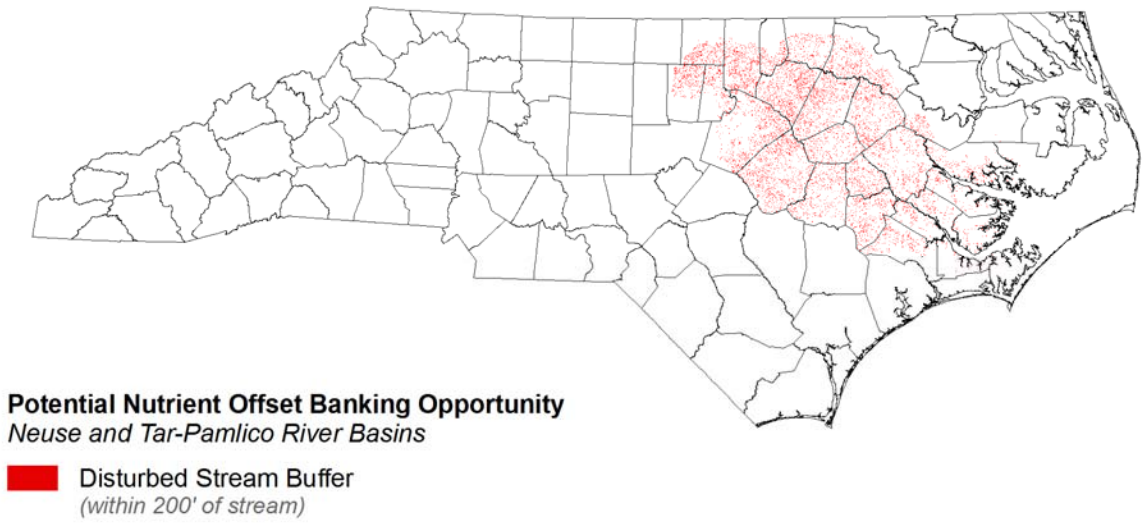
FIGURE 2*f*-1. Approximate wetland and stream mitigation site opportunities for private landowners.



Created by: D. Jones, NCDFR, 2010

enhancement activities in the Neuse River or Tar-Pamlico River basins. Forestland owners within these basins that have degraded and/or unbuffered streams and/or wetlands on their property could be eligible to provide nutrient offset credits and be compensated for planting trees or otherwise enhancing a 200-foot buffer adjacent to streams and wetlands. This Web site has more information about this offset opportunity: www.nceep.net/services/stratplan/Nutrient_Offset_Program.htm. FIGURE 2*f*-2 depicts approximate locations for nutrient offset bank establishment opportunities.

FIGURE 2*f*-2. Approximate nutrient offset bank opportunities for private land owners.



Created by: D. Jones, NCDFR, 2010

Riparian Buffer Mitigation Banking

Certain watersheds and river basins in North Carolina are required to implement state rules that are intended to manage and control nutrients in the streams, wetlands, and bodies of water that exist within these watersheds or basins. These areas include the Catawba River basin, Goose Creek watershed (Union and Mecklenburg counties), Jordan Lake watershed, Neuse River basin, Tar-Pamlico River basin, and Randleman Lake watershed. One of the primary ways to regulate excessive nutrients is by protecting and maintaining vegetated riparian buffers alongside designated streams and bodies of water. A landowner may be able to benefit from the creation of a new forested riparian buffer within these designated watersheds if another landowner or developer in the same drainage area wishes to encroach upon an existing riparian buffer elsewhere. This mitigation of a riparian buffer would then be one alternative allowed under the state's rules. As in all cases, a landowner should employ the services of an environmental consultant who can determine the eligibility and requirements of riparian buffer mitigation or other mitigation-related activities. To learn more about riparian buffers, contact the NC Division of Water Quality: http://h2o.enr.state.nc.us.

Endangered Species Conservation Banking

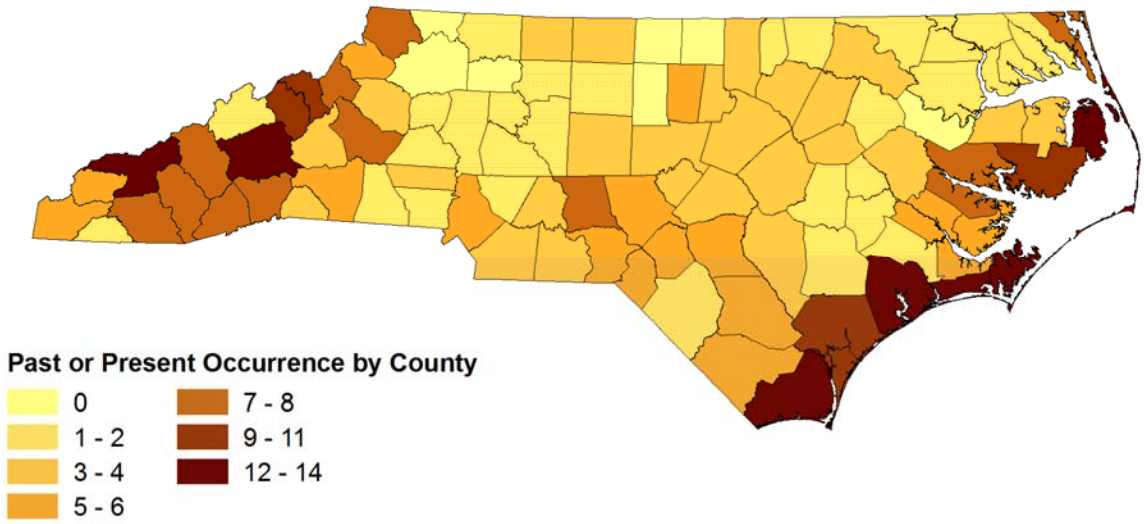
Endangered species conservation banking is a growing strategy for managing adverse impacts to endangered species populations and habitats in the United States (Fox and Nino-Murcia, 2005). Similar to the mitigation policies associated with wetland and stream compensatory mitigation, endangered species conservation banking includes the restoration, enhancement, preservation, and/or creation of habitat for species listed under the Endangered Species Act (ESA) or for those species under consideration for listing. For unavoidable impacts to ESA listed species, conservation banks may be considered on a case-by-case basis by the U.S. Fish and Wildlife Service (USFWS) as a flexible alternative for "meeting a variety of conservation needs of a listed species" (USFWS, 2003).

In 2003, the USFWS prepared a memorandum to be used by USFWS staff when evaluating conservation banking proposals: "Guidance for the Establishment, Use, and Operation of Conservation Banks". The document outlines the goals, objectives, strategy, eligibility, site selection, service area, and other governing characteristics that a proposed conservation bank must consider. This memo is available through USFWS at: http://www.fws.gov/Endangered/pdfs/MemosLetters/conservation-banking.pdf

In North Carolina, there are 13 mammals, seven birds, eight reptiles and amphibians, 19 fish, and 26 plants listed on the endangered species list (USFWS, 2010). Although no private conservation banks exist in North Carolina, at least eight private conservation banks exist across the Southeast, from South Carolina to Texas (EM, 2010). Conservation banking may become a more commonly used strategy as urban land-use development continues to place a strain on species and natural habitats.

FIGURE 2*f*-3 depicts the number of federally listed species that are known to occur (past or present) in each county of North Carolina. When supporting ecosystem habitat exists and/or habitat restoration is undertaken in collaboration with USFWS and in accordance with conservation bank guidelines, the future establishment of conservation banks is more likely to occur in

FIGURE 2*f*-3. Federally-listed species occurrences in North Carolina.



Created by: D. Jones, NCDFR, 2010

counties with listed species occurrences. For more information about specific species listed in North Carolina, refer to the USFWS Web site: www.fws.gov/raleigh/es_tes.html

Carbon / CO_2 Markets

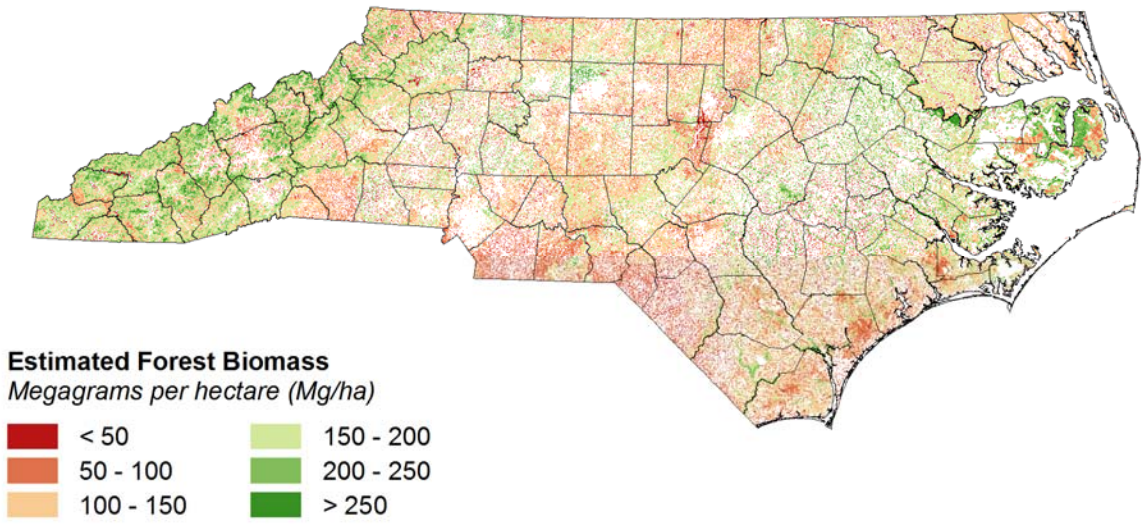
There is a growing recognition that forests, silvicultural practices, forestland management, and increased utilization of wood-based products can contribute to mitigating, offsetting, or reducing the level of carbon dioxide (CO_2) in our atmosphere. Ongoing research is attempting to quantify the existing carbon stock of aboveground vegetation and within the soil; this work is a vital first step in understanding the role forestry plays in CO_2 management. FIGURE 2*f*-4 illustrates the current state of knowledge regarding forest carbon biomass quantities in North Carolina. Carbon retention and carbon sequestration have emerged as the two approaches to CO_2 management.

Carbon retention includes the conservation and/or preservation of existing forestlands, thus preventing them from conversion to nonforest land use. Retention is also accomplished by the conversion of trees into renewable wood-based products, which effectively retain carbon for the duration of the product's life cycle. The forestland that produced the timber is then reforested to continue the carbon management cycle.

Carbon sequestration includes the process of accruing or capturing an incremental amount of CO_2 from the atmosphere, and is generally understood to focus on the establishment of new trees.

The potential markets for forestry-based CO_2 offsets are still developing. While the Chicago Carbon Exchange (CCX) has been trading for a few years as the most well-known market in the United States, the deployment (or reward) of capital to or from forest landowners for the purposes of marketing carbon credits remains a financial under-performer when compared with markets for traditional forest products.

FIGURE 2*f*-4. Estimated forest carbon biomass (above- and below-ground) in North Carolina.



Created by: D. Jones, NC DFR, 2010

Several attributes appear to collectively create a more favorable scenario for the successful implementation of forestry-based strategies for CO_2 management. Each of the following six attributes shows promise in North Carolina:

- Carbon-rich, naturally productive soils
- Diverse forest species composition
- Abundant, privately-owned "working" forestlands
- Proximity to forest product processing facilities and consumer markets
- Proximity to large-volume, identifiable CO_2 emissions
- Access to investment capital, financial markets, and funding to support forestry activities

Soils

Soils are a vast repository of carbon. Ideally, to manage for CO_2 offsets, carbon-rich soils should remain in a relatively stable and undisturbed condition. The relatively long-term growth and harvest cycles of forests are suitable to sustain a stable soil-based carbon bank. In particular, North Carolina's organic (peat) soils in the lower coastal plain should be examined as to how forestry-related management measures can enhance carbon storage and/or reduce the potential of carbon loss from these soils.

Species Composition

According to the literature, forests of diverse species yield greater potential to sequester carbon. North Carolina's tremendous diversity of forest species should prove valuable in the development of CO_2 offset measures.

Private Forestlands

Private forestlands in North Carolina will play an important role in carbon retention. The majority of working forests in which an actively managed CO_2 offset process can be sustained are those in private ownership. Nearly 80 percent of North Carolina's 18-

million acres of forestland is privately owned (Brown et al., 2006).

Forest Products

Retention of CO_2 by processing wood into usable products requires that a substantial network of forest product processing facilities be located near the raw material, and relatively close to the end user. The overall CO_2 management cycle can be implemented more efficiently and with a lower overall carbon footprint when supply is close to demand. North Carolina, despite numerous recent closings of manufacturing facilities during the ongoing economic recession, still retains a high number of wood-based processing facilities throughout the state.

When assessing the potential demand for wood-based products, North Carolina is consistently cited as one of the fastest growing population centers of the U.S., and this trend is expected to continue (U.S. Census Bureau, 1996). Increased populations will produce a commensurate increase in the consumption of forest-based products for construction and other purposes.

CO_2 Emissions

Although there are multiple sources of CO_2 emissions, the most readily identifiable man-made source of emissions is fossil-fueled electricity generation. On the presumption that, as noted above, the supply must meet the demand for an effective CO_2 offset market (or any market) to succeed, North Carolina is well positioned with an estimated 25 fossil-fuel electricity generating units across the state.

Access to Capital

Within the last decade, we have seen significant increases in awareness and action from financial investors and market makers to participate in owning and managing forestland as a component of an investment portfolio. North Carolina is in a unique position among states of the Southeast because several of the well-known timber investment organizations have operations, management offices, and/or timberland properties across the state. This existing base of forest investment knowledge could readily expand into the world of CO_2 offset markets if the opportunity and financial viability improve. In addition, North Carolina is often considered the banking and financial operating center of the South, allowing us to presume that capital may be more readily available for the development and execution of markets for CO_2 management. The financial investment community's proximity to and familiarity with North Carolina's forests and markets could create conditions in which CO_2 offset markets, or other ecosystem markets, would be more readily established and accepted in this state.

In addition to private financial capital, North Carolina has a long history of cooperation with the federal government regarding the stability and sustained operations of several strategic military installations and facilities. In recent years, a renewed focus by state and federal officials has led to new partnerships and efforts to assess how forestry, agriculture, and traditional 'working lands' can serve as operational buffers around military facilities to bolster national security and mitigate potential quality-of-life concerns for surrounding residents and businesses.

The gains North Carolina is poised to realize through the federal Base Realignment and Closure (BRAC) Program, and the state's commitment to cooperation with its federal military partners, may provide additional future funding sources for the conservation of existing privately owned forestlands or the establishment of new forestland in areas

buffering military facilities. The presumption here, as in the paragraph above, is that an increased availability of capital investment in forestland would entice forest owners to participate in a future CO_2 offset management market, in addition to traditional forest product markets.

Summary

Ecosystem services markets vary in their stages of development and potential for sustainable economic opportunity. Markets related to water resources are already established, but so far remain limited in availability to the average forestland owner. North Carolina forestland owners show interest in participating in existing nontraditional markets. It can be presumed that once a stable, verifiable market for carbon credits and offsets from forests is developed, forestland owners (and forests) will also benefit from it.

Map Data Sources

FIGURE 2f-1: National Land Cover Dataset 2001, NRCS SSURGO soils, National Hydrography Dataset (Plus)

FIGURE 2f-2: National Hydrography Dataset (Plus), National Land Cover Dataset 2001

FIGURE 2f-3: N.C. Natural Heritage Program 2010

FIGURE 2f-4: USDA Forest Service – Forest Biomass across the Lower 48 States and Alaska

References and Sources Cited

Brown, M. J.; New, B. D; Oswalt, S. N.; Johnson, T. G.; and Rudis, V. A. 2006. *North Carolina's Forests, 2002.* Resourse Bulletin SRS-113. Asheville, NC: USDA Forest Service, Southern Research Station.

Ecosystem Marketplace (EM). 2010. Species Banking Information Clearinghouse. Web site: http://www.speciesbanking.com/

Fox, J. and A. Nino-Murcia. 2005. Status of species conservation banking in the United States. *J. of Cons. Bio. 19* (4): 996-1007.

U.S. Census Bureau. 1996. *North Carolina's Population Projections: 1995 to 2025*. State Populations Ranking Summary, Population Paper Listing 47, Population Electronic Product 45. Washington, DC: Population Division. Online: http://www.census.gov/population/projections/state/9525rank/ncprsrel.txt

U.S. Fish and Wildlife Service (USFWS). 2003. Guidance for the establishment, use, and operation of conservation banks. Memorandum. Washington, DC: U.S. Department of the Interior, USFWS. Online: http://www.fws.gov/Endangered/pdfs/MemosLetters/conservation-banking.pdf

USFWS. 2010. Endangered and threatened species of North Carolina. Raleigh, NC: USFWS, Raleigh Ecological Services Field Office. Online: http://www.fws.gov/raleigh/es_tes.html