Forest Resource Conditions

Distribution and Abundance of Forests

Most of the information for this section was summarized from data collected through the Forest Inventory and Analysis (FIA) Program of the U.S. Forest Service. Through data collection on permanently established field plots, FIA reports on status and trends in forest area and location; in the species, size, and health of trees; in total tree growth, mortality, and removals by harvest; in wood production and utilization rates by various products; and in forest land ownership. Data was incorporated from two sources - the USDA Forest Service's Forest Inventory EVALIDator (Miles 2009) and Tennessee's FIA Urban Forestry Pilot Study (TDF 2009). In Tennessee, the FIA program is a partnership between the USDA Forest Service and the Tennessee Department of Agriculture Division of Forestry (TDF).

Forestland Area Change

Tennessee's forests cover an estimated 13.98 million acres or 53 percent of the state (Table 1). In 1999 forests covered an estimated 13.85 million acres, an increase of approximately 247,000 acres since 1989. The gain of an estimated 135 thousand acres of forest land since 1999 represents less of an increase as compared to the historical trend of increasing forestland since 1971. Forestland in Tennessee has comprised about one half of the state's 26 million acres of land since before 1961. Since 1961, Tennessee's forests have increased slightly, from an estimated low of 50 percent in the 1970's to an estimated 53 percent in the 2007 inventory. Ninety-six percent (13.45 million acres) of the forestland is considered timberland. Timberland is forestland that is capable of producing 20 cubic feet of industrial wood per acre per year and is not withdrawn from timber utilization.

Table 1. Area by land class (thousand acres)

Land class	1961	1971	1980	1989	1999	2007
Timberland	13,432.4	12,819.8	12,879.0	13,265.2	13,459.2	13,450.3
Other/reserved	263.5	316.5	429.5	337.3	390.3	534.5
Total forest	**13,695.9**	**13,136.3**	**13,308.5**	**13,602.5**	**13,849.5**	**13,984.8**
Nonforest land	12,826.2	13,338.6	13,141.6	12,844.5	12,511.4	12,319.7
Total land area	**26,522.1**	**26,474.9**	**26,450.1**	**26,447.0**	**26,360.9**	**26,304.5**
Percent forested	**52**	**50**	**50**	**51**	**53**	**53**

total may not sum due to rounding; total land area estimate changed slightly over time due to improvements in measurement techniques and refinements in classification of small bodies of water and streams.

Forest Distribution

The Cumberland Plateau and West-Central Tennessee contain the most forested areas within the state. Of 95 Tennessee counties, 51 are estimated to be > 50 percent forested and 15 counties > 75 percent forested (Figure 1). The Cumberland Plateau unit contains the greatest number of counties with 75 percent or more of the land forested. Six counties are estimated to be < 25 percent forested and are mostly located in the western portion of the state where agriculture heavily dominates the landscape.

Ownership of Timberland

Tennessee timberland remains overwhelmingly in private ownership (Figure 2). Eighty-three percent of timberland in the state is owned by private individuals. An estimated 12 percent of Tennessee's timberland is publicly owned and administered, with 5 percent being managed by the U.S. Forest Service as National Forests and 7 percent held by state, local and other federal agencies. At the time of the 2007 inventory, an estimated 5 percent of Tennessee's forests were owned by forest industry. However, recent and ongoing divestments by forest industry will result in a significant amount of industry land being transferred to other public and private ownerships.

Figure 1. Percentage of land in forest by county

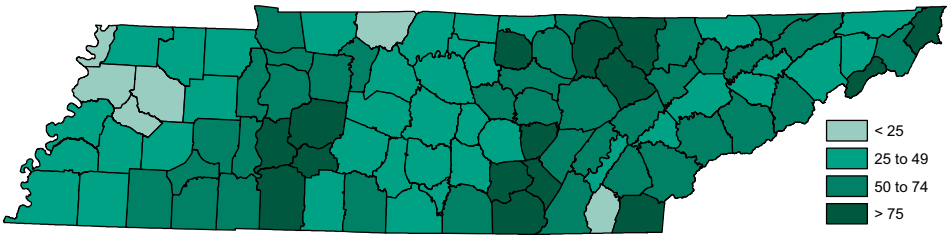
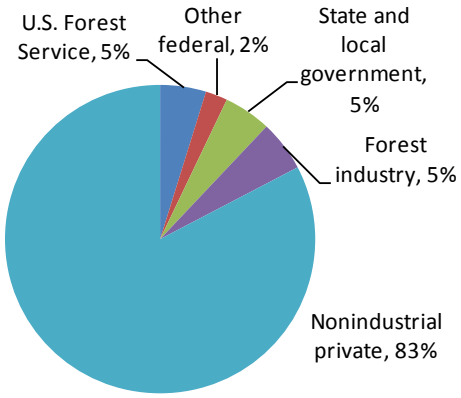


Figure 2. Ownership of timberland (2007)



Forest Composition

Forest types are used to describe assemblages of trees that occur on the landscape. Including yellow-poplar dominated stands, the oak-hickory (Quercus spp. – Carya spp.) forest type accounts for an estimated 74 percent (9.8 million acres) of the timberland in Tennessee (Figure 3). The loblolly-shortleaf pine type accounts for only 7 percent and mixed stands of the oak-pine type account for an estimated 7 percent of timberland in Tennessee. Bottomland hardwoods (Elm-ash-cottonwood and oak-gum-cypress types), in West Tennessee, account for about 7 percent of the timberland. Eastern redcedar and maple-beech-birch each accounts for an estimated 2 percent of timberland. Eastern white pine, including eastern hemlock, accounts for 1 percent of the timberland.

The most significant changes in forest types since 1999 have been an increase in oak-hickory and a decrease in pine/hardwood pine types (Figure 4). These changes are most likely due to impacts from southern pine beetle infestations that occurred in the late 1990's and early 2000's. Increases in maple-beech-birch forest types do not reflect true change and are associated with definitional adjustments within the FIA program.

Figure 3. Forest type composition of timberland (2007)

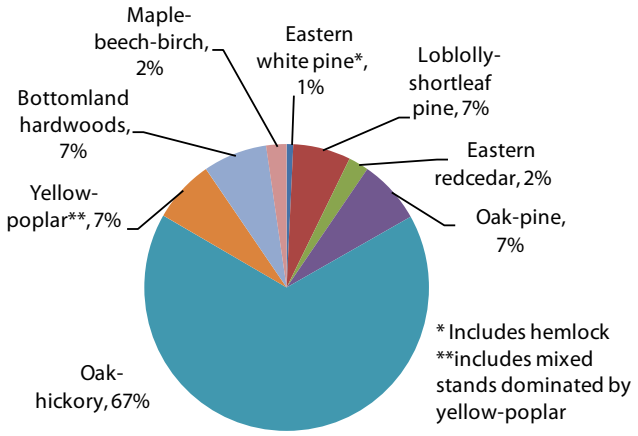
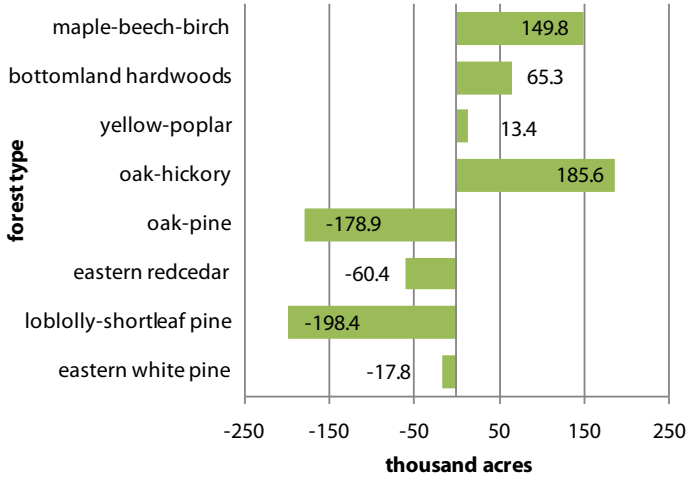


Figure 4. Changes in forest type timberland acres (1999-2007)



Stand-Size Class and Stand-age Class Distributions

Stand-size class distribution provides an indicator of the average tree size in a stand. Sawtimber sized trees are 9 inches diameter breast height (d.b.h.) or greater for softwoods and 11 inches d.b.h. or greater for hardwoods. Poletimber sized trees are 5 inches d.b.h. up to sawtimber size. Seedling/saplings are trees less than 5 inches d.b.h. The number of acres in sawtimber has steadily increased since the 1989 inventory. The 2007 inventory estimates 8.6 million acres of timberland are in the sawtimber stand-size class (Figure 5). Since 1989, timberland acreage has been constantly recruiting from small stand-size classes into larger classes. As a result, the number of acres in the sapling/seedling stand-size class decreased from an estimated 2.4 million acres in 1989 to 1.8 million acres in 2007. Essentially, this represents a loss of habitat available to early successional dependent fauna as the Tennessee forest resource ages.

Stand-age class estimates the average age of individual forest stands. Stand-age class distributions developed from stand ages provide information to determine landscape level forest age structure. In 1999, an estimated 45 percent of Tennessee's timberlands were greater than 50 years old (Figure 6). In 2007, 58 percent of Tennessee's timberlands were greater than 50 years old, indicating an aging forest resource. This trend is consistent with stand-size class distributions that indicate increasing amounts of sawtimber sized trees.

Figure 5. Area of timberland by stand-size class over three decades

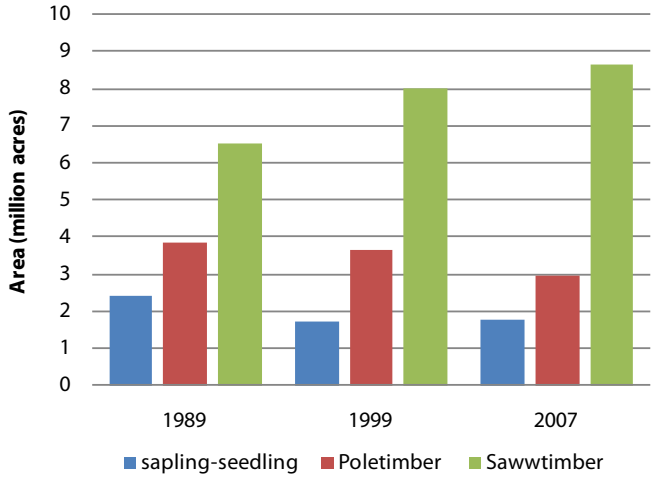
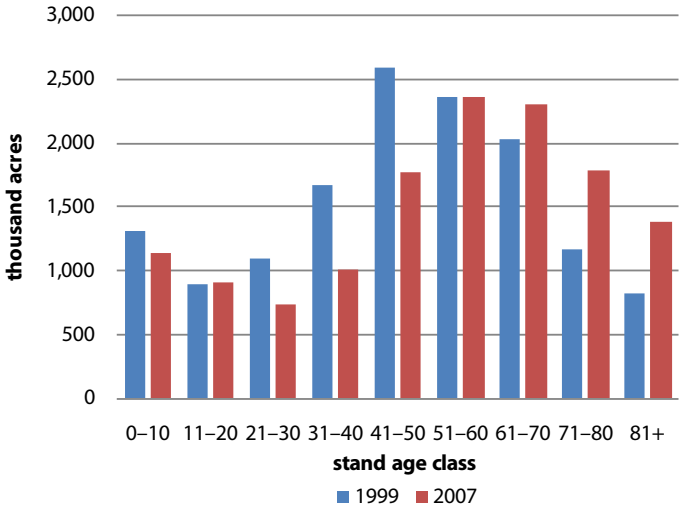


Figure 6. Area of timberland by stand-age class



Tree Volume

All live tree volume has increased slightly from 25.5 billion cubic feet following the 1999 inventory to 27.0 billion cubic feet in 2007. All live tree volume trends from 1999 to 2007 reflect a similar trend as that indicated by stand-size class. Live tree volume is recruiting from smaller diameter classes into larger diameter classes (Figure 7). The peak in the distribution is shifting to larger diameter classes, indicating an aging forest resource. The second peak at the tail of the distribution is a result of clumping all live tree volume greater than or equal to the 22 inch diameter class.

Stand Origin

An estimated 672,000 acres of timberland originated from planted stands (Figure 8). This represents an increase of 158,000 acres from an estimated 513,000 acres following the 1999 inventory. The majority of increase in planted acres occurred in west Tennessee. Most of Tennessee's timberlands (95%) have been established through natural regeneration processes.

Figure 7. Volume of all live trees on timberland, by diameter class and survey

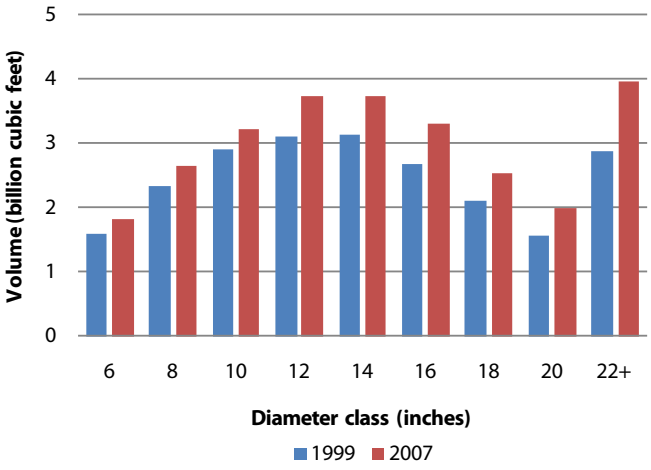
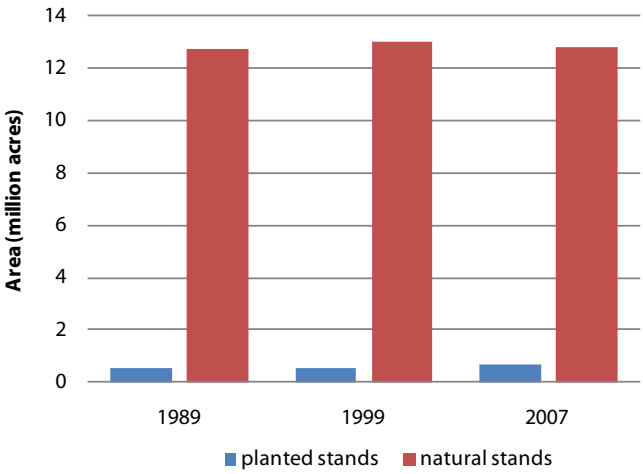


Figure 8. Stand origin of timberland



Growth, Removals and Mortality

Average annual net growth decreased from 843 million cubic feet during the period between 1989 and 1999 to 792 million cubic feet during the period between 1999 and 2007. Hardwood average annual net growth increased from 690 million cubic feet to 725 million cubic feet between 1999 and 2007, whereas softwood average annual net growth decreased from 154 million to 67 million cubic feet (Figure 9). Net growth to removal ratios remain positive for hardwoods (1.9 million cubic feet of growth for every 1 million cubic feet removed) and have become negative for softwoods. Concurrently, average annual mortality, while remaining about level for hardwoods, increased for softwoods. Impacts to softwood mortality and growth are not evenly distributed across the state. Non-industrial private forest landowner investments in pine plantations have resulted in an increase of pine forest types in the western region of the state. Conversely, the southern pine beetle (SPB) outbreak during the late 1990s and early 2000s in east Tennessee killed pine stands at a landscape scale, resulting in a statewide loss of pine resource. Regardless, removals and mortality remains a very small portion of the total volume of all live trees (Figure 10).

Figure 9. Average annual net growth, mortality, and removals of all live trees on timberland

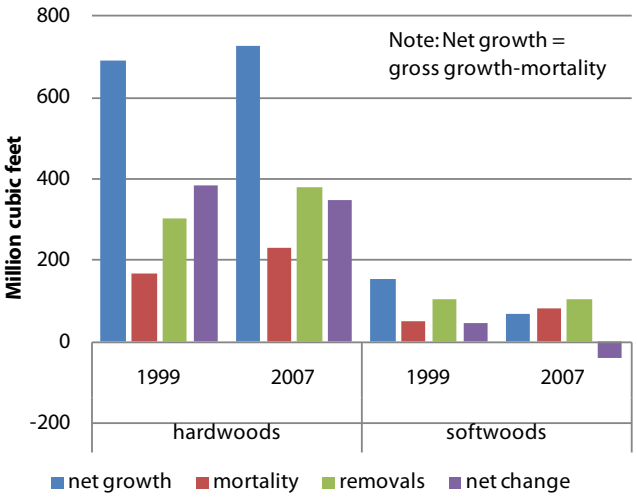
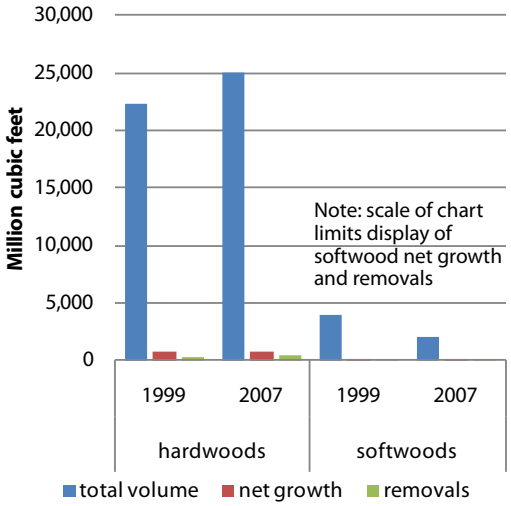


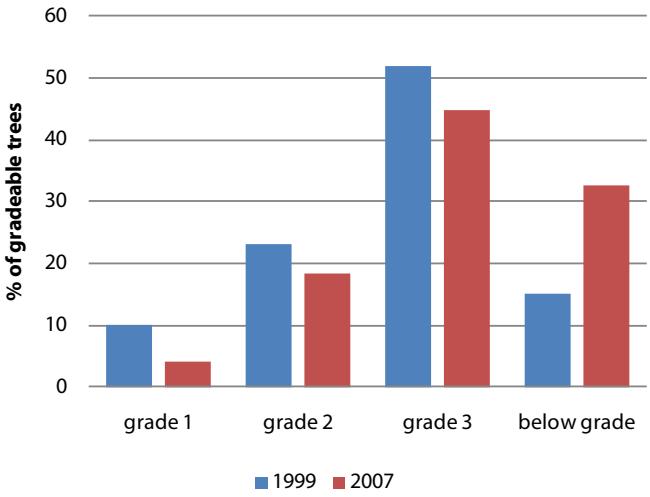
Figure 10. Total volume, average annual net growth and removals of all live trees on timberland



Tree Grade

Tree grade considers the number of defects and straightness in the lower portion of a tree. It is an estimate of quality with tree grade 1 having the highest quality. Higher quality trees produce more defect free lumber. Hardwood tree grade declined from 1999 to 2007. Grade 1 hardwood trees declined from 10 percent to 4 percent (Figure 11). Grade 2 hardwood trees declined from 23 percent to 18 percent. Grade 3 hardwood trees declined from 53 percent to 45 percent. Below grade hardwood trees increased from 15 percent to 33 percent. Decline in tree grade is most likely tied to past cutting practices and reflects the need for better implementation of hardwood forest management practices.

Figure 11. Change in tree grade on timberland



Urban / Suburban Managed Forest

Condition

Urban forests broadly include urban parks, street trees, landscaped boulevards, public gardens, river and coastal promenades, greenways, river corridors, wetlands, nature preserves, natural areas, shelterbelts of trees and working trees at industrial brownfield sites within urban areas.

Historically, the focus of urban forestry was on the public tree resource, or the trees that were growing in parks, along street right of ways, and other public venues. Inventories of these forests are primarily conducted by local governments who have a responsibility to plant, maintain, and remove trees from their public areas. Within the last 5 years, TDF has facilitated such inventories and management plans in Clarksville, Cookeville, Bristol, Chattanooga, Kingsport, Johnson City, Sweetwater, Crossville, Franklin, Knoxville and Livingston. Funding for these inventories was provided through grants from the USDA Forest Service.

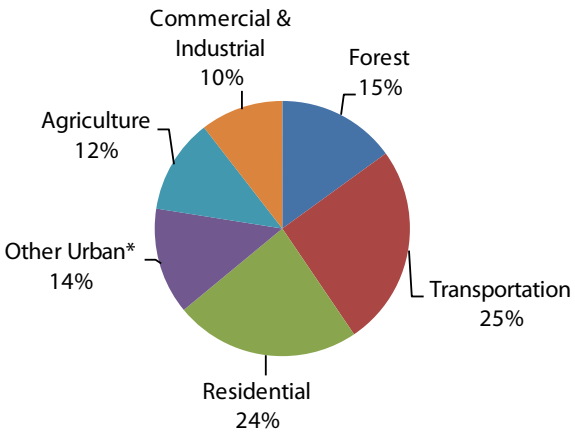
Within the last 2 decades the trend is to include private trees in the maintained environment, stands of trees that have characteristics of a forest, and the traditional public tree resource as part of a comprehensive urban forest. This led Tennessee to partner with the USDA Forest Service and undertake a pilot urban Forest Inventory and Analysis (FIA) project to collect data on Tennessee's urban forests (TDF 2009).

The urban FIA study (2005-2009) established 259 sample plots across the state in areas that met the Census Bureau's definition of urban. Tree data collected included species, trunk and crown sizes, and various tree condition factors. The land use classification of sample plots was also recorded. Some of the preliminary results are included below.

Land Use

According to the urban FIA inventory data, Tennessee has 1.6 million acres of urban lands with a total of 284,116,000 trees. Transportation and residential are the most prominent land uses within these urban forest acres, followed by forest (Figure 12).

Figure 12. Urban land use distribution (2009)



*Other Urban includes vacant, park, cemetery, golf course, institutional and water/swimming pool.

Species

Table 2 lists the species frequency as indicated from the urban FIA inventory by transportation, residential and commercial/industry land uses.

The species mix indicated by this study confirms some beliefs held by urban foresters, but also points out a few surprises. The prevalence of Eastern redcedar, hackberry, dogwood, sugar maple and other native trees from wooded environments is expected to be found in the urban environment. However, the extent of Virginia pine is surprising because it is rarely seen in the built urban environment. The absence of oaks is also some what surprising; given their relative abundance in Tennessee's rural forests and their desirability as a large shade tree. There is a common perception that Bradford pear and its parent species callery pear is an extensive urban tree, but the data indicates that it is still a minor component of the urban forest.

The abundance of non-native privet and honeysuckle indicate a developing problem of invasive species in the urban forest. Usually planted as shrubs in the landscape, these species are prolific seed producers and their fruits are desirable to a variety of bird species. As a result, these shrub species have readily spread and are now being found in a variety of urban habitats. Additionally, these shrub species have the potential to grow into small trees, which is why they are counted as trees in this inventory.

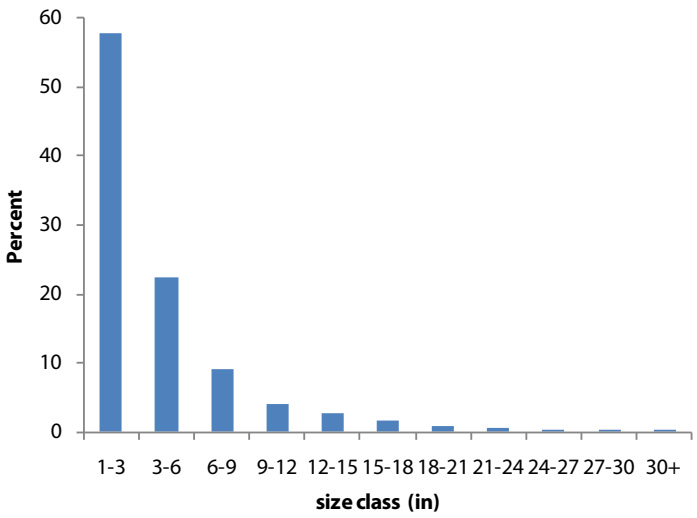
Table 2. Species frequency by land use in urban areas

Transportation		Residential		Commercial/Industry		All Land Uses	
species	**percent**	**species**	**percent**	**species**	**percent**	**species**	**percent**
Virginia pine	18.3	Virginia pine	13.0	Hawthorn	25.0	Chinese privet	10.5
Dogwood	10.1	Amur honeysuckle	11.7	Mimosa	16.3	Virginia pine	6.0
Eastern redcedar	8.2	Dogwood	10.4	Eastern redcedar	9.4	Eastern redcedar	6.0
Chinese privet	7.1	Redbud	4.9	Sweetgum	9.4	Hackberry	5.2
Black gum	6.0	Hackberry	4.9	Slippery elm	8.8	Dogwood	4.9
Yellow buckeye	4.9	Chinese privet	4.3	Sweet cherry	8.1	Amur honeysuckle	4.6
Sugar maple	4.2	Sugar maple	4.3	Hackberry	4.5	Winged elm	3.3
Redbud	3.6	Boxelder	3.2	Siberian elm	3.2	Red maple	3.3
Callery pear	2.9	Ligustum - other privet	3.2	Loblolly pine	3.2	Black gum	3.1
Mockernut hickory	2.9	American elm	2.9	Redbud & Sugar maple (tie)	1.9 ea	American beech	3.1

Size

Figure 13 indicates the tree/shrub diameter distribution across all land uses within Tennessee's urban forests. Tree sizes were grouped into three inch d.b.h. (diameter breast high) size classes. This diameter distribution is fairly normal across the various sizes and is typical for a tree population within an urban forest. Size data is also consistent with species data, in that Privet, the most common species, is also a small tree/large shrub, rarely growing more that 4 inch d.b.h. and 25 feet tall.

Figure 13. Percentage of tree/shrub size class in urban areas of Tennessee



Health

FIA's system uses the term damage to identify various components of a tree's health. The findings of damage from the urban FIA inventory are outlined in Table 3.

Table 3. Percentage of tree damage in urban areas by type

Type of Damage	*percent of all trees*
Included bark	9.3
Vines	7.6
Canker/decay (trunk/limbs)	4.9
Wounds/cracks (trunk)	4.5
Dying top	3.8
Dead top	1.6
Defoliation	1.1
Topping/poor pruning	1.3
Chlorotic/Necrotic (foliage)	0.6
Root/stem girdling	0.5
Borers and/or bark beetles	0.5

From the data, it appears that 1 in 11 trees (9.3 percent) have included bark. Since included bark can be a structural defect, this may indicate a fairly sizeable component of the urban tree population is at risk for storm damage. However, some species, such as American elm (#10 tree in residential category), tend to have included bark and still maintain most of their structural strength. Additional review of the data needs to be completed to determine the true extent of the risk.

Damaging vines occurred on 7.6 percent of the trees observed. Vines are considered a potential health problem in trees because a mature vine that spreads across a tree's crown can take a significant amount sunlight away from the tree, resulting in less vigor/more stress, thereby leading to more susceptibility to insects, diseases, or abiotic problems.

The combined categories of wounds/cracks and canker/decay (9.4%) occurred as frequently as included bark (9.3%). There is a high probability that wounds/cracks will develop decay in the future, indicating that general health and condition for almost 1 in 11 trees is progressively declining. These problems also indicate a lost of structural strength, meaning trees with these damages are more susceptible to storm damage.

Dead or dying tree tops were observed in 5.4 percent of the trees evaluated. This seems like a relatively small proportion of the trees in our urban forests but these problems, due to the potential for falling material to strike people and property, can constitute a significant hazard. If the data on dead or dying tops can be separated by maintained and non-maintained land use, then a more detailed assessment of hazard could be made, providing valuable information to help mitigate risks to visitors and inhabitants of our urban forests.

In addition to the above findings, the data shows 2.0 percent of the trees had overhead wires present, 0.3 percent had root/sidewalk conflict, 0.3 percent showed evidence of improper planting, and 0.1 percent showed excessive mulch.

Additional analysis of the Tennessee Urban Forestry FIA pilot study data is currently underway and may provide further insight on other potential urban forest health issue.

Urban Tree Canopy Cover

While rural forests produce wood and other benefits, urban forests produce canopy. Tree canopy provides many benefits, including energy savings, air quality improvement, storm water mitigation, and other benefits not quantifiable, such as health and well being.

To determine the extent of canopy in Tennessee's urban forests, TDF urban forestry staff completed a statewide review of urban tree canopy. This study consisted of a review of 259 aerial photos of the area around the urban FIA plots. Each photo was analyzed for both canopy and percent of development. The results are shown in Table 4.

As expected, the data indicated a general inverse correlation between canopy cover and developed area (more canopy, less development). There were a few plots with high percentages of each or low percentages of each. Also, this study indicates that even our most urban and suburban counties could still experience a significant amount of development with an accompanying potential loss of canopy.

References:

Miles, P. D. Jul-30-2009. Forest Inventory EVALIDator web-application version 4.01 beta. St. Paul, MN: USDA Forest Service, Northern Research Station [Available only on internet: http://fiatools.fs.fed.us/Evalidator4/tmattribute.jsp].

Tennessee Department of Agriculture Division of Forestry (TDF) and USDA Forest Service. 2009. Urban Forest Inventory Analysis Pilot Study [dataset].

Table 4. Percent of canopy and development within the urban FIA study plots

County	# urban plots	% canopy	% developed
Shelby (Memphis)	42	30	55
Davidson (Nashville)	31	25	61
Knox (Knoxville)	26	32	47
Hamilton (Chattanooga)	26	55	36
next 8 largest counties*	64	30	44
all other	70	34	40
Total urban plots	**259**	**33**	**47**

* *Rutherford, Sullivan, Sumner, Williamson, Montgomery, Blount, Washington, and Madison*

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Ecological Regions and Forest Ecosystems

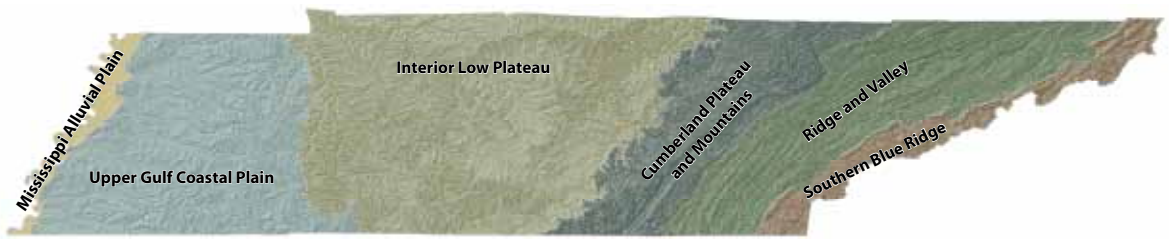
Ecological Regions of Tennessee

Six major terrestrial ecological regions occur across Tennessee (Figure 14). From west to east, these regions include: the Mississippi Alluvial Plain, the Upper Gulf Coastal Plain, the Interior Low Plateau, the Cumberland Plateau & Mountains, the Ridge & Valley, and the Southern Blue Ridge. The names and boundaries of these regions were adapted from an early scheme developed by the U.S. Forest Service and further modified by The Nature Conservancy (Bailey 1994; Keys et al. 1995). Descriptions of these major ecological regions are presented in the following sections and include partial descriptions of respective subregions.

Mississippi Alluvial Plain - MAP

Tennessee's western boundary is formed by the Mississippi River. Alongside the main body of this river lies a floodplain known as the Mississippi Alluvial Plain. Over the millennia, lateral migrations of the river have created numerous oxbow lakes, meander scars, and natural levees. Much of the area periodically floods although artificial levees have been constructed to reduce this flooding. In Tennessee, the MAP consists primarily of alluvial soils. To the east, the floodplain is bound by the loess soils of the Chickasaw Bluffs. The Chickasaw Bluffs rise about 100 feet above the MAP. Much of the floodplain lies over a portion of the New Madrid Fault, which created the great earthquake of 1811-1812 that shook the entire eastern U.S., and formed the 33,000-acre Reelfoot Lake in the northwest corner of Tennessee (Nuttli 1973).

Figure 14. Ecological Regions of Tennessee



Most of the region is in cropland, with isolated areas of deciduous forest. The MAP is known for its bottomland hardwood swamps. Swamp forests occur in areas with standing water present most of the year, typically in the oxbow lakes. Other types of wetlands are also frequently a prominent landscape feature. Bald cypress and water tupelo are usually the dominant trees in permanently flooded areas. Areas flooded during the winter and early spring support a diverse forest dominated by red maple, sweetgum, water hickory, and many species of mesophyllic oaks. Cane often occurs in the understory of the seasonally flooded forest. Dominant trees on the highest, rarely flooded sites include American beech, American elm, sweetgum, a variety of oaks, and shagbark hickory. Forested wetlands, including permanently flooded cypress and tupelo, periodically flooded bottomland hardwoods, and periodically flooded streamside (riparian) forests, are common in the MAP and West Tennessee.

Upper Gulf Coastal Plain - UGCP

The Upper Gulf Coastal Plain is located between the Chickasaw Bluffs on the west and the Tennessee River on the east. This area's undulating terrain gradually increases in elevation moving eastward. The UGCP is comprised of six distinct subregions: the Loess Plain, the Loess Hills, the Clay Hills, the Northern Pontotoc Ridge, the Upper Loam Hills, and the Transition Loam Hills.

In the Loess Plain and Loess Hills, rivers and creeks have created broad floodplains with many of the same wetland features and vegetation as in the MAP. In Tennessee, row crops are the dominant land use. Oak-hickory and southern floodplain forests are the natural vegetation types, although most of the forest cover has been removed for cropland. Some less-disturbed bottomland forest and cypress-gum swamp habitats still remain. Several large river systems with wide floodplains; the Obion, Forked Deer, Hatchie, Loosahatchie, and Wolf, cross the region. Other subregions are a mosaic of cropland, pasture, woodland and upland hardwood forest with the predominant trees being oaks and hickories. While oak-hickory is the general forest type, some of the undisturbed bluff vegetation is rich in mesophytes, such as beech and sugar maple, with similarities to hardwood forests of eastern Tennessee (TNWPC 2000 and Griffith et al. 1997). Southern red oak is dominant on drier upland sites and white oak, often in association with yellow-poplar and sweetgum, is dominant on more mesic sites. Hickories are common throughout the area. There are also many maples, beeches, and birches. Small populations of eastern redcedar, yellow-poplar and yellow pines can be found along with dogwoods and redbuds. Shortleaf pine occurs on sandy soils of the uplands. The average elevation for the region is approximately 492 feet with some hills near the Tennessee River reaching over 705 feet. The Blackland Prairie, extending north from Mississippi, is a flat to undulating lowland region entirely within a small portion of McNairy County, Tennessee. The natural vegetation was sweetgum, post oak, and redcedar, along with patches of bluestem prairie. Today, the area is mostly in cropland and pasture, with small patches of mixed hardwoods. The Transition Loam Hills have the highest elevations in this ecoregion, containing characteristics of both the UGCP and the Interior Low Plateau, and is a mostly forested region of oak-hickory-pine with pine plantations associated with pulp and paper operations (TNWPC 2000 and Griffith et al. 1997).

Interior Low Plateau - ILP

The Interior Low Plateau is composed of two primary areas, the Central Basin and the Highland Rim, which are further divided into six distinct subregions. The Central Basin is an elliptically shaped depression measuring about 120 miles long by 60 miles wide covering an area of 8,600 square miles (Miller 1974). It is oriented nearly north/south and encircled by the Highland Rim. The Central Basin lies in the heart of Middle Tennessee. There are two parts, the Inner and the Outer Basin. The Outer Basin is made up of knobs, narrow ridges and dissected landscape. The Inner Basin is flat with some gently rolling hills dominated by eastern redcedars and hardwoods interspersed with openings of exposed limestone that underlies one of Tennessee's most unique ecosystems, the Limestone Cedar Glades. The average elevation of the Inner Basin is 590 feet. The Outer basin has an average elevation of 754 feet, with a few hills in the southern portion reaching elevations of approximately 1,250 feet. The Central Basin was created as resistant siliceous limestone was breached and soluble limestone was removed. Poor surface drainage, shallow soils, and other karst features such as caves, sinkholes, and underground drainages are common in the Inner Basin. The Outer Basin has much greater relief with rolling hills and narrow ridges. It has deeper phosphoric soils that prior to settlement supported significantly diverse hardwood forests.

The Outer and Inner Basins support forest communities containing mixed mesophytic species such as

yellow-poplar, beech, northern red oak, yellowwood, shagbark hickory, sugar maple, Kentucky coffeetree, pawpaw, bladdernut, spicebush, and flowering dogwood in the ravines, lower terraces and north facing slopes. Dry ridges are often remnants of the Highland Rim and support acid loving species like sourwood, blackgum, blueberry species, oaks and hickories. Dryer limestone sites and south facing slopes of the Outer Basin resemble Inner Basin forests comprised of eastern redcedar mixed with hardwoods and pure stands of eastern redcedar. Deciduous forest with pasture and cropland are the dominant land covers. The region's limestone rocks and soils are high in phosphorus, and commercial phosphate is mined. The limestone cedar glades, a unique mixed grassland/forest vegetation type with many endemic species, are located primarily in the Inner Basin (TNWPC 2000 and Griffith et al. 1997).

The Highland Rim encircles the Central Basin, and stretches from the Tennessee River in the west to the Cumberland Plateau in the east. The Highland Rim is broken into 4 distinct subregions: the Eastern Highland Rim, the Western Highland Rim, the Northern Highland Rim, and the Pennyroyal Plain. Collectively, these subregions represent remnants of an ancient massive dome that eroded. The Highland Rim today is characterized as an upland area heavily dissected by river and creek valleys. In general, the Highland Rim's elevation approaches 1000 feet, being somewhat higher in the Eastern Highland Rim section than in the more expansive Western Highland Rim. The Pennyroyal Plain and Northern Highland Rim sections extend southward from Kentucky into northern Middle Tennessee. Underlain with limestone, the Highland Rim entails an extensive area of karst topography and cave development, especially on the eastern and northern sections.

The Highland Rim is covered with rich oak/hickory/yellow-poplar forests with many woodland streams. The native oak-hickory forests of the Western Highland Rim were removed over broad areas in the mid-to late 1800's in conjunction with the iron-ore related mining and smelting of the mineral limonite, however today the region is again heavily forested. Species of these forests include white, black, and chinkapin oaks, yellow-poplar, beech, hickory and sugar maple. Natural vegetation in the Eastern Highland Rim is transitional between the oak-hickory forests to the west and the mixed mesophytic forests of the Appalachian ecoregions to the east (TNWPC 2000 and Griffith et al. 1997). Swamp forests including pin, overcup, willow, water and swamp chestnut oaks, red maple, sweet gum and black gum occur on poorly drained soils. Extensive nearly flat areas occur in a karst plain in the northern edge of the Pennyroyal Plain and in an area known as the "Barrens" in the Eastern Highland Rim. The Eastern Highland Rim Barrens and former prairie areas are now primarily oak thickets, pasture or cropland. Most of the Pennyroyal Plain is cultivated or in pasture. The natural vegetation consisted of oak-hickory forest with mosaics of bluestem prairie (TNWPC 2000 and Griffith et al. 1997). The vegetation of these Barrens is floristically similar to mid-western prairies that were dominated by big bluestem, little bluestem, Indian grass, switchgrass, and many forbs (Carman 2001).

Cumberland Plateau & Mountains - CPM

The Cumberland Plateau & Mountains region is separated from the ILP by an irregular escarpment. The region cuts diagonally across Tennessee a length of about 140 miles and on average is about 40 miles wide. The CPM stretches from northern Alabama to West Virginia, and represents a western extension of the Southern Appalachian Mountain chain.

The southern portion of this region in Alabama and Tennessee is the "true" plateau section with gently rolling uplands averaging 1500 to 1800 feet in elevation. Along both sides of the Cumberland Plateau are deep gorges known as "gulfs," the deeper being where the Tennessee River cuts through the Cumberland Plateau near Chattanooga. Lookout Mountain, Raccoon Mountain, Signal Mountain, and Walden's Ridge are all fingers of the Cumberland Plateau. Short Mountain and Cardwell Mountain are erosional remnants separated from the Cumberland Plateau proper by several miles.

The northern portion of the region in Tennessee is where the Cumberland Mountains terminate. The topography of this section is quite complex with a lesser mountainous region known as the Black Mountains protruding from Kentucky and Virginia. The entire area is characterized by rugged terrain and elevations ranging up to 3,500 feet on Cross Mountain. The Cumberland Plateau envelops the Cumberland Mountains section to the west and southwest and proceeds southward to Alabama. One of the most unique features of the plateau is the Sequatchie Valley. On the southern reaches of the Cumberland Plateau, the Sequatchie Valley

separates Walden's Ridge from the Cumberland Plateau. This feature is 1000 feet deep, five miles wide and approximately 70 miles long. At the northern end is the Crab Orchard Mountains created by an anticlinal fault system that eroded away along the rest of its length creating the valley.

Surface rock strata in the Cumberland Plateau have produced varied soils and a wide variety of forest types. The region is forested with some agriculture and coal mining activities. The Cumberland Plateau forests differ widely ranging from the hemlock/basswood/buckeye/yellow-poplar forest found in the cool gorges to the oak/hickory/Virginia pine associations found on dry sandy ridges. The mixed mesophytic forest is restricted mostly to the deeper gorges and escarpment slopes. Out of the gorges but directly below the bluff lines occur almost pure stands of chestnut oaks. Directly above the bluff lines Virginia pine stands dominate the dry rocky soil. The forest on top of the Plateau varies from the yellow-poplar/white oak/ red oak associations of the moister, richer hollows, to the post oak/scarlet oak and hickory stands of the dryer, sandy uplands. The Cumberland Plateau Escarpment is characterized by steep, forested slopes and high velocity, high gradient streams. Local relief is often 1000 feet or more. The forest types in the ravines and gorges include mixed oak and chestnut oak on the upper slopes, mesic forests on the middle and lower slopes, with hemlock along rocky streamsides and river birch along floodplain terraces. The Sequatchie Valley is similar to parts of the Ridge and Valley, and is an agriculturally productive region, with areas of pasture, hay, soybeans, small grain, corn, and tobacco (TNWPC 2000 and Griffith et al. 1997).

In the Cumberland Mountains the rugged terrain, cool climate, and infertile soils limit agriculture resulting in a mostly forested landcover. Bituminous coal mines were common in the past, and caused siltation and acidification of streams. Within the Cumberland Mountains the high hills and low mountains are covered by a mixed mesophytic forest with areas of Appalachian oak and northern hardwoods (TNWPC 2000 and Griffith et al. 1997). The mixed mesophytic forest occupies most of the slopes, with species composition varying with topography and microclimate. Hemlock is usually confined to ravines, and rhododendrons and mountain laurel often occur in the understory. Dry slopes and ridges often contain oak/pine communities. The oak is usually chestnut oak. Shortleaf, Virginia and sometimes pitch pine stands occur over the shallow, sandy soils over sandstone. The natural vegetation is a mixed mesophytic forest, although composition and abundance vary greatly depending on aspect, slope position, and degree of shading from adjacent landmasses. (TNWPC 2000 and Griffith et al. 1997).

Ridge & Valley - RV

Between the uplands of the Cumberlands and the Blue Ridge Mountains lies the Ridge & Valley. This province extends from the Coastal Plain of Alabama to southwest Virginia. The RV is creased by several parallel ridges running northeast-southwest. These ridges divide the region into 4 recognized subregions: the rolling limestone hills, the sandstone hills, the Holston Valley, and the Bristol Valley.

The RV was formed concurrently with the CPM, as a shallow inland sea which gradually filled with deltaic sediments of marine life. However, unlike the CPM, the RV contains less impervious sandstone. As a result, the limestone valleys eroded more rapidly into the current system of narrow ridges and broad river valleys. The ridges are higher at the north end with Clinch Mountain 2,624 feet and Bays Mountain 3,100 feet. The valley floors slope gently to the southwest from an average elevation of about 980 feet in the north to about 750 feet in the south.

Present-day forests cover about 50 percent of the region. The forests are dominated by oak-hickory-pine forest types with some mesic northern hardwoods. White oak forest, bottomland oak forest, and sycamore-ash-elm riparian forests are also common forest types. Chestnut oak forests and pine forests are typical for the higher elevations of the ridges, with areas of white oak, mixed mesophytic forest, and yellow-poplar on the lower slopes, knobs, and draws (TNWPC 2000 and Griffith et al. 1997). The mixed-mesophytic forest is similar to the nearby Cumberland Mountains and occurs on the northern slopes and in the ravines of the RV. Scattered patches of prairie remnants, barrens, and cedar-pine glades also dot the region. These areas have similar floristic components as other natural grasslands in the state (Martin 1989; DeSelm 1984).

Southern Blue Ridge - SBR

The eastern-most portion of Tennessee is characterized by the southern reaches of the Appalachian mountain chain that runs in a northeast-southwest direction. The Southern Blue Ridge Mountains between Tennessee and North Carolina form the

highest peaks in the eastern United States at over 6,600 feet elevation. The SBR is characterized by a steep topography that is heavily forested. Valleys tend to be narrow and found only along large creeks and rivers. This geologically complex area is comprised of several mountain ranges: the Iron, Holston, Stone, Unaka, Bald, Great Smoky, and Unicoi mountains. Along the western edge of the SBR region are a series of outlying mountains, generally lower in elevation than those along the North Carolina border: English, Chilhowee, Starr, and Bean Mountains. Also, the SBR contains several isolated limestone valleys at low elevations. The most notable of these are Shady Valley, Bumpass Cove, Wear Cove, Cades Cove, and Tuckaleechee Cove. Overall, the SBR is comprised of two distinct subregions: the Unaka Mountains and the Unicoi Mountains. Some physiographers carve out the Great Smoky Mountains as a third central region.

These Southern Blue Ridge Mountains were created during the Appalachian orogeny. The SBR is part of the oldest land mass in eastern North America, which has not been affected by marine submersion or continental glaciation (Miller 1974). These mountains are composed of ocean sediment laid down millions of years ago that thrust upward as the huge tectonic plates supporting Africa collided with the North American plate. Land was forced up and over, folding and buckling to form the mountain ranges. These mountains have undergone continuous erosion over the last 180 million years. Rainfall in the region is 40 -100 inches per year.

The SBR is one of the richest centers of biodiversity in the eastern United States. It is the most floristically diverse ecoregion of the state (TNWPC 2000 and Griffith et al. 1997). A multitude of forest types occur in the SBR. Lowlands support cove hardwood forests composed of yellow-poplar/sugar maple/ yellow buckeye/and silverbells. Oak/chestnut forests once dominated this forest community until the chestnut blight virtually eliminated the American chestnut. Today the mixed oak and Appalachian oak forest has replaced the oak/chestnut forest. Hemlock forests are found at slightly higher elevations. In association with the hemlock, hydrangea, blackberry, and doghobble can be found in the understory. Northern hardwood forests with yellow birch, beech, and servicberry are usually found above 3000 feet. South-facing slopes support oak/ pine forests. Dryer acidic soils support Virginia pine/ pitch pine/ doghobble/trailing arbutus and mountain laurel. Above 5,500 feet are the "Canadian-like" spruce/fir forests which occur due to the cooler, moister weather. Along this alpine zone, Fraser fir, a Southern Appalachian endemic, and red spruce tower over a mossy forest floor where bluets, trilliums, clintonia, and a host of other herbaceous flowers grow. As well, treeless areas called "balds" are frequently encountered along these ridges. In some places, heath balds occur, with azaleas and rhododendron. Others are grassy balds with approximately 35 different species of grass growing on them. These high elevations have a short summer season.

Urban Micro-Ecological Regions

Urban areas within ecological regions and forest ecosystems have significant differences from the natural settings that surround them. Climate, soils, and species mix have their unique characteristics due to human activity.

Climate

Cities can create their own micro-climates and the heat island effect is well documented. This increase in heat can have a detrimental impact on trees growing in this micro-climate, and therefore influence the selection process toward trees that can tolerate these conditions.

Soils

Urban soils are so sufficiently altered from their native condition that classifying them by standard soil classification systems is futile. Urban soils can be characterized by loss of topsoil which is often removed and sold during construction, compaction from equipment, vehicles and human traffic, impervious surfaces due to paving, incorporated construction materials such as brick or pieces of concrete, and altered pH and lowered fertility.

Species

The urban forest is a mix of natural and human planted forests. Urban areas are dotted with small acreages that mimic the make up and type of forest that surrounds the community. However, the similarity to the surrounding forest ends where the urban landscape begins. The landscape component of the urban forest is artificial in that it is established by hundreds (even thousands) of homeowners, grounds managers and others using a wide variety of species that are chosen for characteristics that meet human needs. The landscape is mixed with lowland, upland, mountain, exotic, wet site, dry site

species, often in the same yard. Adding to the complexity of the tree species mix is grass as a ground cover that can adversely compete for moisture and elements that trees need.

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Characteristics of private forest landowners and their ownerships

Landowner studies conducted in the Western and Cumberland Plateau regions (Mercker 2006; Hoyt 2008) generally concur with statewide results from US Forest Service (Butler 2008). These studies suggest that about 88% of the forest land in Tennessee is in private land holdings (families, partnerships, and forest industry). Of the private ownerships, 94% is owned by families, where there is great diversity in their demographic characteristics. The majority of the landowners (71%) indicated that their forest land was acquired through purchases, as opposed to inheritance or gift. Landowners, on average, are 61 years old and have owned their forest land for 21 years (Table 5). This implies that a considerable amount of forestland will transfer title to new ownerships in the next few decades. Seventy-one percent of landowners in Tennessee claim they intend to retain their land for 15 or more years. Education level among private owners is fairly high, with 68% having some education beyond high school. The preponderance of landowners (85 %) are classified as either retired, professionals, or business or farm owners; less than 10% have blue-collar occupation. A large percent (49%) of tract ownerships fall in the 10 – 50 acre size class and more than two-thirds of the ownerships are less than 100 acres (table 6).

Table 5. Tenure of ownership for West Tennessee forest landowners

Length (years)	% ownerships
Less than 10	23.7
10 to 19	30.3
20 to 29	20.0
30 to 39	12.5
40 to 49	6.1
50 or more	7.4

Table 6. Tract ownership size of Cumberland Plateau NIPF landowners

Tract Size (acres)	% ownerships
Less than 10	3.4
10-50	49.3
51-100	23.0
101-150	10.6
151-200	2.3
201-250	2.2
251-300	1.5
More than 300	7.8

People own forest land for many reasons. Over three-fourths of the landowners indicate that (1) passing the land on to children or other heirs, and (2) scenic enjoyment, were important or very important. The other top five reasons for ownership include (in descending order): to supply food and habitat for wildlife, long-term financial investment, for hunting and fishing, for timber production, and for privacy. Younger landowners are more likely to indicate wildlife, recreation, privacy, and hunting/fishing/recreation as the most important reasons for ownership; while larger ownerships state long-term investment and timber production as most important.

For those landowners with 40 acres or more of forestland, nearly 70 % indicate that they had harvested or cut trees. Of those who had harvested trees, 39 % had used a professional forester to plan, mark, or contract the harvest.

The number of landowners who have received advice or information about their forest land is nearly equally split with 52 % indicating no and 48 % yes. Landowners whom have received advice have: larger ownerships, harvested trees, used a professional forester, participated in government cost-share, and higher education. The most common source of advice is the Tennessee Department of Agriculture Division of Forestry. In west Tennessee it was found that one-in-four landowners with 40+ acres of forest land indicate that they have received cost-share for forestry or wildlife practices in the past. Over half the landowners feel that staying up-to-date with new forestry practices and programs is either important or very important. Over three-fourths of the landowners (78 %) are not aware that their county had formed a county forestry association and only 9 % are members.

Forest landowners have considerable interest in non-timber forest objectives as well. Eighty-two percent (82%) have "some to high interest" in protecting water quality, 78% have "some to high interest" in maintaining forest cover for aesthetics and 66% have "some to high interest" in protecting rare species.

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