USDA

United States
Department of
Agriculture

Forest Service

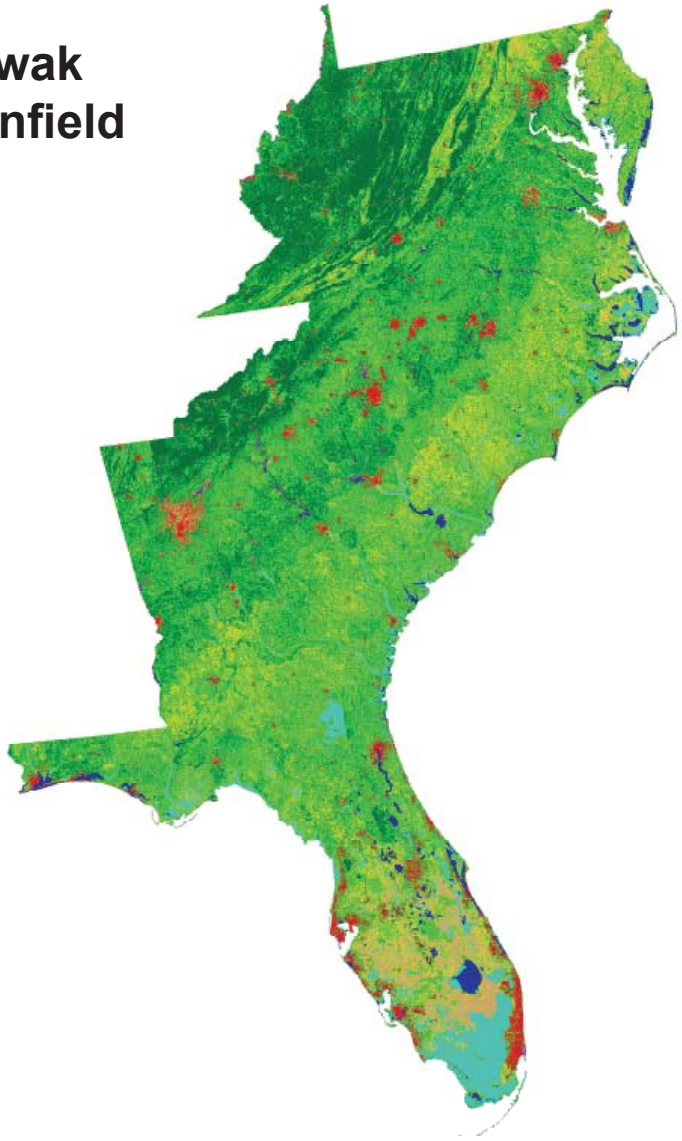
**Northern
Research Station**

General Technical
Report NRS-50

Urban and Community Forests of the Southern Atlantic Region

Delaware
District of Columbia
Florida
Georgia
Maryland
North Carolina
South Carolina
Virginia
West Virginia

David J. Nowak
Eric J. Greenfield



Abstract

This report details how land cover and urbanization vary within the states of Delaware, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, and West Virginia; and the District of Columbia by community (incorporated and census designated places), county subdivision, and county. Specifically this report provides critical urban and community forestry information for each state including human population characteristics and trends, changes in urban and community lands, tree canopy and impervious surface cover characteristics, distribution of land-cover classes, a relative comparison of urban and community forests among local government types, determination of priority areas for tree planting, and a summary of urban tree benefits. Report information can improve the understanding, management, and planning of urban and community forests. The data from this report is reported for each state on the CD provided in the back of this book, and it may be accessed by state at: http://www.nrs.fs.fed.us/data/urban.

The Authors

DAVID J. NOWAK is a research forester and project leader, and ERIC J. GREENFIELD is a research forester with the Forest Service's Northern Research Station at Syracuse, NY.

Manuscript received for publication April 2009

Published by:
U.S. FOREST SERVICE
11 CAMPUS BLVD SUITE 200
NEWTOWN SQUARE, PA 19073

September 2009

For additional copies:
U.S. Forest Service
Publications Distribution
359 Main Road
Delaware, OH 43015
Fax: (740) 368-0152

Visit our homepage at: **http://www.nrs.fs.fed.us/**

Printed on Recycled Paper

CONTENTS

INTRODUCTION

As part of the Forest and Rangeland Renewable Resources Planning Act of 1974, the first national assessment of urban forests was completed in 2000 (Dwyer et al. 2000, Nowak et al. 2001b). This assessment used 1-km resolution Advanced Very-High Resolution Radiometer (AVHRR) data (Zhu 1994) and 1990 U.S. Census Bureau (2007) population and geographic data to assess urban tree cover. The assessment concluded that urban areas in the conterminous United States doubled in size between 1969 and 1994 and covered 3.5 percent of the total land area. Urban areas were estimated to contain approximately 3.8 billion trees with an average tree canopy cover of 27 percent.

To update this first report, higher resolution (30 m) tree canopy and impervious surface cover maps were used (from 2001 Landsat satellite imagery and published in 2007) (Homer et al. 2007, U.S. Geol. Surv. 2007) in conjunction with 1990 and 2000 census and geographic data (1:5,000,000 scale cartographic boundary files) (U.S. Census Bureau 2007) to assess current urban and community forest attributes. These results are being published for each of the lower 48 United States to provide information on urban change and state-specific urban and community forestry data.

This report includes information for the following states: Delaware, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, and West Virginia; and the District of Columbia.

Data are reported for the state, county, county subdivision, and community jurisdictions. The jurisdictional units used in this report are derived from U.S. Census (2007) geographic data and defined legal or statistical divisions. "County"[1] refers to the primary subdivision within states. "County subdivisions" are primary divisions of a county and are statistically equivalent entities for the reporting of census data. They include census county divisions (CCD), census sub areas, minor civil divisions (MCD), and unorganized territories. "Communities" are incorporated and census designated places, and consolidated cities (U.S. Census Bureau 2007). For detailed definitions, see http://www.census.gov/geo/www/cob/cs_metadata.html (2007).

---

[1]The primary legal divisions of most states are termed "counties." In Louisiana, these divisions are known as "parishes." In four states (Maryland, Missouri, Nevada, and Virginia), there are one or more incorporated places that are independent of any county organization and thus constitute primary divisions of their states; these incorporated places are known as "independent cities" and are treated as equivalent to counties for statistical purposes. (For some statistical purposes they may be treated as county subdivisions and places.) The District of Columbia has no primary divisions, and the entire area is considered equivalent to a county for statistical purposes. (http://www.census.gov/geo/www/cob/co_metadata.html, 2007)

REPORT OVERVIEW

The information in this report can aid local and regional managers and planners of urban and community forest resources. This report provides urban and community forest reference information and data from the state to local level on the following attributes related to the urban and community forest resource:

- Human population characteristics and trends
- Urban and community land
- Tree canopy cover characteristics
- Impervious surface cover characteristics
- Classified land-cover characteristics
- Relative comparisons of urban and community forests
- Priority areas for tree planting
- Urban tree benefits

Information in this report can be used by urban and community forestry professionals to:

- Understand general land-cover characteristics and urbanization trends at several geographic scales
- Compare tree canopy cover among similar communities
- Determine areas of greatest growth and areas of highest tree planting priority
- Relate urban and community forests to pollution removal and carbon storage
- Promote more detailed and/or locally appropriate urban and community forest inventories, censuses, or field surveys (e.g., i-Tree – www.itreetools.org)
- Establish local to statewide standards related to urban and community forestry
- Support urban and community forestry programs
- Improve urban and community forest management and planning

The remainder of this section details how information was derived for each attribute reported for the urban and community areas. The subsequent state summaries detail the findings for each state in this region. Most tables for each state are not given in this report, rather they can be found on the CD provided with this report or accessed at: http://www.nrs.fs.fed.us/data/urban.

URBAN FOREST ATTRIBUTES

Human Population Characteristics and Trends

Human population and population density changes over time, and geographic distribution are important measurements of the urban environment because human populations are an integral part of community and urban forest dynamics. Within divisions of state, county, county subdivision, and community, total population, population changes from 1990 to 2000 and population density are detailed based on U.S. Census data (U.S. Census Bureau 2007).

Urban and Community Land

Two geographic definitions overlap: “community” and “urban”. The definition of community is based on jurisdictional or political boundaries delimited by U.S. Census definitions of places (U.S. Census Bureau 2007). Community lands are places of established human settlement that may include all, some, or no urban land within their boundaries.

The definition of urban is based on population density as delimited using the U.S. Census Bureau’s (2007) definition: all territory, population, and housing units located within urbanized areas or urban clusters. Urbanized area and urban cluster boundaries encompass densely settled territories, which are described by one of the following:

- One or more block groups or census blocks with a population density of at least 386.1 people/km^2 (1,000 people/$mile^2$)
- Surrounding block groups and census blocks with a population density of 193.1 people/km^2 (500 people/$mile^2$)
- Less densely settled blocks that form enclaves or indentations, or are used to connect discontinuous areas

More specifically, urbanized areas consist of territory with 50,000 or more people. Urban clusters, a concept new to the 2000 Census, consist of territory with at least 2,500 people but fewer than 50,000 people. This new definition tends to be more restrictive than the 1990 U.S. Census urban definition and encompasses many areas typically considered suburban. The 2000 Census definition of urban was applied to 1990 Census geographic data to analyze change in urban land between 1990 and 2000 (Nowak et al. 2005).

As urban land reveals the more heavily populated areas (population density-based definition) and community land indicates both urban and rural (i.e., non-urban) communities that are recognized by their geopolitical boundaries (political definition), both definitions provide information related to human settlements and the forest resources within those settlements. As some urban land exists beyond community boundaries and not all community land is urban (i.e., communities are often a mix of urban and rural land), the category of "urban or community" was created to understand forest attributes accumulated by the union of these two definitions. The "urban or community" term used throughout this report encompasses both urban land and land in communities.

Percent urban land is a ratio of urban land over total land within a census geographic division, and percent community land is a ratio of community land over total land within the geopolitical unit. In addition, changes in urban land and changes in community land are reported between 1990 and 2000.

For each state, Tables 1 through 4 summarize the population, and urban and community land attributes for the state, communities, county subdivisions, and counties respectively (CD and http://www.nrs.fs.fed.us/data/urban).

Tree Canopy Cover Characteristics

Tree canopy cover is a critical measure of the urban and community forest resource. Tree canopy cover gives a broad indication of the overall forest resource and its associated benefits. To assess urban and community land cover characteristics, the multi-resolution land characteristics consortium's National Land Cover Database (NLCD) was used (Homer et al. 2004, U.S. Geol. Surv. 2007, Yang et al. 2003). The NLCD, released in early 2007, was processed from 2001 Landsat satellite imagery and provides estimates of percentage tree canopy and impervious surface cover within 30-m pixels or cells across the state. The tree canopy percentages in this report are calculated using the land area (not including water) of the geopolitical units derived from the U.S. Census cartographic boundary data and NLCD. In addition to percentage tree cover, four other canopy cover attributes, derived from the same data, were assessed:

- Tree canopy cover per capita—Tree canopy cover (m^2) divided by the number of people within the area of analysis.
- Total green space—Total area minus impervious and water cover (ha). This attribute estimates pervious cover (i.e., grass, soil, or tree-covered areas).
- Canopy green space—Tree cover divided by total green space (percent). This value is the proportion of the total green space that is filled by tree canopies.
- Available green space—Total green space minus tree canopy cover (ha). This value is the amount of grass and soil area not covered with tree canopies and potentially available for planting.

Impervious Surface Cover Characteristics

Similar to tree cover, impervious surface cover provides another piece of valuable information related to the urban environment. Impervious surface cover gives an indication of an area's developed hardscape, which has important influences on urban air temperatures and water flows and also yields information on limitations to urban tree cover. Impervious surface cover also was derived from the NLCD database (U.S. Geol. Surv. 2007). The impervious surface cover percentages in this report are calculated using the land area (not including water) of the geopolitical units derived from the U.S. Census

cartographic boundary data and NLCD. Impervious surface per capita is calculated from NLCD 2001 and U.S. Census data.

For each state, Tables 1, and 5 through 7 summarize the tree canopy and impervious surface cover attributes for the state, communities, county subdivisions, and counties respectively (CD and http://www.nrs.fs.fed.us/data/urban).

Classified Land-cover Characteristics

Land-cover types also are summarized using 2001 Landsat satellite data that were classified with the U.S. Geological Survey land cover categorization scheme based on a modified Anderson land-cover classification (U.S. Geol. Surv. 2007). Land area, tree canopy cover, and available green space within generalized land cover categories vary among communities, county subdivisions, counties, and state. The percentages are calculated from the NLCD 2001 and U.S. Census cartographic boundary data. The land-cover categories defined here are derived from established NLCD 2001 land-cover classes. These generalized land-cover categories or types may not be present in some states.

- Developed—NLCD classes 21 (developed-open space), 22 (developed-low intensity), 23 (developed-medium intensity), and 24 (developed-high intensity)
- Barren—NLCD class 31 (barren land [rock/sand/clay])
- Forested—NLCD classes 41 (deciduous forest), 42 (evergreen forest), and 43 (mixed forest)
- Shrub/Scrub—NLCD class 52 (shrub/scrub)
- Grassland—NLCD class 71 (grassland/herbaceous)
- Agriculture—NLCD classes 81 (pasture/hay) and 82 (cultivated crops)
- Wetland—NLCD classes 90 (woody wetlands) and 95 (emergent herbaceous wetlands)

For each state, Tables 8 through 10 summarize the classified land-cover characteristics for communities, county subdivisions, and counties and state respectively (http://www.nrs.fs.fed.us/data/urban).

Relative Comparisons of Tree Cover

A question commonly asked in evaluating the urban and community forest resource is, "How does my community compare with other communities?"

To help answer this question, tree canopy cover was compared among the counties, county subdivisions, and communities relative to other areas with comparable population density and within the same NLCD mapping unit (ecoregion). For this comparison, seven population density classes were established:

- Density class 1 — 0 to 38.6 people/km^2 (0 to 99.9 people/mile^2)
- Density class 2 — 38.7 to 96.5 people/km^2 (100 to 249.9 people/mile^2)
- Density class 3 — 96.6 to 193.1 people/km^2 (250 to 499.9 people/mile^2)
- Density class 4 — 193.2 to 289.6 people/km^2 (500 to 749.9 people/mile^2)
- Density class 5 — 289.7 to 386.2 people/km^2 (750 to 999.9 people/mile^2)
- Density class 6 — 386.3 to 1931.2 people/km^2 (1000 to 4999.9 people/mile^2) and
- Density class 7 — 1931.3 or greater people/km^2 (5000 or greater people/mile^2)

Mapping zones were delimited within the NLCD to increase classification accuracy and efficiency (Fig. A). The mapping units represent relatively homogeneous ecological conditions (Homer and Gallant 2001). To locate geopolitical units within a mapping zone, centroid (geometric center) points of the local governments were used.

For three or more geographic units in the same mapping zone and population density class, a standardized tree canopy score based on the range of values within that zone and class was assigned to each unit. The standardized score is calculated as:

Standardized score = (tree canopy percent of unit – minimum tree canopy percentage in class)/range of tree canopy percent in class.

Figure A.—The mapping zones of the continental United States relative to states and land cover (NLCD 2001).

Communities, county subdivisions, and counties were assigned to one of the following categories based on their standardized score:

- Excellent—Standardized score of 0.9 to 1.0
- Very Good—0.7 to 0.89
- Good—0.5 to 0.69
- Fair—0.3 to 0.49
- Poor—0 to 0.29

To help understand the variability of tree cover, minimum, median, maximum, and weighted mean values for percent tree canopy cover in each population density class of each political subdivision are reported in Table 11 for each mapping zone (CD and http://www.nrs.fs.fed.us/data/urban). This information can be used to understand the actual range and values used for the assessment.

For each state, Tables 12 through 14 summarize the urban and community forest ratings for communities, county subdivisions, and counties respectively (CD and http://www.nrs.fs.fed.us/data/urban).

Priority Areas for Tree Planting

NLCD (U.S. Geol. Survey 2007) and 2000 U.S. Census data (2007) were used to produce an index that prioritizes tree planting areas for communities, county subdivisions, and counties. An index was developed to help identify areas with relatively low tree canopy cover and high population density (high priority tree-planting areas). This index provides one form of prioritization. States and local governments may design their own prioritization method incorporating individual and diverse value systems. The index used in this report combines three criteria.

- Population density—The greater the population density, the greater the priority for tree planting
- Canopy green space—The lower the value, the greater the priority for tree planting
- Tree canopy cover per capita—The lower the amount of tree canopy cover per person, the greater the priority for tree planting

Each criterion above was standardized[2] on a scale of 0 to 1, with 1 representing the maximum population density and minimum canopy green space and tree cover per capita. The standardized values were weighted to produce a combined score:

$$I = (PD * 40) + (CG * 30) + (TPC * 30)$$

Where I is the combined index score
PD is the standardized population density value
CG is the standardized canopy green space value, and
TPC is the standardized tree cover per capita value.

The combined score was standardized again and multiplied by 100 to produce the planting priority index. The tree planting priority index (PPI) ranks each state's communities, county subdivisions, and counties with values from 100 (highest priority) to 0 (lowest priority). This index is a type of "environmental equity" index with areas of higher human population density and lower canopy green space and tree cover per capita tending to get the higher index value.

For each state, Tables 15 through 17 summarize the tree planting priority index for communities, county subdivisions, and counties respectively (CD and http://www.nrs.fs.fed.us/data/urban).

Urban Tree Benefits

Urban and community forests are important for human and ecological health (Nowak and Dwyer 2007). The benefits ascribed to urban and community trees include:

- Carbon storage and sequestration
- Air pollution removal
- Surface air temperature reduction
- Reduced building energy use
- Absorption of ultraviolet radiation
- Improved water quality
- Reduced noise pollution
- Improved human comfort
- Increased property value
- Improved human physiological and psychological well-being
- Improved aesthetics
- Improved community cohesion

To understand the contribution and magnitude of the forest resource in urban or community areas, the total number of trees, carbon storage and annual carbon uptake (sequestration), air pollution removal, and the associated dollar values for carbon and air pollution benefits are estimated.

Carbon sequestration and storage values were estimated from tree cover (m^2) multiplied by average carbon storage (9.1 kg C/m^2), and sequestration (0.3 kg C/m^2) density values derived from several U.S. communities (e.g., Nowak and Crane 2002). Monetary values associated with urban tree carbon storage and sequestration were based on the 2001-2010 projected marginal social cost of carbon dioxide emissions, $22.8/t C (Fankhauser 1994). The number of urban and community trees was estimated in a similar manner multiplying tree canopy cover (m^2) by average tree density per hectare of canopy cover from several U.S. cities (Table A).

Air pollution removal estimates are derived from the Urban Forest Effects (UFORE) model (Nowak and Crane 2000) and 2000 weather and pollution data (National Climatic Data Center 2000, U.S. EPA 2008). The UFORE model was used to integrate hourly pollution and weather data with urban or community tree cover data to estimate annual pollution removal in each state (Nowak and Crane 2000, Nowak et al. 2006d).

[2]Standardized value for population density (PD) was calculated as PD=(n–min)/r, where PD is the value 0-1, n is the value for the geopolitical unit (population/km^2), min is the minimum value for all units, and r is the range of values among all units (maximum value – minimum value). Standardized value for canopy green space (CG) was calculated as CG=(max–n)/r, where CG is the value 0-1, max is the maximum value for all geopolitical units, n is the value for the unit (tree canopy cover m^2/total green space m^2), and r is the range of values. Standardized value for tree cover per capita (TPC) was calculated as TPC=(max–n)/r, where TPC is the value (0-1), max is the maximum value for all geographic units, n is the value for the geopolitical unit (m^2/capita), and r is the range of values among all units.

Table A.—Average number of trees, carbon storage, and carbon sequestration rates per unit of canopy cover for several U.S. cities

		Carbon	
	Trees	Storage	Sequestration
City	(no./ha cover)	(kg C/m^2 cover)	(kg C/m^2 cover)
Atlanta, GA [a]	751.5	9.7	0.3
Baltimore, MD [a]	598.1	12.3	0.3
Boston, MA [a]	371.7	9.1	0.3
Chicago, IL [b]	618.0	12.9	n/a
Casper, WY [c]	252.8	7.0	0.2
Freehold, NJ [a]	275.0	10.4	0.3
Jersey City, NJ [a]	308.7	4.4	0.2
Minneapolis, MN [d]	245.5	5.7	0.2
Moorestown, NJ [a]	547.9	9.9	0.3
Morgantown, WV [a]	829.6	10.6	0.3
New York, NY [e]	312.0	7.3	0.2
Philadelphia, PA [f]	394.3	9.0	0.3
San Francisco, CA [g]	468.1	12.3	0.3
Syracuse, NY [h]	583.1	10.5	0.3
Oakland, CA [i]	570.0	5.2	n/a
Washington, DC [j]	423.4	10.4	0.3
Woodbridge, NJ [a]	557.3	8.2	0.3
Mean	476.9	9.1	0.3

[a] Unpublished data analyzed using UFORE model
[b] Nowak 1994a,b
[c] Nowak et al. 2006a
[d] Nowak et al. 2006b
[e] Nowak et al. 2007a
[f] Nowak et al. 2007b
[g] Nowak et al. 2007c
[h] Nowak et al. 2001a
[i] Nowak 1993; Nowak and Crane 2002
[j] Nowak et al. 2006c

To estimate pollution by urban trees in each state, state pollutant flux rates (grams of pollution removal per square meter of canopy per year) were derived from a study of national pollution removal by urban trees for the year 1994 (Nowak et al. 2006d). As pollution concentrations vary through time, the 1994 flux rates were adjusted to 2000 values based on average regional pollution concentration changes between 1994 and 2000 (U.S. EPA 2003). As

flux rate = deposition velocity $*$ pollution concentration,

the ratio of the pollution concentration between years was used to update the flux rate. Arithmetic mean concentration values were used for nitrogen dioxide, particulate matter less than 10 microns, and sulfur dioxide, 2nd Max. 8-hr average for carbon dioxide, and 4th Max. 8-hr average for ozone, to determine the ratio of change between 1994 and 2000 (U.S. EPA 2003). The new 2000 flux rates were multiplied by urban or community tree cover in the state to estimate total pollution removal by trees.

Pollution removal dollar value estimates were calculated using 1994 national median externality values used in energy decision making (Murray et al. 1994, Ottinger et al. 1990). The 1994 values were adjusted to 2007 dollars based on the producer price index (U.S. Dept. of Labor 2008). These values, in dollars/metric ton (t) are:

- Nitrogen dioxide (NO_2) = $9,906/t
- Particulate matter less than 10 microns (PM_{10}) = $6,614/t
- Sulfur dioxide (SO_2) = $2,425/t
- Carbon monoxide (CO) = $1,407/t

Externality values for ozone (O_3) were set to equal the value for NO_2. Externality values can be considered the estimated cost of pollution to society that is not accounted for in the market price of the goods or services that produced the pollution.

For each state, Table 1 summarizes carbon storage and air pollution removal estimates for urban, community, and urban or community trees statewide.

Data Accuracy and Application

The data presented in this report yield the most comprehensive and up-to-date assessment of continental U.S. urban and community forests. The data allows for relative comparisons among geographies and provides baseline information for assessing relative changes in urban and community forest cover in the future. As stated previously, tree cover information was based on finer resolution data than used in the original urban forest assessment (Dwyer et al. 2000). As the methodologies for quantifying tree cover have changed between the original and current assessment, evaluating changes is not possible since the detected changes could be caused by either actual landscape changes or differences in methodology.

The U.S. Census generalized cartographic boundary data are a simplified and smoothed extracts of the Topologically Integrated Geographic Encoding and Referencing (TIGER) database, with a target scale range of 1:5,000,000 (U.S. Census Bureau 2007). Because of this scale and generalization, border simplification impacts attribute measurements that are derived from the boundary data, especially for small areas and at the local scale. In particular, percentages (unitless ratios) generated from attribute measurements made for the smallest communities or county subdivisions may be under- or overstated depending upon the relative location of the smoothed border of the geopolitical unit.

While the 2001 NLCD is a substantial improvement over the 1991 AVHRR data (30-m versus 1-km resolution), it also has local-scale data and application limitations. Initial tree canopy cover results revealed mean absolute errors (mean of the absolute difference between predicted and actual values) from 8.4 percent to 14.1 percent, with correlation coefficients between predicted and actual values ranging from 0.78 to 0.93. Impervious surface cover results revealed mean absolute errors from 4.6 percent to 7 percent, with r-values from 0.83 to 0.91 (Homer et al. 2004).

A more recent analysis of 127 community and 20 county geographies sampled throughout the continental United States compared NLCD tree canopy and impervious surface cover estimates with high resolution (1-m or less resolution) aerial photo-interpreted estimates. This analysis revealed that NLCD underestimates both tree canopy and impervious surface cover compared to photo-interpreted values. NLCD underestimates of tree cover vary by mapping zone, while underestimates of impervious surface cover, which are relatively minor, varies by population density (Greenfield et al. in press). These findings are consistent with Walton (2008), who found a consistent under-prediction bias for the 2001 NLCD derived tree canopy cover values in census places (communities) of western New York.

The tree cover and impervious cover data given in this report are directly from the NLCD database. To help understand the potential underestimate in the cover values, each U.S. mapping zone was photo-interpreted using Google Earth images[3]. Table B provides a comparison of results from NLCD versus photo-interpreted data for mapping zones applicable to this collection of states.

Comparisons between NLCD impervious surface cover estimates and photo-interpreted values were not reported because differences were related to population density, which can vary significantly among geographic units. Despite the potential underestimates in tree canopy cover values, relative comparisons

[3]Nowak, D.J.; Greenfield, E.J. Tree and impervious cover in the conterminous United States: Testing of NLCD cover estimates by mapping zone. In review.

Table B.—Comparison of NLCD versus photo-interpretation (PI) derived values of percent tree canopy cover by NLCD mapping zones

Mapping zone [a]	n [b]	Percent tree canopy cover		Difference [e]	Margin of error [f]	Significant difference [g]
		NLCD [c]	PI [d]			
46	709	55.9%	71.1%	15.2%	3.4%	Yes
48	760	45.0%	62.8%	17.8%	3.5%	Yes
53	223	66.8%	77.1%	10.3%	5.6%	Yes
54	993	55.7%	69.1%	13.4%	2.9%	Yes
55	995	51.1%	66.5%	15.4%	3.0%	Yes
56	990	22.8%	40.5%	17.7%	3.1%	Yes
57	642	66.9%	80.7%	13.8%	3.1%	Yes
58	998	39.9%	58.1%	18.3%	3.1%	Yes
59	958	52.5%	67.2%	14.7%	3.0%	Yes
60	972	37.5%	51.5%	14.1%	3.2%	Yes
61	632	55.0%	69.0%	14.0%	3.7%	Yes
62	845	50.0%	58.3%	8.4%	3.4%	Yes

[a] NLCD mapping zones.
[b] Number of photo-interpreted sample points
[c] Percent tree canopy value derived from NLCD data
[d] Percent tree canopy derived from photo-interpreted data
[e] PI value minus NLCD value
[f] 95% confidence interval of PI value
[g] Significant difference between NLCD and PI values if NLCD value is outside of 95% confidence interval of PI value

of tree cover among geographies in this report (e.g., planting priority index and the ratings of excellent to poor for local government tree cover) are reasonable as the under-prediction of tree cover is fairly consistent within each mapping zone. However, it is important to note that the tree canopy and impervious surface cover could be underestimated, as well as their associated ecosystem services and values. A forthcoming analysis will better assess the accuracy of the NLCD cover maps (Homer et al. 2007), but these maps and data provide comprehensive, consistent, and comparable estimates (with an inherent degree of error and uncertainty) of tree canopy and impervious surface cover to help urban and community forest management, planning and policy making. Higher resolution cover data may provide more accurate results at the local scale, but the NLCD cover maps provide a cost-effective means to consistently assess and compare the relative differences of urban cover types regionally. For more refined and locally appropriate data, local field or high resolution (1 m or less) image analyses are recommended (e.g., i-Tree www.itreetools.org; UTC – www.nrs.fs.fed.us/urban/utc).

Because of limited urban and community forest field data, data from several urban and community forests were used to estimate the number of trees and carbon storage by trees. These coarse estimates reveal that urban and community forests contain a large number of trees and provide significant environmental benefits. Field data are needed from all states to help improve these estimates as well as to estimate other forest effects (e.g., building energy conservation and changes in stream flow and water quality). Data from long-term monitoring of urban and community forests used in conjunction with satellite-based cover maps will provide essential information to assess forest health and change, and to improve urban and community forest management.

Practical Applications for Managers

The data from this report can be used to aid urban forest management at both the state and local levels. Data can be used to:

- Determine the extent, magnitude, and variation in the urban and community forestry resource
- Determine areas of greatest population growth, urbanization, and development (sprawl) to direct urban and community forestry to minimize negative impacts and maximize environmental benefits

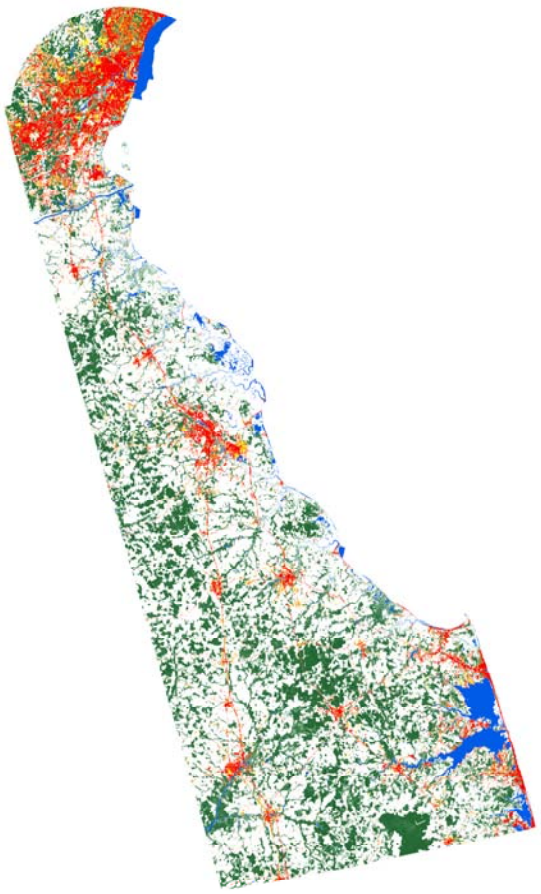
- Evaluate existing tree canopy, impervious surface cover, and available planting space (available green space) to direct current and future urban and community forestry efforts such as planting programs
- Compare tree canopy cover for similar geopolitical units and set tree canopy goals
- Prioritize tree planting based on population density, tree canopy green space, and tree canopy cover per person
- Understand the pollution removal and carbon storage benefits of urban and community forests
- Promote more detailed and/or locally appropriate urban and community forest inventories, censuses, or field surveys (e.g. i-Tree - www.itreetools.org)
- Establish statewide to local standards related to urban and community forestry (e.g., establishing minimum goals of percent canopy green space or tree cover per capita and directing resources so that communities can reach the minimum standards)
- Improve urban and community forest management and cost estimation by providing an estimate of the number of trees in each geopolitical unit (i.e., urban area size (ha) ∗ percent tree cover ∗ 477 trees/ha, or local tree density information from local data)
- Guide policy decisions related to urban sprawl and urban and community forest management

SUMMARY

The data presented in this report provide a better understanding of urban and community forests. This information can be used to advance urban and community forest policy and management that could improve environmental quality and human health throughout the state. The following sections detail specific urban and community forestry data for the states in this regional report.

ACKNOWLEDGMENTS

This research was funded, in part, by the U.S. Forest Service's RPA Assessment Staff, State and Private Forestry's Urban and Community Forestry Program, and Northeastern Area State and Private Forestry. Thanks also goes to Chris Sorrentino for assistance with report compilation, Nana Efua Imbeah for assistance with data processing, and Mike Boarman for assistance with image processing.



DELAWARE'S URBAN AND COMMUNITY FORESTS

Statewide Summary

Urban or community land in Delaware comprises about 17.8 percent of the state land area in 2000, an increase from 14.0 percent in 1990. Statewide tree canopy cover averages 23.1 percent and tree cover in urban or community areas is about 16.4 percent, with 15.5 percent impervious surface cover and 19.4 percent of the total green space covered by tree canopy cover. Statewide, urban or community land in Delaware has an estimated 7.1 million trees, which store about 1.3 million metric tons of carbon ($29.6 million), and annually remove about 44,000 metric tons of carbon ($1.0 million) and 1,710 metric tons of air pollution ($13.5 million) (Table DE-1).

Tables DE-2 through DE-17 are not printed in this report but are available on the CD located on the inside back cover and at http://nrs.fs.fed.us/data/urban.

Table DE-1.—Statewide summary of population, area, population density, tree canopy and impervious surface land cover, and urban tree benefits in urban, community, and urban or community areas.

Delaware		Statewide	Urban [a]	Community [b]	Urban or Community [c]
Population	2000	783,600	627,758	344,549	n/a
	1990	666,168	486,501	255,939	n/a
	% Change (1990-2000)	17.6	29.0	34.6	n/a
	% Total population (2000)	100.0	80.1	44.0	n/a
Total area	km^2 (2000)	6,447.2	786.5	464.9	925.4
	km^2 (1990)	6,447.2	599.9	339.3	728.4
	% Change (1990-2000)	0.0	31.1	37.0	27.0
Land area	km^2 (2000)	5,059.5	780.2	445.3	902.5
	% Land area (2000)	100.0	15.4	8.8	17.8
	km^2 (1990)	5,059.5	596.6	320.5	708.4
	% Land area (1990)	100.0	11.8	6.3	14.0
	% Change (1990-2000)	0.0	30.8	38.9	27.4
Population density (people/land area km^2)	2000	154.9	804.6	773.8	n/a
	1990	131.7	815.4	798.5	n/a
	% Change (1990-2000)	17.6	-1.3	-3.1	n/a
Tree canopy cover (2000)	km^2	1,166.6	129.5	65.9	147.9
	% Land area	23.1	16.6	14.8	16.4
	Per capita (m^2/person)	1,488.8	206.3	191.2	n/a
	% Canopy green space [d]	23.9	19.9	17.9	19.4
Total green space (2000) [e]	km^2	4,884.0	651.0	368.6	762.6
	% Land area	96.5	83.4	82.8	84.5
Available green space (2000) [f]	km^2	3,717.4	521.4	302.7	614.7
	% Land area	73.5	66.8	68.0	68.1
Impervious surface cover (2000)	km^2	175.4	129.3	76.7	139.8
	% Land area	3.5	16.6	17.2	15.5
	Per capita (m^2/person)	223.9	206.0	222.6	n/a
Urban tree benefits (2000)	Estimated number of trees	n/a	6,200,000	3,100,000	7,100,000
	Carbon				
	Carbon stored (metric tons)	n/a	1,200,000	600,000	1,300,000
	Carbon stored ($)	n/a	$27,400,000	$13,700,000	$29,600,000
	Carbon sequestered (metric tons/year)	n/a	39,000	20,000	44,000
	Carbon sequestered ($/year)	n/a	$889,000	$456,000	$1,003,000
	Pollution				
	CO removed (metric tons/year)	n/a	25	13	29
	CO removed ($/year)	n/a	$35,200	$17,900	$40,200
	NO_2 removed (metric tons/year)	n/a	212	108	242
	NO_2 removed ($/year)	n/a	$2,098,600	$1,067,200	$2,396,300
	O_3 removed (metric tons/year)	n/a	651	331	744
	O_3 removed ($/year)	n/a	$6,453,000	$3,282,000	$7,368,000
	SO_2 removed (metric tons/year)	n/a	194	99	221
	SO_2 removed ($/year)	n/a	$469,800	$238,900	$536,500
	PM_{10} removed (metric tons/year)	n/a	417	212	476
	PM_{10} removed ($/year)	n/a	$2,756,700	$1,401,900	$3,147,800
	Total pollution removal (metric tons/year)	n/a	1,500	760	1,710
	Total pollution removal ($/year)	n/a	$11,800,000	$6,000,000	$13,500,000

[a] Urban land is based on population density and was delimited using the United States Census definitions of urbanized areas and urban clusters. [b] Community land is based on jurisdictional or political boundaries of communities based on United States Census definitions of incorporated or census designated places. [c] Urban or communities is land that is urban, community, or both. Communities may include all, some, or no urban land within their boundaries. [d] Canopy green space is the tree canopy cover divided by total green space. [e] Total green space (TGS) is total area – impervious surface cover – water. [f] Available green space (AGS) is total green space – tree canopy cover (if the calculated value is less than 0, then value set at 0).

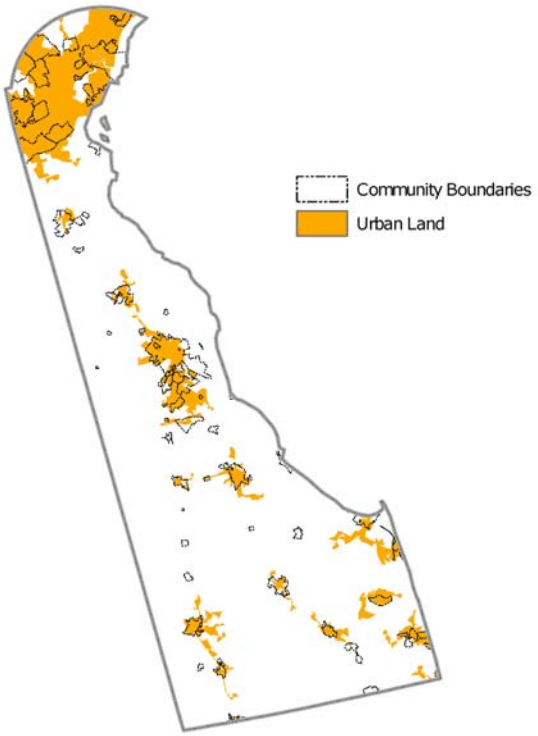


Figure DE-1.—Urban or community land in 2000; urban area relative to community boundaries.

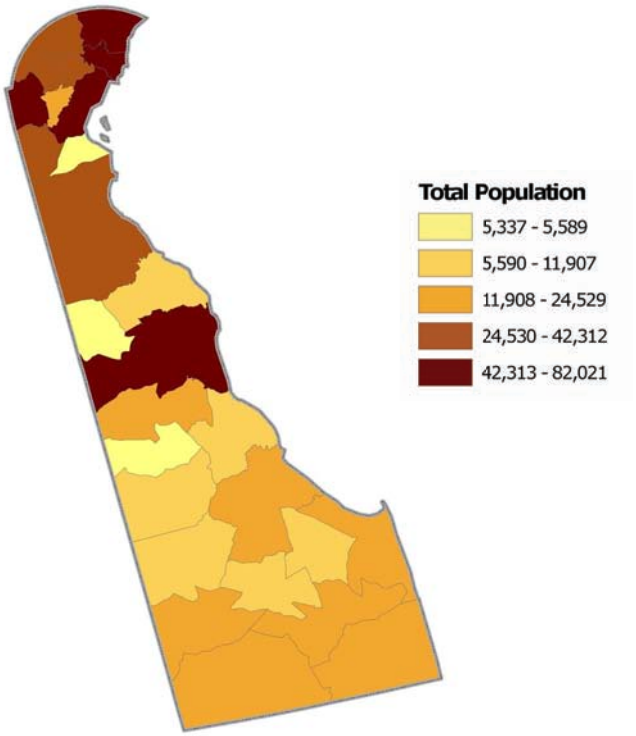


Figure DE-2.—2000 population within county subdivision boundaries.

Human Population Characteristics and Trends

The population in Delaware increased 17.6 percent, from 666,168 in 1990 to 783,600 in 2000 (Table DE-1). In Delaware, 80.1 percent of the State's population is in urban areas (Fig. DE-1), and 44.0 percent of the population is within communities (Fig. DE-2).

Urban and Community Land

Urban land comprises 15.4 percent of the land area of Delaware, while lands within communities make up 8.8 percent of the State (Fig. DE-1). Between 1990 and 2000, urban area increased 30.8 percent, while community land increased from 6.3 to 8.8 percent (Table DE-1). Urban area in Delaware is projected to increase to 39.5 percent by 2050, based on average urban growth pattern of the 1990s (Nowak and Walton 2005). Both urban land (attaining minimum population density) and community land (political boundaries) increased from 1990 to 2000. The percentages are calculated using the total (water and land) area of the geopolitical units derived from U.S. Census cartographic boundary data. Percent urban land varied across the State (Fig. DE-3; Tables DE-2 through 4).

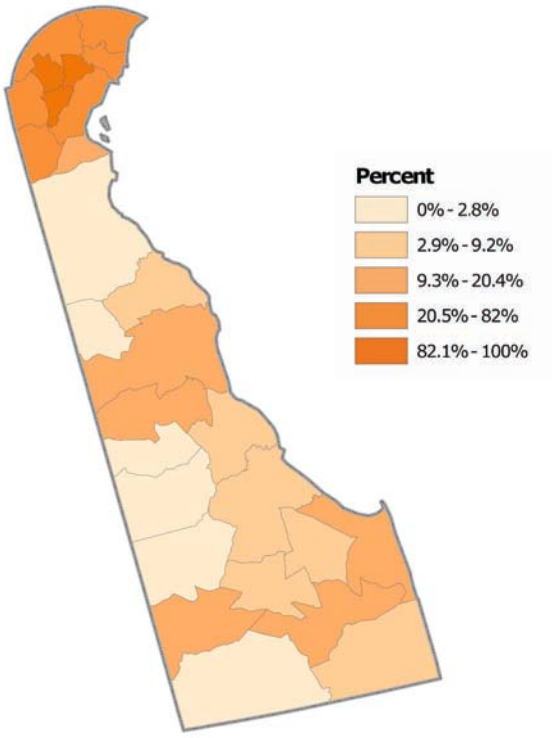


Figure DE-3.—Percent of county subdivision area classified as urban land in 2000.

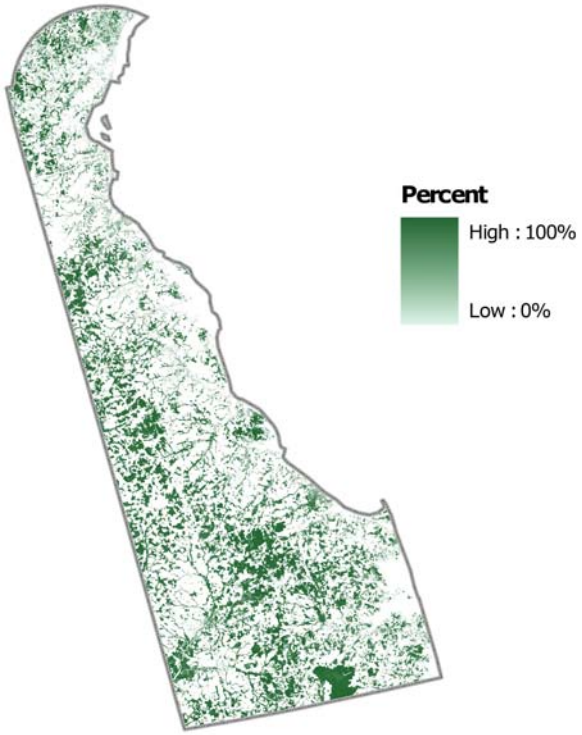


Figure DE-4.—Percentage tree canopy cover.

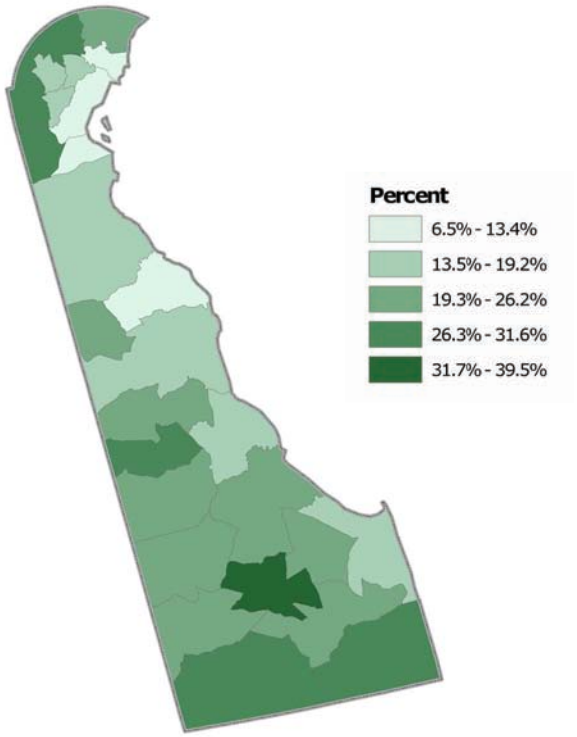


Figure DE-5.—Percentage tree canopy cover within county subdivisions.

Tree Canopy Cover Characteristics

Tree canopy cover in Delaware averages 23.1 percent (Fig. DE-4), with 96.5 percent total green space, 23.9 percent canopy green space, and 1,488.8 m^2 of canopy cover per capita. Average tree cover in urban areas in Delaware was 16.6 percent, with 83.4 percent total green space, 19.9 percent canopy green space, and 206.3 m^2 of canopy cover per capita. Within community lands in Delaware, average tree cover was 14.8 percent, with 82.8 percent total green space, 17.9 percent canopy green space, and 191.2 m^2 of canopy cover per capita (Table DE-1). Tree canopy cover, canopy green space, and tree cover per capita varied among communities, county subdivisions, and counties (Fig. DE-5 through 6; Tables DE-5 through 7).

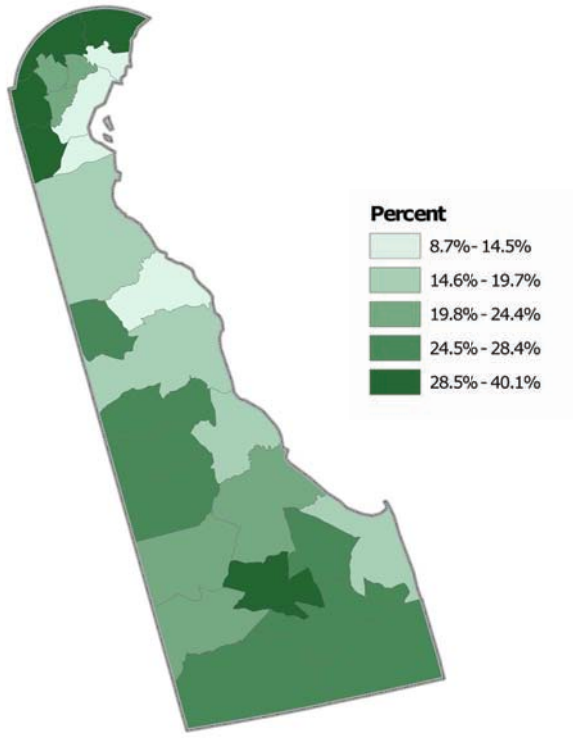


Figure DE-6.—Percentage tree canopy green space in county subdivisions.

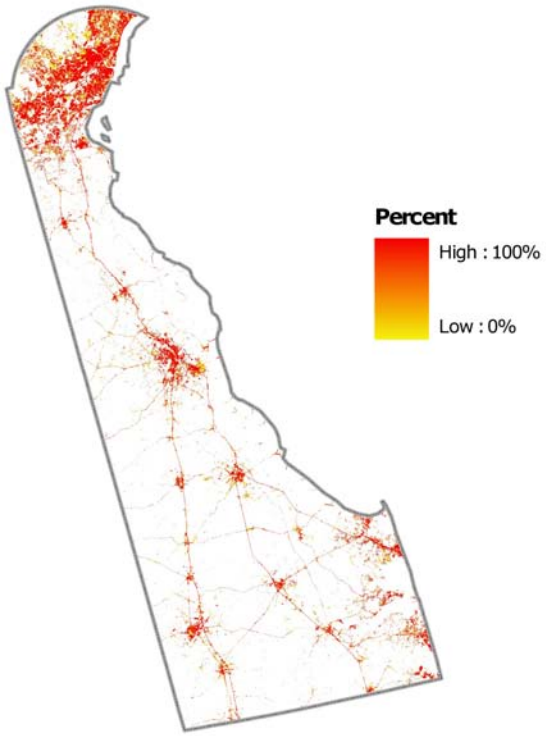


Figure DE-7.—Percentage impervious surface cover.

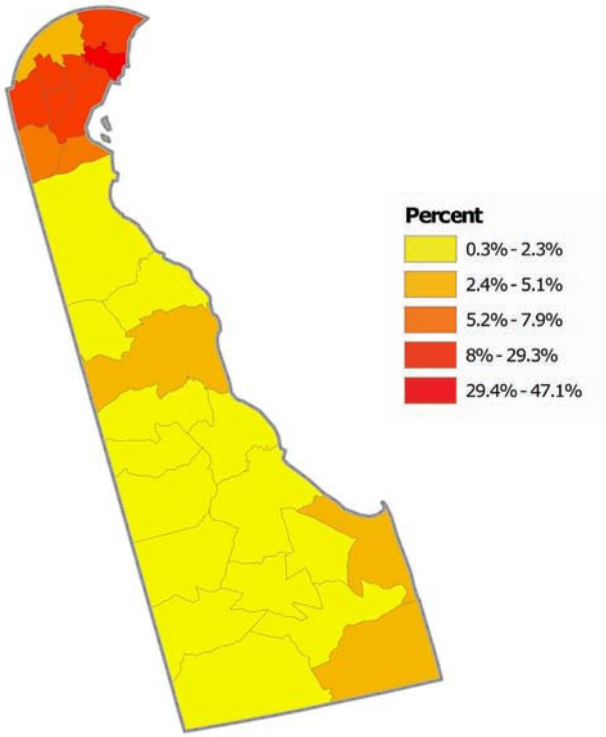


Figure DE-8.—Percentage impervious surface cover within county subdivisions.

Impervious Surface Cover Characteristics

Average impervious surface cover in Delaware is 3.5 percent of the land area (Fig. DE-7), with 223.9 m^2 of impervious surface cover per capita. Average impervious surface cover in urban areas was 16.6 percent, with 206.0 m^2 of impervious surface cover per capita. Within community lands in Delaware, average impervious surface cover was 17.2 percent with 222.6 m^2 of impervious surface cover per capita (Table DE-1). Impervious surface cover varied across the State (Fig. DE-8; Tables DE-5 through 7).

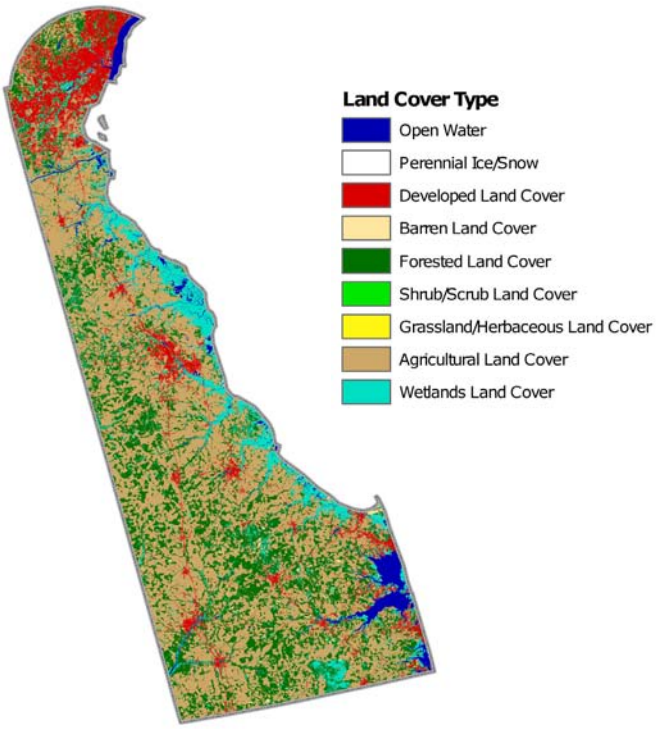


Figure DE-9.—Classified land cover.

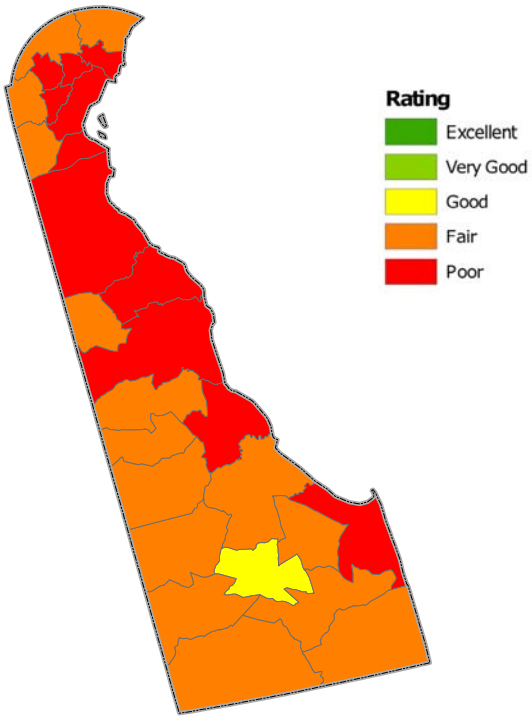


Figure DE-10.—Relative comparisons of tree cover for county subdivisions.

Classified Land-cover Characteristics

Delaware's land cover is dominated by agricultural land (Fig. DE-9). The characteristics as a percent of the total land area in Delaware are (Tables DE-8 through 10):

- Agricultural – 57.5 percent
- Forested – 25.3 percent
- Developed – 10.2 percent
- Wetland – 5.7 percent
- Barren – 1.3 percent

Relative Comparisons of Tree Cover

Out of the 75 Delaware communities, none received a rating of excellent and 66 received a rating of poor (Table DE-12). Of the 27 county subdivisions, none had a rating of excellent and 11 were rated poor (Fig. DE-10, Table DE-13); and out of three counties, none were given a rating of excellent and two were given a rating of poor (Table DE-14). Variability of assessment scores is a product of the difference in land-cover distributions and the percentage of canopy cover within the population density classes and mapping zones (Fig. DE-10; Tables DE-11 through 14).

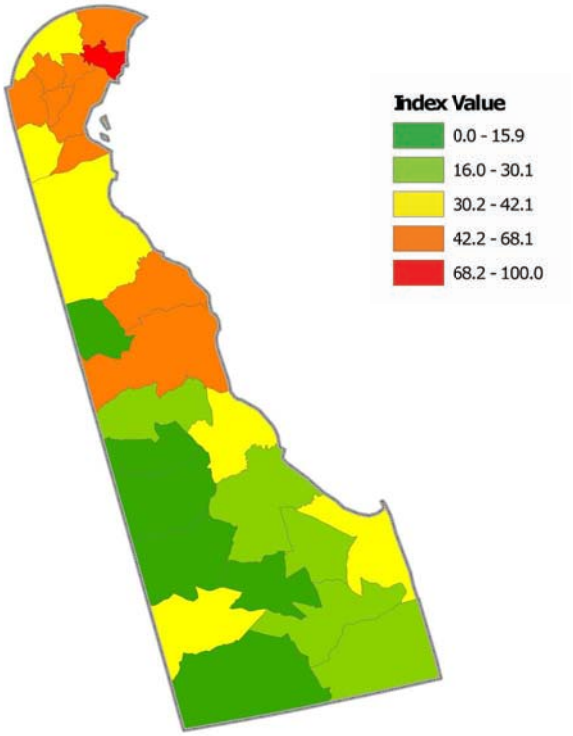


Figure DE-11.—Planting priority index for county subdivisions. The higher the index value, the greater priority for planting.

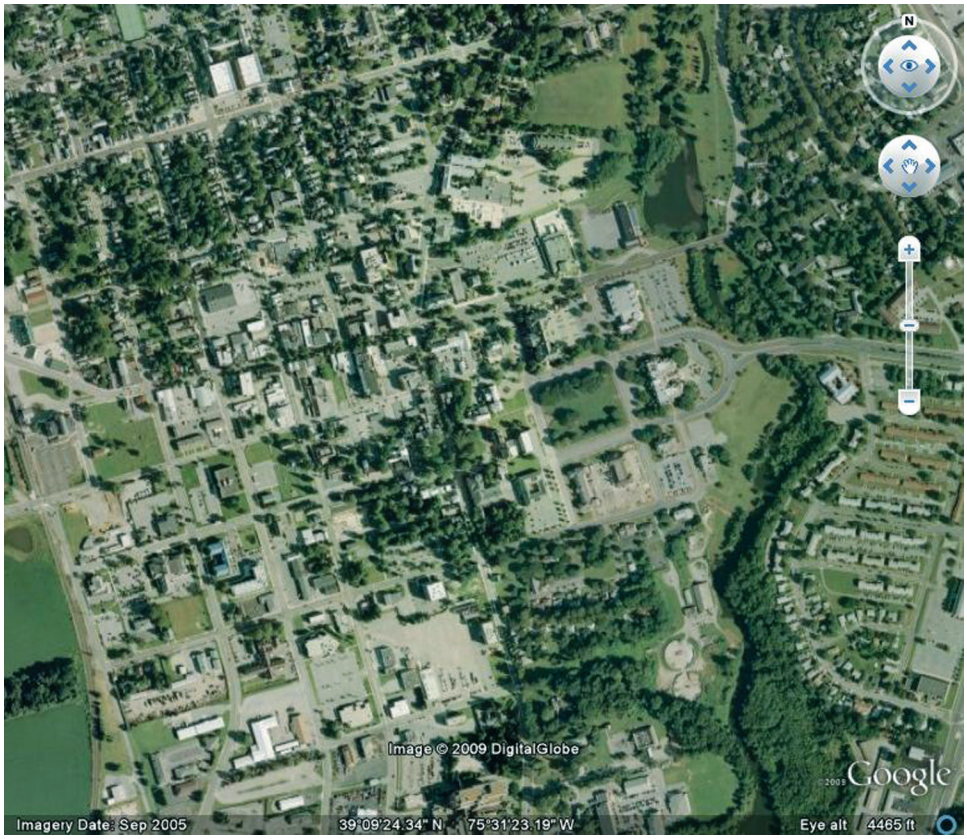
Priority Areas for Tree Planting

Priority areas for planting tend to be highest in more urbanized areas due to higher population density (Fig. DE-11; Tables DE-15 through 17). These index values can also be produced using high resolution cover data to determine local planting priority areas (e.g. neighborhoods).

Urban Tree Benefits

The following forest attributes are estimated for the urban or community land in Delaware (Table DE-1). These are rough estimates of values. More localized data are needed for more precise estimates, but these values reveal first-order approximations.

- 7.1 million trees
- 1.3 million metric tons of C stored ($29.6 million value)
- 44,000 metric tons/year of C sequestered ($1.0 million value)
- 1,710 metric tons/year total pollution removal ($13.5 million value)
  - 29 metric tons/year of CO removed ($40,200 value)
  - 242 metric tons/year NO_2 removed ($2.4 million value)
  - 744 metric tons/year of O_3 removed ($7.4 million value)
  - 221 metric tons/year of SO_2 removed ($536,000 value)
  - 476 metric tons/year of PM_{10} removed ($3.1 million value)

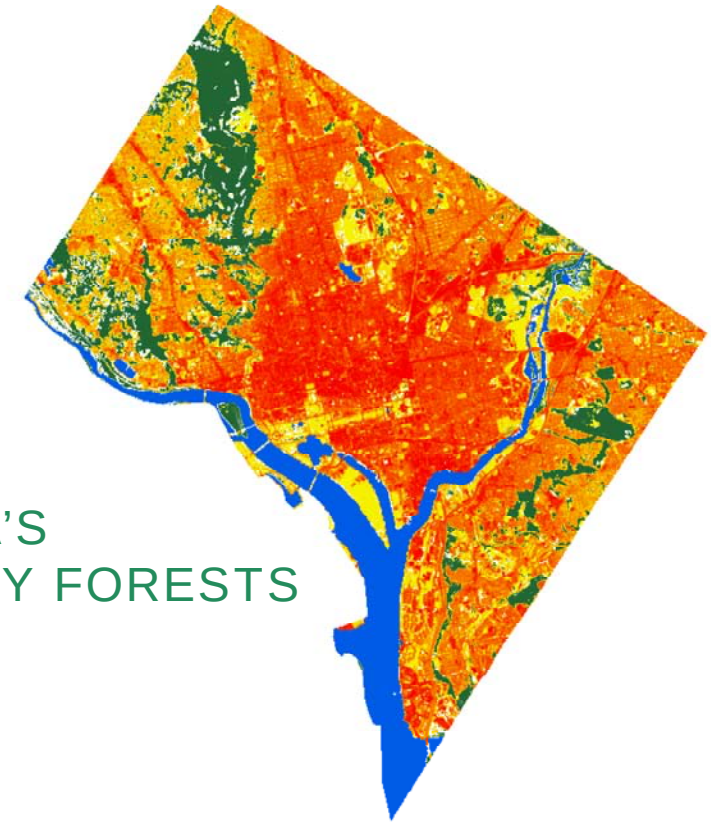


Summary

The data presented in this report provide a better understanding of Delaware's urban and community forests. This information can be used to advance urban and community forest policy and management that could improve environmental quality and human health throughout the State.

These data establish a baseline to assess future change and can be used to understand:

- Extent of the urban and community forest resource
- Variations in the resource across the State
- Magnitude and value of the urban and community forest resource
- Urban growth in Delaware
- Implications of policy decisions related to urban sprawl and urban and community forest management



DISTRICT OF COLUMBIA'S URBAN AND COMMUNITY FORESTS

District-wide Summary

In the District of Columbia, tree canopy cover averages 16.0 percent, with 41.1 percent impervious surface cover and 27.2 percent of the total green space covered by tree canopy cover. In the District of Columbia, a field assessment of the urban forest was conducted in 2004 (Nowak et al. 2006c). The District of Columbia has an estimated 1.9 million trees, which store about 474,000 metric tons of carbon ($10.8 million), and annually remove about 14,600 metric tons of carbon ($334,000) and 490 metric tons of air pollution ($3.7 million) (Table DC-1).

Tables DC-2, 5, 8, and 11 are not printed in this report but are available on the CD located on the inside back cover and at http://nrs.fs.fed.us/data/urban.

Table DC-1.—District-wide summary of population, area, population density, tree canopy and impervious surface land cover, and urban tree benefits in urban and community areas.

District of Columbia		District-wide	Urban [a]	Community [b]
Population	2000	572,059	572,059	572,059
	1990	606,900	606,900	606,900
	% Change (1990-2000)	-5.7	-5.7	-5.7
	% Total population (2000)	100.0	100.0	100.0
Total area	km^2 (2000)	177.0	158.9	177.0
	km^2 (1990)	177.0	159.2	177.0
	% Change (1990-2000)	0.0	-0.1	0.0
Land area	km^2 (2000)	160.1	157.7	160.1
	% Land area (2000)	100.0	98.5	100.0
	km^2 (1990)	160.1	158.0	160.1
	% Land area (1990)	100.0	98.6	100.0
	% Change (1990-2000)	0.0	-0.2	0.0
Population density (people/land area km^2)	2000	3,572.7	3,627.1	3,572.7
	1990	3,790.3	3,842.2	3,791.2
	% Change (1990-2000)	-5.7	-5.6	-5.8
Tree canopy cover (2000)	km^2	25.7	25.2	25.7
	% Land area	16.0	16.0	16.0
	Per capita (m^2/person)	44.9	44.1	44.9
	% Canopy green space [c]	27.2	27.3	27.2
Total green space (2000) [d]	km^2	94.4	92.3	94.4
	% Land area	58.9	58.5	58.9
Available green space (2000) [e]	km^2	68.7	67.1	68.7
	% Land area	42.9	42.5	42.9
Impervious surface cover (2000)	km^2	65.8	65.4	65.8
	% Land area	41.1	41.5	41.1
	Per capita (m^2/person)	114.9	114.3	114.9
Urban tree benefits (2000) [f]	Estimated number of trees	1,928,000	n/a	n/a
	Carbon			
	Carbon stored (metric tons)	474,000	n/a	n/a
	Carbon stored ($)	10,800,000	n/a	n/a
	Carbon sequestered (metric tons/year)	14,600	n/a	n/a
	Carbon sequestered ($/year)	334,000	n/a	n/a
	Pollution			
	CO removed (metric tons/year)	23	n/a	n/a
	CO removed ($/year)	32,000	n/a	n/a
	NO_2 removed (metric tons/year)	65	n/a	n/a
	NO_2 removed ($/year)	645,000	n/a	n/a
	O_3 removed (metric tons/year)	196	n/a	n/a
	O_3 removed ($/year)	1,939,000	n/a	n/a
	SO_2 removed (metric tons/year)	66	n/a	n/a
	SO_2 removed ($/year)	160,000	n/a	n/a
	PM_{10} removed (metric tons/year)	140	n/a	n/a
	PM_{10} removed ($/year)	928,000	n/a	n/a
	Total pollution removal (metric tons/year)	490	n/a	n/a
	Total pollution removal ($/year)	3,700,000	n/a	n/a

[a] Urban land is based on population density and was delimited using the United States Census definitions of urbanized areas and urban clusters. [b] Community land is based on jurisdictional or political boundaries of communities based on United States Census definitions of incorporated or census designated places. [c] Canopy green space is the tree canopy cover divided by total green space. [d] Total green space (TGS) is total area – impervious surface cover – water. [e] Available green space (AGS) is total green space – tree canopy cover (if the calculated value is less than 0, then value set at 0). [f] Based on data from Nowak et al. (2006c), and not from methods detailed in this report. Dollar values are updated to 2007 values.

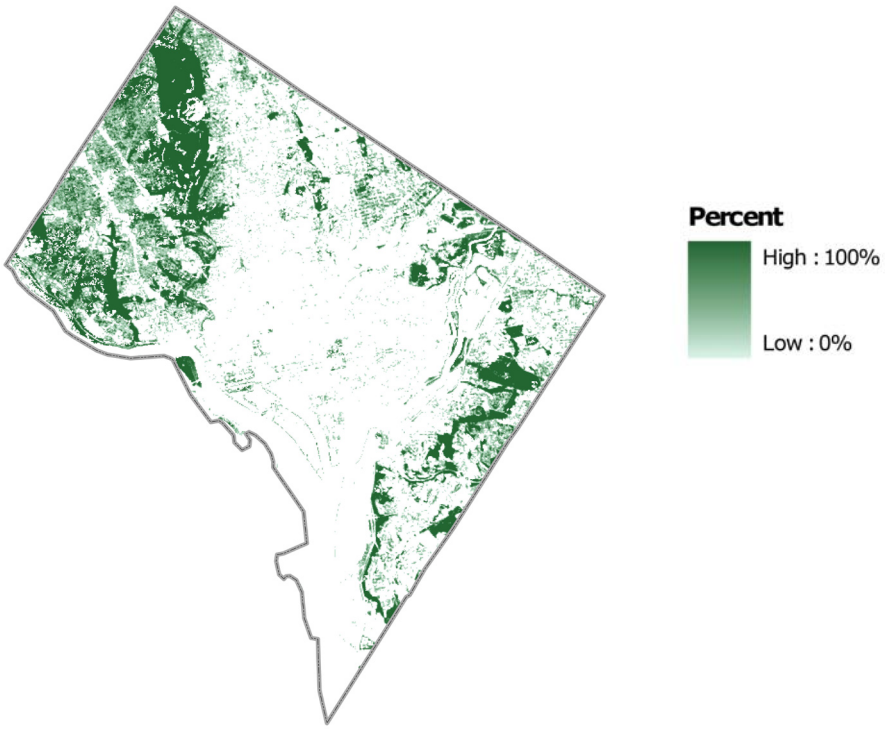


Figure DC-4.—Percentage tree canopy cover.

Human Population Characteristics and Trends

The population in the District of Columbia decreased 5.7 percent, from 606,900 in 1990 to 572,059 in 2000 (Table DC-1).

Urban Land

Urban land comprises 98.5 percent of the land area of the District of Columbia. Between 1990 and 2000, urban area decreased 0.2 percent. The percentages are calculated using the total (water and land) area of the geopolitical units derived from U.S. Census cartographic boundary data (Table DC-2).

Tree Canopy Cover Characteristics

Tree canopy cover in the District of Columbia averages 16.0 percent (Fig. DC-4), with 58.9 percent total green space, 27.2 percent canopy green space, and 44.9 m^2 of canopy cover per capita. Average tree cover in urban areas in District of Columbia was 16.0 percent, with 58.5 percent total green space, 27.3 percent canopy green space, and 44.1 m^2 of canopy cover per capita (Table DC-5).

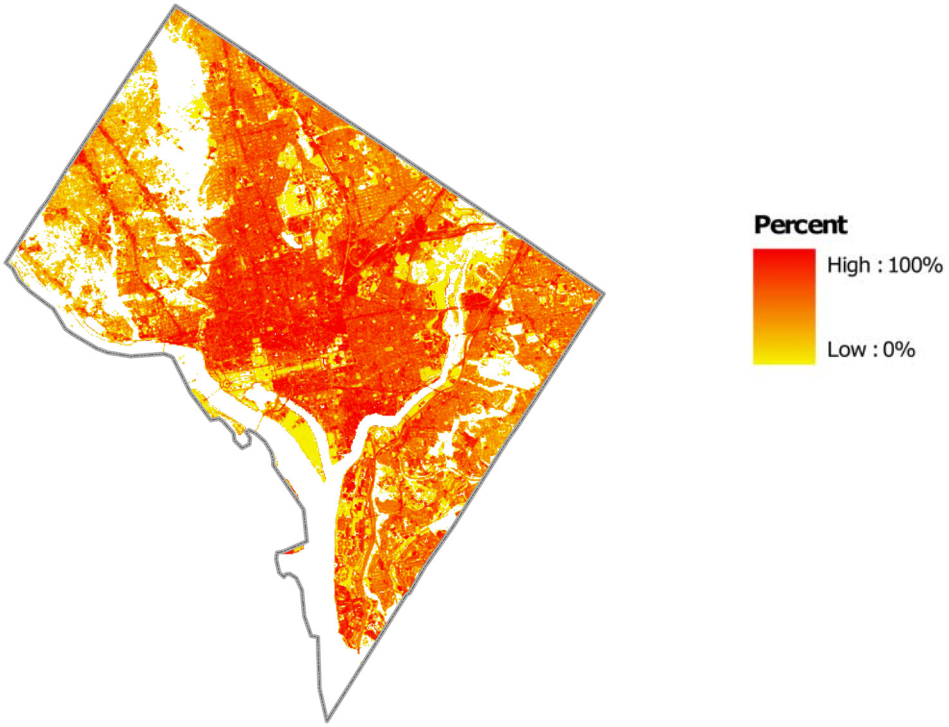


Figure DC-7.—Percentage impervious surface cover.

Impervious Surface Cover Characteristics

Average impervious surface cover in the District of Columbia is 41.1 percent of the land area (Fig. DC-7), with 114.9 m^2 of impervious surface cover per capita. Average impervious surface cover in urban areas was 41.5 percent, with 114.3 m^2 of impervious surface cover per capita. (Table DC-5).

Classified Land-cover Characteristics

The District of Columbia's land cover is dominated by developed land (Fig. DC-9). The characteristics as a percent of the total land area in the District of Columbia are (Table DC-8):

- Developed – 83.5 percent
- Forested – 11.7 percent
- Agricultural – 3.7 percent
- Barren – 0.6 percent
- Wetland – 0.6 percent

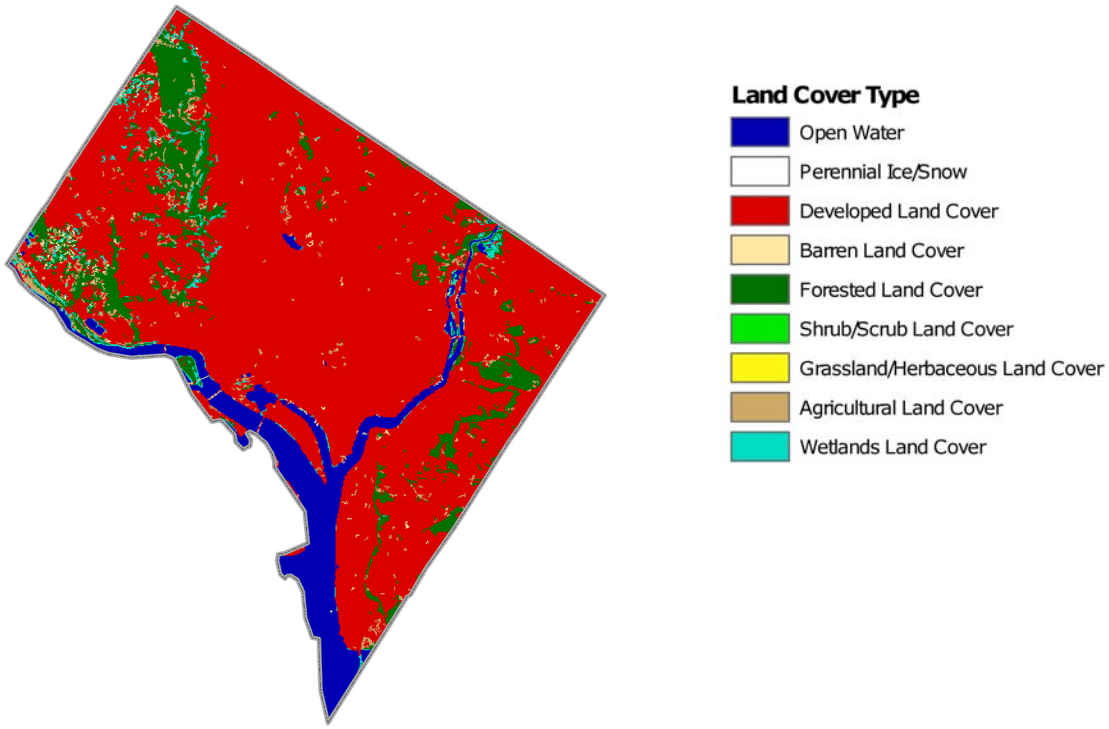
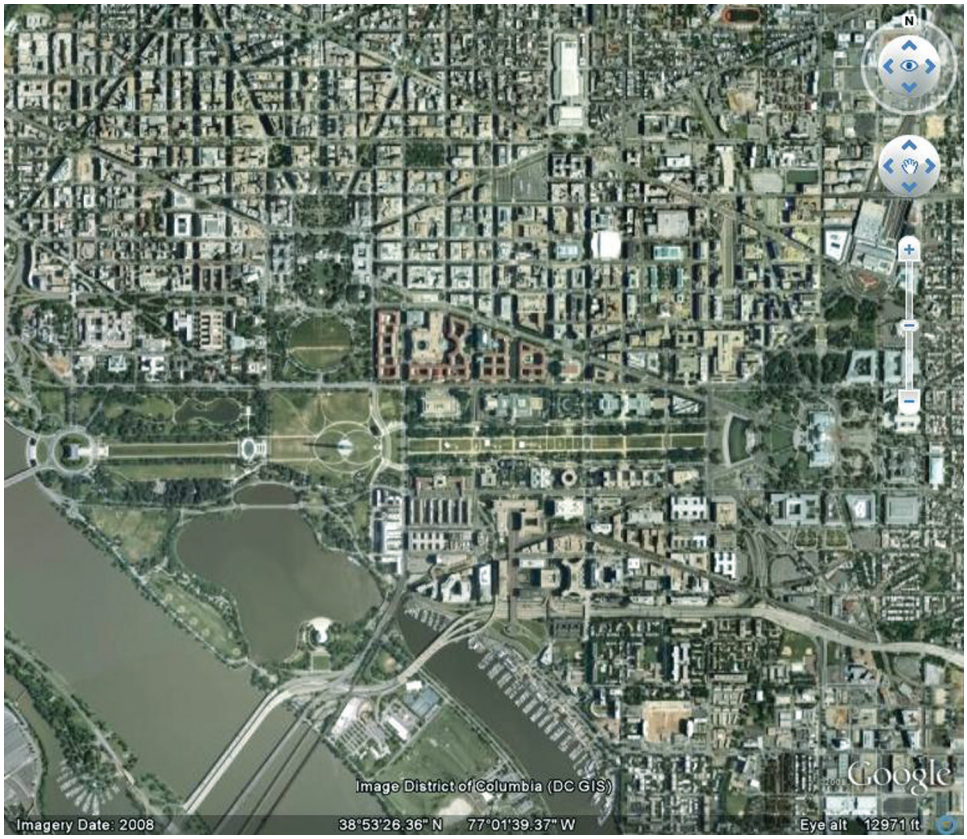


Figure DC-9.—Classified land cover.

Urban Tree Benefits

The following forest attributes are estimated for the District of Columbia (Nowak et al. 2006c) (Table DC-1).

- 1.9 million trees
- 474,000 metric tons of C stored ($10.8 million value)
- 14,600 metric tons/year of C sequestered ($334,000 value)
- 490 metric tons/year total pollution removal ($3.7 million value)
  - 23 metric tons/year of CO removed ($32,000 value)
  - 65 metric tons/year NO_2 removed ($645,000 value)
  - 196 metric tons/year of O_3 removed ($1.9 million value)
  - 66 metric tons/year of SO_2 removed ($160,000 value)
  - 140 metric tons/year of PM_{10} removed ($928,000 value)

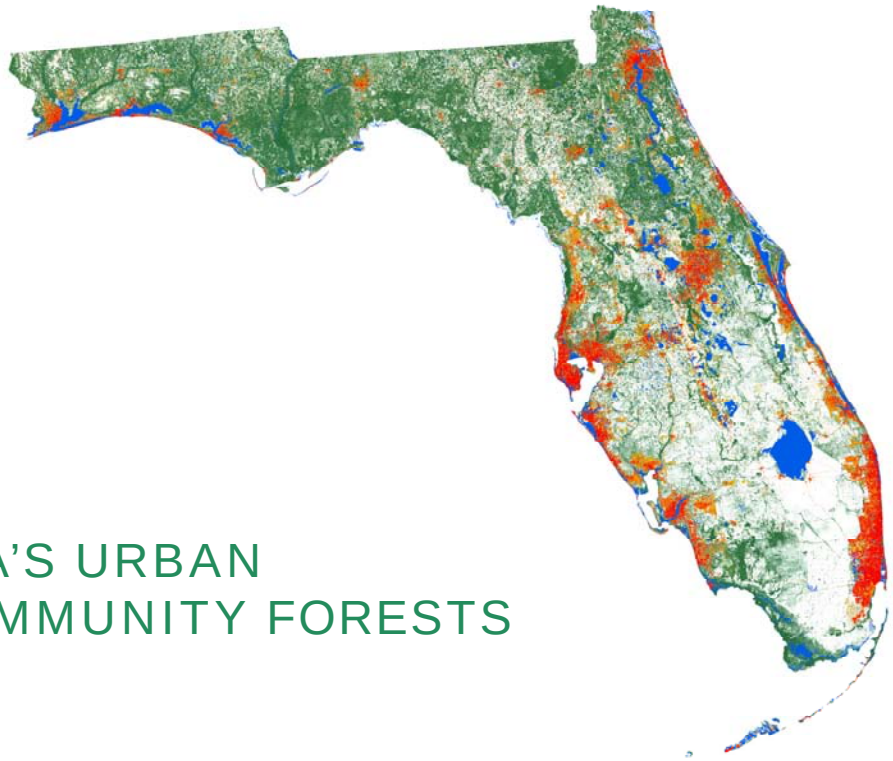


Summary

The data presented in this report provide a better understanding of the District of Columbia's urban and community forests. This information can be used to advance urban and community forest policy and management that could improve environmental quality and human health throughout the district.

These data establish a baseline to assess future change and can be used to understand:

- Extent of the urban and community forest resource
- Variations in the resource across the district
- Magnitude and value of the urban and community forest resource
- Urban growth in the District of Columbia
- Implications of policy decisions related to urban sprawl and urban and community forest management



FLORIDA'S URBAN AND COMMUNITY FORESTS

Statewide Summary

Urban or community land in Florida comprises about 16.2 percent of the state land area in 2000, an increase from 12.5 percent in 1990. Statewide tree canopy cover averages 38.4 percent and tree cover in urban or community areas is about 26.7 percent, with 16.9 percent impervious surface cover and 32.1 percent of the total green space covered by tree canopy cover. Statewide, urban or community land in Florida has an estimated 292 million trees, which store about 55.7 million metric tons of carbon ($1.3 billion), and annually remove about 1.8 million metric tons of carbon ($41.9 million) and 65,750 metric tons of air pollution ($540.5 million) (Table FL-1).

Tables FL-2 through FL-17 are not printed in this report but are available on the CD located on the inside back cover and at http://nrs.fs.fed.us/data/urban.

Table FL-1.—Statewide summary of population, area, population density, tree canopy and impervious surface land cover, and urban tree benefits in urban, community, and urban or community areas.

Florida		Statewide	Urban [a]	Community [b]	Urban or Community [c]
Population	2000	15,982,378	14,270,020	12,006,286	n/a
	1990	12,937,926	10,967,328	8,541,795	n/a
	% Change (1990-2000)	23.5	30.1	40.6	n/a
	% Total population (2000)	100.0	89.3	75.1	n/a
Total area	km^2 (2000)	170,303.6	16,350.3	19,328.2	24,555.1
	km^2 (1990)	170,303.6	13,070.4	15,160.5	19,141.9
	% Change (1990-2000)	0.0	25.1	27.5	28.3
Land area	km^2 (2000)	141,705.9	15,901.6	17,853.7	22,933.9
	% Land area (2000)	100.0	11.2	12.6	16.2
	km^2 (1990)	141,705.9	12,753.9	13,822.3	17,696.6
	% Land area (1990)	100.0	9.0	9.8	12.5
	% Change (1990-2000)	0.0	24.7	29.2	29.6
Population density (people/land area km^2)	2000	112.8	897.4	672.5	n/a
	1990	91.3	859.9	618.0	n/a
	% Change (1990-2000)	23.5	4.4	8.8	n/a
Tree canopy cover (2000)	km^2	54,422.5	3,599.9	4,767.1	6,122.0
	% Land area	38.4	22.6	26.7	26.7
	Per capita (m^2/person)	3,405.2	252.3	397.0	n/a
	% Canopy green space [d]	39.7	29.0	32.4	32.1
Total green space (2000) [e]	km^2	136,964.0	12,413.9	14,733.6	19,058.0
	% Land area	96.7	78.1	82.5	83.1
Available green space (2000) [f]	km^2	82,542.1	8,814.8	9,967.2	12,936.8
	% Land area	58.2	55.4	55.8	56.4
Impervious surface cover (2000)	km^2	4,742.3	3,487.7	3,120.1	3,875.9
	% Land area	3.3	21.9	17.5	16.9
	Per capita (m^2/person)	296.7	244.4	259.9	n/a
Urban tree benefits (2000)	Estimated number of trees	n/a	171,700,000	227,300,000	292,000,000
	Carbon				
	Carbon stored (metric tons)	n/a	32,800,000	43,400,000	55,700,000
	Carbon stored ($)	n/a	$747,800,000	$989,500,000	$1,270,000,000
	Carbon sequestered (metric tons/year)	n/a	1,080,000	1,430,000	1,837,000
	Carbon sequestered ($/year)	n/a	$24,624,000	$32,604,000	$41,884,000
	Pollution				
	CO removed (metric tons/year)	n/a	1,030	1,364	1,751
	CO removed ($/year)	n/a	$1,448,900	$1,918,600	$2,464,000
	NO_2 removed (metric tons/year)	n/a	4,084	5,408	6,945
	NO_2 removed ($/year)	n/a	$40,454,000	$53,570,500	$68,797,100
	O_3 removed (metric tons/year)	n/a	20,121	26,644	34,218
	O_3 removed ($/year)	n/a	$199,316,000	$263,940,000	$338,961,000
	SO_2 removed (metric tons/year)	n/a	2,919	3,865	4,964
	SO_2 removed ($/year)	n/a	$7,078,600	$9,373,700	$12,038,000
	PM_{10} removed (metric tons/year)	n/a	10,510	13,918	17,874
	PM_{10} removed ($/year)	n/a	$69,516,400	$92,055,900	$118,221,300
	Total pollution removal (metric tons/year)	n/a	38,660	51,200	65,750
	Total pollution removal ($/year)	n/a	$317,800,000	$420,900,000	$540,500,000

[a] Urban land is based on population density and was delimited using the United States Census definitions of urbanized areas and urban clusters. [b] Community land is based on jurisdictional or political boundaries of communities based on United States Census definitions of incorporated or census designated places. [c] Urban or communities is land that is urban, community, or both. Communities may include all, some, or no urban land within their boundaries. [d] Canopy green space is the tree canopy cover divided by total green space. [e] Total green space (TGS) is total area – impervious surface cover – water. [f] Available green space (AGS) is total green space – tree canopy cover (if the calculated value is less than 0, then value set at 0).

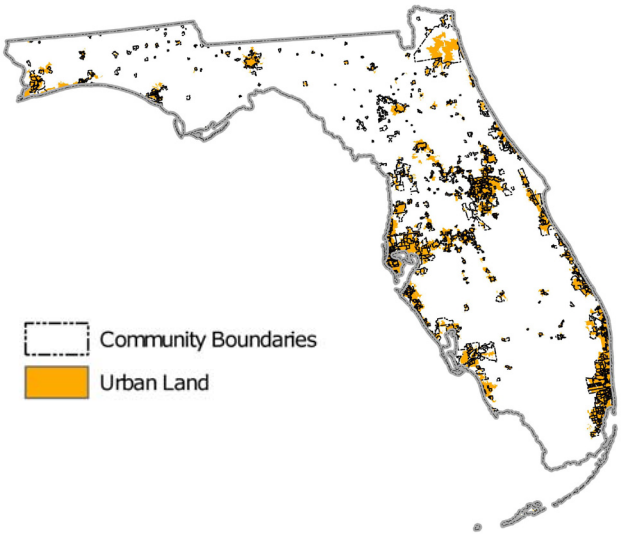


Figure FL-1.—Urban or community land in 2000; urban area relative to community boundaries.

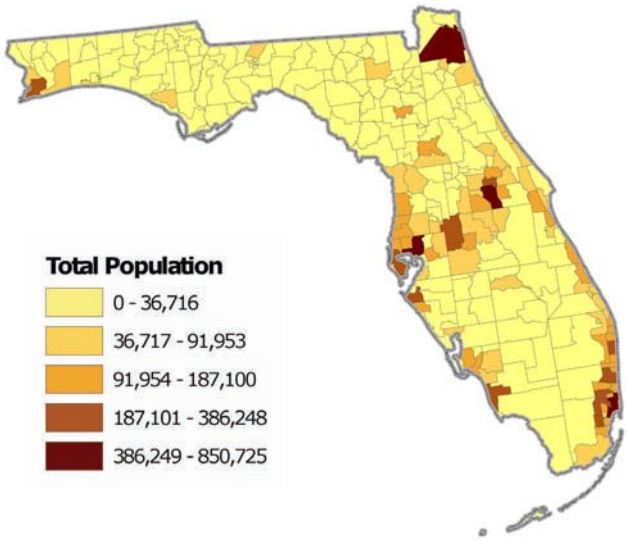


Figure FL-2.—2000 population within county subdivision boundaries.

Human Population Characteristics and Trends

The population in Florida increased 23.5 percent, from 12,937,926 in 1990 to 15,982,378 in 2000 (Table FL-1). In Florida, 89.3 percent of the State's population is in urban areas (Fig. FL-1), and 75.1 percent of the population is within communities (Fig. FL-2).

Urban and Community Land

Urban land comprises 11.2 percent of the land area of Florida, while lands within communities make up 12.6 percent of the State (Fig. FL-1). Between 1990 and 2000, urban area increased 24.7 percent, while community land increased from 9.8 to 12.6 percent (Table FL-1). Urban area in Florida is projected to increase to 27.9 percent by 2050, based on average urban growth pattern of the 1990s (Nowak and Walton 2005). Both urban land (attaining minimum population density) and community land (political boundaries) increased from 1990 to 2000. The percentages are calculated using the total (water and land) area of the geopolitical units derived from U.S. Census cartographic boundary data. Percent urban land varied across the State (Fig. FL-3; Tables FL-2 through 4).

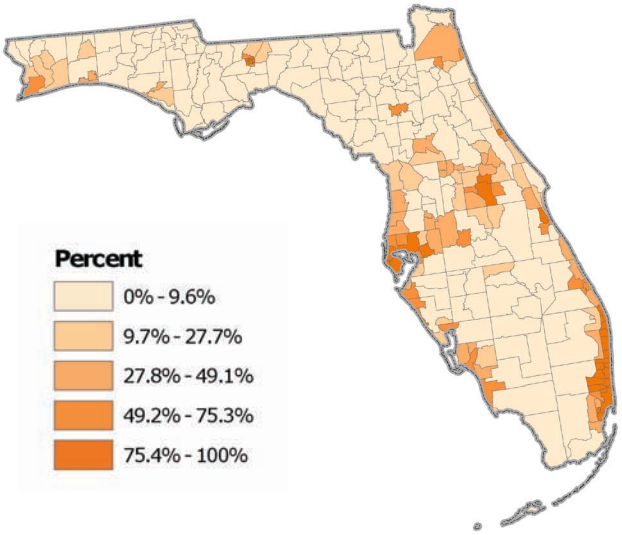


Figure FL-3.—Percent of county subdivision area classified as urban land in 2000.

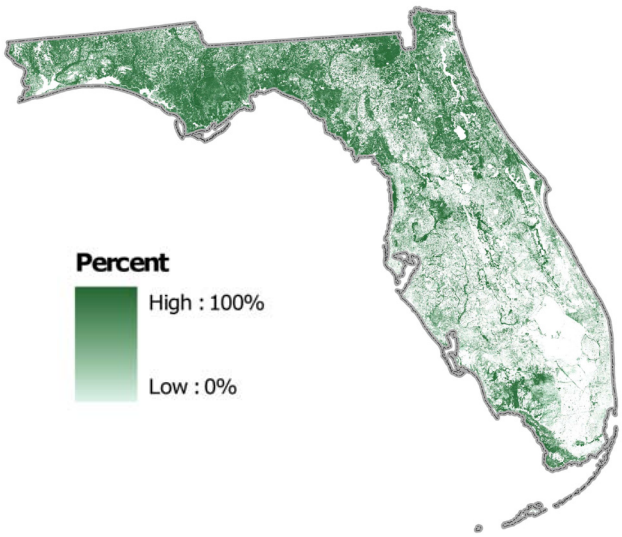


Figure FL-4.—Percentage tree canopy cover.

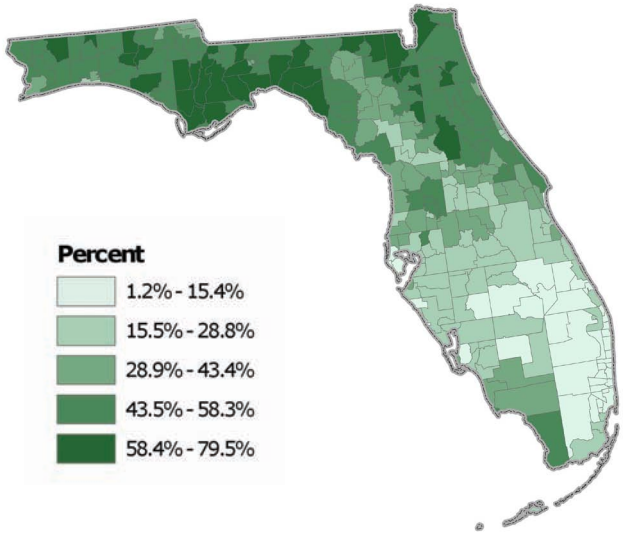


Figure FL-5.—Percentage tree canopy cover within county subdivisions.

Tree Canopy Cover Characteristics

Tree canopy cover in Florida averages 38.4 percent (Fig. FL-4), with 96.7 percent total green space, 39.7 percent canopy green space, and 3,405.2 m^2 of canopy cover per capita. Average tree cover in urban areas in Florida was 22.6 percent, with 78.1 percent total green space, 29.0 percent canopy green space, and 252.3 m^2 of canopy cover per capita. Within community lands in Florida, average tree cover was 26.7 percent, with 82.5 percent total green space, 32.4 percent canopy green space, and 397.0 m^2 of canopy cover per capita (Table FL-1). Tree canopy cover, canopy green space, and tree cover per capita varied among communities, county subdivisions, and counties (Fig. FL-5 through 6; Tables FL-5 through 7).

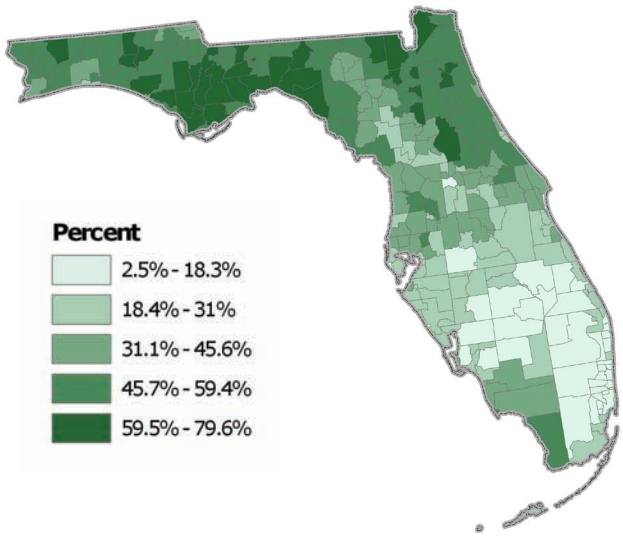


Figure FL-6.—Percentage tree canopy green space in county subdivisions.

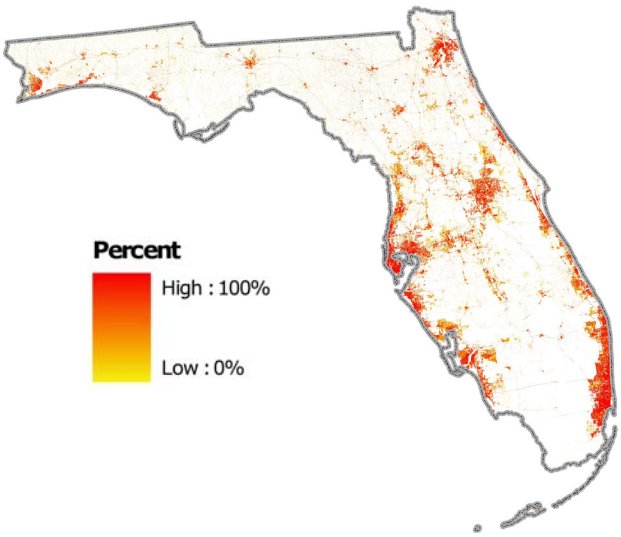


Figure FL-7.—Percentage impervious surface cover.

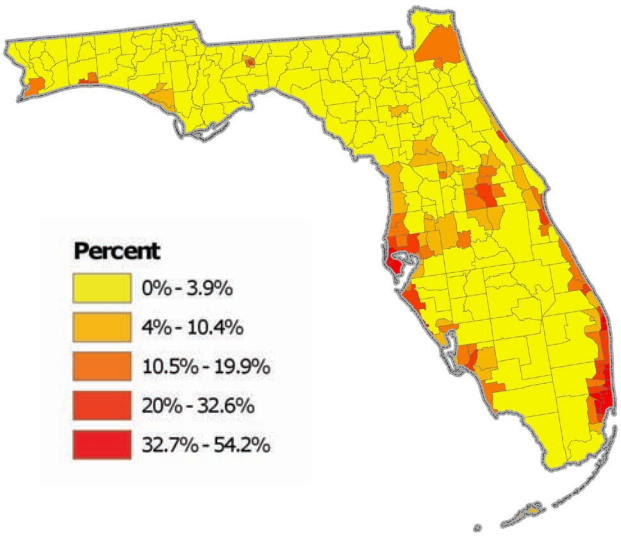


Figure FL-8.—Percentage impervious surface cover within county subdivisions.

Impervious Surface Cover Characteristics

Average impervious surface cover in Florida is 3.3 percent of the land area (Fig. FL-7), with 296.7 m^2 of impervious surface cover per capita. Average impervious surface cover in urban areas was 21.9 percent, with 244.4 m^2 of impervious surface cover per capita. Within community lands in Florida, average impervious surface cover was 17.5 percent with 259.9 m^2 of impervious surface cover per capita (Table FL-1). Impervious surface cover varied across the State (Fig. FL-8; Tables FL-5 through 7).

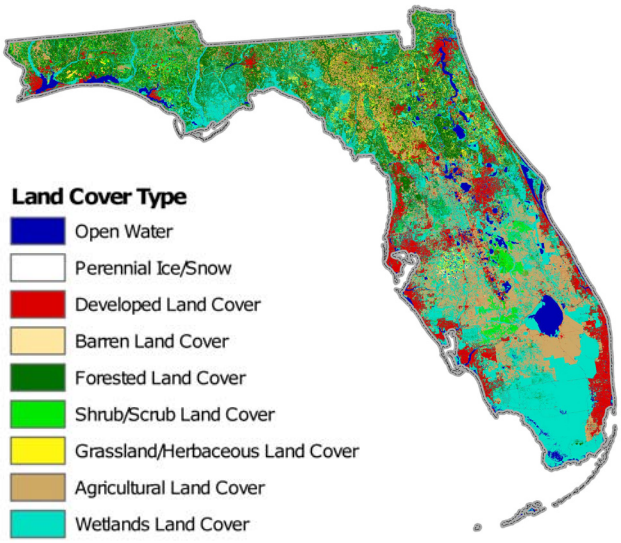


Figure FL-9.—Classified land cover.

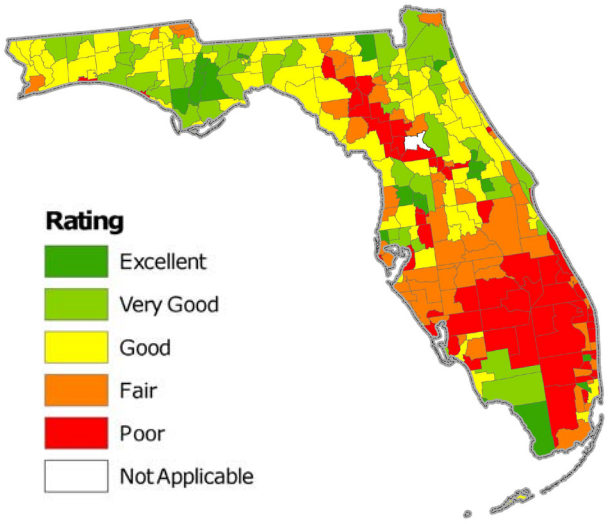


Figure FL-10.—Relative comparisons of tree cover for county subdivisions.

Classified Land-cover Characteristics

Florida's land cover is dominated by agricultural land (Fig. FL-9). The characteristics as a percent of the total land area in Florida are (Tables FL-8 through 10):

- Agricultural – 44.2 percent
- Forested – 21.4 percent
- Developed – 14.3 percent
- Wetland – 10.3 percent
- Grassland – 5.6 percent
- Scrub/Shrub – 3.8 percent
- Barren – 0.5 percent

Relative Comparisons of Tree Cover

Out of the 888 Florida communities, 18 received a rating of excellent and 446 received a rating of poor (Table FL-12). Of the 299 county subdivisions, 22 had a rating of excellent and 70 were rated poor (Fig. FL-10, Table FL-13); and out of 67 counties, eight were given a rating of excellent and 15 were given a rating of poor (Table FL-14). Variability of assessment scores is a product of the difference in land-cover distributions and the percentage of canopy cover within the population density classes and mapping zones (Fig. FL-10; Tables FL-11 through 14).

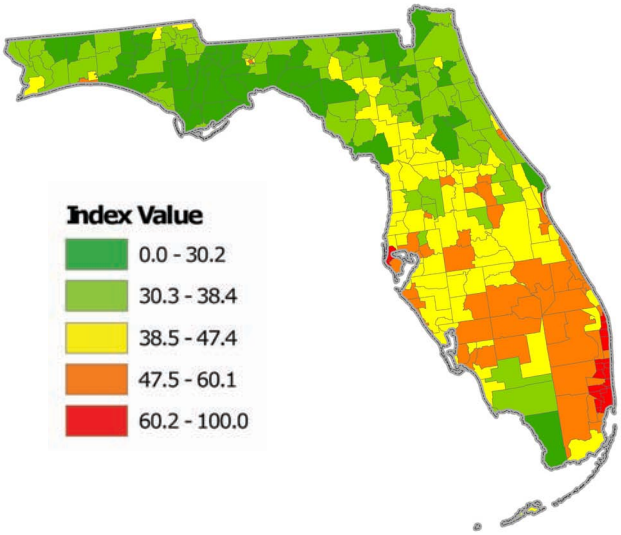


Figure FL-11.—Planting priority index for county subdivisions. The higher the index value, the greater priority for planting.

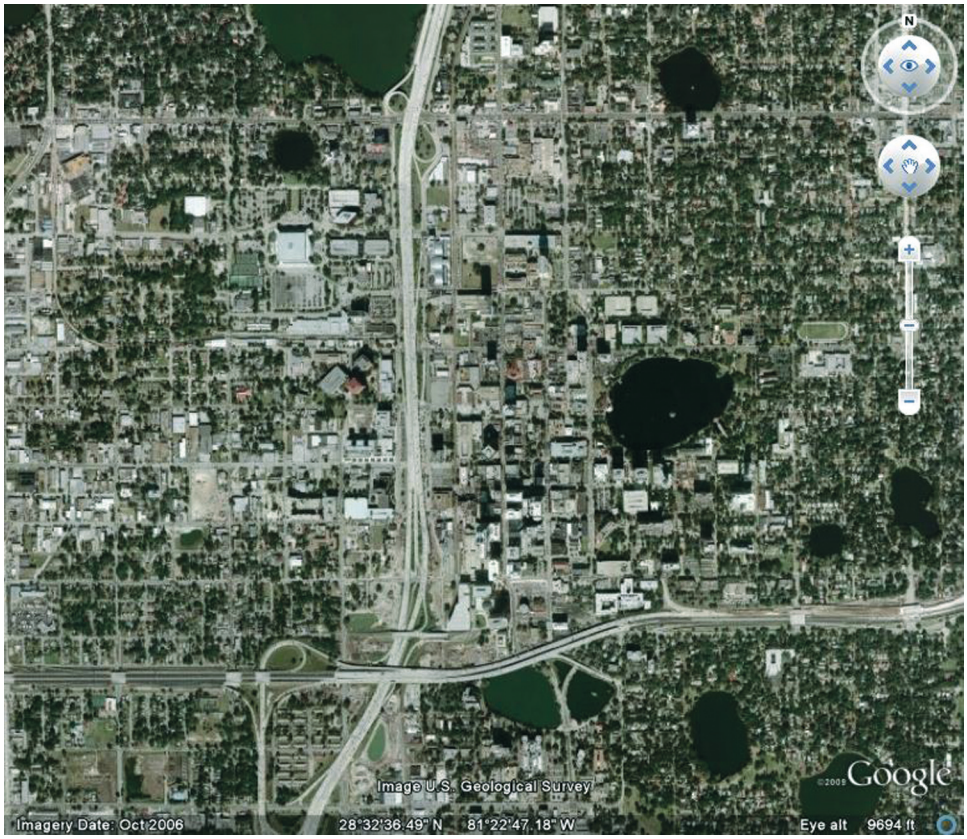
Priority Areas for Tree Planting

Priority areas for planting tend to be highest in more urbanized areas due to higher population density (Fig. FL-11; Tables FL-15 through 17). These index values can also be produced using high resolution cover data to determine local planting priority areas (e.g. neighborhoods).

Urban Tree Benefits

The following forest attributes are estimated for the urban or community land in Florida (Table FL-1). These are rough estimates of values. More localized data are needed for more precise estimates, but these values reveal first-order approximations.

- 292 million trees
- 55.7 million metric tons of C stored ($1.3 billion value)
- 1.8 million metric tons/year of C sequestered ($41.9 million value)
- 65,750 metric tons/year total pollution removal ($540.5 million value)
  - 1,751 metric tons/year of CO removed ($2.5 million value)
  - 6,945 metric tons/year NO_2 removed ($68.8 million value)
  - 34,218 metric tons/year of O_3 removed ($339.0 million value)
  - 4,964 metric tons/year of SO_2 removed ($12.0 million value)
  - 17,874 metric tons/year of PM_{10} removed ($118.2 million value).

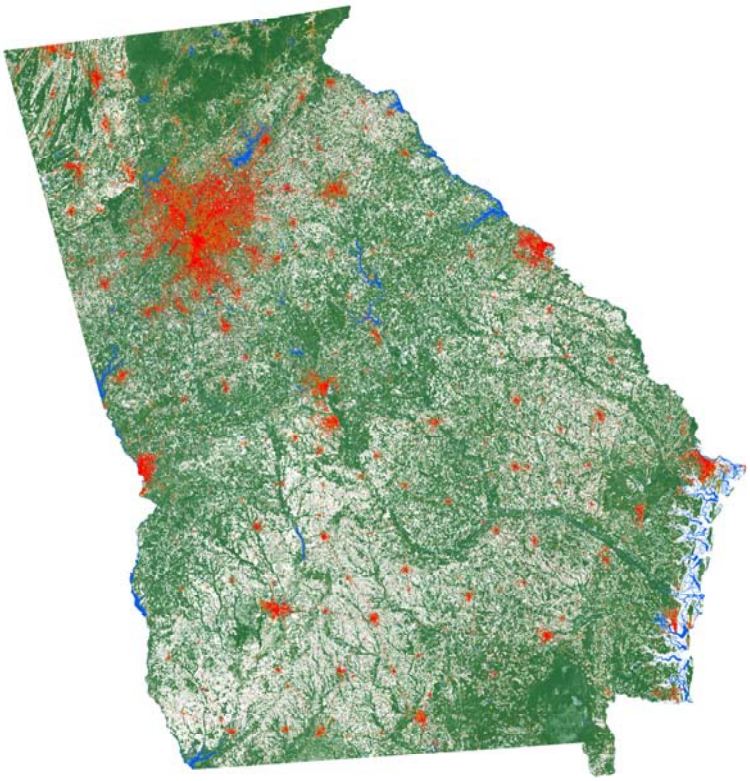


Summary

The data presented in this report provide a better understanding of Florida's urban and community forests. This information can be used to advance urban and community forest policy and management that could improve environmental quality and human health throughout the State.

These data establish a baseline to assess future change and can be used to understand:

- Extent of the urban and community forest resource
- Variations in the resource across the State
- Magnitude and value of the urban and community forest resource
- Urban growth in Florida
- Implications of policy decisions related to urban sprawl and urban and community forest management



GEORGIA'S URBAN AND COMMUNITY FORESTS

Statewide Summary

Urban or community land in Georgia comprises about 9.6 percent of the state land area in 2000, an increase from 7.3 percent in 1990. Statewide tree canopy cover averages 52.0 percent and tree cover in urban or community areas is about 42.6 percent, with 11.8 percent impervious surface cover and 48.3 percent of the total green space covered by tree canopy cover. Statewide, urban or community land in Georgia has an estimated 293.1 million trees, which store about 55.9 million metric tons of carbon ($1.3 billion), and annually remove about 1.8 million metric tons of carbon ($42.0 million) and 49,670 metric tons of air pollution ($410.4 million) (Table GA-1).

Tables GA-2 through GA-17 are not printed in this report but are available on the CD located on the inside back cover and at http://nrs.fs.fed.us/data/urban.

Table GA-1.—Statewide summary of population, area, population density, tree canopy and impervious surface land cover, and urban tree benefits in urban, community, and urban or community areas.

Georgia		Statewide	Urban [a]	Community [b]	Urban or Community [c]
Population	2000	8,186,453	5,864,163	3,809,842	n/a
	1990	6,478,216	4,097,339	2,836,318	n/a
	% Change (1990-2000)	26.4	43.1	34.3	n/a
	% Total population (2000)	100.0	71.6	46.5	n/a
Total area	km^2 (2000)	153,909.4	9,718.5	9,724.0	14,694.8
	km^2 (1990)	153,909.4	7,304.9	8,009.1	11,220.5
	% Change (1990-2000)	0.0	33.0	21.4	31.0
Land area	km^2 (2000)	150,135.0	9,622.0	9,530.8	14,438.7
	% Land area (2000)	100.0	6.4	6.3	9.6
	km^2 (1990)	150,135.0	7,248.3	7,838.8	11,017.6
	% Land area (1990)	100.0	4.8	5.2	7.3
	% Change (1990-2000)	0.0	32.7	21.6	31.1
Population density (people/land area km^2)	2000	54.5	609.5	399.7	n/a
	1990	43.1	565.3	361.8	n/a
	% Change (1990-2000)	26.4	7.8	10.5	n/a
Tree canopy cover (2000)	km^2	78,134.1	4,009.9	3,953.3	6,145.8
	% Land area	52.0	41.7	41.5	42.6
	Per capita (m^2/person)	9,544.3	683.8	1,037.7	n/a
	% Canopy green space [d]	53.0	49.1	47.2	48.3
Total green space (2000) [e]	km^2	147,430.0	8,165.5	8,372.1	12,735.4
	% Land area	98.2	84.9	87.8	88.2
Available green space (2000) [f]	km^2	69,296.8	4,155.9	4,419.1	6,590.1
	% Land area	46.2	43.2	46.4	45.6
Impervious surface cover (2000)	km^2	2,704.8	1,456.6	1,158.7	1,703.4
	% Land area	1.8	15.1	12.2	11.8
	Per capita (m^2/person)	330.4	248.4	304.1	n/a
Urban tree benefits (2000)	Estimated number of trees	n/a	191,200,000	188,500,000	293,100,000
	Carbon				
	Carbon stored (metric tons)	n/a	36,500,000	36,000,000	55,900,000
	Carbon stored ($)	n/a	$832,200,000	$820,800,000	$1,274,500,000
	Carbon sequestered (metric tons/year)	n/a	1,203,000	1,186,000	1,844,000
	Carbon sequestered ($/year)	n/a	$27,428,000	$27,041,000	$42,043,000
	Pollution				
	CO removed (metric tons/year)	n/a	866	854	1,328
	CO removed ($/year)	n/a	$1,218,800	$1,201,600	$1,868,000
	NO_2 removed (metric tons/year)	n/a	3,309	3,263	5,072
	NO_2 removed ($/year)	n/a	$32,783,400	$32,320,400	$50,244,700
	O_3 removed (metric tons/year)	n/a	16,757	16,520	25,682
	O_3 removed ($/year)	n/a	$165,993,000	$163,649,000	$254,405,000
	SO_2 removed (metric tons/year)	n/a	1,942	1,914	2,976
	SO_2 removed ($/year)	n/a	$4,708,400	$4,641,900	$7,216,200
	PM_{10} removed (metric tons/year)	n/a	9,532	9,397	14,609
	PM_{10} removed ($/year)	n/a	$63,043,600	$62,153,300	$96,622,200
	Total pollution removal (metric tons/year)	n/a	32,410	31,950	49,670
	Total pollution removal ($/year)	n/a	$267,700,000	$264,000,000	$410,400,000

[a] Urban land is based on population density and was delimited using the United States Census definitions of urbanized areas and urban clusters. [b] Community land is based on jurisdictional or political boundaries of communities based on United States Census definitions of incorporated or census designated places. [c] Urban or communities is land that is urban, community, or both. Communities may include all, some, or no urban land within their boundaries. [d] Canopy green space is the tree canopy cover divided by total green space. [e] Total green space (TGS) is total area – impervious surface cover – water. [f] Available green space (AGS) is total green space – tree canopy cover (if the calculated value is less than 0, then value set at 0).

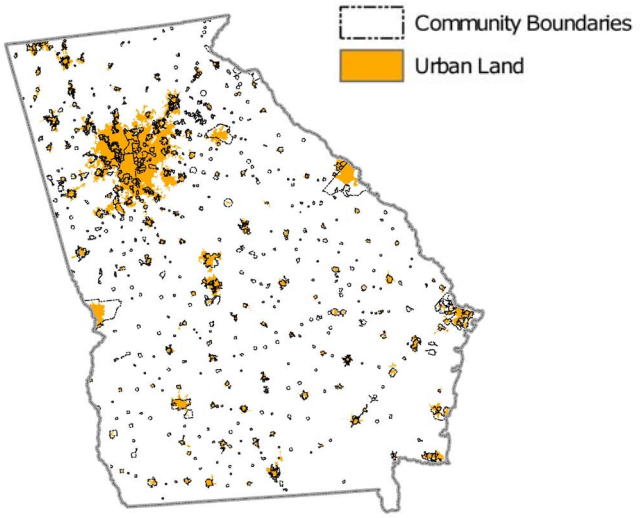


Figure GA-1.—Urban or community land in 2000; urban area relative to community boundaries.

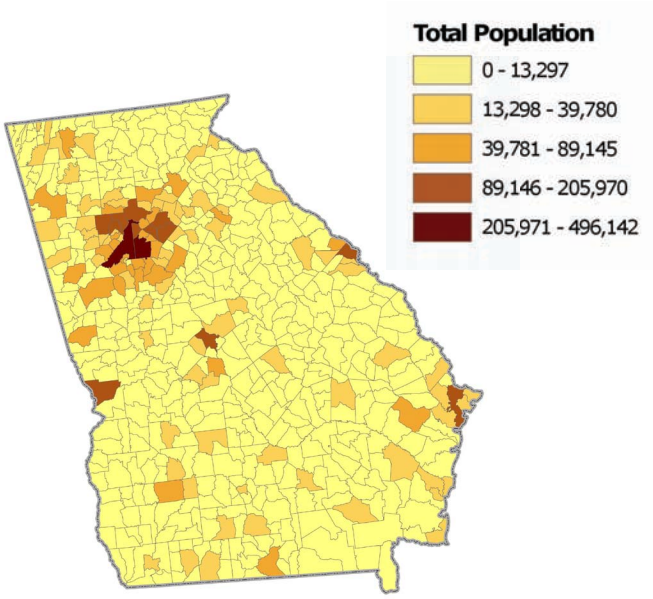


Figure GA-2.—2000 population within county subdivision boundaries.

Human Population Characteristics and Trends

The population in Georgia increased 26.4 percent, from 6,478,216 in 1990 to 8,186,453 in 2000 (Table GA-1). In Georgia, 71.6 percent of the State's population is in urban areas (Fig. GA-1), and 46.5 percent of the population is within communities (Fig. GA-2).

Urban and Community Land

Urban land comprises 6.4 percent of the land area of Georgia, while lands within communities make up 6.3 percent of the State (Fig. GA-1). Between 1990 and 2000, urban area increased 32.7 percent, while community land increased from 5.2 to 6.3 percent (Table GA-1). Urban area in Georgia is projected to increase to 14.3 percent by 2050, based on average urban growth pattern of the 1990s (Nowak and Walton 2005). Both urban land (attaining minimum population density) and community land (political boundaries) increased from 1990 to 2000. The percentages are calculated using the total (water and land) area of the geopolitical units derived from U.S. Census cartographic boundary data. Percent urban land varied across the State (Fig. GA-3; Tables GA-2 through 4).

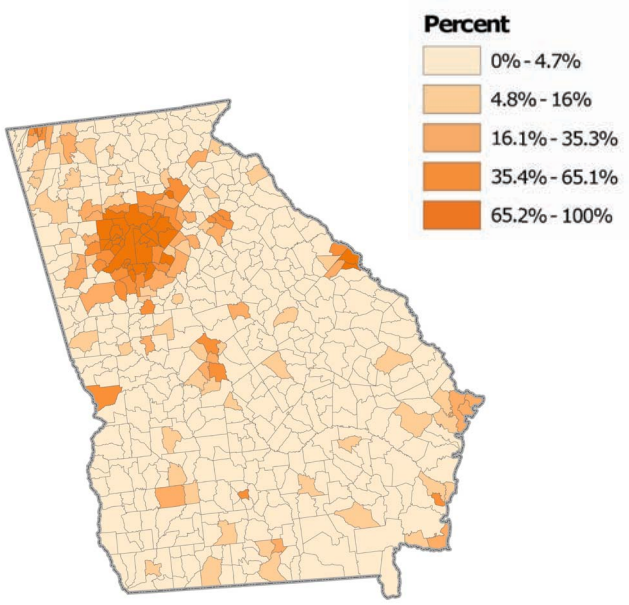


Figure GA-3.—Percent of county subdivision area classified as urban land in 2000.

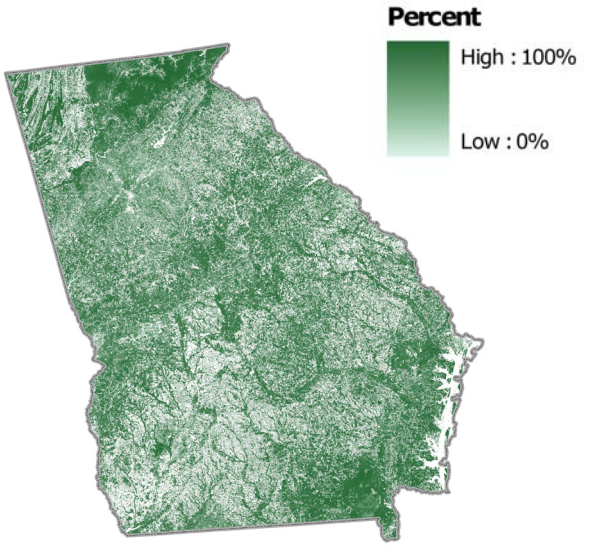


Figure GA-4.—Percentage tree canopy cover.

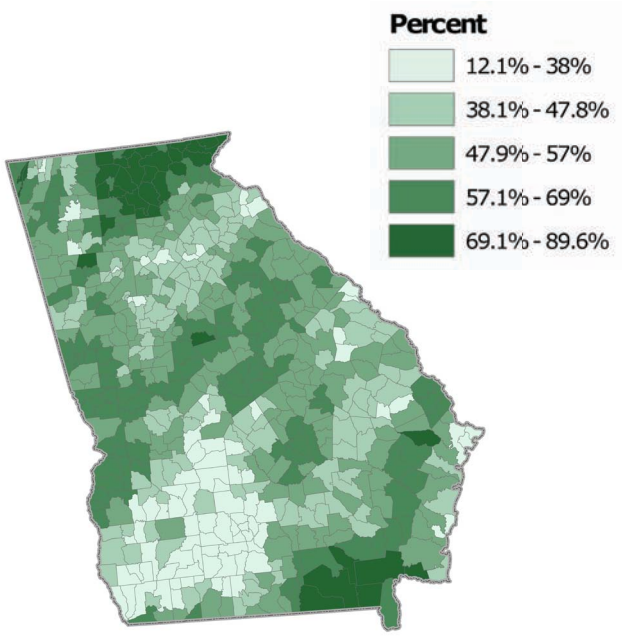


Figure GA-5.—Percentage tree canopy cover within county subdivisions.

Tree Canopy Cover Characteristics

Tree canopy cover in Georgia averages 52.0 percent (Fig. GA-4), with 98.2 percent total green space, 53.0 percent canopy green space, and 9,544.3 m^2 of canopy cover per capita. Average tree cover in urban areas in Georgia was 41.7 percent, with 84.9 percent total green space, 49.1 percent canopy green space, and 683.8 m^2 of canopy cover per capita. Within community lands in Georgia, average tree cover was 41.5 percent, with 87.8 percent total green space, 47.2 percent canopy green space, and 1,037.7 m^2 of canopy cover per capita (Table GA-1). Tree canopy cover, canopy green space, and tree cover per capita varied among communities, county subdivisions, and counties (Fig. GA-5 through 6; Tables GA-5 through 7).

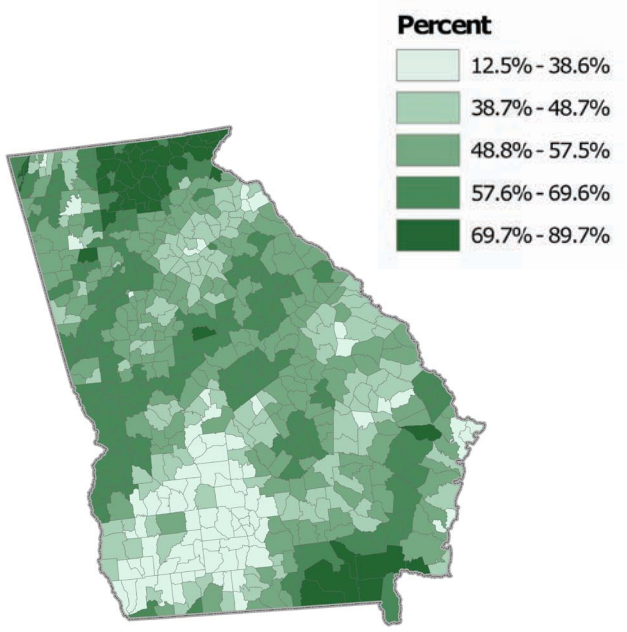


Figure GA-6.—Percentage tree canopy green space in county subdivisions.

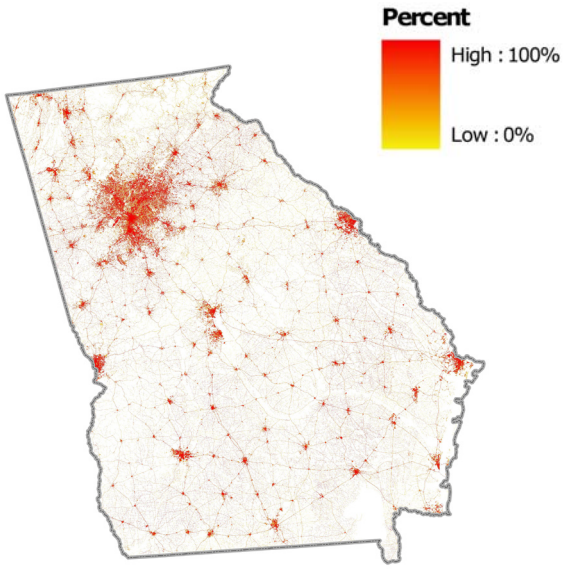


Figure GA-7.—Percentage impervious surface cover.

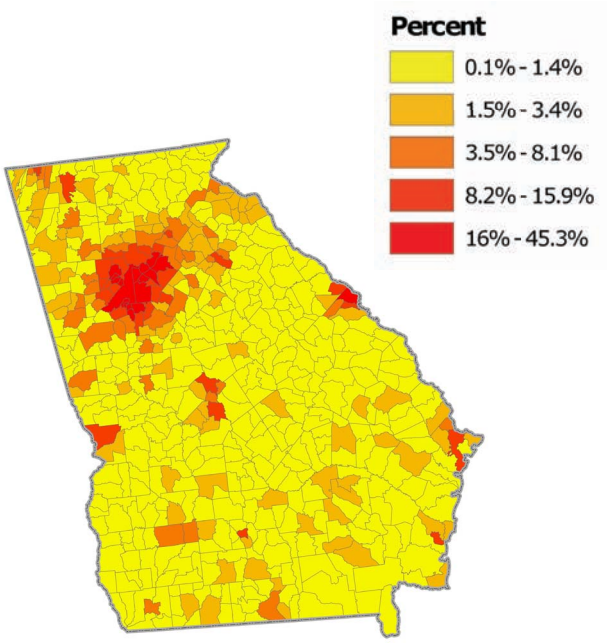


Figure GA-8.—Percentage impervious surface cover within county subdivisions.

Impervious Surface Cover Characteristics

Average impervious surface cover in Georgia is 1.8 percent of the land area (Fig. GA-7), with 330.4 m^2 of impervious surface cover per capita. Average impervious surface cover in urban areas was 15.1 percent, with 248.4 m^2 of impervious surface cover per capita. Within community lands in Georgia, average impervious surface cover was 12.2 percent with 304.1 m^2 of impervious surface cover per capita (Table GA-1). Impervious surface cover varied across the State (Fig. GA-8; Tables GA-5 through 7).

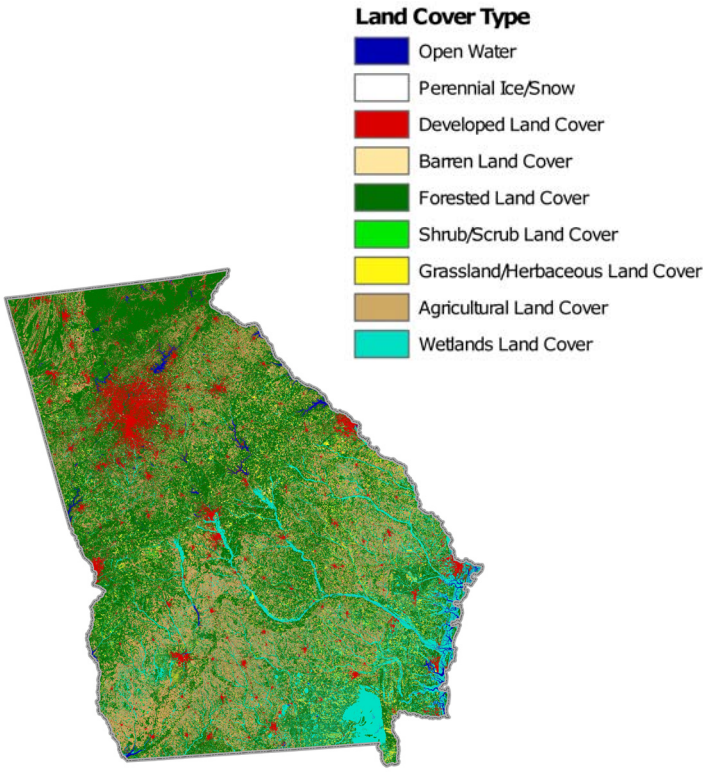


Figure GA-9.—Classified land cover.

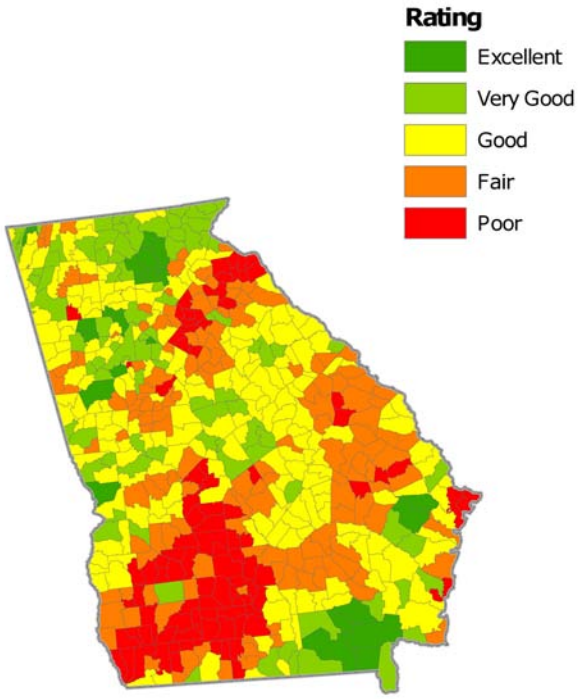


Figure GA-10.—Relative comparisons of tree cover for county subdivisions.

Classified Land-cover Characteristics

Georgia's land cover is dominated by forest land (Fig. GA-9). The characteristics as a percent of the total land area in Georgia are (Tables GA-8 through 10):

- Forested – 48.5 percent
- Agricultural – 30.7 percent
- Developed – 9.0 percent
- Grassland – 8.3 percent
- Wetland – 1.7 percent
- Scrub/Shrub – 1.3 percent
- Barren – 0.5 percent

Relative Comparisons of Tree Cover

Out of the 596 Georgia communities, 16 received a rating of excellent and 114 received a rating of poor (Table GA-12). Of the 577 county subdivisions, 23 had a rating of excellent and 98 were rated poor (Fig. GA-10, Table GA-13); and out of 159 counties, 13 were given a rating of excellent and 30 were given a rating of poor (Table GA-14). Variability of assessment scores is a product of the difference in land-cover distributions and the percentage of canopy cover within the population density classes and mapping zones (Fig. GA-10; Tables GA-11 through 14).

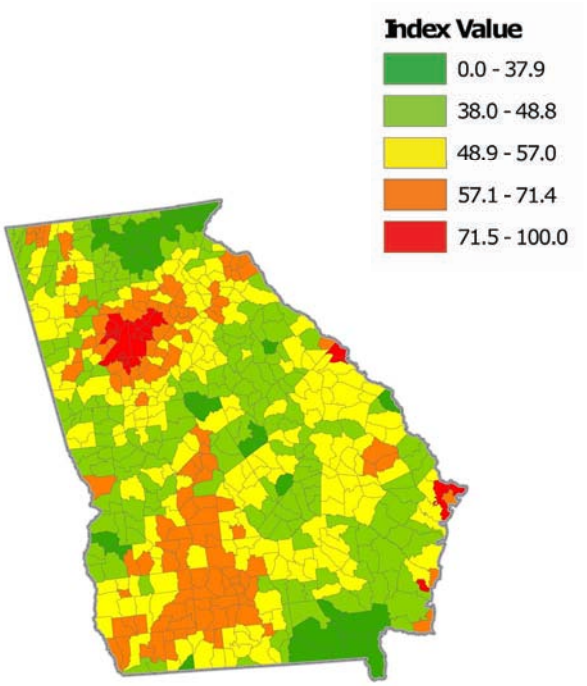


Figure GA-11.—Planting priority index for county subdivisions. The higher the index value, the greater priority for planting.

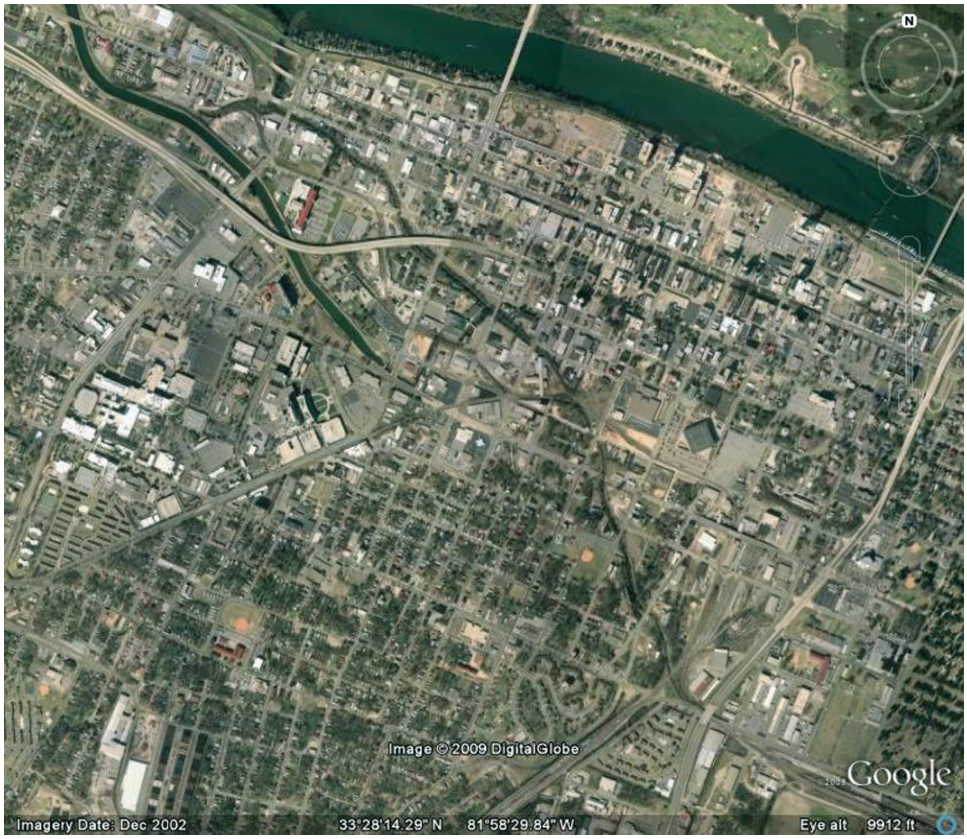
Priority Areas for Tree Planting

Priority areas for planting tend to be highest in more urbanized areas due to higher population density (Fig. GA-11; Tables GA-15 through 17). These index values can also be produced using high resolution cover data to determine local planting priority areas (e.g. neighborhoods).

Urban Tree Benefits

The following forest attributes are estimated for the urban or community land in Georgia (Table GA-1). These are rough estimates of values. More localized data are needed for more precise estimates, but these values reveal first-order approximations.

- 293.1 million trees
- 55.9 million metric tons of C stored ($1.3 billion value)
- 1.8 million metric tons/year of C sequestered ($42.0 million value)
- 49,670 metric tons/year total pollution removal ($410.4 million value)
  - 1,328 metric tons/year of CO removed ($1.9 million value)
  - 5,072 metric tons/year NO_2 removed ($50.2 million value)
  - 25,682 metric tons/year of O_3 removed ($254.4 million value)
  - 2,976 metric tons/year of SO_2 removed ($7.2 million value)
  - 14,609 metric tons/year of PM_{10} removed ($96.6 million value)

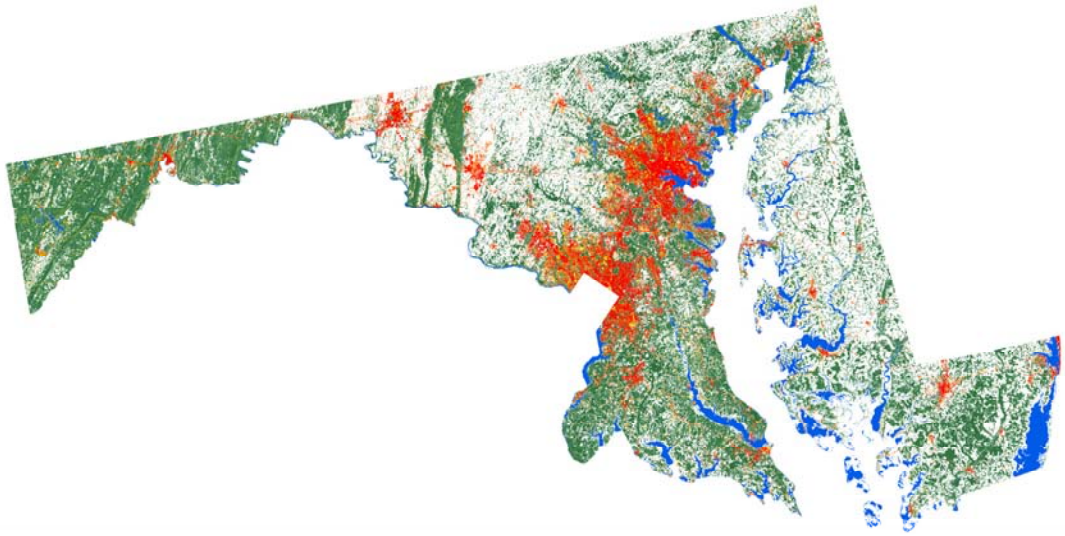


Summary

The data presented in this report provide a better understanding of Georgia's urban and community forests. This information can be used to advance urban and community forest policy and management that could improve environmental quality and human health throughout the State.

These data establish a baseline to assess future change and can be used to understand:

- Extent of the urban and community forest resource
- Variations in the resource across the State
- Magnitude and value of the urban and community forest resource
- Urban growth in Georgia
- Implications of policy decisions related to urban sprawl and urban and community forest management



MARYLAND'S URBAN AND COMMUNITY FORESTS

Statewide Summary

Urban or community land in Maryland comprises about 23.4 percent of the state land area in 2000, an increase from 20.1 percent in 1990. Statewide tree canopy cover averages 35.0 percent and tree cover in urban or community areas is about 29.2 percent, with 13.2 percent impervious surface cover and 33.7 percent of the total green space covered by tree canopy cover. Statewide, urban or community land in Maryland has an estimated 82.6 million trees, which store about 15.8 million metric tons of carbon ($360.2 million), and annually remove about 520,000 metric tons of carbon ($11.9 million) and 16,200 metric tons of air pollution ($133.4 million) (Table MD-1).

Tables MD-2 through MD-17 are not printed in this report but are available on the CD located on the inside back cover and at http://nrs.fs.fed.us/data/urban.

Table MD-1.—Statewide summary of population, area, population density, tree canopy and impervious surface land cover, and urban tree benefits in urban, community, and urban or community areas.

Maryland		Statewide	Urban [a]	Community [b]	Urban or Community [c]
Population	2000	5,296,486	4,558,668	4,245,617	n/a
	1990	4,781,468	3,888,429	3,777,020	n/a
	% Change (1990-2000)	10.8	17.2	12.4	n/a
	% Total population (2000)	100.0	86.1	80.2	n/a
Total area	km^2 (2000)	32,133.2	4,773.7	4,998.5	6,216.3
	km^2 (1990)	32,133.2	4,072.2	4,288.7	5,281.7
	% Change (1990-2000)	0.0	17.2	16.6	17.7
Land area	km^2 (2000)	25,303.4	4,680.5	4,742.5	5,923.9
	% Land area (2000)	100.0	18.5	18.7	23.4
	km^2 (1990)	25,303.4	4,046.1	4,110.5	5,096.0
	% Land area (1990)	100.0	16.0	16.2	20.1
	% Change (1990-2000)	0.0	15.7	15.4	16.2
Population density (people/land area km^2)	2000	209.3	974.0	895.2	n/a
	1990	189.0	961.0	918.9	n/a
	% Change (1990-2000)	10.8	1.3	-2.6	n/a
Tree canopy cover (2000)	km^2	8,851.6	1,311.6	1,357.0	1,731.9
	% Land area	35.0	28.0	28.6	29.2
	Per capita (m^2/person)	1,671.2	287.7	319.6	n/a
	% Canopy green space [d]	36.3	33.2	33.5	33.7
Total green space (2000) [e]	km^2	24,382.4	3,948.8	4,051.3	5,140.8
	% Land area	96.4	84.4	85.4	86.8
Available green space (2000) [f]	km^2	15,530.8	2,637.2	2,694.3	3,409.0
	% Land area	61.4	56.3	56.8	57.5
Impervious surface cover (2000)	km^2	921.1	731.7	691.2	783.0
	% Land area	3.6	15.6	14.6	13.2
	Per capita (m^2/person)	173.9	160.5	162.8	n/a
Urban tree benefits (2000)	Estimated number of trees	n/a	62,600,000	64,700,000	82,600,000
	Carbon				
	Carbon stored (metric tons)	n/a	11,900,000	12,300,000	15,800,000
	Carbon stored ($)	n/a	$271,300,000	$280,400,000	$360,200,000
	Carbon sequestered (metric tons/year)	n/a	393,000	407,000	520,000
	Carbon sequestered ($/year)	n/a	$8,960,000	$9,280,000	$11,856,000
	Pollution				
	CO removed (metric tons/year)	n/a	199	206	263
	CO removed ($/year)	n/a	$280,600	$290,300	$370,500
	NO_2 removed (metric tons/year)	n/a	2,414	2,497	3,187
	NO_2 removed ($/year)	n/a	$23,910,300	$24,738,100	$31,571,200
	O_3 removed (metric tons/year)	n/a	5,654	5,849	7,465
	O_3 removed ($/year)	n/a	$56,006,000	$57,945,000	$73,950,000
	SO_2 removed (metric tons/year)	n/a	1,348	1,395	1,780
	SO_2 removed ($/year)	n/a	$3,269,500	$3,382,700	$4,317,100
	PM_{10} removed (metric tons/year)	n/a	2,655	2,746	3,505
	PM_{10} removed ($/year)	n/a	$17,557,100	$18,165,000	$23,182,500
	Total pollution removal (metric tons/year)	n/a	12,270	12,690	16,200
	Total pollution removal ($/year)	n/a	$101,000,000	$104,500,000	$133,400,000

[a] Urban land is based on population density and was delimited using the United States Census definitions of urbanized areas and urban clusters. [b] Community land is based on jurisdictional or political boundaries of communities based on United States Census definitions of incorporated or census designated places. [c] Urban or communities is land that is urban, community, or both. Communities may include all, some, or no urban land within their boundaries. [d] Canopy green space is the tree canopy cover divided by total green space. [e] Total green space (TGS) is total area – impervious surface cover – water. [f] Available green space (AGS) is total green space – tree canopy cover (if the calculated value is less than 0, then value set at 0).

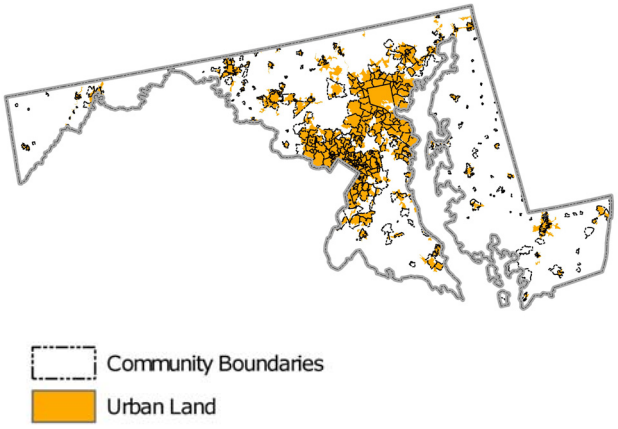


Figure MD-1.—Urban or community land in 2000; urban area relative to community boundaries.

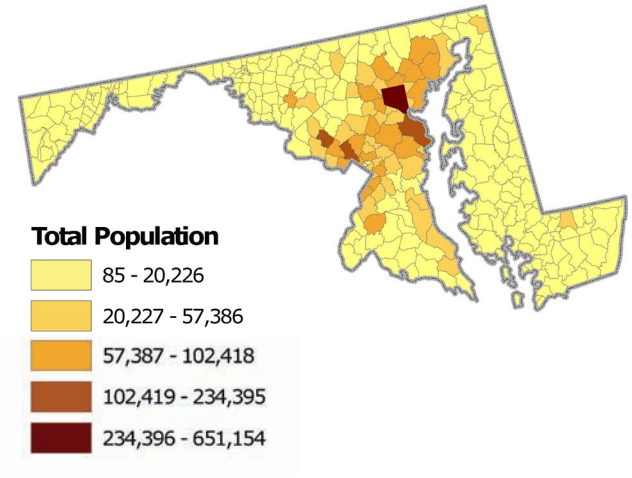


Figure MD-2.—2000 population within county subdivision boundaries.

Human Population Characteristics and Trends

The population in Maryland increased 10.8 percent, from 4,781,468 in 1990 to 5,296,486 in 2000 (Table MD-1). In Maryland, 86.1 percent of the State's population is in urban areas (Fig. MD-1), and 80.2 percent of the population is within communities (Fig. MD-2).

Urban and Community Land

Urban land comprises 18.5 percent of the land area of Maryland, while lands within communities make up 18.7 percent of the State (Fig. MD-1). Between 1990 and 2000, urban area increased 15.7 percent, while community land increased from 16.2 to 18.7 percent (Table MD-1). Urban area in Maryland is projected to increase to 37.5 percent by 2050, based on average urban growth pattern of the 1990s (Nowak and Walton 2005). Both urban land (attaining minimum population density) and community land (political boundaries) increased from 1990 to 2000. The percentages are calculated using the total (water and land) area of the geopolitical units derived from U.S. Census cartographic boundary data. Percent urban land varied across the State (Fig. MD-3; Tables MD-2 through 4).

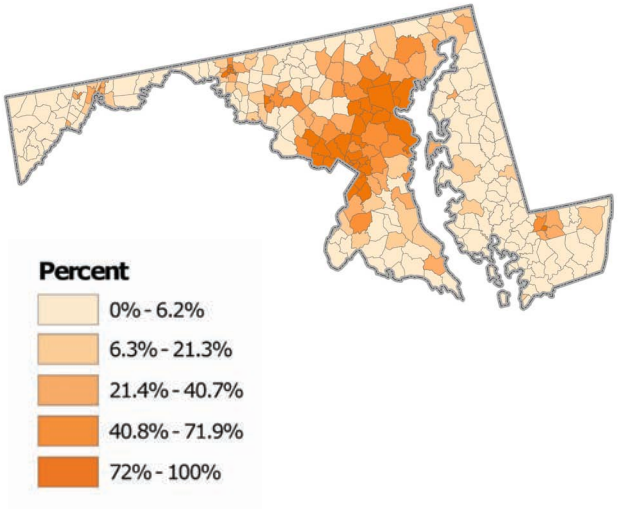


Figure MD-3.—Percent of county subdivision area classified as urban land in 2000.

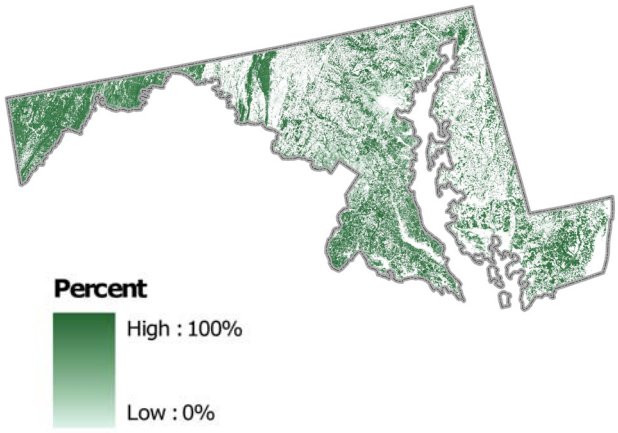


Figure MD-4.—Percentage tree canopy cover.

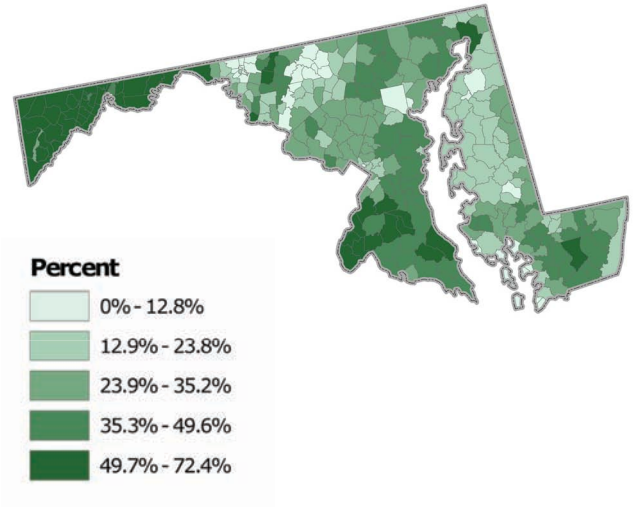


Figure MD-5.—Percentage tree canopy cover within county subdivisions.

Tree Canopy Cover Characteristics

Tree canopy cover in Maryland averages 35.0 percent (Fig. MD-4), with 96.4 percent total green space, 36.3 percent canopy green space, and 1,671.2 m^2 of canopy cover per capita. Average tree cover in urban areas in Maryland was 28.0 percent, with 84.4 percent total green space, 33.2 percent canopy green space, and 287.7 m^2 of canopy cover per capita. Within community lands in Maryland, average tree cover was 28.6 percent, with 85.4 percent total green space, 33.5 percent canopy green space, and 319.6 m^2 of canopy cover per capita (Table MD-1). Tree canopy cover, canopy green space, and tree cover per capita varied among communities, county subdivisions, and counties (Fig. MD-5 through 6; Tables MD-5 through 7).

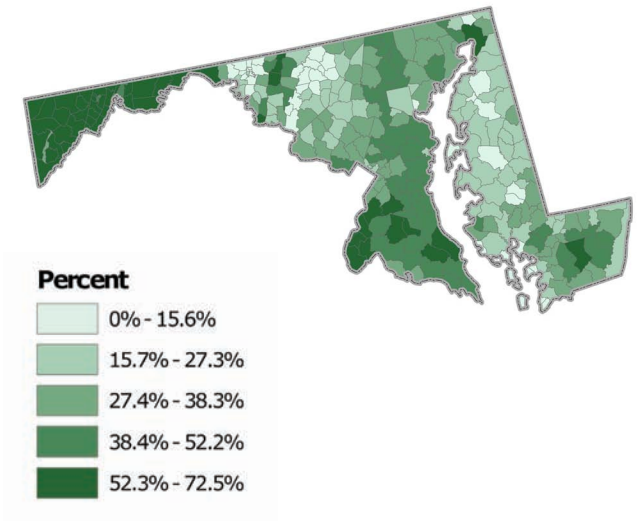


Figure MD-6.—Percentage tree canopy green space in county subdivisions.

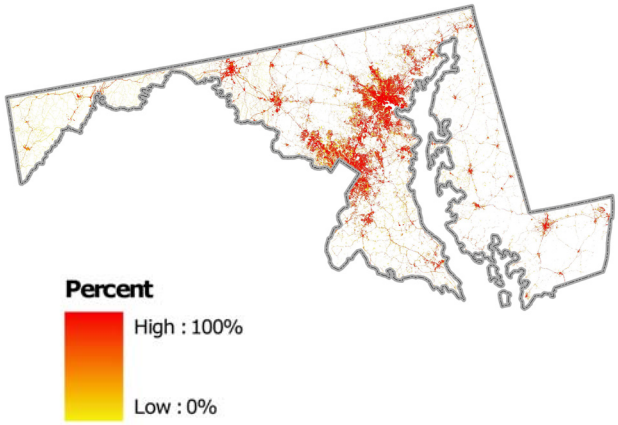


Figure MD-7.—Percentage impervious surface cover.

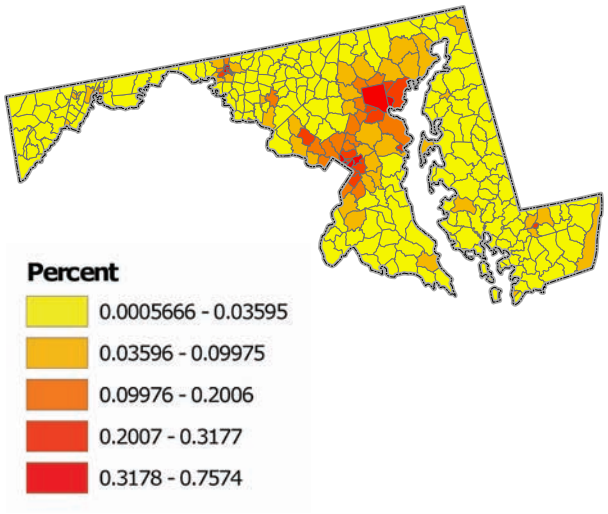


Figure MD-8.—Percentage impervious surface cover within county subdivisions.

Impervious Surface Cover Characteristics

Average impervious surface cover in Maryland is 3.6 percent of the land area (Fig. MD-7), with 173.9 m^2 of impervious surface cover per capita. Average impervious surface cover in urban areas was 15.6 percent, with 160.5 m^2 of impervious surface cover per capita. Within community lands in Maryland, average impervious surface cover was 14.6 percent with 162.8 m^2 of impervious surface cover per capita (Table MD-1). Impervious surface cover varied across the State (Fig. MD-8; Tables MD-5 through 7).

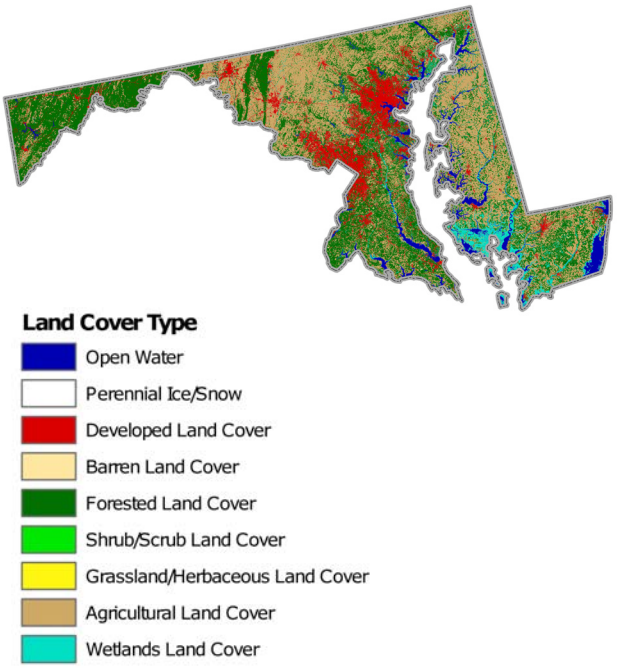


Figure MD-9.—Classified land cover.

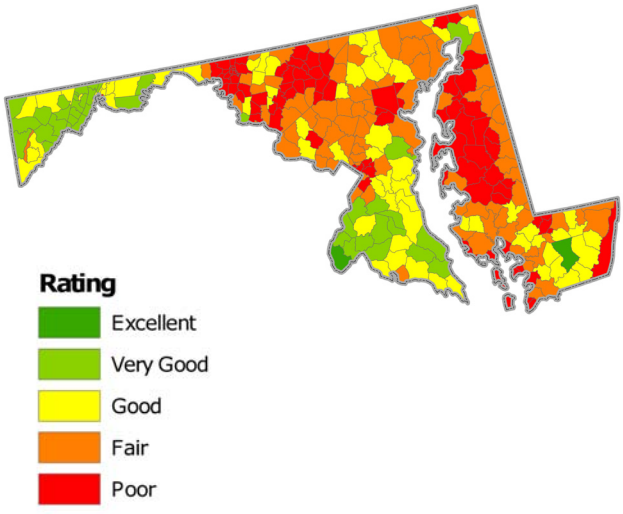


Figure MD-10.—Relative comparisons of tree cover for county subdivisions.

Classified Land-cover Characteristics

Maryland's land cover is dominated by agricultural land (Fig. MD-9). The characteristics as a percent of the total land area in Maryland are (Tables MD-8 through 10):

- Agricultural – 44.3 percent
- Forested – 38.8 percent
- Developed – 12.2 percent
- Wetland – 3.5 percent
- Barren – 1.2 percent

Relative Comparisons of Tree Cover

Out of the 368 Maryland communities, eight received a rating of excellent and 164 received a rating of poor (Table MD-12). Of the 293 county subdivisions, two had a rating of excellent and 91 were rated poor (Fig. MD-10, Table MD-13); and out of 24 counties, one was given a rating of excellent and ten were given a rating of poor (Table MD-14). Variability of assessment scores is a product of the difference in land-cover distributions and the percentage of canopy cover within the population density classes and mapping zones (Fig. MD-10; Tables MD-11 through 14).

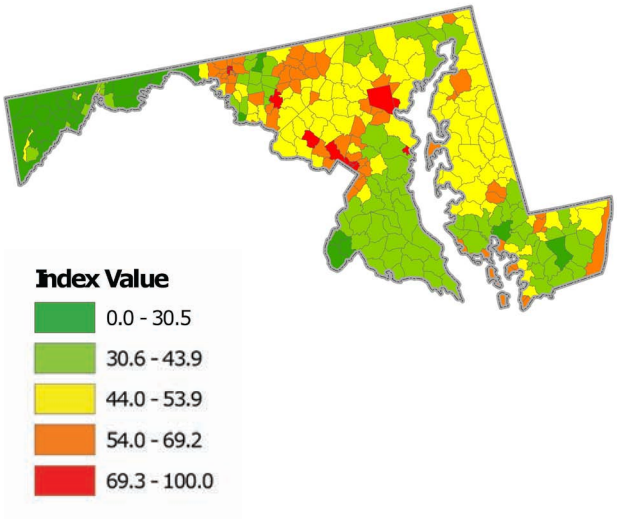


Figure MD-11.—Planting priority index for county subdivisions. The higher the index value, the greater priority for planting.

Priority Areas for Tree Planting

Priority areas for planting tend to be highest in more urbanized areas due to higher population density (Fig. MD-11; Tables MD-15 through 17). These index values can also be produced using high resolution cover data to determine local planting priority areas (e.g. neighborhoods).

Urban Tree Benefits

The following forest attributes are estimated for the urban or community land in Maryland (Table MD-1). These are rough estimates of values. More localized data are needed for more precise estimates, but these values reveal first-order approximations.

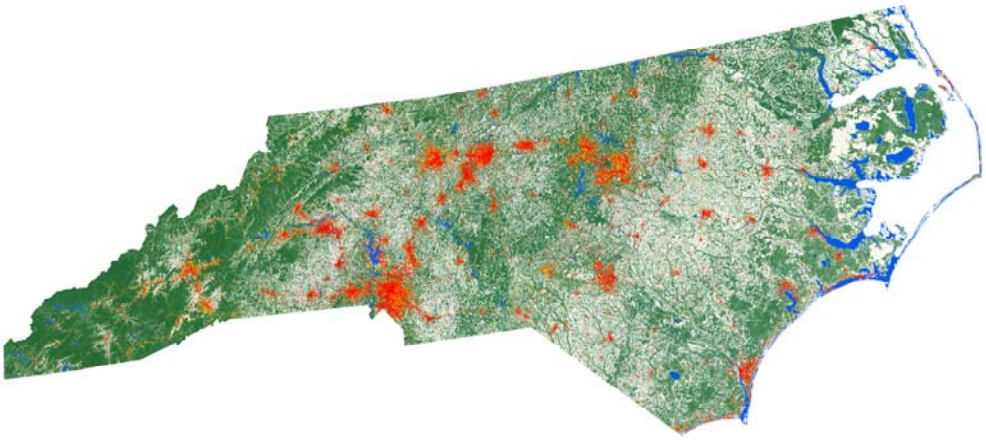
- 82.6 million trees
- 15.8 million metric tons of C stored ($360.2 million value)
- 520,000 metric tons/year of C sequestered ($11.9 million value)
- 16,200 metric tons/year total pollution removal ($133.4 million value)
  - 263 metric tons/year of CO removed ($370,500 value)
  - 3,187 metric tons/year NO_2 removed ($31.6 million value)
  - 7,465 metric tons/year of O_3 removed ($74.0 million value)
  - 1,780 metric tons/year of SO_2 removed ($4.3 million value)
  - 3,505 metric tons/year of PM_{10} removed ($23.2 million value)

Summary

The data presented in this report provide a better understanding of Maryland's urban and community forests. This information can be used to advance urban and community forest policy and management that could improve environmental quality and human health throughout the State.

These data establish a baseline to assess future change and can be used to understand:

- Extent of the urban and community forest resource
- Variations in the resource across the State
- Magnitude and value of the urban and community forest resource
- Urban growth in Maryland
- Implications of policy decisions related to urban sprawl and urban and community forest management



NORTH CAROLINA'S URBAN AND COMMUNITY FORESTS

Statewide Summary

Urban or community land in North Carolina comprises about 10.3 percent of the state land area in 2000, an increase from 7.7 percent in 1990. Statewide tree canopy cover averages 48.6 percent and tree cover in urban or community areas is about 32.8 percent, with 11.9 percent impervious surface cover and 37.2 percent of the total green space covered by tree canopy cover. Statewide, urban or community land in North Carolina has an estimated 202.6 million trees, which store about 38.7 million metric tons of carbon ($882.4 million), and annually remove about 1.3 million metric tons of carbon ($29.0 million) and 36,590 metric tons of air pollution ($293 million) (Table NC-1).

Tables NC-2 through NC-17 are not printed in this report but are available on the CD located on the inside back cover and at http://nrs.fs.fed.us/data/urban.

Table NC-1.—Statewide summary of population, area, population density, tree canopy and impervious surface land cover, and urban tree benefits in urban, community, and urban or community areas.

North Carolina		Statewide	Urban [a]	Community [b]	Urban or Community [c]
Population	2000	8,049,313	4,849,482	4,349,946	n/a
	1990	6,628,637	3,337,778	3,273,560	n/a
	% Change (1990-2000)	21.4	45.3	32.9	n/a
	% Total population (2000)	100.0	60.2	54.0	n/a
Total area	km^2 (2000)	139,389.3	9,250.2	9,848.1	13,247.6
	km^2 (1990)	139,389.3	7,134.9	7,145.1	9,864.2
	% Change (1990-2000)	0.0	29.6	37.8	34.3
Land area	km^2 (2000)	126,122.9	9,176.5	9,605.5	12,967.8
	% Land area (2000)	100.0	7.3	7.6	10.3
	km^2 (1990)	126,122.9	7,101.0	6,970.7	9,674.2
	% Land area (1990)	100.0	5.6	5.5	7.7
	% Change (1990-2000)	0.0	29.2	37.8	34.0
Population density (people/land area km^2)	2000	63.8	528.5	452.9	n/a
	1990	52.6	470.0	469.6	n/a
	% Change (1990-2000)	21.4	12.4	-3.6	n/a
Tree canopy cover (2000)	km^2	61,317.0	2,870.4	2,991.2	4,248.2
	% Land area	48.6	31.3	31.1	32.8
	Per capita (m^2/person)	7,617.7	591.9	687.7	n/a
	% Canopy green space [d]	49.5	36.4	36.2	37.2
Total green space (2000) [e]	km^2	123,814.0	7,875.0	8,263.5	11,421.5
	% Land area	98.2	85.8	86.0	88.1
Available green space (2000) [f]	km^2	62,497.6	5,004.7	5,272.4	7,173.5
	% Land area	49.6	54.5	54.9	55.3
Impervious surface cover (2000)	km^2	2,308.7	1,301.5	1,342.0	1,546.3
	% Land area	1.8	14.2	14.0	11.9
	Per capita (m^2/person)	286.8	268.4	308.5	n/a
Urban tree benefits (2000)	Estimated number of trees	n/a	136,900,000	142,700,000	202,600,000
	Carbon				
	Carbon stored (metric tons)	n/a	26,100,000	27,200,000	38,700,000
	Carbon stored ($)	n/a	$595,100,000	$620,200,000	$882,400,000
	Carbon sequestered (metric tons/year)	n/a	861,000	897,000	1,274,000
	Carbon sequestered ($/year)	n/a	$19,631,000	$20,452,000	$29,047,000
	Pollution				
	CO removed (metric tons/year)	n/a	595	620	881
	CO removed ($/year)	n/a	$837,200	$872,400	$1,239,400
	NO_2 removed (metric tons/year)	n/a	2,578	2,687	3,816
	NO_2 removed ($/year)	n/a	$25,539,500	$26,614,900	$37,798,600
	O_3 removed (metric tons/year)	n/a	12,305	12,823	18,211
	O_3 removed ($/year)	n/a	$121,892,000	$127,024,000	$180,400,000
	SO_2 removed (metric tons/year)	n/a	2,739	2,855	4,054
	SO_2 removed ($/year)	n/a	$6,642,600	$6,922,300	$9,831,200
	PM_{10} removed (metric tons/year)	n/a	6,507	6,781	9,631
	PM_{10} removed ($/year)	n/a	$43,039,200	$44,851,400	$63,698,200
	Total pollution removal (metric tons/year)	n/a	24,720	25,770	36,590
	Total pollution removal ($/year)	n/a	$198,000,000	$206,300,000	$293,000,000

[a] Urban land is based on population density and was delimited using the United States Census definitions of urbanized areas and urban clusters. [b] Community land is based on jurisdictional or political boundaries of communities based on United States Census definitions of incorporated or census designated places. [c] Urban or communities is land that is urban, community, or both. Communities may include all, some, or no urban land within their boundaries. [d] Canopy green space is the tree canopy cover divided by total green space. [e] Total green space (TGS) is total area – impervious surface cover – water. [f] Available green space (AGS) is total green space – tree canopy cover (if the calculated value is less than 0, then value set at 0).

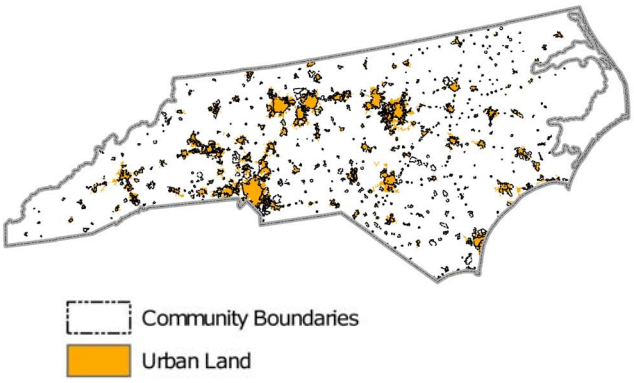


Figure NC-1.—Urban or community land in 2000; urban area relative to community boundaries.

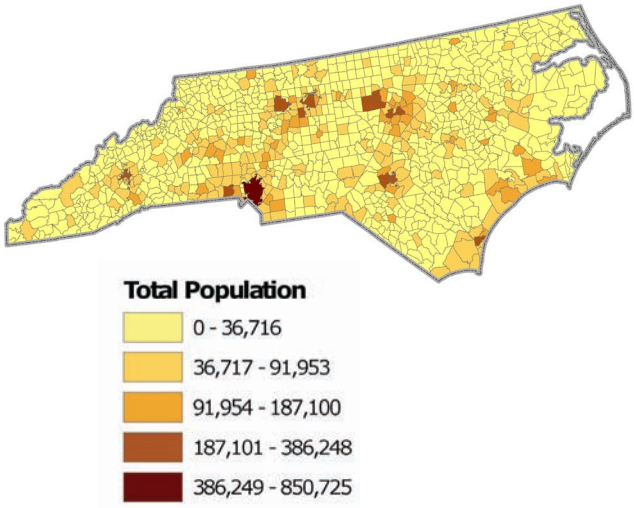


Figure NC-2.—2000 population within county subdivision boundaries.

Human Population Characteristics and Trends

The population in North Carolina increased 21.4 percent, from 6,628,637 in 1990 to 8,049,313 in 2000 (Table NC-1). In North Carolina, 60.2 percent of the State's population is in urban areas (Fig. NC-1), and 54.0 percent of the population is within communities (Fig. NC-2).

Urban and Community Land

Urban land comprises 7.3 percent of the land area of North Carolina, while lands within communities make up 7.6 percent of the State (Fig. NC-1). Between 1990 and 2000, urban area increased 29.2 percent, while community land increased from 5.5 to 7.6 percent (Table NC-1). Urban area in North Carolina is projected to increase to 19.1 percent by 2050, based on average urban growth pattern of the 1990s (Nowak and Walton 2005). Both urban land (attaining minimum population density) and community land (political boundaries) increased from 1990 to 2000. The percentages are calculated using the total (water and land) area of the geopolitical units derived from U.S. Census cartographic boundary data. Percent urban land varied across the State (Fig. NC-3; Tables NC-2 through 4).

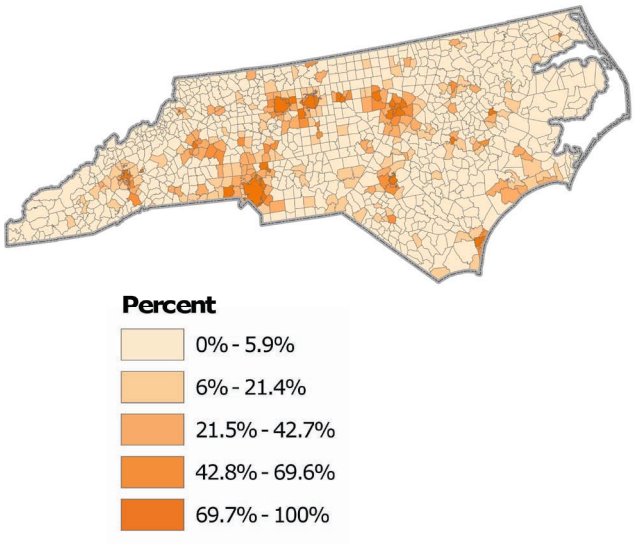


Figure NC-3.—Percent of county subdivision area classified as urban land in 2000.

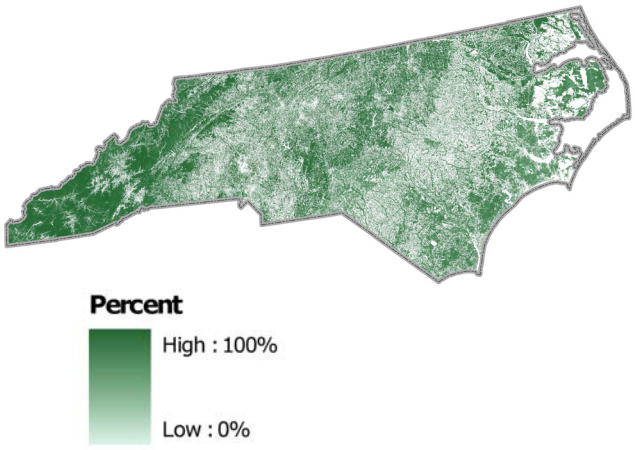


Figure NC-4.—Percentage tree canopy cover.

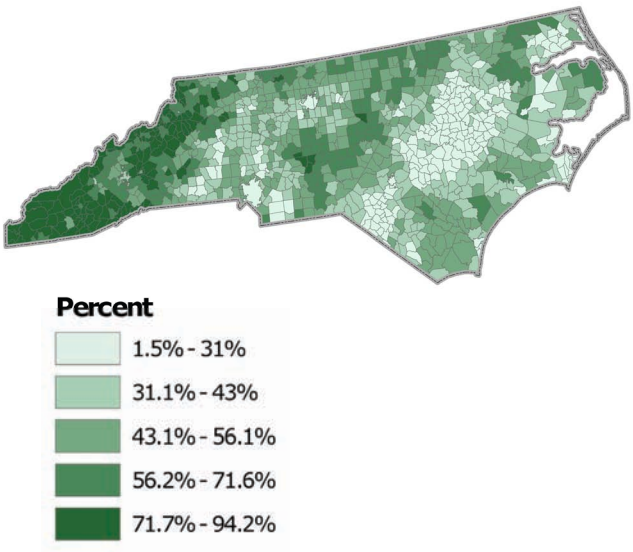


Figure NC-5.—Percentage tree canopy cover within county subdivisions.

Tree Canopy Cover Characteristics

Tree canopy cover in North Carolina averages 48.6 percent (Fig. NC-4), with 98.2 percent total green space, 49.5 percent canopy green space, and 7,617.7 m^2 of canopy cover per capita. Average tree cover in urban areas in North Carolina was 31.3 percent, with 85.8 percent total green space, 36.4 percent canopy green space, and 591.9 m^2 of canopy cover per capita. Within community lands in North Carolina, average tree cover was 31.1 percent, with 86.0 percent total green space, 36.2 percent canopy green space, and 687.7 m^2 of canopy cover per capita (Table NC-1). Tree canopy cover, canopy green space, and tree cover per capita varied among communities, county subdivisions, and counties (Fig. NC-5 through 6; Tables NC-5 through 7).

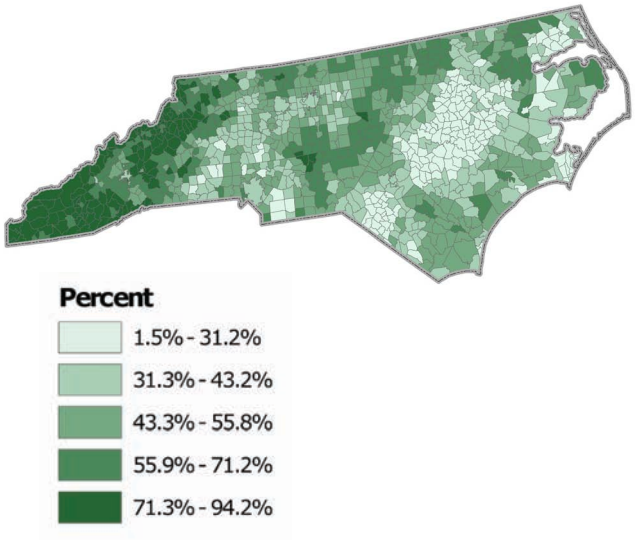


Figure NC-6.—Percentage tree canopy green space in county subdivisions.

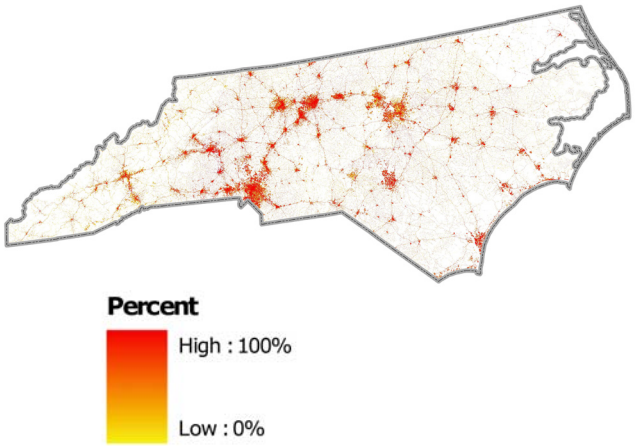


Figure NC-7.—Percentage impervious surface cover.

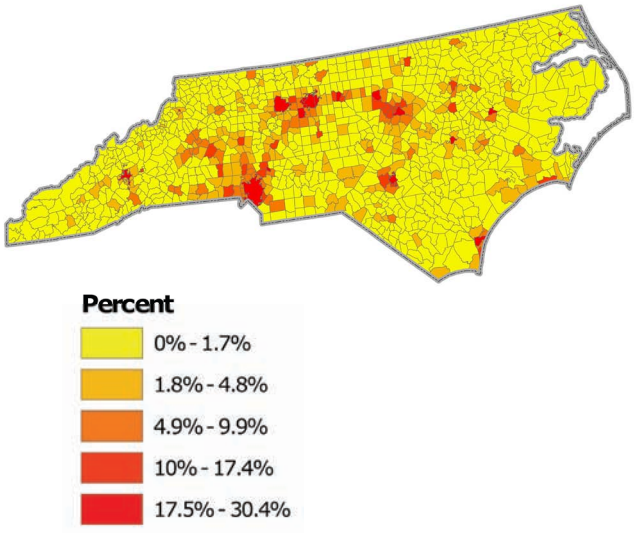


Figure NC-8.—Percentage impervious surface cover within county subdivisions.

Impervious Surface Cover Characteristics

Average impervious surface cover in North Carolina is 1.8 percent of the land area (Fig. NC-7), with 286.8 m^2 of impervious surface cover per capita. Average impervious surface cover in urban areas was 14.2 percent, with 268.4 m^2 of impervious surface cover per capita. Within community lands in North Carolina, average impervious surface cover was 14.0 percent with 308.5 m^2 of impervious surface cover per capita (Table NC-1). Impervious surface cover varied across the State (Fig. NC-8; Tables NC-5 through 7).

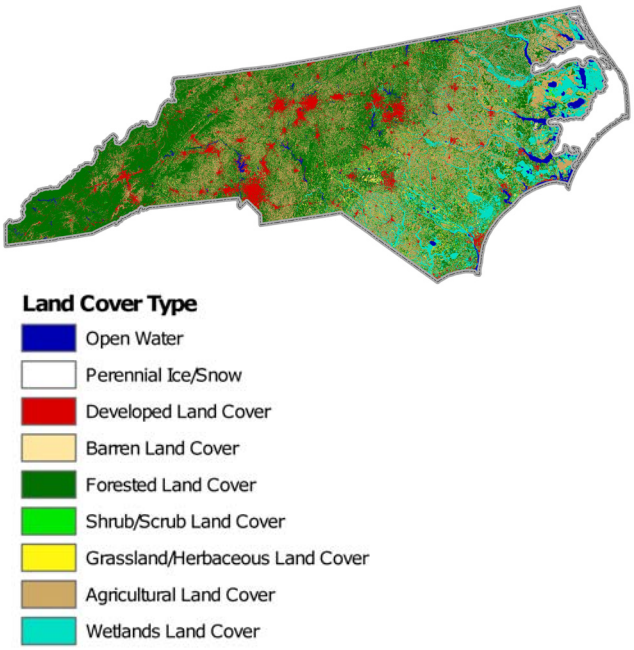


Figure NC-9.—Classified land cover.

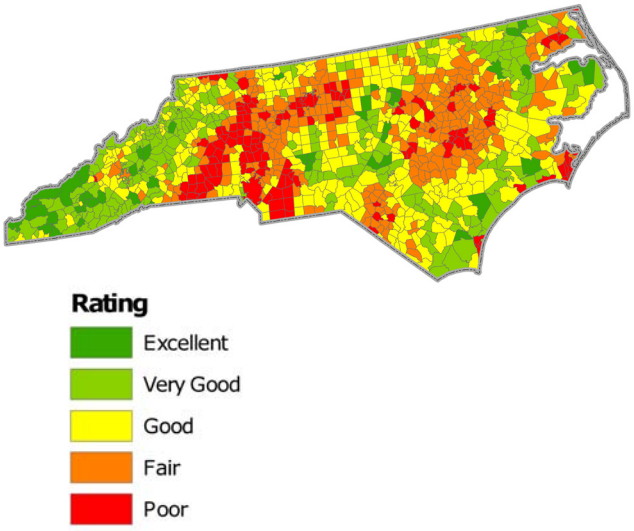


Figure NC-10.—Relative comparisons of tree cover for county subdivisions.

Classified Land-cover Characteristics

North Carolina's land cover is dominated by forest land (Fig. NC-9). The characteristics as a percent of the total land area in North Carolina are (Tables NC-8 through 10):

- Forested – 46.0 percent
- Agricultural – 34.5 percent
- Developed – 9.6 percent
- Grassland – 6.0 percent
- Scrub/Shrub – 2.3 percent
- Wetland – 1.2 percent
- Barren – 0.4 percent

Relative Comparisons of Tree Cover

Out of the 655 North Carolina communities, 22 received a rating of excellent and 152 received a rating of poor (Table NC-12). Of the 1,055 county subdivisions, 51 had a rating of excellent and 145 were rated poor (Fig. NC-10, Table NC-13); and out of 100 counties, 12 were given a rating of excellent and 32 were given a rating of poor (Table NC-14). Variability of assessment scores is a product of the difference in land-cover distributions and the percentage of canopy cover within the population density classes and mapping zones (Fig. NC-10; Tables NC-11 through 14).

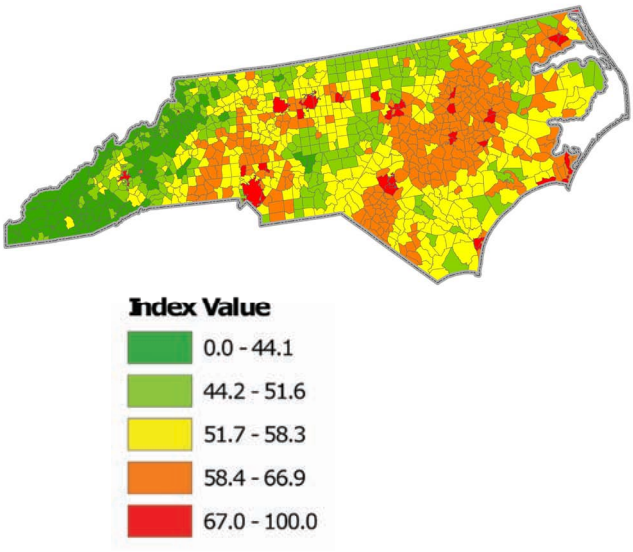


Figure NC-11.—Planting priority index for county subdivisions. The higher the index value, the greater priority for planting.

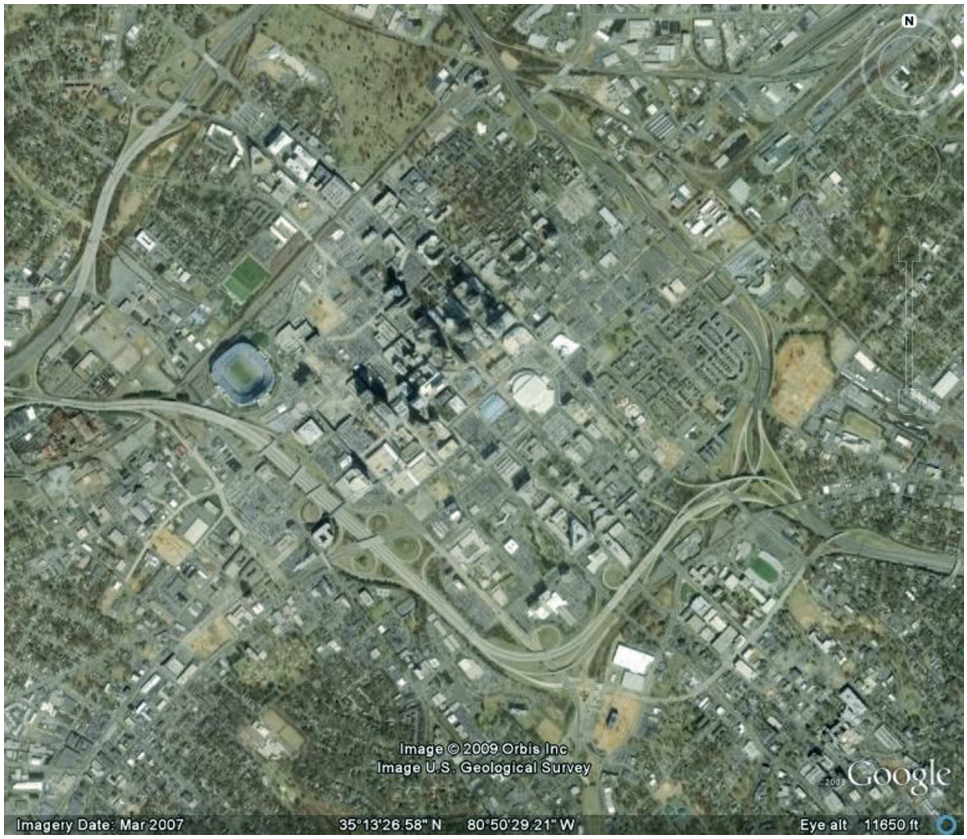
Priority Areas for Tree Planting

Priority areas for planting tend to be highest in more urbanized areas due to higher population density (Fig. NC-11; Tables NC-15 through 17). These index values can also be produced using high resolution cover data to determine local planting priority areas (e.g. neighborhoods).

Urban Tree Benefits

The following forest attributes are estimated for the urban or community land in North Carolina (Table NC-1). These are rough estimates of values. More localized data are needed for more precise estimates, but these values reveal first-order approximations.

- 202.6 million trees
- 38.7 million metric tons of C stored ($882.4 million value)
- 1.3 million metric tons/year of C sequestered ($29.0 million value)
- 36,590 metric tons/year total pollution removal ($293 million value)
  - 881 metric tons/year of CO removed ($1.2 million value)
  - 3,816 metric tons/year NO_2 removed ($37.8 million value)
  - 18,211 metric tons/year of O_3 removed ($180.4 million value)
  - 4,054 metric tons/year of SO_2 removed ($9.8 million value)
  - 9,631 metric tons/year of PM_{10} removed ($63.7 million value)

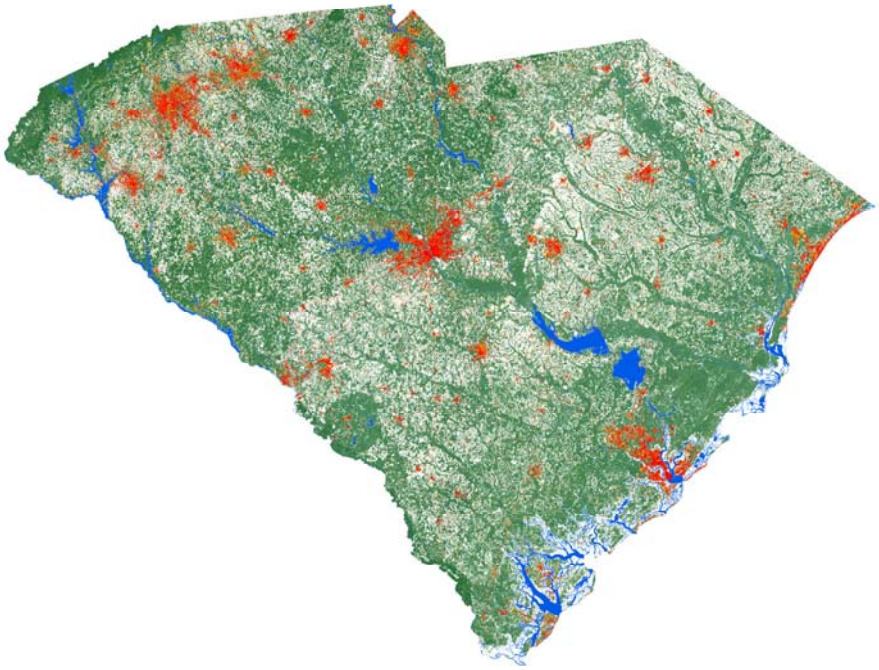


Summary

The data presented in this report provide a better understanding of North Carolina's urban and community forests. This information can be used to advance urban and community forest policy and management that could improve environmental quality and human health throughout the State.

These data establish a baseline to assess future change and can be used to understand:

- Extent of the urban and community forest resource
- Variations in the resource across the State
- Magnitude and value of the urban and community forest resource
- Urban growth in North Carolina
- Implications of policy decisions related to urban sprawl and urban and community forest management



SOUTH CAROLINA'S URBAN AND COMMUNITY FORESTS

Statewide Summary

Urban or community land in South Carolina comprises about 9.2 percent of the state land area in 2000, an increase from 7.3 percent in 1990. Statewide tree canopy cover averages 46.8 percent and tree cover in urban or community areas is about 35.4 percent, with 10.9 percent impervious surface cover and 39.7 percent of the total green space covered by tree canopy cover. Statewide, urban or community land in South Carolina has an estimated 121.5 million trees, which store about 23.2 million metric tons of carbon ($529 million), and annually remove about 765,000 metric tons of carbon ($17.4 million) and 23,420 metric tons of air pollution ($179.8 million) (Table SC-1).

Tables SC-2 through SC-17 are not printed in this report but are available on the CD located on the inside back cover and at http://nrs.fs.fed.us/data/urban.

Table SC-1.—Statewide summary of population, area, population density, tree canopy and impervious surface land cover, and urban tree benefits in urban, community, and urban or community areas.

South Carolina		Statewide	Urban [a]	Community [b]	Urban or Community [c]
Population	2000	4,012,012	2,427,124	1,836,965	n/a
	1990	3,486,703	1,905,378	1,572,089	n/a
	% Change (1990-2000)	15.1	27.4	16.8	n/a
	% Total population (2000)	100.0	60.5	45.8	n/a
Total area	km^2 (2000)	82,931.9	4,842.0	5,332.2	7,479.5
	km^2 (1990)	82,931.9	3,934.9	4,177.3	5,902.3
	% Change (1990-2000)	0.0	23.1	27.6	26.7
Land area	km^2 (2000)	77,937.2	4,786.1	5,083.0	7,207.0
	% Land area (2000)	100.0	6.1	6.5	9.2
	km^2 (1990)	77,937.2	3,900.3	4,010.2	5,719.5
	% Land area (1990)	100.0	5.0	5.1	7.3
	% Change (1990-2000)	0.0	22.7	26.8	26.0
Population density (people/land area km^2)	2000	51.5	507.1	361.4	n/a
	1990	44.7	488.5	392.0	n/a
	% Change (1990-2000)	15.1	3.8	-7.8	n/a
Tree canopy cover (2000)	km^2	36,469.6	1,610.9	1,778.1	2,548.5
	% Land area	46.8	33.7	35.0	35.4
	Per capita (m^2/person)	9,090.1	663.7	967.9	n/a
	% Canopy green space [d]	47.6	39.3	39.4	39.7
Total green space (2000) [e]	km^2	76,636.4	4,103.0	4,511.4	6,423.5
	% Land area	98.3	85.7	88.8	89.1
Available green space (2000) [f]	km^2	40,167.1	2,492.2	2,733.4	3,875.1
	% Land area	51.5	52.1	53.8	53.8
Impervious surface cover (2000)	km^2	1,300.8	683.1	571.6	783.5
	% Land area	1.7	14.3	11.2	10.9
	Per capita (m^2/person)	324.2	281.5	311.2	n/a
Urban tree benefits (2000)	Estimated number of trees	n/a	76,800,000	84,800,000	121,500,000
	Carbon				
	Carbon stored (metric tons)	n/a	14,700,000	16,200,000	23,200,000
	Carbon stored ($)	n/a	$335,200,000	$369,400,000	$529,000,000
	Carbon sequestered (metric tons/year)	n/a	483,000	533,000	765,000
	Carbon sequestered ($/year)	n/a	$11,012,000	$12,152,000	$17,442,000
	Pollution				
	CO removed (metric tons/year)	n/a	361	398	571
	CO removed ($/year)	n/a	$507,600	$560,300	$803,000
	NO_2 removed (metric tons/year)	n/a	1,222	1,349	1,933
	NO_2 removed ($/year)	n/a	$12,104,000	$13,360,100	$19,149,000
	O_3 removed (metric tons/year)	n/a	6,822	7,530	10,793
	O_3 removed ($/year)	n/a	$67,579,000	$74,592,000	$106,912,000
	SO_2 removed (metric tons/year)	n/a	2,116	2,336	3,348
	SO_2 removed ($/year)	n/a	$5,131,600	$5,664,100	$8,118,400
	PM_{10} removed (metric tons/year)	n/a	4,281	4,726	6,773
	PM_{10} removed ($/year)	n/a	$28,317,300	$31,255,900	$44,799,100
	Total pollution removal (metric tons/year)	n/a	14,800	16,340	23,420
	Total pollution removal ($/year)	n/a	$113,600,000	$125,400,000	$179,800,000

[a] Urban land is based on population density and was delimited using the United States Census definitions of urbanized areas and urban clusters. [b] Community land is based on jurisdictional or political boundaries of communities based on United States Census definitions of incorporated or census designated places. [c] Urban or communities is land that is urban, community, or both. Communities may include all, some, or no urban land within their boundaries. [d] Canopy green space is the tree canopy cover divided by total green space. [e] Total green space (TGS) is total area – impervious surface cover – water. [f] Available green space (AGS) is total green space – tree canopy cover (if the calculated value is less than 0, then value set at 0).

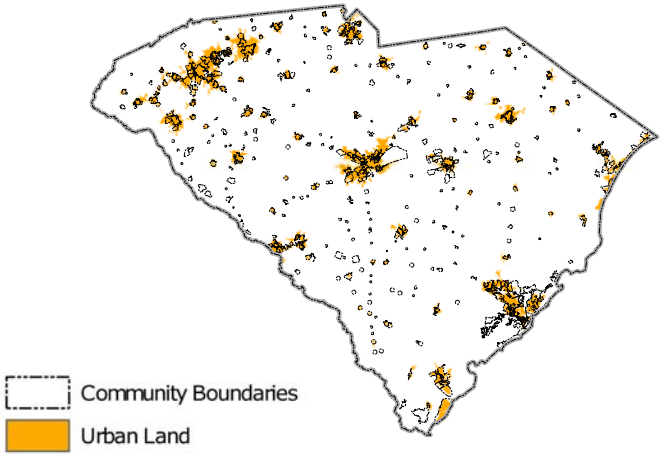


Figure SC-1.—Urban or community land in 2000; urban area relative to community boundaries.

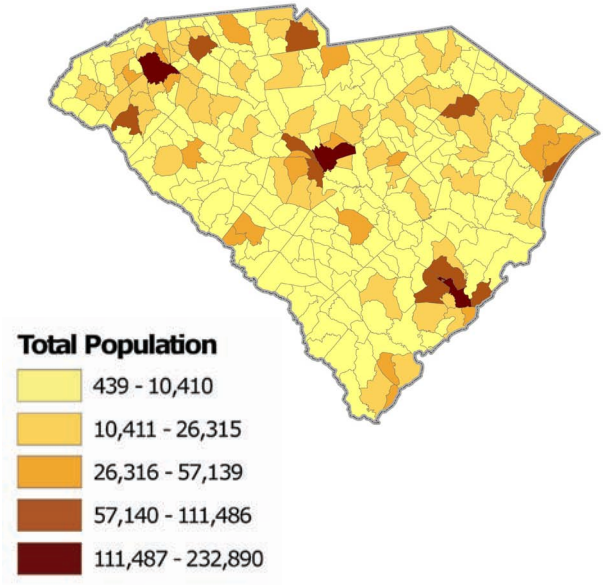


Figure SC-2.—2000 population within county subdivision boundaries.

Human Population Characteristics and Trends

The population in South Carolina increased 15.1 percent, from 3,486,703 in 1990 to 4,012,012 in 2000 (Table SC-1). In South Carolina, 60.5 percent of the State's population is in urban areas (Fig. SC-1), and 45.8 percent of the population is within communities (Fig. SC-2).

Urban and Community Land

Urban land comprises 6.1 percent of the land area of South Carolina, while lands within communities make up 6.5 percent of the State (Fig. SC-1). Between 1990 and 2000, urban area increased 22.7 percent, while community land increased from 5.1 to 6.5 percent (Table SC-1). Urban area in South Carolina is projected to increase to 18.3 percent by 2050, based on average urban growth pattern of the 1990s (Nowak and Walton 2005). Both urban land (attaining minimum population density) and community land (political boundaries) increased from 1990 to 2000. The percentages are calculated using the total (water and land) area of the geopolitical units derived from U.S. Census cartographic boundary data. Percent urban land varied across the State (Fig. SC-3; Tables SC-2 through 4).

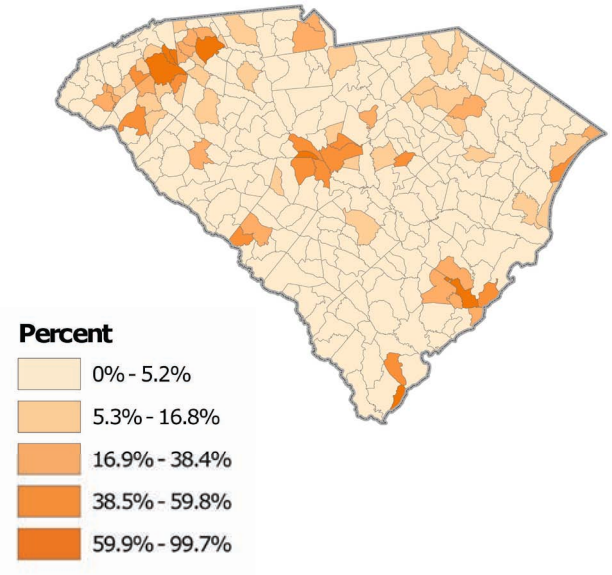


Figure SC-3.—Percent of county subdivision area classified as urban land in 2000.

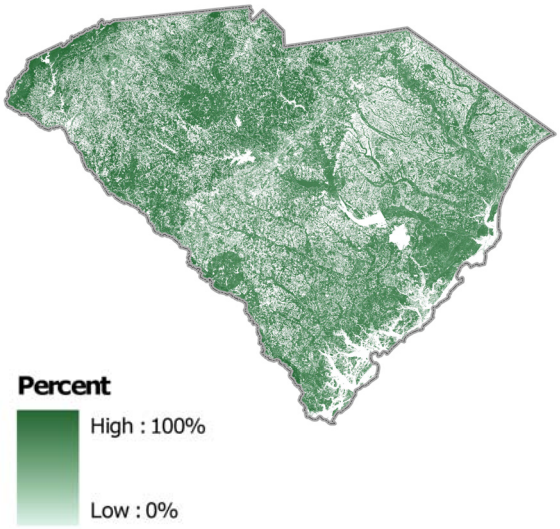


Figure SC-4.—Percentage tree canopy cover.

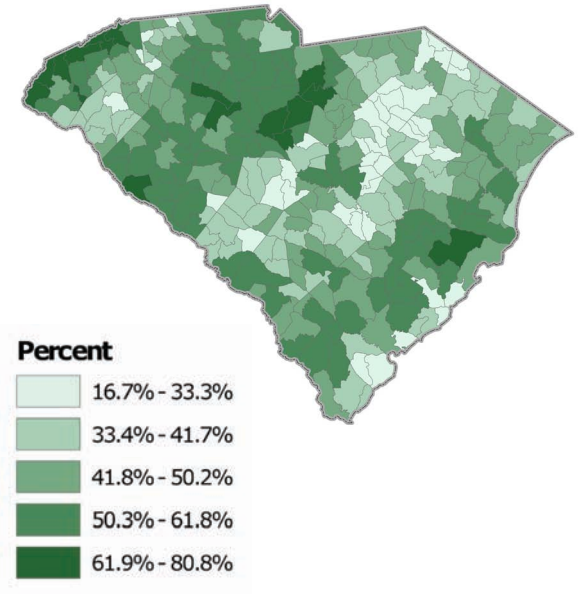


Figure SC-5.—Percentage tree canopy cover within county subdivisions.

Tree Canopy Cover Characteristics

Tree canopy cover in South Carolina averages 46.8 percent (Fig. SC-4), with 98.3 percent total green space, 47.6 percent canopy green space, and 9,090.1 m^2 of canopy cover per capita. Average tree cover in urban areas in South Carolina was 33.7 percent, with 85.7 percent total green space, 39.3 percent canopy green space, and 663.7 m^2 of canopy cover per capita. Within community lands in South Carolina, average tree cover was 35.0 percent, with 88.8 percent total green space, 39.4 percent canopy green space, and 967.9 m^2 of canopy cover per capita (Table SC-1). Tree canopy cover, canopy green space, and tree cover per capita varied among communities, county subdivisions, and counties (Fig. SC-5 through 6; Tables SC-5 through 7).

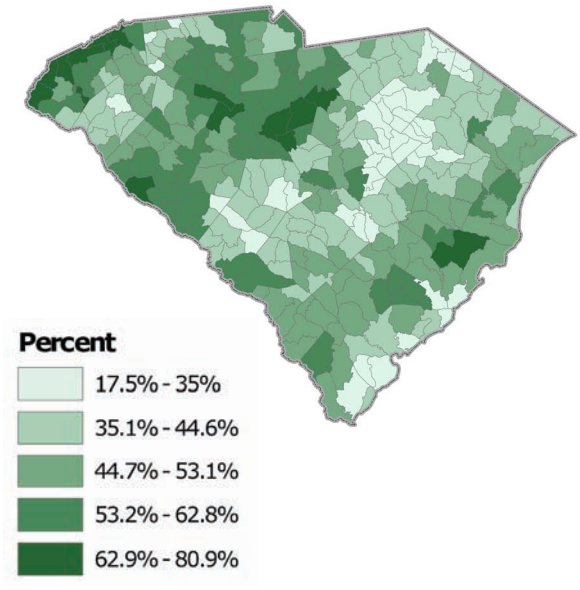


Figure SC-6.—Percentage tree canopy green space in county subdivisions.

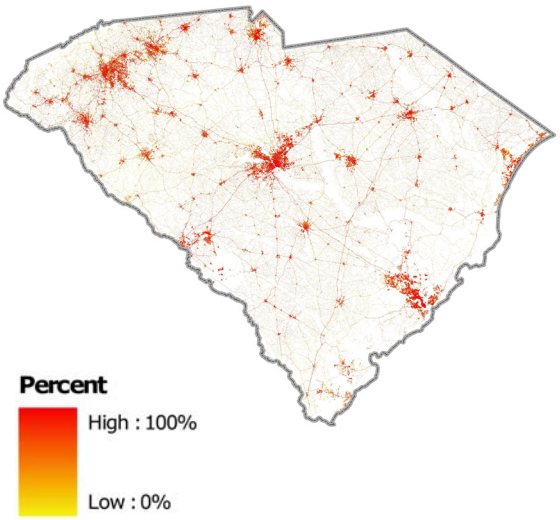


Figure SC-7.—Percentage impervious surface cover.

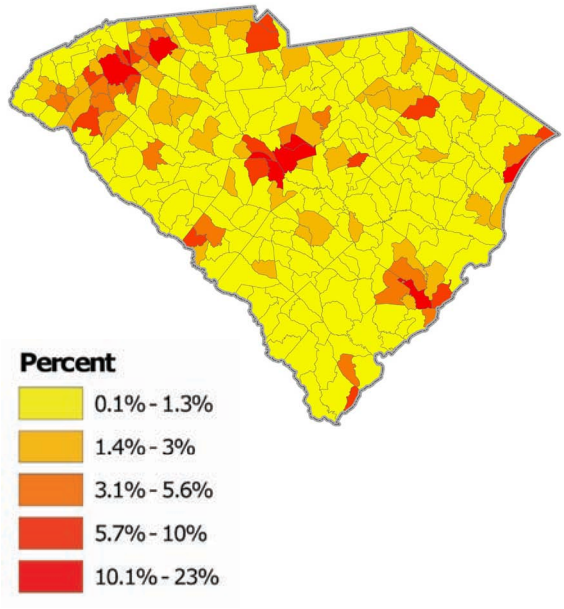


Figure SC-8.—Percentage impervious surface cover within county subdivisions.

Impervious Surface Cover Characteristics

Average impervious surface cover in South Carolina is 1.7 percent of the land area (Fig. SC-7), with 324.2 m^2 of impervious surface cover per capita. Average impervious surface cover in urban areas was 14.3 percent, with 281.5 m^2 of impervious surface cover per capita. Within community lands in South Carolina, average impervious surface cover was 11.2 percent with 311.2 m^2 of impervious surface cover per capita (Table SC-1). Impervious surface cover varied across the State (Fig. SC-8; Tables SC-5 through 7).

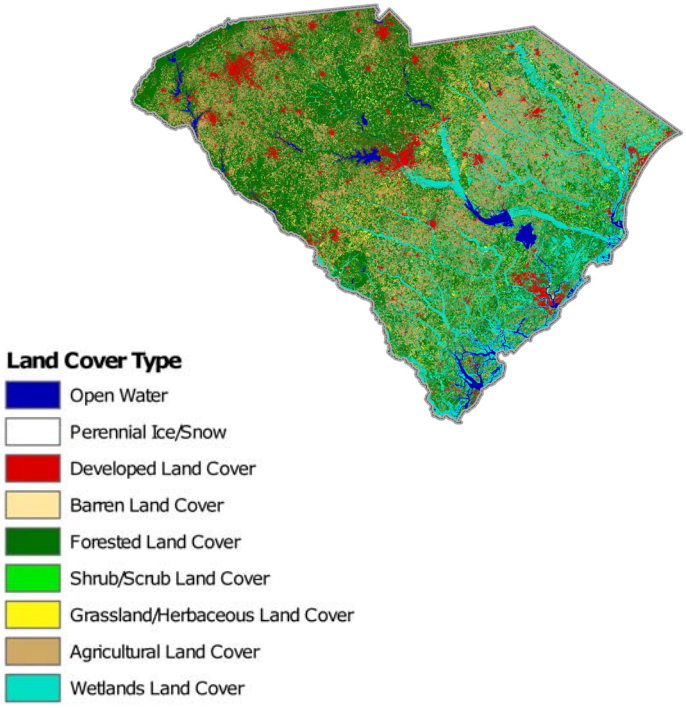


Figure SC-9.—Classified land cover.

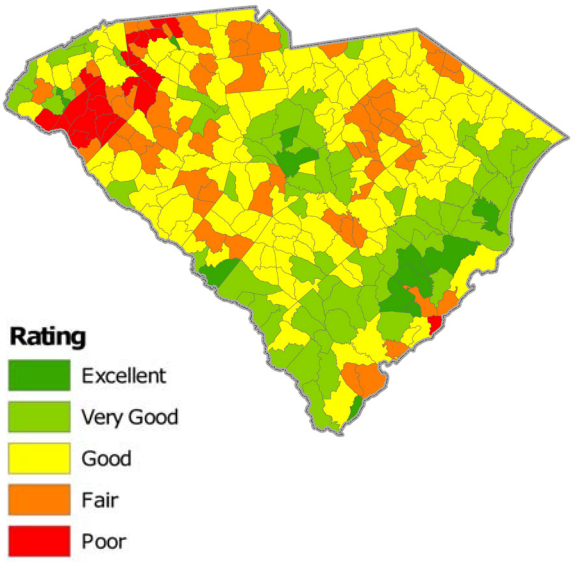


Figure SC-10.—Relative comparisons of tree cover for county subdivisions.

Classified Land-cover Characteristics

South Carolina's land cover is dominated by forest land (Fig. SC-9). The characteristics as a percent of the total land area in South Carolina are (Tables SC-8 through 10):

- Forested – 42.5 percent
- Agricultural – 34.1 percent
- Grassland – 9.7 percent
- Developed – 8.5 percent
- Wetland – 2.5 percent
- Scrub/Shrub – 2.2 percent
- Barren – 0.5 percent

Relative Comparisons of Tree Cover

Out of the 368 South Carolina communities, 13 received a rating of excellent and 61 received a rating of poor (Table SC-12). Of the 296 county subdivisions, 12 had a rating of excellent and 22 were rated poor (Fig. SC-10, Table SC-13); and out of 46 counties, seven were given a rating of excellent and seven were given a rating of poor (Table SC-14). Variability of assessment scores is a product of the difference in land-cover distributions and the percentage of canopy cover within the population density classes and mapping zones (Fig. SC-10; Tables SC-11 through 14).

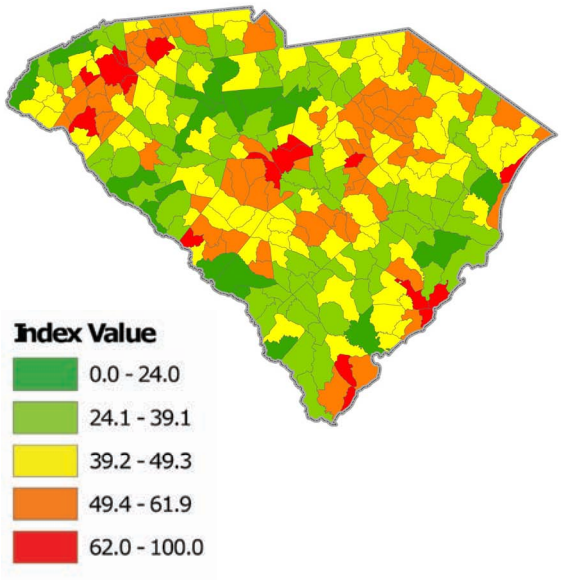


Figure SC-11.—Planting priority index for county subdivisions. The higher the index value, the greater priority for planting.

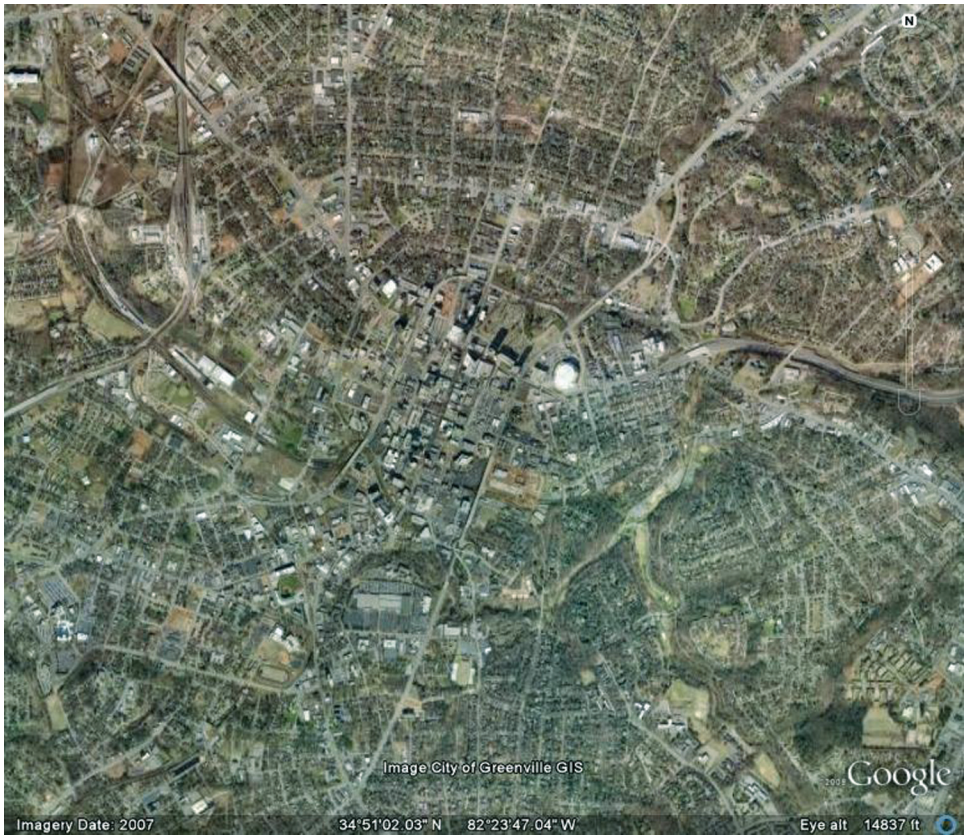
Priority Areas for Tree Planting

Priority areas for planting tend to be highest in more urbanized areas due to higher population density (Fig. SC-11; Tables SC-15 through 17). These index values can also be produced using high resolution cover data to determine local planting priority areas (e.g. neighborhoods).

Urban Tree Benefits

The following forest attributes are estimated for the urban or community land in South Carolina (Table SC-1). These are rough estimates of values. More localized data are needed for more precise estimates, but these values reveal first-order approximations.

- 121.5 million trees
- 23.2 million metric tons of C stored ($529 million value)
- 765,000 metric tons/year of C sequestered ($17.4 million value)
- 23,420 metric tons/year total pollution removal ($179.8 million value)
  - 571 metric tons/year of CO removed ($803,000 value)
  - 1,933 metric tons/year NO_2 removed ($19.1 million value)
  - 10,793 metric tons/year of O_3 removed ($106.9 million value)
  - 3,348 metric tons/year of SO_2 removed ($8.1 million value)
  - 6,773 metric tons/year of PM_{10} removed ($44.8 million value)

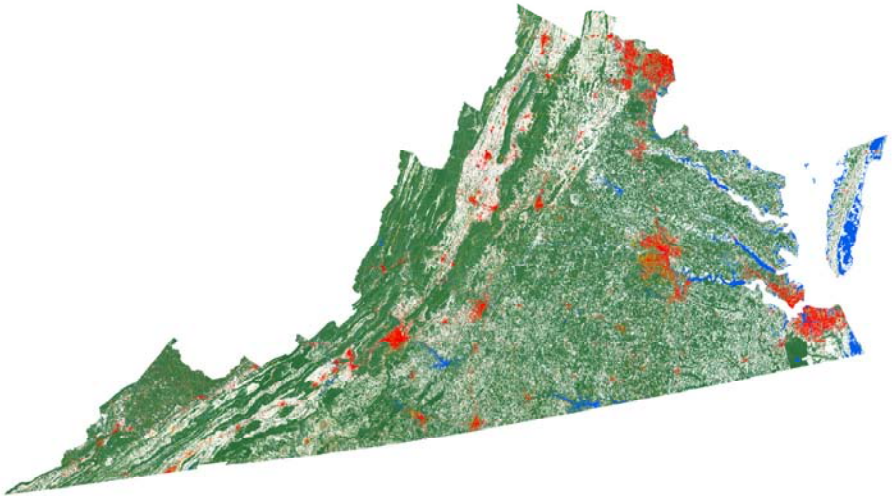


Summary

The data presented in this report provide a better understanding of South Carolina's urban and community forests. This information can be used to advance urban and community forest policy and management that could improve environmental quality and human health throughout the State.

These data establish a baseline to assess future change and can be used to understand:

- Extent of the urban and community forest resource
- Variations in the resource across the State
- Magnitude and value of the urban and community forest resource
- Urban growth in South Carolina
- Implications of policy decisions related to urban sprawl and urban and community forest management



VIRGINIA'S URBAN AND COMMUNITY FORESTS

Statewide Summary

Urban or community land in Virginia comprises about 9.8 percent of the state land area in 2000, an increase from 8.4 percent in 1990. Statewide tree canopy cover averages 54.4 percent and tree cover in urban or community areas is about 34.5 percent, with 11.5 percent impervious surface cover and 39.0 percent of the total green space covered by tree canopy cover. Statewide, urban or community land in Virginia has an estimated 165.8 million trees, which store about 31.6 million metric tons of carbon ($720.5 million), and annually remove about 1.0 million metric tons of carbon ($23.8 million) and 27,310 metric tons of air pollution ($227 million) (Table VA-1).

Tables VA-2 through VA-17 are not printed in this report but are available on the CD located on the inside back cover and at http://nrs.fs.fed.us/data/urban.

Table VA-1.—Statewide summary of population, area, population density, tree canopy and impervious surface land cover, and urban tree benefits in urban, community, and urban or community areas.

Virginia		Statewide	Urban [a]	Community [b]	Urban or Community [c]
Population	2000	7,078,515	5,169,955	4,367,421	n/a
	1990	6,187,358	4,293,443	3,951,499	n/a
	% Change (1990-2000)	14.4	20.4	10.5	n/a
	% Total population (2000)	100.0	73.0	61.7	n/a
Total area	km^2 (2000)	110,784.7	6,329.0	8,513.0	10,555.3
	km^2 (1990)	110,784.7	5,212.3	7,686.3	9,078.0
	% Change (1990-2000)	0.0	21.4	10.8	16.3
Land area	km^2 (2000)	102,554.6	6,198.3	8,063.6	10,080.9
	% Land area (2000)	100.0	6.0	7.9	9.8
	km^2 (1990)	102,554.6	5,168.9	7,276.8	8,659.5
	% Land area (1990)	100.0	5.0	7.1	8.4
	% Change (1990-2000)	0.0	19.9	10.8	16.4
Population density (people/land area km^2)	2000	69.0	834.1	541.6	n/a
	1990	60.3	830.6	543.0	n/a
	% Change (1990-2000)	14.4	0.4	-0.3	n/a
Tree canopy cover (2000)	km^2	55,815.8	1,788.5	2,735.0	3,476.4
	% Land area	54.4	28.9	33.9	34.5
	Per capita (m^2/person)	7,885.2	345.9	626.2	n/a
	% Canopy green space [d]	55.4	34.7	38.5	39.0
Total green space (2000) [e]	km^2	100,814.0	5,156.7	7,108.2	8,917.1
	% Land area	98.3	83.2	88.2	88.5
Available green space (2000) [f]	km^2	45,006.7	3,369.2	4,374.5	5,442.1
	% Land area	43.9	54.4	54.3	54.0
Impervious surface cover (2000)	km^2	1,740.4	1,041.5	955.4	1,163.9
	% Land area	1.7	16.8	11.8	11.5
	Per capita (m^2/person)	245.9	201.5	218.8	n/a
Urban tree benefits (2000)	Estimated number of trees	n/a	85,300,000	130,400,000	165,800,000
	Carbon				
	Carbon stored (metric tons)	n/a	16,300,000	24,900,000	31,600,000
	Carbon stored ($)	n/a	$371,600,000	$567,700,000	$720,500,000
	Carbon sequestered (metric tons/year)	n/a	537,000	820,000	1,043,000
	Carbon sequestered ($/year)	n/a	$12,244,000	$18,696,000	$23,780,000
	Pollution				
	CO removed (metric tons/year)	n/a	216	330	419
	CO removed ($/year)	n/a	$303,600	$464,300	$590,200
	NO_2 removed (metric tons/year)	n/a	1,749	2,674	3,399
	NO_2 removed ($/year)	n/a	$17,323,300	$26,490,500	$33,671,200
	O_3 removed (metric tons/year)	n/a	7,561	11,563	14,697
	O_3 removed ($/year)	n/a	$74,903,000	$114,540,000	$145,589,000
	SO_2 removed (metric tons/year)	n/a	1,354	2,070	2,631
	SO_2 removed ($/year)	n/a	$3,282,600	$5,019,700	$6,380,400
	PM_{10} removed (metric tons/year)	n/a	3,169	4,846	6,159
	PM_{10} removed ($/year)	n/a	$20,959,500	$32,050,900	$40,738,900
	Total pollution removal (metric tons/year)	n/a	14,050	21,480	27,310
	Total pollution removal ($/year)	n/a	$116,800,000	$178,600,000	$227,000,000

[a] Urban land is based on population density and was delimited using the United States Census definitions of urbanized areas and urban clusters. [b] Community land is based on jurisdictional or political boundaries of communities based on United States Census definitions of incorporated or census designated places. [c] Urban or communities is land that is urban, community, or both. Communities may include all, some, or no urban land within their boundaries. [d] Canopy green space is the tree canopy cover divided by total green space. [e] Total green space (TGS) is total area – impervious surface cover – water. [f] Available green space (AGS) is total green space – tree canopy cover (if the calculated value is less than 0, then value set at 0).

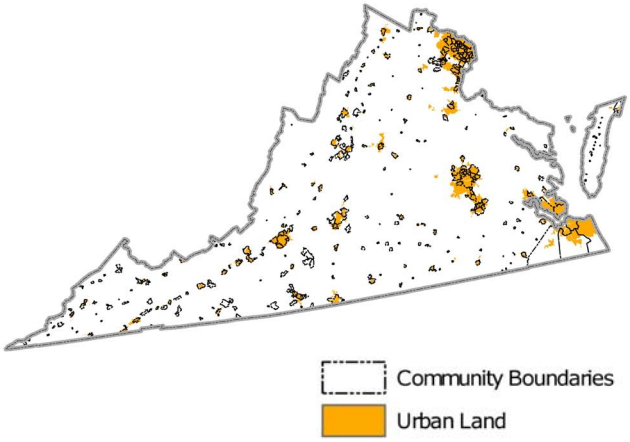


Figure VA-1.—Urban or community land in 2000; urban area relative to community boundaries.

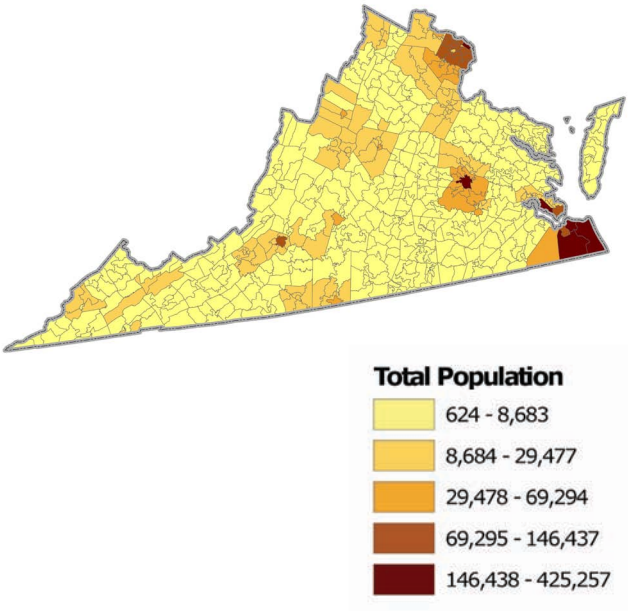


Figure VA-2.—2000 population within county subdivision boundaries.

Human Population Characteristics and Trends

The population in Virginia increased 14.4 percent, from 6,187,358 in 1990 to 7,078,515 in 2000 (Table VA-1). In Virginia, 73.0 percent of the State's population is in urban areas (Fig. VA-1), and 61.7 percent of the population is within communities (Fig. VA-2).

Urban and Community Land

Urban land comprises 6.0 percent of the land area of Virginia, while lands within communities make up 7.9 percent of the State (Fig. VA-1). Between 1990 and 2000, urban area increased 19.9 percent, while community land increased from 7.1 to 7.9 percent (Table VA-1). Urban area in Virginia is projected to increase to 12.6 percent by 2050, based on average urban growth pattern of the 1990s (Nowak and Walton 2005). Both urban land (attaining minimum population density) and community land (political boundaries) increased from 1990 to 2000. The percentages are calculated using the total (water and land) area of the geopolitical units derived from U.S. Census cartographic boundary data. Percent urban land varied across the State (Fig. VA-3; Tables VA-2 through 4).

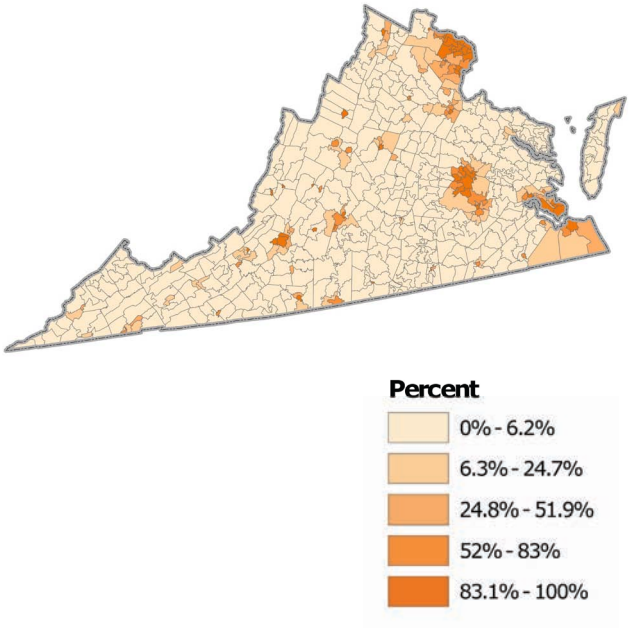


Figure VA-3.—Percent of county subdivision area classified as urban land in 2000.

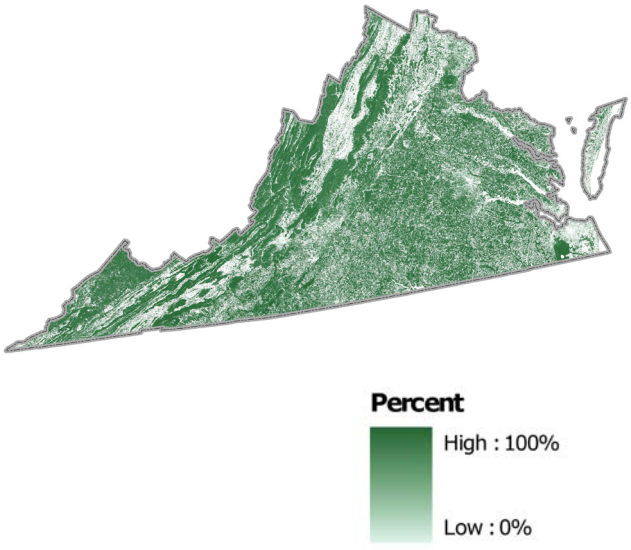


Figure VA-4.—Percentage tree canopy cover.

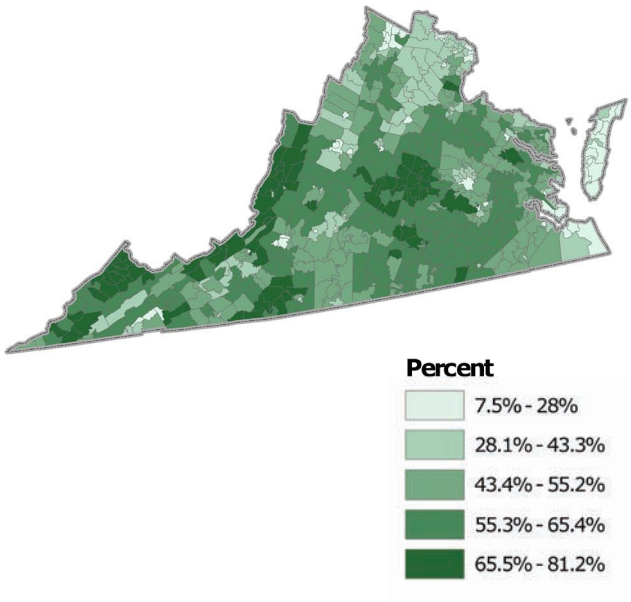


Figure VA-5.—Percentage tree canopy cover within county subdivisions.

Tree Canopy Cover Characteristics

Tree canopy cover in Virginia averages 54.4 percent (Fig. VA-4), with 98.3 percent total green space, 55.4 percent canopy green space, and 7,885.2 m^2 of canopy cover per capita. Average tree cover in urban areas in Virginia was 28.9 percent, with 83.2 percent total green space, 34.7 percent canopy green space, and 345.9 m^2 of canopy cover per capita. Within community lands in Virginia, average tree cover was 33.9 percent, with 88.2 percent total green space, 38.5 percent canopy green space, and 626.2 m^2 of canopy cover per capita (Table VA-1). Tree canopy cover, canopy green space, and tree cover per capita varied among communities, county subdivisions, and counties (Fig. VA-5 through 6; Tables VA-5 through 7).

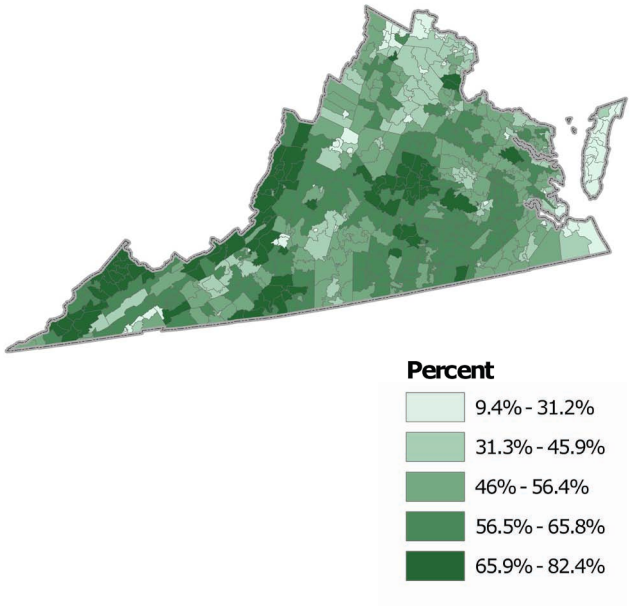


Figure VA-6.—Percentage tree canopy green space in county subdivisions.

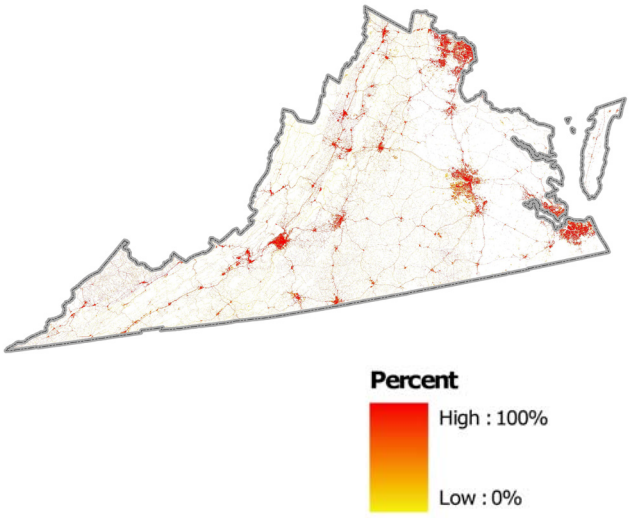


Figure VA-7.—Percentage impervious surface cover.

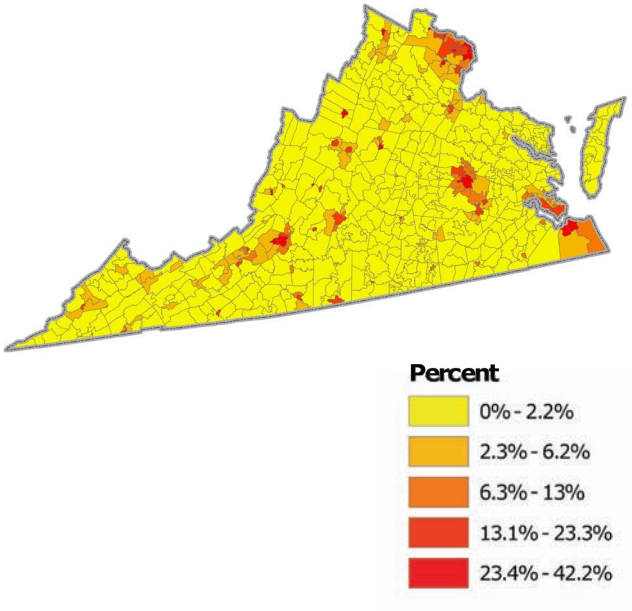


Figure VA-8.—Percentage impervious surface cover within county subdivisions.

Impervious Surface Cover Characteristics

Average impervious surface cover in Virginia is 1.7 percent of the land area (Fig. VA-7), with 245.9 m^2 of impervious surface cover per capita. Average impervious surface cover in urban areas was 16.8 percent, with 201.5 m^2 of impervious surface cover per capita. Within community lands in Virginia, average impervious surface cover was 11.8 percent with 218.8 m^2 of impervious surface cover per capita (Table VA-1). Impervious surface cover varied across the State (Fig. VA-8; Tables VA-5 through 7).

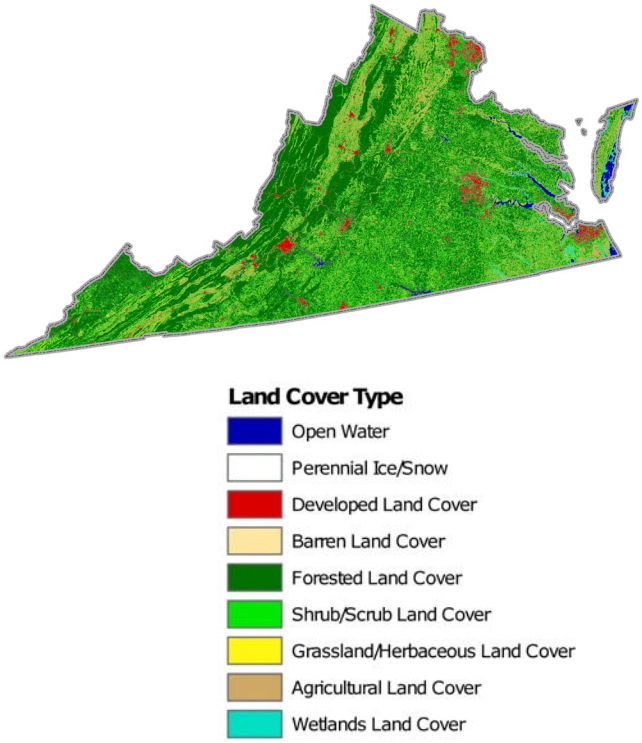


Figure VA-9.—Classified land cover.

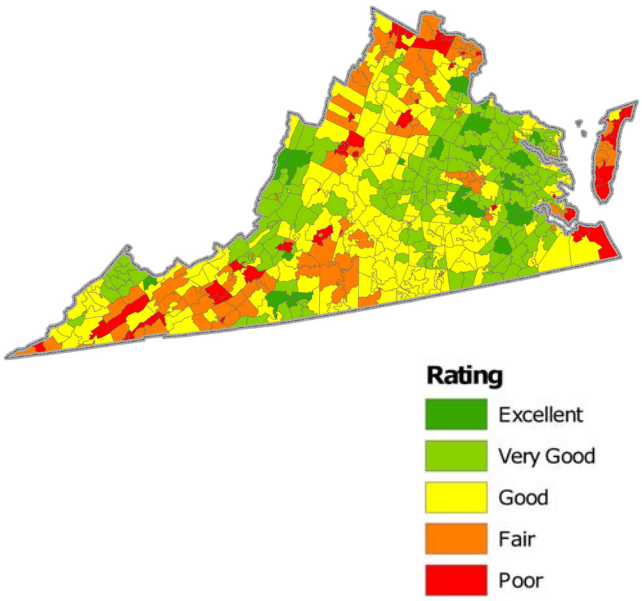


Figure VA-10.—Relative comparisons of tree cover for county subdivisions.

Classified Land-cover Characteristics

Virginia's land cover is dominated by forest land (Fig. VA-9). The characteristics as a percent of the total land area in Virginia are (Tables VA-8 through 10):

- Forested – 61.5 percent
- Agricultural – 26.9 percent
- Developed – 7.7 percent
- Grassland – 1.5 percent
- Wetland – 1.0 percent
- Barren – 0.8 percent
- Scrub/Shrub – 0.7 percent

Relative Comparisons of Tree Cover

Out of the 371 Virginia communities, nine received a rating of excellent and 140 received a rating of poor (Table VA-12). Of the 544 county subdivisions, 24 had a rating of excellent and 57 were rated poor (Fig. VA-10, Table VA-13); and out of 135 counties, 26 were given a rating of excellent and 28 were given a rating of poor (Table VA-14). Variability of assessment scores is a product of the difference in land-cover distributions and the percentage of canopy cover within the population density classes and mapping zones (Fig. VA-10; Tables VA-11 through 14).

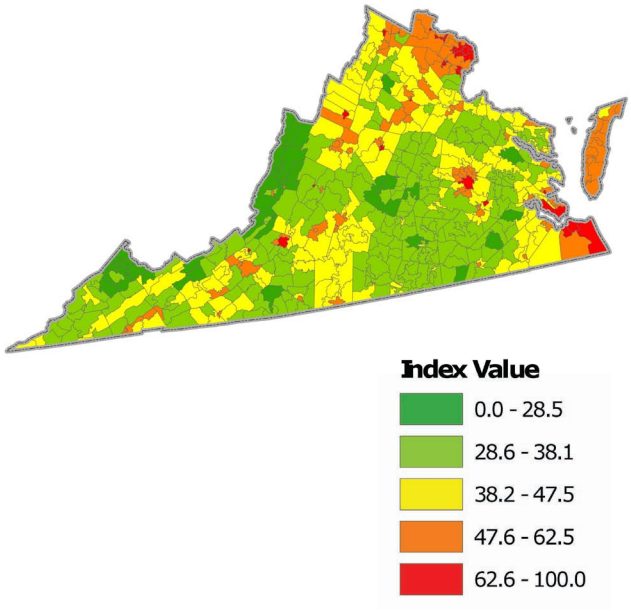


Figure VA-11.—Planting priority index for county subdivisions. The higher the index value, the greater priority for planting.

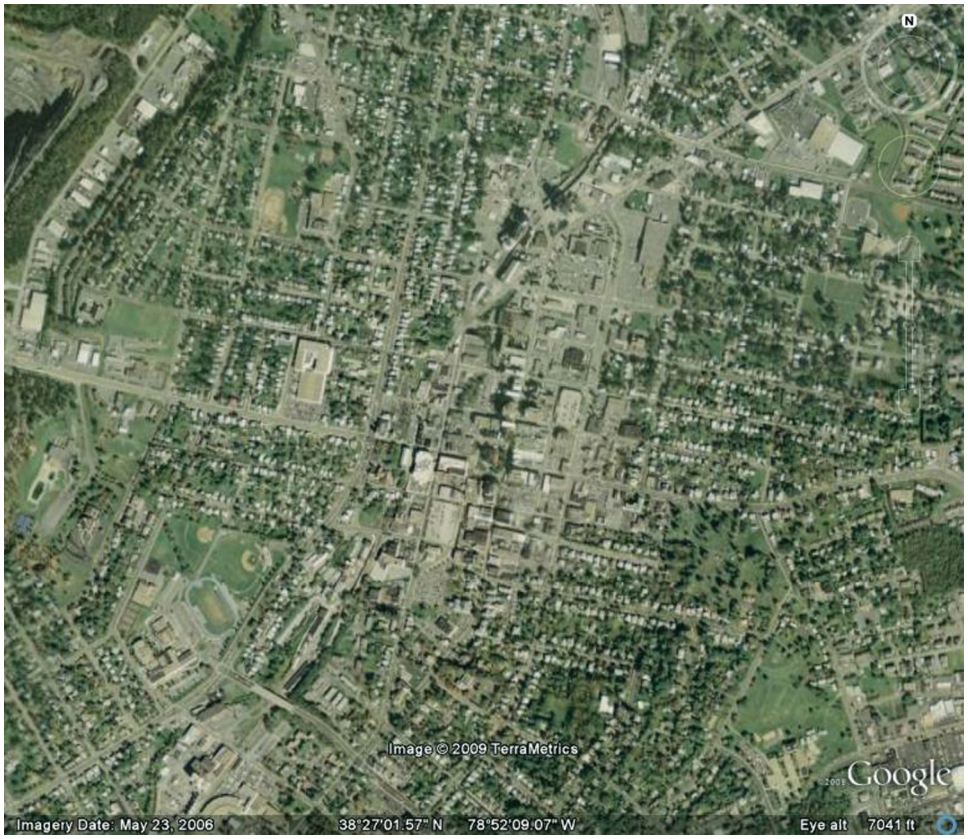
Priority Areas for Tree Planting

Priority areas for planting tend to be highest in more urbanized areas due to higher population density (Fig. VA-11; Tables VA-15 through 17). These index values can also be produced using high resolution cover data to determine local planting priority areas (e.g. neighborhoods).

Urban Tree Benefits

The following forest attributes are estimated for the urban or community land in Virginia (Table VA-1). These are rough estimates of values. More localized data are needed for more precise estimates, but these values reveal first-order approximations.

- 165.8 million trees
- 31.6 million metric tons of C stored ($720.5 million value)
- 1.0 million metric tons/year of C sequestered ($23.8 million value)
- 27,310 metric tons/year total pollution removal ($227 million value)
  - 419 metric tons/year of CO removed ($590,200 value)
  - 3,399 metric tons/year NO_2 removed ($33.7 million value)
  - 14,697 metric tons/year of O_3 removed ($145.6 million value)
  - 2,631 metric tons/year of SO_2 removed ($6.4 million value)
  - 6,159 metric tons/year of PM_{10} removed ($40.7 million value)

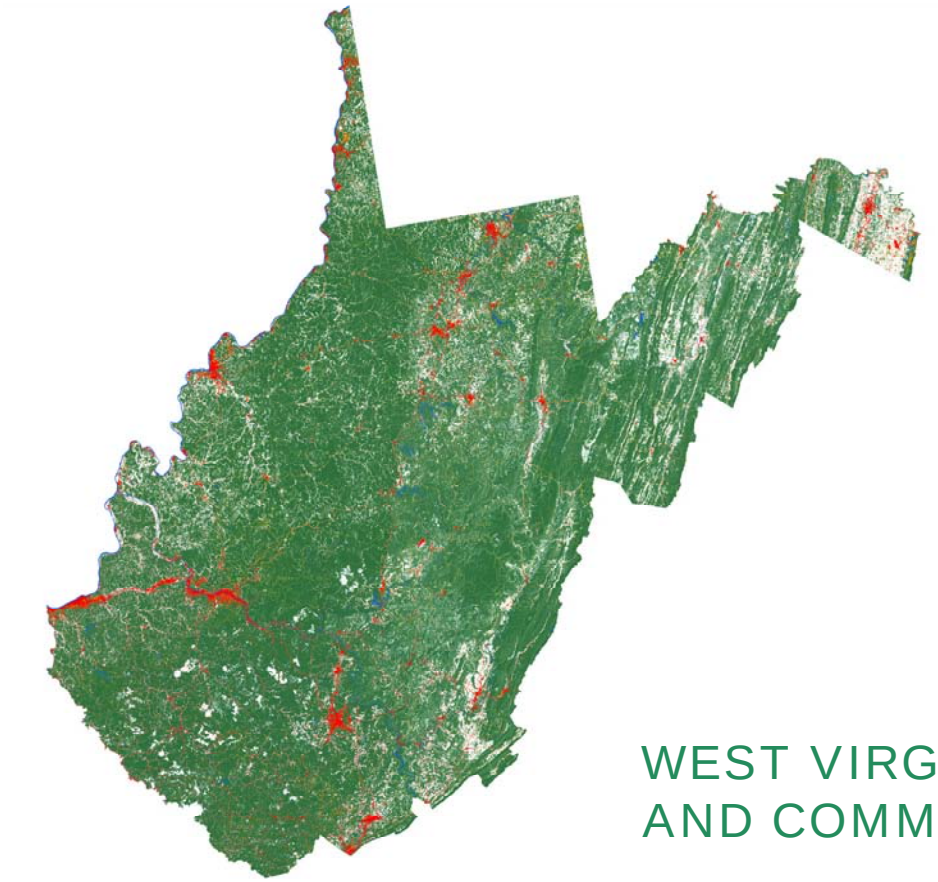


Summary

The data presented in this report provide a better understanding of Virginia's urban and community forests. This information can be used to advance urban and community forest policy and management that could improve environmental quality and human health throughout the State.

These data establish a baseline to assess future change and can be used to understand:

- Extent of the urban and community forest resource
- Variations in the resource across the State
- Magnitude and value of the urban and community forest resource
- Urban growth in Virginia
- Implications of policy decisions related to urban sprawl and urban and community forest management



WEST VIRGINIA'S URBAN AND COMMUNITY FORESTS

Statewide Summary

Urban or community land in West Virginia comprises about 4.1 percent of the state land area in 2000, an increase from 3.8 percent in 1990. Statewide tree canopy cover averages 69.3 percent and tree cover in urban or community areas is about 47.2 percent, with 12.4 percent impervious surface cover and 53.9 percent of the total green space covered by tree canopy cover. Statewide, urban or community land in West Virginia has an estimated 57.6 million trees, which store about 11 million metric tons of carbon ($250.8 million), and annually remove about 363,000 metric tons of carbon ($8.3 million) and 7,240 metric tons of air pollution ($57.2 million) (Table WV-1).

Tables WV-2 through WV-17 are not printed in this report but are available on the CD located on the inside back cover and at http://nrs.fs.fed.us/data/urban.

Table WV-1.—Statewide summary of population, area, population density, tree canopy and impervious surface land cover, and urban tree benefits in urban, community, and urban or community areas.

West Virginia		Statewide	Urban [a]	Community [b]	Urban or Community [c]
Population	2000	1,808,344	832,780	760,120	n/a
	1990	1,793,477	648,184	769,498	n/a
	% Change (1990-2000)	0.8	28.5	-1.2	n/a
	% Total population (2000)	100.0	46.1	42.0	n/a
Total area	km^2 (2000)	62,754.8	1,463.7	2,013.3	2,633.0
	km^2 (1990)	62,754.8	1,318.9	1,844.5	2,405.8
	% Change (1990-2000)	0.0	11.0	9.2	9.4
Land area	km^2 (2000)	62,203.7	1,440.3	1,949.2	2,559.0
	% Land area (2000)	100.0	2.3	3.1	4.1
	km^2 (1990)	62,203.7	1,301.3	1,783.7	2,336.5
	% Land area (1990)	100.0	2.1	2.9	3.8
	% Change (1990-2000)	0.0	10.7	9.3	9.5
Population density (people/land area km^2)	2000	29.1	578.2	390.0	n/a
	1990	28.8	498.1	431.4	n/a
	% Change (1990-2000)	0.8	16.1	-9.6	n/a
Tree canopy cover (2000)	km^2	43,086.6	502.5	967.7	1,208.6
	% Land area	69.3	34.9	49.6	47.2
	Per capita (m^2/person)	23,826.5	603.4	1,273.0	n/a
	% Canopy green space [d]	70.1	42.6	57.0	53.9
Total green space (2000) [e]	km^2	61,506.0	1,181.0	1,697.5	2,241.7
	% Land area	98.9	82.0	87.1	87.6
Available green space (2000) [f]	km^2	18,428.1	679.4	731.5	1,035.0
	% Land area	29.6	47.2	37.5	40.4
Impervious surface cover (2000)	km^2	697.7	259.3	251.7	317.3
	% Land area	1.1	18.0	12.9	12.4
	Per capita (m^2/person)	385.8	311.4	331.1	n/a
Urban tree benefits (2000)	Estimated number of trees	n/a	24,000,000	46,100,000	57,600,000
	Carbon				
	Carbon stored (metric tons)	n/a	4,600,000	8,800,000	11,000,000
	Carbon stored ($)	n/a	$104,900,000	$200,600,000	$250,800,000
	Carbon sequestered (metric tons/year)	n/a	151,000	290,000	363,000
	Carbon sequestered ($/year)	n/a	$3,443,000	$6,612,000	$8,276,000
	Pollution				
	CO removed (metric tons/year)	n/a	31	59	74
	CO removed ($/year)	n/a	$43,300	$83,400	$104,100
	NO_2 removed (metric tons/year)	n/a	360	693	865
	NO_2 removed ($/year)	n/a	$3,563,100	$6,861,200	$8,569,700
	O_3 removed (metric tons/year)	n/a	1,389	2,675	3,341
	O_3 removed ($/year)	n/a	$13,760,000	$26,498,000	$33,096,000
	SO_2 removed (metric tons/year)	n/a	406	782	977
	SO_2 removed ($/year)	n/a	$985,300	$1,897,400	$2,369,900
	PM_{10} removed (metric tons/year)	n/a	824	1,586	1,981
	PM_{10} removed ($/year)	n/a	$5,448,100	$10,491,100	$13,103,600
	Total pollution removal (metric tons/year)	n/a	3,010	5,800	7,240
	Total pollution removal ($/year)	n/a	$23,800,000	$45,800,000	$57,200,000

[a] Urban land is based on population density and was delimited using the United States Census definitions of urbanized areas and urban clusters. [b] Community land is based on jurisdictional or political boundaries of communities based on United States Census definitions of incorporated or census designated places. [c] Urban or communities is land that is urban, community, or both. Communities may include all, some, or no urban land within their boundaries. [d] Canopy green space is the tree canopy cover divided by total green space. [e] Total green space (TGS) is total area – impervious surface cover – water. [f] Available green space (AGS) is total green space – tree canopy cover (if the calculated value is less than 0, then value set at 0).

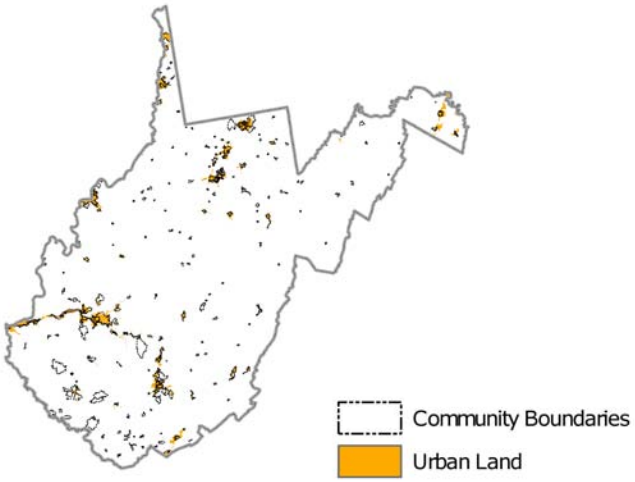


Figure WV-1.—Urban or community land in 2000; urban area relative to community boundaries.

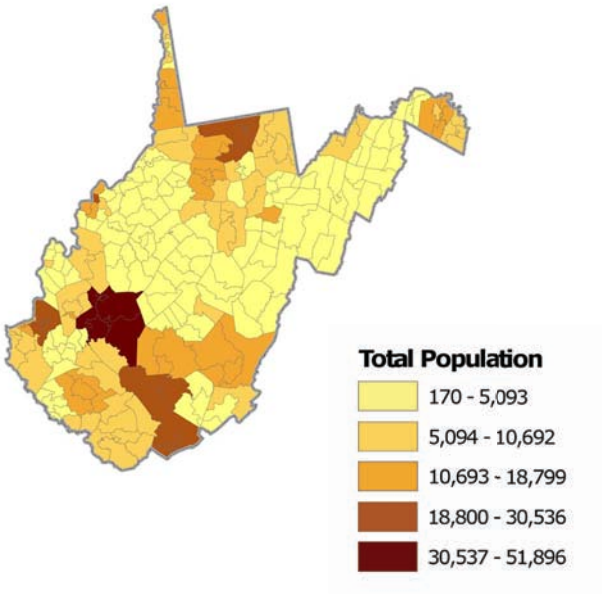


Figure WV-2.—2000 population within county subdivision boundaries.

Human Population Characteristics and Trends

The population in West Virginia increased 0.8 percent, from 1,793,477 in 1990 to 1,808,344 in 2000 (Table WV-1). In West Virginia, 46.1 percent of the State's population is in urban areas (Fig. WV-1), and 42.0 percent of the population is within communities (Fig. WV-2).

Urban and Community Land

Urban land comprises 2.3 percent of the land area of West Virginia, while lands within communities make up 3.1 percent of the State (Fig. WV-1). Between 1990 and 2000, urban area increased 10.7 percent, while community land increased from 2.9 to 3.1 percent (Table WV-1). Urban area in West Virginia is projected to increase to 7.7 percent by 2050, based on average urban growth pattern of the 1990s (Nowak and Walton 2005). Both urban land (attaining minimum population density) and community land (political boundaries) increased from 1990 to 2000. The percentages are calculated using the total (water and land) area of the geopolitical units derived from U.S. Census cartographic boundary data. Percent urban land varied across the State (Fig. WV-3; Tables WV-2 through 4).

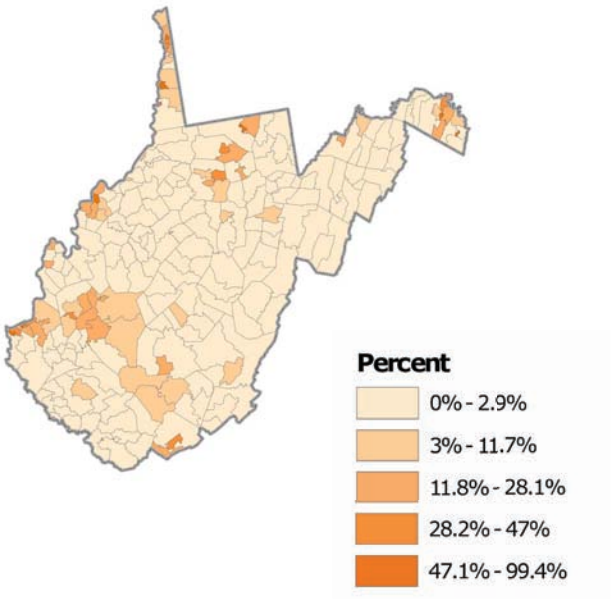


Figure WV-3.—Percent of county subdivision area classified as urban land in 2000.

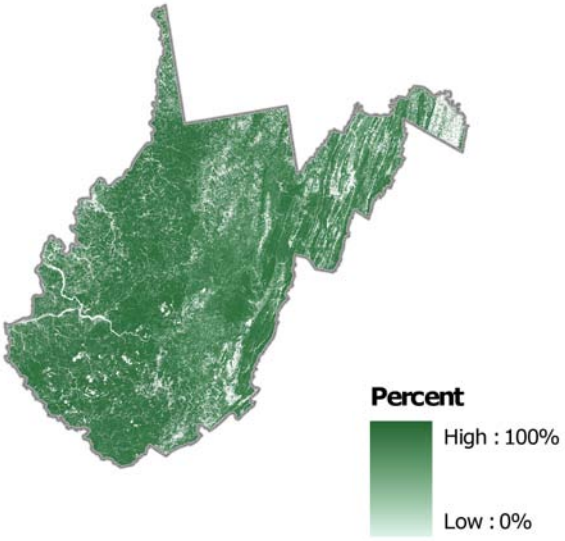


Figure WV-4.—Percentage tree canopy cover.

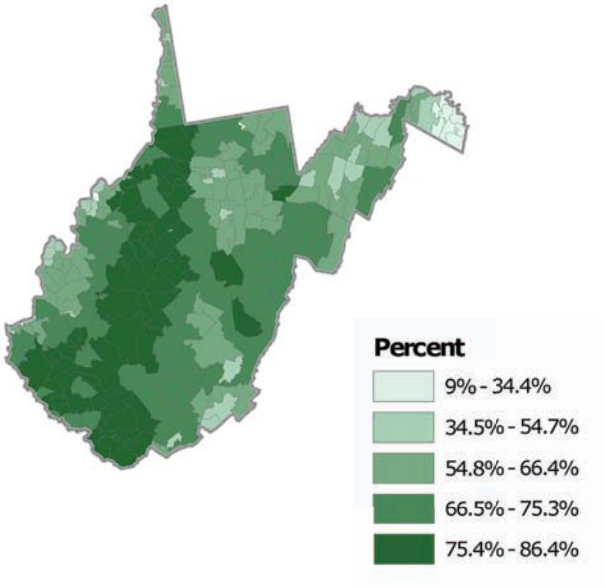


Figure WV-5.—Percentage tree canopy cover within county subdivisions.

Tree Canopy Cover Characteristics

Tree canopy cover in West Virginia averages 69.3 percent (Fig. WV-4), with 98.9 percent total green space, 70.1 percent canopy green space, and 23,826.5 m^2 of canopy cover per capita. Average tree cover in urban areas in West Virginia was 34.9 percent, with 82.0 percent total green space, 42.6 percent canopy green space, and 603.4 m^2 of canopy cover per capita. Within community lands in West Virginia, average tree cover was 49.6 percent, with 87.1 percent total green space, 57.0 percent canopy green space, and 1,273.0 m^2 of canopy cover per capita (Table WV-1). Tree canopy cover, canopy green space, and tree cover per capita varied among communities, county subdivisions, and counties (Fig. WV-5 through 6; Tables WV-5 through 7).

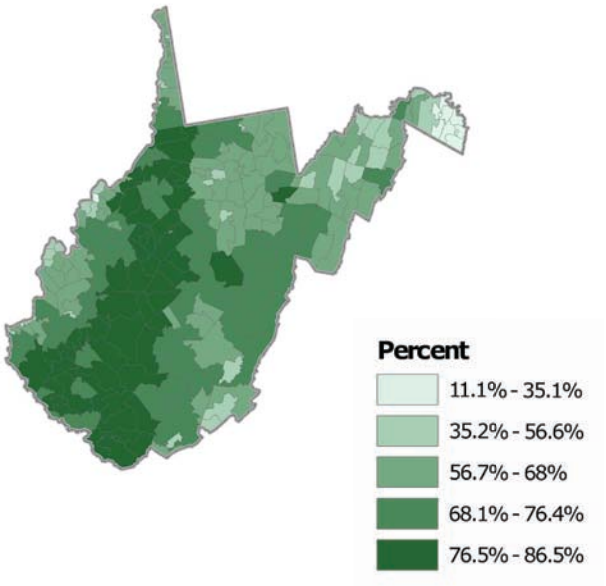


Figure WV-6.—Percentage tree canopy green space in county subdivisions.

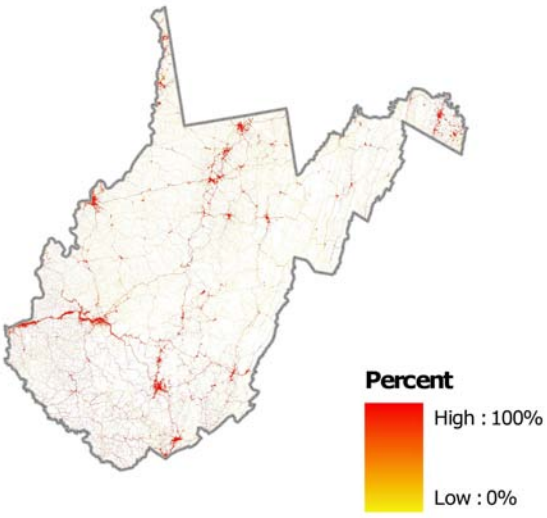


Figure WV-7.—Percentage impervious surface cover.

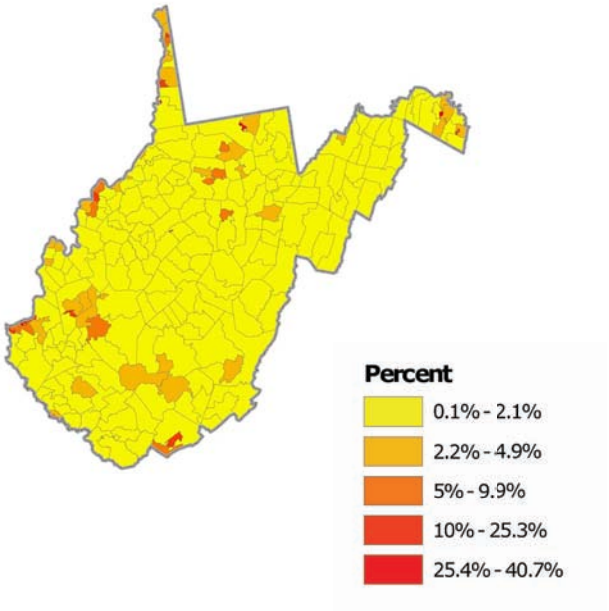


Figure WV-8.—Percentage impervious surface cover within county subdivisions.

Impervious Surface Cover Characteristics

Average impervious surface cover in West Virginia is 1.1 percent of the land area (Fig. WV-7), with 385.8 m^2 of impervious surface cover per capita. Average impervious surface cover in urban areas was 18.0 percent, with 311.4 m^2 of impervious surface cover per capita. Within community lands in West Virginia, average impervious surface cover was 12.9 percent with 331.1 m^2 of impervious surface cover per capita (Table WV-1). Impervious surface cover varied across the State (Fig. WV-8; Tables WV-5 through 7).

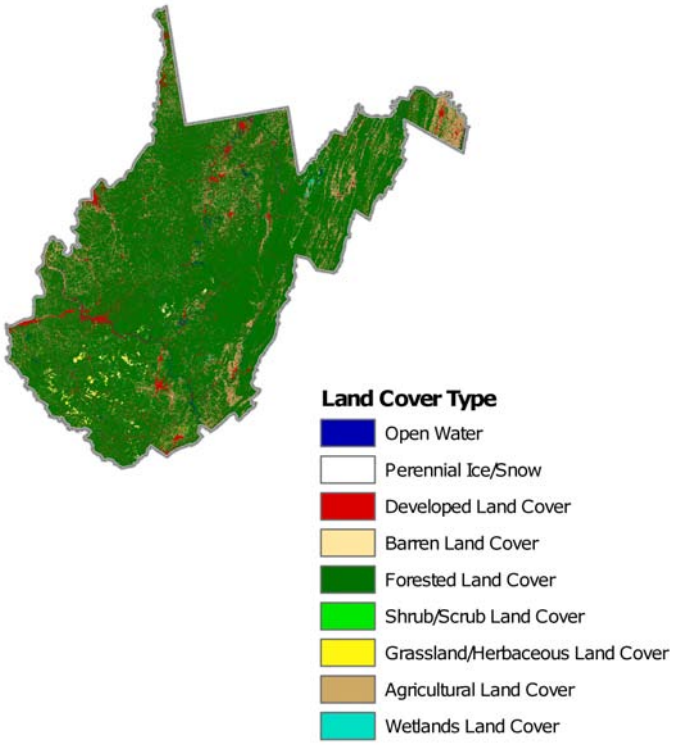


Figure WV-9.—Classified land cover.

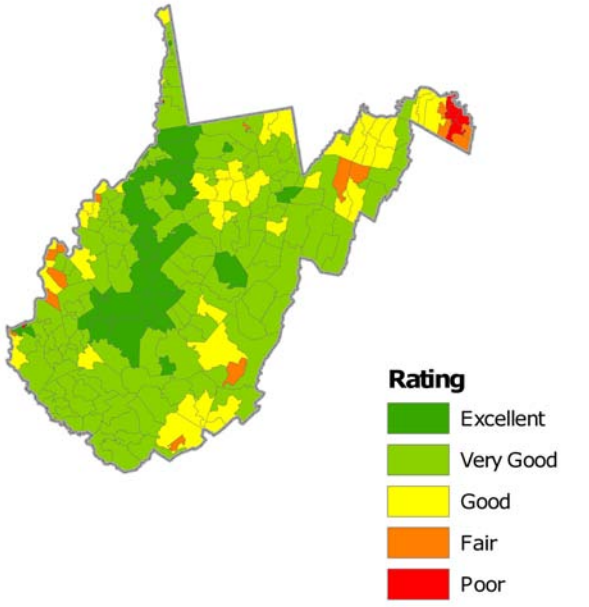


Figure WV-10.—Relative comparisons of tree cover for county subdivisions.

Classified Land-cover Characteristics

West Virginia's land cover is dominated by forest land (Fig. WV-9). The characteristics as a percent of the total land area in West Virginia are (Tables WV-8 through 10):

- Forested – 81.6 percent
- Agricultural – 9.5 percent
- Developed – 6.9 percent
- Grassland – 1.4 percent
- Barren – 0.6 percent
- Wetland – 0.1 percent
- Scrub/Shrub – less than 0.1 percent

Relative Comparisons of Tree Cover

Out of the 282 West Virginia communities, 28 received a rating of excellent and 64 received a rating of poor (Table WV-12). Of the 240 county subdivisions, 35 had a rating of excellent and nine were rated poor (Fig. WV-10, Table WV-13); and out of 55 counties, 14 were given a rating of excellent and one was given a rating of poor (Table WV-14). Variability of assessment scores is a product of the difference in land-cover distributions and the percentage of canopy cover within the population density classes and mapping zones (Fig. WV-10; Tables WV-11 through 14).

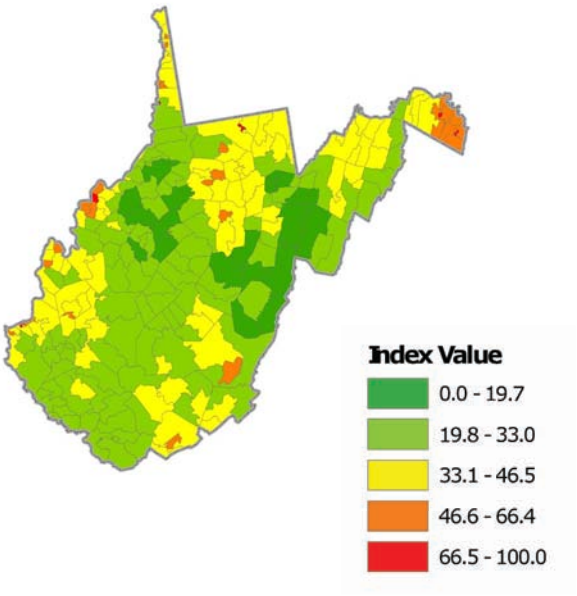


Figure WV-11.—Planting priority index for county subdivisions. The higher the index value, the greater priority for planting.

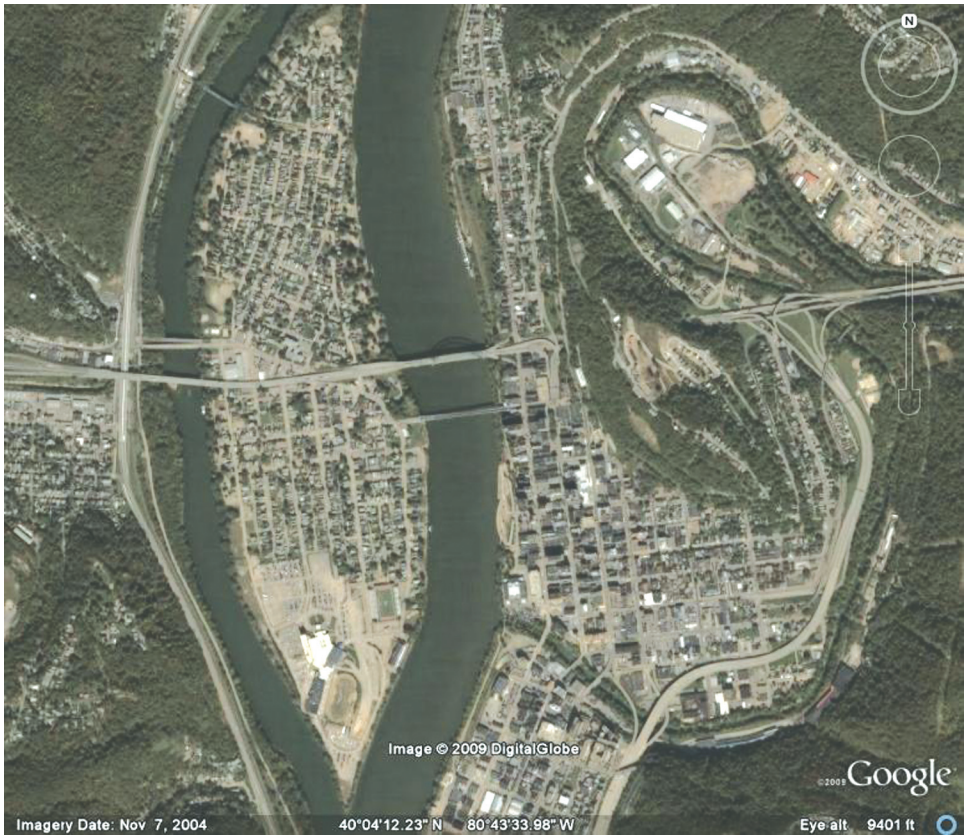
Priority Areas for Tree Planting

Priority areas for planting tend to be highest in more urbanized areas due to higher population density (Fig. WV-11; Tables WV-15 through 17). These index values can also be produced using high resolution cover data to determine local planting priority areas (e.g. neighborhoods).

Urban Tree Benefits

The following forest attributes are estimated for the urban or community land in West Virginia (Table WV-1). These are rough estimates of values. More localized data are needed for more precise estimates, but these values reveal first-order approximations.

- 57.6 million trees
- 11 million metric tons of C stored ($250.8 million value)
- 363,000 metric tons/year of C sequestered ($8.3 million value)
- 7,240 metric tons/year total pollution removal ($57.2 million value)
  - 74 metric tons/year of CO removed ($104,100 value)
  - 865 metric tons/year NO_2 removed ($8.6 million value)
  - 3,341 metric tons/year of O_3 removed ($33.1 million value)
  - 977 metric tons/year of SO_2 removed ($2.4 million value)
  - 1,981 metric tons/year of PM_{10} removed ($13.1 million value)



Summary

The data presented in this report provide a better understanding of West Virginia's urban and community forests. This information can be used to advance urban and community forest policy and management that could improve environmental quality and human health throughout the State.

These data establish a baseline to assess future change and can be used to understand:

- Extent of the urban and community forest resource
- Variations in the resource across the State
- Magnitude and value of the urban and community forest resource
- Urban growth in West Virginia
- Implications of policy decisions related to urban sprawl and urban and community forest management

LITERATURE CITED

Dwyer, J.F.; Nowak, D.J.; Noble, H.M.; Sisinni, S.M. 2000. **Assessing our nation's urban forests: connecting people with ecosystems in the 21st century.** Gen. Tech. Rep. PNW-490. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 540 p.

Fankhauser, S. 1994. **The social costs of greenhouse gas emissions: an expected value approach.** The Energy Journal. 15(2): 157-184.

Greenfield, E.J.; Nowak D.J.; Walton, J.T. In press. **Assessment of 2001 NLCD percent tree and impervious cover estimates.** Photogrammetric Engineering and Remote Sensing.

Homer, C.; Huang, C.; Yang, L.; Wylie, B.; Coan, M. 2004. **Development of a 2001 national land cover database for the United States.** Photogrammetric Engineering and Remote Sensing. 70(7): 829-840.

Homer, C.G.; Gallant, A. 2001. **Partitioning the conterminous United States into mapping zones for Landsat TM land cover mapping.** Unpublished U.S. Geologic Survey report. http://landcover.usgs.gov/pdf/homer.pdf. (1 August 2008).

Homer, C.; Dewitz, J.; Fry, J.; Coan, M.; Hossain, N.; Larson, C.; Herold, N.; McKerrow, A.; VanDriel, J.N.; Wickham, J. 2007. **Completion of the 2001 national land cover database for the coterminous United States.** Photogrammetric Engineering and Remote Sensing. 73(4): 337-341.

Murray, F.J.; Marsh, L.; Bradford, P.A. 1994. **New York state energy plan Vol. II: issue reports.** Albany, NY: New York State Energy Research and Development Authority.

National Climatic Data Center. 2000. **Integrated surface hourly observations 2000.** Silver Spring, MD: U.S. Department of Commerce, National Oceanic and Atmospheric Administration. [CD-ROM].

Nowak, D.J. 1993. **Compensatory value of an urban forest: an application of tree-value formula.** Journal of Arboriculture. 19(3): 173-177.

Nowak, D.J. 1994a. **Atmospheric carbon dioxide reduction by Chicago's urban forest.** In: McPherson, E.G; Nowak, D.J.; Rowntree, R.A. Chicago's urban forest ecosystem: results of the Chicago urban forest climate project. Gen. Tech. Rep. NE-186. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 83-94.

Nowak, D.J. 1994b. **Urban forest structure: the state of Chicago's urban forest.** In: McPherson, E.G; Nowak, D.J.; Rowntree, R.A. Chicago's urban forest ecosystem: results of the Chicago urban forest climate project. Gen. Tech. Rep. NE-186. Radnor, PA: U.S. Department of Agriculture, Forest Service Northeastern Research Station: 3-18 and 140-164 [appendix].

Nowak, D.J.; Crane, D.E. 2000. **The Urban Forest Effects (UFORE) model: quantifying urban forest structure and functions.** In: Hansen, M.; Burk, T., eds. Integrated tools for natural resources inventories in the 21st century, proceedings of the IUFRO conference; 1998 August 16-20; Boise, ID. Gen. Tech. Rep. NC-212. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station: 714-720.

Nowak, D.J.; Crane, D.E. 2002. **Carbon storage and sequestration by urban trees in the United States.** Environmental Pollution. 116(3): 381-389.

Nowak, D.J.; Crane, D.E.; Stevens, J.C. 2001a. **Syracuse's urban forest resource.** In: Nowak, D.J.; O'Connor, P., comps. Syracuse urban forest master plan: guiding the city's forest resource in the 21st century. Gen. Tech. Rep. NE-287. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 9-14.

Nowak, D.J.; Crane, D.E.; Stevens, J.C. 2006d. **Air pollution removal by urban trees and shrubs in the United States.** Urban Forestry and Urban Greening. 4: 115-123.

Nowak, D.J.; Hoehn, R.; Crane, D.E.; Stevens, J.C.; Walton, J.T. 2006a. **Assessing urban forest effects and values: Casper, WY's urban forest.** Res. Bull. NRS-4. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station. 20 p.

Nowak, D.J.; Hoehn, R.; Crane, D.E.; Stevens, J.C.; Walton, J.T. 2006b. **Assessing urban forest effects and values: Minneapolis' urban forest.** Res. Bull. NE-166. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station. 20 p.

Nowak, D.J.; Hoehn, R.; Crane, D.E.; Stevens, J.C.; Walton, J.T. 2006c. **Assessing urban forest effects and values: Washington D.C.'s urban forest.** Resour. Bull. NRS-1. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station. 24 p.

Nowak, D.J.; Hoehn, R.; Crane, D.E.; Stevens, J.C.; Walton, J.T. 2007a. **Assessing urban forest effects and values: New York's urban forest.** Resour. Bull. NRS-9. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station. 22 p.

Nowak, D.J.; Hoehn, R.; Crane, D.E.; Stevens, J.C.; Walton, J.T. 2007b. **Assessing urban forest effects and values: Philadelphia's urban forest.** Resour. Bull. NRS-7. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station. 22 p.

Nowak, D.J.; Hoehn, R.; Crane, D.E.; Stevens, J.C.; Walton, J.T. 2007c. **Assessing urban forest effects and values: San Francisco's urban forest.** Resour. Bull. NRS-8. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station. 22 p.

Nowak, D.J.; Noble, M.H.; Sisinni, S.M.; Dwyer, J.F. 2001b. **People and trees: assessing the U.S. urban forest resource.** Journal of Forestry. 99(3): 37-42.

Nowak, D.J.; Walton, J.T.; Dwyer, J.F.; Kaya, L.G.; Myeong, S. 2005. **The increasing influence of urban environments on U.S. forest management.** Journal of Forestry. 103(8): 377-382.

Nowak, D.J.; Walton, J.T. 2005. **Projected urban growth and its estimated impact on the U.S. forest resource (2000-2050).** Journal of Forestry. 103(8): 383-389.

Ottinger, R.L.; Wooley, D.R.; Robinson, N.A.; Hodas, D.R.; Babb, S.E.; Buchanan, S.C.; Chernick, P.L.; Caverhill, E.; Krupnick, A.; Fritsche, U. 1990. **Environmental costs of electricity.** White Plains, NY: Oceana Publications. 769 p.

U.S. Census Bureau. n.d. **www.census.gov.** (January 2007).

U.S. Department of Interior, Geologic Survey. 2008. **Multi-resolution land characteristics consortium.** www.mrlc.gov. (1 August 2008).

U.S. Department of Labor Bureau of Labor Statistics. n.d. **www.bls.gov/ppi/** (June 2007).

U.S. Environmental Protection Agency. 2003. **National air quality and emissions trends report: 2003 special studies edition.** Research Triangle Park, NC: U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Emissions Monitoring and Analysis Division.

U.S. Environmental Protection Agency. n.d. **www.epa.gov/oar/data** (June 2008).

Walton, J.T. 2005. **An investigation of national tree canopy assessments applied to urban forestry.** Syracuse, NY: State University of New York, College of Environmental Science and Forestry. 95 p. Ph.D. dissertation.

Yang, L.; Huang, C.; Homer, C.G.; Wylie, B.K.; Coan, M.J. 2003. **An approach for mapping large-area impervious surfaces: synergistic use of Landsat-7 ETM+ and high spatial resolution imagery.** Canadian Journal of Remote Sensing. 29(2): 230-240.

Zhu, Z. 1994. **Forest density mapping in the lower 48 states: a regression procedure.** Res. Pap. SO-280. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Research Station. 11 p.

APPENDIX

Urban Forest Data: States of the Southern Atlantic Region

The following tables are generated to support state reports on urban and community forests of the Southern Atlantic States of Delaware, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, and West Virginia, and the District of Columbia. For specific state data tables use the CD accompanying this publication and search within the regional or state folder, or go to: http://www.nrs.fs.fed.us/data/urban.

State Specific Tables:

Table 1.—Statewide summary of population, area, population density, tree canopy and impervious surface land cover, and urban tree benefits in urban, community, and urban or community areas.

Table 2.—2000 population characteristics, population change (1990-2000), and percent of land classified as urban within communities.

Table 3.—2000 population characteristics, population change (1990-2000), percent of land classified as urban or as communities within county subdivisions.

Table 4.—2000 population characteristics, population change (1990-2000), percent of land classified as urban or as communities within counties.

Table 5.—Tree canopy and impervious surface cover characteristics by community.

Table 6.—Tree canopy and impervious surface cover characteristics by county subdivision.

Table 7.—Tree canopy and impervious surface cover characteristics by county.

Table 8.—Land area, tree canopy cover, and available green space distributed within generalized land cover categories for communities.

Table 9.—Land area, tree canopy cover, and available green space distributed within generalized land cover categories for county subdivisions.

Table 10.—Land area, tree canopy cover, and available green space distributed within generalized land cover categories for counties.

Table 11.—Statistical summary of mapping zone values used to calculate urban and community forestry assessment.

Table 12.—Urban and community forestry assessment by community.

Table 13.—Urban and community forestry assessment by county subdivisions.

Table 14.—Urban and community forestry assessment by counties.

Table 15.—Planting priority index for communities.

Table 16.—Planting priority index for county subdivisions.

Table 17.—Planting priority index for counties.

Nowak, David J.; Greenfield, Eric J. 2009. **Urban and community forests of the Southern Atlantic region: Delaware, District of Columbia, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, West Virginia.** Gen. Tech. Rep. NRS-50. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 85 p.

This report details how land cover and urbanization vary within the states of Delaware, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, and West Virginia; and the District of Columbia by community (incorporated and census designated places), county subdivision, and county. Specifically this report provides critical urban and community forestry information for each state including human population characteristics and trends, changes in urban and community lands, tree canopy and impervious surface cover characteristics, distribution of land-cover classes, a relative comparison of urban and community forests among local government types, determination of priority areas for tree planting, and a summary of urban tree benefits. Report information can improve the understanding, management, and planning of urban and community forests. This data is reported for each state on the CD provided in the back of this book and may be accessed by state at: http://www.nrs.fs.fed.us/data/urban.

KEY WORDS: urban forestry, tree cover, impervious cover, classified land cover, ecosystem services, urbanization

Capitalizing on the strengths of existing science capacity in the Northeast and Midwest to attain a more integrated, cohesive, landscape-scale research program

www.nrs.fs.fed.us