NumbersUSA

PAVING THE PIEDMONT

Weighing Sprawl Factors in the Emerging Piedmont Megalopolis

Analysis of U.S. Census Bureau and National Resources Inventory Data on the Emerging Southern Megalopolis Stretching from Atlanta to Raleigh, and Beyond

By Leon Kolankiewicz, Eric Ruark, and Roy Beck

May 2017

NumbersUSA
Arlington, Virginia

PAVING THE PIEDMONT

Weighing Sprawl Factors in the Emerging Piedmont Megalopolis

Analysis of U.S. Census Bureau and National Resources Inventory Data on the Emerging Southern Megalopolis Stretching from Atlanta to Raleigh, and Beyond

Table of Contents

List of Tables

List of Figures

PAVING THE PIEDMONT:
Weighing Sprawl Factors in the Emerging Piedmont Megalopolis

Analysis of U.S. Census Bureau and National Resources Inventory Data on the Emerging Southern Megalopolis Stretching from Atlanta to Raleigh, and Beyond

Executive Summary

The Emerging Piedmont Megalopolis

The Southeastern United States has been one of the fastest-growing regions of the country for decades, and it is here that America's newest megalopolis is emerging. This reality was documented and dramatized by a 2014 paper published in the online scientific journal *PLOS One*. Entitled "The Southern Megalopolis: Using the Past to Predict the Future of Urban Sprawl in the Southeast U.S." This paper presented the results of a study by researchers affiliated with the Raleigh, North Carolina office of the U.S. Geological Survey (USGS) and North Carolina State University, also in Raleigh.

The USGS-NC State study team developed a baseline Business as Usual (BAU) urbanization scenario for a region covering nine states in the Southeast. The most widespread pattern of new development in this emerging Piedmont megalopolis is suburban, automobile-dependent sprawl, characterized by low-density, single-family housing that requires extensive road networks and expands across large land areas. The team's simulations indicate that by 2060 the extent of urbanization in the Southeast under the BAU scenario would increase by 101% to 192%, or two to nearly three times more than the area of land already developed.

These projected land use changes and the emergence of a new megalopolis over the coming decades would impose enormous adverse effects on the Southern Piedmont region's existing largely rural character, natural habitats, biodiversity, farmlands, and quality of life. They would also compromise the region's environmental sustainability.

Many Piedmont residents are concerned about the future of the region as it urbanizes. In a 2015 opinion survey conducted in conjunction with the present report on population growth and sprawl, 55 percent of adult residents polled indicated that continuous development from Atlanta to Raleigh would make the region a "worse and more congested" place to live in, compared to 20 percent who thought it would become "better and more exciting."

Urban Sprawl as a Function of Increasing Population and Per Capita Land Consumption

Dozens of diverse factors have been suggested as causes of America's relentless, unending sprawl, defined here as the expansion of urban land at the expense of rural land. One factor is **population growth**. All of the other factors combine to increase **per capita land consumption**.

This study is one in a series of national, regional, and state studies begun by the authors and NumbersUSA in the year 2000 to quantify the extent to which urban sprawl in the nation's regions, states, counties, and urbanized areas (cities and towns) is related to: 1) population growth, and/or 2) growth in per capita land consumption. Initially, the authors were motivated by their skepticism in the face of frequently repeated claims by many anti-sprawl and "smart growth" advocacy groups, politicians, and the news media, that sprawl was almost entirely a function of the second of these factors, namely increasing per capita land consumption, typically characterized as declining population density. Indeed, sprawl would typically be described as "low-density development", implying that high-density development was entirely acceptable, even if it still paved over vast amounts of the country's dwindling farmland and natural habitat every decade.

This study defines the term "Overall Sprawl" as the amount of rural land lost to development. Overall Sprawl can be measured using two distinct, comprehensive inventories conducted by two unrelated federal agencies: the U.S. Census Bureau (Census) and the Natural Resources Conservation Service (NRCS) of the U.S. Department of Agriculture (USDA). Census has tabulated changes in the size and shape of the nation's Urbanized Areas (UAs) every 10 years since 1950, while the NRCS has estimated changes in the size and shape of America's Developed Lands since 1982 in their Natural Resources Inventories (NRIs).

A city or state's population grows based on personal behavior – births and in-migration – and on local and national governmental policies and actions. Looking more closely, the net increase (or decrease) in population in any given time period (e.g., one year, one decade) is due to the number of births minus the number of deaths plus the number of in-migrants minus the number of out-migrants.

Per capita land consumption may increase or decrease in a given urban region due to a variety of factors, including consumer preferences for size and type of housing and yards, governmental subsidies, energy prices (cheaper fuel encourages sprawl), real and perceived crime rates, quality of schools and other public facilities and services, ethnic and cultural tensions or harmony, job opportunities, and a number of other factors listed in Section 2.4.3 of this report.

Findings

The Piedmont Sprawl Study includes 128 counties in three Southern states – 42 in North Carolina, 23 in South Carolina, and 63 in Georgia (Figure ES-1). It also includes 25 UAs: 11 in North Carolina, five in South Carolina, and nine in Georgia (Table ES-1).

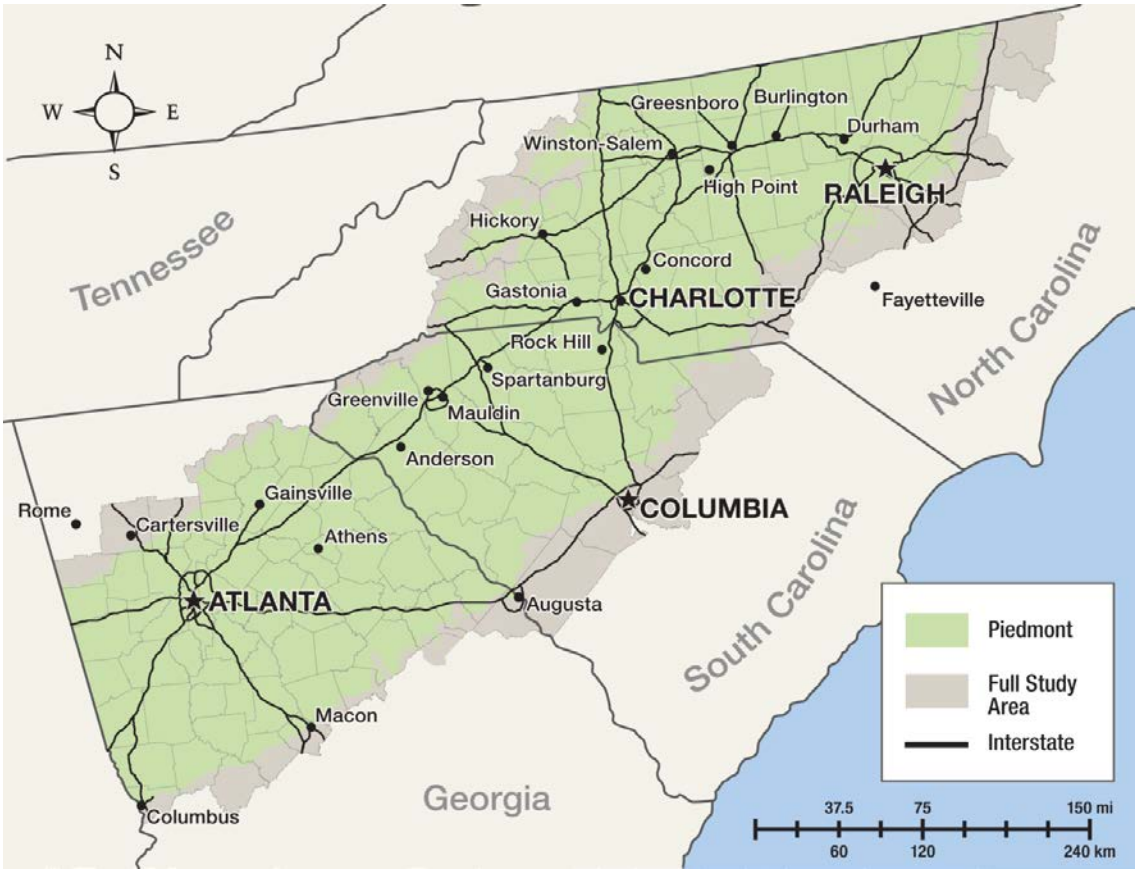


Figure ES-1. Piedmont Sprawl Study Area

Table ES-1. Urbanized Areas (UAs) as of 2010 in the Piedmont Study Area

North Carolina	South Carolina	Georgia
Asheville	Anderson	Athens-Clarke County
Burlington	Columbia	Atlanta
Charlotte	Greenville	Augusta-Richmond County, GA-SC
Concord	Mauldin-Simpsonville	Cartersville
Durham	Rock Hill	Dalton
Gastonia, NC-SC		Columbus, GA-AL
Greensboro		Gainesville
Hickory		Macon
High Point		Rome
Raleigh		
Winston-Salem		

The 25 UAs in the three-state Piedmont study area grew in population from 8,547,127 in 2000 to 11,351,473 in 2010, an increase of 2,804,346 or 33 percent in just one decade. Over that same decade, the aggregate area of urbanized land – Overall Sprawl – expanded by 37 percent. Using a method explained in Section 3.1.3 of this report to apportion consumption of natural resources between two or more factors, we determined that approximately 84 percent of the sprawl in these 25 Southern Piedmont UAs was related to population growth in those UAs, and 16 percent due to increase in per capita land consumption, or what we term "per capita sprawl" (Figure ES-2).

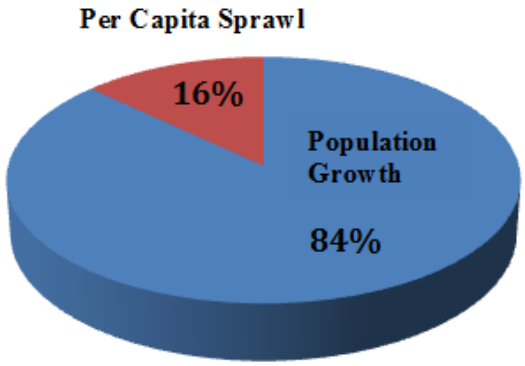


Figure ES-2. Percentages of Sprawl Related to Population Growth and Per Capita Sprawl in Piedmont's 25 Urbanized Areas, 2000-2010

Results for the 128 counties of the three-state Piedmont study area were very similar, in spite of using raw data on developed land from a completely different source, the NRI (based on a completely different methodology) and a completely different federal agency, the NRCS. From 2002 to 2010, approximately 86 percent of the overall sprawl could be attributed to population growth, and 14 percent to per capita sprawl, or declining population density (Figure ES-3). The similarity of these results gives us confidence in the robustness of our findings.

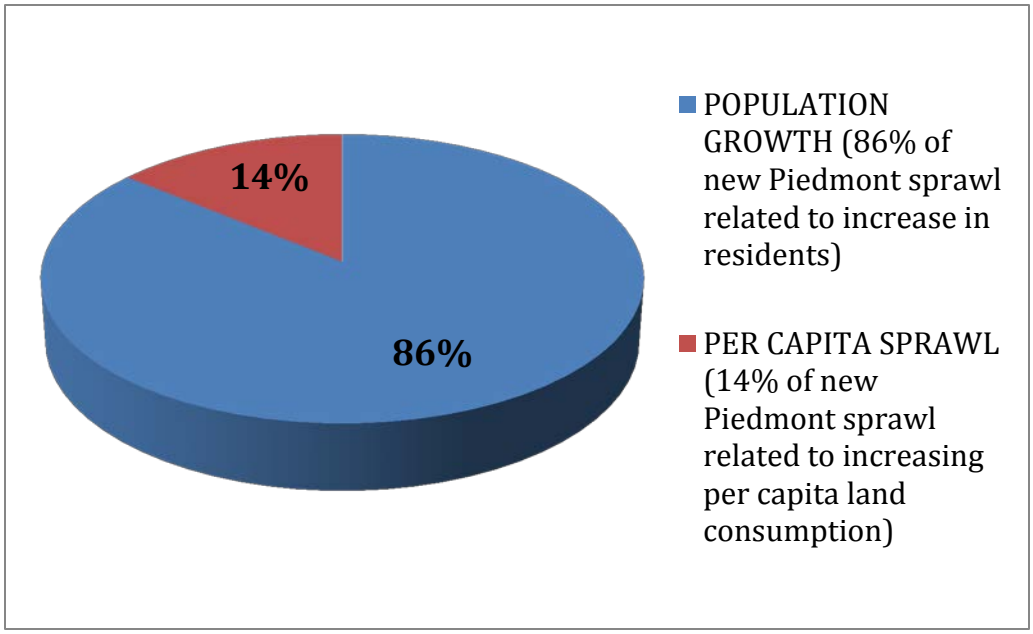


Figure ES-3. Percentages of Sprawl Related to Population Growth and Per Capita Sprawl in Piedmont Study Area's 128 Counties, 2002-2010

Examining the longer, entire 28-year period of record for which NRI data on developed land are available – 1982 to 2010 – a somewhat different apportionment of sprawl between the population and per capita factors is evident in the Southern Piedmont. Figure ES-4 shows that population growth accounts for 68 percent and per capita sprawl for 32 percent of overall sprawl during the entire period of record.

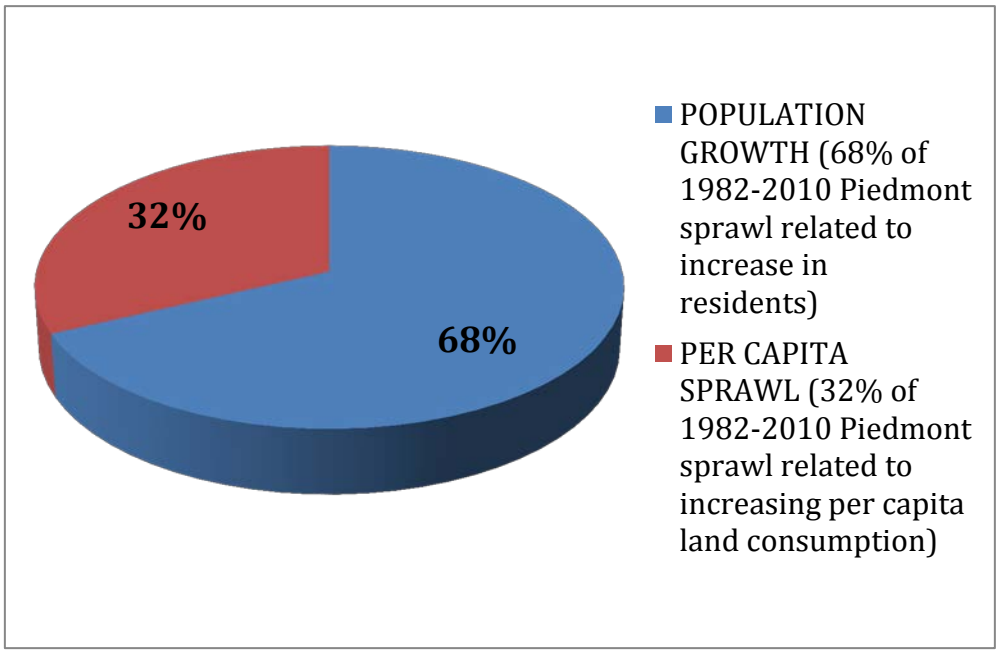


Figure ES-4. Percentages of Sprawl Related to Population Growth and Per Capita Sprawl in Piedmont Study Area's 128 Counties, 1982-2010

These findings and trends also parallel those of other sprawl studies conducted by NumbersUSA since 2000, which indicate that in more recent years, the role of population growth in driving America's urban sprawl has increased. From 1970 to 1990, for example, about half of sprawl nationwide was associated with population growth and about half with growth in per capita land consumption (per capita sprawl). The upshot is that as development in the United States has become denser, through Smart Growth initiatives and other factors, overall sprawl rates (conversion of rural lands to urban land) have declined somewhat, but the share of that sprawl related to continuing population growth has risen.

Policy Implications of these Findings

Our findings couldn't be clearer: Population growth accounts for the great majority of the sprawl in the Southern Piedmont. This contradicts the tenacious national myth that America's loss of rural lands and open space from post-World War II urbanization is due primarily to low-density sprawl from Americans' and Southerners' preferences for large

homes on large suburban lots on the city's outskirts. The emergence of the Southern Megalopolis in the Piedmont region is driven primarily by persistent population growth.

While the findings of this study directly challenge the assumptions of many Smart Growth and New Urbanism advocates that population growth plays only a small role in Overall Sprawl, they do not discount the necessity for smarter urban planning that reduces per capita land consumption. The results of this study suggest that in the Piedmont of Georgia, South Carolina, and North Carolina, only about 15 percent of recent sprawl was caused by a complicated array of zoning laws, infrastructure subsidies, and complex socioeconomic forces. Efforts to make cities and communities more space-efficient and livable are certainly needed, but they largely ignore the main concern that sprawl is devouring the Piedmont's remaining undeveloped lands.

Following the logic of this study's findings it isn't hard to conclude that even the most aggressive and well-intentioned policies promoting smarter growth, better urban planning, and higher residential densities cannot escape the immense population pressures facing many communities around the rapidly growing Piedmont region. Demographic and development pressures are pushing it to become a sprawling southern megalopolis.

Under Smart Growth alone, the Piedmont's cities will never stop consuming countryside as long as the region's population boom continues – until no open space is left outside of existing protected parks and wildlife reserves, which themselves will feel squeezed and hemmed in by surrounding higher human population densities. These protected habitats will experience greater noise, visitation, pollution, invasive species, habitat fragmentation, and indirect adverse effects on native flora and fauna.

Simply stated, the results of this study indicate that in the Southern Piedmont, population growth has more than five times the impact on sprawl than all other factors combined. Neglecting the population factors in the anti-sprawl fight would be to ignore 85 percent of the problem.

Beyond the short term, local Piedmont officials supportive of growth control and management can at best hope to slow population growth in their jurisdictions if national population continues to increase by some 2.5 to 3 million additional residents each year. These 25-30 million additional Americans each decade will all settle in some community or another, inevitably leading to additional sprawl as far and as long as the eye can see. Many of these added millions will choose to settle in the Southern Piedmont.

Thus, long-term population growth in the United States in general and the Southern Piedmont in particular are in the hands of federal policy makers. It is they who have increased the annual settlement of legal immigrants from one-quarter million in the 1950s and1960s to over a million since 1990. Unless the numerical level of national immigration is addressed, even the best local plans and political commitment will be unable to stop sprawl. Any

serious efforts to halt the loss of farmland and wildlife habitat in the Southern Piedmont must include reducing the volume of population growth, which requires lowering the volume of immigrants entering the country each year, unless Americans and immigrants decide to move toward a one-child per woman average.

A far more sustainable immigration level would be the approximately half-million a year recommended in 1995 by the bi-partisan U.S. Commission on Immigration Reform, established by President Clinton and chaired by former Congresswoman Barbara Jordan (D-TX).

That would appear to be a popular option among most Americans and residents of the Southern Piedmont in North Carolina, South Carolina, and Georgia. Polls of America's likely voters in 2014 and adult Piedmont residents in 2015 by Pulse Opinion Research found that reducing immigration was a popular policy choice among most when linked with the goal of slowing down U.S. population growth.

In the 2014 national poll, when informed that immigration levels currently are around one million a year, voters were asked by pollsters what level they would prefer. Only 21 percent chose to keep it at one million or increase it. However, 63 percent of voters said they preferred to reduce immigration by at least half, which would put immigration at about the level advocated in the mid-1990s by the Jordan Commission.

This lower level of immigration at around 500,000 a year would drive far less population growth and sprawl than the present levels exceeding a million a year. But unless Americans decide to lower their birth rates to far below replacement level, the 500,000 a year would still drive considerable population growth and sprawl indefinitely.

That is why another federal commission recommended far greater reductions in immigration. The President's Council on Sustainable Development in 1996 recommended that the United States stabilize its population in order to meet various environmental and quality-of-life goals, and it called for reducing immigration to a level that would allow for a stable population. At current just below-replacement native fertility rates, that would require a return down to at least the quarter-million level of immigration in the 1950s and 1960s.

The Population and Consumption Task Force of President Clinton's Council on Sustainable Development concluded in 1996: "This is a sensitive issue, but reducing immigration levels is a necessary part of population stabilization and the drive toward sustainability."

It is important to note that the sprawl which occurs because of high immigration levels has nothing to do with the quality of immigrants as people or their attributes as individuals but everything to do with the sheer quantity of population growth that occurs because of immigration. This can be seen by simply observing that, on average, cities with high

population growth have high amounts of sprawl, regardless of whether most of the incoming new residents come from another region of the United States or from another country or continent.

On a local level, the sprawl pressures of population growth are similar regardless of where the new residents originate. Yet very few Urbanized Areas are likely to be able to subdue population growth and sprawl if the federal government continues immigration policies that add around 20 million people to the nation each decade, all of whom have to settle in some locality. The reality – which can only be partially mitigated but not eliminated by good planning or Smart Growth – is that these localities all occupy lands that were formerly productive agricultural lands or irreplaceable natural habitats.

In a nutshell, if the United States in general, and Piedmont residents in particular, are serious about reducing or halting sprawl in the coming decades – and its unacceptable, untenable impacts on the environment, quality of life, and sustainability – immigration rates must be lowered substantially.

PAVING THE PIEDMONT: Weighing Sprawl Factors in the Emerging Piedmont Megalopolis

Analysis of U.S. Census Bureau and National Resources Inventory Data on the Emerging Southern Megalopolis Stretching from Atlanta to Raleigh, and Beyond

1. INTRODUCTION AND BACKGROUND

1.1 The Emerging Piedmont Megalopolis

"Metropolis" is a word with origins in ancient Greece. Originally it denoted the "mother city" of a Greek colony. Later it came to denote a large, densely populated city or urbanized area. A modern metropolis typically contains one or more city centers or cores – where the skyscrapers and taller buildings are concentrated, often known as "downtown" – surrounded by lower-density but still built-up suburbs and "satellite" or edge cities. Metropolises include a variety of urban land uses, such as commercial, office, institutional, industrial, transportation (e.g., roads, streets, freeways, driveways, parking lots and structures, railways, airports, bus terminals), residential (high, medium and low density), and open space (city parks).

A "megalopolis" could be thought of as a metropolis on steroids. The prefix "mega-" of course, connotes enormity, or more specifically, a million, as in "megawatt" (a million watts of power). If a metropolis is a giant beehive of humanity, a megalopolis is a gigantic beehive: a veritable colossus of human beings (tens of millions) and their cumulative built environment (millions of manmade structures).

A megalopolis is thus an even larger metropolis, or more typically, an entire dynamic region consisting of two or more metropolises or conurbations that are connected by transportation corridors. Open space or rural lands – farmland and wildlife habitat – that have the misfortune of being squeezed between the developed poles of a megalopolis have either been eliminated already by lower-density sprawl development or are in the process of being so. Typically the growth occurs along the established transportation corridors such as freeways, highways, or interstates, concentrating initially at exits and intersections and spreading out from there.

In the Northeast and Mid-Atlantic U.S., America's longest-standing megalopolis stretches across portions of nine states (Massachusetts, Connecticut, Rhode Island, New York, New Jersey, Pennsylvania, Delaware, Maryland, and Virginia) from Boston in the north to

Richmond in the south, encompassing New York City, Philadelphia, Wilmington, Baltimore, and Washington D.C., as well as scores of smaller cities and towns.

The Southeast, for reasons steeped in the turbulent history of the United States, developed more slowly than New England, the Mid-Atlantic, the Great Lakes States, and even the West. But it has been one of the fastest-growing regions of the United States for decades now, and it is in the South that America's newest megalopolis is emerging.

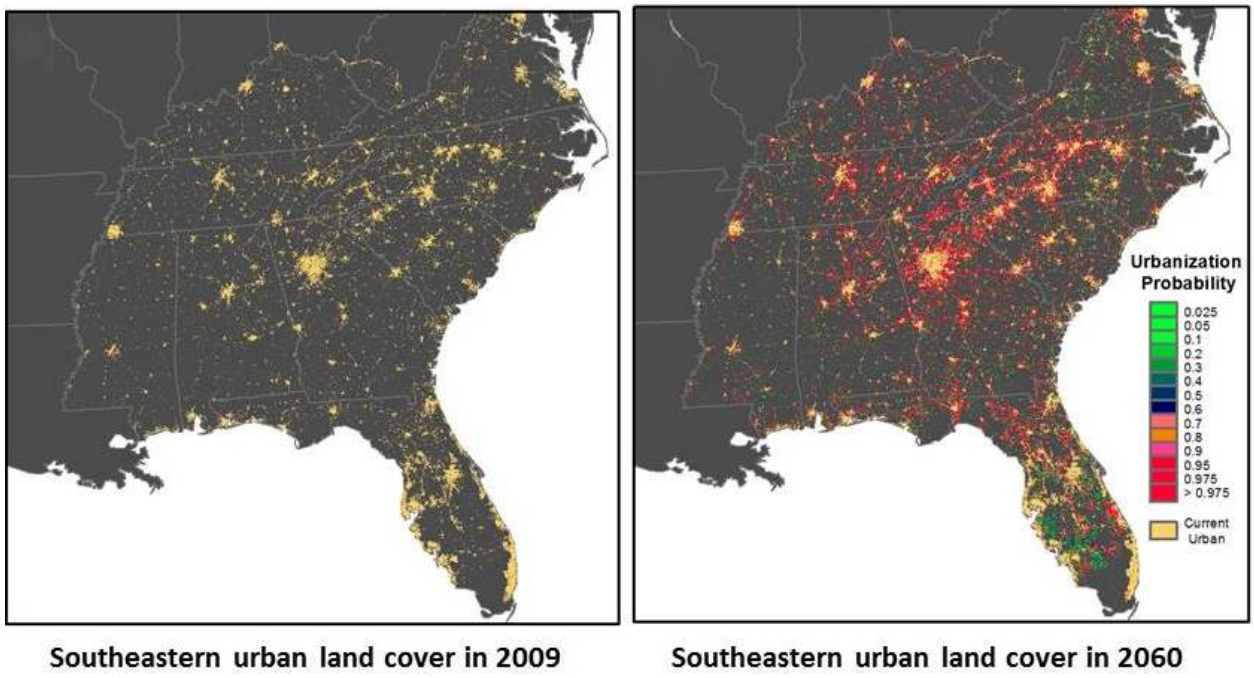
This reality was documented and dramatized by a 2014 paper published in the online scientific journal *PLOS One*.[1] The paper, entitled "The Southern Megalopolis: Using the Past to Predict the Future of Urban Sprawl in the Southeast U.S.," presented the results of a study by researchers affiliated with the Raleigh, North Carolina office of the U.S. Geological Survey (USGS) and North Carolina State University, also in Raleigh.

Using the SLEUTH urban growth model, the USGS-NC State study team developed a baseline Business as Usual (BAU) urbanization scenario for a region covering nine states in the Southeast. This region of the country has experienced, in the words of the authors, "explosive growth" for over a half century. Its current population growth rate is nearly 40 percent higher than the rest of the U.S., resulting in a population of more than 77 million and counting. The most widespread pattern of new development in this emerging Piedmont megalopolis is suburban, automobile-dependent sprawl, characterized by low-density, single-family housing that requires extensive road networks and expands across large land areas. The team's simulations indicate that by 2060 the extent of urbanization in the Southeast under the BAU scenario would increase by 101% to 192% (i.e., two to nearly three times more than the area of land already developed) (**Figures 1 and 2**).

The Southeast supports quite high levels of biodiversity. Many unique ecological communities native to the region have been modified, compromised and reduced by human actions.[2] These actions include habitat loss, alteration, and fragmentation due to urbanization, conversion to agriculture, clearcut logging, fire suppression, and filling or draining of wetlands. The USGS-NC State researchers cite the case of the once widespread but now severely diminished longleaf pine (*Pinus palustris*) ecosystem (**Figure 3**), which once dominated as much as 90 million acres from southern Virginia to Florida and west to eastern Texas, but now occupies less than five percent of its former range. The longleaf pine ecosystem contains possibly the most species-rich communities outside of the tropics, including many highly endangered species such as the Red-cockaded Woodpecker (*Leuconotopicus borealis*) (**Figure 4**).

[1] Adam J. Terando, Jennifer Costanza, Curtis Belyea, Robert R. Dunn, Alexa McKerrow, Jaime A. Collazo. 2014. The Southern Megalopolis: Using the Past to Predict the Future of Urban Sprawl in the Southeast U.S. *PLOS ONE*, Vol. 9, Issue 7. July. Available online at: www.plosone.org.
[2] Reed F. Noss. 2012. *Forgotten Grasslands of the South: Natural History and Conservation*. Washington, DC: Island Press.

Figure 1. Projected Increase in the Extent of Urbanized Areas in the Southeastern United States, 2009 to 2060



Source for Figures 1 and 2: Terando et al., footnote 1.

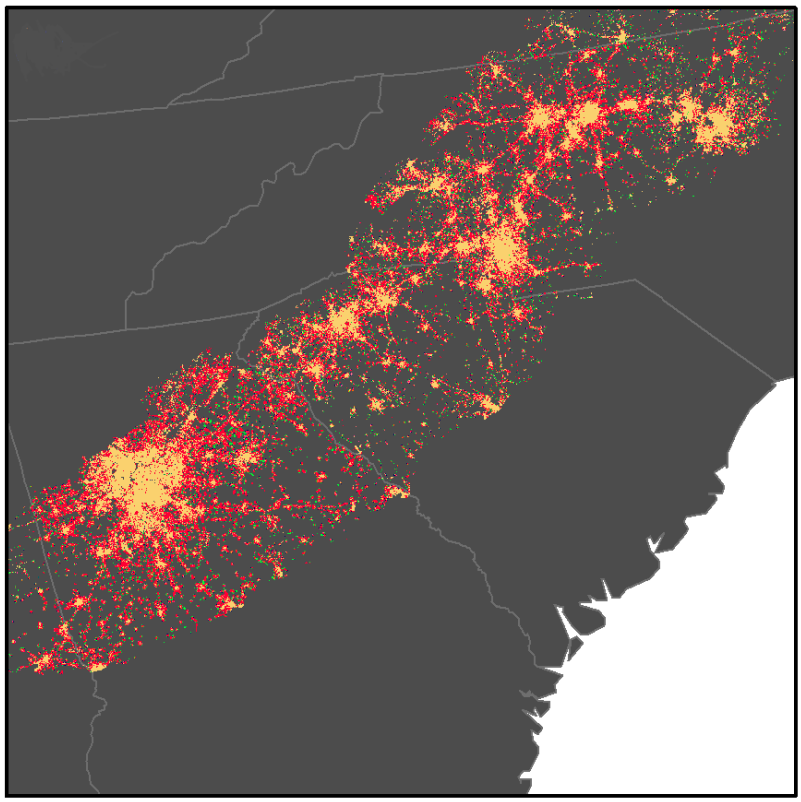


Figure 2. Predicted 2060 Extent of Urbanization in the Southern Piedmont – the "Southern Megalopolis"

Figure 3. Longleaf Pine Ecosystem, a Type of Pine Savanna

Figure 4. Red-cockaded Woodpecker

Overall, the USGS-NC State Southern Megalopolis study reached these conclusions:

- The urban footprint in the nine-state Southeast region will increase greatly over the next 50 years.

- Under the median projection, the amount of land in urban areas in the Southeast will more than double, increasing by 139%, from approximately 35,000 square miles (7.4% of total land area) in 2009 to 83,750 square miles (17.8% of total land area) by 2060.

- In the Piedmont ecoregion in particular, which includes many of the largest metropolitan centers in the Southeast, such as Atlanta, Charlotte, and Raleigh, urban areas are projected to expand by a whopping 165%, from 6,870 square miles in 2009 to 18,340 square miles in 2060.

- In terms of land use/land cover types, the largest conversion would be from agriculture to urban land use, in which the percentage of all agriculture lands that are converted to urban land use ranges from 11% - 21% by 2060 (at the 95% confidence level).

- Urban areas will most likely occupy a much greater land area in the Southeastern United States. The size of urban area in the region is projected to double or triple by 2060.

- There are a "combination of growth attractors" in the Piedmont region, such as the current "existence of large urban areas, a lack of geographic constraints on growth, auto-oriented residential development, and proximity to natural amenities (Appalachian Mountains and the Atlantic Ocean)."

- A wide range of species and ecosystems will suffer reduced habitat area and many imperiled species of plants and animals will experience increased difficulty in migration and dispersal.

- The projected changes would have significant and lasting effects on the region's ecosystems. An increasingly fragmented natural landscape would compromise available habitat, repress ecologically important natural disturbance processes (such as wildfires), stymie management actions such as prescribed fire in the wildland-urban interface, and likely truncate or eliminate existing wildlife corridors. Moreover, all these impacts could take place concurrently, posing a particularly difficult threat to already vulnerable species and ecosystems.

- Not only would habitats and corridors for wildlife be lost, but the continuous urban corridor would have a warmer climate than surrounding rural areas.

1.2 Still a Problem after All These Years (and Americans Still Concerned)

In the late 1990s and early 2000s, nearly two decade ago, this report's senior authors were encouraged by like-minded scientists, academics, planners, and conservationists around the country to explore and quantify the role of population growth in urban sprawl. At the time, in both academic and government research on the subject, as well as in the popular press and the pronouncements of anti-sprawl activist organizations, if population was mentioned at all, typically it was to dismiss or minimize its importance as a causal agent of sprawl. Yet intuitively and logically, it seemed there should be a correlation to some extent between the population size of a city and the size of the physical area it occupied. Likewise, it seemed that a city's rate of population growth – how quickly it was adding residents per year or per decade – should have some bearing on how rapidly it was sprawling outwards, that is, on the rate at which rural land or open space at its perimeter was being converted into urban or built-up land.

As related subsequently in this report, we eventually found the approaches, data, and methodology by which to derive credible estimates of population growth's influence on sprawl around the country.

While there is more than one way to define sprawl, our studies consider it to be the conversion of open spaces like farmland and natural habitat into developed land containing man-made structures and surfaces on the expanding edges of large or small urban areas.

Much like our previous studies at the national, regional, and statewide scales, this examination of the role of population growth in helping to drive sprawl in the Piedmont attempts to move beyond what has often been an abstract and non-quantitative discussion about the loss of farmland, natural habitat, and open space and toward a conversation about how much of this loss is attributable to population growth, development decisions, and Americans' personal consumption desires and behaviors. This study uses data from the same reliable, authoritative government agency sources and applies the same methods as our original studies in quantifying the roles of the two *Overall Sprawl* factors: increase in per capita land consumption and population growth.

When our first sprawl study was published in 2000, sprawl was a hot topic with many environmental organizations, and the general public worried about the impacts of ever-expanding urban areas.[3] Nearly two decades later, sprawl continues to devour valuable farm and forestland both at the national level and in the Southeast and Piedmont in particular. Yet national and state environmental groups, by and large, have shifted their focus to global issues like climate change and away from the loss of habitat and open space due to unsustainable urban growth in America itself.

Despite our nation's many economic setbacks over the last decade, sprawl continues to be a major threat to rural land and natural habitats in the United States. Nationally, in just the eight years from 2002 to 2010 over 8.3 million acres (approximately 13,000 square miles) – an area larger than Maryland – of previously undeveloped land succumbed to the bulldozer's blade.

Although sprawl by name is not much seen in the news these days, the results of sprawl continue to fuel numerous local controversies and are a factor in many of the nation's most pressing environmental challenges. Americans remain concerned, and in large numbers would like to see sprawl halted or at least tamed. In April 2014, Pulse Opinion Research conducted a "Sprawl & Population National Poll" of likely voters.[4] When asked about the Maryland-sized loss of farmland and natural habitat in the last decade, 77 percent of said it is

[3] David P. Fan, David N. Bengston, Robert S. Potts, Edward G. Goetz. 2005. The Rise and Fall of Concern about Urban Sprawl in the United States: An Updated Analysis. Bengston, David N., tech. ed. 2005. Policies for managing urban growth and landscape change: a key to conservation in the 21st Century. Gen. Tech. Rep. NC-265. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station. 51 pp.

[4] Pulse Opinion Research. 2014. Sprawl & Population National Poll – Survey of 1,000 Likely Voters. Conducted April 1-2, 2014. Margin of Sampling Error, +/- 3 percentage points with a 95% level of confidence. See Appendix J for entire poll.

a problem (42% said it is a "major problem"). Moreover, 85 percent said the loss of wildlife habitat due to sprawl is a significant problem (53% said "very significant").

As native-born Americans and immigrants alike seek better economic opportunities, new sprawling cities are emerging in traditionally less developed areas of the country, such as the Southeast, and the Piedmont in particular. Indeed, a new American megalopolis is in the making, situated squarely in the Piedmont, a formerly rural region of the country that was sparsely populated and dominated by forests and farming half a century ago. As the 2014 USGS-NC State paper emphatically illustrated, projected development in the Piedmont will place enormous additional pressure on already stressed natural resources, ecologically sensitive habitats, and species. It is for these reasons that the authors decided that a study examining the factors behind sprawl in the Piedmont was in order.

This Piedmont sprawl study examines the quantity and rate of rural land lost to development from 1982 to 2010 in a core Piedmont sprawl study area containing 128 counties in three states – Georgia, South Carolina, and North Carolina. It ascribes the "shares of sprawl" that are related to population growth and to increasing per capita land consumption. The study also looks at the amounts and causes of sprawl in 25 Urbanized Areas (as designated by the U.S. Census Bureau) in four states within the Piedmont sprawl study area from 2000 to 2010.

Although rates (percentage increases) of sprawl are important, the most significant environmental fact about a city's sprawl – or a state's increase in developed land – is the actual area in acres or square miles of rural land that has been urbanized or developed.

1.2.1 Causes for Concern – National Scale

Table 1 lists America's top 10 Urbanized Areas that eliminated the most rural land over the past decade for which data are available (2000-2010). Clearing, scraping, paving, and building over thousands of square miles of America's woodlands, wetlands, croplands, prairies, pastures, range, deserts, and fields, they truly earned the dubious distinction as the nation's "Top Sprawlers." It is noteworthy, and surely not a coincidence, that three of the Top Ten Sprawlers are Piedmont cities in three of the fastest growing states in the country: Georgia, South Carolina, and North Carolina. Atlanta, Georgia generated far and away the greatest amount of sprawl of any city in the U.S. from 2000 to 2010, nearly double that of its nearest rival, Dallas-Fort Worth, Texas. Charlotte and Raleigh ranked 6th and 8th in the nation, respectively.

Table 1. USA's Top Sprawlers: Urbanized Areas with Greatest Sprawl in Square Miles (2000 to 2010)

Urbanized Area	**Sprawl** (sq. miles)
1. Atlanta, GA	**683**
2. Dallas-Fort Worth-Arlington, TX	372
3. Houston, TX	365
4. Phoenix-Mesa, AZ	348
5. Chicago, IL-IN	320
6. Charlotte, NC-SC	**307**
7. Austin, TX	205
8. Raleigh, NC	**199**
9. San Antonio, TX	190
10. Philadelphia, PA-NJ-DE-MD	182
Total sprawl from top 10 cities	**3,171**

Source: U.S. Census Bureau Urbanized Area data

Figure 5 is a map that provides a sense of scale, depicting the size, shape, and location of 486 Urbanized Areas and 3,087 Urban Clusters (smaller urban zones/population centers also designated and delineated by the Census Bureau) within the United States as a whole in 2010, after more than a century of continuous population growth and urban expansion. Of particular note is the nearly unbroken band of urbanization (conurbation) stretching from Virginia across eight additional states (Maryland, Delaware, Pennsylvania, New Jersey, New York, Connecticut, Massachusetts, and Rhode Island) all the way to New Hampshire. On this map, land in the more thinly populated West (except for the West Coast proper) does indeed appear much less dominated by urbanization, reflecting the widespread presence of uninhabitable deserts, rugged mountains, and vast irrigated agricultural hinterlands that produce food for the masses congregated in America's teeming cities.

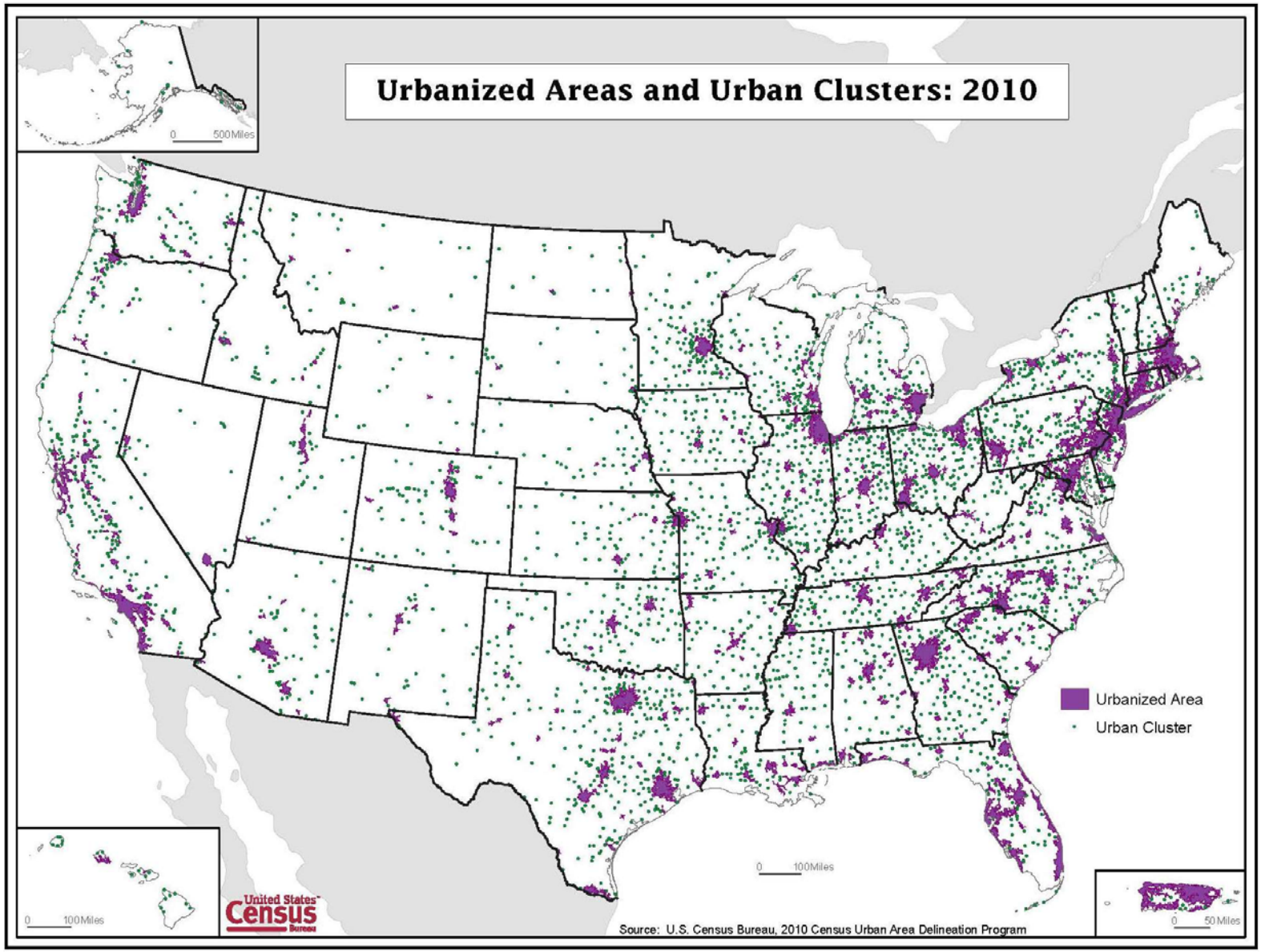


Figure 5. Nationwide Distribution and Pattern of Urbanized Areas and Urban Clusters in 2010

1.2.2 Causes for Concern – Regional Scale

While the 2014 USGS-NC State Southern Megalopolis Study acknowledged population growth as one factor behind the rampant conversion of farmlands and natural habitats into suburban land cover in the Southeast, it did not quantify the degree to which this was actually the case. Another study released in 2014 by NumbersUSA did just that. *Vanishing Open Spaces: Population Growth and Sprawl in America* found that population growth was a greater cause of sprawl than all other causes combined.[5]

This study was designed to specifically examine the current extent of sprawl in the Piedmont area and to use the USGS-NC State **study to map the extent of future sprawl in** one of the fastest growing regions in the United States. **Table 2** lists the four main Southern states that the Piedmont Plateau encompasses and uses the Southern Megalopolis Study to measure sprawl from 1982 to 2010.

Table 2. Sources of Sprawl in Four Piedmont-including Southern States, 1982-2010

State	Total Sprawl (square miles), 1982-2010	National Ranking by % Increase in Total Sprawl from 1982-2010	% of Total Sprawl Related to Growth in POPULATION	% of Total Sprawl Related to Growth in PER CAPITA LAND CONSUMPTION
Georgia	3,735	3	74%	26%
North Carolina	3,771	4	65%	35%
South Carolina	2,020	5	55%	45%
Virginia	2,027	15	70%	30%
Total Sprawl	**11,553**		**66%**	**34%**

Sources: USDA Natural Resources Conservation Service (NRCS) National Resources Inventories (NRIs); U.S. Census Bureau population estimates and decadal Census; Tables 8 and 10, *Vanishing Open Spaces.*

Table 2 shows that, as in the U.S. as a whole, over the past three decades in these four states overall (not only in Piedmont portions of each state), all of the factors that combine to result in higher per capita land consumption – that is, low population density in developed areas – do not add up to the dominant sprawl-driving role exercised by population growth. **Table 2** also shows the high rankings these four states in the nation as a whole, as measured by their

[5] Leon Kolankiewicz, Roy Beck, and Anne Manetas. 2014. *Vanishing Open Spaces: Population Growth and Sprawl in America*. Arlington, VA: NumbersUSA. Available at: https://www.numbersusa.com/resource-download/vanishing-open-spaces.

percentage increase in developed area (sprawl) between 1982 and 2000. Georgia ranked third nationally, North Carolina fourth, South Carolina fifth, and Virginia 15th. Indeed, only the western states of Nevada and Arizona had a high percentage increase in the amount of lands covered by sprawl than Georgia, North Carolina and South Carolina.

In recent years, the sprawl-inducing influence of population growth has only increased. **Table 3** shows total sprawl in the same four Piedmont states from 2002 to 2010. All of the nearly 2,000 square miles (1.3 million acres) of sprawl is related to population growth. While the national rankings of the Piedmont states slightly, all four are still in the top third nationally in terms of their percentage increase in the area of total sprawl between 2002 and 2010.

Table 3. Sources of Sprawl in Four Piedmont-including Southern States, 2002-2010

State	Total Sprawl (square miles), 2002-2010	National Ranking by % Increase in Total Sprawl from 2002-2010	% of Total Sprawl Related to Growth in POPULATION	% of Total Sprawl Related to Growth in PER CAPITA LAND CONSUMPTION
Georgia	646	10	100%	0%
North Carolina	581	16	100%	0%
South Carolina	354	14	100%	0%
Virginia	413	15	100%	0%
Total Sprawl	**1,994**		**100%**	**0%**

Sources: National Resources Inventories (NRIs); U.S. Census Bureau population estimates and decadal Census; *Vanishing Open Spaces, Packing Population into the Piedmont.*

Table 4 shows the dramatic population growth that the four Southern Piedmont states have experienced over the last several decades: 11.5 million new residents between 1982 and 2010.

Table 4. Population Growth in Four Piedmont-including Southern States from 1982 to 2010, and National Ranking by Percentage Growth in Population

State	Population 1982	Population 2010	Population Growth, 1982-2010	% Population Increase from 1982 to 2010	National Ranking by % Population Increase
Georgia	5,649,792	9,687,653	4,037,861	71%	5
North Carolina	6,019,101	9,535,483	3,516,382	58%	9
South Carolina	3,207,614	4,625,364	1,417,750	44%	15

State	Population 1982	Population 2010	Population Growth, 1982-2010	% Population Increase from 1982 to 2010	National Ranking by % Population Increase
Virginia	5,492,783	8,001,024	2,508,241	46%	14
Totals	20,369,290	31,849,524	11,480,234	56%	N/A

Sources: Census population counts for states (2010) and estimates for 1982; Table K-1in Appendix K of *Vanishing Open Spaces, Packing Population into the Piedmont.*

This rapid population growth and concomitant expansion in the geographic size of urban areas in the Southeast has led to fewer and fewer rural lands like those of **Figure 6** and more and more developed lands like those of **Figure 7**. Cumulatively, it has resulted in the image shown in **Figure 8**, which is NASA satellite imagery of the Southeastern USA (approximately the same geographic area shown in Figure 1) at night showing the bright glare from lighting that blots out the night sky and forever prevents stargazers east of the Mississippi River from truly being able to appreciate genuinely dark sky and our Milky Way.

Figure 6. Gently Rolling, Rural Landscape of the Piedmont as it Approaches the Appalachians

Figure 7. A Sprawling Subdivision on the Outskirts of Charlotte, North Carolina, Sixth Most Sprawling City in the USA from 2000 to 2010

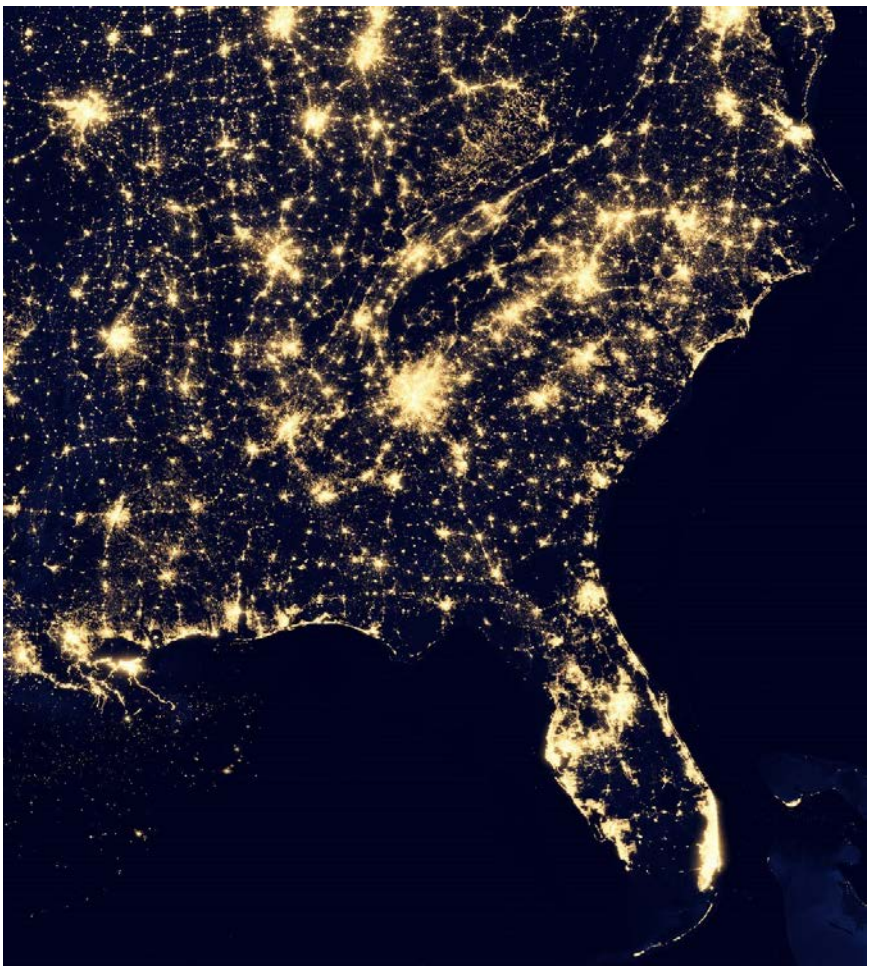


Figure 8. Southeastern States at Night – Glare from Illumination Pollutes the Night Sky; Large Bright Patch in Center is Atlanta.

Table 5 on the next page presents population growth and sprawl statistics for six major urbanized areas on or near the Piedmont Plateau region of these four states: Atlanta, GA; Charlotte, NC; Greenville, SC; Columbia, SC; Raleigh, NC; and Richmond, VA.

Table 5. Population Growth and Related Urban Sprawl in Selected Large Piedmont Urbanized Areas, 1970-1990 and 2000-2010

Urbanized Area	Population 1970	Population 1990	Overall sprawl 1970-1990 (square miles)	1970-1990 sprawl related to population growth	Population 2000	Population 2010	Overall sprawl 2000-2010 (square miles)	2000-2010 sprawl related to population growth
Atlanta, GA	1,172,778	2,157,806	701.7	64%	3,499,840	4,515,419	682.8	85%
Charlotte, NC	279,530	455,597	241.7	59%	758,927	1,249,442	306.6	93%
Columbia, SC	241,781	328,349	95.6	47%	420,537	549,777	111.1	78%
Greenville, SC	157,073	248,173	77.2	62%	302,194	400,492	93.7	81%
Raleigh, NC	152,289	305,925	105.4	76%	541,527	884,891	198.5	100%
Richmond, VA	416,563	589,980	158.1	47%	818,836	953,556	55.4	100%

Sources: (1) U.S. Census Bureau data on Urbanized Areas; (2) L. Kolankiewicz and R. Beck. 2001. *Weighing Sprawl Factors in Large U.S. Cities*. Arlington, VA: NumbersUSA; (3) L. Kolankiewicz, R. Beck, and A. Manetas. 2014. *Vanishing Open Spaces*. Arlington, VA: NumbersUSA.

Table 5 highlights:

1) In all cities, percentage of sprawl related to population growth increased significantly from earlier to more recent period.
2) In 4 of 6 cities, overall sprawl was actually higher in just the 10 years from 2000 to 2010 than in the 20 years from 1970 to 1990.

The rapid rate at which urbanization has developed rural lands into urban lands in the Piedmont states in recent decades would be expected to reduce the amount of farmland and natural habitats remaining in these states. That is because all open space or rural lands are either farmland (e.g., cropland, pastureland, ranchland) or natural habitats (forests and woodlands, grasslands, wetlands, etc.) and the total amount of these lands is fixed. As wags have uttered over the years about land, "*they ain't making any more of it*." Thus, as urbanization spreads across the formerly rural landscape, it is automatically converting either farmland or natural habitat into developed areas.

Table 6 shows changes in the amount of cropland, pastureland, ranchland, and forest in George, South Carolina, North Carolina and Virginia from 1982 to 2010.

Table 6. Changes in Farmland and Forestland, 1982-2010, thousands of acres

Land type by state	1982	2010	Change	% Change, 1982 to 2010
Croplands				
Georgia	6,586.9	4,098.9	-2,488.0	-38%
South Carolina	3,549.2	2,205.9	-1,343.3	-38%
North Carolina	6,669.8	5,151.1	-1,518.7	-23%
Virginia	3,396.5	2,690.9	-705.6	-21%
All croplands	**20,202.4**	**14,146.8**	**-6,055.6**	**-30%**
Pastureland				
Georgia	2,942.8	2,718.9	-223.9	-8%
South Carolina	1,171.3	1,108.7	-62.6	-5%
North Carolina	1,949.9	1,914.5	-35.4	-2%
Virginia	3,248.7	2,968.0	-280.7	-9%
All pasturelands	**9,312.7**	**8,710.1**	**-602.6**	**-6%**
Forest land				
Georgia	22,012.4	21,901.9	-110.5	-1%

Land type by state	1982	2010	Change	% Change, 1982 to 2010
South Carolina	11,347.8	11,166.1	-181.7	-2%
North Carolina	17,069.3	15,545.2	-1,524.1	-9%
Virginia	13,481.4	13,058.2	-423.2	-3%
All Forest lands	**63,910.9**	**61,671.4**	**-2,239.5**	**-4%**
Total rural land				
Georgia	32,454.5	29,905.0	-2,549.5	-8%
South Carolina	16,776.4	15,435.6	-1,340.8	-8%
North Carolina	26,442.1	23,639.9	-2,802.2	-11%
Virginia	20,737.2	19,375.9	-1,361.3	-7%
All total rural lands	**96,410.2**	**88,356.4**	**-8,053.8**	**-8%**

According to the data in Table 6, the decline in croplands was the largest of all the land use categories. In all four states combined, there was a 30% decrease in croplands from 1982 to 2010. However, most of the decline in croplands was not due to development, but rather conversion to other rural land uses, namely pastureland, forestland, and other rural land uses (other rural lands do not appear in Table 6). Nevertheless, considering all rural lands as a whole, there was an eight percent decrease in these four states between 1982 and 2010.

The rest of this section provides background on what sprawl is all about and what is at stake in the Piedmont due to sprawl's relentless march. Section 2 then describes our methodology, sources and definitions. Then, our findings are presented in Section 3.

1.3 Paving Over Farmland, Wildlife Habitat, and Open Space that Rejuvenates the Human Spirit

One of the primary concerns about urban sprawl has been that it is replacing our nation's forests, wetlands, and prime farmland with subdivisions, new and expanded roads, strip malls, and business parks. In fact, from 1982 to 2010, 41.4 million acres (approximately

65,000 square miles) – an area about equivalent to the state of Florida – of previously undeveloped non-federal rural land was paved over to accommodate our growing cities.[6] Of these 41 million acres lost – or "converted" as land managers and planners generally refer to it – over 17 million acres were forestland, 11 million acres cropland, and 12 million acres pasture and rangeland.

As the Natural Resources Conservation Service (NRCS, formerly the Soil Conservation Service, or SCS) put it in their 2007 summary report, reviewing the 1982-2007 quarter-century:

> "The net change of rural land into developed land has averaged 1.6 million acres per year over the last 25 years, resulting in reduced agricultural land, rangeland, and forest land. Loss of prime farmland, which may consist of agriculture land or forest land, is of particular concern due to its potential effect on crop production and wildlife."[7]

Figure 9 shows the increase in developed land from 1982 to 2010, as tracked by the NRCS and the NRI initially in 5-year intervals, and later more frequently. The total area of developed land grew from 71.9 million acres (112,356 square miles) in 1982 to 113.3 million acres (177,096 square miles) in 2010. This latter area is about equal in size to the states of Maine, New Hampshire, Vermont, Massachusetts, Connecticut, Rhode Island, Delaware, New York, and Pennsylvania, in other words, all of New England and then some. All of this land was originally developed from either agricultural land or natural habitat. As the NRCS observes: "more than one-third of all land that has ever been developed in the lower 48 states was developed during the last quarter-century."

The annual increase in Developed Land over this 28-year period varied from 760,000 acres to 2,159,000 acres, and averaged 1.5 million acres/year. The low of 760,000 acres/year was the annual average for the 2007-2010 period, corresponding to the Great Recession.

The right column of **Table 7** shows the average amount of open space that was developed to accommodate the addition of each extra person to the U.S. population during the designated period. The land developed for each additional resident in the United States ranged from a low of 0.3 acre during the 2007-2010 period to a high of 0.85 acre during the 1992-1997 period. The average was 0.53 acre for the entire 28-period of study. In essence, every

[6] U.S. Department of Agriculture. 2013. *Summary Report: 2010 National Resources Inventory*. Natural Resources Conservation Service (NRCS), Washington, DC, and Center for Survey Statistics and Methodology, Iowa State University, Ames, Iowa. Available on the World Wide Web at: http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1167354.pdf.
[7] Natural Resources Conservation Service (NRCS). 2013. 2007 National Resources Inventory: Development of Non-Federal Rural Land. March.

additional person added to the United States population entails the development of about half an acre of farmland or natural habitat.

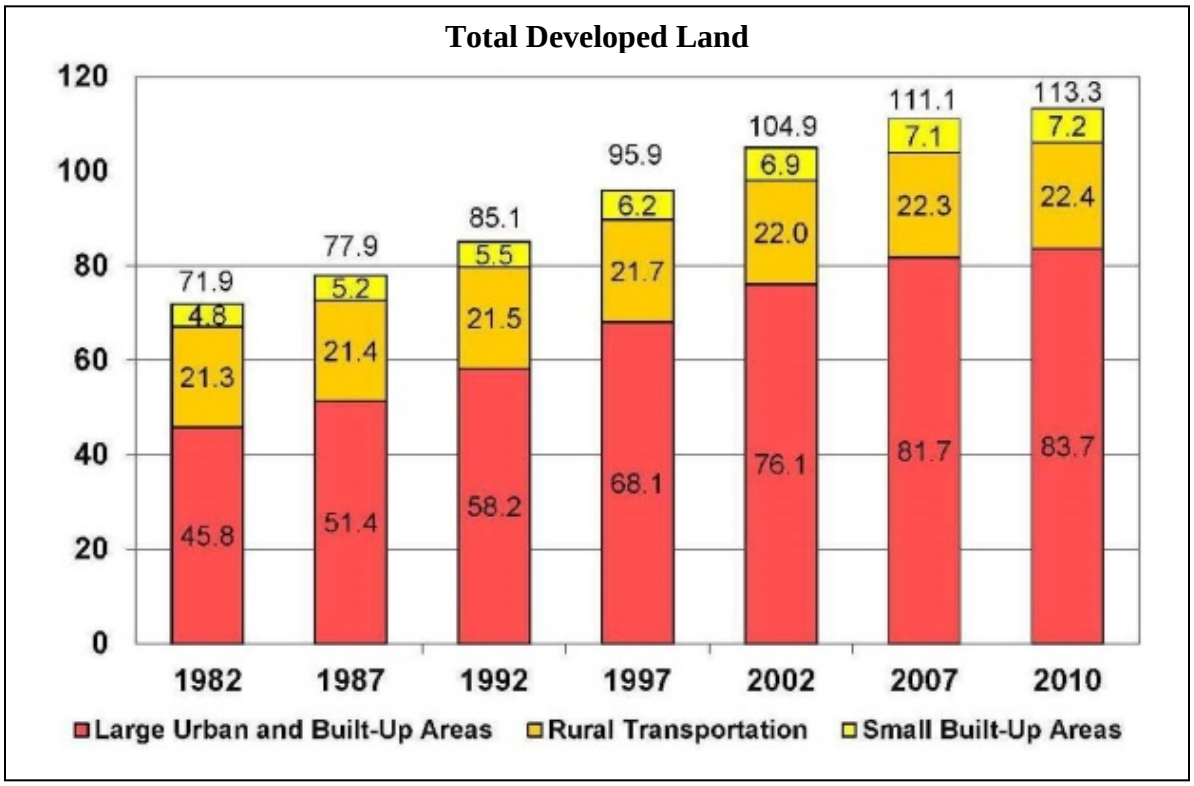


Figure 9. Change in Developed Land, 1982-2010
Source: NRCS, 2013. *Summary Report: 2010 National Resources Inventory*.

Table 7 dissects the data presented in **Figure 11**.

Table 7. Increase in Developed Land & Change in Developed Land Per Capita, 1982-2010

Period	Period Growth in Developed Land (thousand acres)	Annual Growth in Developed Land (thousand acres)	Added Acreage for Each Person Added to Population During Period Shown	
1982-1987	6,025	1,205	1982-1987: 0.58	1982-1992: 0.58
1987-1992	7,205	1,441	1987-1992: 0.57	
1992-1997	10,796	2,159	1992-1997: 0.85	1992-2002: 0.65
1997-2002	9,007	1,801	1997-2002: 0.45	
2002-2007	6,121	1,224	2002-2007: 0.45	2002-2010: 0.39
2007-2010	2,281	760	2007-2010: 0.30	

Within the overall open-space acreage threatened by sprawl are some of our nation's most critical natural habitats. According to the World Wildlife Fund, habitat loss poses the greatest threat to endangered species. The United States is home to over 1,000 endangered or threatened animal and plant species that are seriously harmed by ever-encroaching development. Eliminating forests and wetlands not only threatens native species, but has serious human health, safety, and economic consequences as well. Wetlands are important filters that clean pollutants out of our water. Wetlands can also moderate the devastating effects of floods by acting as natural buffers, soaking up and storing floodwaters. And according to the EPA nearly two-thirds of all fish we consume spend some portion of their lives in wetlands, which often serve as "nurseries" for juveniles. Paving over our nation's breadbasket and valuable habitats with unrelenting sprawl entails serious long-term economic and human health and safety costs that we simply cannot afford.

American sprawl is more than a domestic issue. It also has global implications. The relentless and accelerating disappearance of natural habitats dominated by communities of wild plants and animals, replaced by biologically impoverished artificial habitats (e.g., monoculture croplands, plantation forests, surface mines, paved areas, urban areas) dominated by human structures and communities, contributes cumulatively to what may become a "state shift" or "tipping point" in Earth's biosphere. This would be an uncontrollable, rapid transition to a less desirable condition in which the biosphere's ability to sustain us and other species would be severely compromised. A 2012 paper in the prestigious British scientific journal *Nature* reviews the evidence that: "…such planetary scale critical transitions have occurred previously in the biosphere, albeit rarely, and that humans are now forcing another such transition, with the potential to transform Earth rapidly and irreversibly into a state unknown in human experience."[8]

Figure 10 shows the breakdown in the types of rural land developed between 1982 and 2007 in 5-year increments. As is evident, the single greatest type of land developed in each period was forest land. Forest land is, of course, wildlife habitat. More broadly, it is a type of "natural capital" that provides a range of ecological services and socioeconomic benefits, among them climate regulation, watershed protection, soil conservation, flood prevention, streamflow moderation, wood products, aesthetic qualities, and serving as a magnet for outdoor recreation such as hunting, fishing, hiking, and wildlife observation and photography.

1.4 National Security Implications of Farmland Loss

Development is not the only factor responsible for the degradation and disappearance of high-quality agricultural land. Arable land is also vulnerable to other damaging natural and anthropogenic forces such as soil erosion from wind and water, and salinization and

[8] Barnosky, A.D. et al. 2012. "Approaching a state shift in Earth's biosphere." *Nature*, Vol. 486, 7 June.

waterlogging from irrigation, which can compromise the fertility, productivity, and depth of soils, and possibly even lead to their premature withdrawal from agriculture. Many of these adverse effects are due to over-exploitation by intensive agricultural practices needed to constantly raise agricultural productivity (yield per acre) in order to provide ever more food for the world's ever-increasing populations and more meat- and dairy-intensive diets.

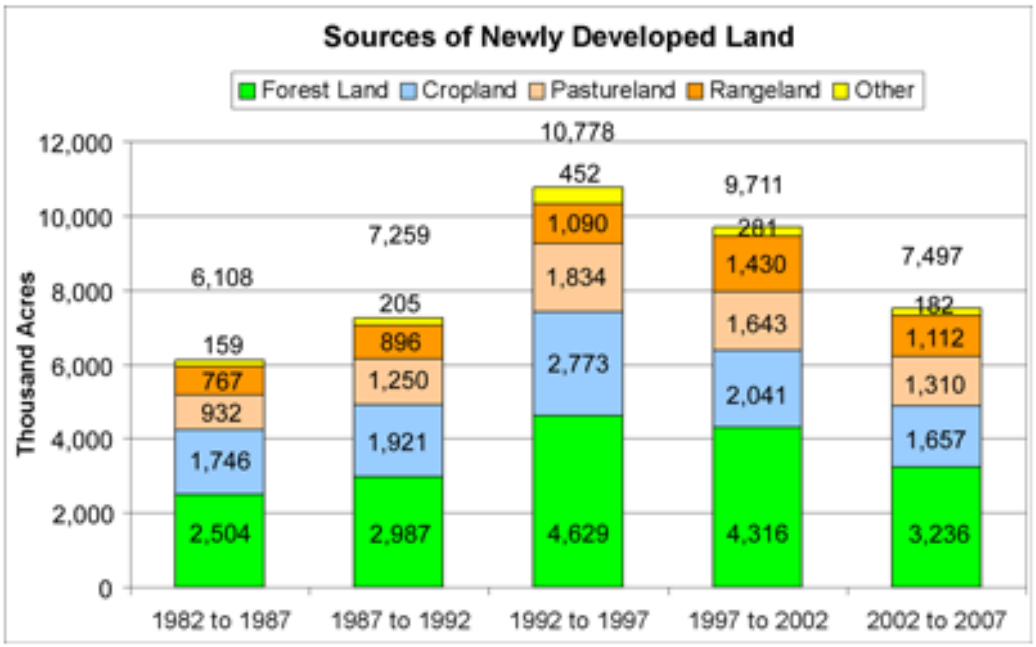


Figure 10. Area of Newly Developed Land, by Major Type, 1982-2007

Thus, the potent combination of unrelenting development and land degradation from soil erosion and other factors is reducing America's productive agricultural land base even as the demands on that same land base from a growing population are increasing. The NRI estimates that the amount of cropland in the United States declined from 420 million acres in 1982 to 361 million acres in 2010, a decrease of nearly 60 million acres (14 percent) in just 28 years (**Figure 11**). Some of this cropland (cumulatively, 27 million acres in 2010) was withheld from active farming with federal government support and subsidies and placed into the Conservation Reserve Program (CRP), but these tend to be marginal or fragile sites on which cultivation is not deemed to be sustainable in any case. Even with the federal ethanol mandate and strong financial incentives over much of the last decade to grow corn in order to produce ethanol as fuel for vehicles, the amount of cropland dropped by seven million acres in the eight years between 2002 and 2010, increasing slightly between 2007 and 2010.[9] The land uses into which cropland was converted are shown in **Figure 12**.

[9] Op. cit. Footnote #6.

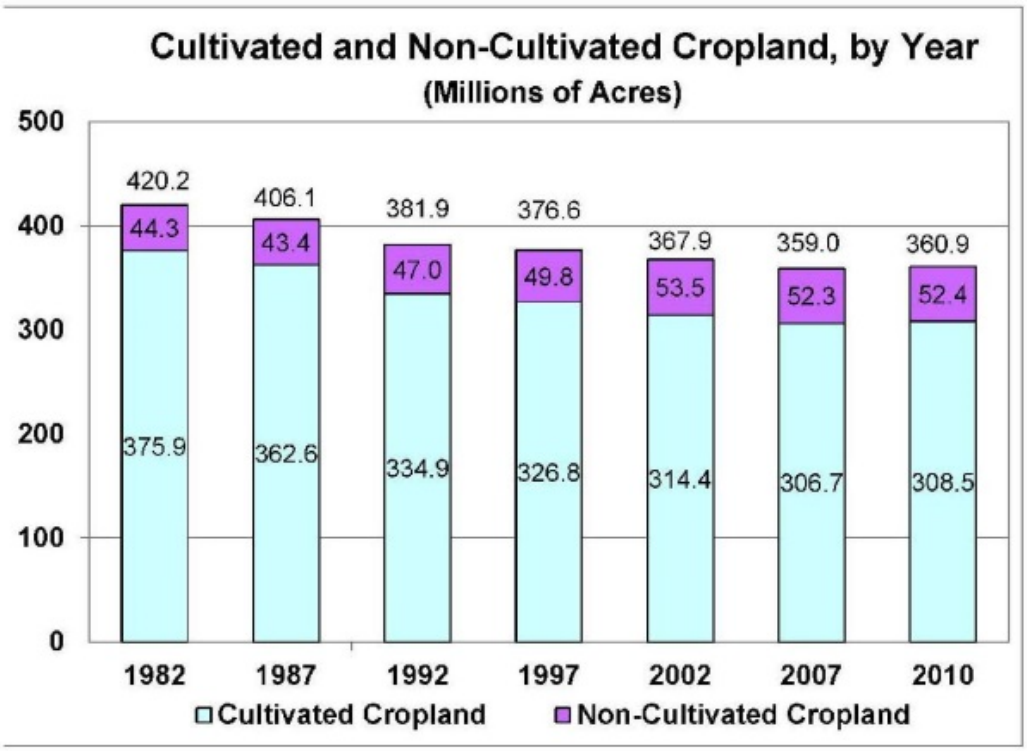


Figure 11. Area of Cropland in the United States, 1982-2010

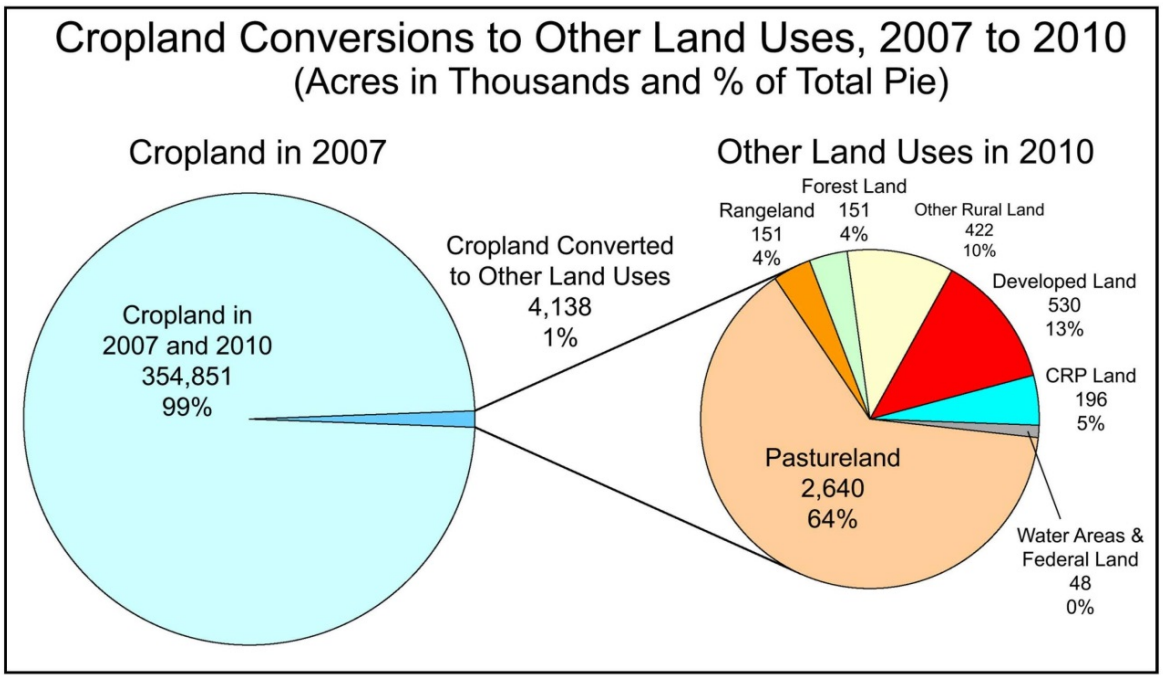


Figure 12. Cropland Converted to other Land Uses from 2007 to 2010

If the same rate of cropland conversion and loss that prevailed from1982 to 2010 were to continue to the year 2100, the United States will have lost an additional 193 million acres of its remaining 361 million acres of cropland, for a total cumulative loss of 253 million acres. Only 168 million acres would then remain – about 40 percent of the original allotment – and none of this acreage would be in pristine condition after two centuries or so of intensive exploitation. Its soils and nutrients, while perhaps not exhausted, would require even greater inputs of costly fertilizers. Two of the most crucial fertilizers – ammonium nitrate, produced from natural gas, and phosphorus, produced from phosphate mines – may be far more expensive, perhaps prohibitively so, in 2100 than at present, due to the inexorable depletion of the highest-quality reserves of these non-renewable resources.

Table 8 shows the amount of cropland per capita in the United States in 1982, 2010, and projected to 2050 and 2100, assuming the same rate of cropland decline from 1982 to 2010 and using the most recent Census Bureau projections. Available cropland will have declined from 1.9 acres per person in 1982 to 0.3 acre per person in 2100, an 84 percent decrease. **Figure 13** graphically depicts this striking loss in the form of a bar chart.

Table 8. Projected Long-term Decline in Cropland per Person

Year	Cropland in 48 contiguous states (millions of acres)	U.S. Population in Millions (48 states)	Acres of cropland per capita
1982	420	225	1.9
2010	361	306	1.2
2050	276[1]	400[2]	0.7
2100	168[1]	571[2]	0.3

[1]Projected using annual rate of cropland loss from 1982-2010 (2.1 million acres)
[2]Most recent projections from the United States Census Bureau

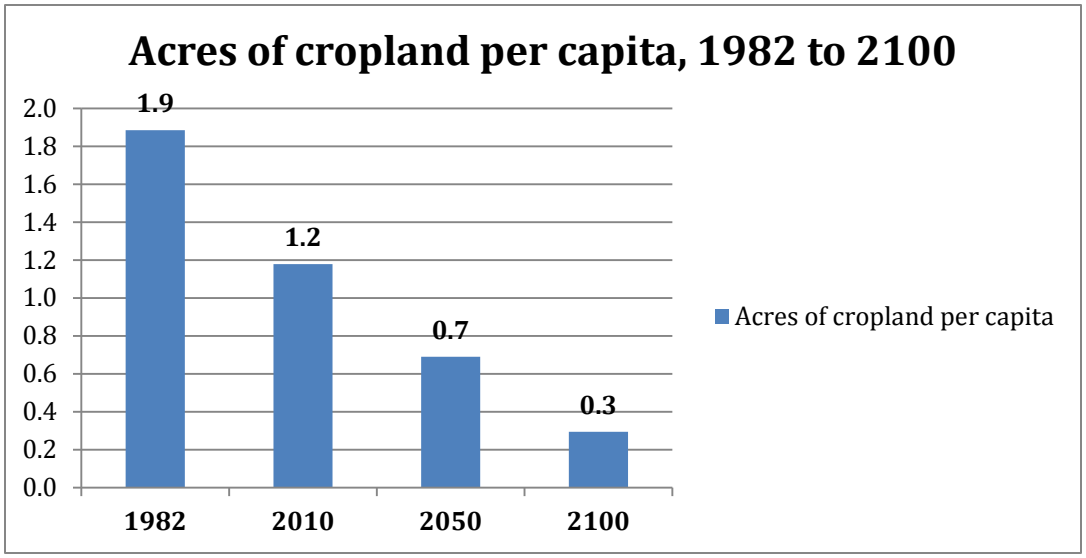


Figure 13. Projected Long-term Decline in Cropland per Person

However, this dire scenario is unlikely to come to pass, even if the United States continues to reject population stabilization as an acceptable course of action or to enact more aggressive farmland protection measures. This because rising demand and prices for foodstuffs would increase the value of land maintained as cropland vis-à-vis developed land, and because conversion from other types of lands to cropland, including pastureland, rangeland, forested land and other natural areas, would certainly occur (**Figure 14**). This actually did happen from 2007 to 2010, during which the area in cropland increased by 1.9 million acres; most of this was CRP land called back into production because high agricultural commodity prices encouraged farmers to plant it. Again, in an ideal world, erosive or sensitive CRP lands should *not* be cultivated and would best be conserved as wildlife habitat; that is why the voluntary Conservation Reserve Program was established in the first place in the 1980s.

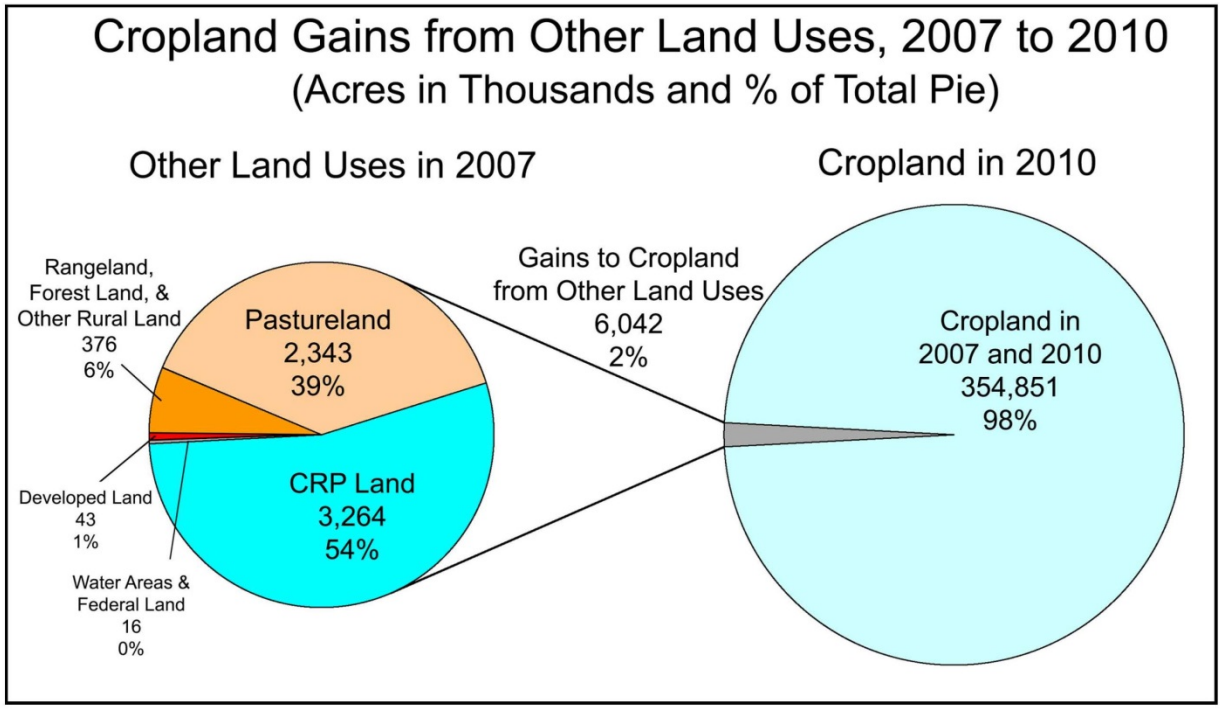


Figure 14. Cropland Gains from other Land Uses, 2007-2010
Source: NRCS, 2013. *Summary Report: 2010 National Resources Inventory*.

Furthermore, the decrease from 1982 to 2010 in the acreage of highest quality soils classified as Prime Farmland, which constitutes only 23 percent (or 316 million acres) of the non-Federal rural land base was "only" 13 million acres, compared to the nearly 60-million-acre decrease in cropland. NRCS states that "most of this loss was due to development." As shown in **Figure 15,** not all designated Prime Farmland is cultivated as cropland; indeed, only 64 percent of it is cropland; the rest is in other non-developed land uses or cover types.

Nevertheless, given the projected decline in cropland per capita, that is, the acreage of land on which to cultivate grains and other crops for each resident, biotechnology will have to

work miracles in constantly raising yields per acre in order to maintain the diverse, meat-and-dairy-rich diet Americans came to expect in the late 20th and early 21st centuries.

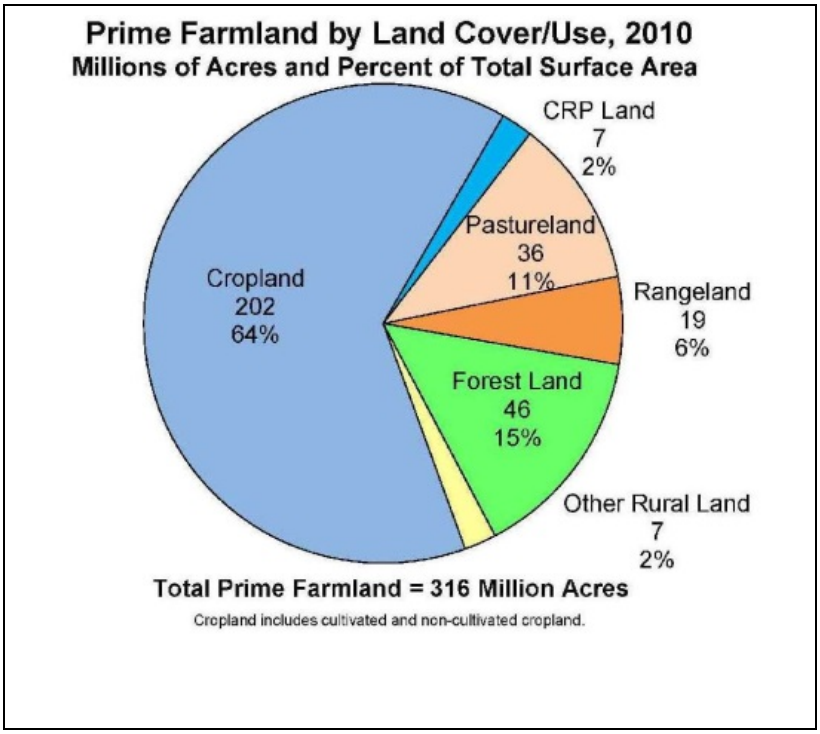


Figure 15. Prime Farmland by Type in 2010
Source: NRCS, 2013. *Summary Report: 2010 National Resources Inventory*.

Ominous, divergent trends – an increasing population, a decreasing arable land base, diversions of water supplies needed for irrigated agriculture to urban populations, and a modern, mechanized agriculture that is heavily dependent on limited fossil fuels at all stages – have led some scientists to conclude that someday within this century the United States may cease to be a net food exporter.[10] Food grown in this country would be needed for domestic consumption. By mid-century, the ratio of arable land per capita may have dropped to the point that, "the diet of the average American will, of necessity, include more grains, legumes, tubers, fruits and vegetables, and significantly less animal products."[11] While this may in fact constitute a healthier diet, it would also represent a significant loss of choice for a country that has always prided itself on its abundant agriculture, plentiful consumer options, and comparative freedom from want.

[10] Pimentel, D. and M. Giampietro. 1994. "Food, Land, Population and the U.S. Economy." Washington, D.C.: Carrying Capacity Network; David Pimentel and Marcia Pimentel. 1997. "U.S. Food Production Threatened by Rapid Population Growth." Washington, D.C.: Carrying Capacity Network; D. Pimentel, M. Whitecraft, Z. R. Scott, L. Zhao, P. Satkiewicz, T. J. Scott, J. Phillips, D. Szimak, G. Singh, D. O. Gonzalez, and T. L. Moe. 2010. Will Limited Land, Water, and Energy Control Human Population Numbers in the Future? *Human Ecology*. 12 August.
[11] Pimentel and Giampietro. 1994. "Food, Land, Population and the U.S. Economy."

Preserving farmland and maintaining its fertility is more than a question of producing an adequate supply of food and engendering a healthy diet for Americans, it is a matter of national security. According to Brig. Gen. (Ret.) W.E. King, Ph.D., P.E., Dean of Academics, U.S. Army Command and General Staff College, Fort Leavenworth, Kansas, without a sustainable environment and resources that meet basic human needs, instability and insecurity will be the order of the day.[12] The World Food Summit held in Rome, Italy in 1996 revived interest in the issue of food security, and thus, in farmland preservation because of its bearing on food security.[13] As Oxford ecology professor Norman Meyers noted in a now-classic 1986 article:

> "…national security is not just about fighting forces and weaponry. It relates to watersheds, croplands, forests, genetic resources, climate and other factors that rarely figure in the minds of military experts and political leaders…"[14]

One of the lasting effects on the world food system of the global crisis in food prices from 2007 to 2008 has been the accelerating acquisition of farmland in poorer countries by wealthier countries which seek to ensure their own food supplies. As the International Food Policy Research Institute states:

> "Increased pressures on natural resources, water scarcity, export restrictions imposed by major producers when food prices were high, and growing distrust in the functioning of regional and global markets have pushed countries short in land and water to find alternative means of producing food."[15]

By 2009, foreign governments and investors had already purchased more than 50 million acres (78,000 square miles) of farmland – an area the size of Nebraska – in Africa and Latin America.[16]

Finally, U.S. agriculture and related food industries contribute nearly $1 trillion to our national economy annually. They comprise more than 13 percent of the GDP and employ 17

[12] King, W.E. A Strategic Analytic Approach to the Environmental Security Program for NATO. W. Chris King, Ph.D. P.E.is Brigadier General, US Army retired and Dean of Academics, US Army Command and General Staff College, Fort Leavenworth, Kansas.
[13] Tweeten, L. 1998. Food Security and Farmland Preservation. *Drake Journal of Agricultural Law*. 3:237-250.
[14] Meyers, N. 1986. The Environmental Dimension to Security Issues. *The Environmentalist*. 6(4): 251-257; Liotta, P.H., et al. (eds.). 2007. Proceedings of the NATO Advanced Research Workshop on Environmental Change and Human Security: Recognizing and Acting on Hazard Impacts. Newport, Rhode Island, 4-7 June 2007.
[15] International Food Policy Research Institute. 2009. "Land grabbing" by foreign investors in developing countries. Available online at: http://www.ifpri.org/publication/land-grabbing-foreign-investors-developing-countries.
[16] Leahy, S. 2009. Wealthy Countries and Investors Buying Up Farmland in Poor Countries. Available online at: http://stephenleahy.net/2012/05/17/wealthy-countries-and-investors-buying-up-farmland-in-poor-countries/.

percent of the labor force. World demand for U.S. agricultural exports is only expected to increase over the foreseeable future due to a rapidly growing world population, increasing demand for meat and dairy products, and expanding global markets.[17]

Americans are not unaware of these national security implications, according to a national poll[18] of likely voters in 2014 (see Appendix J for the entire poll results):

> QUESTION: How important is it to protect farmland from development so the United States is able to produce enough food to completely feed its own population in the future?
>
> 71% - Very important
> 21% - Somewhat important (92% very or somewhat important)
> 6% - Not very important
> 0% - Not important at all
> 2% - Not sure

When asked about having enough food left over to provide to other nations, not as many Americans appear to have a sense of urgency related either to national security or humanitarian issues, but few thought it unimportant.

> QUESTION: How important is it for the United States to have enough farmland to be able to feed people in other countries as well as its own?
>
> 26% - Very important
> 46% - Somewhat important (72% very or somewhat important)
> 19% - Not very important
> 6% - Not important at all
> 2% - Not sure

The poll found most Americans consider the treatment of good cropland to be not just a practical issue but one of ethics. The poll forced people to choose between the practical need for more housing (a pressure that exists in nearly every Urbanized Area in the country) and the ethics of eliminating food-producing land to provide more housing. The high level (22%) answering "not sure" indicates that a lot of people haven't thought about this tradeoff between two competing goods (cropland vs. land for housing), or that they are unwilling to choose.

> QUESTION: Which do you agree with more: That it is unethical to pave over and build on good cropland or that the need for more housing is a legitimate reason to eliminate cropland?

[17] American Farmland Trust. 2013. Farmland Protection. Available on the World Wide Web at: http://www.farmland.org/programs/protection/.
[18] Op. cit. Footnote #2, Pulse Opinion Research. Appendix I includes the entire poll's results.

59% - It is unethical to pave over and build on good cropland
19% - The need for more housing is a legitimate reason to eliminate cropland
22% - Not sure

1.5. Physiological and Psychological Benefits of Open Space

Open space, parks, green spaces, natural areas – including wetlands, riparian corridors, farmland, beaches, rivers, lakes, the ocean, fields and forests – provide demonstrable mental and physical health benefits. They have proven to be preventative measures that can actually lower health care costs and reduce the need for health interventions. Exploring or even just gazing upon natural areas – such as a forest-covered mountain range next to a city – gives human beings a sense of perspective, continuity in a changing world, spiritual renewal, well-being, and a feeling of harmony with the world around us. The presence of open space within and adjacent to our urban areas – and the assurance that this open space will outlast us – serves to counter-balance the stress and strain of modern life (**Figure 16**).

Figure 16. Central Park Has Been Called a "Green Oasis" in New York City

Contact with nature and open space provides both physiological and psychological benefits. Research on the physiological benefits of open space has centered on how direct or indirect

(vicarious) experience with vegetated and/or natural landscapes reduces stress, and anxiety.[19] A series of studies spanning nearly 20 years in the seventies and eighties linked photo simulations of natural settings to reduced stress levels as measured by heart rate and brain waves. One study revealed that subjects experienced more "wakeful relaxation" in response to slides showing vegetation only and vegetation with water as compared with urban scenes without vegetation. These data were corroborated by attitude measures which indicated lower levels of fear and sadness when experimental subjects observed nature-related slides, as opposed to urban slides.[20] In studies of hospital patients, recovery was faster, there were fewer negative evaluations in patient reports, and there was less use of analgesic drugs among post-surgery patients with views of exterior greenery than among control group patients with views of buildings.[21]

In other research, breast cancer survivors who engaged in personally enjoyable and nature-related "restorative activities" showed dramatic effects on their cognitive process and quality of life.[22] At the end of three months, the experimental group showed significant improvements in attention and self-reported quality of life measures; they had begun a variety of new projects. Control group members, meanwhile, who had been given no advice regarding nature exposure activities, continued with deficits in measures of attention, had started no new projects, and had lower scores on quality of life measures. This research underscored that difference between nature as an amenity and as a human need. As one reviewer of the study observed:

> "People often say that they like nature; yet they often fail to recognize that they need it...Nature is not merely 'nice.' It is not just a matter of improving one's mood, rather it is a vital ingredient in healthy human functioning."[23]

There is an important distinction between nature as amenity and nature as need. As one book affirms:

[19] Rubenstein, N.R. The Psychological Value of Open Space. Chapter 4 in *The Benefits of Open Space*. The Great Swamp Watershed Association. 1997. Available on the World Wide Web at: http://www.greatswamp.org/publications/rubinstein.htm.
[20] Ulrich, R. 1979. Visual landscapes and psychological well-being. *Landscape Research*, 4(1): 17-23.
[21] Ulrich, R. 1983. Aesthetic and affective response to natural environment. Chapter 3 in I. Altman, & J. F. Wohlwill (Eds.), *Human Behavior and Environment*: Volume 6 (pp. 85-126). New York: Plenum Press; Ulrich, R. 1984. Views through a window may influence recovery from surgery. *Science*, 224, 420-421.
[22] Cimprich, B. E. 1990. Attentional fatigue and restoration in individuals with cancer. Unpublished Doctoral Dissertation, University of Michigan.
[23] Kaplan, S. (1992). The Restorative Environment: Nature and human experience. In D. Relf (ed.), *The Role of horticulture in human well-being and social development: A National Symposium* [Proceedings of Conference Held 19-21 April 1990, Arlington, VA] (pp. 134-142). Portland, OR: Timber Press.

> "Viewed as an amenity, nature may be readily replaced by some greater technological achievement. Viewed as an essential bond between human and other living things, the natural environment has no substitutes."[24]

While there are many anecdotal reports connecting the natural environment or open space to everything from increased self-esteem to stress reduction, there are few studies attempting to categorize the many phrases used to identify the worth of a walk in the woods or a day bird-watching beside a marsh.[25] Few studies track long-term longitudinal effects on changed attitudes and behavior. While it is difficult to characterize and quantify the long-term manner in which lives are modified, it is easy to acquire narrative accounts about the effect of a favorite overlook, trail, or patch of woods on one's psyche. One of the best known of such testimonials is from pioneering naturalist-conservationist John Muir:

> "Climb the mountains and get their good tidings. Nature's peace will flow into you as sunshine flows into trees. The winds will blow their own freshness into you, and the storms their energy, while cares will drop away from you like the leaves of Autumn."

Natural settings are unparalleled in their ability to furnish solitude and privacy. They also have "existence value," that is, there is value to knowing that they are simply *there* and to the very idea that we *could* get away into them, if we so chose; this is a value in and of itself, which provides for a psychological "time-out" and a sense of wellbeing.

A 2014 national survey[26] of Americans found most of them at least superficially recognizing the value of non-developed open spaces for their emotional well-being.

> QUESTION: Do you feel an emotional or spiritual uplift from time spent in natural areas like woodlands and open grasslands?
>
> 70% - Yes
> 18% - No
> 12% - Not sure

An even larger majority of Americans indicated to pollsters that they want to have easy access to open spaces, something that is increasingly difficult because so many Americans live in the midst of giant metropolitan areas far from the urban edges where they can encounter nature.

> QUESTION: How important is it that you get to natural areas fairly quickly from where you live?

[24] Kaplan, R., & Kaplan, S. (1989). *The Experience of nature: A Psychological perspective*. New York: Cambridge University Press.
[25] Op. cit. Footnote #19, Rubenstein.
[26] Op. cit. Footnote #4, Pulse Opinion Research.

48% - Very important
37% - Somewhat important (85% very or somewhat important)
11% - Not very important
2% - Not important at all
2% - Not sure

1.6 Why Americans Still Don't Like Sprawl

While not garnering the media attention they once did, the topics of urban sprawl and the environment remain a major concern to many American citizens. A 2013 Earth Day poll conducted on attitudes towards environmental issues indicated that 80% of those polled believe that it is important to protect our natural environment.[27] According to the Land Trust Alliance, voters still care deeply about conserving our remaining natural land, approving over 80% of land conservation measures on the ballot around the country in November 2012.[28] The 46 measures passed nationally provide a total of $767 million to protect and improve water quality, acquire new parks and open space, and conserve working farms and ranches. Many of the referenda won by landslides – 27 measures passed with at least 65% of the vote. National and regional non-governmental land conservancies such as The Nature Conservancy, the Trust for Public Land, and the New Mexico Land Conservancy and other state land trusts continue to garner substantial public support.

Urban sprawl also imposes significant economic and financial costs on the public. These costs are often hidden in the form of taxpayer subsidies to build new roads, water supply systems, sewage collection and treatment systems, and schools to accommodate runaway growth.[29]

In essence, Americans still value our rural land, oppose longer commute times to work and to daily, weekly, and monthly open-space destinations, increased environmental degradation, and higher economic costs, all of which are part of the price tag of sprawling urban development.

As noted earlier, the 2014 polling[30] found sizeable majorities of Americans who feel strongly about the need to protect farmland and natural habitats for themselves, for their fellow Americans and for the nation's wildlife. In general, Americans see sprawl as a threat to their

[27] Omnibus Poll of 1000 adults on April 9-10, 2013 with a margin of error of +/- 3.7%. Available at http://big.assets.huffingtonpost.com/toplines_earthday411.pdf.
[28] Land Trust Alliance. 2012. Voters Approve 81% of Land Conservation Ballot Measures. Available at: http://www.landtrustalliance.org/policy/public-funding/voters-enthusiastically-approve-new-spending-on-conservation-nationwide.
[29] Eben Fodor. 1999. *Better Not Bigger: How to Take Control of Urban Growth and Improve Your Community*. New Catalyst Books; Eben Fodor. 2012. "The Myth of Smart Growth." Available at: www.fodorandassociates.com/Reports/Myth_of_Smart_Growth.pdf
[30] Op. cit. Footnote #4, Pulse Opinion Research. Also see Appendix J.

quality of life. Polling found most Americans expect a continuation of recent trends to make life where they live "worse." Few things affect the day-to-day quality of life of modern-day Americans as much as changes in traffic and commuting. Asked if a continuation of recent trends would make traffic "much worse," 68% said yes, while only 20% said they thought the government would "be able to build enough extra transportation capacity to accommodate the extra people." (Poll results are shown in their entirety in Appendix J.)

These concerns are shared by Piedmont residents.

Residents of the Piedmont are aware of the rapid changes that have taken place in their region, and many are concerned about its long-term effects on the environment and the quality of life for Piedmont residents. A Pulse opinion poll was conducted in July 2015 of those living within the Piedmont area covered in this report.[31] It found that 55 percent of residents believe that the creation of a megalopolis in the Piedmont stretching from Atlanta to Raleigh would make the region “a worse and more congested place to live” compared to only 20 percent who felt that this transformation would make the region “better and more exciting.”

There was a clear consensus about the need to protect farmland from development, as 80 percent said they were concerned about the issue, while just 18 percent said there was little or no need to be concerned about farmland preservation. In a related question about whether it was “unethical to pave over and build on good farmland” to meet the demand for more housing, 64 percent said it was unethical, 19 percent said housing should take priority, while 18 percent were not sure.

Piedmont residents clearly favor the preservation of open space. Eighty-eight percent say it is important to preserve the natural areas and open spaces that currently exist in the region, and 89 percent believe it is important that it is “fairly easy to spend time in natural areas” near where one lives.

One of the aspects of rapid growth that can be lost in the discussion of long-term planning is the regional or local identities that have formed over time in various communities across the United States, and the desire for members of those communities to preserve those identities. Many people feel that what makes their town or small city unique is threatened by the growth of a megaregion that will engulf them and lead to the uniformity that characterizes densely population urbanized areas. When asked directly about this issue, over three-quarters of respondents (76%) in the Piedmont poll would choose to preserve the identity of their individual community, compared to less than one-fifth (17%) who said being absorbed into a larger city and losing some of that unique local identity did not matter to them.

[31] Pulse Opinion Poll of Piedmont residents. 19-23 July 2015. Included in this report as Appendix I.

1.7 What Will Be Lost If We Allow Sprawl to Pave the Piedmont

1.7.1 What is the Piedmont?

The North American Piedmont stretches from New Jersey to central Alabama. The Piedmont, taken from the French and translated as "foot hills," lies between the Appalachian Mountains and the Atlantic coastal plain (see **Figure 17**). It is categorized by the USGS as a physiographic province within the Appalachian Highlands. It is distinguished by its steep-sided hills, periodic plains, forests of Appalachian oak, oak-hickory and mixed oak-pines that dot the landscape. Underlain by mostly red clayey soils and embedded with metamorphic rocks, the region contains sporadic monadnocks – isolated hills of erosion-resistant bedrock. The climate and soil compositions vary over the range of the Piedmont, which is divided into four subregions: Inner Piedmont, Outer Piedmont, Carolina Slate Belt, and Triassic Uplands.[32]

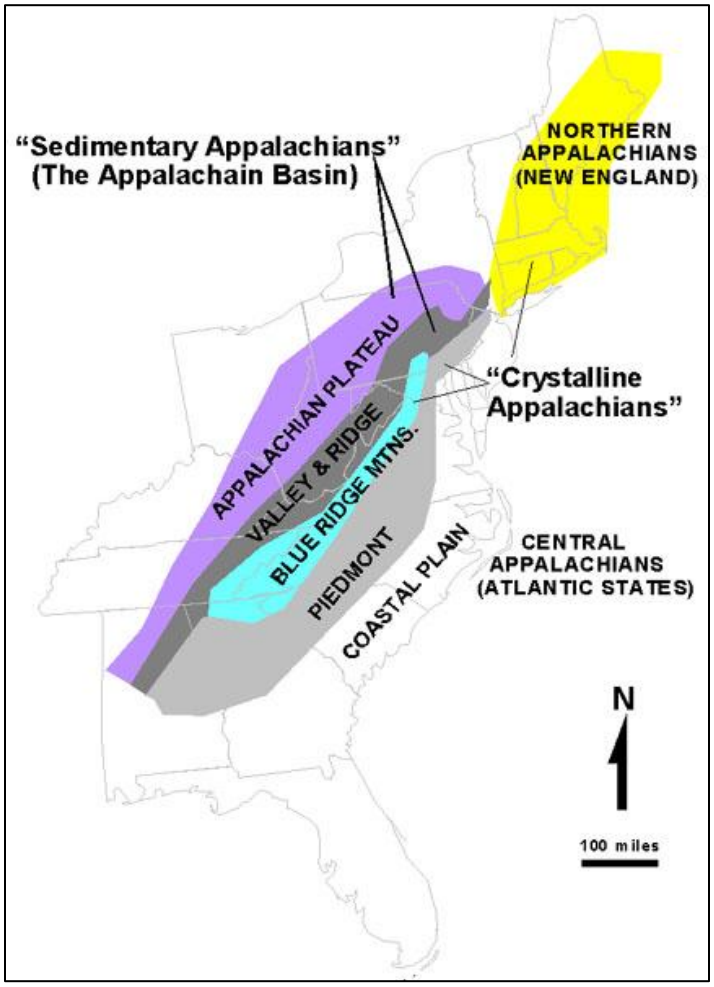


Figure 17. Geological Provinces of the Eastern United States, Showing Location of the Piedmont Between the Appalachian Mountains and the Coastal Plain

[32] Alan J. Woods, James M. Omernik, and Douglas D. Brown, "Level III and IV Ecoregions of Delaware, Maryland, Pennsylvania, Virginia, and West Virginia," U.S. EPA National Health and Environmental Effects Research Laboratory, July 1999, pp. 7-10 (http://training.fws.gov/courses/csp/csp3200/resources/documents/epa_region_3_eco_desc.pdf).

The Piedmont area covered in this study is confined to counties in that region in North Carolina, South Carolina, and Georgia (**Figure 18**). This is because this region of the Piedmont has seen the most rapid development in recent years in areas that were largely rural and undeveloped even into the 1990s. By measuring the rate of growth and comparing the Piedmont to other areas that have already undergone extensive sprawl, an accurate projection of the region's future is possible.

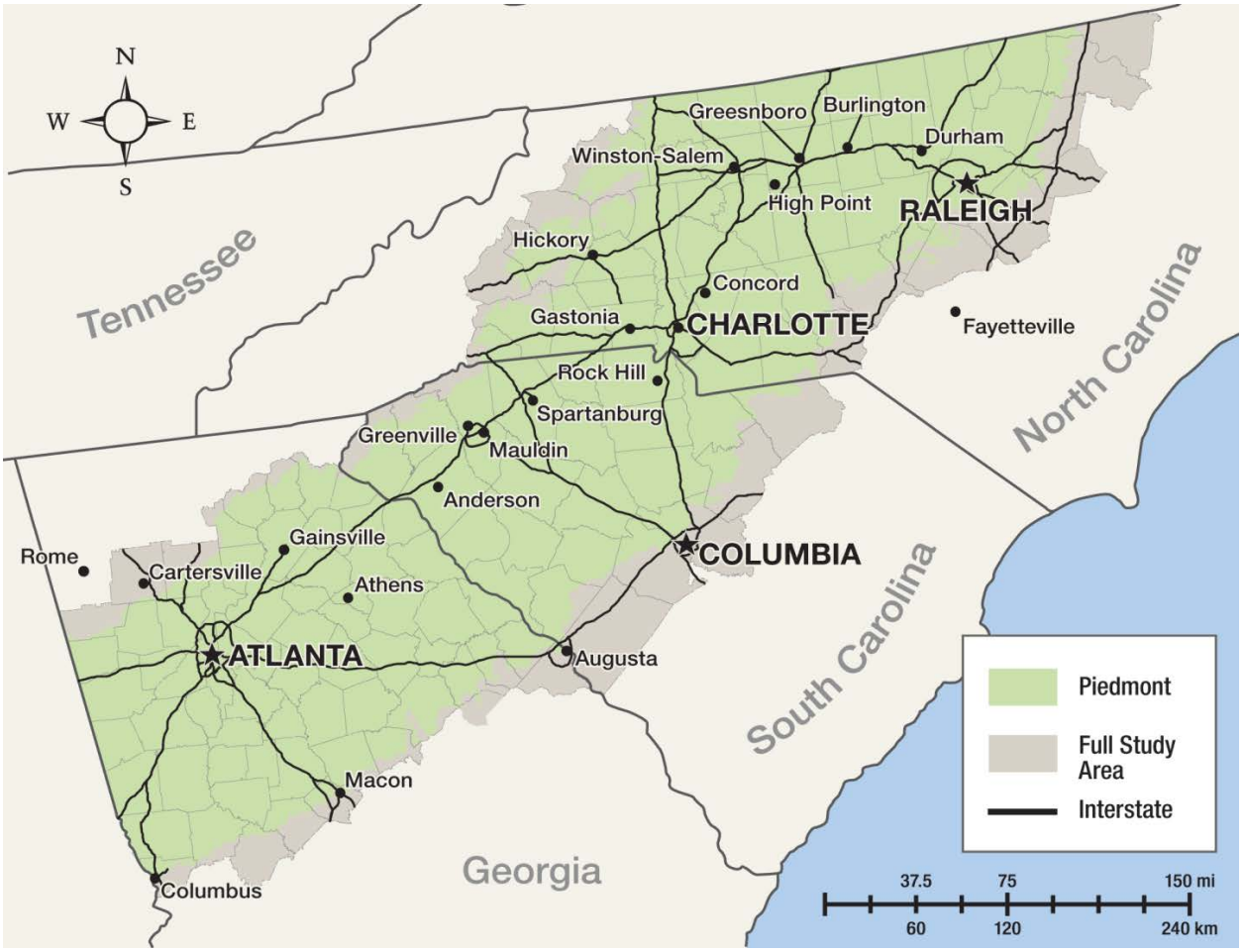


Figure 18. Piedmont Sprawl Core Study Area

Figures 19-21 are more detailed maps of showing the specific counties in North Carolina, South Carolina, and Georgia that are included in our Piedmont Sprawl Study. The counties selected correspond to the Piedmont belt that traverses the three states, as well as portions of Alabama, Virginia, Maryland, Pennsylvania, and New Jersey.

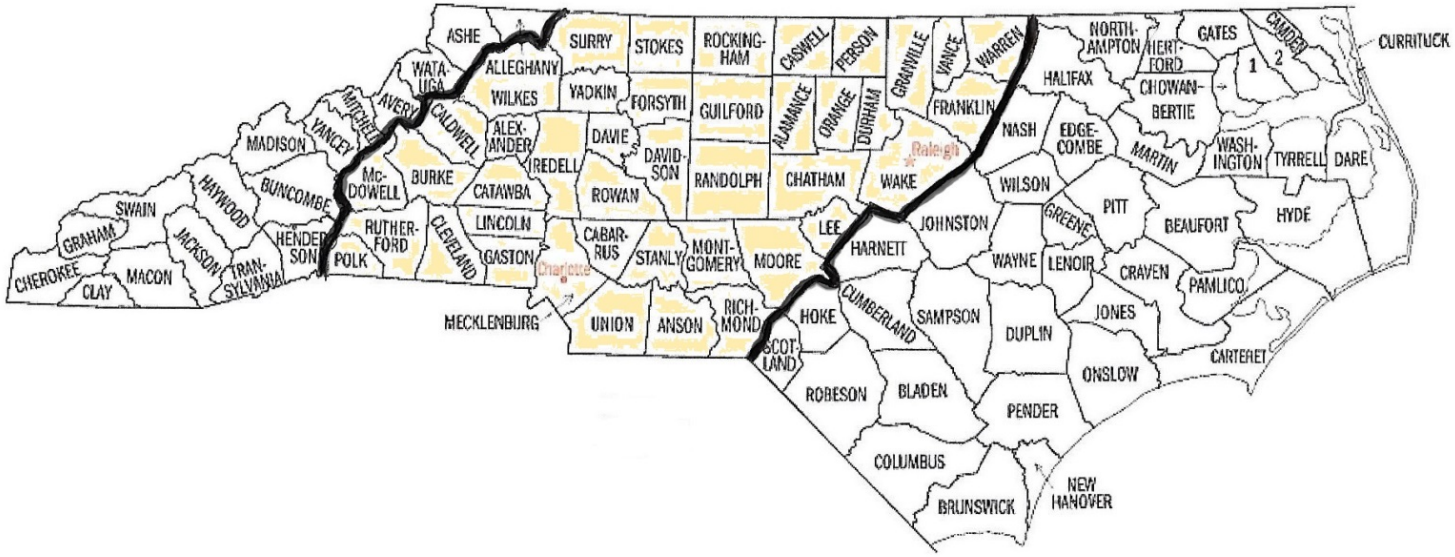


Figure 19. Map of North Carolina Counties in the Piedmont Study Area

Table 9. North Carolina Counties in the Piedmont Study Area

Alamance	Catawba	Franklin	McDowell	Randolph	Surry
Alexander	Chatham	Gaston	Mecklenburg	Richmond	Union
Anson	Cleveland	Granville	Montgomery	Rockingham	Vance
Burke	Davidson	Guilford	Moore	Rowan	Wake
Cabarrus	Davie	Iredell	Orange	Rutherford	Warren
Caldwell	Durham	Lee	Person	Stanly	Wilkes
Caswell	Forsyth	Lincoln	Polk	Stokes	Yadkin

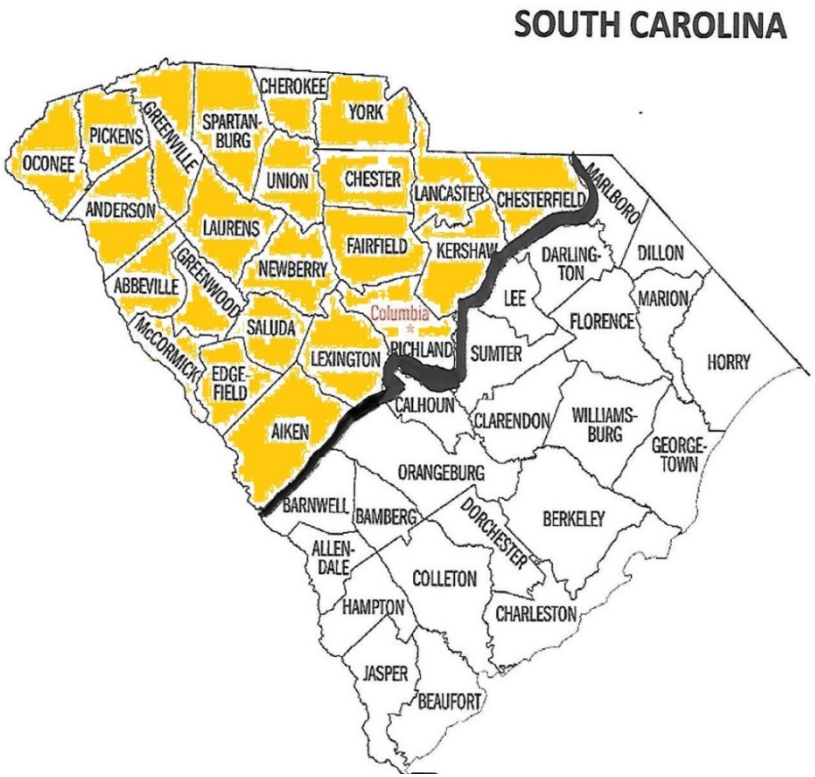


Figure 20. Map of South Carolina Counties in the Piedmont Study Area

Table 10. South Carolina Counties in the Piedmont Study Area

Abbeville	Laurens
Aiken	Lexington
Anderson	McCormick
Cherokee	Newberry
Chester	Oconee
Chesterfield	Pickens
Edgefield	Richland
Fairfield	Saluda
Greenville	Spartanburg
Greenwood	Union
Kershaw	York
Lancaster	

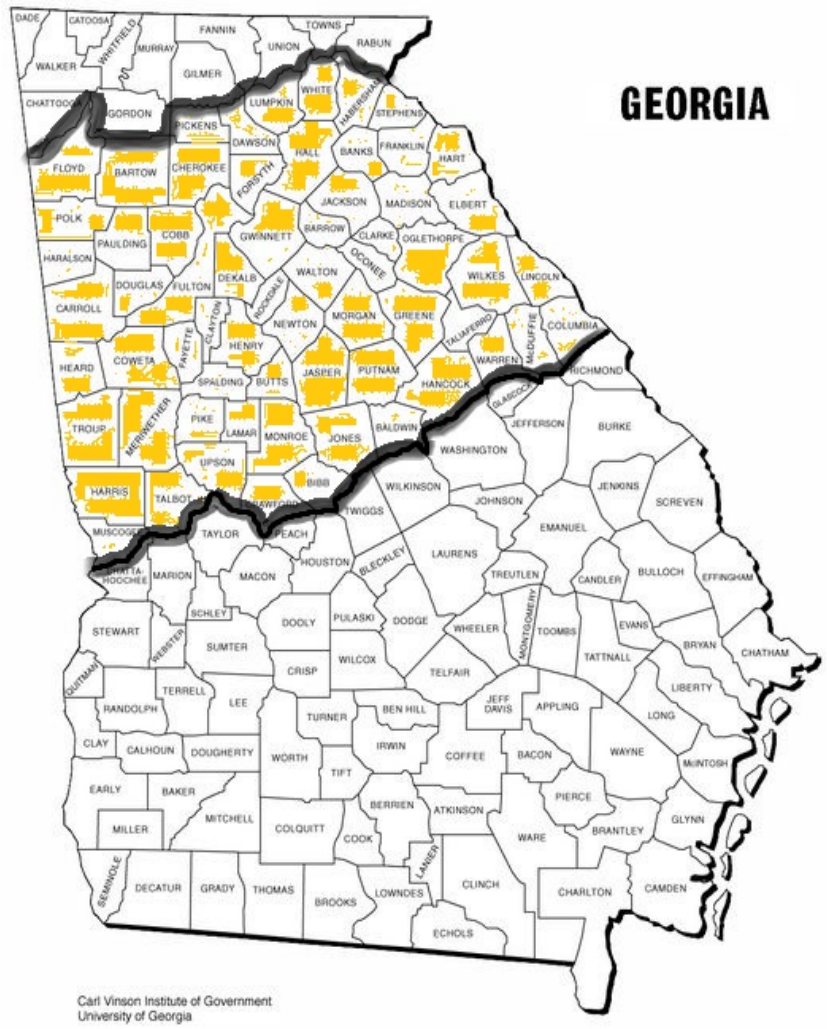


Figure 21. Map of Georgia Counties in the Piedmont Study Area

Table 11. Georgia Counties in the Piedmont Study Area

Baldwin	Douglas	Henry	Pickens
Banks	Elbert	Jasper	Pike
Barrow	Fayette	Jones	Polk
Bartow	Floyd	Lamar	Putnam
Bibb	Forsyth	Lincoln	Rockdale
Butts	Franklin	Lumpkin	Spalding
Carroll	Fulton	Madison	Stephens
Cherokee	Greene	McDuffie	Talbot
Clarke	Gwinnett	Meriwether	Taliaferro
Clayton	Habersham	Monroe	Troup
Cobb	Hall	Morgan	Upson
Columbia	Hancock	Muskogee	Walton
Coweta	Haralson	Newton	Warren
Crawford	Harris	Oconee	White
Dawson	Hart	Oglethorpe	Wilkes
DeKalb	Heard	Paulding	

1.7.2 Loss of Historic Piedmont Pine Habitat

The Piedmont's historical fire regime is typified by its low-intensity fires with a return interval of four to seven years. This regime occurred prior to European arrival and for some time afterwards. These fires would burn most of the understory and low-lying vegetation, but leave the overstory (canopy) and large trees intact, helping to preserve the dominance of fire resistant pines by retarding the encroachment of oaks, maples, and other hardwoods. While traditionally viewed as destructive, wildland fire in fact plays an important ecological role in maintaining the health of the Longleaf Pine Ecosystem and all the organisms that inhabit its distinctive landscape. For instance, the Gopher Tortoise and Bachman's Sparrow rely on low-severity fires every 3 to 4 years for nesting and reproductive success. Because of increased human settlement and excessive fire suppression, the composition of the Piedmont forests has changed substantially, and wildland fires are not left to burn uncontrolled. Frequent, low-intensity controlled burns (prescribed fires) are less effective at forest management as cities proliferate, due in part to less land for burning and more houses in proximity to fires, raising objections about smoke and fear about prescribed burns getting out of control and causing property damage.

The need to balance wildfires periodically for ecosystem health and reduce the threat of wildfires to urban development is most prominent at the wildland-urban interface (WUI). Defined by the USDA and other federal agencies, a WUI is where, "humans and their development meet or intermix with wildland fuel."[33] A high and growing number of residential areas in the northeast and southeast megalopolis are in close proximity to this intermix with wildland fuel. This means more and more people are in danger of coming into closer contact with wildfires as cities, suburbs, and "exurbs" expand into their surrounding environs. The space or buffer between wildlands and homes is important because firefighting authorities will need to spend more resources on management and suppression.

The environmental costs of aggressive fire suppression and houses built near fire-prone areas are transforming the Piedmont's fragile ecosystem. In an area where fires are frequent and low in intensity, recent fires' periodicity (return interval) has been lengthened, fuel has had longer to increase in volume, and consequently fires have burned hotter. This has contributed to a change in the plants and animals that dominate the ecosystem and threatened native species. Due in part to historic logging of fire-resistant pines, grazing of grasslands, and 20th century firefighting techniques, the pre-Piedmont's ecosystem has been altered to a mixed pine and hardwood forest. Unfortunately, shortleaf and loblolly pines, as well as southern red oak and hickories, are currently the dominant tree species where old growth longleaf pine forests used to stand. This is a major concern for biodiversity in the Piedmont; forest management and habitat restoration projects will need to double their efforts to attempt to preserve what's left of the old Longleaf Pine ecosystem.

[33] Susan I. Stewart, Volker C. Radeloff, Roger B. Hammer, and Todd J. Hawbaker, "Defining the Wildland-Urban Interface," *Journal of Forestry* (June 2007): 201-207 (http://naldc.nal.usda.gov/download/2272/PDF).

Figure 22. More than 95% of the Longleaf Pine Ecosystem in the Southeast has been lost to Agriculture, Inappropriate Forest Management and Fire Suppression Practices, and Development

1.7.3 Increased Energy Consumption

A booming population in the Piedmont continues to drive demand for energy and overall consumption will continue to increase apace despite per capita consumption of energy being almost as low as in 1970. Georgia's Environmental Finance Authority attributes the downturn in per capita energy consumption (a positive development) to modified consumption patterns, high price of energy, technological advancements in efficiency, and the 2008 economic collapse.[34] However Georgia's overall energy consumption is growing steadily. Demand in the Carolinas is similarly trending upward. In North Carolina, the state consumed almost 1,000 trillion British Thermal Units (BTU's; 1 BTU = 1,055 joules), or one quad (1.0 quad = one quadrillion BTU's = 1,000,000,000,000,000 BTU's), of energy in 1960 compared to over 2,500 trillion BTU's (2.5 quads) of energy in 2007.[35] South Carolina's Energy Office calculated that the state used over 1,000 trillion BTUs (one quad) of energy in 2012 compared to about 400 trillion BTUs (0.4 quad) in 1960.[36]

Aggregate population growth has offset each individual's decreasing use of electricity. While Americans have made great strides in reducing their per capita energy use, we are still among

[34] Georgia Environmental Finance Authority, "Georgia Energy Report: 2014," p. 4 (http://gefa.georgia.gov/sites/gefa.georgia.gov/files/related_files/document/Georgia-Energy-Report-2014.pdf).
[35] North Carolina Energy Policy Council and North Carolina Energy Office, "North Carolina State Energy Report," prepared by Appalachian State University Department of Technology and Energy Center, March 2010, p. 2 (https://www.nccommerce.com/Portals/14/Documents/Publications/ANNUAL%20NC%20ENERGY%20REPORT%20final%20feb%202010%20v2-1.pdf).
[36] South Carolina Energy Office, "South Carolina Energy Statistical Highlights," South Carolina Budget and Control Board, August 2014, p. 5 (http://www.energy.sc.gov/files/view/2014SCEnergyStatisticalHighlights.pdf).

the world's leaders in per capita consumption, and second only to China in total energy consumption despite having less than one-fourth of China's population. This ever-growing demand for more energy has prevented Americans from reducing their overwhelming reliance on fossil fuels as a source of that energy; about 85% of our primary energy is provided by the fossil fuels (oil, coal, natural gas). Strides have been made in the production of renewable energy from solar, wind, and hydropower, but these sources in total still account for less than 15 percent of America's consumption (and much less, if hydropower from large hydroelectric dams is excluded). Hydraulic fracturing (fracking), conventional drilling in wild areas and offshore (especially in the wake of the 2010 Deepwater Horizon spill in the Gulf of Mexico), and nuclear power all divide public opinion, and all have drawbacks for the environment. A growing population coupled with the quality of life most Americans expect, enjoy, and wish to continue to enjoy, is going to make meeting our future energy needs more difficult, and in the long term, impossible.

1.7.4 Regional Warming

An Urban Heat Island (UHI) is characterized as any built-up environment that becomes warmer than the surrounding areas due to human activity. There are a variety of causal factors, such as loss of tree canopy, the spread of roads and other pavement, exhaust from cars, and the widespread use of artificial lighting. One of the main causes of UHI effect is the heat generated by air conditioning, which allows so many people to live comfortably in the Piedmont region.

The Environmental Protection Agency (EPA) estimates the UHI effect can increase a city's annual mean air temperature from 1.8 to 5.4 degrees Fahrenheit.[37] This leads to even more energy output for artificial cooling, and demonstrates how intertwined are the factors that lead to environmental degradation as the Piedmont's population grows.

The UHI effect will serve to exacerbate the impacts of anthropogenic climate disruption and global warming. In other words, cities and suburbs in the Piedmont will suffer even hotter summer days in the coming decades than they would have in the absence of projected population growth, development, and sprawl.

1.7.5 Water Resources

When talking about water shortages in the United States, California immediately come to mind, or the arid, sparsely settled regions of the Southwest. But the southeastern United States has battled drought and water shortages frequently since the 1980s. Of course, below average rainfalls are the main reason for droughts, but rising population exacerbates the situation and prolongs droughts. It is not just increases in households and businesses using water for everyday needs, but irrigation for agriculture, and for natural gas extraction through

[37] United States Environmental Protection Agency, "Heat Island Effect," http://www.epa.gov/hiri/index.htm, accessed March 16, 2016.

hydraulic fracturing, which uses large quantities of water. Fracking not only diverts water away from residential and agricultural use, but could affect the water quality for millions of households in the region.

During the 2007-2009 drought in Georgia, it was found that a quarter of that state's total water use was directed toward public water supplies, with much of it sent to Atlanta.[38] Journalists have reported that overall water use in Georgia has declined over the last 30 years.[39] But this statistic includes not only the public supply, but entire water use portfolio, including thermoelectric and other sources that aren't directly tied to population.[40] If one looks at water consumption for solely public supplies, overall use has increased steadily during our study's timeframe. A similar story played out in the other Piedmont states, where North Carolina almost doubled public supply water withdrawals, from 595 million gallons per day (GPD) in 1985 to 960 million GPD in 2010.[41]

Water authorities across all Piedmont states acted in "severe" drought modes, doling out conservation requirements and penalties. In Raleigh, it was prohibited to wash your car outside of a certified conservation facility or serve water in a restaurant before a customer's request. A year later, aggregate water consumption declined by a modest 7 to 11 percent. Since then, the conservation measures have helped these states weather recurring droughts. However, domestic use of publicly-supplied deliveries for freshwater were higher in 2010 than 1985 in all three states (USGS Total Water Use). Columbia University found, "At the root of the water supply problem in the Southeast is a growing population, driven in large part by in-migration, over the last few decades."[42]

According to the 2014 National Climate Assessment, the Southeast Region is anticipated to experience water use challenges. The Assessment concluded: "Decreased water availability, exacerbated by population growth and land-use change, will continue to increase competition

[38] Richard Seager, Alexandrina Tzanova and Jennifer Nakamura, "Drought in the Southeastern United States: Causes, Variability over the Last Millennium and the Potential for Future Hydroclimate Change" in *Journal of Climate* vol. 22 (October 2009): 5022 (http://journals.ametsoc.org/doi/pdf/10.1175/2009JCLI2683.1); U.S. Department of the Interior, U.S. geological Survey, "Public-Supply Water Use," https://water.usgs.gov/edu/wups.html.

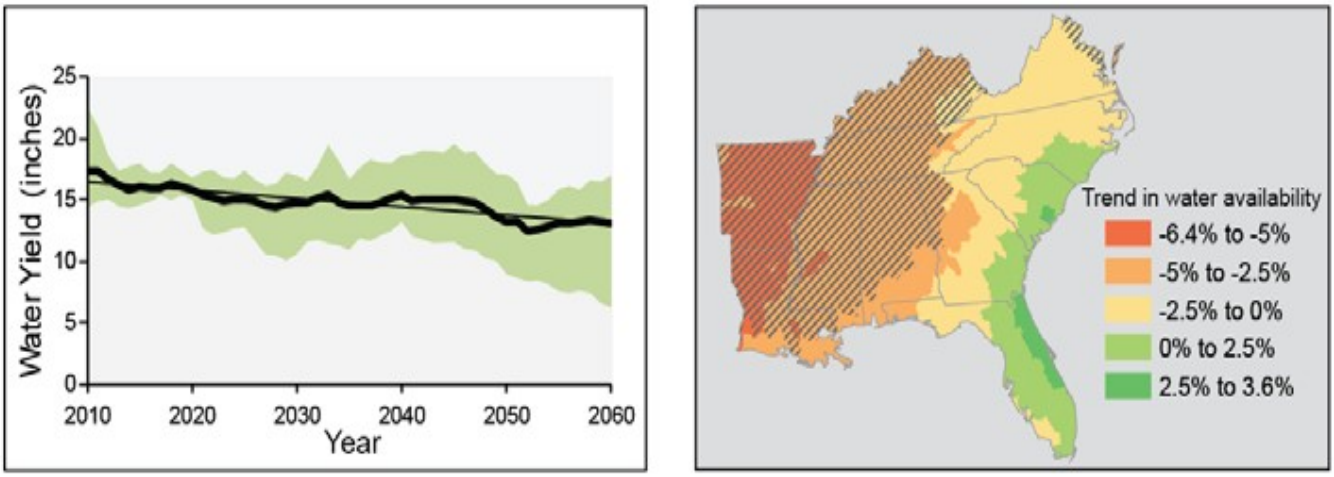
[39] Lee Shearer, "Water use in Georgia declines, even as population grows," *Athens Banner-Herald*, May 9, 2015 (http://onlineathens.com/local-news/2015-05-09/water-use-georgia-declines-even-population-grows); Molly Samuel, "Personal Water Use In Atlanta Drops Thanks To Conservation, WABE, August 27, 2015 (http://news.wabe.org/post/personal-water-use-atlanta-drops-thanks-conservation).

[40] U.S. Department of the Interior, U.S. geological Survey, "Water Withdrawal Trends, 1980-2010 in Georgia, https://ga.water.usgs.gov/infodata/wateruse/trends.html, accessed July 8, 2017.

[41] Wayne B. Solley, Charles F. Merk, Robert R. Pierce, "Estimated Water Use in the United States in 1985," Table 2: Public-supply freshwater use, by State, 1985, Circular 1004, U.S. Department of the Interior, U.S. Geological Survey, 1988, p. 13 (https://pubs.usgs.gov/circ/1988/1004/report.pdf); Molly Maupin, Joan F. Kenny, Susan S. Hutson, Kristin S. Linsey, "Estimated Water Use in the United States in 2010," Table 5: Public-supply water withdrawals, 2010," Circular 1045, U.S. Department of the Interior, U.S. Geological Survey, 2014, p.19 (https://www.researchgate.net/publication/270588660_Estimated_Use_of_Water_in_the_United_States_in_2010).

[42] Seager, et. al., "Drought in the Southeastern United States," *Journal of Climate*, p. 5022.

for water and affect the region's economy and unique ecosystems."[43] While changes in projected precipitation for this region are highly uncertain, the reasonable expectation is that there will be reduced water availability due to the increased evaporative losses resulting from rising temperatures alone.[44]



Projected water yield **Projected trend of water availability**

Figure 23. Downward Trend in Water Availability in the Southeastern United States
Source: United States Global Change Research Program (USGCRP)

1.7.6 Ground Level Ozone and Smog

With increasingly warmer temperatures, smog is expected to increase in the biggest 19 urban areas in the southeast.[45] In the presence of heat and sunlight, the precursors of tropospheric ozone, nitrogen oxides (NOx) and volatile organic compounds (VOCs), react for form ozone (O_3). With more heat and sunlight expected in the coming decades, plan on more smog alerts. The air pollutants NOx and VOCs are ozone precursors which originate mostly from vehicular emissions, industrial and utility operations, and chemical solvents. Although stratospheric ozone is good for human health (because it prevents harmful UV-B radiation from reaching the Earth's surface), ground level or tropospheric ozone is harmful to people, especially those with respiratory issues. It also harms plants and some crops, causing more

[43] Jerry M. Melillo, Terese Richmond, and Gary W. Yohe, eds., *Climate Change Impacts in the United States*: *The Third National Climate Assessment*, U.S. Global Change Research Program U.S. Global Change Research Program (Washington, D.C.: GPO, 2014), p. 11.
[44] L. M. Carter, et. al., "Southeast and the Caribbean," in *Climate Change Impacts in the United States*, eds. Jerry M. Melillo, et. al., pp. 396-417.
[45] Howard H. Chang, Jingwen Zhou, and Montserrat Fuentes, "Impact of Climate Change on Ambient Ozone Level and Mortality in Southeastern United States," *International Journal of Environmental Research and Public Health* vol. 7, no. 7 (2010): 2866-2880 (http://www.mdpi.com/1660-4601/7/7/2866).

damage than all other air pollutants combined.[46] As air quality worsens, health risks increase as well.

1.7.7 Traffic

With housing sizes getting larger and a preference for suburban life persisting, traffic in the Piedmont will grind to a halt more frequently, for longer periods of time. A 2008 report from the U.S. Department of Transportation warned that the transportation networks in the country's megaregions are ill-equipped to handle future demand.[47] There is potential for metropolitan authorities to collaborate and harness all roadway systems; however, this type of multi-state, multi-juridical coordination poses great challenges. More attention and resources will need to be channeled into existing critical corridors and interstate highways.

Commuters in the Piedmont Atlantic megaregion have some of longest commute times in the country, while at the same time having less miles of roadway per person.[48] The average commuter in Atlanta spends 52 extra hours in traffic every year and wastes 20 gallons of gas, costing the city a whopping $3.2 billion dollars annually and contributing to the deterioration of air quality.[49] A motorist in Charlotte spends 43 hours a year stuck in gridlock, while the average commuter in Raleigh sits for 34 hours of bumper-to-bumper traffic.[50] The attempted solution to this problem, as long as the population continues to grow, will be to pave over ever more open space.

1.7.8 Compromising Quality of Life

As noted earlier, many Southern Piedmont residents are cognizant of the rapid growth and changes taking place in their region, and many care deeply about the long-term effects of increasing development and sprawl on their environment and quality of life. In the 2015 Pulse opinion poll of Piedmont adults cited above, 55 percent believe that emergence of a megalopolis stretching from Atlanta to Raleigh would make the region "a worse and more congested place to live" while 89 percent believe it is important that it is "fairly easy to spend time in natural areas" near where one lives.[51] Sixty-nine percent preferred to live in a rural area, town, or small city compared to 35 percent who preferred to live in a big city or the suburbs.

---

[46] Agricultural Research Service, "Effects of Ozone Air Pollution on Plants," U.S. Department of Agriculture, http://www.ars.usda.gov/Main/docs.htm?docid=12462, accessed March 16, 2016.
[47] U.S. Department of Transportation, Department of Highway Safety "Megaregions: Literature Review of the Implications for U.S. Infrastructure Investment and Transportation Planning," submitted by Georgia Tech Research Corporation, September 2008, p. 21-33 (https://www.fhwa.dot.gov/planning/megaregions/reports/megaregions_report_2008/megaregions.pdf).
[48] David Schrank, et. al., "2015 Urban Mobility Scorecard," Texas A&M Transportation Institute and INRIX, August 2015, pp. 18-37 (http://d2dtl5nnlpfr0r.cloudfront.net/tti.tamu.edu/documents/mobility-scorecard-2015.pdf).
[49] Schrank, et. al., "2015 Urban Mobility Scorecard."
[50] Ibid.
[51] Pulse Opinion Poll of Piedmont residents. 19-23 July 2015. Included in this report as Appendix I.

If the Southern Piedmont region continues to grow by leaps and bounds as it has in recent decades, and as projected to 2050 and beyond, the desire to live in a rural area or at most a small urban area will more and more become an unattainable pipe dream for the region's residents. Moreover, residents of the Southern Piedmont are active outdoorspeople, eagerly embracing outdoor recreation pursuits such as hiking, camping, hunting, fishing, and boating. In the coming decades, the parks and open spaces they like to frequent in pursuit of these pastimes will become more and more hemmed in by development and overcrowded with increasing numbers of users all competing for the same scarce resources: open, uncrowded spaces and elbow room.

Figure 24. Peaceful Piedmont Pastime: Solitary Fishing from a Pier on Lake Craig in Croft State Park near Spartanburg, South Carolina

2. THE FACTORS IN SPRAWL

Over the past few decades, dozens of diverse factors have been suggested as causes of America's relentless, unending sprawl, defined here as the expansion of urban land at the expense of rural land.

1. One factor is population growth.
2. All the other factors combine to increase per capita land consumption.

This study examines the relative importance of those two overall factors.

2.1 Sprawl Defined

The word "sprawl" is not a precise term. But we do indeed use the term "Overall Sprawl" in a precise way in this study – it is the amount of rural land lost to development.

Fortunately, it is easy to measure the amount of Overall Sprawl because of two distinct, painstaking processes conducted by two unrelated federal agencies: the U.S. Census Bureau (Census) and the Natural Resources Conservation Service (NRCS) of the U.S. Department of Agriculture (USDA). Using data from decennial censuses, Census has tabulated changes in the size and shape of the nation's Urbanized Areas (UAs) every 10 years since 1950, while the NRCS has estimated changes in the size and shape of America's Developed Lands every five years since 1982.

The Census Bureau uses a rather complicated but consistent set of conditions to measure the spread of cities into surrounding rural land. Census defines the contiguous developed land of a central city and its suburbs an "Urbanized Area." It is possible to measure sprawl from decade to decade by calculating the change in overall acreage of a specific UA.

The NRCS uses remote sensing, survey, and statistical techniques to derive estimates of changes in land use on the nation's non-federal lands. Built-up or developed lands are one of the categories of land use NRCS delineates.

Defining sprawl by the Census standards has some limitations that are discussed in Appendix D. But the UA delineations, coupled with the National Resources Inventory (NRI) surveys, are unequalled as uniform quantitative longitudinal measures of rural urbanization by cities and towns in all regions of the country.

2.2 Our Two Main Data Sources

Urbanized Area data from the 2000-2010 Census and Developed Land data from the 1982-2010 National Resources Inventories (NRIs) served as our main data sources for this study of sprawl in the Piedmont, as well as our prior 2001, 2003, and 2014 national sprawl studies and state/regional studies for California, Florida, Minnesota, and the Chesapeake Bay

Watershed.[52] While the Census data pertain to a discrete list of designated cities, the NRI data furnish a portrait that also includes development in places outside of the boundaries of the Census Bureau's UAs. Therefore, we were able to assess and include traditional sprawl and development within large American cities as well as the more diffuse development and sprawl dispersed across entire states, as evidenced in the NRI data. The NRI refers to these areas of more dispersed development as "Small Built-up Areas." In 2010, Small Built-up Areas comprised 7.2 million acres or about six percent of the total of 113.3 million acres of Developed Land in the contiguous United States.

This study provides an update on the amount of sprawl over the most recent periods for which the most comprehensive government data are available: 2000-2010 for UAs and 2002-2010 for Developed Lands. Since Urbanized Area data are calculated only once every 10 years, our study can assess the march of sprawl up until 2010.

NRI data available span uninterrupted from 1982-2007 in five 5-year intervals although the most recent interval is three years (2007-2010). These data quantify how much rural land was converted into developed or built-up land over these discrete time intervals, as well as over the 28-year time period in its entirety. Therefore, we are able to see how sprawl has consistently impacted areas outside of the Census' Urbanized Areas over the last 28 years.

2.2.1 Census Bureau's Urbanized Areas

The U.S. Census Bureau classifies geographic areas of the United States as either urban or rural. Urban places are those characterized by densely developed land; they include residential, commercial, industrial and other non-residential urban land uses.[53]

The Census Bureau first defined urban places in reports following the 1880 and 1890 censuses. It adopted the current minimum population threshold for urban areas of 2,500 a century ago back in the 1910 Census; any place that contained at least 2,500 people within its boundaries was designated as urban. All territories outside of these urban places, regardless of their population densities, were considered rural.[54]

---

[52] For example: Leon Kolankiewicz and Roy Beck. 2000. *Overpopulation = Sprawl in Florida*. Arlington, VA: NumbersUSA. 30 pp. Available online at: https://www.numbersusa.com/content/resources/publications/publications/studies/sprawl-florida.html; Leon Kolankiewicz, Roy Beck and Anne Manetas. 2014. *Vanishing Open Spaces: Population Growth and Sprawl in America*. Arlington, VA: NumbersUSA. Available online at: https://www.numbersusa.com/content/resources/publications/publications/studies/outsmarting-smartgrowth-population-grow.html.

[53] U.S. Census Bureau. 2013. 2010 Census Urban and Rural Classification and Urban Area Criteria. Accessed at: http://www.census.gov/geo/reference/ua/urban-rural-2010.html

[54] U.S. Census Bureau. 2010 Census Urban Area FAQs. Accessed at: http://www.census.gov/geo/reference/ua/uafaq.html.

Census started designating densely populated Urbanized Areas of 50,000 or more residents beginning with the 1950 Census, accounting for the increased presence of densely inhabited suburban development on the periphery of large cities. Outside of UAs, the Bureau continued to identify as urban any incorporated place or census designated place of at least 2,500 and less than 50,000 people.

Beginning with the 2000 Census, the Bureau introduced the concept of "urban clusters" (UCs), replacing urban places located outside of UAs. These are defined based on the same criteria as UAs, but represent areas containing at least 2,500 and less than 50,000 people. "Rural" areas continue to be defined as any population, housing, or territory outside of urban areas.

According to the Census Bureau, in the 2010 Census, an urban area consists of a "densely settled core of census tracts and/or census blocks that meet minimum population density requirements, along with adjacent territory containing non-residential urban land uses as well as territory with low population density included to link outlying densely settled territory with the densely settled core."[55] In essence, UAs represent America's "urban footprint."[56]

For the 2010 Census, the Bureau utilized Geographic Information System (GIS) software from the world's largest developer and supplier of GIS software, the Environmental Systems Research Institute, Inc. (ESRI) to delineate the nation's urban areas.[57]

The initial delineation of an urbanized core includes census tracts or blocks with a population density of 1000 people per square mile (ppsm). Adjacent tracts or blocks with a density of 500 ppsm are then added iteratively. Impervious qualifying blocks are also added iteratively to the UA. These are areas of impervious ground surface (covered with pavement or structures) that support non-residential urban land use such as commercial or industrial; they have low population density because they are non-residential, but they are functionally part of the urban landscape. The Bureau uses an ESRI tool called ArcGIS Spatial Analyst to analyze the Multi-Resolution Land Characteristics Consortium (MRLC) National Land Cover Database (NLCD) 2006 impervious 30-meter raster dataset. Holes or enclaves in the polygon less than five square miles in area that are completely surrounded by qualifying land are filled in, and counted as part of the UA.[58]

UA delineation may also employ "hops" and "jumps." These are a means of connecting outlying densely settled territory with the main body of the UA or UC. A hop is a connection from one urban area core to other qualifying urban territory along a road connection of half a

[55] See note 32.
[56] U.S. Census Bureau. 2011. The Use of ESRI Software in the Delineation of Urban Areas for the 2010 Census. PowerPoint presentation at the ESRI International User Conference July 12th, 2011.
[57] Ibid.
[58] Ibid.

mile (0.5 mile) or less in length; multiple hops may be made along any given road corridor. This criterion recognizes that alternating patterns of residential development and non-residential development are a typical feature of urban landscapes.

A jump is a connection from one urban area core to other qualifying urban territory along a road connection between 0.5 mile and 2.5 miles in length; only one jump may be made along any given road connection. The jump concept has been part of the UA delineation process since the 1950 Census. It provides a means for recognizing that urbanization may be offset by intervening areas that have not yet developed. The Census Bureau changed the maximum jump distance criterion from 1.5 miles to 2.5 miles between the 1990 and 2000 censuses.[59]

The Census Bureau lists a number of revealing facts and figures about UAs in 2010:

- **3,573**: Total number of 2010 Census urban areas in the United States
  - **486**: Number of Urbanized Areas (UAs)
  - **3,087**: Number of Urban Clusters (UCs)
- **71.2%**: Percent of U.S. population living within UAs
- **80.7%**: Percent of the U.S. population that is urban
- **16**: Number of UAs with populations of 2,500,000 or more
- **41**: Number of UAs with populations of 1,000,000 or more
- **179**: Number of UAs with populations of 200,000 or more
- **36**: Number of new UAs between 2000 and 2010
- **2,534.4** persons per square mile: Overall Urbanized Area population density in the U.S.

Between 2000 and 2010, the country's urban population grew by 12.1%, in comparison with total U.S. population growth of 9.7% during the same period. In other words, America's urban areas grew at a faster pace than the country as a whole, continuing a demographic trend – a relative shift or migration of the population from rural to urban areas – that has been underway for more than a century. This trend is evident around the entire world.

In this study's core area there are 25 cities which qualify as Census-designated Urbanized Areas, listed by state in Table 12. There are nine in Georgia, five in South Carolina and 11 in North Carolina. There are also scores of Urban Clusters.

[59] Ibid.

Table 12. Urbanized Areas (UAs) as of 2010 in the Core Piedmont Study Area

Georgia UAs	South Carolina UAs	North Carolina UAs
Athens-Clarke County, GA	Anderson, SC	Asheville, NC
Atlanta, GA	Columbia, SC	Burlington, NC
Augusta-Richmond County, GA--SC	Greenville, SC	Charlotte, NC--SC
Cartersville, GA	Mauldin--Simpsonville, SC	Concord, NC
Dalton, GA	Rock Hill, SC	Durham, NC
Columbus, GA--AL		Gastonia, NC--SC
Gainesville, GA		Greensboro, NC
Macon, GA		Hickory, NC
Rome, GA		High Point, NC
		Raleigh, NC
		Winston-Salem, NC

2.2.2 Natural Resources Conservation Service's National Resources Inventory and Developed Lands

The National Resources Inventory (NRI) is based on rigorous scientific and survey protocols. The U.S. Department of Agriculture's NRCS began developing the NRI in 1977 in response to several Congressional mandates. The first NRI published in 1982 used most of the survey methodology and protocols utilized by earlier inventories. However, the scope and sample size of the 1982 NRI were expanded to meet the demands of the Soil and Water Resources Conservation Act (RCA) of 1977, as well as to better address emerging issues like the permanent loss of agricultural lands to nonagricultural uses, such as transportation, industry, commercial and residential land uses.[60]

The NRI covers the entire surface area (both land and water) of the United States, including all 50 states, Puerto Rico, the U.S. Virgin Islands, and certain Pacific Basin islands. The sample includes all land ownership categories, including federal lands (e.g., national parks, national wildlife refuges, national forests, Bureau of Land Management lands, military installations), although NRI data collection activities have historically focused on non-federal lands. Sampling is conducted on a county-by-county basis, using a stratified, two-stage, area sampling scheme. The two-stage sampling units are nominally square segments of land and points within these segments. The segments are typically half-mile-square parcels of land equal to 160-acre quarter-sections (a section is a square of territory one mile on each side, and comprising one square mile or 640 acres in area) in the Public Land Survey System, but there are a number of exceptions in the western and northeastern U.S. Three specific sample

[60] U.S. Department of Agriculture. 2009. *Summary Report: 2007 National Resources Inventory*, Natural Resources Conservation Service, Washington, DC, and Center for Survey Statistics and Methodology, Iowa State University, Ames, Iowa. 123 pages. http://www.nrcs.usda.gov/technical/NRI/2007/2007_NRI_Summary.pdf.

points are selected for most segments, although two are selected for 40-acre segments in irrigated portions of some western States, and some segments originally contained only one sample point.[61]

The 1997 NRI sample contained about 300,000 sample segments and 800,000 sample points. Whereas the NRI was conducted every five years up to 1997, an annual or continuous approach was begun in 2000. Each year a subset of between 71,000 and 72,000 segments from the 1997 sample is selected for observation. The subset is selected using a "supplemented panel rotation" design, meaning that a "core panel" of about 40,000 segments is observed each year along with a different supplemental or rotation panel chosen for each year.

The NRI survey system uses points as the sampling units rather than farms or fields, because land use and land unit boundaries often change in some parts of the country. Utilizing points has allowed the survey process to generate a database with dozens of factors or data elements that are properly correlated over many years. Thus, analyses and inferences based on these data are using proper combinations of longitudinal data.[62]

Data for the initial 1982 NRI were collected by thousands of field staff of the Soil Conservation Service (SCS – precursor agency to NRCS), whose efforts were supplemented by contractors and employees of other agencies working under SCS supervision. Data collection began in the spring of 1980 and ran for more than two years, finishing in the autumn of 1982. For the 1987 NRI, data were also collected by teams of trained personnel. Remote sensing techniques (via aircraft or satellite) were used to update 1982 conditions for about 30 percent of the sample sites. Reliance upon remote sensing increased during the 1990s. Beginning in 2000, special high-resolution imagery was obtained for each NRI sample site.[63]

In 2004, NRCS established Remote Sensing Laboratories (RSLs) in Greensboro, NC; Fort Worth, TX; and Portland, OR. These three labs were designed, equipped, and staffed to take advantage of modern geospatial technologies, enabling efficient collection and processing of NRI survey data. The RSLs are now staffed with permanent employees whose full-time job is NRI data collection and processing.[64]

A number of quality control and quality assurance (QCQA) processes are conducted by NRCS and contract staff as well as by the Statistical Unit and NRCS resource inventory specialists. Many of these QCQA processes are embedded within the survey software developed by NRCS and the Statistical Unit. The QCQA processes ensure that differences in

[61] Ibid.
[62] Ibid.
[63] Ibid.
[64] Ibid.

the data over time reflect actual changes in resource conditions, rather than differences in the perspectives of two different data collectors, or changes in technologies and protocols.

One of the special features of the NRI is its genuine longitudinal nature, that is, its reliability and consistency through time, so that users of this dataset can be confident that, for example, differences in the area of developed land shown for 2007 and 1997 accurately reflect true differences "on the ground" or in reality. Even though many operational features of the NRI survey program have evolved over the years, processes have been implemented to ensure that data contained within the 2007 NRI database are longitudinally consistent. Data collection protocols always include review and editing of historical data for the particular NRI sampling units being observed.[65]

NRI's broadest classification divides all U.S. territory into three categories: federal land, water areas, and non-federal land. Non-federal land is broken out into developed and rural. Rural lands are further subdivided into cropland, Conservation Reserve Program (CRP) land, pastureland, rangeland, forestland, and other rural land. In the present study we are concerned only with developed land.

NRI's category of developed land differs from that used by other federal data collection entities. While other studies and inventories emphasize characteristics of human populations (e.g., Census of Population) and housing units (e.g., American Housing Survey), for the NRI, the intent is to identify which lands have been permanently eliminated from the rural land base. The NRI Developed Land category includes: (a) large tracts of urban and built-up land; (b) small tracts of built-up land less than 10 acres in size; and (c) land outside of these built-up areas that is in a rural transportation corridor (roads, interstates, railroads, and associated rights-of-way).

Tables 9-11 and Figures 19-21 on pages 39-41 in this report show the 128 counties in the core Piedmont study area within Georgia, South Carolina, and North Carolina for which the authors performed an analysis of the two factors driving urban sprawl from 1982 to 2010: population growth and increasing per capita land consumption.

2.3 Population Growth

A city or state's population grows based on personal behavior – births and in-migration – and on local and national governmental actions. Looking more closely, the net increase (or decrease) in population in any given time period (e.g., one year, one decade) is due to the number of births minus the number of deaths plus the number of in-migrants minus the number of out-migrants.

An urban area's population growth today is much more likely to be the result of enticing residents from elsewhere. Local and state governments can and do create many incentives

[65] Ibid.

that encourage people to move into a city. These include aggressive campaigns to persuade industries to move their factories and jobs from another location, public subsidies for the infrastructure that supports businesses, expansion of water service and sewage lines into new areas, new housing developments and new residents, and general public relations that increase the attractiveness of a city to outsiders. Even without trying, a city can attract new residents just by maintaining amenities and a high quality of life, especially if the nation's population is growing significantly, as continues to be the case today.

2.3.1 Population Growth in Piedmont Study Area UAs

Table 13 shows population growth in the Piedmont study area Urbanized Areas from 2000 to 2010. On average, these combined UAs grew by 33 percent in just ten years, or an annual compound (exponential) rate of 2.88%.

Table 13. Population Growth in Piedmont's Urbanized Areas – 2000 to 2010

Urbanized Area	Population in 2000	Population in 2010	% growth
Georgia UAs	**4,557,764**	**5,751,545**	**26%**
Athens-Clarke County, GA	106,482	128,754	21%
Atlanta, GA	3,499,840	4,515,419	29%
Augusta-Richmond County, GA--SC	335,630	386,787	15%
Cartersville, GA	33,685	52,477	56%
Dalton, GA	57,666	85,239	48%
Columbus, GA--AL	242,324	253,602	5%
Gainesville, GA	88,680	130,846	48%
Macon, GA	135,170	137,570	2%
Rome, GA	58,287	60,851	4%
South Carolina UAs	**941,005**	**1,251,544**	**33%**
Anderson, SC	70,436	75,702	7%
Columbia, SC	420,537	549,777	31%
Greenville, SC	302,194	400,492	33%
Mauldin--Simpsonville, SC	77,831	120,577	55%

Urbanized Area	Population in 2000	Population in 2010	% growth
Rock Hill, SC	70,007	104,996	50%
North Carolina UAs	**2,749,068**	**3,957,360**	**43%**
Asheville, NC	221,570	280,648	27%
Burlington, NC	94,248	119,911	27%
Charlotte, NC--SC	758,927	1,249,442	65%
Concord, NC	115,057	214,881	87%
Durham, NC	287,796	347,602	21%
Gastonia, NC--SC	141,407	169,495	20%
Greensboro, NC	267,884	311,810	16%
Hickory, NC	187,808	212,195	13%
High Point, NC	132,844	166,485	25%
Raleigh, NC	541,527	884,891	63%
Winston-Salem, NC	299,290	391,024	31%
All Urbanized Areas	**8,547,127**	**11,351,473**	**33%**

2.3.2 Population Growth in Piedmont Study Area Counties

Table 14 shows population growth in the Piedmont study area Urbanized Areas from 2002 to 2010. On average, these combined UAs grew by 16 percent in just eight years, at an annual compound (exponential) rate of 1.84%. This annual compound rate is lower than that for the Urbanized Areas from 2000 to 2010 (2.88%), but this is exactly to be expected because these 128 counties include a number that have grown very little or at all to date, but which are expected to grow enormously in coming decades if demographic projections come to pass.

Table 14. Population Growth in Piedmont Study Area Counties – 2002 to 2010

County	Population in 2002	Population in 2010	% growth
63 Georgia Counties	**5,883,701**	**6,840,363**	**16%**
Baldwin	45,203	45,735	1%
Banks	15,485	18,415	19%

County	Population in 2002	Population in 2010	% growth
Barrow	50,409	69,731	38%
Bartow	83,106	100,195	21%
Bibb	153,929	155,715	1%
Butts	20,993	23,674	13%
Carroll	94,087	110,661	18%
Cherokee	158,682	215,129	36%
Clarke	104,673	116,668	11%
Clayton	248,954	259,623	4%
Cobb	631,018	690,063	9%
Columbia	95,818	124,815	30%
Coweta	97,191	127,955	32%
Crawford	12,553	12,591	0%
Dawson	17,521	22,343	28%
DeKalb	669,789	692,902	3%
Douglas	98,582	132,722	35%
Elbert	20,610	20,112	-2%
Fayette	95,707	106,945	12%
Floyd	92,597	96,274	4%
Forsyth	115,797	176,738	53%
Franklin	20,942	22,048	5%
Fulton	815,224	926,197	14%
Greene	14,984	16,006	7%
Gwinnett	641,986	808,719	26%
Habersham	37,421	43,080	15%
Hall	150,229	180,253	20%

County	Population in 2002	Population in 2010	% growth
Hancock	9,829	9,391	-4%
Haralson	26,676	28,774	8%
Harris	25,327	32,167	27%
Hart	23,286	25,217	8%
Heard	11,207	11,854	6%
Henry	140,747	205,265	46%
Jasper	12,027	13,926	16%
Jones	24,909	28,634	15%
Lamar	16,289	18,335	13%
Lincoln	8,375	7,966	-5%
Lumpkin	23,048	29,998	30%
Madison	26,512	28,167	6%
McDuffie	21,141	21,876	3%
Meriwether	22,726	21,849	-4%
Monroe	22,767	26,467	16%
Morgan	16,244	17,862	10%
Muskogee	185,139	190,417	3%
Newton	71,102	100,086	41%
Oconee	26,501	32,984	24%
Oglethorpe	13,152	14,919	13%
Paulding	94,561	142,741	51%
Pickens	25,258	29,436	17%
Pike	14,445	17,905	24%
Polk	39,109	41,523	6%

County	Population in 2002	Population in 2010	% growth
Putnam	19,366	21,205	9%
Rockdale	73,158	85,434	17%
Spalding	59,699	64,081	7%
Stephens	25,625	26,193	2%
Talbot	6,749	6,844	1%
Taliaferro	2,040	1,698	-17%
Troup	60,224	67,187	12%
Upson	27,624	27,087	-2%
Walton	66,103	84,004	27%
Warren	6,270	5,804	-7%
White	22,281	27,168	22%
Wilkes	10,695	10,590	-1%
23 South Carolina Counties	**2,425,797**	**2,737,992**	**13%**
Abbeville	26,311	25,335	-4%
Aiken	145,226	160,565	11%
Anderson	170,287	187,269	10%
Cherokee	53,407	55,397	4%
Chester	34,083	33,096	-3%
Chesterfield	43,834	46,665	6%
Edgefield	24,962	26,966	8%
Fairfield	23,890	23,890	0%
Greenville	390,197	452,859	16%
Greenwood	66,996	69,703	4%
Kershaw	53,714	61,851	15%

County	Population in 2002	Population in 2010	% growth
Lancaster	63,282	76,889	22%
Laurens	68,841	66,500	-3%
Lexington	222,761	263,406	18%
McCormick	10,110	10,228	1%
Newberry	36,244	37,575	4%
Oconee	68,194	74,359	9%
Pickens	111,806	119,217	7%
Richland	331,285	385,745	16%
Saluda	19,180	19,926	4%
Spartanburg	258,467	284,713	10%
Union	29,699	28,867	-3%
York	173,021	226,971	31%
42 North Carolina Counties	**5,217,772**	**6,077,327**	**16%**
Alamance	135,239	151,528	12%
Alexander	34,665	37,239	7%
Anson	25,723	26,908	5%
Burke	89,371	90,771	2%
Cabarrus	140,054	178,588	28%
Caldwell	78,920	82,998	5%
Caswell	23,767	23,695	0%
Catawba	145,343	154,389	6%
Chatham	53,857	63,821	19%
Cleveland	97,068	98,050	1%
Davidson	151,296	162,930	8%

County	Population in 2002	Population in 2010	% growth
Davie	36,446	41,321	13%
Durham	233,505	268,454	15%
Forsyth	314,215	351,335	12%
Franklin	50,622	60,848	20%
Gaston	191,930	206,213	7%
Granville	51,977	60,063	16%
Guilford	432,068	489,681	13%
Iredell	130,352	159,771	23%
Lee	49,313	57,951	18%
Lincoln	66,400	78,450	18%
McDowell	42,911	45,016	5%
Mecklenburg	736,422	923,427	25%
Montgomery	26,991	27,826	3%
Moore	77,521	88,569	14%
Orange	117,667	134,197	14%
Person	36,751	39,461	7%
Polk	18,928	20,465	8%
Randolph	132,989	141,960	7%
Richmond	46,659	46,659	0%
Rockingham	92,798	93,641	1%
Rowan	132,765	138,446	4%
Rutherford	63,924	67,772	6%
Stanly	58,689	60,595	3%
Stokes	45,079	47,351	5%
Surry	72,152	73,694	2%

County	Population in 2002	Population in 2010	% growth
Union	138,329	202,206	46%
Vance	44,056	45,426	3%
Wake	676,392	906,969	34%
Warren	20,131	20,931	4%
Wilkes	67,202	69,287	3%
Yadkin	37,285	38,425	3%
All 128 Counties in 3-State Piedmont Study Area	**13,527,270**	**15,655,682**	**16%**

Table 15 shows population growth in the same counties for the entire study period from 1982 to 2010. During these 28 years, growth occurred on average at annual compound (exponential) rate of 2.00%. At a sustained rate of two percent annual compound growth, a population will double in size every 35 years.

Table 15. Population Growth in Piedmont Study Area Counties – 1982 to 2010

County	Population in 1982	Population in 2010	% growth
Georgia Counties	**3,518,749**	**6,840,363**	**94%**
Baldwin	36,758	45,735	24%
Banks	8,927	18,415	106%
Barrow	22,371	69,731	212%
Bartow	42,427	100,195	136%
Bibb	151,671	155,715	3%
Butts	14,598	23,674	62%
Carroll	59,634	110,661	86%
Cherokee	56,171	215,129	283%
Clarke	77,682	116,668	50%
Clayton	155,788	259,623	67%

County	Population in 1982	Population in 2010	% growth
Cobb	321,994	690,063	114%
Columbia	43,509	124,815	187%
Coweta	40,933	127,955	213%
Crawford	7,393	12,591	70%
Dawson	5,261	22,343	325%
DeKalb	492,317	692,902	41%
Douglas	57,293	132,722	132%
Elbert	18,991	20,112	6%
Fayette	33,701	106,945	217%
Floyd	79,897	96,274	20%
Forsyth	29,596	176,738	497%
Franklin	15,495	22,048	42%
Fulton	607,085	926,197	53%
Greene	11,512	16,006	39%
Gwinnett	192,057	808,719	321%
Habersham	25,810	43,080	67%
Hall	78,832	180,253	129%
Hancock	9,379	9,391	0%
Haralson	19,241	28,774	50%
Harris	15,356	32,167	109%
Hart	18,863	25,217	34%
Heard	6,648	11,854	78%
Henry	38,270	205,265	436%
Jasper	7,486	13,926	86%
Jones	17,540	28,634	63%

County	Population in 1982	Population in 2010	% growth
Lamar	12,041	18,335	52%
Lincoln	6,731	7,966	18%
Lumpkin	11,364	29,998	164%
Madison	18,240	28,167	54%
McDuffie	18,810	21,876	16%
Meriwether	21,277	21,849	3%
Monroe	14,865	26,467	78%
Morgan	11,995	17,862	49%
Muskogee	174,633	190,417	9%
Newton	36,771	100,086	172%
Oconee	13,282	32,984	148%
Oglethorpe	9,085	14,919	64%
Paulding	27,800	142,741	413%
Pickens	12,079	29,436	144%
Pike	9,005	17,905	99%
Polk	32,868	41,523	26%
Putnam	10,817	21,205	96%
Rockdale	38,639	85,434	121%
Spalding	49,564	64,081	29%
Stephens	22,051	26,193	19%
Talbot	6,605	6,844	4%
Taliaferro	2,063	1,698	-18%
Troup	51,196	67,187	31%
Upson	26,530	27,087	2%

County	Population in 1982	Population in 2010	% growth
Walton	31,576	84,004	166%
Warren	6,621	5,804	-12%
White	10,615	27,168	156%
Wilkes	11,140	10,590	-5%
South Carolina	**1,875,298**	**2,737,992**	**46%**
Abbeville	22,964	25,335	10%
Aiken	108,220	160,565	48%
Anderson	136,853	187,269	37%
Cherokee	41,368	55,397	34%
Chester	31,122	33,096	6%
Chesterfield	38,233	46,665	22%
Edgefield	17,745	26,966	52%
Fairfield	20,671	23,890	16%
Greenville	295,615	452,859	53%
Greenwood	57,563	69,703	21%
Kershaw	39,846	61,851	55%
Lancaster	54,088	76,889	42%
Laurens	53,391	66,500	25%
Lexington	145,414	263,406	81%
McCormick	7,413	10,228	38%
Newberry	32,069	37,575	17%
Oconee	50,425	74,359	47%
Pickens	82,920	119,217	44%
Richland	273,620	385,745	41%
Saluda	16,212	19,926	23%

County	Population in 1982	Population in 2010	% growth
Spartanburg	207,456	284,713	37%
Union	30,969	28,867	-7%
York	111,121	226,971	104%
North Carolina	**3,604,044**	**6,077,327**	**69%**
Alamance	101,000	151,528	50%
Alexander	25,572	37,239	46%
Anson	25,317	26,908	6%
Burke	73,583	90,771	23%
Cabarrus	89,158	178,588	100%
Caldwell	68,057	82,998	22%
Caswell	21,416	23,695	11%
Catawba	107,754	154,389	43%
Chatham	34,430	63,821	85%
Cleveland	83,144	98,050	18%
Davidson	116,026	162,930	40%
Davie	25,316	41,321	63%
Durham	156,300	268,454	72%
Forsyth	249,154	351,335	41%
Franklin	30,769	60,848	98%
Gaston	166,369	206,213	24%
Granville	34,790	60,063	73%
Guilford	322,602	489,681	52%
Iredell	84,487	159,771	89%
Lee	37,405	57,951	55%
Lincoln	43,361	78,450	81%

County	Population in 1982	Population in 2010	% growth
McDowell	35,838	45,016	26%
Mecklenburg	422,435	923,427	119%
Montgomery	22,495	27,826	24%
Moore	51,394	88,569	72%
Orange	78,644	134,197	71%
Person	29,356	39,461	34%
Polk	13,799	20,465	48%
Randolph	93,626	141,960	52%
Richmond	44,468	46,659	5%
Rockingham	84,428	93,641	11%
Rowan	101,319	138,446	37%
Rutherford	55,280	67,772	23%
Stanly	48,757	60,595	24%
Stokes	34,256	47,351	38%
Surry	59,896	73,694	23%
Union	73,308	202,206	176%
Vance	37,206	45,426	22%
Wake	316,973	906,969	186%
Warren	16,293	20,931	28%
Wilkes	59,191	69,287	17%
Yadkin	29,072	38,425	32%
All 128 Counties in 3-State Piedmont Study Area	**8,998,091**	**15,655,682**	**74%**

2.3.3 Sources of the 3-State Region's Population Growth

The combined populations of Georgia, North Carolina, and South Carolina increased from 20,942,252 in the year 2002 to 23,910,457 in 2010, an increase of three million in just eight years. Between 2002 and 2010, the three states combined grew at an annual compound rate of 1.67%; at a sustained, steady rate of 1.67%, a population would double in size in 42 years.

This addition of three million residents from 2002 and 2010 was the result of four factors, namely births to U.S. natives in the state, people moving into the region from other states (in-migration), people moving into the region from other countries (foreign-born immigrants), and births to immigrants.

- Native fertility: At 1.9 births per woman, it remains below the replacement level of 2.1 and has not been a source of long-term population growth in the U.S since 1971.

- Immigration: The sole source of long-term population growth in the United States is immigration, due both to new immigrants (arriving at about four times higher than the "replacement level" where immigration equals emigration) and to immigrants' higher fertility, which despite declines during the 2007 recession has remained well above replacement level.

Table 16. Increase in Total and Foreign-born Populations in Piedmont Study Area States, 1970 to 2010

State	1970			2010		
	Total Population	Foreign-born	% Foreign-born	Total Population	Foreign-born	% Foreign-born
North Carolina	5,082,036	28,620	0.6%	9,271,178	682,955	7.4%
South Carolina	2,590,509	14,364	0.6%	4,511,428	212,259	4.3%
Georgia	4,589,569	32,988	0.7%	9,468,815	909,022	9.6%
TOTAL	**12,262,114**	**75,972**	**0.62%**	**23,251,421**	**1,804,236**	**7.8%**

As shown in **Table 16,** the foreign-born population has risen disproportionately compared to the total percentage of population growth in all the three Piedmont states. However, if the increase in the foreign-born population was the only increase in the Piedmont, the extent of sprawl would not be close to its current level. Only looking at the rise in the foreign-born within in these states to measure the full impact of immigration distorts immigration's contribution to population growth, and related sprawl, in the United States and in the southern Piedmont. This is because all children born in the United States to immigrants automatically become U.S. citizens and when counted by the Census Bureau, these children are classified as native-born and not foreign-born, so the true contribution of immigration to population growth can be obscured. This is illustrated in the textbox below. Between the 2000 and 2010 censuses, the total population of the United States grew by 27.9 million while the foreign-born population increased by 13.5 million. This means that immigration accounted for 48 percent of population growth. When the 9 million new births to immigrants

during that decade are added in, 81 percent of population growth was due to immigrants and their U.S.-born children.

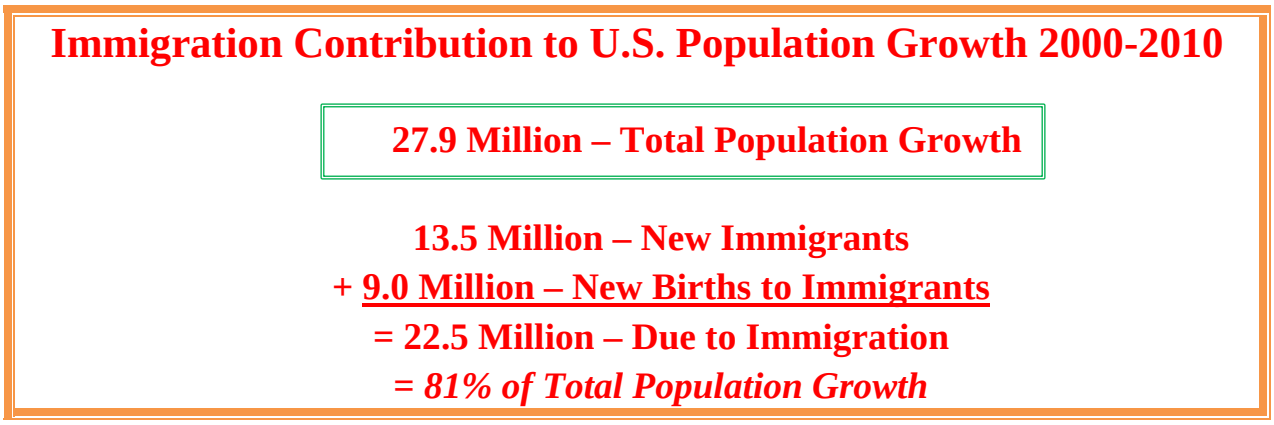


Figure 25. Immigration's Direct and Indirect Contribution to U.S. Population Growth

In 2015, the Pew Research Center projected that over the course of the next fifty years, "future immigrants and their descendants" will be responsible for 88 percent of U.S. population growth.[66] Thus, long-term population growth – and therefore sprawl – in the United States and in the Piedmont is in the hands of federal policy makers. It is they who have increased the annual settlement of immigrants from about one-quarter of a million in the 1950s and 1960s to over a million since 1990. Until the numerical level of national immigration is addressed, even the best local plans and political commitment will be unable to stop sprawl. Any serious efforts to halt the loss of farmland and wildlife habitat to continuing sprawl in the Piedmont must include reducing the volume of population growth, which requires lowering the level of immigrants entering the country each year.

According to Census Bureau data, 40 percent of the recent population growth in the Piedmont is attributable to new immigrants and their U.S. born children. This means that immigration is a major contributor to population growth in the region, but also that the means that majority of new people moving to the region are coming from regions within the United States.

In-Migration to the Piedmont from Other States

The excessive level of immigration to the United States has a secondary effect on the southern Piedmont. Because this region has lower population density and more open space than Northeastern states, the Piedmont has been an attractive place for Americans in more

[66] "Modern Immigration Wave Brings 59 Million to U.S., Driving Population Growth and Change Through 2065: Views of Immigration's Impact on U.S. Society Mixed," Pew Research Center, September 28, 2015, http://www.pewhispanic.org/2015/09/28/modern-immigration-wave-brings-59-million-to-u-s-driving-population-growth-and-change-through-2065/, accessed March 16, 2016.

populated (in some cases severely overpopulated areas) to relocate to, and is popular as a retirement destination. As the American population continues to age, and as immigration causes crowding in other areas of the United States (e.g. Florida, New Jersey, and the New York and Washington D.C. metro areas), the population in the Piedmont is projected to grow exponentially.

Seventeen counties in North Carolina have more than half of their population born outside North Carolina; 33 counties have more than 40 percent born outside the state; 77 counties have at least a quarter of its population born outside the state.[67]

Figure 26 is a bar chart showing migration from other states to North Carolina in 2010. Remarkably, even faraway California, on the opposite side of the country and the continent, contributes substantially to North Carolina's population growth. In 2010 alone, more than 15,000 Californians relocated to North Carolina. As would be expected however, after Florida, neighboring Virginia and South Carolina contributed the most to the state's growth.

South Carolina is the ninth-fastest growing state in the United States since the 2010 Census.[68] Figure 27 shows migration from other states to South Carolina in 2010. South Carolina's northern neighbor North Carolina dominates this list, with about 23,000 North Carolinians settling in South Carolina in 2010. Unsurprisingly, North Carolina is followed by Georgia and Florida, which each contributed more than 15,000 migrants to South Carolina in 2010. More distant states such as New York, Pennsylvania, Ohio, Michigan, and California also made substantial contributions.

According to the Georgia Governor's Office of Planning and Budget, the state's population will reach 14.7 million people by the year 2030, a 79 percent increase from the 2000 level.[69] Figure 28 depicts migration from other states to Georgia in 2010. Florida is by far the most dominant contributor, sending more than 40,000 former residents to relocate in Georgia. North Carolina, Alabama, South Carolina, and Tennessee follow in that order. The more distant but very populous states of Texas, California, and New York also contributed significantly to Georgia's population growth from internal U.S. sources.

[67] Carolina Demography, Carolina Population Center at UNC-Chapel Hill, "Non-NC Native Population by County," April 4, 2014, http://demography.cpc.unc.edu/2014/08/04/non-nc-native-population-by-county/, accessed March 16, 2016.

[68] "List of U.S. states by population growth," Wikipedia, https://en.wikipedia.org/wiki/List_of_U.S._states_by_population_growth_rate, accessed March 16, 2016.

[69] Governor's Office of Planning and Budget, "Georgia 2030: Population Projections," Performance Management Office, March 12, 2010, p. 1 (http://www.georgialibraries.org/lib/construction/georgia_population_projections_march_2010.pdf).

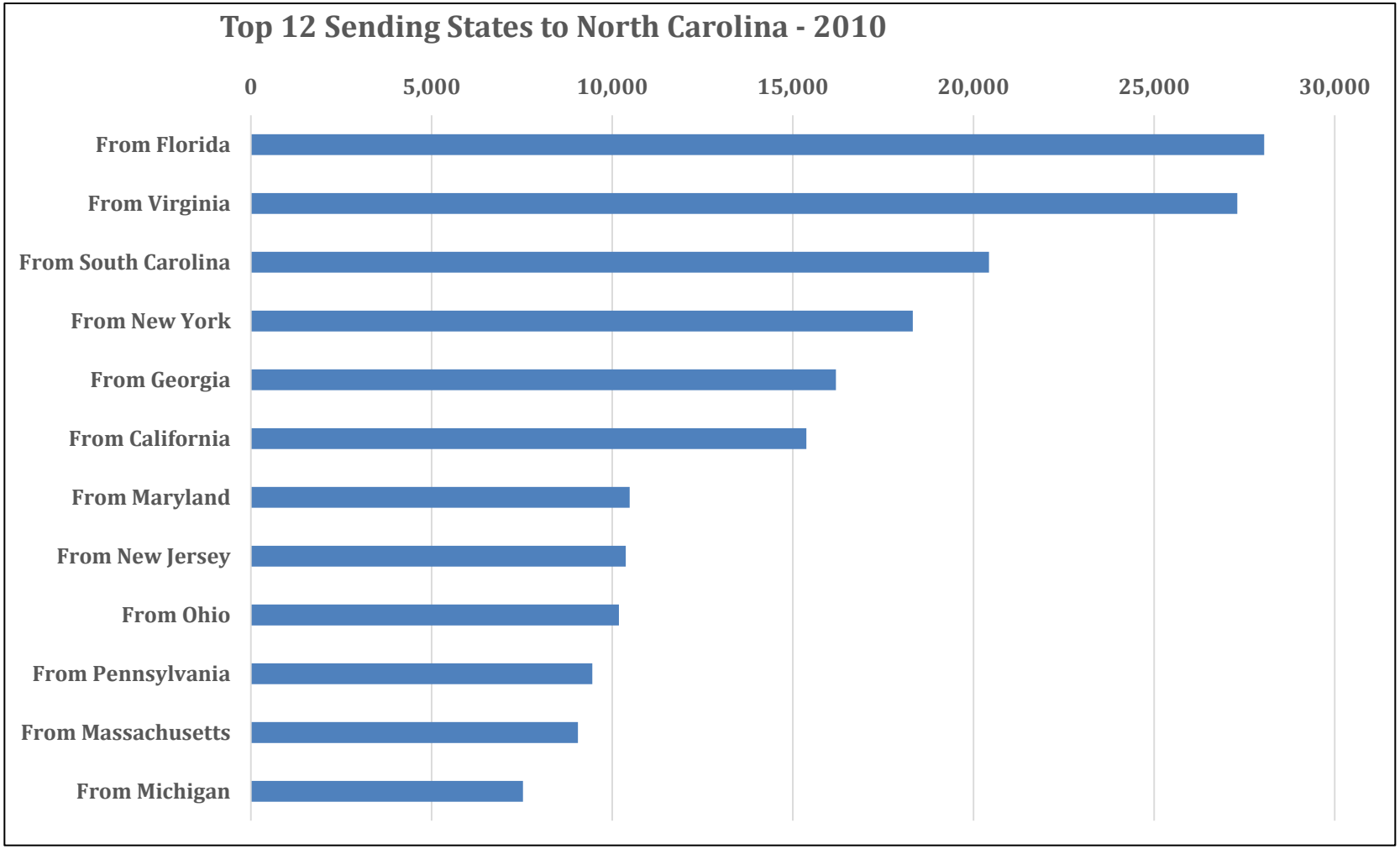


Figure 26. In-Migration to North Carolina
Source: U.S. Census Bureau

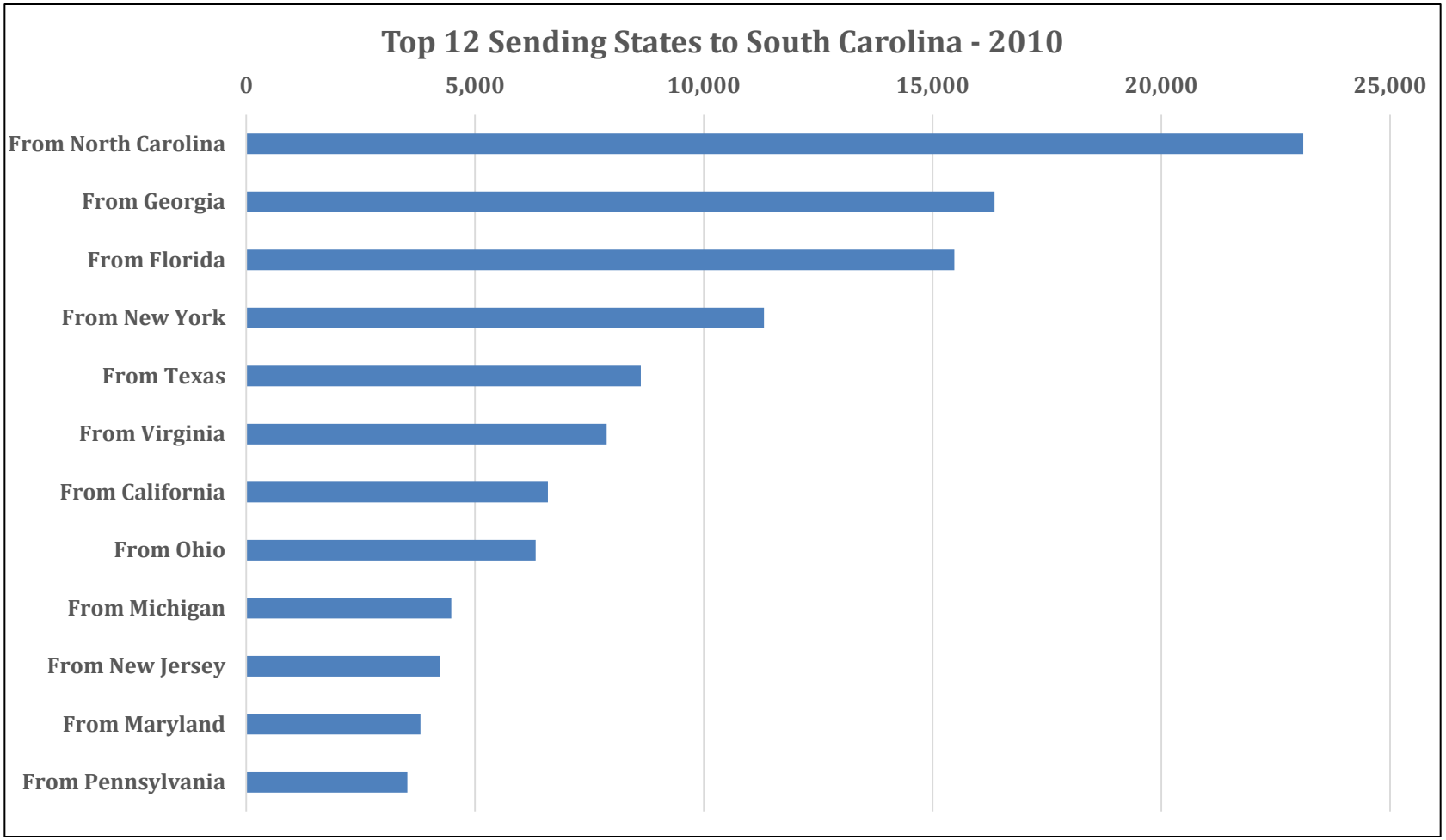


Figure 27: In-Migration to South Carolina
Source: U.S. Census Bureau

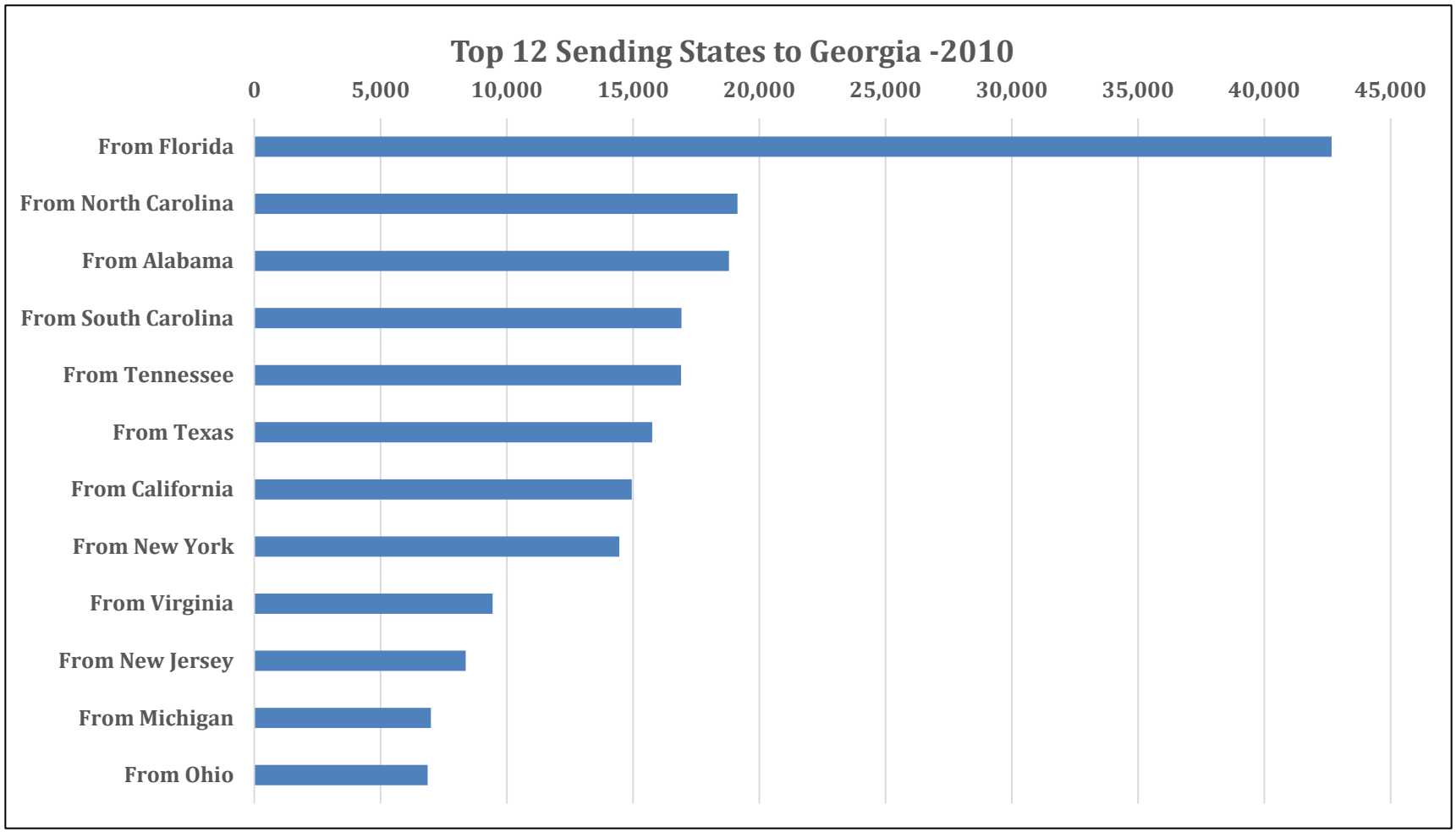


Figure 28. In-Migration to Georgia
Source: U.S. Census Bureau

The Role of Foreign Immigration

The percentage of immigrants (aka the foreign-born) in the populations of each of the three states in the study area increased significantly from 2000 to 2012. The increase in the foreign-born population in North Carolina accounted for 51% of the total population increase in the state from 2000 to 2012.[70] Immigrants grew from 4.8% of the North Carolina population in 2000 to 7.5% in 2012, from 430,000 to 718,794 (see **Table 17**).

Table 17. Immigration Component in North Carolina Population Growth, 2000-2012

North Carolina	2000	2012	% Increase 2000-2012
Total Population	**8,976,457**	**9,544,249**	**6.3**
Foreign-born Population	**430,000**	**718,794**	**67.1**
Residents born outside of state	37%	42%	13.5
Foreign-born	4.8%	7.5%	56.3

The increase in the foreign-born population in South Carolina accounted for 17.2% of the total population increase in the state from 2000 to 2012.[71] The immigrant share of the South Carolina population grew from 2.9% in 2000 to 4.8% in 2012, or from 115,978 to 222,106. This rate of increase was even faster than North Carolina's, 92 percent versus 67 percent (see **Table 18**).

Table 18. Immigration Component in South Carolina Population Growth, 2000-2012

South Carolina	2000	2012	% Increase 2000-2012
Total Population	**4,012,012**	**4,630,351**	**15.4**
Foreign-born Population	**115,978**	**222,106**	**91.5**
Residents born outside of state	36%	42%	16.7
Foreign-born	2.9%	4.8%	65.5

[70] U.S. Census Bureau, American FactFinder; Gregor Aisch, Robert Gebeloff, and Kevin Quealy, "Where We Came From and Where We Went, State by State," *The New York Times*, August 19, 2014, https://www.nytimes.com/interactive/2014/08/13/upshot/where-people-in-each-state-were-born.html, accessed May 22, 2017.
[71] U.S. Census Bureau, American FactFinder; Gregor Aisch, et. al., "Where We Came From and Where We Went."

The increase in the foreign-born population in Georgia accounted for 23.7% of the total population increase in the state from 2000 to 2012.[72] While immigrants accounted for less than one fourth of Georgia's population growth, the immigrant population itself surged by nearly 63 percent in just 12 years (see **Table 19**).

Table 19. Immigration Component in Georgia Population Growth, 2000-2012

Georgia	2000	2012	% Increase 2000-2012
Total Population	**8,186,453**	**9,714,569**	**18.7**
Foreign-born Population	**577,273**	**939,564**	**62.8**
Residents born outside of state	43%	45%	4.7
Foreign-born	7.1%	9.7%	36.6

2.4 Per Capita Land Consumption

Per capita land consumption statistics are a useful way to understand the combined power of numerous land use and consumption choices that can lead to urban sprawl. [See **Table 20** for the per capita numbers for the Piedmont sprawl study area Urbanized Areas from 2000 to 2010, **Table 21** for the study area's counties from 2002 to 2010, Table 11 for the study area's counties from 1982 to 2010, and **Appendices B and C** for how the statistic is calculated.]

2.4.1 Change in Per Capita Land Consumption in Piedmont Study Area UAs

The increase in per capita land consumption (Per Capita Sprawl) is an important cause of Overall Sprawl in many urban areas. Census data on the nation's Urbanized Areas allow us to track the change in per capita land consumption from decade to decade.

When Census Bureau data show that per capita land consumption in the Atlanta UA is 0.375 acre, that means it takes slightly more than a third of an acre to provide the average greater Atlanta resident with space for housing, work, retail, transportation, education, religious and other private assembly, government, recreation and all other urban needs.

Table 20 shows the variation of per capita land use among the Piedmont study area's 25 Urbanized Areas. The average Hickory, NC resident "occupies" between seven-tenths and eight-tenths (0.789) of an acre, while on the other extreme, the average resident of the Durham, NC UA uses less than half as much, about a third of an acre (0.335). In general,

[72] U.S. Census Bureau, American FactFinder; Gregor Aisch, et al., "Where We Came From and Where We Went."

larger cities like Atlanta and Charlotte have higher population densities, which should come as no surprise.

Table 20. Per Capita Land Consumption in Piedmont Study Area's Urbanized Areas – 2000 and 2010

Urbanized Area	Fraction of Acre per Resident – 2000	Fraction of Acre per Resident - 2010	% Change in Per Capita Land Consumption, 2000-2010
Georgia UAs	**0.381**	**0.395**	**4%**
Athens-Clarke County, GA	0.478	0.489	2%
Atlanta, GA	0.359	0.375	4%
Augusta-Richmond County, GA--SC	0.442	0.429	**(-3%)**
Cartersville, GA	0.727	0.617	**(-15%)**
Dalton, GA	0.604	0.607	1%
Columbus, GA--AL	0.360	0.371	3%
Gainesville, GA	0.652	0.618	**(-5%)**
Macon, GA	0.381	0.456	20%
Rome, GA	0.448	0.501	12%
South Carolina UAs	**0.463**	**0.488**	**5%**
Anderson, SC	0.626	0.626	0%
Columbia, SC	0.409	0.442	8%
Greenville, SC	0.480	0.512	7%
Mauldin--Simpsonville, SC	0.459	0.444	**(-3%)**
Rock Hill, SC	0.559	0.583	4%
North Carolina UAs	**0.438**	**0.441**	**1%**
Asheville, NC	0.597	0.604	1%
Burlington, NC	0.440	0.483	10%
Charlotte, NC--SC	0.367	0.380	4%
Concord, NC	0.507	0.537	6%

Urbanized Area	Fraction of Acre per Resident – 2000	Fraction of Acre per Resident - 2010	% Change in Per Capita Land Consumption, 2000-2010
Durham, NC	0.349	0.335	**(-4%)**
Gastonia, NC--SC	0.538	0.523	**(-3%)**
Greensboro, NC	0.324	0.380	17%
Hickory, NC	0.718	0.789	10%
High Point, NC	0.453	0.434	**(-4%)**
Raleigh, NC	0.378	0.375	**(-1%)**
Winston-Salem, NC	0.538	0.528	**(-2%)**
All Urbanized Areas	**0.410**	**0.423**	**3%**

Within all Urbanized Areas of the 3-state Piedmont sprawl study area combined, average per capita land consumption increased slightly during the 2000-2010 period of study, by three percent, from 2000 to 2010. However, Table 20 also shows that per capita land consumption actually went down in eight Urbanized Areas from 2000 to 2010; this reflects an increase in average population density across those UAs as a result of some combination of higher density housing and more compact and mixed-used development generally.

2.4.2 Change in Per Capita Land Consumption in Piedmont Study Area Counties

Table 21 displays changes in per capita land consumption from 2000 to 2010 in the 128-county, three-state Piedmont study area as a whole. As is evident, while individual counties vary, overall average per capita land consumption across the entire Piedmont sprawl study area actually decreased somewhat during this recent eight-year period, by some six percent.

Table 21. Per Capita Land Consumption in Piedmont Study Area's Counties – 2002 and 2010

County	Fraction of Acre per Resident – 2002	Fraction of Acre per Resident – 2010	% Change in Per Capita Land Consumption, 2002-2010
63 Georgia Counties	**0.424**	**0.404**	**(-5)**
Baldwin	0.608	0.726	19%
Banks	1.020	1.168	14%

County	Fraction of Acre per Resident – 2002	Fraction of Acre per Resident – 2010	% Change in Per Capita Land Consumption, 2002-2010
Barrow	0.518	0.433	**(-16%)**
Bartow	0.501	0.454	**(-9%)**
Bibb	0.420	0.432	3%
Butts	0.605	0.579	**(-4%)**
Carroll	0.631	0.619	**(-2%)**
Cherokee	0.613	0.549	**(-10%)**
Clarke	0.356	0.341	**(-4%)**
Clayton	0.244	0.252	3%
Cobb	0.269	0.258	**(-4%)**
Columbia	0.502	0.429	**(-14%)**
Coweta	0.732	0.660	**(-10%)**
Crawford	0.868	0.921	6%
Dawson	0.605	0.501	**(-17%)**
DeKalb	0.200	0.203	1%
Douglas	0.509	0.448	**(-12%)**
Elbert	0.311	0.333	7%
Fayette	0.580	0.554	**(-4%)**
Floyd	0.573	0.570	**(-1%)**
Forsyth	0.549	0.421	**(-23%)**
Franklin	0.726	0.767	6%
Fulton	0.271	0.259	**(-5%)**
Greene	0.761	0.768	1%
Gwinnett	0.295	0.262	**(-11%)**
Habersham	0.684	0.738	8%

County	Fraction of Acre per Resident – 2002	Fraction of Acre per Resident – 2010	% Change in Per Capita Land Consumption, 2002-2010
Hall	0.556	0.505	**(-9%)**
Hancock	0.956	1.033	8%
Haralson	0.847	0.851	1%
Harris	1.082	0.911	**(-16%)**
Hart	0.794	0.821	3%
Heard	0.580	0.523	**(-10%)**
Henry	0.466	0.403	**(-13%)**
Jasper	0.840	0.790	**(-6%)**
Jones	0.771	0.688	**(-11%)**
Lamar	0.743	0.693	**(-7%)**
Lincoln	0.836	0.879	5%
Lumpkin	0.555	0.497	**(-11%)**
Madison	0.498	0.497	0%
McDuffie	0.851	0.859	1%
Meriwether	1.272	1.538	21%
Monroe	1.001	0.888	**(-11%)**
Morgan	0.991	0.935	**(-6%)**
Muskogee	0.235	0.233	**(-1%)**
Newton	0.661	0.550	**(-17%)**
Oconee	0.649	0.561	**(-14%)**
Oglethorpe	0.304	0.288	**(-5%)**
Paulding	0.493	0.357	**(-28%)**
Pickens	0.705	0.659	**(-6%)**

County	Fraction of Acre per Resident – 2002	Fraction of Acre per Resident – 2010	% Change in Per Capita Land Consumption, 2002-2010
Pike	1.391	1.251	**(-10%)**
Polk	0.532	0.542	2%
Putnam	0.800	0.783	**(-2%)**
Rockdale	0.601	0.577	**(-4%)**
Spalding	0.972	1.064	10%
Stephens	0.773	0.855	11%
Talbot	1.689	1.680	**(-1%)**
Taliaferro	1.176	1.413	20%
Troup	0.903	0.881	**(-2%)**
Upson	1.068	1.167	9%
Walton	0.604	0.596	**(-1%)**
Warren	1.340	1.499	12%
White	0.386	0.390	1%
Wilkes	0.991	1.020	3%
23 South Carolina Counties	**0.595**	**0.573**	**(-4%)**
Abbeville	0.680	0.746	10%
Aiken	0.755	0.769	2%
Anderson	0.717	0.717	0%
Cherokee	0.708	0.737	4%
Chester	0.892	0.934	5%
Chesterfield	0.830	0.881	6%
Edgefield	0.489	0.530	9%
Fairfield	0.837	0.829	**(-1%)**

County	Fraction of Acre per Resident – 2002	Fraction of Acre per Resident – 2010	% Change in Per Capita Land Consumption, 2002-2010
Greenville	0.391	0.360	**(-8%)**
Greenwood	0.621	0.624	1%
Kershaw	1.270	1.217	**(-4%)**
Lancaster	0.548	0.496	**(-10%)**
Laurens	0.540	0.555	3%
Lexington	0.579	0.531	**(-8%)**
McCormick	1.227	1.222	0%
Newberry	0.847	0.868	2%
Oconee	0.865	0.862	0%
Pickens	0.567	0.555	**(-2%)**
Richland	0.391	0.365	**(-7%)**
Saluda	0.490	0.577	18%
Spartanburg	0.574	0.578	1%
Union	0.694	0.745	7%
York	0.699	0.593	**(-15%)**
42 North Carolina Counties	**0.486**	**0.450**	**(-7%)**
Alamance	0.451	0.426	**(-6%)**
Alexander	0.721	0.747	4%
Anson	0.793	0.832	5%
Burke	0.755	0.777	3%
Cabarrus	0.433	0.377	**(-13%)**
Caldwell	0.722	0.711	**(-2%)**
Caswell	0.602	0.646	7%

County	Fraction of Acre per Resident – 2002	Fraction of Acre per Resident – 2010	% Change in Per Capita Land Consumption, 2002-2010
Catawba	0.729	0.705	**(-3%)**
Chatham	0.852	0.782	**(-8%)**
Cleveland	0.414	0.442	7%
Davidson	0.536	0.527	**(-2%)**
Davie	0.560	0.561	0%
Durham	0.310	0.282	**(-9%)**
Forsyth	0.298	0.280	**(-6%)**
Franklin	0.589	0.544	**(-8%)**
Gaston	0.470	0.466	**(-1%)**
Granville	0.489	0.476	**(-3%)**
Guilford	0.342	0.328	**(-4%)**
Iredell	0.737	0.666	**(-10%)**
Lee	0.734	0.707	**(-4%)**
Lincoln	0.630	0.614	**(-2%)**
McDowell	0.816	0.973	19%
Mecklenburg	0.368	0.313	**(-15%)**
Montgomery	0.730	0.740	1%
Moore	0.826	0.768	**(-7%)**
Orange	0.449	0.408	**(-9%)**
Person	0.536	0.563	5%
Polk	1.384	1.358	**(-2%)**
Randolph	0.524	0.563	7%
Richmond	0.759	0.808	6%
Rockingham	0.542	0.566	4%

County	Fraction of Acre per Resident – 2002	Fraction of Acre per Resident – 2010	% Change in Per Capita Land Consumption, 2002-2010
Rowan	0.590	0.609	3%
Rutherford	0.745	0.724	**(-3%)**
Stanly	0.603	0.599	**(-1%)**
Stokes	0.619	0.619	0%
Surry	0.572	0.596	4%
Union	0.454	0.332	**(-27%)**
Vance	0.611	0.649	6%
Wake	0.371	0.304	**(-18%)**
Warren	0.984	0.979	0%
Wilkes	0.695	0.710	2%
Yadkin	0.601	0.669	11%
All 128 Counties in 3-State Piedmont Study Area	**0.478**	**0.451**	**(-6%)**

Table 22 displays changes in per capita land consumption from 1982 to 2010 in the 128-county, three-state Piedmont study area as a whole. As is evident, while individual counties vary considerably, overall average per capita land consumption across the entire Piedmont sprawl study area actually increased somewhat in each state during this recent 28-year period, by some 18 percent in aggregate.

Table 22. Per Capita Land Consumption in Piedmont Study Area's Counties – 1982 and 2010

County	Fraction of Acre per Resident – 1982	Fraction of Acre per Resident – 2010	% Change in Per Capita Land Consumption, 1982-2010
63 Georgia Counties	**0.358**	**0.404**	**13%**
Baldwin	0.392	0.726	85%

County	Fraction of Acre per Resident – 1982	Fraction of Acre per Resident – 2010	% Change in Per Capita Land Consumption, 1982-2010
Banks	0.683	1.168	71%
Barrow	0.541	0.433	**(-20%)**
Bartow	0.495	0.454	-8%
Bibb	0.191	0.432	126%
Butts	0.432	0.579	34%
Carroll	0.693	0.619	**(-11%)**
Cherokee	0.263	0.549	108%
Clarke	0.297	0.341	15%
Clayton	0.253	0.252	**(-1%)**
Cobb	0.351	0.258	**(-26%)**
Columbia	0.552	0.429	**(-22%)**
Coweta	0.643	0.660	3%
Crawford	0.500	0.921	84%
Dawson	0.969	0.501	**(-48%)**
DeKalb	0.190	0.203	7%
Douglas	0.548	0.448	**(-18%)**
Elbert	0.169	0.333	98%
Fayette	0.866	0.554	**(-36%)**
Floyd	0.428	0.570	33%
Forsyth	0.720	0.421	**(-42%)**
Franklin	0.490	0.767	56%
Fulton	0.245	0.259	5%
Greene	0.539	0.768	43%
Gwinnett	0.363	0.262	**(-28%)**

County	Fraction of Acre per Resident – 1982	Fraction of Acre per Resident – 2010	% Change in Per Capita Land Consumption, 1982-2010
Habersham	0.256	0.738	189%
Hall	0.620	0.505	**(-19%)**
Hancock	0.693	1.033	49%
Haralson	0.733	0.851	16%
Harris	0.775	0.911	18%
Hart	0.520	0.821	58%
Heard	0.647	0.523	**(-19%)**
Henry	0.384	0.403	5%
Jasper	0.815	0.790	**(-3%)**
Jones	0.661	0.688	4%
Lamar	0.332	0.693	109%
Lincoln	0.609	0.879	44%
Lumpkin	0.387	0.497	28%
Madison	0.280	0.497	78%
McDuffie	0.548	0.859	57%
Meriwether	0.898	1.538	71%
Monroe	0.484	0.888	83%
Morgan	1.000	0.935	**(-7%)**
Muskogee	0.149	0.233	56%
Newton	0.647	0.550	**(-15%)**
Oconee	0.444	0.561	26%
Oglethorpe	0.418	0.288	**(-31%)**
Paulding	0.237	0.357	50%

County	Fraction of Acre per Resident – 1982	Fraction of Acre per Resident – 2010	% Change in Per Capita Land Consumption, 1982-2010
Pickens	0.530	0.659	24%
Pike	0.566	1.251	121%
Polk	0.420	0.542	29%
Putnam	0.545	0.783	44%
Rockdale	0.489	0.577	18%
Spalding	0.488	1.064	118%
Stephens	0.381	0.855	124%
Talbot	0.984	1.680	71%
Taliaferro	1.115	1.413	27%
Troup	0.693	0.881	27%
Upson	0.418	1.167	179%
Walton	0.532	0.596	12%
Warren	0.846	1.499	77%
White	0.283	0.390	38%
Wilkes	0.512	1.020	99%
23 South Carolina Counties	**0.428**	**0.573**	**34%**
Abbeville	0.579	0.746	29%
Aiken	0.597	0.769	29%
Anderson	0.560	0.717	28%
Cherokee	0.474	0.737	55%
Chester	0.688	0.934	36%
Chesterfield	0.591	0.881	49%
Edgefield	0.462	0.530	15%

County	Fraction of Acre per Resident – 1982	Fraction of Acre per Resident – 2010	% Change in Per Capita Land Consumption, 1982-2010
Fairfield	0.774	0.829	7%
Greenville	0.293	0.360	23%
Greenwood	0.441	0.624	41%
Kershaw	0.653	1.217	87%
Lancaster	0.346	0.496	43%
Laurens	0.485	0.555	14%
Lexington	0.382	0.531	39%
McCormick	1.160	1.222	5%
Newberry	0.580	0.868	50%
Oconee	0.670	0.862	29%
Pickens	0.459	0.555	21%
Richland	0.269	0.365	36%
Saluda	0.475	0.577	22%
Spartanburg	0.384	0.578	50%
Union	0.449	0.745	66%
York	0.428	0.593	38%
42 North Carolina Counties	**0.381**	**0.450**	**18%**
Alamance	0.434	0.426	**(-2%)**
Alexander	0.368	0.747	103%
Anson	0.549	0.832	52%
Burke	0.707	0.777	10%
Cabarrus	0.430	0.377	**(-12%)**
Caldwell	0.426	0.711	67%

County	Fraction of Acre per Resident – 1982	Fraction of Acre per Resident – 2010	% Change in Per Capita Land Consumption, 1982-2010
Caswell	0.294	0.646	119%
Catawba	0.627	0.705	12%
Chatham	0.700	0.782	12%
Cleveland	0.310	0.442	42%
Davidson	0.452	0.527	17%
Davie	0.458	0.561	23%
Durham	0.285	0.282	**(-1%)**
Forsyth	0.238	0.280	18%
Franklin	0.367	0.544	48%
Gaston	0.299	0.466	56%
Granville	0.256	0.476	86%
Guilford	0.298	0.328	10%
Iredell	0.515	0.666	29%
Lee	0.545	0.707	30%
Lincoln	0.263	0.614	134%
McDowell	0.424	0.973	129%
Mecklenburg	0.348	0.313	**(-10%)**
Montgomery	0.533	0.740	39%
Moore	0.566	0.768	36%
Orange	0.356	0.408	15%
Person	0.255	0.563	120%
Polk	0.746	1.358	82%
Randolph	0.396	0.563	42%
Richmond	0.600	0.808	35%

County	Fraction of Acre per Resident – 1982	Fraction of Acre per Resident – 2010	% Change in Per Capita Land Consumption, 1982-2010
Rockingham	0.302	0.566	87%
Rowan	0.433	0.609	41%
Rutherford	0.271	0.724	167%
Stanly	0.418	0.599	43%
Stokes	0.508	0.619	22%
Surry	0.376	0.596	59%
Union	0.379	0.332	**(-12%)**
Vance	0.258	0.649	152%
Wake	0.353	0.304	**(-14%)**
Warren	0.595	0.979	65%
Wilkes	0.389	0.710	83%
Yadkin	0.430	0.669	56%
All 128 Counties in 3-State Piedmont Study Area	**0.382**	**0.451**	**18%**

In comparing Tables 21 and 22, the 2002-2010 versus 1982-2010 periods for per capita land consumption, it is striking that during the longer-term time period, population density declined (by 18 percent overall), but for the most recent eight years (2002 to 2010), population density rose (by six percent overall). Clearly, a reversal in land development patterns occurred over this time frame. In the early part of the period, a more conventional version of sprawl was taking place – that is, low-density development spreading out across the countryside. In the new century however, overall population densities actually increased in all three states, suggesting that the old model of sprawl as the spread of low-density development across the landscape no longer applied.

2.4.3 Causes of Changes in Per Capita Land Consumption

At a minimum, the per capita land consumption figure reflects the combined outcome of all the following individual and institutional choices and factors:

- Development
  - Consumer preferences for size and type of housing and yards
  - Developer preferences for constructing housing, offices and retail facilities
  - Governmental subsidies that encourage land consumption, and fees and taxes that discourage consumption
  - Quality of urban planning and zoning
  - Level of affluence
- Transportation
  - Governmental subsidies and programs for highways, streets and mass transit
  - Consumer preferences favoring the mobility and flexibility offered by using private vehicles rather than public transit
  - Price of gasoline (cheap gas encourages sprawl)
- Quality of existing communities and ability to hold onto their residents
  - Quality of schools
  - Reality and perceptions concerning crime and safety
  - Ethnic and cultural tensions or harmony
  - Quality of government leadership
  - Job opportunities
  - Levels of pollution
  - Quality of parks, other public facilities and infrastructure
- Number of people per household
  - Marriage rate and average age for marriage
  - Divorce rate
  - Recent fertility rate
  - Level of independence of young adults
  - Level of affluence enabling single people to live separately

2.4.4 Comparison of Changes in Population and Per Capita Land Consumption

Table 23 compares changes in population to changes in per capita land consumption in the three-state Piedmont study area UAs from 2000 to 2010. On average, these UAs grew in population by 33 percent, while their per capita land consumption increased by just three percent. In other words, on the whole, population increased by greater than ten times more than per capita land consumption. Thus, population growth was a much larger factor than growth in per capita use of land (declining population density) in driving the increase in the area of urbanized land, i.e., sprawl.

Table 23. Population Change vs. Change in Per Capita Land Consumption in Piedmont Urbanized Areas, 2000-2010

Urbanized Area	% POPULATION GROWTH, 2000-2010	% GROWTH IN PER CAPITA LAND CONSUMPTION, 2000-2010
Georgia UAs	**26%**	**4%**
Athens-Clarke County, GA	21%	2%
Atlanta, GA	29%	4%
Augusta-Richmond County, GA--SC	15%	**(-3%)**
Cartersville, GA	56%	**(-15%)**
Dalton, GA	48%	1%
Columbus, GA--AL	5%	3%
Gainesville, GA	48%	**(-5%)**
Macon, GA	2%	20%
Rome, GA	4%	12%
South Carolina UAs	**33%**	**5%**
Anderson, SC	7%	0%
Columbia, SC	31%	8%
Greenville, SC	33%	7%
Mauldin--Simpsonville, SC	55%	**(-3%)**
Rock Hill, SC	50%	4%
North Carolina UAs	**44%**	**1%**
Asheville, NC	27%	1%
Burlington, NC	27%	10%
Charlotte, NC--SC	65%	4%
Concord, NC	87%	6%

Urbanized Area	% POPULATION GROWTH, 2000-2010	% GROWTH IN PER CAPITA LAND CONSUMPTION, 2000-2010
Durham, NC	21%	**(-4%)**
Gastonia, NC--SC	20%	**(-3%)**
Greensboro, NC	16%	17%
Hickory, NC	13%	10%
High Point, NC	25%	**(-4%)**
Raleigh, NC	63%	**(-1%)**
Winston-Salem, NC	31%	**(-2%)**
All Urbanized Areas	**33%**	**3%**

Table 24 compares change in population to changes in per capita land consumption in the 128-county, three-state Piedmont study area UAs from 2002 to 2010. On average, these counties grew in population by 16 percent, while their per capita land consumption decreased by six percent. Population density actually rose during these eight years, meaning that on average, increasing per capita land consumption did not contribute at all to sprawl.

Table 24. Population Change vs. Change in Per Capita Land Consumption in Piedmont Counties, 2002-2010

County	% POPULATION GROWTH, 2002-2010	% GROWTH IN PER CAPITA LAND CONSUMPTION, 2002-2010
63 Georgia Counties	**16%**	**(-5)**
Baldwin	1%	19%
Banks	19%	14%
Barrow	38%	**(-16%)**
Bartow	21%	**(-9%)**

County	% POPULATION GROWTH, 2002-2010	% GROWTH IN PER CAPITA LAND CONSUMPTION, 2002-2010
Bibb	1%	3%
Butts	13%	**(-4%)**
Carroll	18%	**(-2%)**
Cherokee	36%	**(-10%)**
Clarke	11%	**(-4%)**
Clayton	4%	3%
Cobb	9%	**(-4%)**
Columbia	30%	**(-14%)**
Coweta	32%	**(-10%)**
Crawford	0%	6%
Dawson	28%	**(-17%)**
DeKalb	3%	1%
Douglas	35%	**(-12%)**
Elbert	-2%	7%
Fayette	12%	**(-4%)**
Floyd	4%	**(-1%)**
Forsyth	53%	**(-23%)**
Franklin	5%	6%
Fulton	14%	**(-5%)**
Greene	7%	1%
Gwinnett	26%	**(-11%)**
Habersham	15%	8%
Hall	20%	**(-9%)**

County	% POPULATION GROWTH, 2002-2010	% GROWTH IN PER CAPITA LAND CONSUMPTION, 2002-2010
Hancock	-4%	8%
Haralson	8%	1%
Harris	27%	**(-16%)**
Hart	8%	3%
Heard	6%	**(-10%)**
Henry	46%	**(-13%)**
Jasper	16%	**(-6%)**
Jones	15%	**(-11%)**
Lamar	13%	**(-7%)**
Lincoln	-5%	5%
Lumpkin	30%	**(-11%)**
Madison	6%	0%
McDuffie	3%	1%
Meriwether	-4%	21%
Monroe	16%	**(-11%)**
Morgan	10%	**(-6%)**
Muskogee	3%	**(-1%)**
Newton	41%	**(-17%)**
Oconee	24%	**(-14%)**
Oglethorpe	13%	**(-5%)**
Paulding	51%	**(-28%)**
Pickens	17%	**(-6%)**

County	% POPULATION GROWTH, 2002-2010	% GROWTH IN PER CAPITA LAND CONSUMPTION, 2002-2010
Pike	24%	**(-10%)**
Polk	6%	2%
Putnam	9%	**(-2%)**
Rockdale	17%	**(-4%)**
Spalding	7%	10%
Stephens	2%	11%
Talbot	1%	**(-1%)**
Taliaferro	-17%	20%
Troup	12%	**(-2%)**
Upson	-2%	9%
Walton	27%	**(-1%)**
Warren	-7%	12%
White	22%	1%
Wilkes	-1%	3%
23 South Carolina Counties	**13%**	**(-4%)**
Abbeville	-4%	10%
Aiken	11%	2%
Anderson	10%	0%
Cherokee	4%	4%
Chester	-3%	5%
Chesterfield	6%	6%
Edgefield	8%	9%

County	% POPULATION GROWTH, 2002-2010	% GROWTH IN PER CAPITA LAND CONSUMPTION, 2002-2010
Fairfield	0%	**(-1%)**
Greenville	16%	**(-8%)**
Greenwood	4%	1%
Kershaw	15%	**(-4%)**
Lancaster	22%	**(-10%)**
Laurens	-3%	3%
Lexington	18%	**(-8%)**
McCormick	1%	0%
Newberry	4%	2%
Oconee	9%	0%
Pickens	7%	**(-2%)**
Richland	16%	**(-7%)**
Saluda	4%	18%
Spartanburg	10%	1%
Union	-3%	7%
York	31%	**(-15%)**
42 North Carolina Counties	**16%**	**(-7%)**
Alamance	12%	**(-6%)**
Alexander	7%	4%
Anson	5%	5%
Burke	2%	3%
Cabarrus	28%	**(-13%)**

County	% POPULATION GROWTH, 2002-2010	% GROWTH IN PER CAPITA LAND CONSUMPTION, 2002-2010
Caldwell	5%	**(-2%)**
Caswell	0%	7%
Catawba	6%	**(-3%)**
Chatham	19%	**(-8%)**
Cleveland	1%	7%
Davidson	8%	**(-2%)**
Davie	13%	0%
Durham	15%	**(-9%)**
Forsyth	12%	**(-6%)**
Franklin	20%	**(-8%)**
Gaston	7%	**(-1%)**
Granville	16%	**(-3%)**
Guilford	13%	**(-4%)**
Iredell	23%	**(-10%)**
Lee	18%	**(-4%)**
Lincoln	18%	**(-2%)**
McDowell	5%	19%
Mecklenburg	25%	**(-15%)**
Montgomery	3%	1%
Moore	14%	**(-7%)**
Orange	14%	**(-9%)**
Person	7%	5%
Polk	8%	**(-2%)**

County	% POPULATION GROWTH, 2002-2010	% GROWTH IN PER CAPITA LAND CONSUMPTION, 2002-2010
Randolph	7%	7%
Richmond	0%	6%
Rockingham	1%	4%
Rowan	4%	3%
Rutherford	6%	**(-3%)**
Stanly	3%	**(-1%)**
Stokes	5%	0%
Surry	2%	4%
Union	46%	**(-27%)**
Vance	3%	6%
Wake	34%	**(-18%)**
Warren	4%	0%
Wilkes	3%	2%
Yadkin	3%	11%
All 128 Counties in 3-State Piedmont Study Area	**16%**	**(-6%)**

All in all, in the 128 counties of the three-state Piedmont sprawl study area combined, population grew by 16 percent from 2002 to 2010, while per capita land consumption actually decreased by six percent in the same time period. This means that in aggregate, the developed areas in these counties had higher population density in 2010 than in 2002. This closely reflects national trends. Per capita land use increased for decades after World War II as urban sprawl gathered force. By the first decade of the 21st century however, the trend towards lower population density (higher per capita land consumption) had begun to sputter or even reverse itself. In **Table 25**, which encompasses and averages most of the last two decades of the 20th century and the first decade of the 21st century, the change in per capita land consumption is still positive (18%), but still much less than population growth (74%).

Table 25. Population Change vs. Change in Per Capita Land Consumption in Piedmont Counties, 1982-2010

County	% POPULATION GROWTH, 1982-2010	% GROWTH IN PER CAPITA LAND CONSUMPTION, 1982-2010
63 Georgia Counties	**94%**	**13%**
Baldwin	24%	85%
Banks	106%	71%
Barrow	212%	**(-20%)**
Bartow	136%	-8%
Bibb	3%	126%
Butts	62%	34%
Carroll	86%	**(-11%)**
Cherokee	283%	108%
Clarke	50%	15%
Clayton	67%	**(-1%)**
Cobb	114%	**(-26%)**
Columbia	187%	**(-22%)**
Coweta	213%	3%
Crawford	70%	84%
Dawson	325%	**(-48%)**
DeKalb	41%	7%
Douglas	132%	**(-18%)**
Elbert	6%	98%
Fayette	217%	**(-36%)**
Floyd	20%	33%

County	% POPULATION GROWTH, 1982-2010	% GROWTH IN PER CAPITA LAND CONSUMPTION, 1982-2010
Forsyth	497%	**(-42%)**
Franklin	42%	56%
Fulton	53%	5%
Greene	39%	43%
Gwinnett	321%	**(-28%)**
Habersham	67%	189%
Hall	129%	**(-19%)**
Hancock	0%	49%
Haralson	50%	16%
Harris	109%	18%
Hart	34%	58%
Heard	78%	**(-19%)**
Henry	436%	5%
Jasper	86%	**(-3%)**
Jones	63%	4%
Lamar	52%	109%
Lincoln	18%	44%
Lumpkin	164%	28%
Madison	54%	78%
McDuffie	16%	57%
Meriwether	3%	71%
Monroe	78%	83%
Morgan	49%	**(-7%)**

County	% POPULATION GROWTH, 1982-2010	% GROWTH IN PER CAPITA LAND CONSUMPTION, 1982-2010
Muskogee	9%	56%
Newton	172%	**(-15%)**
Oconee	148%	26%
Oglethorpe	64%	**(-31%)**
Paulding	413%	50%
Pickens	144%	24%
Pike	99%	121%
Polk	26%	29%
Putnam	96%	44%
Rockdale	121%	18%
Spalding	29%	118%
Stephens	19%	124%
Talbot	4%	71%
Taliaferro	-18%	27%
Troup	31%	27%
Upson	2%	179%
Walton	166%	12%
Warren	-12%	77%
White	156%	38%
Wilkes	-5%	99%
23 South Carolina Counties	**46%**	**34%**

County	% POPULATION GROWTH, 1982-2010	% GROWTH IN PER CAPITA LAND CONSUMPTION, 1982-2010
Abbeville	10%	29%
Aiken	48%	29%
Anderson	37%	28%
Cherokee	34%	55%
Chester	6%	36%
Chesterfield	22%	49%
Edgefield	52%	15%
Fairfield	16%	7%
Greenville	53%	23%
Greenwood	21%	41%
Kershaw	55%	87%
Lancaster	42%	43%
Laurens	25%	14%
Lexington	81%	39%
McCormick	38%	5%
Newberry	17%	50%
Oconee	47%	29%
Pickens	44%	21%
Richland	41%	36%
Saluda	23%	22%
Spartanburg	37%	50%
Union	-7%	66%
York	104%	38%

County	% POPULATION GROWTH, 1982-2010	% GROWTH IN PER CAPITA LAND CONSUMPTION, 1982-2010
42 North Carolina Counties	**69%**	**18%**
Alamance	50%	**(-2%)**
Alexander	46%	103%
Anson	6%	52%
Burke	23%	10%
Cabarrus	100%	**(-12%)**
Caldwell	22%	67%
Caswell	11%	119%
Catawba	43%	12%
Chatham	85%	12%
Cleveland	18%	42%
Davidson	40%	17%
Davie	63%	23%
Durham	72%	**(-1%)**
Forsyth	41%	18%
Franklin	98%	48%
Gaston	24%	56%
Granville	73%	86%
Guilford	52%	10%
Iredell	89%	29%
Lee	55%	30%
Lincoln	81%	134%

County	% POPULATION GROWTH, 1982-2010	% GROWTH IN PER CAPITA LAND CONSUMPTION, 1982-2010
McDowell	26%	129%
Mecklenburg	119%	**(-10%)**
Montgomery	24%	39%
Moore	72%	36%
Orange	71%	15%
Person	34%	120%
Polk	48%	82%
Randolph	52%	42%
Richmond	5%	35%
Rockingham	11%	87%
Rowan	37%	41%
Rutherford	23%	167%
Stanly	24%	43%
Stokes	38%	22%
Surry	23%	59%
Union	176%	**(-12%)**
Vance	22%	152%
Wake	186%	**(-14%)**
Warren	28%	65%
Wilkes	17%	83%
Yadkin	32%	56%
All 128 Counties in 3-State Piedmont Study Area	**74%**	**18%**

2.5 Measuring Overall Sprawl

Using both the Census Bureau (Urbanized Area) and NRCS National Resources Inventory (Developed Land) data, we were able to measure the overall amount different settlements in the three-state Piedmont study area sprawled, along with what fraction or percentage of that sprawl could be attributed to population growth and what portion was a result of an increase in per capita land use.

With the Census Bureau Urbanized Areas, the Overall Sprawl was measured by calculating the change in the land area of each of the UAs from the 2000 Census to the 2010 Census. Meanwhile, county by county, the NRI provided estimates of how many acres of rural land had been converted into developed land in 5-year increments (and one 3-year increment) within their 28-year time span. Changes in the area of developed land were compared with changes in population size over time.

Figure 29. Sprawl Spreads Across Bucolic Piedmont Landscape – an all-too-common scene that will play out all too frequently if business-as-usual demographic trends are allowed to continue in the coming decades

3. FINDINGS

This study focuses on the loss of previously undeveloped land (including cropland, pastureland, rangeland, forest, and other natural habitat and open space) in the three-state, 128-county Piedmont study area in Georgia, South Carolina, and North Carolina.

At its most basic level, there are three reasons for an increase in the area of developed land in a city, county, or state: 1) each individual, on average, is consuming more land; 2) there are more people; or 3) a combination of the two factors is working together to create sprawl. This study attempts to quantify the relative roles the two fundamental factors behind sprawl: rising per capita land consumption and population growth.

3.1 Piedmont Urbanized Areas and Developed Areas

3.1.1 Per Capita Sprawl and Overall Sprawl

Many respected environmental organizations and urban planners contend that implementing Smart Growth, New Urbanism, and LEED[73] building strategies into our new and existing cities is the best way to rein in sprawl in our cities. However, this is based on the premise that it is only or primarily our land-use choices resulting in rising per capita land consumption (decreasing population density) that cause the Piedmont's sprawl. As our series of studies beginning 15 years ago have demonstrated conclusively, Per Capita Sprawl could not explain Overall Sprawl in the Piedmont's Urbanized Areas of Georgia, South Carolina and North Carolina.

By comparing the percentage growth of per capita land consumption with the percentage growth of Overall Sprawl in the 24 Piedmont Urbanized Areas in Georgia, South Carolina and North Carolina from 2000 to 2010 in **Figure 30,** we find that the Per Capita Sprawl percentage is much smaller than the Overall Sprawl percentage: 3 percent versus 37 percent. This is not to disparage Smart Growth, New Urbanism, and the LEED program, but to recognize their limitations. These multi-faceted, multi-jurisdictional approaches have indeed slowed the pace at which sprawl is converting the countryside into pavement and buildings over the last decade. Given incessant population growth, however, they will be capable only of slowing sprawl, not stopping it.

[73] LEED stands for Leadership in Energy & Environmental Design. According to the U.S. Green Building Council, LEED "is transforming the way we think about how our buildings and communities are designed, constructed, maintained and operated across the globe. Comprehensive and flexible, LEED is a green building tool that addresses the entire building lifecycle recognizing best-in-class building strategies." http://www.usgbc.org/leed

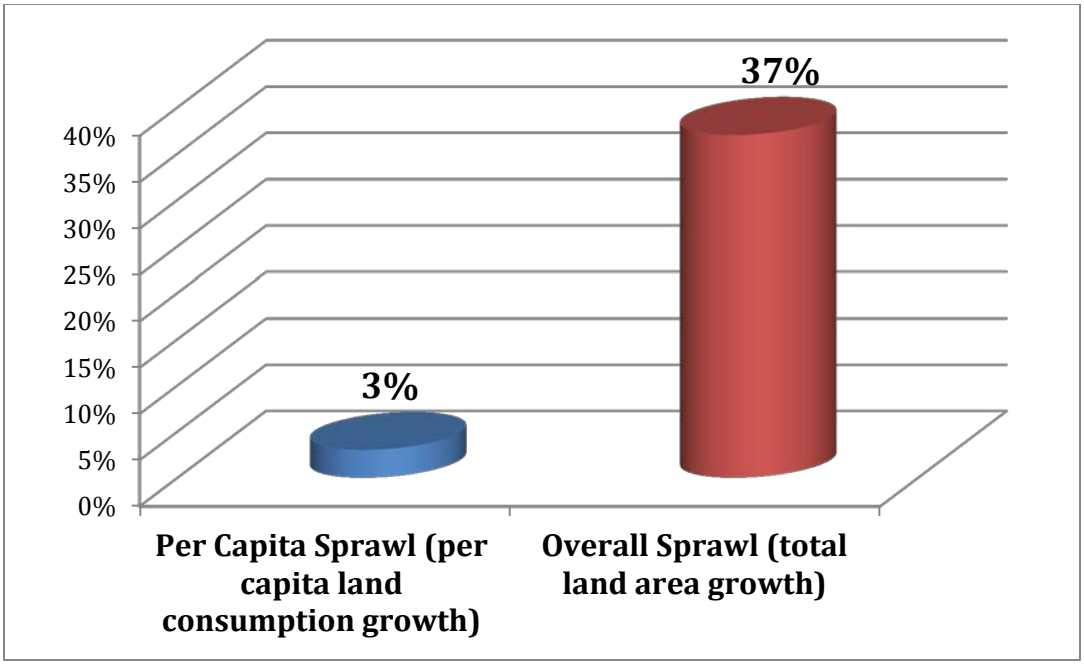


Figure 30. Per Capita Sprawl vs. Overall Sprawl in the Piedmont's 25 UAs, 2000-2010

Description**:** The growth in per capita land consumption reflects the combined effects of land use planning, government subsidies, urban policies and individual consumption decisions that determine residential densities.

Even the best Smart Growth, New Urbanism, and LEED strategies are able to engineer only so much population density. As long as the Piedmont's population is still growing, the land area taken up by Georgia, South Carolina and North Carolina cities in the Piedmont will almost certainly continue to grow.

Table 26. Per Capita Sprawl vs. Overall Sprawl
Piedmont's Urbanized Areas – 2000 to 2010

Urbanized Area	% Change in Per Capita Land Consumption, 2000-2010 (PER CAPITA SPRAWL)	% Change in Overall Land Consumption, 2000-2010 (OVERALL SPRAWL)
Georgia UAs	**4%**	**31%**
Athens-Clarke County, GA	2%	24%
Atlanta, GA	4%	35%
Augusta-Richmond County, GA--SC	**(-3%)**	12%

Urbanized Area	% Change in Per Capita Land Consumption, 2000-2010 (PER CAPITA SPRAWL)	% Change in Overall Land Consumption, 2000-2010 (OVERALL SPRAWL)
Cartersville, GA	**(-15%)**	32%
Dalton, GA	1%	49%
Columbus, GA--AL	3%	8%
Gainesville, GA	**(-5%)**	40%
Macon, GA	20%	22%
Rome, GA	12%	17%
South Carolina UAs	**5%**	**40%**
Anderson, SC	0%	8%
Columbia, SC	8%	41%
Greenville, SC	7%	41%
Mauldin--Simpsonville, SC	**(-3%)**	50%
Rock Hill, SC	4%	56%
North Carolina UAs	**1%**	**46%**
Asheville, NC	1%	28%
Burlington, NC	10%	40%
Charlotte, NC--SC	4%	70%
Concord, NC	6%	98%
Durham, NC	**(-4%)**	16%
Gastonia, NC--SC	**(-3%)**	17%
Greensboro, NC	17%	37%
Hickory, NC	10%	24%
High Point, NC	**(-4%)**	20%

Urbanized Area	% Change in Per Capita Land Consumption, 2000-2010 (PER CAPITA SPRAWL)	% Change in Overall Land Consumption, 2000-2010 (OVERALL SPRAWL)
Raleigh, NC	**(-1%)**	62%
Winston-Salem, NC	**(-2%)**	28%
All Urbanized Areas	**3%**	**37%**

Figure 31 compares Per Capita Sprawl to Overall Sprawl from 2002 to 2010 in the 128-county Piedmont study area, while **Figure 32** does the same the entire 1982 to 2010 time period. Because per capita land consumption (Per Capita Sprawl) actually declined (by -6%) from 2002 to 2010, according to this measure, in aggregate it contributed virtually nothing to sprawl in these counties during the first decade of the new century. In contrast, during the entire 1982-2010 study time frame, during which per capita land consumption grew by 18 percent, Per Capita Sprawl did comprise a share of Overall Sprawl, which will be discussed in upcoming sections.

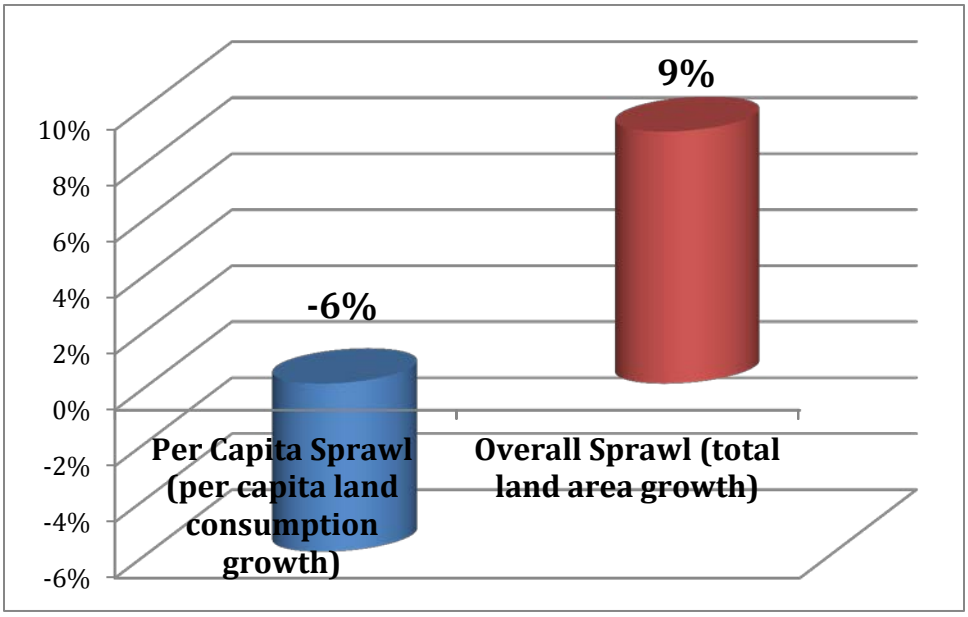


Figure 31. Per Capita Sprawl vs. Overall Sprawl in the 128 Piedmont counties, 2002-2010

Description**:** The growth in per capita land consumption reflects the combined effects of land use planning, government subsidies, urban policies and individual consumption decisions that determine residential densities.

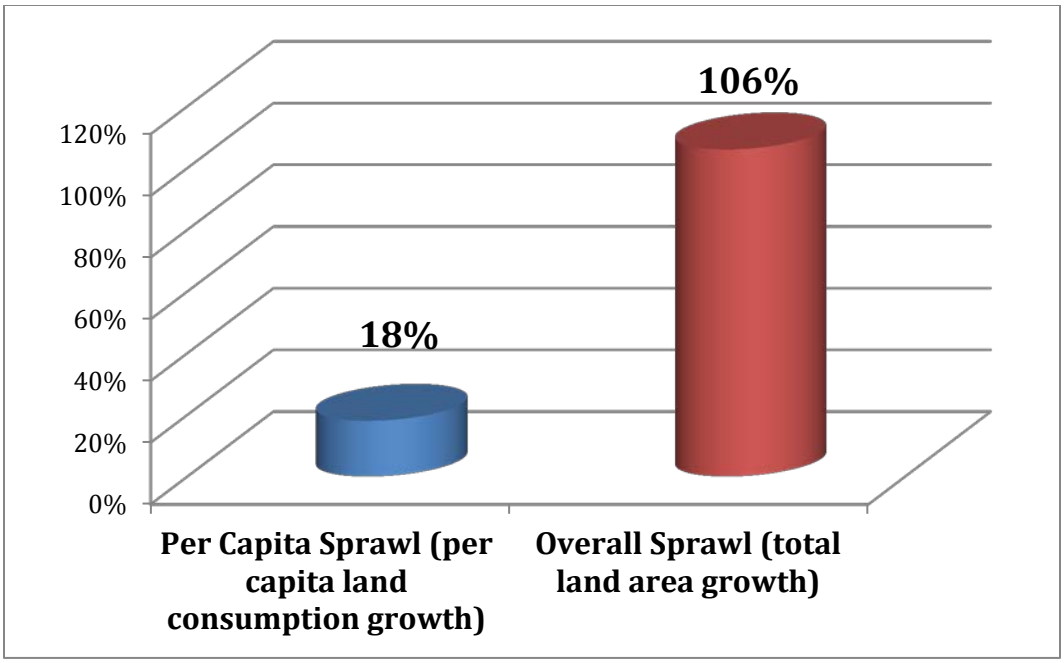


Figure 32. Per Capita Sprawl vs. Overall Sprawl in the 128 Piedmont counties, 1982-2010

Description**:** The growth in per capita land consumption reflects the combined effects of land use planning, government subsidies, urban policies and individual consumption decisions that determine residential densities.

3.1.2 Per Capita Sprawl vs. Population Growth

Since Overall Sprawl is explained by the combination of population change and per capita consumption change, we can learn much about their relative roles by simply lining up those percentages side by side, which was done in Section 2.4.4 above.

Figure 33 aggregates the 25 UAs in the Piedmont study area and finds that from 2000 to 2010 their average population change was 33% while their per capita land change was 3%. This figure corresponds to the data in **Table 23** above. Thus we can see that the rate of population growth was more than ten times as much as of a factor as the rate of per capita land change in Piedmont urban sprawl.

Even after just a cursory examination of **Figure 33,** it should be obvious not only that Per Capita Sprawl cannot account for all or even most of Overall Sprawl, but that for UAs between 2000 and 2010 it does not appear to be nearly as significant a factor in generating sprawl as Population Growth is. Subsequent sections will explore this finding further by apportioning responsibility for sprawl in cities and states between Population Growth and Per Capita Sprawl by using another methodology. **Figures 34 and 35** make the same comparison for the Piedmont counties from 2002-2010 and 1982-2010, with similar results.

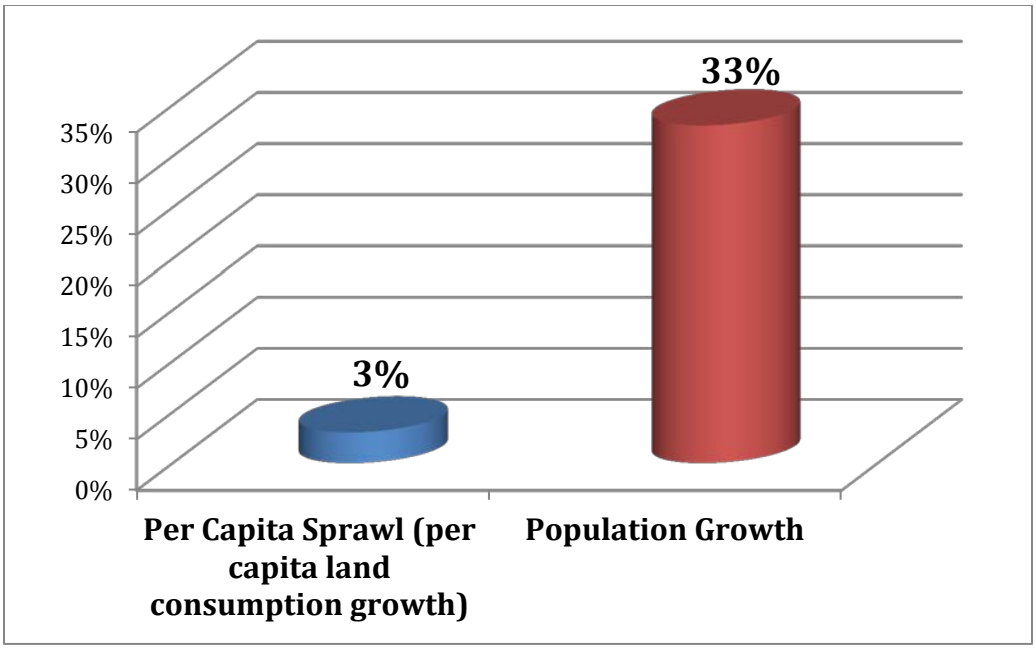


Figure 33. Per Capita Sprawl vs. Population Growth in Piedmont's 25 UAs, 2000-2010

Description**:** When comparing the growth rates of the two factors behind Overall Sprawl we find that population growth was more than 10 times greater than per growth in capita land consumption from 2000 to 2010.

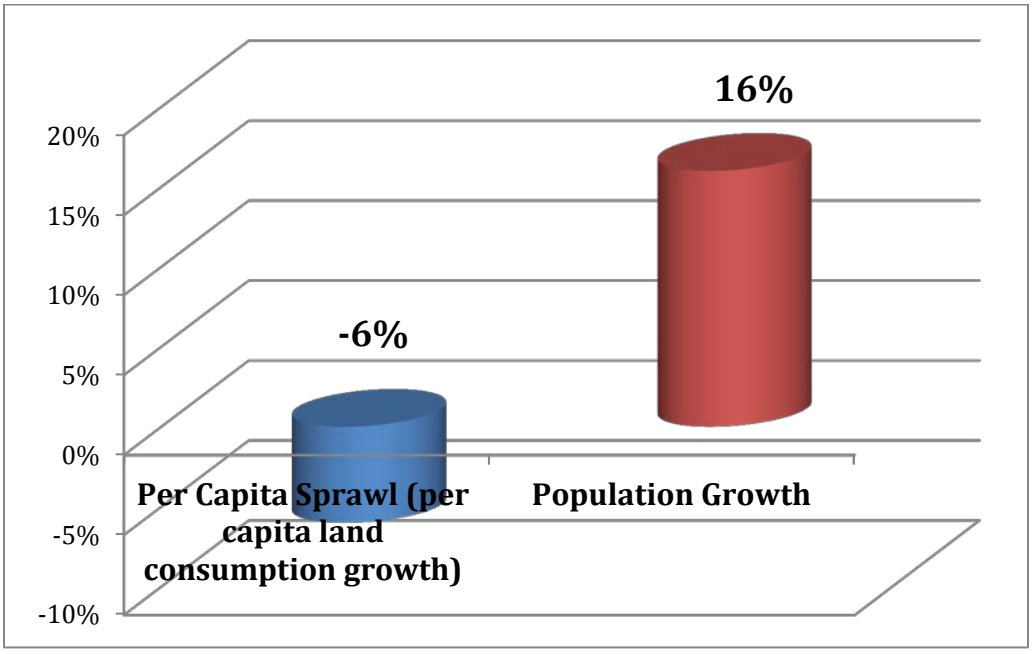


Figure 34. Per Capita Sprawl vs. Population Growth in 128 Piedmont Counties, 2002-2010

Description**:** When comparing the growth rates of the two factors behind Overall Sprawl in the Piedmont counties from 2002 to 2010, we find that population grew during this time period, but that Per Capita Sprawl (per capita land consumption) actually fell.

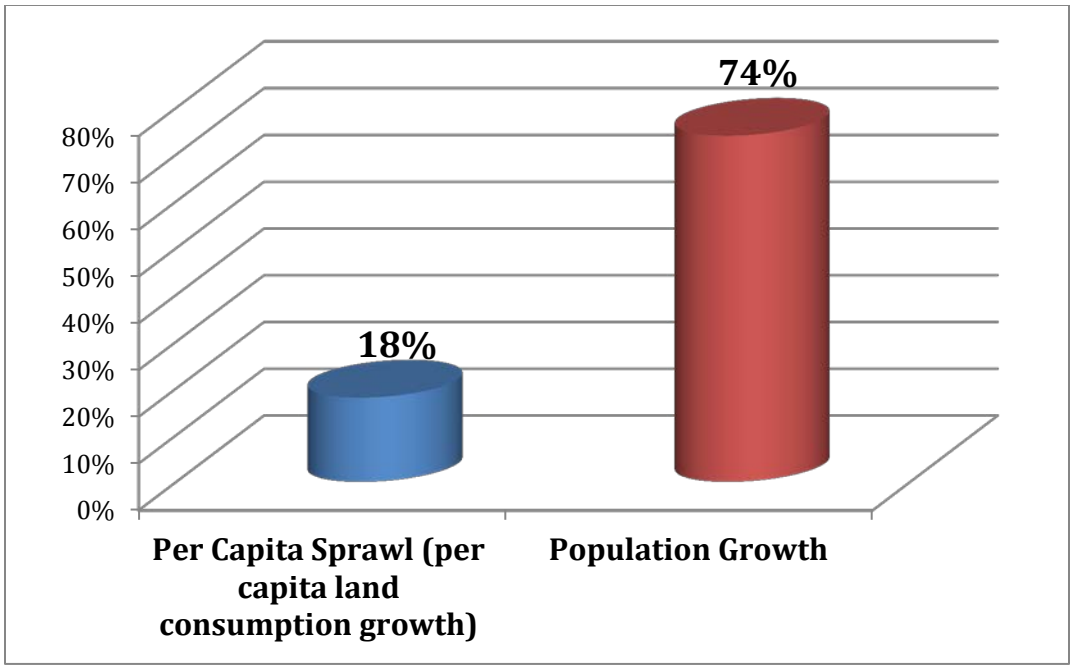


Figure 35. Per Capita Sprawl vs. Population Growth in 128 Piedmont Counties, 1982-2010

Description**:** When comparing the growth rates of the two factors behind Overall Sprawl in the 128 Piedmont counties from 1982 to 2010, we find that population growth was more than four times greater than per growth in capita land consumption from 1982 to 2010.

Since our primary concern is the ongoing loss of rural lands – agricultural lands, natural habitats, and other open space – to development and sprawl, it is worth seeing how much of this loss is related to Per Capita Sprawl and how much to Population Growth.

The findings of the current study on sprawl in the Piedmont broadly reinforce one of the conclusions of our original sprawl studies 15 years ago ago and our more recent studies for the nation and for Florida – that when investigating the causes of sprawl, and presenting findings, it is best to avoid absolutes or categorical statements. Unlike some who have looked into the sprawl phenomenon, we attribute sprawl neither to population growth entirely nor declining density entirely, that is, to increasing per capita land consumption. Once again, our findings are unequivocal that both factors are involved and important, although it is evident that, in the three-state Piedmont study area especially, the population growth factor substantially outweighs the Per Capita Sprawl factor in importance.

Figure 36 compares the rates of sprawl when the 24 Piedmont UAs are divided into groups based on the rate of population growth from 2000-2010. On average, cities that added more population clearly sprawled over greater area. Strikingly, the 10 cities that experienced 10-30 percent population growth sprawled twice as much on average (25 percent) as compared

to those cities that experienced 0-10 percent population growth (13 percent). Cities whose populations grew by more than 50 percent averaged 62 percent sprawl (i.e., a 62% increase in the area of urbanized land) between 2000 and 2010.

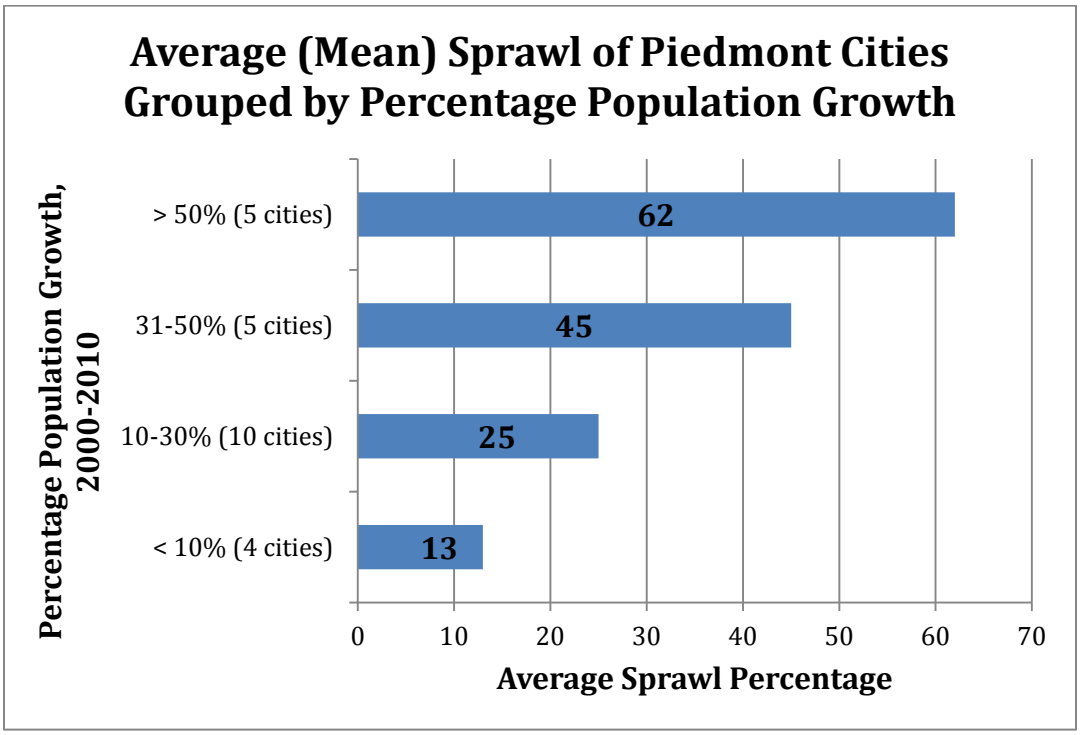


Figure 36. Piedmont Cities with More Population Growth Experienced More Sprawl

Figure 37 displays the results of another grouping that once again demonstrates population growth's preeminent role in driving sprawl in the Piedmont. This figure highlights the amount of population growth in the top third of sprawling cities (eight of them) versus the bottom third of sprawling cities (also eight in number).

The eight cities in the three-state Piedmont region with the most sprawl (199 square miles on average) between 2000 and 2010 had average population growth of 282,536 during that period. In sharp contrast, the 10 cities with the least sprawl (just 14 square miles on average) averaged just 15,538 population growth during the same decade, roughly 1/20th the population growth of those cities or urbanized areas with the most sprawl.

Clearly sprawl is a function of population growth, not just of population growth, but primarily population growth. **Figures 38 and 39** depict the same groupings as Figure 37, but for the 128 counties in the three-state Piedmont study area. Figure 38 shows population growth in the 20 counties that experienced the greatest amount of sprawl vs. those the 20 that experienced the least sprawl from 2002 to 2010, while Figure 39 shows the same for the entire 1982-2010 time period.

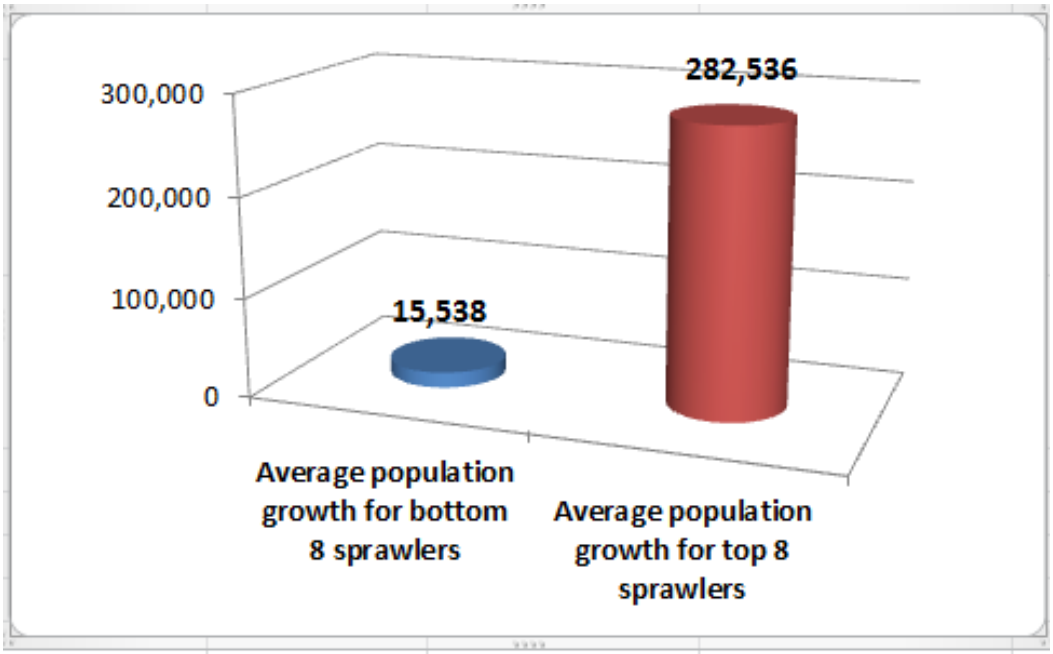


Figure 37. Population Growth in Piedmont Study Area's Highest vs. Lowest Sprawling Cities, 2000-2010

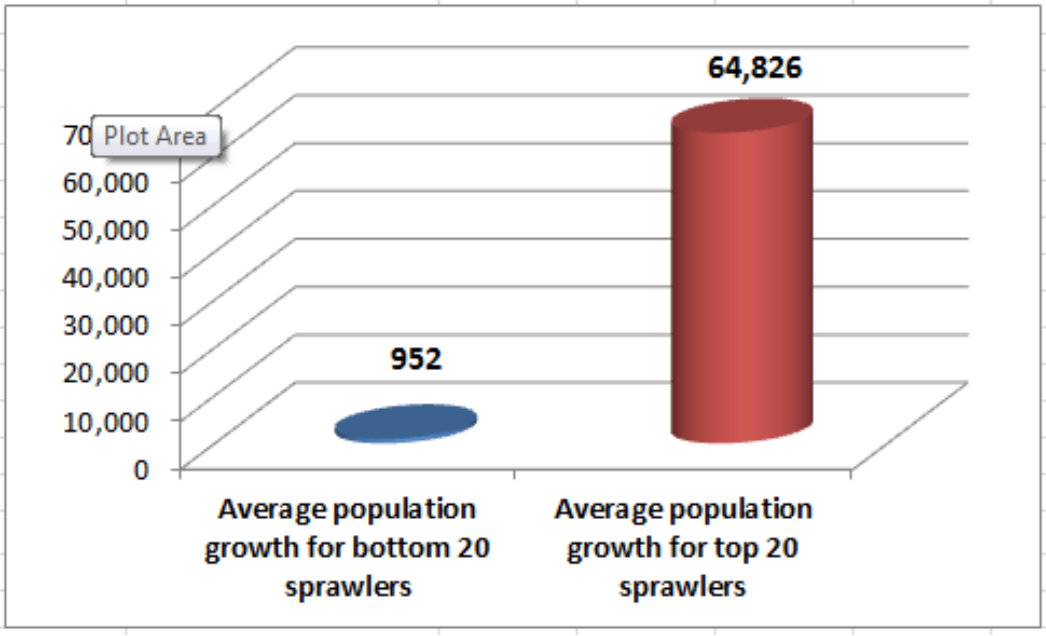


Figure 38. Population Growth in Piedmont Study Area's Highest vs. Lowest Sprawling Counties, 2002-2010

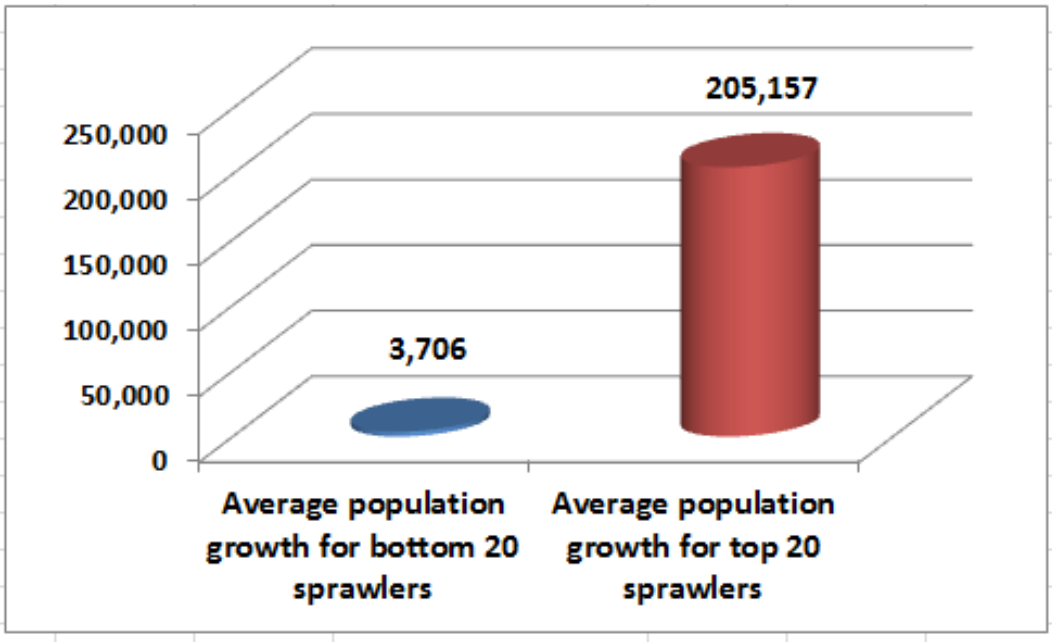


Figure 39. Population Growth in Piedmont Study Area's Highest vs. Lowest Sprawling Counties, 1982-2010

3.1.3 Relative Weight of Sprawl Factors in the Piedmont's Urbanized Areas

To better understand and quantify the respective roles of population growth and per capita land consumption in generating Overall Sprawl, we can use a more mathematically sophisticated method that is sometimes used to apportion consumption of natural resources between two or more factors. John Holdren, Ph.D., former Assistant to the President for Science and Technology and Director of the White House Office of Science and Technology Policy from 2009 to 2017, developed and applied this methodology in a scientific paper evaluating how much of the increase in energy consumption in the United States in recent decades was due to population growth, and how much to increasing per capita energy consumption.[74] This "Holdren method" can be applied to virtually any type of resource in which use of the resource in question is increasing over time, and the number of resource consumers is changing, the amount of the resource being used by each consumer on average is changing, or both.

[74] John P. Holdren. 1991. "Population and the Energy Problem." *Population and Environment*, Vol. 12, No. 3, Spring 1991. Prior to becoming Director of the White House Office of Science and Technology Policy in the Obama Administration in January 2009, Holdren was Teresa and John Heinz Professor of Environmental Policy and Director of the Program on Science, Technology, and Public Policy at Harvard University's Kennedy School of Government, as well as Professor of Environmental Science and Public Policy in the Department of Earth and Planetary Sciences at that university. Trained in aeronautics/ astronautics and plasma physics at MIT and Stanford, he co-founded and for 23 years co-led the campus-wide interdisciplinary graduate degree program in energy and resources at the University of California, Berkeley. On April 12, 2000 he was awarded the Tyler Prize for Environmental Achievement at the University of Southern California, which administers the award. The Tyler Prize is the premier international award honoring achievements in environmental science, energy, and medical discoveries.

This study applies this method to sprawl, as did our national, state and regional studies a decade ago, as well as our more recent studies in 2014 and 2015. Rural, undeveloped land is thus the natural resource in question. As in the case of looking at energy consumption, the issue here is how much of the increased total consumption of rural land (Overall Sprawl) is related to the increase in per capita land consumption (Per Capita Sprawl) and how much is related to the increase in the number of land consumers (Population Growth).

Table 27 applies the Holdren method to all of the Piedmont study area's 25 Urbanized Areas. In the case of Atlanta, for example, 15 percent of its Overall Sprawl from 2000 to 2010 was related to, or explained by, increases in per capita land consumption, and 85 percent was related to its population growth. **Table 27** shows how much of the sprawl in the Piedmont study area's towns and cities is related to population growth and how much is related to growth in per capita land consumption (declining population density). Overall, population growth accounts for 90 percent of the sprawl and growth in per capita land consumption for 10 percent. While there is some variation between the UAs in the three states, they are all in the same approximate ballpark of 85-95% of sprawl attributable to population growth.

Table 27. Sources of Sprawl in Piedmont Study Area Urbanized Areas, 2000-2010

Urbanized Area	Total Sprawl 2000 to 2010 (square miles)	% of Total Sprawl Related to POPULATION	% of Total Sprawl Related to GROWTH IN PER CAPITA LAND CONSUMPTION
Georgia UAs	**839.2**	**86%**	**14%**
Athens-Clarke County, GA	18.8	89%	11%
Atlanta, GA	682.8	85%	15%
Augusta-Richmond County, GA--SC	27.7	100%	0%
Cartersville, GA	12.4	100%	0%
Dalton, GA	26.4	99%	1%
Columbus, GA--AL	10.9	59%	41%
Gainesville, GA	35.9	100%	0%
Macon, GA	17.5	9%	91%
Rome, GA	6.8	28%	72%

Urbanized Area	Total Sprawl 2000 to 2010 (square miles)	% of Total Sprawl Related to POPULATION	% of Total Sprawl Related to GROWTH IN PER CAPITA LAND CONSUMPTION
South Carolina UAs	**272.2**	**85%**	**15%**
Anderson, SC	5.2	99%	1%
Columbia, SC	111.1	78%	22%
Greenville, SC	93.7	81%	19%
Mauldin--Simpsonville, SC	27.7	100%	0%
Rock Hill, SC	34.4	91%	9%
North Carolina UAs	**913.4**	**98%**	**2%**
Asheville, NC	58.1	95%	5%
Burlington, NC	25.7	72%	28%
Charlotte, NC--SC	306.6	93%	7%
Concord, NC	89.0	92%	8%
Durham, NC	25.0	100%	0%
Gastonia, NC--SC	19.8	100%	0%
Greensboro, NC	49.7	49%	51%
Hickory, NC	50.8	57%	43%
High Point, NC	18.9	100%	0%
Raleigh, NC	198.5	100%	0%
Winston-Salem, NC	71.2	100%	0%
Aggregated across all Piedmont Urbanized Areas*	**2,024.8**	**90%**	**10%**
Weighted mean of all Piedmont Urbanized Areas**	**2,024.8**	**84%**	**16%**

Source: U.S. Census Bureau Urbanized Area data for 2000 and 2010

*Aggregated across entire study area (tends to overstate overall role of population growth)
**Weighted mean average (mean of individual UA values but weighted by relative size of contribution of each UA to overall sprawl)

Applying the same methodology the 128 counties in the Piedmont study area, and using the NRI Developed Land datasets and Census Bureau population estimates for 2002 and 2010, the results are quite similar, as shown in **Table 28.**

Table 28. Sources of Sprawl in Piedmont Study Area Counties, 2002-2010

County	Total Sprawl 2002 to 2010 (square miles)	% of Total Sprawl Related to POPULATION	% of Total Sprawl Related to GROWTH IN PER CAPITA LAND CONSUMPTION
Georgia Counties*	**425.2**	**100%**	**0%**
Baldwin	8.9	6%	94%
Banks	8.9	56%	44%
Barrow	6.4	100%	0%
Bartow	6.1	100%	0%
Bibb	4.2	28%	72%
Butts	1.6	100%	0%
Carroll	14.2	100%	0%
Cherokee	32.7	100%	0%
Clarke	3.9	100%	0%
Clayton	7.0	59%	41%
Cobb	13.0	100%	0%
Columbia	8.6	100%	0%
Coweta	20.8	100%	0%
Crawford	1.1	5%	95%

County	Total Sprawl 2002 to 2010 (square miles)	% of Total Sprawl Related to POPULATION	% of Total Sprawl Related to GROWTH IN PER CAPITA LAND CONSUMPTION
Dawson	0.9	100%	0%
DeKalb	10.2	72%	28%
Douglas	14.5	100%	0%
Elbert	0.5	0%	100%
Fayette	5.9	100%	0%
Floyd	2.8	100%	0%
Forsyth	16.9	100%	0%
Franklin	2.7	49%	51%
Fulton	28.9	100%	0%
Greene	1.4	87%	13%
Gwinnett	34.8	100	0%
Habersham	9.7	65	35%
Hall	11.7	100	0%
Hancock	0.5	0	100%
Haralson	3.0	94	6%
Harris	3.0	100	0%
Hart	3.4	71	29%
Heard	-0.5	0	100%
Henry	26.9	100	0%
Jasper	1.4	100	0%
Jones	0.8	100	0%

County	Total Sprawl 2002 to 2010 (square miles)	% of Total Sprawl Related to POPULATION	% of Total Sprawl Related to GROWTH IN PER CAPITA LAND CONSUMPTION
Lamar	0.9	100	0%
Lincoln	0.0	N/A	N/A
Lumpkin	3.3	100	0%
Madison	1.3	100	0%
McDuffie	1.3	79	21%
Meriwether	7.3	0	100%
Monroe	1.1	100%	0%
Morgan	0.9	100%	0%
Muskogee	1.1	100%	0%
Newton	12.5	100%	0%
Oconee	2.0	100%	0%
Oglethorpe	0.5	100%	0%
Paulding	6.7	100%	0%
Pickens	2.5	100%	0%
Pike	3.6	100%	0%
Polk	2.7	76%	24%
Putnam	1.7	100%	0%
Rockdale	8.3	100%	0%
Spalding	15.9	44%	56%
Stephens	4.1	18%	82%
Talbot	0.2	100%	0%

County	Total Sprawl 2002 to 2010 (square miles)	% of Total Sprawl Related to POPULATION	% of Total Sprawl Related to GROWTH IN PER CAPITA LAND CONSUMPTION
Taliaferro	0.0	N/A	N/A
Troup	7.5	100%	0%
Upson	3.3	0	100%
Walton	15.9	100	0%
Warren	0.5	0	100%
White	3.1	95	5%
Wilkes	0.3	0%	100%
Weighted mean across all Georgia counties in Piedmont study area**	**425.2**	**87%**	**13%**
South Carolina Counties*	**195.0**	**100%**	**0%**
Abbeville	1.6	0%	100%
Aiken	21.6	85%	15%
Anderson	19.1	100%	0%
Cherokee	4.7	48%	52%
Chester	0.8	0%	100%
Chesterfield	7.3	52%	48%
Edgefield	3.3	49%	51%
Fairfield	-0.3	0%	100%
Greenville	16.4	100%	0%
Greenwood	3.0	89%	11%

County	Total Sprawl 2002 to 2010 (square miles)	% of Total Sprawl Related to POPULATION	% of Total Sprawl Related to GROWTH IN PER CAPITA LAND CONSUMPTION
Kershaw	11.1	100%	0%
Lancaster	5.3	100%	0%
Laurens	-0.5	100%	0%
Lexington	17.3	100%	0%
McCormick	0.2	100%	0%
Newberry	3.0	60	40%
Oconee	8.0	100	0%
Pickens	4.4	100	0%
Richland	17.7	100	0%
Saluda	3.3	19	81%
Spartanburg	25.5	93	7%
Union	1.4	0	100%
York	21.1	100	0%
Weighted mean across all South Carolina counties in Piedmont study area**	**195.0**	**90%**	**10%**
North Carolina Counties*	**307.5**	**100%**	**0%**
Alamance	5.5	100%	0%
Alexander	4.4	67%	33%
Anson	3.1	48%	52%
Burke	4.7	36%	64%

County	Total Sprawl 2002 to 2010 (square miles)	% of Total Sprawl Related to POPULATION	% of Total Sprawl Related to GROWTH IN PER CAPITA LAND CONSUMPTION
Cabarrus	10.5	100%	0%
Caldwell	3.1	100%	0%
Caswell	1.6	0%	100%
Catawba	4.5	100%	0%
Chatham	6.3	14%	86%
Cleveland	4.8	100%	0%
Davidson	7.3	98%	2%
Davie	4.4	100%	0%
Durham	5.0	100%	0%
Forsyth	7.8	100%	0%
Franklin	5.2	100%	0%
Gaston	9.1	100%	0%
Granville	5.0	100%	0%
Guilford	19.8	100%	0%
Iredell	16.1	100%	0%
Lee	7.5	100%	0%
Lincoln	10.0	21	79%
McDowell	13.8	100	0%
Mecklenburg	27.5	68	32%
Montgomery	1.4	100	0%
Moore	6.3	100	0%

County	Total Sprawl 2002 to 2010 (square miles)	% of Total Sprawl Related to POPULATION	% of Total Sprawl Related to GROWTH IN PER CAPITA LAND CONSUMPTION
Orange	3.1	100	0%
Orange	3.1	100%	0%
Person	3.9	60%	40%
Polk	2.5	100%	0%
Randolph	15.9	48%	52%
Richmond	3.6	0%	100%
Rockingham	4.2	17%	83%
Rowan	9.4	57%	43%
Rutherford	2.3	100%	0%
Stanly	1.4	100%	0%
Stokes	2.2	100%	0%
Surry	4.1	35%	65%
Union	6.7	100%	0%
Vance	4.1	33	67%
Wake	39.4	100	0%
Warren	1.1	100	0%
Wilkes	3.9	59	41%
Yadkin	5.2	22	78%
Weighted mean across all North Carolina counties in Piedmont study area**	**307.5**	**82%**	**18%**

County	Total Sprawl 2002 to 2010 (square miles)	% of Total Sprawl Related to POPULATION	% of Total Sprawl Related to GROWTH IN PER CAPITA LAND CONSUMPTION
Aggregated Piedmont Sprawl Study Area*	**927.7**	**100%**	**0%**
Weighted mean across entire Piedmont study area**	**927.7**	**86%**	**14%**

Source: NRI county-level Developed Land data and U.S. Census Bureau county population estimates data for 2002 and 2010

*Aggregated across entire study area (tends to overstate overall role of population growth)
**Weighted mean average (mean of individual UA values but weighted by relative size of contribution of each UA to overall sprawl in state or entire study area)

The findings shown in **Table 27** using the Census Bureau's Urbanized Area data from 2000 to 2010 and **Table 28** using the NRCS's Developed Land data for 2002 to 2010 are remarkably close. Eight-seven percent (using the weighted mean measure) of Overall Sprawl is due to population growth in the former, while 86 percent is related to population growth in the latter.

As has been stated earlier, the share of sprawl related to population growth both in the Piedmont region and nationally has increased in recent years along with the increasing population density of newer residential development in urban areas. Overall, the average amount of developed land used per capita has stabilized or even begun to decrease slightly, rather than increasing as it did when sprawl began devouring open countryside in earnest the first few decades after World War II. Most anti-sprawl activists and Americans in general still labor under the misconception that "low-density development" is the leading cause of contemporary, 21st century sprawl, but this study, and the others in our series, have thoroughly debunked this myth and shown it to be outdated. Only if sprawl is purposely and narrowly defined as "low-density development" can anti-sprawl activists claim that population growth is not responsible for sprawl, but in this way they define away most of the development that is actually responsible for the ongoing loss of thousands of square miles of open space, farmland, and natural habitat in the United States.

Looking at the entire 1982-2010 study period for the 128 counties in our Piedmont sprawl study area, in keeping with the point of the previous paragraph, population growth accounted for 77 percent of the sprawl in the Piedmont counties during this longer time period, a lower share than in the most recent 2002-2010 time frame, wherein population growth accounted for something in the range of 86-100% of sprawl, depending on the specific measure used.

Using the more conservative "weighted mean" of counties, population growth was related to 68 percent of the sprawl from 1982 to 2010 in the Piedmont counties studied. More than two-thirds of the sprawl in the three-state Piedmont region was thus due to population growth in the last two decades of the 20th century and first decade of the 21st century.

Given this apportionment or breakdown, opponents of sprawl in the Piedmont region of Georgia, South Carolina, and North Carolina should know that most of the challenge they face is the rapid growth of population in the Piedmont. In contrast, a very small part of the problem has been the inability to stabilize or raise per capita land use within developed and urban areas in these states. Overall, using the more conservative measure of population's role in sprawl, in the 25 Urbanized Areas in the three-state Piedmont study area, 84 percent of the sprawl from 2000 to 2010 was related to population growth and 16 percent to increasing per capita land consumption (declining population density). **Figure 40** displays the relative magnitude of these factors on a pie chart.

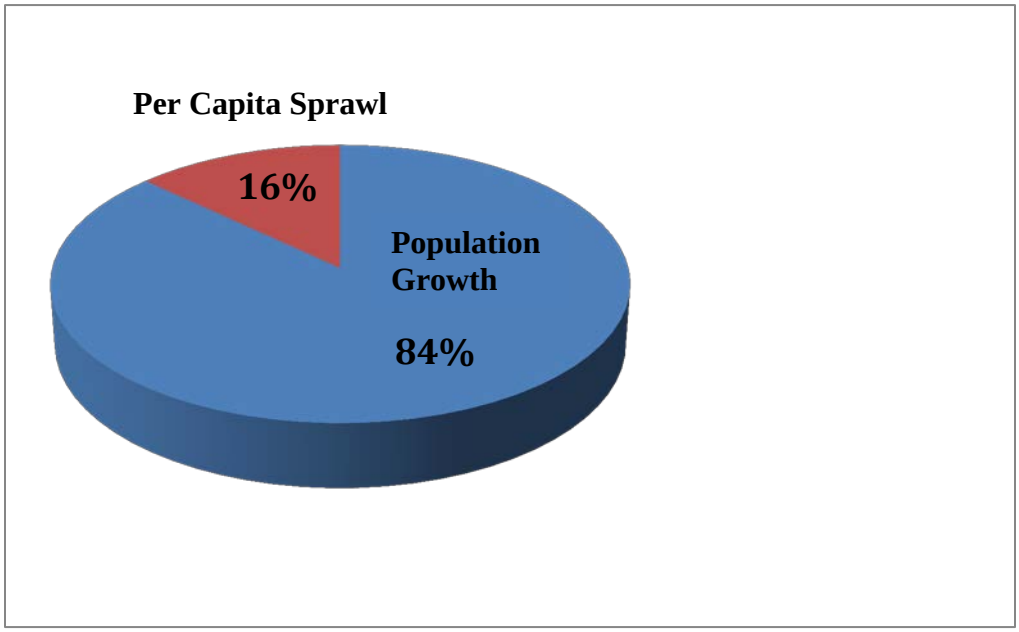


Figure 40. Percentages of Sprawl Related to Population Growth and Per Capita Sprawl in Piedmont's 25 Urbanized Areas, 2000-2010

Source: U.S. Census Bureau Urbanized Areas, 2000 and 2010

Description: Approximately 16 percent of the sprawl in the Piedmont study area's town and cities was related to increasing per capita land consumption. Approximately 84 percent of the sprawl was related to population growth.

Figure 41 and **Figure 42** are also pie charts showing our study's findings on the role of population growth in driving sprawl in the 128 counties of the Piedmont sprawl study area.

Figure 41 concerns the more recent 2002-2010 time period, while **Figure 42** covers the entire 1982 to 2010 time frame. Again, using even the more conservative measures of the share of sprawl due to population growth, for the 2002-2010 time period it is 86 percent and for the entire 1982 to 2010 time period it is 68 percent.

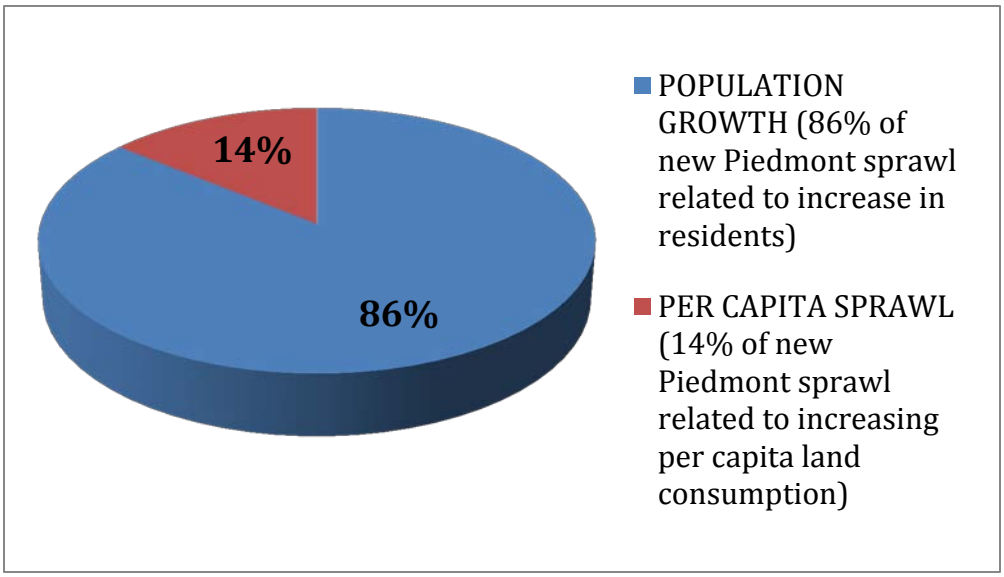


Figure 41. Percentages of Sprawl Related to Population Growth and Per Capita Sprawl in Piedmont Study Area's 128 Counties, 2002-2010

Source: NRI county-level Developed Land data and U.S. Census Bureau county population estimates data for 2002 and 2010

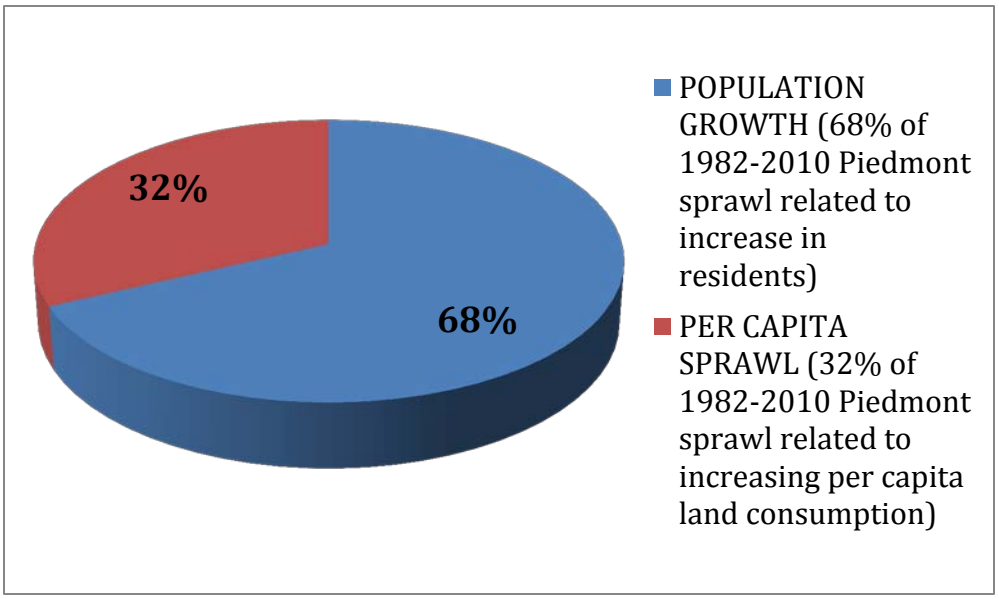


Figure 42. Percentages of Sprawl Related to Population Growth and Per Capita Sprawl in Piedmont Study Area's 128 Counties, 1982-2010

Source: NRI county-level Developed Land data and U.S. Census Bureau county population estimates data for1982 and 2010

3.1.4 The Piedmont's Urbanized Areas Versus Its Developed Areas

Recall that the Census Bureau's Urbanized Areas and the Natural Resources Conservation Service's Developed Areas in the National Resources Inventory (NRI) are measured in two totally different manners, with different methodologies for collecting data on urban areas versus rural areas, and two completely distinct ways of defining the two land uses. Thus, quantifying sprawl using these two very different databases would not be expected to generate identical results, and indeed, our calculations do not. However, they produce quite similar results, which is a sign of the robustness of our findings and an indication of their probable veracity.

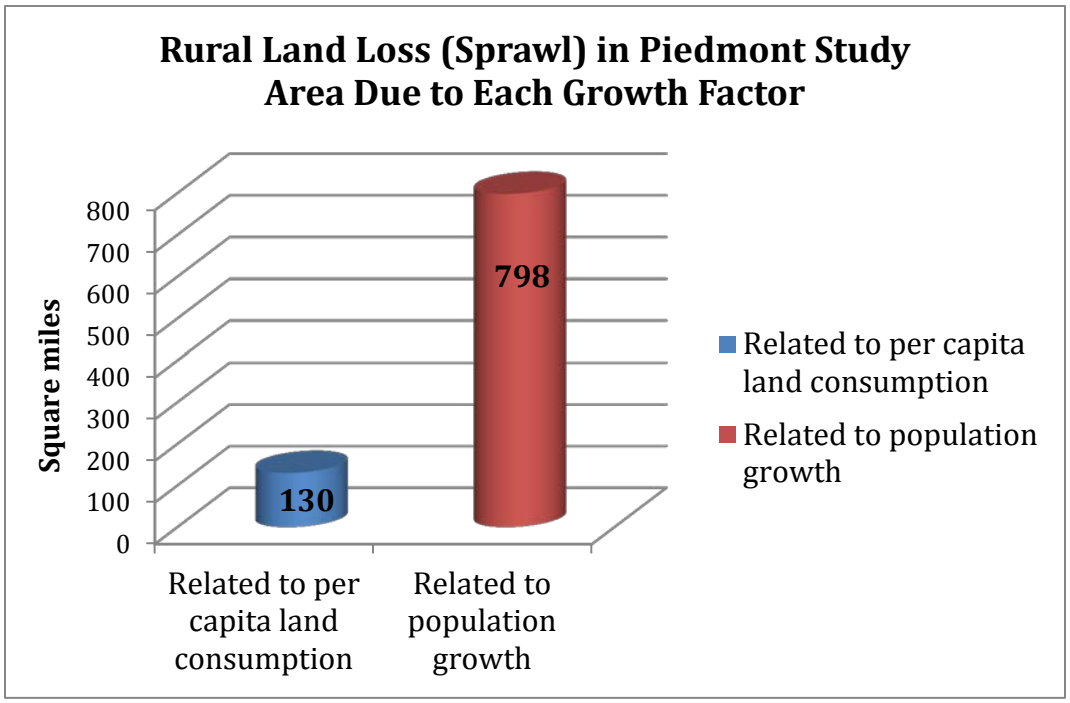


Figure 43. Rural land lost to per capita sprawl vs. population growth in Piedmont Study Area's 128 Counties, 2002-2010

Source: NRI Developed Land data and Census Bureau population estimates for 2002 and 2010

Between 2002 and 2010, the Piedmont study area's 128 counties sprawled across and consumed 928 additional square miles of land in aggregate. **Figure 43** indicates that population growth is responsible for more than six times as much loss of rural land as Per Capita Sprawl or rising land consumption per capita: 798 square miles vs. 130 square miles.

From 2000 to 2010, a slightly different time frame than the NRI's most recent time period (2002 to 2010), the analysis of Census Bureau Urbanized Land data for the 25 UAs in the Piedmont study area shows that population growth accounted for 87 percent of the sprawl in these UAs, that is, for 87% (or 1,700 square miles) of the 1,954 square miles of rural land

converted to urbanized land. Per Capita Sprawl accounted for 13 percent of the sprawl, or 254 square miles.

If the Census Bureau Urbanized Areas data were exaggerating the contribution of population growth to sprawl, applying the Holdren method to the National Resources Conservation Service's National Resources Inventory results would likely give us a significantly lower figure, but our findings do not indicate this.

Unlike the Census Bureau data, the NRCS survey picks up small clusters of development such as weekend cottages, second homes, and related facilities and infrastructure that are built by city residents far enough into the country that they don't get included in the data on expanding Urbanized Areas (because they don't have permanent residential populations). The NRI includes them in the "Small Built-up Areas" category. The NRI survey also captures all the rural land that succumbs to the development of recreational areas, resorts, roads, manufacturing, parking areas, and sprawling smallish towns under 2,500 residents.

3.2 Piedmont Sprawl Study Area Compared to Sprawl in U.S.

It is interesting to compare the relative amounts and causes of sprawl in the Piedmont study area to the country as a whole using the NRI data on Developed Land. Here we do so for two time periods: 1982 to 2010 and 2002-2010. The first covers the nearly entire three-decade period of NRCS NRI land use data, while the second concentrates on the most recent eight-year period.

3.2.1 Developed Land in the U.S. from 1982 to 2010

Figure 44 shows that over the entire 28-year period between 1982 and 2010, greater than six out of every ten acres developed (63%) in the U.S. was associated with population growth and four out of every ten acres developed (37%) was associated with growing per capita land consumption or Per Capita Sprawl.

This compares to 68 percent of the sprawl in the Piedmont study area being associated with population growth, and 32 percent being associated with Per Capita Sprawl during that same 1982-2010 time period.

Thus, the relative importance of the two main sprawl factors in the Piedmont study area are quite close to the relative importance of those same factors at the national level. If anything, the role of population as a causal agent in driving sprawl is slightly greater in the Piedmont than in the country as a whole.

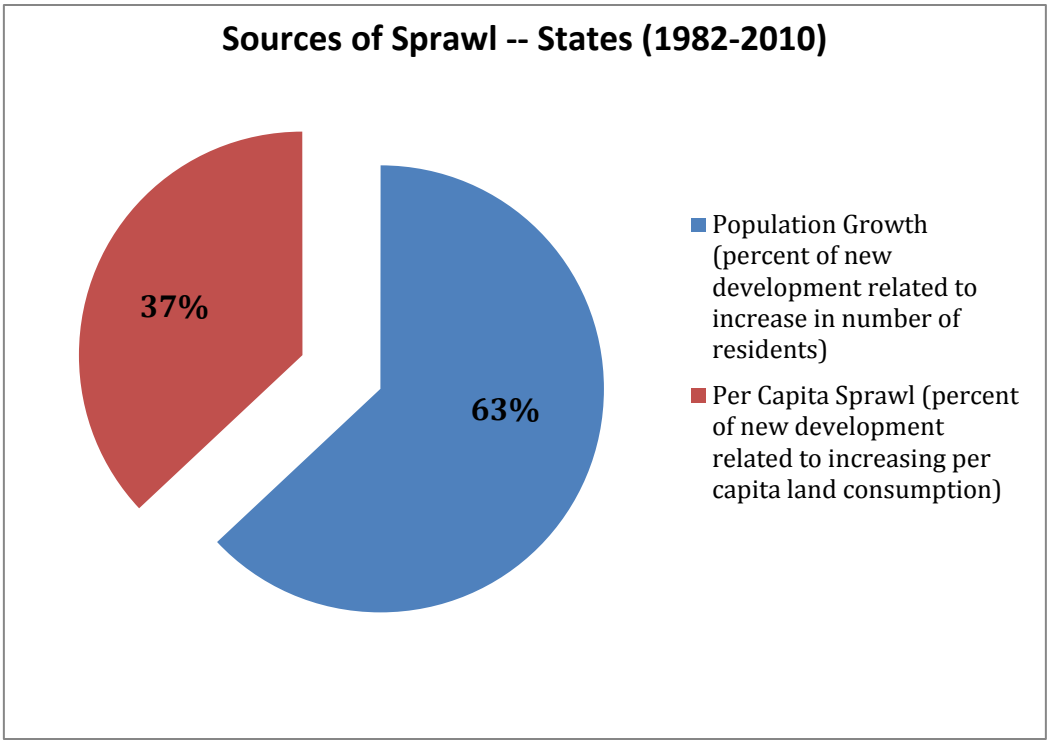


Figure 44. Sources of Sprawl in 48 Contiguous States, 1982-2010
Source: National Resources Inventory 1982-2010

3.2.2 Developed Land in the U.S. from 2002 to 2010

If we examine national-level data for the most recent eight-year period, from 2002-2010, the role of the Population Growth factor is higher than the average for the entire 28-year period, as was the case as well in the Piedmont study area. Whereas the 28-year average was 63 percent from 1982 to 2007, Population Growth accounted for 91 percent of the conversion from rural land to developed land from 2002 to 2010, or 80 percent using the more conservative measure (weighted average), as seen in **Figure 45**.

Thus, it is evident that both nationally, and in the case of the Piedmont in particular, the relative importance of population growth in driving urban sprawl and land development has trended upward over time, to the extent that in the first decade of the 21st century, population growth now accounts for between eight and nine out of every ten acres of land developed or urbanized in the United States as well as in the Piedmont. The Census Bureau Urbanized Area data sets and the NRCS National Resources Inventory Developed Land data sets corroborate one another in confirming this broad temporal trend.

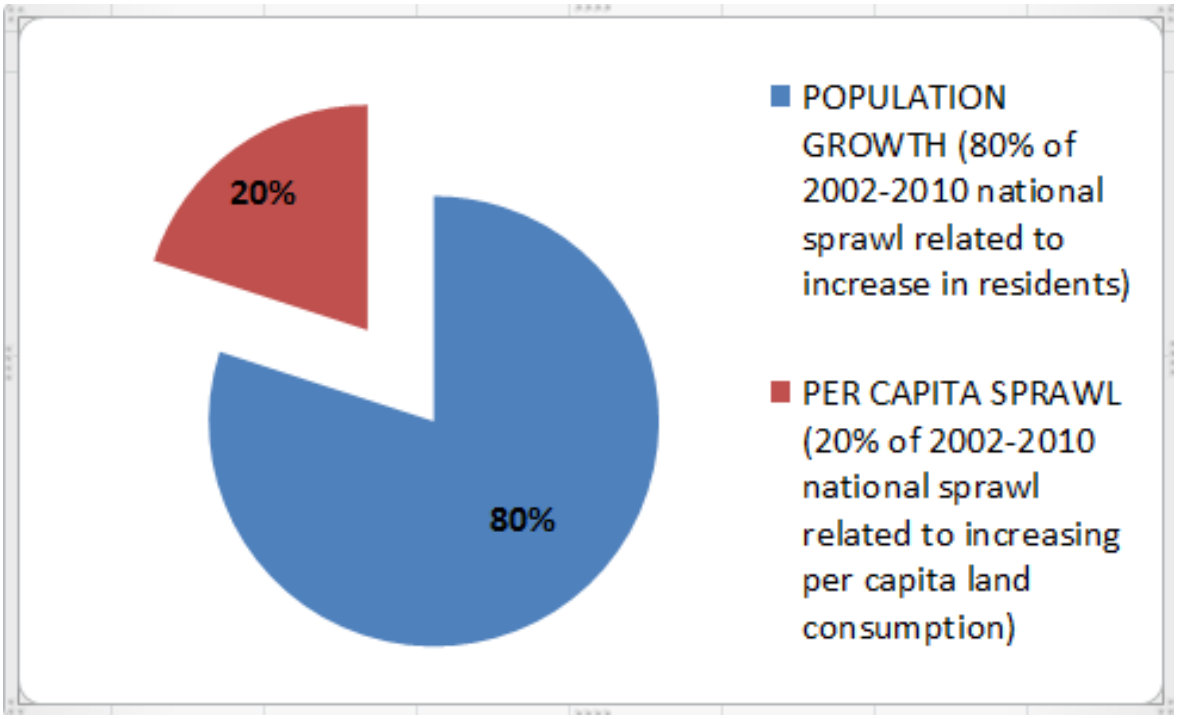


Figure 45. Sources of Recent Sprawl in the 48 Contiguous States, 2002-2010
Description: The NRI calculates the conversion of rural land to developed land in 49 states and U.S. territories. Included in this figure are the 48 coterminous states. These data indicate that from 2002 to 2010 approximately two-tenths of the loss of rural land nationwide was related to an increase in developed land per person, and about eight-tenths of the loss was related to population growth.

3.2.3 Scatter Plots of Population Growth and Sprawl

Another useful way to examine the relationships between the factors in sprawl is by using scatter plot analysis. **Figure 46** is a scatter plot that examines the relationship between each county's percentage population growth on the x-axis (horizontal axis) and the percentage increase in the area of developed land (i.e., sprawl) on the y-axis (vertical axis). The scatter plot has a "best fit" line that shows the linear relationship between the data points.
The left-to-right, upward-trending, positively sloped "best fit" line for **Figure 46** indicates that there is a positive relationship between population increase and Overall Sprawl, i.e., sprawl is a function of population growth. On average, counties with more population growth were also counties where more land is being developed. These results are not surprising, but if sprawl and population growth were not related, as some have always contended, the trend line would be flat or negative. While this scatter plot alone does not prove that population growth always causes sprawl, or that sprawl can only happen when there is population growth, it does strongly suggest and reinforce the hypothesis that the two are closely correlated.

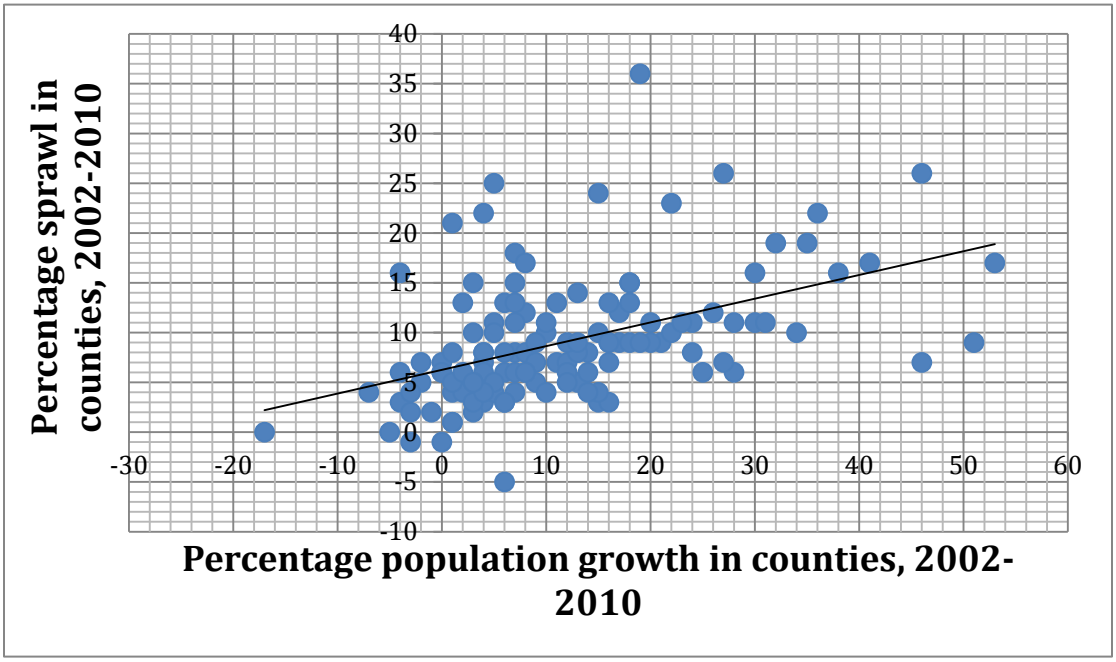


Figure 46. Scatter Plot of Population Growth vs. Sprawl in 128 Piedmont Counties, 2002-2010

Sources: Census Bureau and National Resources Inventory

The reason the slope of the line is not even steeper is that population density increases with population, that is, per capita land consumption decreases with higher population growth. In other words, they are inversely correlated, as shown by the negative slop in **Figure 47.**

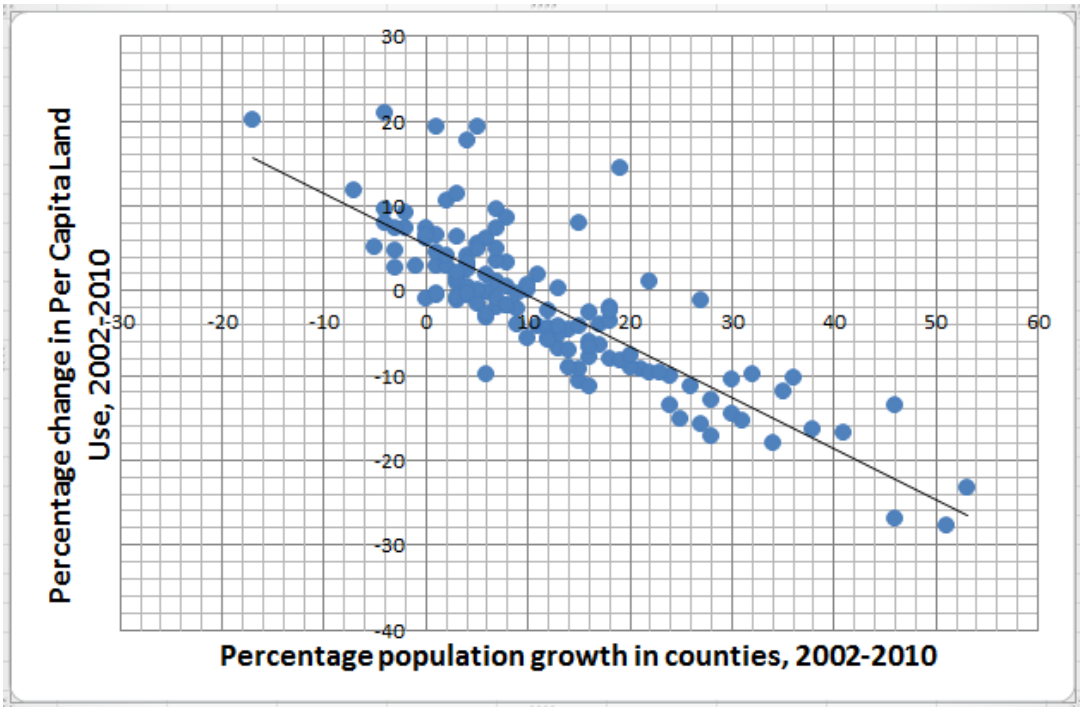


Figure 47. Population Growth vs. Per Capita Sprawl in 128 Counties, 2002-2010

On average, the faster population grows in a given Piedmont county, the more per capita land consumption shrinks. This higher average population density at least reduces the amount of rural landscape devoured by sprawl, but it means that population growth is responsible for virtually all of the sprawl that does result in the end. Given the rapid population growth the Piedmont has experienced in recent decades, and its pronounced effect on development and sprawl – to say nothing of business-as-usual growth projections for decades to come – this rising density is clearly beneficial, because it has prevented even more countryside-consuming sprawl from happening. Another way of looking at it though, is that even rising density, at least to the extent to which it has occurred to date, has not been enough to stop sprawl in its tracks.

Nonetheless, Piedmont residents are ambivalent, at best, about combating land-devouring sprawl by simply restricting development or by regulations and zoning that foster higher population density, as indicated by the responses to Questions #14 and #15 in the 2015 Pulse public opinion survey conducted for this study:

> 14. Should local and state governments in the Piedmont make it more difficult for people to move to the region by restricting development?
>
> 30% Yes
> 52% No
> 18% Not sure
>
> 15. Should governments protect farmland and natural habitats with regulations that push a growing population to live in higher-density houses and apartment and condo buildings which take up less space?
>
> 42% Yes
> 34% No
> 25% Not sure

Figure 48 is a similar scatter plot with the percentage population growth from 2000 to 2010 in each of the 24 Piedmont Urbanized Area on the x-axis and the percentage increase in the area of urbanized land (i.e., Overall Sprawl) for each of those UAs on the y-axis. Once again, there is a clear correlation between population growth and sprawl, as evidenced by the left-to-right upward (positive) slope of the "best fit" line. On the whole, sprawl clearly results from population growth under current urban growth patterns, policies, and politics. Yet to emphasize once more, this graphic does not prove that the sole cause of sprawl is population growth, or that whenever there is population growth there will always be sprawl. But **Figure 48** does demonstrate that population growth is a strong driver of sprawl.

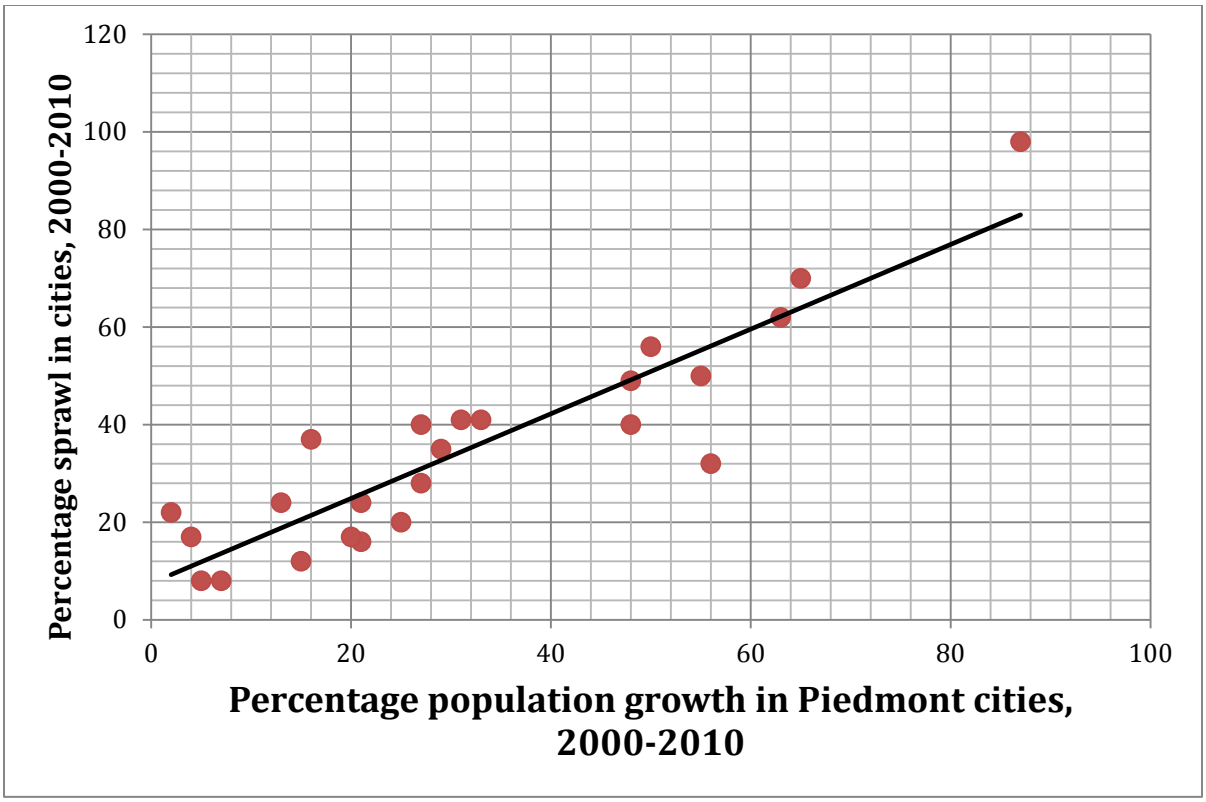


Figure 48. Scatter Plot and "Best Fit" Line of Population Growth vs. Sprawl in 25 Piedmont Urbanized Areas, 2000-2010

3.3 Trends

3.3.1 Comparison of the Southern Piedmont to the Nation

From 2000 to 2010 the most significant factor contributing to Overall Sprawl in the United States was the addition of more than 17 million new residents to our nation's Urbanized Areas, and the additional nine million residents who settled elsewhere. Per Capita Sprawl was halted in 192 of our cities, and was responsible for less than 30% of Overall Sprawl in Urbanized Areas during the same period of study.

Likewise, in the Piedmont study area, the addition of 2.7 million new residents to Urbanized Areas between 2000 and 2010 was responsible for almost all sprawl in the region, more than 1,950 square miles in this decade alone.

At the national level, NRCS data on sprawl in the contiguous 48 states from 2002-2010 were also consistent with our findings for the cities and counties in the Piedmont. From 2002-2010 population growth was the most important factor in the loss of non-federal rural land, accounting for 91 percent of new development. The ten states experiencing the most sprawl by percentage (Nevada, Utah, Arizona, Delaware, Texas, Florida, Arkansas, Oklahoma, Mississippi, and Georgia) had populations that grew on average more than three times as fast

as the ten least sprawling states by percentage (Massachusetts, Minnesota, Rhode Island, New York, Kansas, Connecticut, New Jersey, Nebraska, South Dakota and North Dakota) (**Figure 49**).

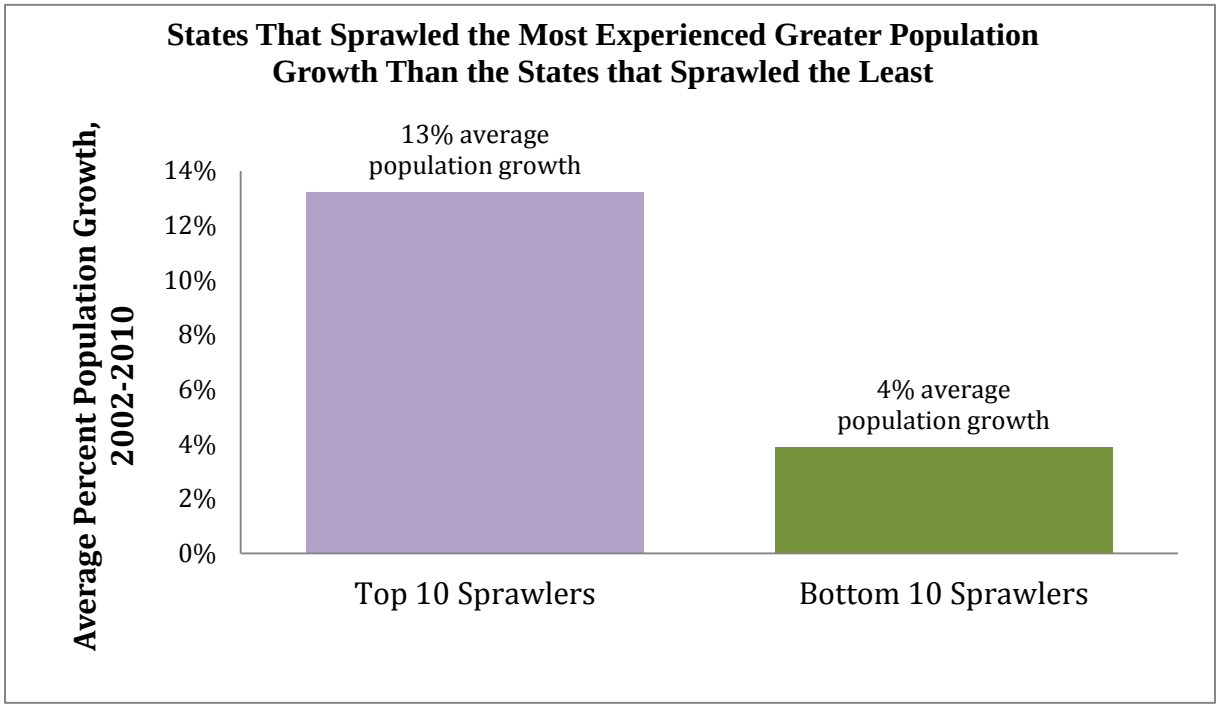


Figure 49. Comparison of Population Growth Between High and Low Sprawling States

Description: The populations of ten states experiencing the most sprawl by percentage (Nevada, Utah, Arizona, Delaware, Texas, Florida, Arkansas, Oklahoma, Mississippi, and **Georgia**), grew on average more than three times faster than the ten least sprawling states (Massachusetts, Minnesota, Rhode Island, New York, Kansas, Connecticut, New Jersey, Nebraska, South Dakota and North Dakota)

Figure 50 looks at the same data and the same 2002-2010 time period from a different angle.

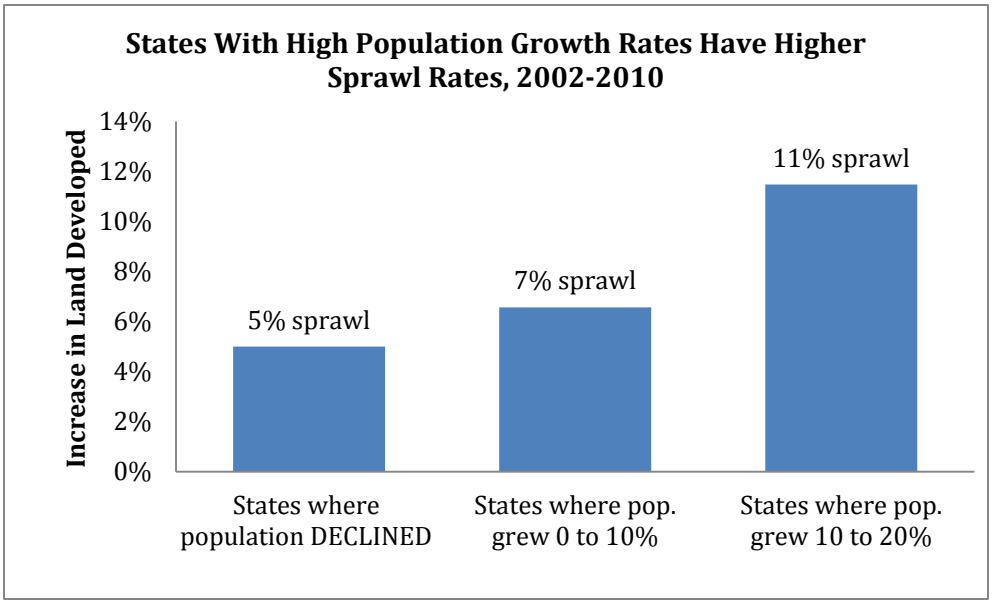


Figure 50. Comparison of Sprawl in Slow-growing vs. Fast-growing States

Table 29 ranks the states according to their sprawl rate from 2002 to 2010, from highest to lowest, by percentage. **Table 29** also includes the entire 28-year, 1982-2010 period, so that for each state, the percent sprawl and ranking are provided for the entire extended period of study. Georgia, South Carolina, and North Carolina all ranked in the top third of all states.

Table 29. Sprawl in 48 States, Ranked by Percentage

Ranking (by percentage) 2002-2010	Total Sprawl (percentage), 2002-2010 Recent	State	Total Sprawl (percentage), 1982-2010 Overall	Total Sprawl Ranking by Percentage, 1982-2010
1	18.7%	Nevada	134.3%	1
2	17.6%	Utah	90.8%	7
3	17.4%	Arizona	114.0%	2
4	15.6%	Delaware	81.8%	12
5	13.0%	Texas	69.1%	17
6	11.1%	Florida	94.9%	6
7	10.7%	Arkansas	50.7%	28
8	10.2%	Oklahoma	44.4%	32

Ranking (by percentage) 2002-2010	Total Sprawl (percentage), 2002-2010 Recent	State	Total Sprawl (percentage), 1982-2010 Overall	Total Sprawl Ranking by Percentage, 1982-2010
9	10.2%	Mississippi	61.7%	18
10	**9.8%**	**.Georgia**	**106.8%**	**3**
11	9.8%	Tennessee	87.8%	8
12	9.6%	Idaho	61.2%	19
13	9.4%	Alabama	77.0%	14
14	**9.3%**	**.South Carolina**	**95.2%**	**5**
15	9.3%	Virginia	71.1%	15
16	**8.5%**	**.North Carolina**	**102.2%**	**4**
17	8.4%	Maine	69.9%	16
18	8.4%	Louisiana	51.5%	27
19	8.2%	New Hampshire	80.5%	13
20	8.0%	Wyoming	29.2%	41
21	7.7%	Kentucky	85.3%	9
22	7.6%	Wisconsin	38.5%	36
23	7.6%	Indiana	40.6%	34
24	7.5%	New Mexico	84.4%	10
25	7.4%	Missouri	38.4%	37
26	7.3%	Washington	57.1%	23
27	7.3%	Montana	27.9%	42
28	7.3%	West Virginia	82.1%	11
29	7.2%	California	52.0%	26
30	7.2%	Colorado	59.1%	20
31	6.8%	Maryland	54.4%	25

Ranking (by percentage) 2002-2010	Total Sprawl (percentage), 2002-2010 Recent	State	Total Sprawl (percentage), 1982-2010 Overall	Total Sprawl Ranking by Percentage, 1982-2010
32	6.2%	Vermont	49.4%	29
33	6.2%	Ohio	45.4%	31
34	6.2%	Oregon	44.0%	33
35	5.6%	Illinois	29.9%	40
36	5.2%	Pennsylvania	58.5%	21
37	5.2%	Iowa	18.1%	46
38	5.1%	Michigan	48.3%	30
39	5.1%	Massachusetts	57.6%	22
40	4.9%	Minnesota	40.2%	35
41	4.9%	Rhode Island	34.0%	39
42	4.3%	New York	35.1%	38
43	4.3%	Kansas	22.3%	44
44	3.9%	Connecticut	27.8%	43
45	3.8%	New Jersey	56.4%	24
46	3.8%	Nebraska	14.1%	47
47	2.6%	South Dakota	18.4%	45
48	1.3%	North Dakota	8.4%	48

Sources: NRCS National Resources Inventory; U.S. Census Bureau

Table 30 arranges the states according to the amount they sprawled from 2002 to 20010, from highest to lowest, in terms of total or overall area, not percentage. **Table 30** also includes the entire 28-year, 1982-2010 period, so that for each state, the amount of sprawl and ranking are provided for the entire extended period of study. By this measure of sprawl, Georgia is in fourth place both for the more recent 2002-2010 time period, as well as the overall 1982-2010 time period. North Carolina (5th place) is right behind Georgia in the most

period and in 3rd place for the entire 1982-2010 time period. South Carolina is in 11th place in both the 2002-2010 and 1982-2010 time periods.

Table 30. Sprawl in 48 States, Ranked by Area of Rural Land Lost

Ranking (by area) 2002-2010	Total Sprawl (square miles), 2002-2010 Recent	State	Total Sprawl (square miles), 1982-2010 Overall	Total Sprawl Ranking by Area, 1982-2010
1	1,572	Texas	5,591	1
2	853	Florida	4,168	2
3	656	California	3,323	5
4	**646**	**Georgia**	**3,735**	**4**
5	**581**	**North Carolina**	**3,771**	**3**
6	490	Arizona	1,763	13
7	434	Tennessee	2,274	7
8	413	Virginia	2,027	10
9	386	Alabama	1,964	12
10	381	Ohio	2,033	9
11	**354**	**South Carolina**	**2,020**	**11**
12	341	Pennsylvania	2,529	6
13	325	Missouri	1,302	17
14	321	Michigan	2,153	8
15	311	Oklahoma	1,034	25
16	304	Wisconsin	1,196	19
17	283	Illinois	1,228	18
18	278	Arkansas	967	28
19	275	Indiana	1,134	20
20	271	Washington	1,439	16

Ranking (by area) 2002-2010	Total Sprawl (square miles), 2002-2010 Recent	State	Total Sprawl (square miles), 1982-2010 Overall	Total Sprawl Ranking by Area, 1982-2010
21	265	Mississippi	1,097	21
22	248	New York	1,555	14
23	236	Kentucky	1,515	15
24	229	Louisiana	1,008	26
25	203	Utah	646	33
26	198	Colorado	1,093	22
27	177	Minnesota	1,079	23
28	150	Maryland	830	30
29	148	Iowa	462	39
30	143	New Mexico	941	29
31	137	Nevada	497	38
32	136	Kansas	604	34
33	132	Massachusetts	1,001	27
34	128	Oregon	673	32
35	124	Idaho	537	36
36	122	West Virginia	813	31
37	113	Montana	361	41
38	106	New Jersey	1,038	24
39	104	Maine	551	35
40	86	New Hampshire	507	37
41	80	Wyoming	245	42
43	63	Connecticut	366	40
44	61	Delaware	203	46

Ranking (by area) 2002-2010	Total Sprawl (square miles), 2002-2010 Recent	State	Total Sprawl (square miles), 1982-2010 Overall	Total Sprawl Ranking by Area, 1982-2010
45	38	South Dakota	233	43
46	36	Vermont	204	45
47	19	North Dakota	119	47
48	17	Rhode Island	91	48

Sources: NRCS National Resources Inventory, Census Bureau

Overall, at a national level, two main temporal trends are evident in both the Census Bureau's UA data set and the NRI's Developed Land data set. The first trend, supported primarily by the NRI data, is that Overall Sprawl may have peaked in the late 1990s but continued into the late 2000s at a very high rate that still exceeded that experienced in the 1980s and early 1990s. The second temporal trend is that the role of the population growth factor has increased markedly over time, from approximately half (50%) in the 1970-1990 period to roughly 70% to 90% or more in the 2000s. The Census Bureau and NRCS data, obtained in such different manners, are remarkably consistent in this regard.

3.3.2 What the Future Holds for the Piedmont if Sprawl Patterns Continue

In a nutshell, if demographic trends and sprawl patterns continue for several more decades, this once largely rural area will be converted into a Southern Piedmont Megalopolis. Concrete, steel, and asphalt will replace fields and forests on an enormous scale. The region will be transmogrified.

Figures 51 to 54 on the following pages show what is in store for the Southern Piedmont if national, state, regional, and local policy-makers maintain business-as-usual approaches to population growth and development. Figure 51 shows the extent of urban development within our Piedmont study area in 1990. In the 10 years between 1982 and 1992, the 128 countries in the tristate Southern Piedmont region added 1.8 million in population, and lost 1,146,700 acres of open space to urban sprawl.

In the 18 years from 1992 to 2010, growth and development accelerated in the Southern Piedmont. The population in the 128 counties of our study area grew by 4.84 million, and nearly 2.5 million acres of open space were permanently lost to urban and suburban sprawl.

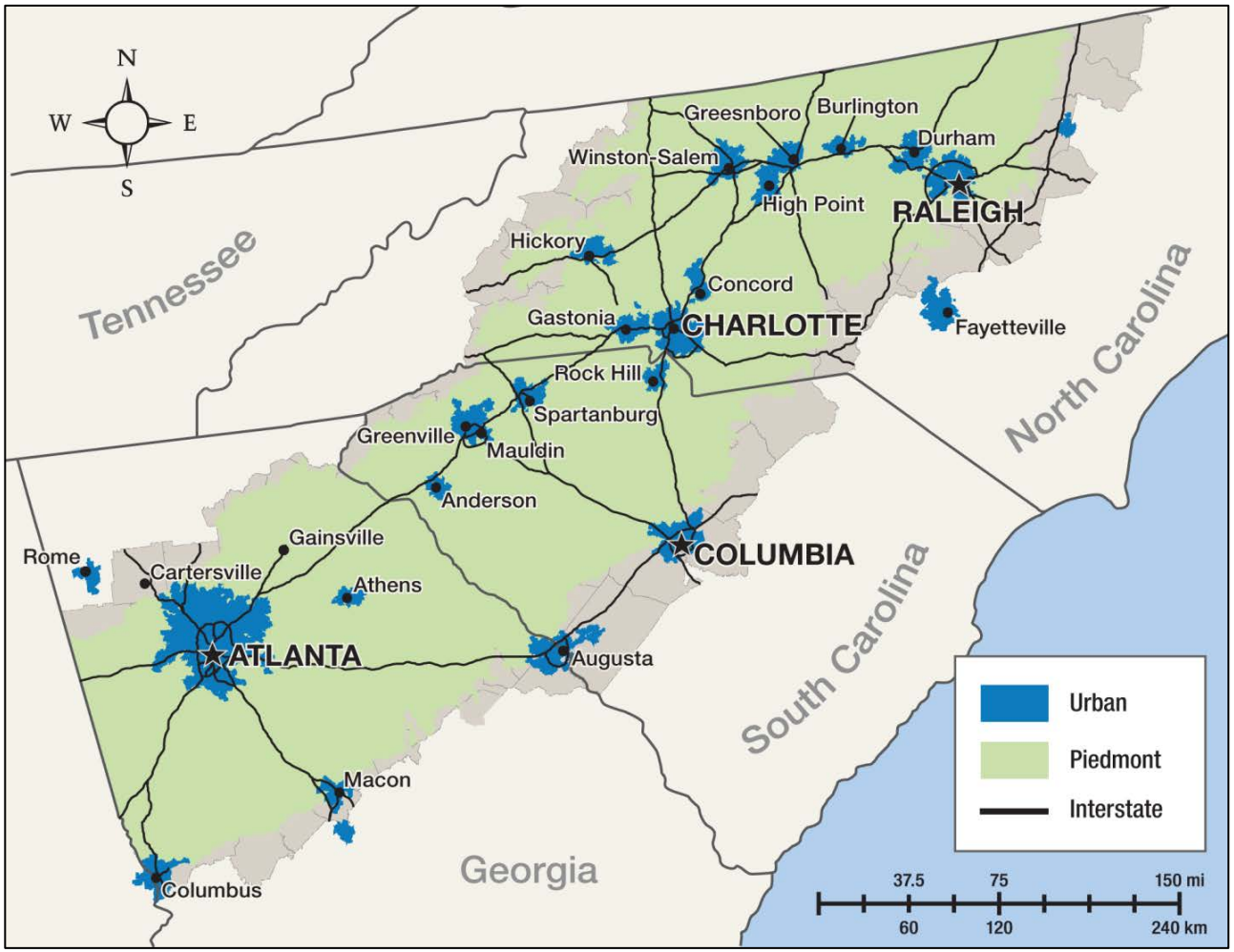


Figure 51. Urban Development in the Southern Piedmont Study Area in 1990

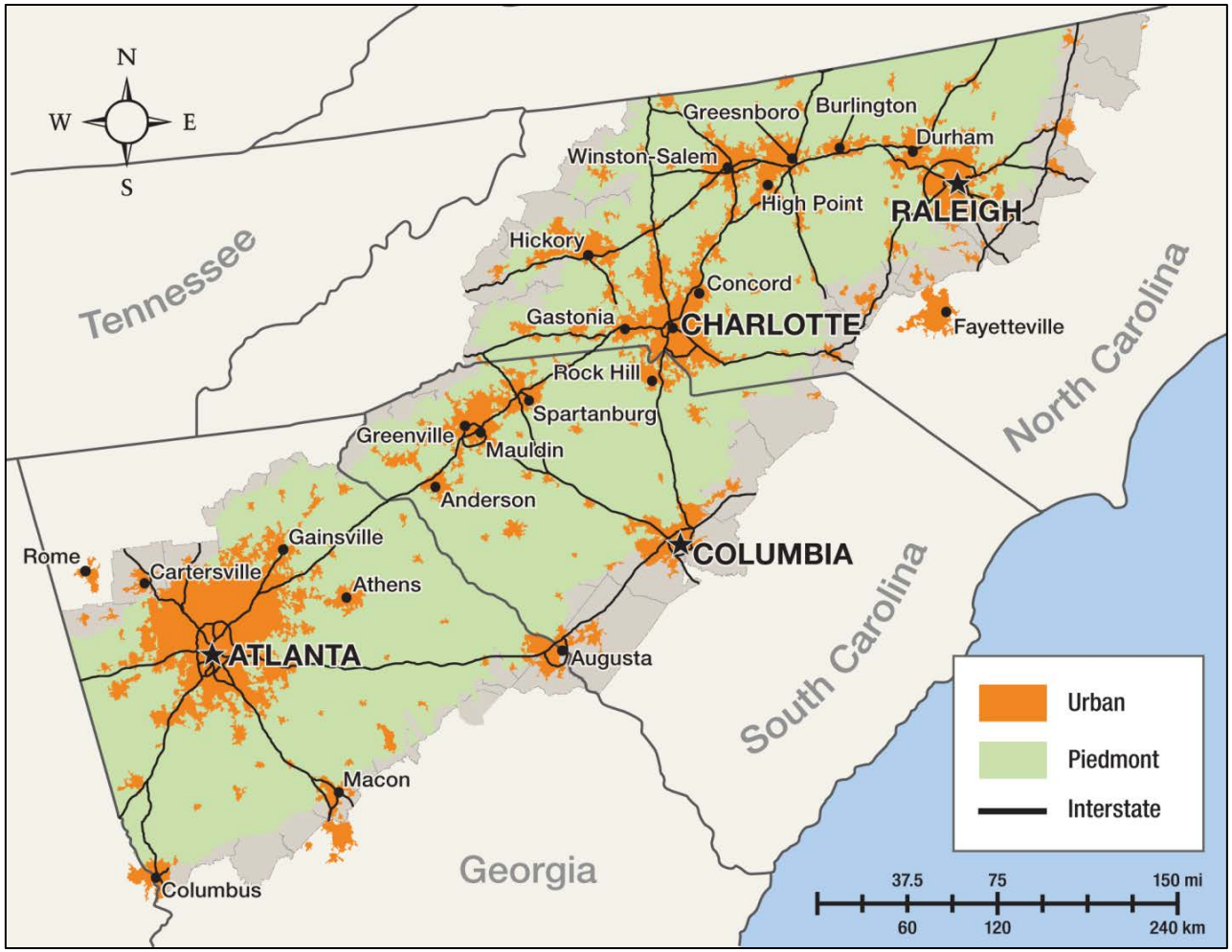


Figure 52. Urban Development in the Southern Piedmont Study Area in 2010

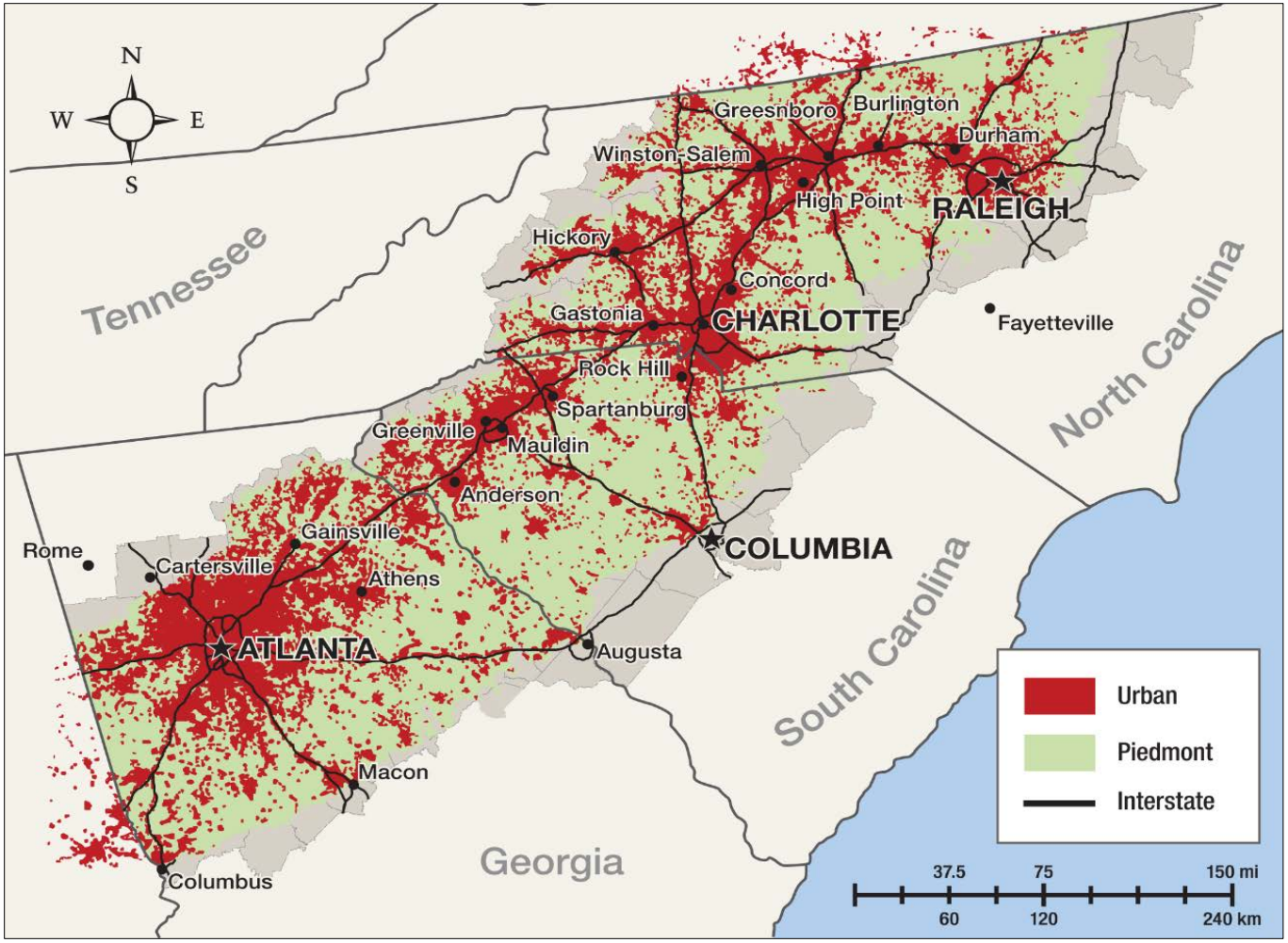


Figure 53. Projected Urban Development in the Southern Piedmont Study Area in 2050, if Current Trends Are Allowed to Continue

Projected 2060 Piedmont Megalopolis **Actual 2010 Northeastern Megalopolis**

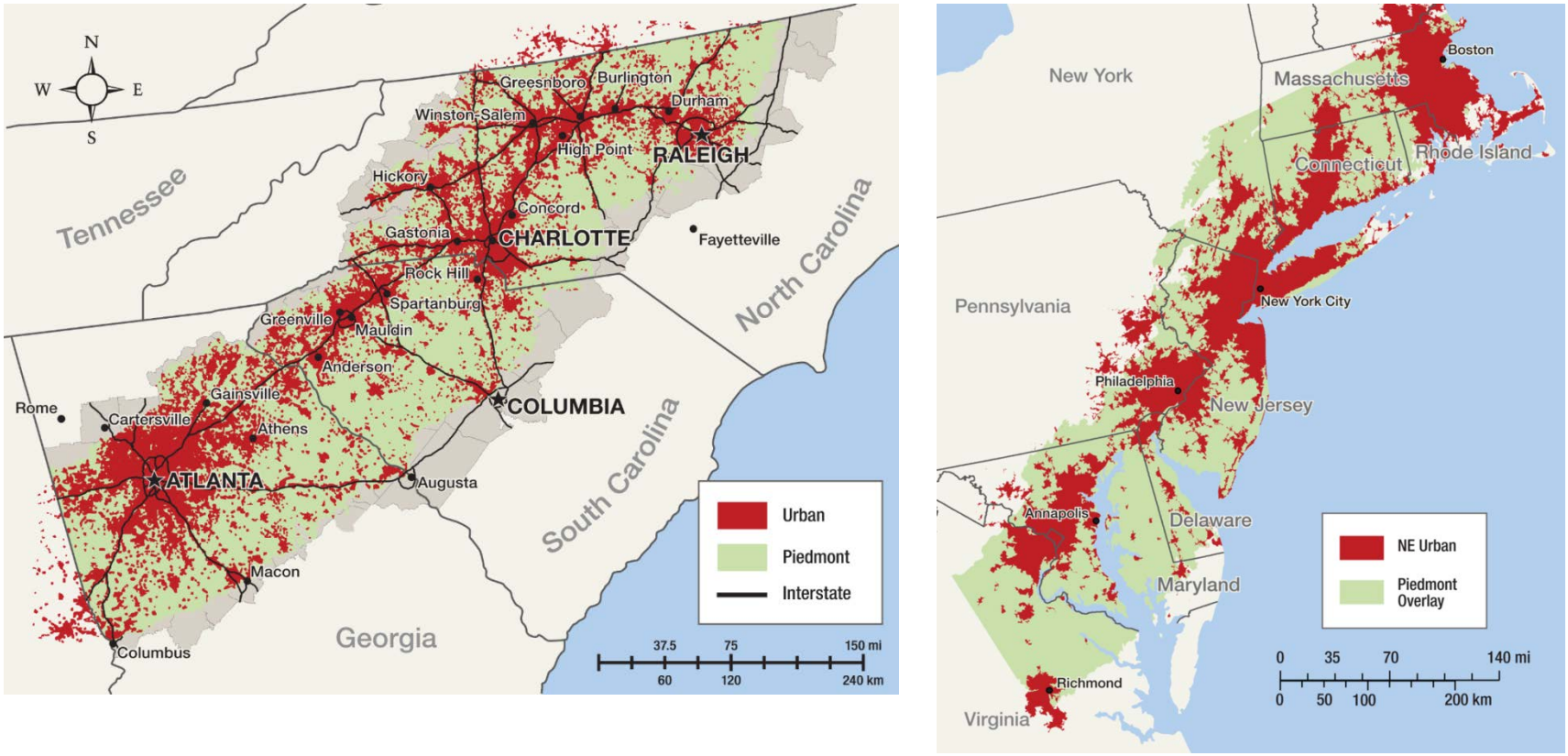


Figure 54. Comparison of Projected Urban Development in Southern Piedmont in 2060 – the "Emerging Megalopolis" – with the Actual Northeastern Megalopolis in 2010

Source: Based on the projections in the 2014 Southern Megalopolis study in PLOS One (Footnote #1)

4. CONCLUSIONS AND POLICY IMPLICATIONS

4.1 Conclusions

In both cities and counties of the Southern Piedmont, there is a broad correlation between population size and sprawl: generally, the larger a city or county's population, the larger the land area it will sprawl across. This is shown clearly in **Figure 55**, a simple scatter plot of the populations and developed land areas in 2010 of the 128 counties in our Southern Piedmont study area. The positive (upward tilting toward the right) slope of the best-fit line means that as a county's population increases, the area of built-up, developed land increases as well. This demolishes the whimsical notion entertained by those prone to wishful thinking and fairy tales that there is no connection between population size or growth rates and the impact this imposes on the land and environment.

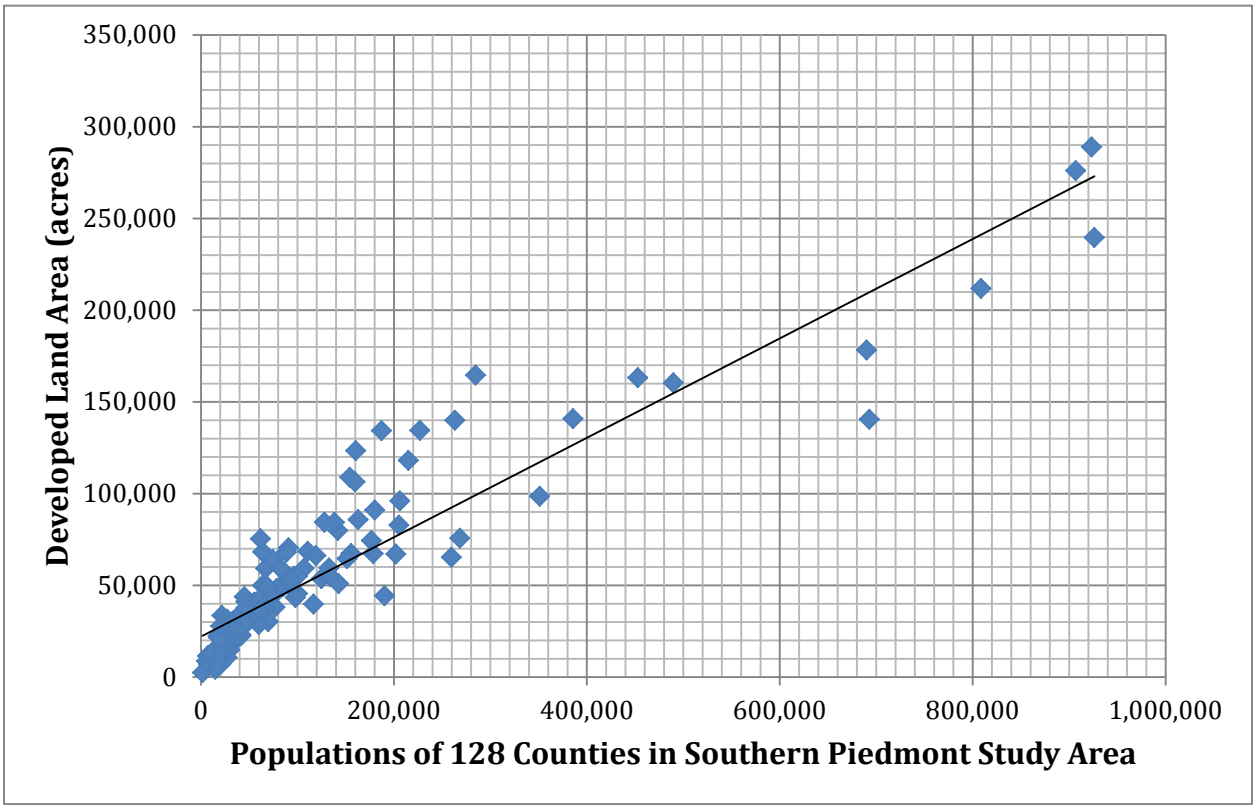


Figure 55. Cumulative Developed Land Area (Sprawl) is a Function of Population Size
Sources: U.S. Census Bureau; NRCS, County-level data from *2010 National Resources Inventory*

Sprawl continues to devour rural land in the Southern Piedmont at a very rapid rate. Although the pace of sprawl in the Piedmont may have peaked in the late 1990s, our most recent data show that it continues to devour open space at an astonishing pace, exceeding 200 acres per day, or almost one square mile every three days, and over 116 square miles or

74,000 acres per year. (This rate has likely accelerated with the gradual waning of the "Great Recession"). Even at this reduced rate, sprawl would continue to convert an additional 1,160 square miles or 740,400 acres of the Piedmont's valuable agricultural land and wildlife habitat into built-up land every decade. By 2050, more than an additional 4,000 square miles (2,560,000 acres) of the Piedmont's vanishing rural lands will have been paved or covered with subdivisions; industrial, office and theme parks; schools; and commercial strips, at great cost to the region's agricultural land base and production, wildlife habitat, quality of life, and environmental sustainability.

Smart growth efforts, higher gasoline prices, fiscal and budgetary constraints (limiting new road-building, for example), and the recession-inducing mortgage meltdown may have all played roles in slowing the Piedmont's rate of sprawl late in the first decade of this century. The extent to which any of these and still other unforeseen factors may affect the rate of sprawl in the coming decades is unknown and unpredictable. Yet as more and more rural areas in the Piedmont succumb to development – chipped away and clogged with roads, vehicles, people, facilities and infrastructure – at some point it will not be possible to maintain this rapid rate of sprawl simply because other critical land uses – e.g., high-value cropland; national and state parks, forests, and wildlife refuges; mines; watersheds and reservoir buffer zones; utility corridors; military bases and arsenals – will represent a larger and larger fraction of the remaining undeveloped land.

The role of population growth in driving sprawl in the Piedmont has increased in recent years. From 1970 to 1990, our earlier studies – based on two independent, longitudinal datasets, delineations, and methodologies – from two distinct federal agencies and research programs – the Census Bureau's Urbanized Areas and the USDA's National Resources Inventory – showed clearly that on a nationwide scale, population growth and increasing per capita land consumption (what we referred to as "land use choices") were each responsible for about half of the sprawl America was then experiencing. In the three Southern Piedmont states that are the focus of this study – North Carolina, South Carolina, and Georgia – the average percentage of sprawl attributable to population growth was a bit smaller than the national average of 50 percent. For North Carolina, it was 44 percent, for South Carolina 36 percent, and for Georgia, 56 percent.

In our more recent 2014 study of national sprawl, *Vanishing Open Spaces*, using more recent data from the same two agencies and the same two long-term data gathering programs, during the decade just passed (2000-2010), population growth accounted for approximately 70-90% of sprawl on the national scale; declining density or increasing per capita land consumption accounted for about 10-30%. In other words, nationally, the relative role of the population growth factor has increased by about 20-40 percentage points (from 50 to 70-90) over the four-decade period from 1970 to 2010 that the study encompasses.

In the Piedmont, meanwhile, the sprawl-forcing population growth factor went from a bit less than the national average on average to about equal to or even a bit higher. In Urbanized Areas, our analysis shows population growth related to about 87 percent of the sprawl in the Piedmont's UAs. For the 128 counties in the Piedmont Study Area, using the USDA/NRCS's National Resources Inventory, our analysis indicates that population growth accounted for 86 percent of sprawl from 2002 to 2010.

In sum, the role of population growth as a forcing factor in sprawl grew even faster in the Southern Piedmont than in the United States as a whole.

Attempts to direct development to limited areas are not enough to offset population growth. A central goal of Smart Growth is to preserve open space, farmland, natural beauty and critical environmental areas by preventing declining density. Thus, places where population density increases should be hailed as success stories. Between 2000 and 2010 in the Southern Piedmont, population density increased (average per capita land consumption fell) in nine out of 25 Urbanized Areas (36% of all Piedmont UAs). However, all of these cities still experienced appreciable sprawl, as shown in Table 31.

Table 31. Overall Sprawl in Piedmont UAs Which Increased Their Population Density, 2000 to 2010

Urbanized Area	Increased Average Population Density By	Yet Still Sprawled By
Georgia UAs		
Augusta-Richmond County, GA--SC	3%	12%
Cartersville, GA	15%	32%
Gainesville, GA	5%	40%
South Carolina UAs		
Mauldin--Simpsonville, SC	3%	50%
North Carolina UAs		
Durham, NC	4%	16%
Gastonia, NC--SC	3%	17%
High Point, NC	4%	20%
Raleigh, NC	1%	62%
Winston-Salem, NC	2%	28%

The Raleigh UA achieved an impressive environmental goal by increasing its average population density by one percent from 2000 to 2010, yet it still sprawled by 62 percent in this single decade, devouring an additional 199 square miles (127,360 acres) of farmland and wildlife habitat in the process. All of this sprawl was due to the Raleigh UA's population growth of 343,364 (from 541,527 in 2000 to 884,891 in 2010), an increase of 63 percent in just ten years. Raleigh ranked eighth among the USA's top ten sprawlers (see Table 1), a distinction that should invoke feelings not of civic pride but of shame and loss.

No city anywhere in the Southern Piedmont has gone to the lengths of trying to control sprawl than **Portland, Oregon** has, and perhaps no city better exemplifies the shortcoming and limitations of the "smart growth" approach than Portland.

Despite being lauded for its urban growth boundary (UGB), extensive light rail infrastructure, and high-density mixed-use developments, even Portland has been unable to contain its own sprawl. Between 2000 and 2010, the Portland UA decreased its per capita land consumption by 5.3% from 0.192 acre per person to 0.181 acre per person. (By comparison, the average per capita 2010 land consumption in the Piedmont Urbanized Areas was 0.419 acre/person, more than double that of Portland.)

However, despite its modest gain in population density over the decade, the Portland UA still sprawled outward an additional 50.4 square miles. The addition of 266,760 people during the decade was more than enough to offset the increased population density and cause the urbanized area to swell by an additional 11 percent. While the UGB and other smart growth initiatives have certainly slowed the pace of sprawl in Portland, some contend that they have driven up real estate and housing prices within the city. This has led to spill-over sprawl in other nearby cities as people seek sanctuary from higher home prices. Supporting this contention is the nearby city of Salem, Oregon, whose urbanized area population grew by 14% from 2000 to 2010, and which has quickly become the second largest city in Oregon.

The drop in per capita land consumption can be explained by the efforts of city planners to tame sprawl by directing development toward certain centers within the Urbanized Area. These were not enough to prevent the construction of new suburban neighborhoods, the development of retail centers, and the creation of roads and highways to connect these sprawl products.

In our first national sprawl study in 2001, 18 of the 100 largest Urbanized Areas in the U.S. had reduced per capita land consumption, and during that time period all 18 of those Urbanized Areas still experienced Overall Sprawl. Between 2000 and 2010, 26 Urbanized Areas had a decline in their per capita land consumption, and 22 of those cities experienced Overall Sprawl. The four areas that did not sprawl saw a decrease in their total urbanized land area by an average of 18.5 square miles. While it is encouraging to see that some cities are stopping both their per capita and Overall Sprawl, 22 of the nation's major cities that

stopped per capita growth still sprawled in an unsustainable manner. A stronger approach must be taken towards suppressing sprawl before our already dwindling rural lands disappear altogether.

Stabilized population alone does not prevent sprawl. In **Pittsburgh, Pennsylvania**, many local officials see population growth as a driver of economic development and an indicator of the vibrancy of the locales they represent. This mentality is seen in the aggressive campaigns and taxpayer subsidies that local officials use to attract new residents. However, economic growth does not necessarily require growing populations and sprawling cities. According to a 2012 study by Eben Fodor and Associates, **cities experiencing rapid population growth had higher rates of unemployment** and were more affected by the 2007-2008 recession than were cities with slower growth rates. Piedmont cities certainly likely into this camp.[75]

This can be seen in urbanized areas like Pittsburgh, which have benefited from a stabilized population in recent years. From 2000 to 2010, Pittsburgh experienced no population-induced sprawl and had a relatively low level of Overall Sprawl. One benefit Pittsburgh has seen from a stabilized population is that it has an unemployment level of only 6.6%, well below the national rate in 2014. Energized largely by strong gains in the education, healthcare, financial, and natural gas industries, Pittsburgh has been able to distance itself from both the image of the "smoky city" of steel mills and the image of the city of shut-down steel mills.

Pittsburgh has also been making headlines in the 2000s as one of the country's most livable cities. In 2011 *The Economist* Intelligence Unit named it America's most livable city, and the 29th most livable city in the world. Despite having a stable population and diverse economy, the Pittsburgh Urbanized Area sprawled over an additional 52.8 square miles in the last decade. The reason was high levels of Per Capita Sprawl. One possible culprit could be that Pittsburgh has fewer people per household than the nationwide average. This means that the population of Pittsburgh requires more dwellings and more area for the same population size than do other American cities of comparable population size. Also, the decline of the steel industry left parts of the city abandoned as "brownfields", driving residents to build outward into the suburbs. Cases like Pittsburgh highlight the necessity of a two-pronged approach to addressing both population growth – undertaken primarily at a national level, not a local one – and per capita consumption sprawl.

4.2 Policy Implications

In order for policy makers in the Piedmont region to reduce the negative impacts of sprawl and over-development, they must adopt a two-pronged approach. Building on the findings of our original studies a decade ago, and using the same analysis of U.S. Census Bureau and

[75] Eben Fodor. 2012. Relationship Between Growth and Prosperity in the 100 Largest U.S. Metropolitan Areas. *Economic Development Quarterly*. Available at: http://edq.sagepub.com/content/26/3/220.

U.S. National Resource Conservation Service data, this study provides further evidence of the necessity for such a two-pronged approach in order to effectively combat sprawl in the Southern Piedmont. Furthermore this study found that the role of population growth in contributing to Overall Sprawl has increased in the Piedmont from the 1970s to the present. These findings further reinforce the need for measures that both reduce wasteful over-consumption of our land and resources as well as others that address the large population boom that persists in our country as a whole and in the Southern Piedmont in particular.

While the findings of this study directly challenge the assumptions of many Smart Growth and New Urbanism advocates that population growth plays only a small role in Overall Sprawl, they do not discount the necessity for smarter urban planning that reduces per capita land consumption. The results of this study suggest that in the Piedmont of Georgia, South Carolina, and North Carolina, only 10-15 percent of recent sprawl was caused by a complicated array of zoning laws, infrastructure subsidies, and complex socioeconomic forces. Efforts to make cities and communities more space-efficient and livable are certainly needed, but they largely ignore the main concern that sprawl is eating away at the Piedmont's remaining undeveloped lands.

Following the logic of this study's findings it isn't hard to conclude that even the most aggressive and well-intentioned policies promoting smarter growth, better urban planning, and higher residential densities cannot escape the immense population pressures facing many communities around the rapidly growing Piedmont region. Demographic and development pressures are pushing it to become a sprawling southern megalopolis.

As noted above, no city in the Piedmont has done as much to aggressively limit sprawl as Portland, Oregon, with its Urban Growth Boundary and extensive light rail system. Yet, despite planners' best efforts, that city continues to sprawl significantly, due entirely to the addition of hundreds of thousands of new residents in the past decade. Even the best-intentioned and politically palatable urban planning policies are only able to slow, but not halt, urban sprawl when faced with intense population pressure. Using this approach, a given patch of open space beyond the existing periphery of a typical rapidly expanding city would fall to sprawl a bit later rather than sooner, but fall to sprawl it would. Under Smart Growth alone, the Piedmont's cities will never stop consuming countryside as long as the region's population boom continues – until no open space is left outside of existing protected parks and wildlife reserves, which themselves will feel squeezed and hemmed in by surrounding higher human population densities, experiencing greater noise, visitation, pollution, invasive species, habitat fragmentation, and indirect adverse effects on native flora and fauna.

Simply stated, the results of this study indicate that in the Southern Piedmont, population growth has more than five times the impact on sprawl than all other factors combined. Neglecting the population factors in the anti-sprawl fight would be to ignore 85 percent of the problem.

4.2.1 Local Influence on Sprawl

Local policy makers truly trying to curb sprawl in Southern Piedmont urban areas have a number of policy actions to pursue. While most local officials see population growth as an indicator of the vibrancy and vitality of their respective communities, there is little evidence to suggest that unfettered population growth is any of those things. Well-known sprawl critic and urban planner Eben Fodor, author of *Better Not Bigger*,[76] challenged this very notion in his 2010 study "Relationship between Growth and Prosperity in 100 Largest U.S. Metropolitan Areas."

Fodor's study found that rapidly expanding metropolitan areas did not hold up well in terms of standard economic indicators such as unemployment, per capita income, and poverty rates in comparison with slower-growing metropolitan areas. Yet, despite this, local officials and city planners continue to offer subsidies and tax breaks to attract new residents, investment and development. Many times these subsidies are tax burden born unfairly by existing residents, who see their property taxes rise and are stuck paying the bill for sprawling highways, new schools, water and waste water treatment, and electrical grids ever farther from the urban core.

Many cities have overly complicated zoning laws and ordinances that drive up home prices. New immigrants and low-income families are being priced out and into the more affordable suburbs and Sunbelt cities. This is especially evident in the Piedmont's sprawling cities, which are rapidly expanding due to a large influx of international migrants, interstate migrants, young professionals, retirees, and Northerners seeking less expensive housing and a more favorable business climate. In order for cities to properly address sprawl, taxpayer subsidies need to be removed and the true costs of development need to be borne by those developing the land. Also, as Harvard economist Edward Glaeser suggests, the true social costs of activities such as driving should be paid for. More sensible planning policies and zoning ordinances can help curb sprawl and reduce the size of population booms in areas not suited to handle large populations.

4.2.2 National Influence on Population Growth

Beyond the short term, local Piedmont officials supportive of growth control and management can hope only to slow population growth in their jurisdictions if national population continues to increase by some 2.5 to 3 million additional residents each year. These 25-30 million additional Americans each decade will all settle in some community or another, inevitably leading to additional sprawl as far and as long as the eye can see. Many of these added millions will choose to settle in the Southern Piedmont.

[76] Eben Fodor. See note #27.

In essence there are only three sources of national population growth: native fertility (in conjunction with slowly increasing life spans), immigration, and immigrant fertility. We know the following about their contribution to long-term growth:

- Native fertility: At 1.9 births per woman, it remains below the replacement level of 2.1 and has not been a source of long-term population growth in the U.S since 1971.

- Immigration: The sole source of long-term population growth in the United States is immigration, due both to new immigrants (arriving at about four times higher than the "replacement level" where immigration equals emigration) and to immigrants' fertility, which despite declines during and after the 2008 recession has remained above replacement level.

Thus, long-term population growth in the United States in general and the Southern Piedmont in particular are in the hands of federal policy makers. It is they who have increased the annual settlement of immigrants from one-quarter million in the 1950s and1960s to over a million since 1990. Until the numerical level of national immigration is addressed, even the best local plans and political commitment will be unable to stop sprawl. Any serious efforts to halt the loss of farmland and wildlife habitat in the Southern Piedmont must include reducing the volume of population growth, which requires lowering the volume of immigrants entering the country each year, unless Americans and immigrants decide to move toward a one-child per woman average.

A far more sustainable immigration level would be the approximately half-million a year recommended in 1995 by the bi-partisan U.S. Commission on Immigration Reform, established by President Clinton and chaired by former Congresswoman Barbara Jordan (D-TX).

That would appear to be a popular option among most Americans and residents of the Southern Piedmont in North Carolina, South Carolina, and Georgia. Polls of America's likely voters in 2014 and adult Piedmont residents in 2015 by Pulse Opinion Research found that reducing immigration was a popular policy choice among most when linked with the goal of slowing down U.S. population growth (see Appendix I and Appendix J for the full survey questions and results).

Question from 2015 Poll of 2,500 Adults in Piedmont: Should the federal government reduce new immigration to slow down population growth, keep new immigration and population growth at the current rate, or increase annual immigration and population growth?

60% Reduce new immigration to slow down Piedmont population growth
26% Keep new immigration and population growth at current rate
5% Increase immigration and population growth
9% Not sure

Question from 2014 National Poll of 1,000 Likely Voters: Census data show that since 1972, the size of American families has been at replacement-level. But annual immigration has tripled and is now the cause of nearly all long-term population growth. Does the government need to reduce immigration to slow down population growth, keep immigration the same and allow the population to double this century, or increase immigration to more than double the population?

68% Reduce immigration to slow down population growth
18% Keep immigration the same and allow population to double
4% Increase immigration to more than double the population
10% Not sure

Question from 2014 National Poll of 1,000 Likely Voters: Currently the government allows one million legal immigrants each year. How many legal immigrants should the government allow each year – two million, one million, a half-million, 100,000, or zero?

7% Two million
14% One million
23% Half a million
20% 100,000
20% Zero
16% Not sure

GROUPINGS: 21% Keep same level or increase
63% Cut immigration at least in half

In the 2014 national poll, when informed that immigration levels currently are around one million a year, voters were asked by pollsters what level they would prefer. Only 21 percent chose to keep it at one million or increase it. However, 63 percent of voters said they preferred to reduce immigration by at least half, which would put immigration at about the level advocated in the mid-1990s by the Jordan Commission.

This lower level of immigration at around 500,000 a year would drive far less population growth and sprawl than the present levels exceeding a million a year. But unless Americans decide to lower their birth rates to far below replacement level, the 500,000 a year would still drive considerable population growth and sprawl indefinitely.[77]

That is why another federal commission recommended far greater reductions in immigration. The President's Council on Sustainable Development in 1996 recommended that the United States stabilize its population in order to meet various environmental and quality-of-life goals, and it called for reducing immigration to a level that would allow for a stable

[77] Camarota, Steve, *Projecting Immigration's Impact on the Size and Age Structure of the 21st Century American Population*, Center for Immigration Studies, December 2012

population. At current just below-replacement native fertility rates, that would require a return down to at least the quarter-million level of immigration in the 1950s and 1960s.

The Population and Consumption Task Force of President Clinton's Council on Sustainable Development concluded in 1996: "This is a sensitive issue, but reducing immigration levels is a necessary part of population stabilization and the drive toward sustainability."[78]

In another public opinion poll, conducted in conjunction with a study we conducted in 2015 on urban sprawl in the Sunshine State, 800 likely Florida voters were asked: "If a political candidate supports higher immigration and population growth, would that make you more likely to vote for them, less likely or would it not make much difference?"[79] Their responses were:

11% More likely
56% Less likely
26% It wouldn't make much difference
7% Not sure

In our 2003 study, we devoted several pages to our findings on ways in which an Urbanized Area's population growth from immigrants would have either a greater or lesser effect on sprawl than a net population growth of the same size from U.S.-born residents. We could find no precise method of quantification but concluded that the various factors largely balanced each other.

A key way in which growth from immigration has a somewhat smaller effect on sprawl is the lower average income level and, thus, a lower consumption level of the average immigrant. But we found that an assumption about immigrants having less of an effect because they presumably prefer central cities to suburbs was false. The majority of immigrants now live in suburbs where the sprawl occurs.[80] And the adult children of immigrants were found to be just as likely to shun living in core cities as the adult children of natives. In fact, the lower

[78] President's Council on Sustainable Development. 1996. *Population and Consumption Task Force Report.* 1996. Co-Chairs: Dianne Dillon-Ridgley, Co-Chair, Citizen's Network for Sustainable Development and Timothy E. Wirth, Under Secretary for Global Affairs, U.S. Department of State.
[79] Pulse Opinion Research. 2015 Florida Poll on Sprawl and Population. Florida Survey of 800 Likely Voters. Conducted February 25-27, 2015. Appendix I in *Vanishing Open Spaces in Florida: Population Growth and Sprawl in the Sunshine State*, by Leon Kolankiewicz, Roy Beck, and Anne Manetas. Available online at: https://www.numbersusa.com/sites/default/files/public/assets/resources/files/spawl-study-florida-web.pdf .
[80] Jill H. Wilson and Audrey Singer. October 2011. *Immigrants in 2010 Metropolitan America: A Decade of Change*. Metropolitan Policy Program at Brookings. Available online at: http://www.brookings.edu/~/media/research/files/papers/2011/10/13%20immigration%20wilson%20singer/1013_immigration_wilson_singer.pdf.

incomes were causing immigrants to move to the edges of cities and even to rural settlements beyond the cities to in search of less expensive housing.

Nonetheless, it is important to note that the sprawl which occurs because of high immigration levels has nothing to do with the quality of immigrants as people or their attributes as individuals but everything to do with the sheer quantity of population growth that occurs because of immigration. This can be seen by simply observing that, on average, cities with high population growth have high amounts of sprawl, regardless of whether most of the incoming new residents come from another region of the United States or from another country or continent.

On a local level, the sprawl pressures of population growth are similar regardless of where the new residents originate. But very few Urbanized Areas are likely to be able to subdue population growth and sprawl if the federal government continues policies that add around 20 million people to the nation each decade, all of whom have to settle in some locality. The reality – which can only be mitigated but not eliminated by good planning or Smart Growth – is that these localities all occupy lands that were formerly productive agricultural lands or irreplaceable natural habitats.

In a nutshell, if the United States in general, and Piedmont residents in particular, are serious about reducing or halting sprawl in the coming decades – and its unacceptable, unsustainable impacts on the environment, quality of life, and sustainability – immigration rates must be lowered substantially.

"This is a sensitive issue, but reducing immigration levels is a necessary part of population stabilization and the drive toward sustainability."
– President's Council on Sustainable Development, 1996

Appendix A
Glossary

Central Place – The Census Bureau delineates an urbanized area (UA) as one or more "central places" and the "urban fringe" (the adjacent densely settled surrounding territory) that together contain a minimum of 50,000 residents. A central place functions as the dominant center of each UA. The identification of a UA central place permits the comparison of this dominant center with the remaining territory in the UA. A central place generally is the most densely populated and oldest city in a metropolitan area.

Density – Shorthand for population density, or the number of residents per unit area, usually measured in number of residents per acre or square mile. Density is the mathematical inverse or opposite of land consumption per person (per capita). For example, a density of five persons or residents per acre equals 3,200 per square mile. This in turn equals a per capita land consumption of 0.2 acre per person.

Developed Land – As defined by the U.S. Department of Agriculture's Natural Resources Conservation Service in its National Resources Inventories (NRIs), issued every five years since 1982, built-up or paved land that is at least one-quarter acre in area. Developed land can include built-up areas outside of urbanized areas, towns, or cities. The NRI Developed Land category includes: (a) large tracts of urban and built-up land; (b) small tracts of built-up land less than 10 acres in size; and (c) land outside of these built-up areas that is in a rural transportation corridor (roads, interstates, railroads, and associated rights-of-way).

Foreign Born – Describing a person born in a country other than the United States. Excludes those born abroad to American parents. Can be used as a noun or an adjective.

High-Density – A large number of residents per unit area, usually measured in terms of residents per acre or square mile. While there is no one precise, agreed-upon criterion or threshold of high-density residential development, a density of approximately 5,000 per square mile would be considered relatively high-density.

Holdren Method – Mathematical methodology for determining the percentages of Overall Sprawl attributable to Per Capita Sprawl and Population-driven Sprawl, in other words, to increasing per capita land consumption (decreasing population density) and to population growth.

Hop – a connection from one urban area core to other qualifying urban territory along a road connection of half a mile (0.5 mile) or less in length; multiple hops may be made along any given road corridor. This criterion recognizes that alternating patterns of residential development and non-residential development are a typical feature of urban landscapes.

Immigration – Permanent movement (i.e., settlement) of a foreign-born person to the United States either with permission from U.S. authorities (legal immigration) or without such permission (illegal immigration).

Immigrant Fertility – Fertility of foreign-born immigrants to the United States, usually expressed in terms of the Total Fertility Rate (TFR) of women, which is the average total number of children born to women of a defined group during the course of their reproductive years.

Jump – a connection from one urban area core to other qualifying urban territory along a road connection between 0.5 mile and 2.5 miles in length; only one jump may be made along any given road connection.

Low-Density – Relatively low population density, or low number of residents per unit area (acre or square mile). Urban / suburban densities of 1,000-2,000 per square mile would be considered low-density, though still enough to qualify as urban.

Native Born – A person born in the United States.

Natural Habitat – That portion of rural or undeveloped land that consists of upland and bottomland forests, woodlands, savanna, scrub-shrub, natural grasslands or prairie, wetlands (marshes, swamps, bogs), ponds, watercourses, deserts, alpine meadow and tundra. Natural habitats support wildlife and provide other ecosystem services. They may be in public or private ownership.

New Urbanism – A movement that sees urban centers as potentially vibrant communities that can mix and harmonize residential and commercial uses in clever and innovative ways to make cities satisfying and safe places to live and work. New urbanism supports such concepts as higher density in urban cores, mixed uses, mass transit, close proximity of dwellings to workplace, walkable communities, bicycle lanes, community gardens, and others. New urbanism sees relentless sprawl in America as one consequence of the abandonment of our central cities.

Per Capita Land Consumption – Average amount of land used by each resident of an urbanized area or developed area. Includes not just residential land but all developed land used by urban residents, including commercial, institutional, small park, transportation (e.g., streets, roads, railroads, freeways, parking lots), and industrial land uses.

Open Space – Land lacking significant built structures or pavement. Includes rural and undeveloped lands and natural habitat outside of urban boundaries; also includes larger natural areas, parks and green space within urban areas, such as golf courses and extensive lawns or gardens. Yards or wooded lots on quarter-acre lots in residential areas would not qualify as open space.

Overall Sprawl – See "sprawl" below. Overall sprawl is the sum of Per Capita Sprawl and Population-driven sprawl [the total amount of open space converted to development over a period of time].

Per Capita Sprawl – Sprawl that is driven by increase in per capita land consumption, that is, land consumption per resident, of an urbanized area, developed area, city or town; Per Capita

Sprawl is measured in terms the increase in acres or square miles of developed or urbanized acres of land per person. Per Capita Sprawl and population-driven sprawl add up to 100 percent of Overall Sprawl.

Population-driven Sprawl – Sprawl that is driven by increase in the population of an urbanized or developed area. Population-driven and Per Capita Sprawl add up to 100 percent.

Population Growth – Increase in the number of residents of a given area, such as a town, city, urbanized area, state, or country over time. Population growth is equal to the total births of native-born residents minus the total deaths of native-born residents minus the emigration of native-born residents PLUS total immigration of the foreign born plus births to the foreign born minus deaths of the foreign born minus emigration of the foreign born (i.e., return to the country of their birth or a third country). In recent decades, annual population growth in the United States as a whole has been running about 2.5 million to 3 million per year on average, or roughly 30 million per decade.

Rural Land – Undeveloped lands outside of urban areas, including farmland, pastureland, rangeland, and natural or semi-natural habitats, like forests, woodlands, wetlands, grasslands or prairie, and deserts. Rural lands may be flat or mountainous, and publicly or privately owned.

Smart Growth – The use of a variety of land-use, planning, statutory, regulatory, taxing, and other tools by federal and state governments and local jurisdictions (municipalities) to reduce haphazard, low-density, and poorly planned development in a given region.

Smart Growth Movement – A loose, eclectic coalition of environmentalists, local growth-control activists, New Urbanists, municipal and regional planners, think-tanks, the federal government and many state governments, and even some home-builders united by their interest in slowing the rate of sprawl, and making existing communities more sustainable and livable.

Sprawl – As defined in this study, the increase in the physical area of a town or city over time – outward expansion – as undeveloped or rural land at its periphery is permanently converted to developed or urbanized land as population and/or per capita land consumption grow. More specifically, in this study, sprawl is: 1) the increase in the area of the Census Bureau's Urbanized Areas, as delineated every 10 years in the decadal censuses, and/or 2) the increase in the area of a state's area of Developed Land, as determined by the Natural Resources Conservation Service.

Suburbs – Residential or commercial zones on the outskirts of a central city or town; generally corresponds to "urban fringe." Tend to have a lower population density than the central place or urban core, though not always, as when downtown districts are dominated by office, institutional, and commercial zones.

Urban Core – Used in this report as another description for "central location" as defined by the Census Bureau. The urban core is the entire city that anchors a metropolitan area, and usually is at its center. It generally is the oldest, most densely populated and most built-up portion of an urbanized area.

Urban Fringe – Built-up areas near the edge of an urbanized area, generally with lower population density than the urban core; generally corresponds to the inner and outer suburbs of a town or city.

Urban Sprawl – See "sprawl."

Urbanized Area – As defined by the U.S. Census Bureau, an area of contiguous census blocks or block groups with a population of at least 50,000 and an average population density of at least 1,000 residents per square mile.

Appendix B
Calculating Per Capita Land Consumption

The per person land consumption in each state or Urbanized Area can be expressed as:

(1) $a = A / P$

where:

a = area of developed or urbanized land area for the average resident
A = Area of total developed or urbanized land in a state
P = Population of that state

For example, in 2010 Oregon had 3,831,074 residents and approximately 1,407,600 developed acres. Thus, per capita developed land use for all purposes was around 0.367 acre (between one-third and four-tenths of an acre) per resident.

The land used per person is the total developed land area divided by the total number of people. This is the inverse of population density, which is the number of people per unit area of land. When per capita land consumption goes up, density goes down; when per capita land consumption goes down, density goes up.

The developed land area of any given state can be expressed as:

(2) $A = P \times a$

This can be stated as: the total developed area in square miles (or acres) of a state can be simply expressed or "factored" into the product of the Population of the state (*viz*., P) multiplied by the per capita urban land consumption (*viz*., a). This second equation (2) is the basis for attributing or apportioning the shares of sprawl (viz. growth in A) back onto two contributing factors, the growth in P and the growth in a.

Appendix C
Apportioning Shares of Overall Sprawl Between Population Growth and Per Capita Sprawl

A methodology for quantifying the respective contributions of population growth and changes in per capita consumption of any type of resource use was outlined in a 1991 paper by physicist John Holdren ("Population and the Energy Problem." *Population and Environment*, Vol. 12, No. 3, Spring 1991). Although Dr. Holdren's 1991 paper dealt specifically with the role of population growth in propelling the increase in U.S. energy consumption, the same methodology can also be applied to many types of population and resource consumption analyses.

In the case of sprawl, the resource under consideration is rural land, namely the expansion over time in the total acreage of rural land urbanized or converted into developed land and subsequently used for urban purposes, such as for housing, commerce, retail, office space, education, light and heavy industry, transportation, and so forth.

As stated in **Appendix B**, the total land area developed in a city (urbanized area) or state can be expressed as:

(1) $A = P \times a$

Where*:*

A = Area of total are (in acres or square miles) of development in city or state
P = Population of that city or state
a = area of city or state used by the average resident (per capita land use)

Following the logic in Holdren's paper, if over a period of time Δt (e.g., a year or a decade), the population grows by an increment ΔP and the per capita land use changes by Δa, the total urbanized land area grows by ΔA, expressed as:

(2) $A + \Delta A = (P + \Delta P) \times (a + \Delta a)$

Subtracting eqn. (1) from eqn. (2) and dividing through by *A* to compute the relative change (i.e., $\Delta A/A$) in urbanized land area over time interval Δt yields:

(3) $\Delta A/A = \Delta P/P + \Delta a/a + (\Delta P/P) \times (\Delta a/a)$

Now equation (3) is quite general and makes no assumption about the growth model or time interval. On a year-to-year basis, the percentage increments in *P* and *a* are small (i.e., single digit percentages), so the second order term in equation (3) can be ignored. Hence following the Holdren paradigm, eqn. (3) states that the percentage growth in urbanized land area (viz., 100 percent x $\Delta A/A$) is the sum of the percentage growth in the population (100

percent x $\Delta P/P$) plus the percentage growth in the per capita land use (100 percent x $\Delta a/a$). Stated in words, equation (3) becomes:

(4) *Overall percentage land area growth = Overall percentage population growth + Overall percentage per capita growth*

In essence, the Holdren methodology quantifies population growth's share of total land consumption (sprawl) by finding the ratio of the overall percentage change in population over a period of time to the overall percentage change in land area consumed for the same period. This can be expressed as:

(5) $$\textit{Population share of growth} = \frac{\textit{(Overall percentage population growth)}}{\textit{(Overall percentage land area growth)}}$$

The same form applies for per capita land use:

(6) $$\textit{Per capita land use share of growth} = \frac{\textit{(Overall \% per capita land use growth)}}{\textit{(Overall \% land area growth)}}$$

The above two equations follow the relationship based on Prof. Holdren's equation (5) in his 1991 paper. A common growth model follows the form (say for population):

(7) $$P(t) = P_0(1 + g_p)t$$

Where $P(t)$ is population at time t, P_0 is the initial population and g_p the growth rate over the interval. Solving for g_p the growth rate yields:

(8) $$\ln (1 + g_p) = (1/t) \ln (P(t)/P_0)$$

Since ln (1 + x) approximately equals x for small values of x, equation (8) can be written as:

(9) $$g_p = (1/t) \ln (P(t)/P_0)$$

The same form of derivation of growth rates can be written for land area (A) and per capita land use (a)

(10) $$g_A = (1/t) \ln (A(t)/A_0)$$

(11) $$g_a = (1/t) \ln (a(t)/a_0)$$

These three equations for the growth rates allow the result of equation (4) to be restated as:

(12) $$gP + g_a = g_A$$

Substituting the formulae (equations 9 through 11) for the growth rates and relating the initial and final values of the variables P, a and A over the period of interest into equation (12), the actual calculational relationship becomes:

(13) ln (*final population / initial population*) + ln (*final per capita land area / initial per capita land area*) = ln (*final total land area / initial total land area*)

In other words, the natural logarithm (ln) of the ratio of the final to initial population, plus the logarithm of the ratio of the final to initial per capita land area (i.e., land consumption per resident), equals the logarithm of the final to the initial total land area.

In the case of Florida from 1982 to 2010, this formula would appear as:

(14) ln (*18,801,310 residents / 10,471,407residents*) + ln (*0.29127acre per resident / 0.26826 acre per resident*) =ln (*5,476,300 acres / 2,809,100 acres*)

Computing the ratios yields:

(15) ln (1.79549) + ln (1.08577) = ln (1.94949)

0.58528 + 0.08229 = 0.66757

Then applying equations (5) and (6), the percentage contributions of population growth and per capita land area growth are obtained by dividing (i.e., normalizing to 100 percent) each side by 0.05018:

(16) $\frac{0.58528}{0.66757} + \frac{0.08229}{0.66757} = \frac{0.66757}{0.66757}$

Performing these divisions yields:

(17) 0.88 + 0.12 = 1.0

Thus, we note that in the case of the Florida from 1982 to 2010, the share of sprawl due to population growth was 88 percent [100 percent x (0.58528 / 0.66757)], while declining density (i.e., an increase in land area per capita) accounted for 12 percent [100 percent x (0.08229/ 0.66757)]. Note that the sum of both percentages equals 100 percent.

Appendix D
Anomalies – Urbanized Areas with Populations that Grew but Areas that Supposedly Shrank

From 2000 to 2010 Panama City and Titusville both gained population, while at the same time losing overall urban area, according to the Census Bureau's decadal inventories of Urbanized Land.

In each of these areas, the reduction in developed urban land was likely on paper only, the result of changes in assumptions and calculations by the federal government. Although it is possible for an Urbanized Area to reduce its amount of actual developed land by returning large swaths of previously developed acreage to a natural, semi-natural, feral, or agricultural condition (as has happened in the case of Detroit, Michigan), that was not the case with these two Urbanized Areas that the government shows as having shrunk in land area over the last decade.

The cause for these anomalies can be traced to changes in the delineation criteria for the 2010 Census from the 2000 Census. The most notable of these changes is the use of census tracts rather than block groups for establishing initial urban cores. One consequence of these changes was for initial urban cores to decrease in territory for the 2010 Census from the 2000 Census.

Source:

Christopher J. Henrie. U.S. Census Bureau, Geography Division, Geographic Standards and Criteria. "Urban Area Data Anomalies." Email message to Brian S. Schoepfer, NumbersUSA. 5 June 2013.

Census Tracts, Blocks, and Block Groups

A **census tract** is a geographic area defined for the purpose of taking a census. Usually census tract boundaries coincide with the limits of cities, towns, or other municipalities. Several tracts typically exist within a single county. However, in unincorporated census tract boundaries are often arbitrary, except for coinciding with political lines.

Census tracts are divided into **block groups** and these are further subdivided into **census blocks**. According to the Census Bureau, tracts are "designed to be relatively homogeneous units with respect to population characteristics, economic status, and living conditions." On average, about 4,000 inhabitants live in a census tract.

While censuses are conducted the world over, and have been carried out for centuries, the concept of the census tract was developed in the United States, where it was first applied in the 1910 decadal census.

A **census block** is the smallest geographic unit used by the Census Bureau for tabulation of 100-percent data (data collected from all houses, rather than a sample of houses). Several blocks comprise a **block group**. There are on average about 39 blocks per block group, but this varies. Blocks typically have a four-digit number, where the first digit indicates which block group the block is in. For example, census block 3019 would be in block group 3. There are about 8,200,000 blocks in the U.S.

Block boundaries are typically streets, roads or creeks. The size of census block populations varies considerably. There are about 2,700,000 blocks with zero inhabitants, while a block that is entirely occupied by an apartment complex might have several hundred inhabitants.

Appendix E
Change in Developed Land Area and Population in Southern Piedmont Counties 1982-2010

Table E-1. Developed Land Area by County in 1982, 2010, Change from 1982 to 2010, and Percentage Change in Area

County	Developed Area 1982 (thousand acres)	Developed Area 2010 (thousand acres)	Change in Area (thousand acres)	% Change in Area
Georgia				
Baldwin	14.4	33.2	18.8	131
Banks	6.1	21.5	15.4	252
Barrow	12.1	30.2	18.1	150
Bartow	21.0	45.5	24.5	117
Bibb	29.0	67.3	38.3	132
Butts	6.3	13.7	7.4	117
Carroll	41.3	68.5	27.2	66
Cherokee	14.8	118.1	103.3	698
Clarke	23.1	39.8	16.7	72
Clayton	39.4	65.3	25.9	66
Cobb	113.1	178.3	65.2	58
Columbia	24.0	53.6	29.6	123
Coweta	26.3	84.4	58.1	221
Crawford	3.7	11.6	7.9	214
Dawson	5.1	11.2	6.1	120
DeKalb	93.6	140.5	46.9	50

County	Developed Area 1982 (thousand acres)	Developed Area 2010 (thousand acres)	Change in Area (thousand acres)	% Change in Area
Douglas	31.4	59.5	28.1	89
Elbert	3.2	6.7	3.5	109
Fayette	29.2	59.3	30.1	103
Floyd	34.2	54.9	20.7	61
Forsyth	21.3	74.4	53.1	249
Franklin	7.6	16.9	9.3	122
Fulton	148.9	239.6	90.7	61
Greene	6.2	12.3	6.1	98
Gwinnett	69.7	211.8	142.1	204
Habersham	6.6	31.8	25.2	382
Hall	48.9	91.0	42.1	86
Hancock	6.5	9.7	3.2	49
Haralson	14.1	24.5	10.4	74
Harris	11.9	29.3	17.4	146
Hart	9.8	20.7	10.9	111
Heard	4.3	6.2	1.9	44
Henry	14.7	82.8	68.1	463
Jasper	6.1	11.0	4.9	80
Jones	11.6	19.7	8.1	70
Lamar	4.0	12.7	8.7	218
Lincoln	4.1	7.0	2.9	71

County	Developed Area 1982 (thousand acres)	Developed Area 2010 (thousand acres)	Change in Area (thousand acres)	% Change in Area
Lumpkin	4.4	14.9	10.5	239
Madison	5.1	14.0	8.9	175
McDuffie	10.3	18.8	8.5	83
Meriwether	19.1	33.6	14.5	76
Monroe	7.2	23.5	16.3	226
Morgan	12.0	16.7	4.7	39
Muskogee	26.1	44.3	18.2	70
Newton	23.8	55.0	31.2	131
Oconee	5.9	18.5	12.6	214
Oglethorpe	3.8	4.3	0.5	13
Paulding	6.6	50.9	44.3	671
Pickens	6.4	19.4	13.0	203
Pike	5.1	22.4	17.3	339
Polk	13.8	22.5	8.7	63
Putnam	5.9	16.6	10.7	181
Rockdale	18.9	49.3	30.4	161
Spalding	24.2	68.2	44.0	182
Stephens	8.4	22.4	14.0	167
Talbot	6.5	11.5	5.0	77
Taliaferro	2.3	2.4	0.1	4
Troup	35.5	59.2	23.7	67

County	Developed Area 1982 (thousand acres)	Developed Area 2010 (thousand acres)	Change in Area (thousand acres)	% Change in Area
Upson	11.1	31.6	20.5	185
Walton	16.8	50.1	33.3	198
Warren	5.6	8.7	3.1	55
White	3.0	10.6	7.6	253
Wilkes	5.7	10.8	5.1	89
Georgia Piedmont Counties Total	**1,261.1**	**2,764.7**	**1,503.6**	**119**
South Carolina				
Abbeville	13.3	18.9	5.6	42
Aiken	64.6	123.4	58.8	91
Anderson	76.6	134.3	57.7	75
Cherokee	19.6	40.8	21.2	108
Chester	21.4	30.5	9.1	43
Chesterfield	22.6	41.1	18.5	82
Edgefield	8.2	14.3	6.1	74
Fairfield	16.0	19.8	3.8	24
Greenville	86.6	163.2	76.6	88
Greenwood	25.4	43.5	18.1	71
Kershaw	26.0	75.3	49.3	190
Lancaster	18.7	38.1	19.4	104
Laurens	25.9	36.9	11.0	42
Lexington	55.5	140.0	84.5	152

County	Developed Area 1982 (thousand acres)	Developed Area 2010 (thousand acres)	Change in Area (thousand acres)	% Change in Area
McCormick	8.6	12.5	3.9	45
Newberry	18.6	32.6	14.0	75
Oconee	33.8	64.1	30.3	90
Pickens	38.1	66.2	28.1	74
Richland	73.6	140.8	67.2	91
Saluda	7.7	11.5	3.8	49
Spartanburg	79.7	164.6	84.9	107
Union	13.9	21.5	7.6	55
York	47.6	134.5	86.9	183
S. Carolina Piedmont Counties Total	**802.0**	**1,568.4**	**766.4**	**96**
North Carolina				
Alamance	43.8	64.5	20.7	47
Alexander	9.4	27.8	18.4	196
Anson	13.9	22.4	8.5	61
Burke	52.0	70.5	18.5	36
Cabarrus	38.3	67.3	29.0	76
Caldwell	29.0	59.0	30.0	103
Caswell	6.3	15.3	9.0	143
Catawba	67.6	108.9	41.3	61
Chatham	24.1	49.9	25.8	107
Cleveland	25.8	43.3	17.5	68

County	Developed Area 1982 (thousand acres)	Developed Area 2010 (thousand acres)	Change in Area (thousand acres)	% Change in Area
Davidson	52.4	85.8	33.4	64
Davie	11.6	23.2	11.6	100
Durham	44.6	75.7	31.1	70
Forsyth	59.4	98.5	39.1	66
Franklin	11.3	33.1	21.8	193
Gaston	49.8	96.0	46.2	93
Granville	8.9	28.6	19.7	221
Guilford	96.2	160.4	64.2	67
Iredell	43.5	106.4	62.9	145
Lee	20.4	41.0	20.6	101
Lincoln	11.4	48.2	36.8	323
McDowell	15.2	43.8	28.6	188
Mecklenburg	146.9	288.9	142.0	97
Montgomery	12.0	20.6	8.6	72
Moore	29.1	68.0	38.9	134
Orange	28.0	54.8	26.8	96
Person	7.5	22.2	14.7	196
Polk	10.3	27.8	17.5	170
Randolph	37.1	79.9	42.8	115
Richmond	26.7	37.7	11.0	41
Rockingham	25.5	53.0	27.5	108

County	Developed Area 1982 (thousand acres)	Developed Area 2010 (thousand acres)	Change in Area (thousand acres)	% Change in Area
Rowan	43.9	84.3	40.4	92
Rutherford	15.0	49.1	34.1	227
Stanly	20.4	36.3	15.9	78
Stokes	17.4	29.3	11.9	68
Surry	22.5	43.9	21.4	95
Union	27.8	67.1	39.3	141
Vance	9.6	29.5	19.9	207
Wake	111.8	276.0	164.2	147
Warren	9.7	20.5	10.8	111
Wilkes	23.0	49.2	26.2	114
Yadkin	12.5	25.7	13.2	106
N. Carolina Piedmont Counties Total	**1,371.6**	**2,733.4**	**1,361.8**	**99**
3-State Piedmont Total	**3,434.7**	**7,066.5**	**3,631.8**	**106**

Table E-2. Population by County in 1982, 2010, Change from 1982 to 2010, and Percentage Change in Population

County	Population in 1982	Population in 2010	Change in Population	% Change in Population
Georgia				
Baldwin	36,758	45,735	8,977	24
Banks	8,927	18,415	9,488	106
Barrow	22,371	69,731	47,360	212
Bartow	42,427	100,195	57,768	136
Bibb	151,671	155,715	4,044	3
Butts	14,598	23,674	9,076	62
Carroll	59,634	110,661	51,027	86
Cherokee	56,171	215,129	158,958	283
Clarke	77,682	116,668	38,986	50
Clayton	155,788	259,623	103,835	67
Cobb	321,994	690,063	368,069	114
Columbia	43,509	124,815	81,306	187
Coweta	40,933	127,955	87,022	213
Crawford	7,393	12,591	5,198	70
Dawson	5,261	22,343	17,082	325
DeKalb	492,317	692,902	200,585	41
Douglas	57,293	132,722	75,429	132
Elbert	18,991	20,112	1,121	6
Fayette	33,701	106,945	73,244	217

County	Population in 1982	Population in 2010	Change in Population	% Change in Population
Floyd	79,897	96,274	16,377	20
Forsyth	29,596	176,738	147,142	497
Franklin	15,495	22,048	6,553	42
Fulton	607,085	926,197	319,112	53
Greene	11,512	16,006	4,494	39
Gwinnett	192,057	808,719	616,662	321
Habersham	25,810	43,080	17,270	67
Hall	78,832	180,253	101,421	129
Hancock	9,379	9,391	12	0
Haralson	19,241	28,774	9,533	50
Harris	15,356	32,167	16,811	109
Hart	18,863	25,217	6,354	34
Heard	6,648	11,854	5,206	78
Henry	38,270	205,265	166,995	436
Jasper	7,486	13,926	6,440	86
Jones	17,540	28,634	11,094	63
Lamar	12,041	18,335	6,294	52
Lincoln	6,731	7,966	1,235	18
Lumpkin	11,364	29,998	18,634	164
Madison	18,240	28,167	9,927	54
McDuffie	18,810	21,876	3,066	16

County	Population in 1982	Population in 2010	Change in Population	% Change in Population
Meriwether	21,277	21,849	572	3
Monroe	14,865	26,467	11,602	78
Morgan	11,995	17,862	5,867	49
Muskogee	174,633	190,417	15,784	9
Newton	36,771	100,086	63,315	172
Oconee	13,282	32,984	19,702	148
Oglethorpe	9,085	14,919	5,834	64
Paulding	27,800	142,741	114,941	413
Pickens	12,079	29,436	17,357	144
Pike	9,005	17,905	8,900	99
Polk	32,868	41,523	8,655	26
Putnam	10,817	21,205	10,388	96
Rockdale	38,639	85,434	46,795	121
Spalding	49,564	64,081	14,517	29
Stephens	22,051	26,193	4,142	19
Talbot	6,605	6,844	239	4
Taliaferro	2,063	1,698	-365	-18
Troup	51,196	67,187	15,991	31
Upson	26,530	27,087	557	2
Walton	31,576	84,004	52,428	166
Warren	6,621	5,804	-817	-12

County	Population in 1982	Population in 2010	Change in Population	% Change in Population
White	10,615	27,168	16,553	156
Wilkes	11,140	10,590	-550	-5
Georgia Piedmont Counties Total	**3,518,749**	**6,840,363**	**3,321,614**	**94**
South Carolina				
Abbeville	22,964	25,335	2,371	10
Aiken	108,220	160,565	52,345	48
Anderson	136,853	187,269	50,416	37
Cherokee	41,368	55,397	14,029	34
Chester	31,122	33,096	1,974	6
Chesterfield	38,233	46,665	8,432	22
Edgefield	17,745	26,966	9,221	52
Fairfield	20,671	23,890	3,219	16
Greenville	295,615	452,859	157,244	53
Greenwood	57,563	69,703	12,140	21
Kershaw	39,846	61,851	22,005	55
Lancaster	54,088	76,889	22,801	42
Laurens	53,391	66,500	13,109	25
Lexington	145,414	263,406	117,992	81
McCormick	7,413	10,228	2,815	38
Newberry	32,069	37,575	5,506	17
Oconee	50,425	74,359	23,934	47

County	Population in 1982	Population in 2010	Change in Population	% Change in Population
Pickens	82,920	119,217	36,297	44
Richland	273,620	385,745	112,125	41
Saluda	16,212	19,926	3,714	23
Spartanburg	207,456	284,713	77,257	37
Union	30,969	28,867	-2,102	-7
York	111,121	226,971	115,850	104
S. Carolina Piedmont Counties Total	**1,875,298**	**2,737,992**	**862,694**	**46**
North Carolina				
Alamance	101,000	151,528	50,528	50
Alexander	25,572	37,239	11,667	46
Anson	25,317	26,908	1,591	6
Burke	73,583	90,771	17,188	23
Cabarrus	89,158	178,588	89,430	100
Caldwell	68,057	82,998	14,941	22
Caswell	21,416	23,695	2,279	11
Catawba	107,754	154,389	46,635	43
Chatham	34,430	63,821	29,391	85
Cleveland	83,144	98,050	14,906	18
Davidson	116,026	162,930	46,904	40
Davie	25,316	41,321	16,005	63
Durham	156,300	268,454	112,154	72

County	Population in 1982	Population in 2010	Change in Population	% Change in Population
Forsyth	249,154	351,335	102,181	41
Franklin	30,769	60,848	30,079	98
Gaston	166,369	206,213	39,844	24
Granville	34,790	60,063	25,273	73
Guilford	322,602	489,681	167,079	52
Iredell	84,487	159,771	75,284	89
Lee	37,405	57,951	20,546	55
Lincoln	43,361	78,450	35,089	81
McDowell	35,838	45,016	9,178	26
Mecklenburg	422,435	923,427	500,992	119
Montgomery	22,495	27,826	5,331	24
Moore	51,394	88,569	37,175	72
Orange	78,644	134,197	55,553	71
Person	29,356	39,461	10,105	34
Polk	13,799	20,465	6,666	48
Randolph	93,626	141,960	48,334	52
Richmond	44,468	46,659	2,191	5
Rockingham	84,428	93,641	9,213	11
Rowan	101,319	138,446	37,127	37
Rutherford	55,280	67,772	12,492	23
Stanly	48,757	60,595	11,838	24

County	Population in 1982	Population in 2010	Change in Population	% Change in Population
Stokes	34,256	47,351	13,095	38
Surry	59,896	73,694	13,798	23
Union	73,308	202,206	128,898	176
Vance	37,206	45,426	8,220	22
Wake	316,973	906,969	589,996	186
Warren	16,293	20,931	4,638	28
Wilkes	59,191	69,287	10,096	17
Yadkin	29,072	38,425	9,353	32
N. Carolina Piedmont Counties Total	**3,604,044**	**6,077,327**	**2,473,283**	**69**
3-State Piedmont Total	**8,998,091**	**15,655,682**	**6,657,591**	**74**

Appendix F
Population Change in Southern Piedmont Urbanized Areas 2000 to 2010

Urbanized Area	Population in 2000	Population in 2010	Change in Population	% Change in Population
Georgia				
Athens-Clarke County, GA	106,482	128,754	22,272	21
Atlanta, GA	3,499,840	4,515,419	1,015,579	29
Augusta-Richmond County, GA--SC	335,630	386,787	51,157	15
Cartersville, GA	33,685	52,477	18,792	56
Dalton, GA	57,666	85,239	27,573	48
Columbus, GA--AL	242,324	253,602	11,278	5
Gainesville, GA	88,680	130,846	42,166	48
Macon, GA	135,170	137,570	2,400	2
Rome, GA	58,287	60,851	2,564	4
All Georgia UAs	**4,557,764**	**5,751,545**	**1,193,781**	**26**
South Carolina				
Anderson, SC	70,436	75,702	5,266	7
Columbia, SC	420,537	549,777	129,240	31
Greenville, SC	302,194	400,492	98,298	33
Mauldin--Simpsonville, SC	77,831	120,577	42,746	55
Rock Hill, SC	70,007	104,996	34,989	50
All South Carolina UAs	**941,005**	**1,251,544**	**310,539**	**33**

Urbanized Area	Population in 2000	Population in 2010	Change in Population	% Change in Population
North Carolina				
Asheville, NC	221,570	280,648	59,078	27
Burlington, NC	94,248	119,911	25,663	27
Charlotte, NC--SC	758,927	1,249,442	490,515	65
Concord, NC	115,057	214,881	99,824	87
Durham, NC	287,796	347,602	59,806	21
Gastonia, NC	141,407	169,495	28,088	20
Greensboro, NC	267,884	311,810	43,926	16
Hickory, NC	187,808	212,195	24,387	13
High Point, NC	132,844	166,485	33,641	25
Raleigh, NC	541,527	884,891	343,364	63
Winston-Salem, NC	299,290	391,024	91,734	31
All North Carolina UAs	**3,048,358**	**4,348,384**	**1,300,026**	**43**
All Piedmont UAs in GA, SC, and NC	**8,247,837**	**10,960,449**	**2,712,612**	**33**

Appendix G
Change in Size of Southern Piedmont Urbanized Areas 2000 to 2010

Urbanized Area	Land Area in 2000 (square miles)	Land Area in 2010 (square miles)	Change in Land Area	% Change in Land Area
Georgia				
Athens-Clarke County, GA	79.6	98.4	18.8	24
Atlanta, GA	1,962.6	2,645.4	682.8	35
Augusta-Richmond County, GA--SC	231.8	259.5	27.7	12
Cartersville, GA	38.2	50.6	12.4	32
Dalton, GA	54.4	80.8	26.4	49
Columbus, GA--AL	136.2	147.1	10.9	8
Gainesville, GA	90.4	126.3	35.9	40
Macon, GA	80.5	98.0	17.5	22
Rome, GA	40.8	47.7	6.8	17
All Georgia UAs	**2,714.5**	**3,553.7**	**839.2**	**31**
South Carolina				
Anderson, SC	68.9	74.1	5.2	8
Columbia, SC	268.9	380.0	111.1	41
Greenville, SC	226.5	320.3	93.7	41
Mauldin--Simpsonville, SC	55.9	83.6	27.7	50
Rock Hill, SC	61.2	95.6	34.4	56
All South Carolina UAs	**681.4**	**953.5**	**272.2**	**40**

Urbanized Area	Land Area in 2000 (square miles)	Land Area in 2010 (square miles)	Change in Land Area	% Change in Land Area
North Carolina				
Asheville, NC	206.8	264.9	58.1	28
Burlington, NC	64.8	90.4	25.7	40
Charlotte, NC--SC	434.9	741.5	306.6	70
Concord, NC	91.2	180.2	89.0	98
Durham, NC	156.8	181.7	25.0	16
Gastonia, NC	118.8	138.6	19.8	17
Greensboro, NC	135.5	185.2	49.7	37
Hickory, NC	210.8	261.6	50.8	24
High Point, NC	94.1	113.0	18.9	20
Raleigh, NC	319.6	518.1	198.5	62
Winston-Salem, NC	251.4	322.6	71.2	28
All North Carolina UAs	**2084.6**	**2997.9**	**913.4**	**44**
All Piedmont UAs in GA, SC, and NC	**5,229.0**	**7,182.6**	**1,953.52**	**37**

Appendix H
Advisors* to the 2001 study
"Weighing Sprawl Factors in Large U.S. Cities"

Urban Planning Oversight

Earl M. Starnes, *Ph.D., professor emeritus, urban and regional planning*, University of Florida
Eben Fodor, *urban planning consultant, Eugene (OR); author*, Better not Bigger: How to Take Control of Urban Growth and Improve Your Community
Gabor Zovanyi, *Ph.D., professor of urban planning*, Eastern Washington University
Robert Seaman, a*ssociate professor of environmental science*, New England College*; executive committee,* American Society of Civil Engineers' Urban and Development Division
Ruth Steiner, *Ph.D., professor of urban and regional planning*, University of Florida

Statistical Oversight

Alan J. Truelove, *Ph.D., statistician, retired professor*, University of the District of Columbia
B. Meredith Burke (1947-2002), *Ph.D., demographer*
Ben Zuckerman, *Ph.D., professor of physics and astronomy*, UCLA*; member*, UCLA Institute of the Environment
David Simcox, *director*, Migration Demographics
Dick Schneider, *chair,* Sierra Club Northern California Regional Sustainability Task Force
Leon Bouvier (1922-2011), *Ph.D., demographer*, Old Dominion University (VA)
Mark C. Thies, *Ph.D., P.E., professor of chemical engineering*, Clemson University
Marshall Cohen, *Ph.D., professor emeritus of astronomy*, California Institute of Technology
Paul Nachman, *Ph.D., physicist*
Scott Briles, *Ph.D., engineer*, Los Alamos National Laboratory, University of California
Steven A. Camarota, *Ph.D., public policy analyst*
William E. Murray, Jr., *Ph.D., physicist*
Michael Mueller, *Ph.D., natural resource economist*

Continued on next page

***** The individuals on this list volunteered to provide advice and guidance to the 2001 Kolankiewicz-Beck sprawl study for NumbersUSA and to have their names listed prominently as Advisors inside the front cover.

The affiliations of the Advisors were listed for identification purposes only, and it was emphasized that the views in the report did not necessarily reflect the views either of the institutions listed alongside them or of all views of the Advisors. Several Advisors helped shape the methodology of the study during the 18 months it lasted, and also assisted with production of interim reports on California and Florida. As the national-level study neared completion, the authors sought the assurance of having many more Advisors with a broad array of expertise to read the results and examine the analysis and methodology. The authors gratefully acknowledged the detailed recommendations, rigorous reviews, and vigorous discussion from and among the Advisors.

Environmental and General Oversight

Albert Bartlett (1923-2013), *Ph.D., professor emeritus of physics,* University of Colorado
Betty B. Davis, *Ph.D., psychologist*
Bill Smith, *Ph.D., dean, College of Global Economics,* EarthNet Institute
Craig Diamond, *adjunct faculty, environmental studies,* Florida State University*; technical advisor to the Sierra Club carrying capacity campaign*
David Pimentel, *Ph.D., professor of ecology and agricultural sciences,* Cornell University
Diana Hull, *Ph.D., behavioral scientist, retired,* Baylor College of Medicine
Edward G. Di Bella, *adjunct faculty,* Grossmont Community College (CA)*; president,* Friends of Los Penasquitos Canyon Preserve
Garrett Hardin (1915-2003), *Ph.D., professor emeritus of human ecology,* University of California, Santa Barbara
George Wolford, *Ph.D., president,* EarthNet Institute
Herbert Berry, *Ph.D., retired associate professor of computer information systems,* Morehead State University (KY)
James G. McDonald, a*ttorney, civil engineer*
Jeffrey Jacobs, *Ph.D.,* National Academy of Sciences
John Bermingham, *former Colorado state senator*
John Rohe, *attorney; board,* Conservation News Service
Linda Thom, *retired government budget analyst,* Santa Barbara County (CA)
Michael Hanauer, *member, Vision 2020,* growth management project of Lexington, (MA)
Ross McCluney, *Ph.D., principal research scientist, Florida Solar Energy Center,* University of Central Florida
Steve Miller, *former Las Vegas councilman,* Clark County (NV) Regional Transportation Commissioner
Stuart Hurlbert, *Ph.D., professor of biology,* San Diego State University
Terry Paulson, *Mayor Pro-tem,* Aspen (CO) City Council
Tom Reitter, Livermore (CA) City Council

Appendix I
2015 Piedmont Poll on Sprawl and Population

Piedmont Survey of 2,500 Adults
Conducted July 19-23, 2015
By Pulse Opinion Research

1. Do you know that your three-state region is called the Piedmont?

77% Yes
16% No
7% Not sure

2. On balance, has the development of the Piedmont made your region a better place to live, a worse place to live or did it not have much effect?

28% Better
30% Worse
33% Did not have much of an effect
8% Not sure

3. Have governments been able to provide the roads and transportation systems to handle the extra population in the Piedmont region well, or has traffic become worse?

23% New roads and transportation have handled extra population well
66% Traffic has become worse
11% Not sure

4. Has your Piedmont region developed too much, too little or about as much as it should?

29% Too much
14% Too little
48% About as much as it should
8% Not sure

5. Have you heard of a federal government study that concluded that – if recent development trends continue – the 400 miles between Raleigh and Atlanta would be filled with a broad swath of continuous urban and suburban development in 50 years?

26% Yes
56% No
17% Not sure

6. Would the continuous development from Atlanta to Raleigh make the region a better and more exciting place to live, a worse and more congested place to live, or would it not make much difference?

20% Better and more exciting
55% Worse and more congested
18% Not much difference
7% Not sure

7. If the developed areas of Atlanta and Raleigh – and everything in between – grew together into a 400 mile long metropolitan area, it is more likely that traffic would become much worse or that the government would be able to build enough extra transportation capacity?

73% Traffic would become much worse
18% The government would be able to build enough extra transportation capacity to accommodate the extra people
9% Not sure

8. Do you prefer that the Piedmont's towns and small cities remain separated from each other and keep their own identity or does it not matter too much if they are absorbed by larger cities?

76% Prefer towns and small cities remain separate and with own identity
17% It doesn't much matter if they are absorbed by larger cities
7% Not sure

9. How concerned are you about the ability to protect farmland from development in the Piedmont region?

44% Very concerned
36% Somewhat concerned
14% Not very concerned
4% Not at all concerned
3% Not sure

GROUPINGS: 80% Very or somewhat concerned
18% Not very or not at all concerned

10. Is it unethical to pave over and build on good farmland or is the demand for more housing for a growing population a legitimate reason to pave over and build on farmland?

64% It is unethical to pave over and build on good farmland
19% The demand for more housing is a legitimate reason to pave over farmland
18% Not sure

11. How important is it to save the natural areas and open spaces that are currently between the cities of your Piedmont region?

61% Very important
27% Somewhat important
6% Not very important
1% Not at all important
4% Not sure

GROUPINGS: 88% Very or somewhat important
7% Not very or not at all important

12. Would you prefer that the Piedmont's population continue to grow at the recent rapid rate, that it grow much more slowly, that it stay about the same size as it is now, or that it become smaller?

13% Prefer the Piedmont's population grow at recent rapid rate
48% Grow much more slowly
25% Stay about the same size as it is now
9% Become smaller
5% Not sure

GROUPINGS: 82% Population should grow much more slowly than at present, stay the same size (stabilize), or become smaller

13. Should the federal government reduce new immigration to slow down population growth, keep new immigration and population growth at the current rate, or increase annual immigration and population growth?

60% Reduce new immigration to slow down Piedmont population growth
26% Keep new immigration and population growth at current rate
5% Increase immigration and population growth
9% Not sure

14. Should local and state governments in the Piedmont make it more difficult for people to move to the region by restricting development?

30% Yes
52% No
18% Not sure

15. Should governments protect farmland and natural habitats with regulations that push a growing population to live in higher-density houses and apartment and condo buildings which take up less space?

42% Yes
34% No
25% Not sure

16. Which would you prefer as a way to protect farmland and natural habitats in the Piedmont?

39% Slow down population growth
12% Push people to live in higher density
22% Both
18% Neither
9% Not sure

17. How long have you lived in the three-state Piedmont region?

51% Whole life
11% Moved here while a child
36% Moved here as an adult
2% Not sure

18. Do you live in a rural area, a town, a small city, the suburbs or in a big city?

27% Rural
17% Town
20% Small city
21% Suburbs
8% Big city
3% Not sure

19. Where would you prefer to live?

32% Rural
17% Town
20% Small city
27% Suburbs
8% Big city
1% Not sure

Appendix J
2014 National Poll on Sprawl and Population

SPRAWL & POPULATION National Poll

Survey of 1,000 Likely Voters
Conducted April 1-2, 2014
By Pulse Opinion Research
NOTE: Margin of Sampling Error, +/- 3 percentage points with a 95% level of confidence

1* The U.S. Department of Agriculture calculates that over the last decade urban sprawl destroyed millions of acres of farmland and natural habitat equal in size to the entire state of Maryland. If this were to continue, would it be a major problem, somewhat of a problem, not much of a problem or not a problem at all?

42% A major problem
35% Somewhat of a problem
17% Not much of a problem
3% Not a problem at all
4% Not sure

GROUPINGS: 77% A major or somewhat PROBLEM
20% NOT MUCH or at all a problem

2* How important is it to protect farmland from development so the United States is able to produce enough food to completely feed its own population in the future?

71% Very important
21% Somewhat important
6% Not very important
0% Not important at all
2% Not sure

GROUPINGS: 92% Very or somewhat IMPORTANT
6% NOT VERY important

3* How important is it for the United States to have enough farmland to be able to feed people in other countries as well as its own?

26% Very important
46% Somewhat important
19% Not very important
6% Not important at all
2% Not sure

GROUPINGS: 72% Very or somewhat IMPORTANT
25% NOT VERY or at all important

4* Which do you agree with more: That it is unethical to pave over and build on good cropland or that the need for more housing is a legitimate reason to eliminate cropland?

59% It is unethical to pave over and build on good cropland
19% The need for more housing is a legitimate reason to eliminate cropland
22% Not sure

5* The government reports that to make room for growing cities the last three decades, 17 million acres of surrounding woodlands have been cut down. How significant a problem is this loss of natural wildlife habitat?

53% Very significant
32% Somewhat significant
11% Not very significant
1% Not at all significant
3% Not sure

GROUPINGS: 85% Very or somewhat SIGNIFICANT
12% NOT VERY or at all significant

6* Do you feel an emotional or spiritual uplift from time spent in natural areas like woodlands and open grasslands?

70% Yes
18% No
12% Not sure

7* How important is it that you can get to natural areas fairly quickly from where you live?

48% Very important
37% Somewhat important
11% Not very important
2% Not important at all
2% Not sure

GROUPINGS: Very or somewhat IMPORTANT
NOT VERY or at all important

8*A study of government data found that most of the development destruction of farmland and natural habitat over the last decade was related to rapid growth in the United States population. The Census Bureau projects the population is on pace to double this century. Would doubling the population in YOUR area make it better, worse or not much different?

9% Better
60% Worse
24% Not much different
7% Not sure

9* If the population in YOUR AREA were to double, would traffic become much worse or would the government be able to build enough extra transportation capacity to accommodate the extra people?

68% Traffic would become much worse
20% The government would be able to build enough extra transportation capacity to accommodate the extra people
13% Not sure

10* Over the rest of this century, would you prefer that the nation's population continue to double to 600 million, grow by half to 450 million, stay about the same as it is now at just over 300 million, or slowly become smaller?

9% Continue to double to 600 million
26% Grow by half to 450 million
43% Stay about the same at more than 300 million
12% Slowly become smaller
9% Not sure

GROUPINGS: 9% Continue present pace
81% Slow pace of growth by at least half

11* Census data show that since 1972, the size of American families has been at replacement-level. But annual immigration has tripled and is now the cause of nearly all long-term population growth. Does the government need to reduce immigration to slow down population growth, keep immigration the same and allow the population to double this century, or increase immigration to more than double the population?

68% Reduce immigration to slow down population growth
18% Keep immigration the same and allow population to double
4% Increase immigration to more than double the population
10% Not sure

12* Currently the government allows one million legal immigrants each year. How many legal immigrants should the government allow each year – two million, one million, a half-million, 100,000, or zero?

7% Two million
14% One million
23% Half a million
20% 100,000
20% Zero
16% Not sure

GROUPINGS: 21% Keep same level or increase
63% Cut immigration at least in half

Appendix K
Major Findings of our Previous National Sprawl Studies in 2001 and 2003

Our two sprawl studies – conducted more than a decade ago (published in 2001 and 2003) – were titled "Weighing Sprawl Factors in Large U.S. Cities: A report on the nearly equal roles played by population growth and land use choices in the loss of farmland and natural habitat to urbanization"[81] and "Outsmarting Smart Growth: Population Growth, Immigration, and the Problem of Sprawl."[82] They made a number of key findings and conclusions.

The two main findings from the 2001 study on the 100 largest Urbanized Areas in the U.S. were the following:

> **(1) Per Capita Sprawl:** About half the sprawl nationwide appears to be related to the land-use and consumption choices that lead to an increase in the average amount of urban land per resident (**Figure K-1**).
>
> **(2) Population Growth:** The other half of sprawl is related to the increase in the number of residents within those 100 Urbanized Areas.

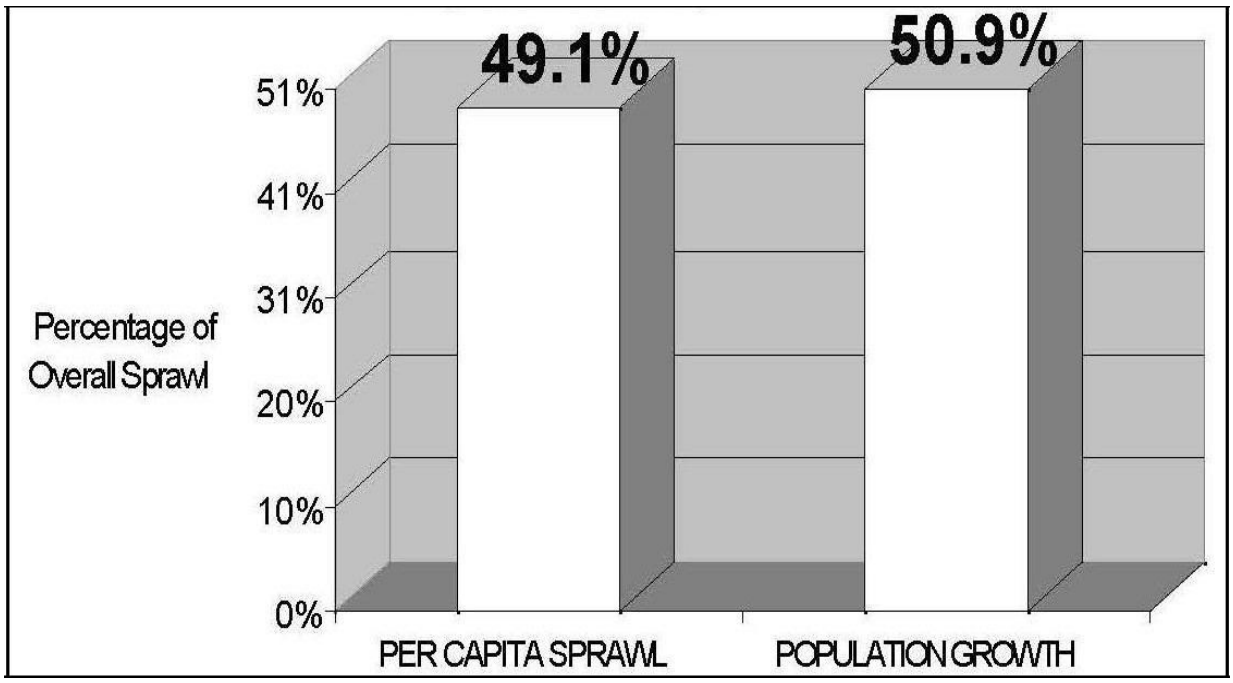
"On average, there are more of us, and each of us is using more urban land, and therein lie the two halves of the problem," wrote the authors in the 2001 study. These findings then led the authors to the following conclusions:

- The toll of urban sprawl on ecosystems, farmland and scenic open spaces cannot be substantially halted unless anti-sprawl efforts include a two-pronged attack using both land-use/consumption tools and population tools.
- Anyone advocating U.S. population stabilization who derides the importance of consumption and planning controls is ignoring half the story of American sprawl.
- Similarly, any Smart Growth advocate who relegates population growth to a side issue is turning a blind eye to half the problem and, thus, approximately half the solution, which is U.S. population stabilization.

[81] Kolankiewicz, L. and R. Beck. 2001. Weighing Sprawl Factors in Large U.S. Cities: A report on the nearly equal roles played by population growth and land use choices in the loss of farmland and natural habitat to urbanization. Analysis of U.S. Bureau of the Census Data on the 100 Largest Urbanized Areas of the United States. March 19. NumbersUSA: Arlington, VA. 64 pp. Available at: https://www.numbersusa.com/content/resources/publications/publications/studies/weighing-sprawl-factors-large-us-cities.html.

[82] Beck, R., L. Kolankiewicz, and S. Camarota. 2003. Outsmarting Smart Growth: Population Growth, Immigration, and the Problem of Sprawl. Washington, DC: Center for Immigration Studies. Center Paper 22. August. 122 pp. Available at: http://www.cis.org/sites/cis.org/files/articles/2003/sprawl.html.

Figure K-1. Sources of Urban Sprawl in 100 Largest Cities, 1970-1990



Source: Kolankiewicz and Beck (2001). Footnote #1.

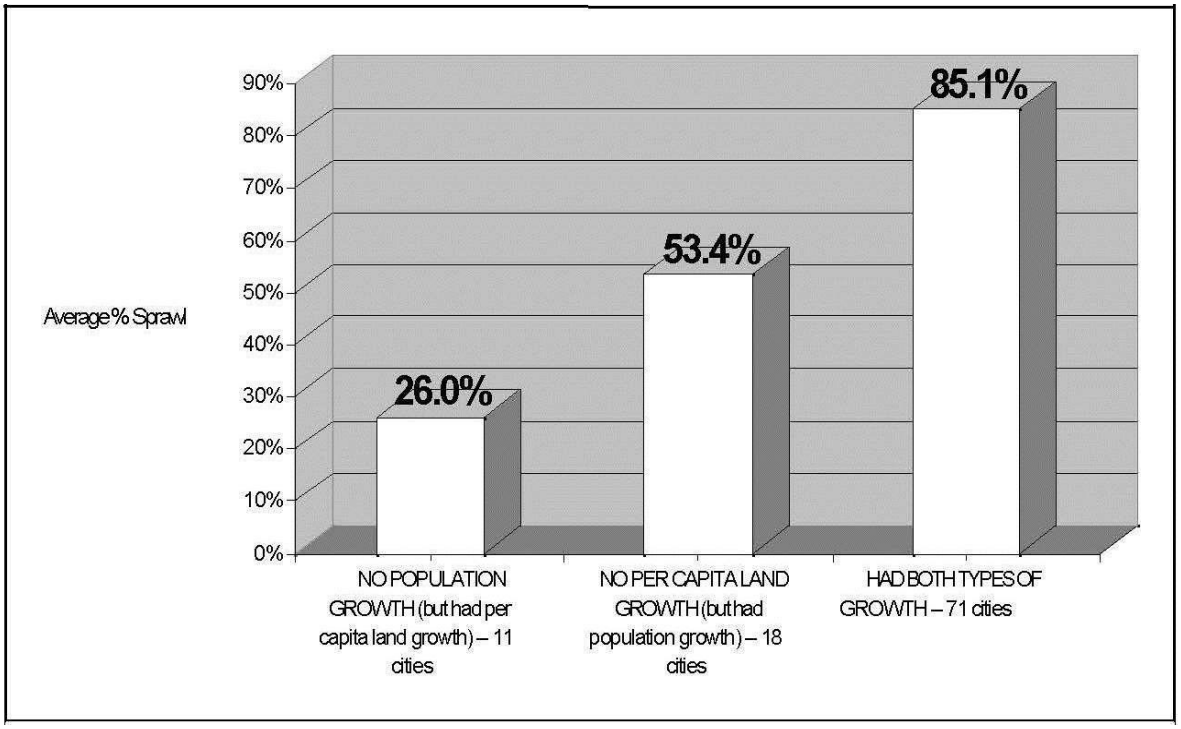
- Although the circumstances of each city are different, the power of both sprawl factors is potentially the same in each. Every city that wishes to restrain its land expansion will need to continually keep in mind the impacts on sprawl of both growth factors. Cities with no recent per capita land consumption growth should not throw away land-use tools, lest Per Capita Sprawl resume. And cities with no recent population growth will still need to be reminded regularly of the role population can play in sprawl, lest they inadvertently create incentives to promote population growth in the future.

- The forces driving overall national population growth cannot be ignored as contributors to sprawl, since national population growth manifests itself as growth in local communities.

The 2001 study concluded that cities with either, 1) no growth in population or, 2) no growth in per capita land consumption, still had sprawl. However, cities that had both types of growth had far higher sprawl (**Figure K-2**).

The main emphasis of the later 2003 study "Outsmarting Smart Growth" was analysis of sample data from the National Resource Conservation Service's NRI that estimated the increase in developed land from 1982-1997. That study reached these findings and conclusions:

Figure K-2. Average Sprawl Rate by Type of Growth, 100 Largest Cities, 1970-1990



Source: Kolankiewicz and Beck (2001). Footnote #1.

- The more a given state's population grew, the more the state sprawled (see **Figure K-3**). For example, states that grew in population by more than 30 percent between 1982 and 1997 sprawled 46% on average. In contrast, states that grew in population by less than 10% sprawled only 26% on average.

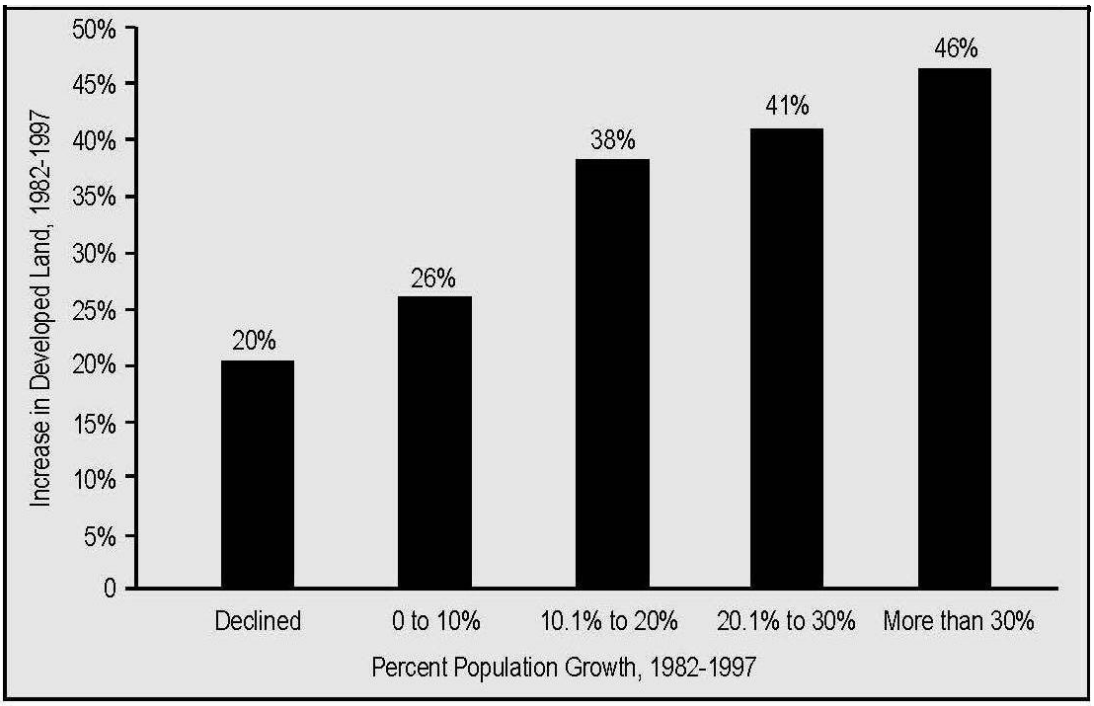
- On average, each 10,000-person increase in a state's population resulted in 1,600 acres of undeveloped rural land being developed, even controlling for other factors such as changes in population density.

- Apportioning the share of sprawl that is due to increases in population versus increases in per-capita land consumption shows that, nationally, population growth accounted for 52 percent of the loss of rural land between 1982 and 1997, while increases in per-capita land consumption accounted for 48 percent.

- While population growth is a key factor driving sprawl, our findings indicate that Smart Growth must also play a significant role in anti-sprawl efforts because per capita land use has been increasing. Between 1982 and 1997, land use per person rose 16 percent from 0.32 acres to 0.37 acres.

- There is significant variation between states in the factors accounting for sprawl. For example, population growth accounted for more than half of sprawl in five of the 10 states that lost the most land, while increases in per-capita land use accounted for more than half of sprawl in the other five worst sprawling states.

Figure K-3. Percentage Increase in Developed Land by State's Percentage Population Growth



Source: Beck, Kolankiewicz and Camarota (2003). Footnote #2.

- An examination of the nation's largest urban areas reveals the same pattern as in the states. Between 1970 and 1990, population growth accounted for slightly more than half of the expansion of urbanized land in the nation's 100 largest cities.

- In the 1990s, new immigration and immigrant fertility accounted for most of the 33-million increase in the U.S. population. Census Bureau data from 2002 indicate that the more than 1.5 million legal and illegal immigrants who settle in the country each year along with 750,000 yearly births to immigrants are equal to 87 percent of the annual increase in the U.S. population.

- Contrary to the common perception, about half the country's immigrants now live in the nation's suburbs. The pull of the suburbs is even greater in the second generation. Of the children of immigrants who have settled down and purchased a home, only 24 percent have done so in the nation's central cities.

- The suburbanization of immigrants and their children is a welcomed sign of integration. But it also means that they contribute to sprawl just like other Americans.

"In short," concluded the 2003 study, "Smart Growth efforts to slow or stop the increase in per capita land use are being negated by population growth. Immigration-driven population growth, in effect, is 'out-smarting' Smart Growth initiatives by forcing continued rural land destruction.

When Atlanta & Raleigh Collide

Which Factors at Fault in Emerging Piedmont Megalopolis?