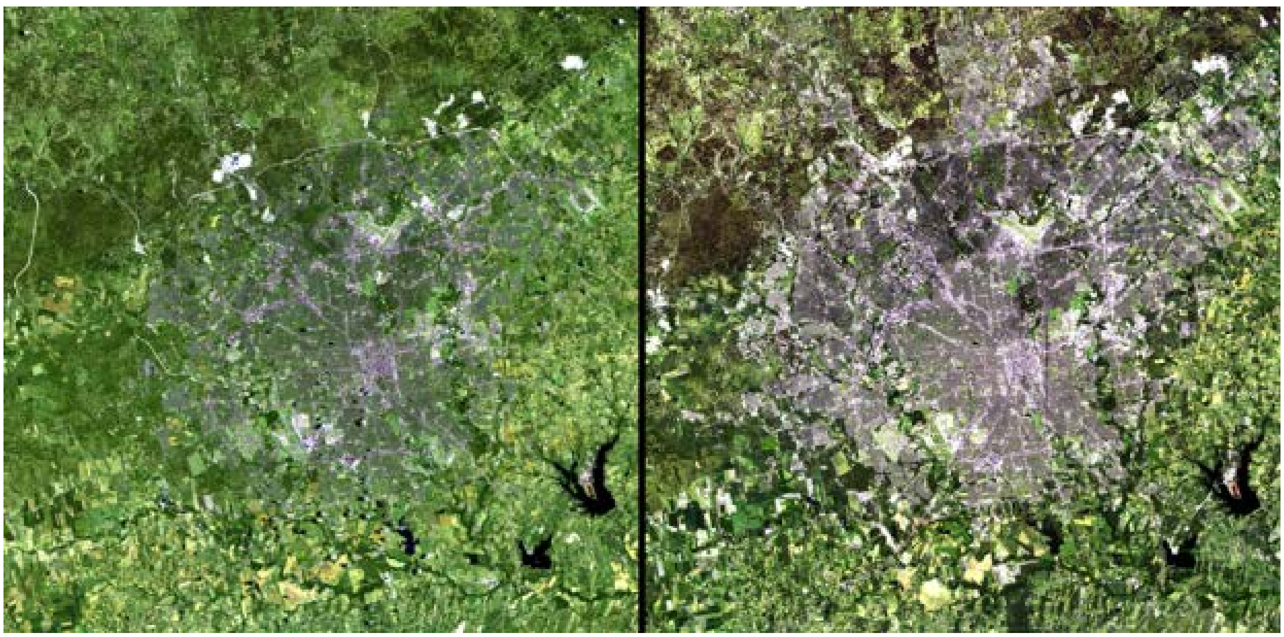
POPULATION GROWTH AND SPRAWL IN TEXAS

How an Exploding Population Consumes Natural Habitat and Agricultural Land in the Lone Star State



Sprawling San Antonio in 1991 (l.) and 2010 (r.)
Images: NASA

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Executive Summary

Lone Star State Leads Nation in Both Population Growth and Sprawl

Between 1990 and 2016, Texas added 11 million people to its population, more than any other state in the country. Its population has grown faster even than the nation's most populous state, California, both in terms of the sheer numbers of people added (10.9 million versus 9.5 million), as well as much faster in terms of percentage growth (64% versus 32%).

These millions of additional Texas residents all need additional space and land for their homes; workplaces; schools; hospitals; commercial areas; recreation sites; surface transportation facilities; and energy, water supply and other utility infrastructure; among other developed land uses that service their needs as modern American consumers.

Thus, it is not surprising that in recent decades Texas has also led the nation in urban sprawl. In fact, between 2002 and 2012, Texas lost more than twice as much open space to sprawl as its nearest rival, Florida. These "open spaces" or rural lands are either natural habitats or agricultural lands (farmland) or some combination of both. Their permanent disappearance under pavement, buildings, and asphalt represents a profound, long-term loss of agricultural potential, ecological values and functions, and quality-of-life amenities for Texans.

The Texas population is growing by 1,000 people per day (a rate of 365,000 people per year, or more than a million additional people every three years). Approximately half of these new Texans are migrants who come from other states and countries, while Texas births comprise the other half. According to the U.S. Census Bureau, net migration to Texas was 187,545 people between July 2017 and July 2018.

For the second year in a row, more than half of the net migration came from other countries (foreign migration) rather than from other U.S. states. In 2018, nearly 105,000 immigrants to Texas were foreigners. Previously, domestic migration had dominated the migration input to Texas growth.

If current demographic trends in Texas – characterized by the most rapid population growth of any state in the union – continue as projected by official state demographers and shown in Figure ES-1, Texas will have a population of about 50 million in 2070, up from approximately 30 million in 2020, and 20.9 million in 2000. The Texas population will still be growing rapidly in 2070 with no end in sight.

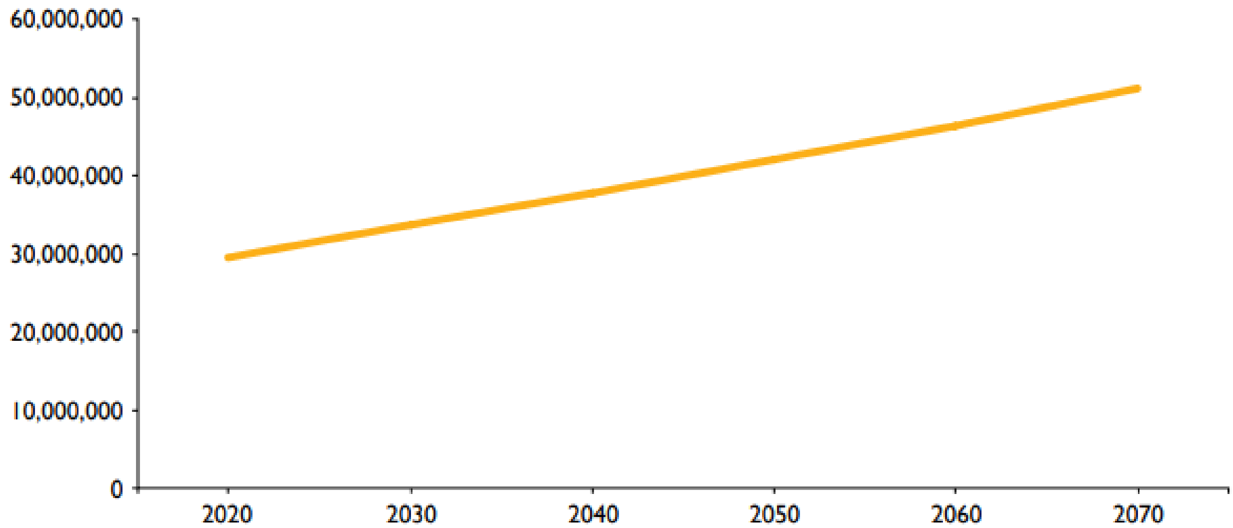

Figure ES-1. Projected Population Growth in Texas, 2020 to 2070
Source: Texas Water Development Board

Combining these demographic trends and current sprawl development patterns, Texans can expect to see millions of additional acres of their state's remaining open space converted to urbanized and developed lands in the coming decades. In 2012, the average Texas consumed or accounted for about one-third of an acre of developed land. If the 20 million additional Texans projected by 2070 continue to use land at the same rate as the average resident in 2012, approximately 6.8 million acres (over 10,600 square miles, an area about the size of Massachusetts) of additional open space – e.g., farmland, pastureland, ranchland, wildlife habitat – in the state will be converted permanently from rural to developed land.

Not many Texans, we believe, would assert that this loss of open space in perpetuity amounts to "progress." Bigger may be better, but only to a point, and there can be too much of a good thing.

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 in this study 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 on sprawl in the Lone Star State 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 fixed and dwindling inventory of 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 gasoline 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 of this report.

Findings

Figure ES-2 compares the rates of sprawl when the 34 Texas 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 18 cities that experienced 10-30 percent population growth sprawled almost three times as much on average (29 percent) as those cities that experienced below 10 percent population growth (11 percent sprawl or increase in urban area). Cities whose populations grew between 31 and 50 percent experienced mean sprawl of 49 percent between 2000 and 2010. And the three cities whose populations grew by more than 50 percent sprawled by a whopping mean of 173 percent, though this high number may be somewhat misleading, biased by the small sample size (three UAs).

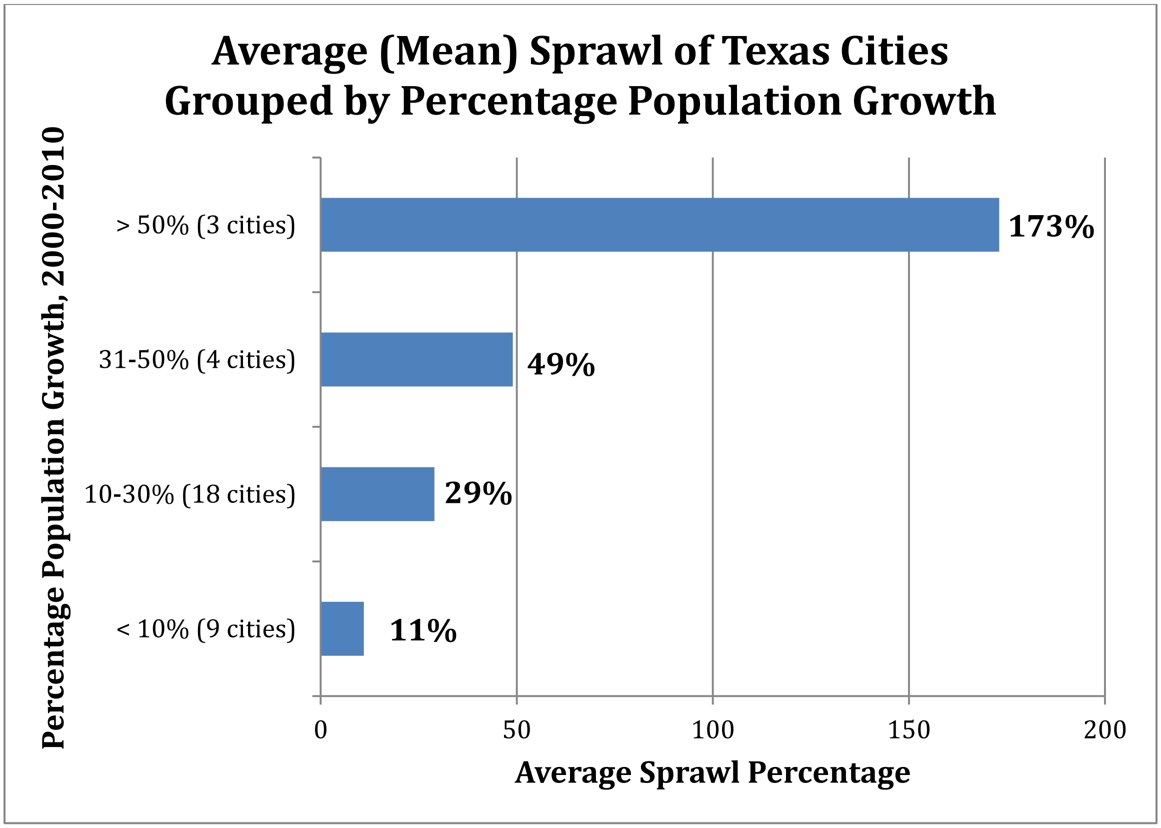

Figure ES-2. Texas Cities with More Population Growth Generated More Sprawl

The 10 cities in Texas with the most sprawl (144 square miles on average) between 2000 and 2010 experienced average population growth of approximately 355,000. In contrast, the 10 cities with the least sprawl (just six square miles on average) averaged about 10,400 population growth during the same decade.

Our primary concern as conservationists is the ongoing loss of rural lands – agricultural lands, natural habitats, and other open space – to development and sprawl. Thus, it is worth estimating how much of this loss is related to Per Capita Sprawl (increase in per capita land consumption) and how much is related to Population Growth.

Using a methodology explained in Appendix C, we determined the percentage of sprawl in Texas that is related to population growth and the percentage related to increasing per capita land consumption (Per Capita Sprawl). Figure ES-3 is a pie chart displaying the results of this analysis for the 34 UAs between 2000 and 2010. Approximately 15 percent of the sprawl in Texas' town and cities was related to increasing per capita land consumption. Approximately 85 percent of the sprawl in UAs over this decade was related to population growth.

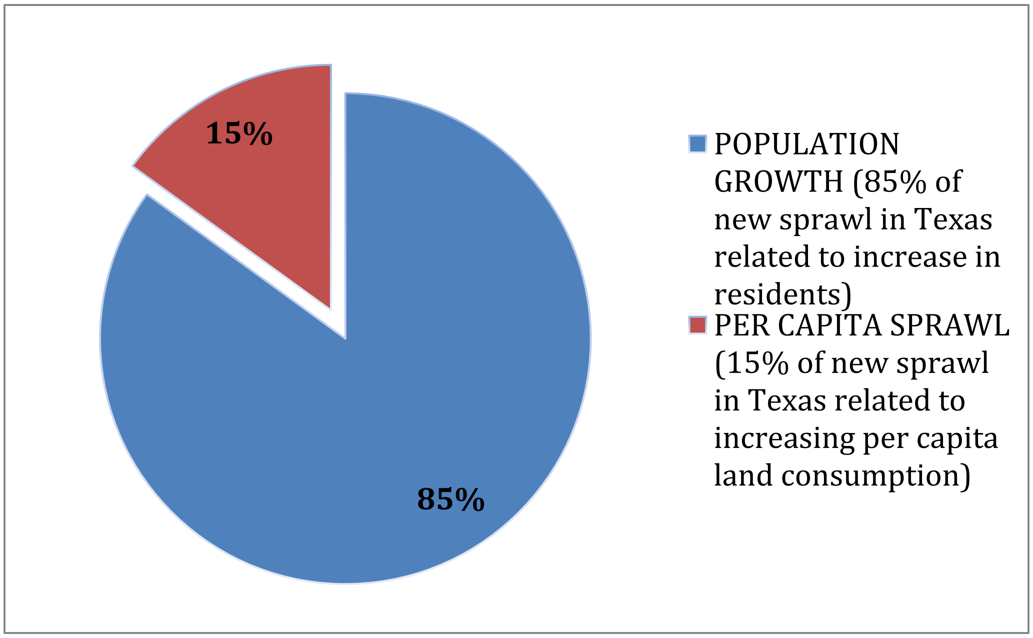

Figure ES-3. Percentages of Sprawl Related to Population Growth and Per Capita Sprawl in Texas' 34 Urbanized Areas

Source: U.S. Census Bureau, 2000-2010

These same findings can also be depicted as shown in Figure ES-4. Between 2000 and 2010, Texas UAs sprawled across an additional 1,726 square miles of land. Population growth was responsible for more than five times as much loss of rural land as per capita sprawl or rising land consumption per capita: 1,460 square miles vs. 266 square miles.

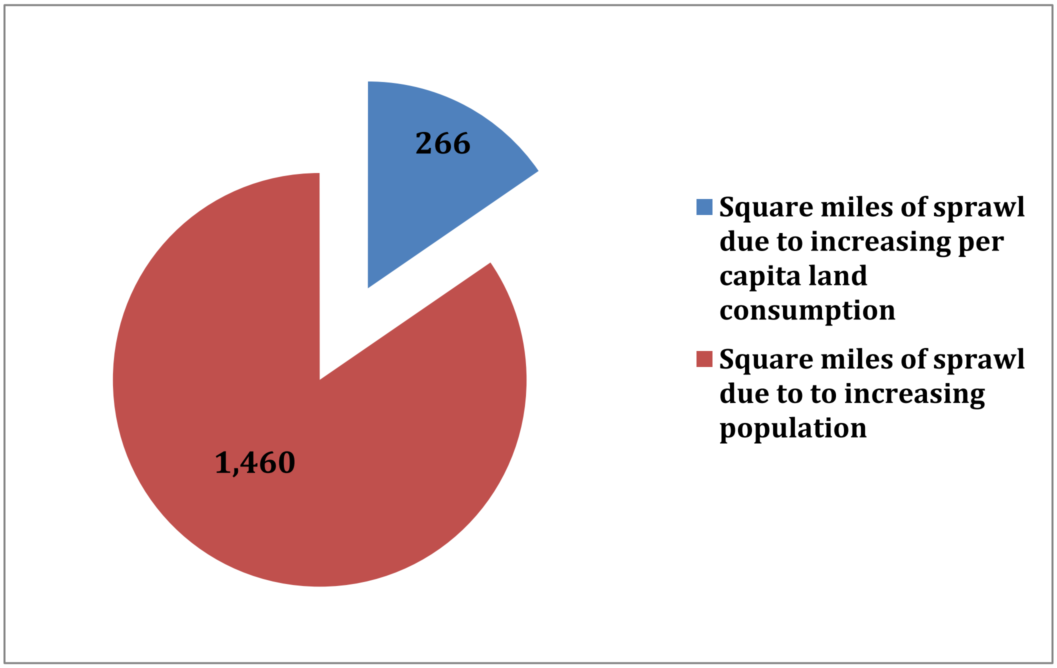

Figure ES-4. Rural Land Lost to Per Capita Sprawl vs. Population Growth in 34 Texas UAs, 2000-2010

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 yield identical results, and indeed, our calculations do not. However, they produce fairly similar results, which is a sign of the robustness of our findings and an indication of their probable veracity.

From 2002 to 2012, a slightly different time frame than the Census Bureau's most recent decade (2000 to 2010), the analysis of NRI Developed Land data for Texas shows that population growth accounted for 68 percent of sprawl in the state (Figure ES-5). This compares to 85 percent for the 2000-2010 Census Bureau UA delineations. It is not surprising that population density would be higher in growing urban areas than outlying rural parts of the state that are also growing, and this accounts for the difference between the 85% and 68% results.

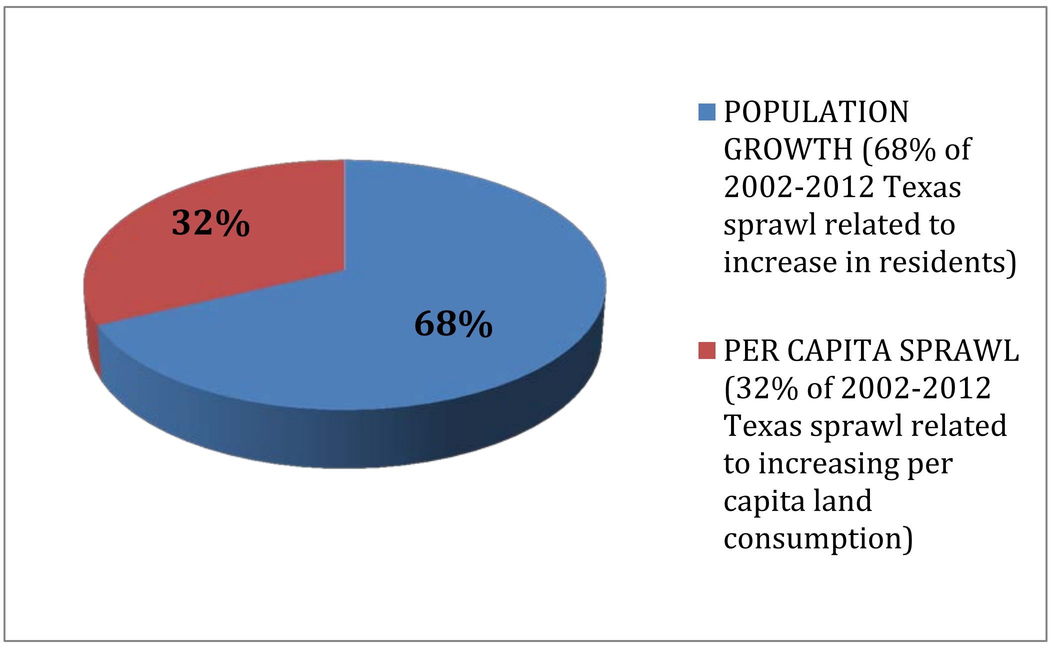

Figure ES-5. Sprawl Factors (Increasing Population and Increasing Per Capita Land Consumption) in all Texas Counties, 2002-2012

Conclusions and Policy Implications

- At both the state level of Texas and the national level there is a broad correlation between population size and sprawl: generally, the larger a city, county, or state's population, the larger the land area it will sprawl across.

- Sprawl continues to devour rural land around Texas cities at a very rapid rate.
- The role of population growth in driving sprawl in Texas has stayed consistently high through the last several decades, but has gradually increased over time.
- Attempts to concentrate and direct development into confined areas are not enough to offset the pressures from population growth.
- Stabilized population alone does not prevent sprawl.
- People continue to flock en masse to the Lone Star State.
- If current population trends are allowed to continue, Texas will experience enormous amounts of sprawl over the next half century.

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 and denser development that reduce per capita land consumption. The results of this study suggest that in Texas less than a third 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 remaining undeveloped lands of Texas.

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 state of Texas. Between July 1, 2015 and July 1, 2016, according to Census Bureau estimates, Texas added nearly 400,000 people, which is a rate of 4 million per decade.

At this rate, 28 million Texans at present will have increased to more than 40 million by 2050. In fact, the Texas Office of the State Demographer has published population projections to 2050 under three migration scenarios (0.0, 0.5, 1.0) for all counties and the entire state. The 2050 population projections for Texas ranged from 31,246,355 under the no in-migration scenario (0.0), through 40,502,749 for the middle scenario (0.5, in which in-migration occurs at half the rate as during the high in-migration 2000-2010 period), up to 54,369,297 in the high 1.0 series. The 1.0 projection assumes that migration into Texas from all sources (foreign and domestic) would continue all the way to 2050 at the same rapid rate that occurred during the 2000 to 2010 decade. In the 1.0 scenario, the population of Texas will have approximately doubled in just 33 years.

Based on the results of our study, urban sprawl will engulf perhaps another four million acres or 6,000 square miles of farmland and wildlife habitat in Texas by 2050 if current population growth trends continue.

Population is growing fastest in the "Texas Triangle Megaregion," those Texas counties located in the triangle formed by the Dallas – Fort Worth Metroplex to the north, Houston to the southeast, and San Antonio to the southwest. These Urbanized Areas are connected by Interstate 35 (Dallas-Ft. Forth to San Antonio), I-40 (San Antonio to Houston), and I-45 (Houston to Dallas-Ft. Worth). The triangle also includes the UAs for Austin, Waco, College Station-Bryan, and Temple. The Texas Triangle is also the area of the state most threatened by urban sprawl.

Bigger Is Not Always Better

Long-term population growth in the United States and Texas is in the hands of federal policy makers and lawmakers. It is they who have increased the annual settlement of immigrants in the U.S. 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 Texas must include reducing the volume of population growth, which requires lowering the level of immigrants entering the country each year unless Americans and immigrants were to decide to move to a one-child per woman average fertility rate, which is highly unlikely and is found nowhere on Earth.

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.

That would appear to be a popular option among most Americans. A poll of America's likely voters in 2014 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.

> **QUESTION:** Over the rest of this century, would you prefer that the <u>nation's population</u> 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

QUESTION: 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: 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

We strongly suspect that Texans would endorse these opinions expressed by their fellow Americans. And they are sentiments that are widely shared. 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.”

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1. INTRODUCTION

Since 1990, Texas has added 11 million people to its population, more than any other state in the country (Table 1). Its population has grown faster even than the most populous state, California, both in terms of the sheer numbers of people added (10.9 million versus 9.5 million), as well as much faster in terms of percentage growth (64% versus 32%).

Table 1. Ten Highest Population Growth States in the U.S., 1990 to 2016

Top 10 states by rank	Population in 1990[1]	Population in 2016[2]	Growth, 1990-2016	Annual Growth 1990-2016	% growth, 1990 to 2016
1. Texas	16,986,510	27,862,596	10,876,086	418,311	64%
2. California	29,760,021	39,250,017	9,489,996	365,000	32%
3. Florida	12,937,926	20,612,439	7,674,513	295,174	59%
4. Georgia	6,478,216	10,310,371	3,832,155	147,391	59%
5. North Carolina	6,628,637	10,146,788	3,518,151	135,314	53%
6. Arizona	4,375,099	6,931,071	2,555,972	98,307	58%
7. Washington	4,866,692	7,288,000	2,421,308	93,127	50%
8. Colorado	3,294,394	5,540,545	2,246,151	86,390	68%
9. Virginia	6,187,358	8,411,808	2,224,450	85,556	36%
10. New York	17,990,455	19,745,289	1,754,834	67,494	10%

[1] From 1990 Census, at: https://www.census.gov/population/cen2000/tab05.txt
[2] July 1, 2016 estimate from U.S. Census Bureau at: www.census.gov/quickfacts

These millions of additional residents all need additional space and land for their homes; workplaces; schools; hospitals; commercial areas; recreation sites; surface transportation facilities; and energy, water supply and other utility infrastructure; among other developed land uses that service their needs as modern American consumers. Thus, it is not surprising that in recent decades Texas has also led the nation in urban sprawl. In fact, between 2002 and 2012, Texas lost more than twice as much open space to sprawl as its nearest rival, Florida. Table 2 lists the top ten states in terms of the area of open space converted to developed or urbanized land uses in recent years. These "open spaces" or rural lands are either natural habitats or agricultural lands (farmland) or some combination of both. Their permanent disappearance under pavement, buildings, and asphalt represents a profound, long-term loss of agricultural potential, ecological values and functions, and quality-of-life amenities for Texans and Americans.

Table 2. Top Ten Sprawling States, Ranked by Area of Open Space Lost

Ranking (by area) 2002-2012	Total Sprawl (square miles), 2002-2012	State	Total Sprawl (square miles), 1982-2012	Total Sprawl Ranking by Area, 1982-2012
1	1,855	Texas	5,857	1
2	892	Florida	4,193	2
3	755	California	3,404	5
4	648	Georgia	3,740	4
5	643	North Carolina	3,818	3
6	528	Arizona	1,809	13
7	458	Virginia	2,076	10
8	445	Tennessee	2,280	7
9	404	Ohio	2,056	9
10	403	Alabama	1,944	12

Source: USDA Natural Resources Conservation Service, *2012 National Resources Inventory, Summary Report* (August 2015)

1.1 Sprawl Still a Problem After All These Years (and Americans and Texans Are Still Concerned)

When NumbersUSA published its first national level study on sprawl in 2001,[1] sprawl was a hot topic with many environmental organizations and the general public concerned about the impacts of ever-expanding cities and the nation's steadily disappearing rural land.[2] Sixteen years later, sprawl is still devouring valuable farmland and wildlife habitat, both in Texas and

[1] 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.

[2] 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.

nationwide, but national and state environmental groups, by and large, have shifted their focus toward global issues like climate change, and away from the loss of habitat and open space due to the unsustainable outward expansion of cities in America. Concern about sprawl is no longer regarded as "sexy."

Despite our country's economic setbacks since the Great Recession of 2008, sprawl continues to be a major threat to rural land and natural habitats in the United States. Nationally, in just the ten years from 2002 to 2012 over 9.2 million acres (about 14,400 square miles) – an area larger than Maryland – of previously undeveloped land succumbed to the bulldozer's blade.

Although urban sprawl by name is not particularly salient in the news anymore, 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 would like these unfavorable trends halted or at least curbed. A 2014 survey of likely American voters revealed that 77 percent thought that the destruction of farmland and natural habitat because of urban sprawl was a "major problem" (42%) or "somewhat of a problem" (35%). Eighty-five percent responded that the loss of natural wildlife habitat to growing cities was "very" (53%) or "somewhat" (32%) significant.[3]

In the 1982-2012 period measured by the National Resources Inventory (NRI), conducted by the United States Department of Agriculture's (USDA) Natural Resources Conservation Service (or NRCS, formerly the Soil Conservation Service or SCS), approximately 5,857 square miles (3,748,600 acres) of open space in Texas were converted into housing, shopping malls, streets, schools, government buildings, waste treatment facilities, parking lots, vacation homes, resorts, highways, and places of work, worship, and entertainment.[4]

As native-born Texans and newcomers to the state seek jobs and better economic opportunities, Texas cities have sprawled ever further outward. This new development puts pressure on natural resources, habitats, and species in many ecologically sensitive areas. It is for these reasons that the authors decided Texas warranted its own study on population growth and sprawl. In studying the factors that cause sprawl, we have previously conducted three national-level studies (2001, 2003, and 2014), two on Florida (2000 and 2015), one on California (2000), one on the Chesapeake Bay watershed (2003), and one on the Southern Piedmont (portions of North Carolina, South Carolina, and Georgia) in 2015-2016. These

[3] 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 H of this study for entire poll.

[4] USDA Natural Resources Conservation Service (NRCS). 2015. *2012 National Resources Inventory, Summary Report* (August). Accessed online March 2017 at: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcseprd396218.pdf

studies are available at the NumbersUSA website, www.numbersusa.com and have been cited numerous times in the technical and popular literature.

This study, focused on Texas, examines the quantity and rate of rural land lost to development surrounding the state's 34 Urbanized Areas (UAs – entities defined by the Census Bureau as central cities and the contiguous development of their suburbs). In these 34 UAs alone, 1,656 square miles (1,059,840 acres) of surrounding rural land were lost to urbanization during the most recent decade between the 2000 Census and the 2010 Census (Table 3). We also examine the two principal factors behind this sprawl, determining the degree to which population growth and growth in per capita land consumption (decreasing population density) each "drove" sprawl from 2000 to 2010.

With regard to Table 3, it is important to note that the amount of sprawl that occurred around these 34 UAs by no means encompasses all sprawl and land development that occurred throughout the entire state. Sprawl also took place around smaller cities and towns and that smaller-scale sprawl is not captured in this table; in aggregate, it is substantial.

Table 3. Texas Urbanized Areas Ranked by Amount of Sprawl from 2000 to 2010

Urbanized Area	Sprawl (sq. miles)
1. Dallas--Fort Worth--Arlington	372
2. Houston	365
3. Austin	205
4. San Antonio	190
5. Conroe--The Woodlands	92
6. Port Arthur	60
7. McKinney	47
8. McAllen	44
9. Tyler	33
10. Longview	32
11. El Paso, TX--NM	31
12. Brownsville, TX	24
13. Harlingen	24
14. Denton--Lewisville	24
15. Laredo	23
16. College Station--Bryan	22
17. Lubbock	22
18. Killeen	21
19. Waco	21
20. Texas City	17
21. Temple	13
22. Beaumont	10
23. Corpus Christi	10
24. Lake Jackson--Angleton	8

Urbanized Area	Sprawl (sq. miles)
25. Midland, TX	8
26. Abilene, TX	7
27. Amarillo, TX	7
28. Texarkana, TX—Texarkana, AR	6
29. Odessa, TX	6
30. Sherman, TX	4
31. San Marcos, TX	2
32. San Angelo, TX	1
33. Wichita Falls, TX	-2
34. Victoria, TX	-22
Total open space lost to sprawl around the edges of the 30 Texas urbanized areas	**1,726**

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

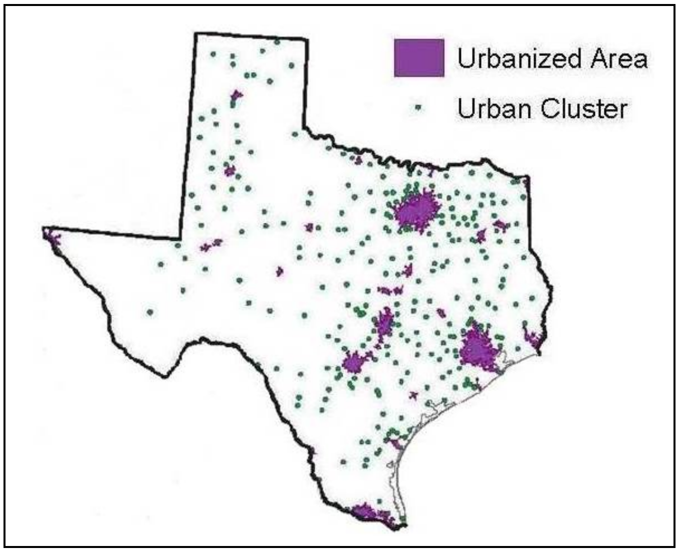
This study also includes changes in the amount of Developed Land in Texas as delineated by the NRI of the NRCS of the U.S. Department of Agriculture.

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.

Figure 1 is a map that provides a sense of scale, depicting the size, shape, and location of Texas' 34 Urbanized Areas and scores of Urban Clusters (smaller urban zones/population centers also designated and delineated by the Census Bureau) within the state as a whole in 2010, after more than a century of population growth and urban expansion. The largest two UAs are Dallas and Houston, followed by Austin and San Antonio.

Figure 1. Urbanized Areas (UAs) and Urban Clusters in Texas, 2010

Source: U.S. Census Bureau, 2010 Census Urban Area Delineation Program



It is evident that the eastern half of Texas is becoming ever more urbanized. Figure 2 is a satellite image depicting Texas and small portions of surrounding states (New Mexico, Oklahoma, Louisiana, and northern Mexico) at night. The two brightest blotches are Dallas and Houston, followed by Austin, San Antonio, and El Paso in the far west (on the left edge). Figure 2 is a small section of Figure 3, which is a composite nighttime satellite image of the United States as a whole. Viewing this image, it is easy to understand why astronomers say that residents of the United States east of the Mississippi River could go their entire lives without ever once seeing the Milky Way, the galaxy in which we reside. This is due to the combination of the glow and glare from artificial lighting (light pollution) that cloak urbanized areas and the air pollution that the traffic, factories, and power plants associated with these areas often generate.

Figure 2. Satellite Image of Texas at Night

Figure 3. Composite Satellite Image of the United States at Night

The rest of this section provides some background on what sprawl is and what is at stake due to its relentless outward march. Section 2 then describes our methodology, sources and definitions. Section 3 presents our findings.

1.2 Loss of Farmland, Wildlife Habitat, and Open Space

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, nationwide, from 1982 to 2012, 42.2 million acres (approximately 66,000 square miles) – an area about equal to the state of Florida – of previously undeveloped non-federal rural land was paved over to accommodate our growing cities.[5] Of these 42.2 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.[6]

As the NRCS 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 4 shows the increase in developed land nationwide from 1982 to 2012, as tracked by the NRCS and the NRI in 5-year intervals. The total area of developed land grew from 71.9 million acres (112,356 square miles) in 1982 to 114.1 million acres (178,281 square miles) in 2012. 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. In just the three decades between 1982 and 2012, 37 percent of all land that has ever been developed in the lower 48 states was developed. This is a rapid rate of change.

[5] Op. cit. Reference 4 (*2012 National Resources Inventory, Summary Report*).
[6] 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-smart-growth-population-grow.html
[7] Natural Resources Conservation Service (NRCS). 2013. 2007 National Resources Inventory: Development of Non-Federal Rural Land. March.

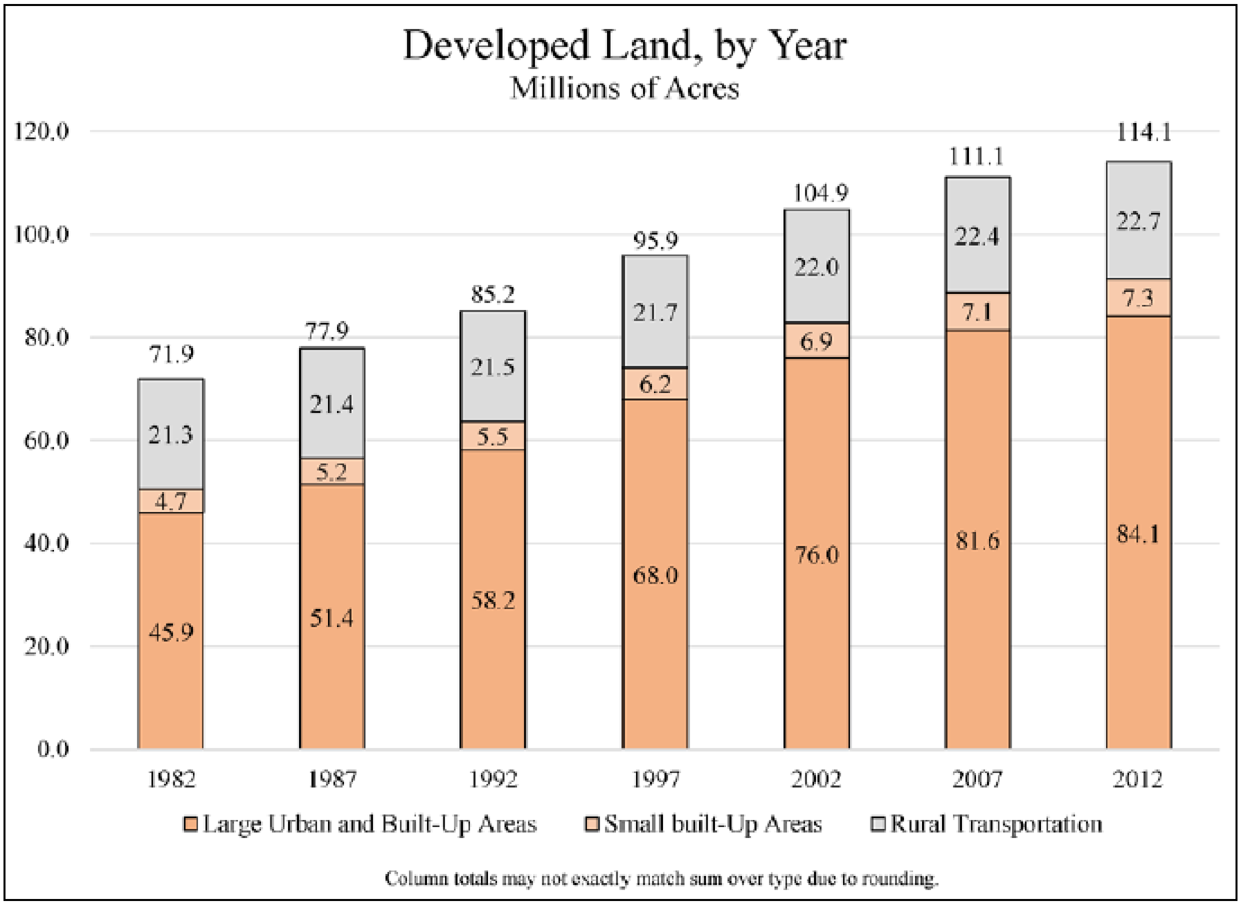


Figure 4. Change in Developed Land Nationwide, 1982-2012
Source: NRCS, 2015, *2012 National Resources Inventory, Summary Report*; Footnote 4.

In Texas alone, according to the NRCS and its NRI, the amount of developed land increased by 72 percent in the 30 years between 1982 and 2012, from 5,188,000 acres (8,106 square miles) to 8,936,600 acres (13,963 square miles). Table 4 and Figure 5 show the relentless increase in developed land in Texas at five-year intervals from 1982 to 2012. It is worth reiterating once more that all of the land developed during this 30-year period was land taken permanently Texas' agricultural land base or its natural habitats. These lost croplands, pasturelands, rangelands, open spaces, and wildlife habitats are irreplaceable on any relevant time scale.

The adverse effects of encroaching development extend beyond the zone of impervious surfaces, pavement, and rooftops and penetrate into nearby natural habitats. The fact is that development disturbs natural habitat even without destroying or altering it directly with bulldozers and construction. Development can cause habitat fragmentation, that is, breaking up large, intact areas of natural habitat into smaller strips, shreds, and fragments. In such cases, these smaller disparate, disconnected habitat bits and pieces may be too small to support viable populations of various wild flora and fauna, which are prevented from interacting and breeding due to development barriers like buildings, walls, fences, and streets. Fragmentation is accompanied with biodiversity impoverishment and species loss, of both wild plants and animals.

Table 4. Increase in Developed Land in Texas, 1982-2012

Year	Area of Developed Land (thousand acres)	Period	Added annual increment of Developed Land during period (acres)	Average daily amount of land consumed by sprawl during period (acres)
1982	5,188.0			
1987	5,703.2	1982-1987	103,040	282
1992	6,249.0	1987-1992	109,160	299
1997	6,922.4	1992-1997	134,680	369
2002	7,749.1	1997-2002	165,340	453
2007	8,490.9	2002-2007	148,360	406
2012	8,936.6	2007-2012	89,140	244
Average		**1982-2012**	**124,950**	**342**

Source: Calculated from NRCS, 2015. *Summary Report: 2012 National Resources Inventory,* Table 1.

On average, on each of the 10,950 days in the 30 years between 1982 and 2012, approximately 342 acres of open space in Texas succumbed to the bulldozer, asphalt, concrete, and buildings.

The area of cropland in Texas decreased 9,599,600 acres from 1982 to 2012, a loss of 29 percent. Some of this land was protected under the Conservation Reserve Program (CRP), some was retired from cultivation and converted to pastureland, rangeland, and other rural lands. However, some of it was also developed. "Asphalt is the land's last crop," observed former U.S. Assistant Secretary of Agriculture and conservationist Rupert Cutler back in the 1970s.[8] Once a piece of ground with its soils and the micro- and macro-ecosystems they support are paved over, the probability of that piece of the Earth being restored within the foreseeable future to a functioning ecological habitat or productive agricultural land is miniscule.

[8] Lester R. Brown and Ed Ayers (eds.), 1998. *World Watch Reader on Global Environmental Issues*. W.W. Norton & Company (New York, London).

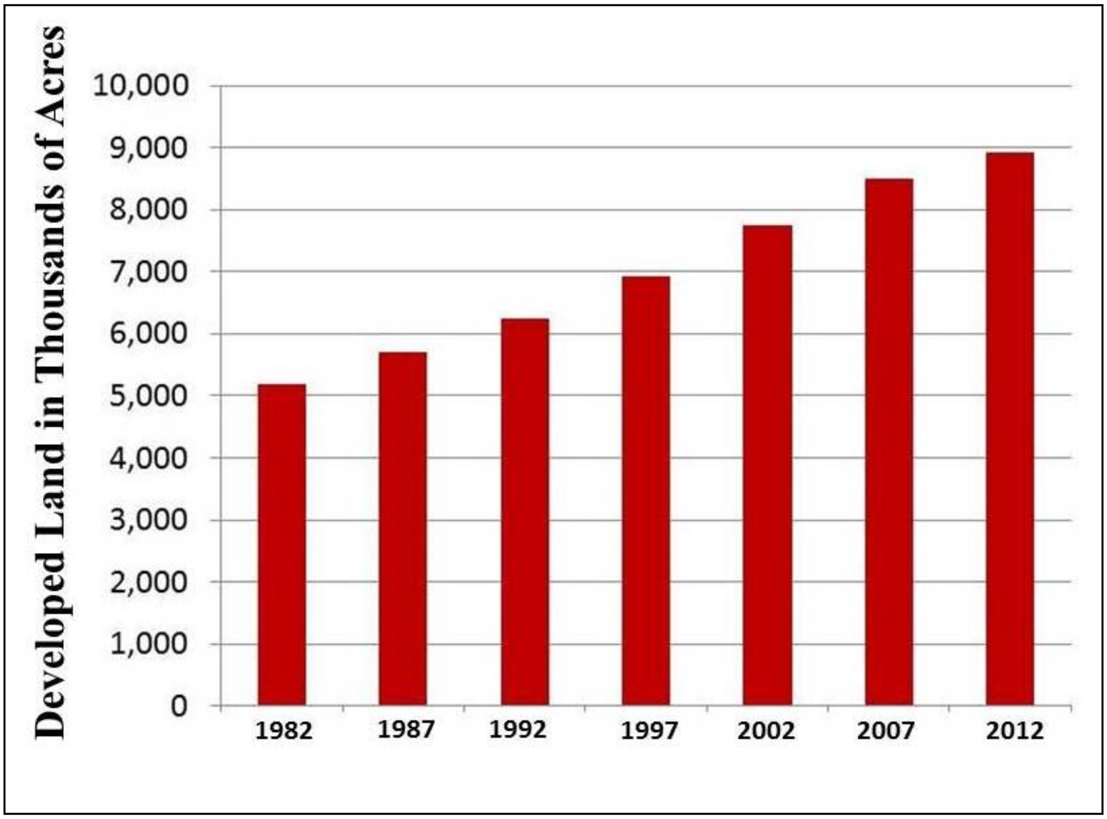


Figure 5. Growth in Acreage of Developed Land in Texas, 1982-2012
Data Source: Table 1 in *2012 National Resources Inventory, Summary Report* (NRCS, 2015)

1.2.1 Threatened Species and Habitats

Within the overall open-space acreage threatened by sprawl are some of our most critical natural habitats. According to the World Wildlife Fund, habitat loss poses the single greatest threat to endangered species around the world. The United States is home over 1,000 endangered or threatened animal and plant species and sub-species that are seriously harmed by ever-encroaching development.

Endangered species are those rare plants or animals that, if recent trends continue, will likely become extinct within the foreseeable future, barring heroic measures to save them. Threatened species or sub-species may become endangered within the foreseeable future. In Texas, plants or animals may be protected under the authority of state law and/or under the Federal Endangered Species Act. Two examples of federally-listed species in Texas are the black-capped vireo (*Vireo atricapilla*) and golden-cheeked warbler (*Setophaga chrysoparia*). Two examples of state-listed species are the Texas horned lizard or horny toad (*Phrynosoma cornutum*) and the Texas kangaroo rat (*Dipodomys elator*).[9]

[9] Texas Parks and Wildlife Department. Threatened and Endangered Species. Accessed March 2017 at: http://tpwd.texas.gov/landwater/land/habitats/cross_timbers/endangered_species/ .

Figure 6. Male Black-Capped Vireo
Credit: Texas Park and Wildlife Department

Figure 7. Golden-Cheeked Warbler at Balcones Canyonlands National Wildlife Refuge in Texas

Photo: U.S. Fish and Wildlife Service

Figure 8. Texas Horned Lizard

By Ben Goodwyn - Own work, CC BY 2.5, https://commons.wikimedia.org/w/index.php?curid=1167353

According to the Texas Parks and Wildlife Department (TPWD), loss and/or fragmentation of wildlife habitat is the leading cause of species declines in the state.[10] By way of example, the black-footed ferret (*Mustela nigripes*), a predator of prairie dogs and one of the rarest mammals in North America, once inhabited prairie dog towns in North Texas, as recently as 1963. While the prairie dog towns still exist, they are now much too small, too few in number, and too scattered to support even a single population of ferrets.

Numerous other creatures have met the same fate in rapidly developing North Central Texas over the past century and a half: plains bison, red and gray wolves, black and grizzly bears, passenger pigeon, ivory-billed woodpecker, and pronghorn antelope. Each of these is either extinct (passenger pigeon and probably the ivory-billed woodpecker), federally threatened /endangered, or extirpated (eliminated) from North Central Texas. These are all animals that need large habitat expanses which are no longer available. From the time of the earliest Euro-American settlement, native prairies and forests were gradually fragmented into smaller and smaller bits, separated by roads, developed areas, and cropland.[11]

This trend is continuing and even accelerating at present, as the Texas population grows rapidly: cities expand outward and even rural areas become more populous, filling up with houses and crisscrossed by more and more roads. This process is especially evident along the I-35 corridor in the heart of the Blackland Prairie and Cross Timbers regions (Figure 10). Historically the Blackland Prairie ecological area – virgin tallgrass prairie – extended across 10.6 million acres. Conservative estimates are that only 200,000 acres remain. The Cross Timbers and Prairies ecological area once covered 17.9 million acres. Within this ecoregion, some counties have experienced more than 200 percent population growth just since 1970.[12]

Figure 9. Habitat Fragmentation Cobbles and Compromises Ecosystems

[10] Ibid.
[11] Ibid.
[12] Ibid.

Figure 10. Texas Ecoregions
Source: Texas Parks and Wildlife Department,
http://tpwd.texas.gov/landwater/land/maps/gis/map_downloads/images/pwd_mp_e0100_1070ad_6.gif

Early settlers were drawn to the Blackland Prairie Ecoregion for its lush native grasslands, fertile, productive soils, and gentle topography. Although originally a tallgrass prairie ecoregion, today most areas have been converted to cropland and pasture. Cotton, corn, milo, and wheat are cultivated and livestock grazing is common. There are few remnant native prairie sites left. Urban expansion in this ecoregion is rampant and the space for wildlife and wildlife habitat is rapidly dwindling.[13]

[13] Texas Parks and Wildlife Department. Blackland Prairie Ecological Region. Accessed March 2017 at: http://tpwd.texas.gov/landwater/land/habitats/cross_timbers/ecoregions/blackland.phtml.

The Brazos and Trinity River basins bisect the Blackland Prairie Ecoregion. These rivers and their tributaries, wetlands, riparian zones, and bottomland hardwood forests provide habitats for diverse wildlife species. Trees and shrubs including mesquite, hackberry, elm, osage orange (bois d'arc), and other woody species growing along fence lines and field borders provide wildlife habitat. Other habitat occurs in steeper terrain not subjected to cultivation where plant communities containing species such as eastern red cedar, Ashe juniper, cedar elm, Texas persimmon, elbowbush, deciduous holly, live oak, and other woody species are found. Upland wildlife includes small-game animals, songbirds, raptors, and white-tailed deer. Waterfowl and shorebirds abound in the waters and wetlands of the Blackland Prairie Ecoregion.[14]

Just to the west of the Blackland Prairie Ecoregion, the Cross Timbers Ecoregion is the main ecoregion of northcentral Texas. Its vegetation has changed substantially over the past century and a half as much of it has been converted to agriculture. The earliest travelers through north Texas coined the name "Cross Timbers" because they had to repeatedly cross densely timbered areas with sometimes impenetrable undergrowth that impeded their travel their travel toward open prairies to the east and west. One early traveler described this region as “bountifully supplied with buffalo, bear, deer, antelope, wild boars, partridges, and turkeys.”

Today, according to TPWD, although wildlife habitat is still present throughout the ecoregion, wildlife populations vary greatly between sub-regions, influenced by the diversity and configuration of plant communities on the landscape. Other factors determining the density and diversity of wildlife include fragmentation of once continuous habitat into smaller land holdings, competition with livestock for food and cover, conversion of woodland habitat to improved pastures or other agricultural enterprises, urban and rural development, and lack of proper wildlife and habitat management.[15]

Other habitats and ecoregions in Texas are threatened by urban sprawl as well, including the Piney Woods, Post Oak Savannah, and Gulf Prairies.

[14] Ibid.
[15] Texas Parks and Wildlife Department. Cross Timbers and Prairies Ecological Region. Accessed March 2017 at: http://tpwd.texas.gov/landwater/land/habitats/cross_timbers/ecoregions/cross_timbers.phtml.

Figure 11. The Unbroken Expanses of Habitat That Once Covered North-Central Texas

1.2.2 Stability of Ecosystems and the Biosphere

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 and sponges, soaking up and storing floodwaters. According to the Environmental Protection Agency, nearly two-thirds of all fish we consume spend some portion of their lives in wetlands, which often serve as "nurseries" for juveniles. Continuing to pave 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.

In addition, sprawl in the United States is more than a domestic environmental or quality-of-life 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 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 uncontrolled, sudden switch 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."[16]

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

1.2.3 Agriculture and Food Security

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.[17] 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."[18] 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, affordable food, plentiful consumer options, and comparative freedom from want.

Table 5 documents the decline in Texas' cropland acreage from 1982 to 2012. In that 30-year span, croplands declined by 9.6 million acres, or 29 percent. Most of that cropland was not urbanized or paved over, but rather converted to other types of rural lands: pastureland, rangeland, forestland, or the conservation reserve program (CRP). Nevertheless, a 29 percent loss still represents a striking change in the area of croplands in just three decades.

Table 5. Decline in Texas Croplands, 1982-2012*

Year	Cropland	% Decline from 1982
1982	33,495.2	0.0
1987	31,435.6	6.1
1992	28,524.1	14.8
1997	27,183.1	18.8
2002	25,803.3	23.0
2007	24,319.3	27.4
2012	23,895.6	28.7

*In thousands of acres

Source: NRCS, 2015. *2012 National Resources Inventory: Summary Report*, Table 2.

[17] 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.

[18] Pimentel and Giampietro. 1994. See footnote #17.

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.[19] 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.[20] As Oxford ecology professor Norman Meyers observed 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…"[21]

One of the lasting consequences for 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 enhance and ensure their food supplies. Making these investments are food-importing countries with large populations or high population density, limited arable land and domestic agriculture, and overall food security concerns such as China, South Korea, India, Saudi Arabia, the United Arab Emirates, and Qatar. 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."[22]

[19] 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.
[20] Tweeten, L. 1998. Food Security and Farmland Preservation. *Drake Journal of Agricultural Law*. 3:237-250.
[21] 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.
[22] 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.

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.[23]

Finally, U.S. agriculture and related food industries contribute nearly $1 trillion to our national economy annually. They comprise more than 13 percent of American GDP and employ 17 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.[24]

Americans are not unaware of these national security implications, according to a 2014 poll[25] of likely voters (see Appendix H for the entire poll results). Some 92 percent thought that it was very important or somewhat important for the U.S. to be able to produce enough food domestically to be able to feed its own population in the future:

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
6% - Not very important
0% - Not important at all
2% - Not sure

GROUPINGS: 92% - Very or somewhat important
6% - Not very important

Two related questions in this 2014 poll pertained to the importance of feeding foreigners with U.S. agricultural exports and the ethics of paving over good cropland even for as legitimate a reason as providing additional housing:

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
19% - Not very important
6% - Not important at all
2% - Not sure

[23] 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/.
[24] American Farmland Trust. 2013. Farmland Protection. Available on the World Wide Web at: http://www.farmland.org/programs/protection/.
[25] Op. cit. Footnote #3, Pulse Opinion Research. Appendix H includes the entire poll's results.

GROUPINGS: 72% - Very or somewhat important
25% - Not very or at all important

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?

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

It is obvious from these survey results that most Americans believe that protecting productive farmland is a national priority.

1.3. Rejuvenating the Human Spirit: 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 swamp or mangrove-fringed estuary 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 (Figure 12) – and the assurance that this open space will outlast us – serves to counter-balance the stress and strain of modern life.

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.[26] 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 compared to 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.[27] In studies of hospital patients, recovery was faster, there were fewer negative evaluations in patient reports, and there was less use of analgesic drugs

[26] 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.
[27] Ulrich, R. 1979. Visual landscapes and psychological well-being. *Landscape Research*, 4(1): 17-23.

among post-surgery patients with views of exterior greenery than among control group patients with views of buildings.[28]

Figure 12. Central Park Has Been Called a "Green Oasis" in New York City

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.[29] 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:

[28] 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.

[29] Cimprich, B. E. 1990. Attentional fatigue and restoration in individuals with cancer. Unpublished Doctoral Dissertation, University of Michigan.

> "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."[30]

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

> "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."[31]

While there are many anecdotal reports linking 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.[32] Few studies track long-term longitudinal effects on changed attitudes and behavior. While it is difficult to characterize and quantify the long-term, intangible 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."[33]

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.

The 2014 national survey[34] mentioned above 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?

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[30] 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.
[31] Kaplan, R., & Kaplan, S. (1989). *The Experience of nature: A Psychological perspective*. New York: Cambridge University Press.
[32] Op. cit. Footnote #26, Rubenstein.
[33] John Muir. *The Mountains of California*. First published in 1894.
[34] Op. cit. Footnote #3. Pulse Opinion Research, 2014; Appendix H to this report.

70% - Yes
18% - No
12% - Not sure

A majority of Americans also indicated to pollsters that they want to have easy access to natural areas near where they live.

QUESTION: 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: 85% - Very or somewhat important
13% - Not very or at all important

Texans are avid outdoorsmen and women. Hunting, fishing, camping, boating, and hiking are all very popular in the state. Texas has a large and well-used system of state parks managed by TPWD, as well as millions of acres of private rural lands and ranches that are also used for consumptive (hunting and fishing) and non-consumptive outdoor recreation (hiking, wildlife observation and photography, etc.). As the state becomes more and populated and open space diminishes due to the development and urbanization needed to accommodate that population growth, opportunities for outdoor recreation will decline and the "user experience," that is, how enjoyable the outdoor experience is, will decrease. Overcrowding, congestion, and increased competition for space and resources will increase.

Figure 13. Texans Are Avid Users of the Great Outdoors and State Parks

Figure 14. Male White-tailed Deer (Buck) with Antlers, Popular with Hunters and Wildlife Enthusiasts Alike

1.4 Why Americans (and Texans) Still Dislike Sprawl

While not garnering the media attention it once did, the topic of urban sprawl remains a major concern to many American citizens. 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.[35] The 46 measures passed nationally provided 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, Tampa Bay Conservancy, Inc., and the North Florida Land Trust continue to garner substantial public support. In the November 2016 election alone, 25 land conservation ballot measures were voted on in 10 different states.[36]

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

[35] 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.
[36] Trust for Public Land. 2016 conservation ballot measures. Accessed March 2017 at: https://www.tpl.org/2016-conservation-ballot-measures#sm.0001r394ttayecqpw771offt5wflx.

systems, sewage collection and treatment systems, and schools to accommodate runaway growth.[37]

In short, Americans still value our rural lands and natural habitats; oppose longer commute times to work and to daily, weekly, and monthly open-space destinations; and dislike increased environmental degradation, greater economic costs, and higher taxes; all of which are part of the price tag of sprawling urban development.

As noted above, the 2014 polling[38] found that sizeable majorities of Americans feel strongly about the need to protect farmland and natural habitats for themselves, for their fellow Americans, for posterity, and for the nation's wildlife. Large majorities also indicated it was important to have ready access to natural areas and open space and that they felt spiritually and emotionally rejuvenated by the time they spent in natural areas. Texans no doubt feel the same way.

Figure 15. Rural Setting in Fannin County, Texas, North of Dallas

[37] 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.

[38] Op. cit. Footnote #3, Pulse Opinion Research. Also see Appendix H.

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 for more than a half a century (since 1950), while the NRCS has estimated changes in the size and shape of America's Developed Lands every five years or so for more than thirty 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 NRI surveys, are unequalled as uniform, quantitative, longitudinal measures of expanding urbanization – converting rural lands to urban lands – 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 2002-2012 National Resources Inventories served as our main data sources for our current study of sprawl in Texas. 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 Texas cities as well as the more diffuse development and sprawl dispersed across the entire state, as evidenced in the NRI data. The NRI refers to these areas of more dispersed development as "Small Built-up Areas." In 2012, Small Built-up Areas comprised 7.3 million acres or about six percent of the total of 114.1 million acres of Developed Land in the contiguous United States (Figure 4).

This study quantifies the amount of sprawl in Texas over the most recent periods for which the most comprehensive government data are available: 2000-2010 for UAs and 2002-2012 for Developed Lands. Urbanized Area data are calculated only once every 10 years. Thus, our study can assess the march of sprawl up to 2012.

Available NRI Developed Land estimates span an uninterrupted 30-year period from 1982-2012 in six 5-year intervals (1982-1987, 1987-1992, 1992-1997, 1997-2002, 2002-2007, 2007-2012). These estimates quantify how much rural land was converted into developed or built-up land over these discrete time intervals, as well as over the 30-year time period in its entirety. Therefore, we are able to see how sprawl in Texas has consistently impacted areas outside of the Census' Urbanized Areas over the last 30 years.

2.2.1 Census Bureau's Urbanized Areas

The U.S. Census Bureau classifies all geographic areas of the United States as either urban or rural. Urban places are those characterized by densely populated and developed land above a minimum population threshold; they include residential, commercial, industrial and other non-residential urban land uses.[39]

The Census Bureau has been making these classifications for a long time: it 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 incorporated 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.[40]

Census started designating and delineating 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.

[39] 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

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

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 designated urban areas (UAs and UCs).

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.”[41] In essence, UAs represent America’s “urban footprint.”[42]

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.[43]

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.[44]

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 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 burgeoning 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

[41] See note 29.
[42] 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.
[43] Ibid.
[44] Ibid.

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 are not developed for whatever reason. The Census Bureau changed the maximum jump distance criterion from 1.5 miles to 2.5 miles between the 1990 and 2000 censuses.[45]

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 Urbanized Areas
- **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, including Texas. In Texas, between 2000 and 2010, the population of the state's 34 UAs grew by 28%, compared to 21% for the state as a whole, meaning that that there was a relative shift of population from rural to urban areas as well as rapid population growth overall; simply put, rural areas didn't grow as fast as urban areas, and some rural areas actually shrank in population.

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

[45] Ibid.

permanent loss of agricultural lands to nonagricultural uses, such as transportation, industry, commercial and residential land uses.[46]

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 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.[47]

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.[48]

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

[46] 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.
[47] Ibid.
[48] Ibid.

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.[49]

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.[50]

A number of quality control and quality assurance (QC/QA) processes are conducted by NRCS and contract staff as well as by the Statistical Unit and NRCS resource inventory specialists. Many of these QC/QA processes are embedded within the survey software developed by NRCS and the Statistical Unit. The QC/QA processes ensure that differences in 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.[51]

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;

[49] Ibid.
[50] Ibid.
[51] Ibid.

(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).

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 and policies. 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.

Nowadays, rapid growth in an urban area's population is much more likely to be the result of enticing residents to relocate from elsewhere. Local and state governments can and do create many incentives that encourage people to move into a particular urban area. These include aggressive campaigns to persuade industries and corporations to move their factories, offices, headquarters, and jobs from another location, public subsidies for the infrastructure that supports businesses, tax breaks, expansion of water service and sewage lines into new areas, new housing developments and new residents, and general public relations that increase the attractiveness and "business friendliness" of a city to outsiders and the business community. Even without trying, a city can attract new residents just by maintaining amenities, good schools, low crime rates, pleasant parks, 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 Texas Urbanized Areas

Table 6 shows population growth in Texas Urbanized Areas from 2000 to 2010. On average, these UAs grew by 28 percent in ten years, at an annual compound (exponential) rate of 2.5%.

Table 6. Population Growth in Texas Urbanized Areas – 2000 to 2010

Urbanized Area	Population in 2000	Population in 2010	% growth
Abilene	107,041	110,421	3%
Amarillo	179,312	196,651	10%
Austin	901,920	1,362,416	51%
Beaumont	139,304	147,922	6%
Brownsville	165,776	217,585	31%
College Station--Bryan	132,500	171,345	29%

Urbanized Area	Population in 2000	Population in 2010	% growth
Conroe--The Woodlands	89,445	239,938	168%
Corpus Christi	293,925	320,069	9%
Dallas--Fort Worth--Arlington	4,145,659	5,121,892	24%
Denton--Lewisville	299,823	366,174	22%
El Paso[1]	674,801	803,086	19%
Harlingen	110,770	135,663	22%
Houston	3,822,509	4,944,332	29%
Killeen	167,976	217,630	30%
Lake Jackson--Angleton	73,416	74,830	2%
Laredo	175,586	235,730	34%
Longview	78,070	98,884	27%
Lubbock	202,225	237,356	17%
McAllen	523,144	728,825	39%
McKinney	54,525	170,030	212%
Midland	99,221	117,807	19%
Odessa	111,395	126,405	14%
Port Arthur	114,656	153,150	34%
San Angelo	87,969	92,984	6%
San Antonio	1,327,554	1,758,210	32%
San Marcos	47,333	52,826	12%
Sherman	56,168	61,900	10%
Temple	71,937	90,390	26%
Texarkana[2]	72,288	78,162	8%
Texas City	96,417	106,383	10%
Tyler	101,494	130,247	28%
Victoria	61,529	63,683	3%

Urbanized Area	Population in 2000	Population in 2010	% growth
Waco	153,198	172,378	12%
Wichita Falls	99,396	99,437	0%
All Texas UAs	**14,838,282**	**19,004,741**	**28%**

[1]Includes portions of the El Paso UA in New Mexico
[2] Includes portions of the Texarkana UA in Arkansas

2.3.2 Population Growth in Texas Counties

Appendix F has a table listing population growth in all Texas counties from 1982 to 2012. On average, these 254 counties grew by 70 percent in these 30 years, at an annual compound (exponential) rate of 1.8%. Yet during these three decades, even as the state population as a whole grew significantly, all counties did not grow equally. Far from it. Counties on the periphery of existing urbanized areas tended to have the highest growth rates, counties in established cities middle growth rates, and rural counties the lowest growth rates, with a number of the rural counties actually declining in population.

Indeed, 94 counties out of the 254 (37 percent) counties in Texas actually lost population between 1982 and 2012. These population declines did not happen as a result of the death rate exceeding the birth rate, but as a result of out-migration toward jobs and greater economic, social, and cultural opportunities elsewhere. Out-migration from these rural counties tended to be towards larger towns and cities, rather than out of the state altogether; they form part of the historic, long-term process of urbanization that began in England with industrialization in the late 1700s, came to America in the 1800s, and continues around the world to this day and well into the future. As of 2014, 54 percent of the world's population resided in urban areas, a percentage that is increasing; by 2050, two-thirds (66%) of the world's population is projected to be urban.[52]

2.3.3 Sources of Texas Population Growth

In 1990, Texas' population stood at 16,986,510. By 2000, it had grown to 20,851,820, for a total increase of 3.9 million in the 1990s. Foreign immigration directly accounted for 795,951 of this growth, or 20.6 percent, while domestic in-migration (from other states) directly added 1,143,856 new residents to Texas, or 29.6 percent of the aggregate growth. Thus, total migration represented 50.2 percent of the state's growth from 1990 to 2000. Natural increase (births minus deaths) accounted for 49.8% of Texas population growth in 1990s; when births to native-born and foreign-born migrants to Texas are included, migration

[52] United Nations, Department of Economic and Social Affairs, Population Division (2014). World Urbanization Prospects: The 2014 Revision, Highlights (ST/ESA/SER.A/352).

accounted directly and indirectly for well over half of the state's population growth in the 1990s.

By 2010, Texas had grown by an additional 4.3 million to approximately 25.1 million residents. About 42 percent of this increase was due directly to immigration and in-migration, and when births to these migrants are included, migration to Texas accounted for over half the state's growth from 2000 to 2010.

More recently, Texas added 187,545 people from net migration between July 2017 and July 2018, according to U.S. Census data. In 2018, the majority of migrants to Texas – 104,976 – immigrated from foreign countries.[53]

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 7 for the per capita numbers for the Texas Urbanized Areas and Appendices B and C for how the statistic is calculated. When Census Bureau data show that per capita land consumption in Abilene is 0.32 acre, it means that it takes approximately one-third of an acre to provide the average Abilene resident with space for housing, work, retail, transportation, education, religious assembly, government, recreation, utilities, and all other urban needs.

Table 7 shows the variation of per capita land use among Texas' 34 Urbanized Areas. The average Laredo resident "occupies" less than two-tenths (0.18) of an acre, while on the other extreme, the average resident of the Longview UA uses three times as much, more than half of an acre (0.54). In general, larger cities like Austin (0.25), Dallas (0.22), and Houston (0.21) have higher population densities (i.e., lower per capita land consumption), which should come as no surprise.

The mean per capita land consumption for all 34 Urbanized Areas in Texas was 0.239 acre in 2000 and 0.244 acre (slightly less than one fourth of an acre) in 2010, an increase of two percent over those ten years. Essentially, per capita land consumption remained flat in Texas UAs across the first decade of the new century.

[53] Maria Mendez. 2019. Where is Texas' growing population coming from? *The Texas Tribune*. Accessed online at: https://www.texastribune.org/2019/05/08/texas-keeps-growing-where-are-newest-transplants-coming/

Table 7. Per Capita Land Consumption in Texas Urbanized Areas – 2000 and 2010

Urbanized Area	Per Capita Land Consumption – 2000 (acre)	Per Capita Land Consumption - 2010 (acre)	% Change in Per Capita Land Consumption, 2000-2010
Abilene	0.28	0.32	12%
Amarillo	0.26	0.26	0%
Austin	0.23	0.25	9%
Beaumont	0.37	0.40	6%
Brownsville	0.22	0.24	8%
College Station--Bryan	0.24	0.27	12%
Conroe--The Woodlands	0.30	0.36	19%
Corpus Christi	0.24	0.24	0%
Dallas--Fort Worth--Arlington	0.22	0.22	2%
Denton--Lewisville	0.26	0.25	-2%
El Paso[1]	0.21	0.20	-4%
Harlingen	0.34	0.39	14%
Houston	0.22	0.21	-1%
Killeen	0.24	0.25	2%
Lake Jackson--Angleton	0.29	0.36	21%
Laredo	0.15	0.18	15%
Longview	0.41	0.54	30%
Lubbock	0.24	0.26	10%
McAllen	0.38	0.31	-18%
McKinney	0.32	0.28	-12%
Midland	0.29	0.29	-2%
Odessa	0.31	0.30	-2%
Port Arthur	0.26	0.44	72%
San Angelo	0.33	0.32	-3%

Urbanized Area	Per Capita Land Consumption – 2000 (acre)	Per Capita Land Consumption - 2010 (acre)	% Change in Per Capita Land Consumption, 2000-2010
San Antonio	0.20	0.22	11%
San Marcos	0.34	0.32	-5%
Sherman	0.36	0.37	2%
Temple	0.37	0.38	4%
Texarkana[2]	0.51	0.53	3%
Texas City	0.39	0.46	18%
Tyler	0.36	0.44	22%
Victoria	0.53	0.29	-45%
Waco	0.29	0.34	15%
Wichita Falls	0.33	0.32	-3%
All Texas UAs	**0.24**	**0.24**	**2%**

[1]Includes portions of the El Paso UA in New Mexico
[2] Includes portions of the Texarkana UA in Arkansas

In general, around the United States, 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.

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

Table 8 compares growth in population to growth in per capita land consumption in Texas UAs from 2000 to 2010. On average, these UAs grew in population by 28 percent, while their per capita land consumption increased by two percent, with about one in three (11 of 34) UAs actually decreasing their per capita land consumption (that is, increasing their population density).

Table 8. Population Growth vs. Growth in Per Capita Land Consumption Texas Urbanized Areas, 2000-2010

Urbanized Area	% POPULATION GROWTH, 2000-2010	% GROWTH IN PER CAPITA LAND CONSUMPTION, 2000-2010
Abilene	3%	12%
Amarillo	10%	0%
Austin	51%	9%
Beaumont	6%	6%
Brownsville	31%	8%
College Station--Bryan	29%	12%
Conroe--The Woodlands	168%	19%

Urbanized Area	% POPULATION GROWTH, 2000-2010	% GROWTH IN PER CAPITA LAND CONSUMPTION, 2000-2010
Corpus Christi	9%	0%
Dallas--Fort Worth--Arlington	24%	2%
Denton--Lewisville	22%	-2%
El Paso[1]	19%	-4%
Harlingen	22%	14%
Houston	29%	-1%
Killeen	30%	2%
Lake Jackson--Angleton	2%	21%
Laredo	34%	15%
Longview	27%	30%
Lubbock	17%	10%
McAllen	39%	-18%
McKinney	212%	-12%
Midland	19%	-2%
Odessa	14%	-2%
Port Arthur	34%	72%
San Angelo	6%	-3%
San Antonio	32%	11%
San Marcos	12%	-5%
Sherman	10%	2%
Temple	26%	4%
Texarkana[2]	8%	3%
Texas City	10%	18%
Tyler	28%	22%
Victoria	3%	-45%

Urbanized Area	% POPULATION GROWTH, 2000-2010	% GROWTH IN PER CAPITA LAND CONSUMPTION, 2000-2010
Waco	12%	15%
Wichita Falls	0%	-3%
All Texas UAs	**28%**	**2%**

[1]Includes portions of the El Paso UA in New Mexico
[2] Includes portions of the Texarkana UA in Arkansas

2.5 Measuring Overall Sprawl

Using both the Census Bureau (Urbanized Area) and National Resources Inventory (Developed Land) data, we were able to measure the overall amount different settlements around Texas 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, the NRI provided the exact data, county by county, on how many acres of rural land had been converted into developed land in 5-year increments within their 30-year time span.

Figure 16. Suburban Sprawl in the Austin UA, the Third Most Sprawling City in Texas

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 state of Texas. At its most basic level, there are three reasons for an increase in the area of developed land: 1) each individual, on average, is consuming more land; 2) there are more people; or 3) a combination of both 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 Texas 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[54] 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 that cause sprawl in Texas. As our multiple studies over the past decade and a half show conclusively, Per Capita Sprawl by itself could not explain Overall Sprawl in the great majority of America's Urbanized Areas. Texas is no exception. By comparing the percentage growth of per capita land consumption with the percentage growth of Overall Sprawl in all 34 Urbanized Areas in Texas from 2000 to 2010 in Figure 17, we find that the Per Capita Sprawl percentage is much smaller than the Overall Sprawl percentage: 2 percent versus 19 percent. This is not to denigrate 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.

Table 9 compares the percentages of Per Capita Sprawl and Overall Sprawl from 2000 to 2010 in all 34 UAs in the state of Texas. In virtually all cases, Per Capita Sprawl is only a small fraction of Overall Sprawl.

[54] 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

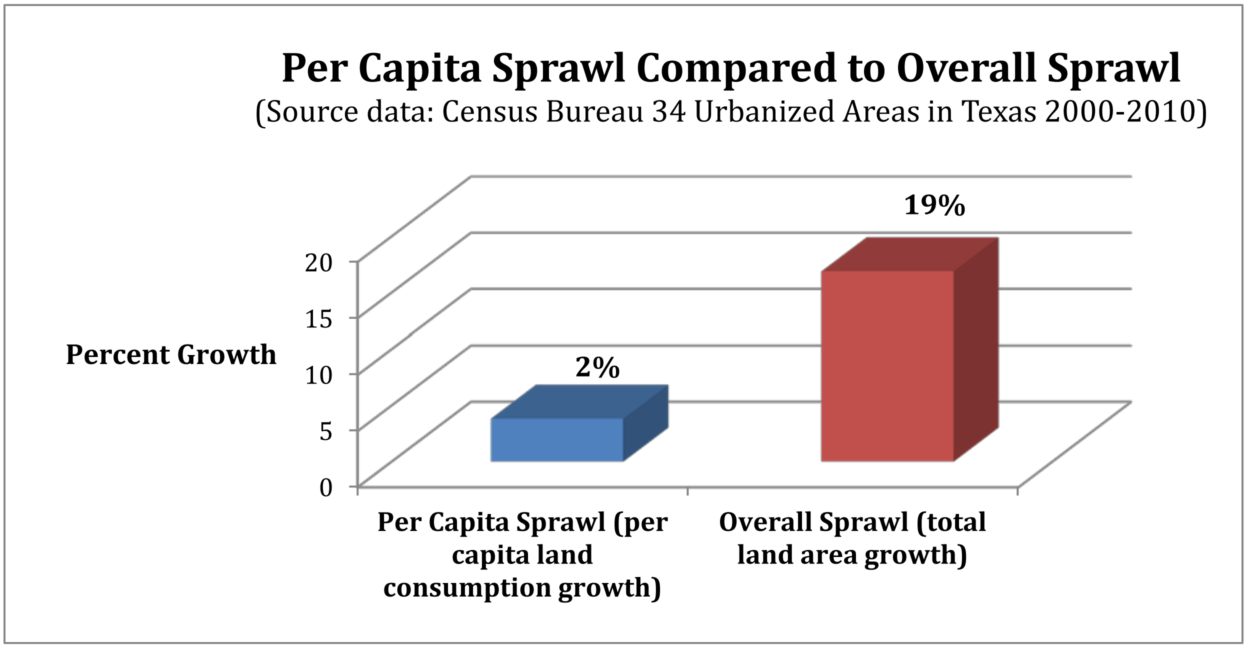

Figure 17. Per Capita Sprawl vs. Overall Sprawl in Texas UAs, 2000-2010

Note**:** Per Capita Sprawl is % growth in per capita land consumption and Overall Sprawl is % growth in urbanized land area.

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

Table 9. Per Capita Sprawl vs. Overall Sprawl
Texas 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)
Abilene	12%	15%
Amarillo	0%	10%
Austin	9%	64%
Beaumont	6%	13%
Brownsville	8%	42%
College Station--Bryan	12%	45%

Urbanized Area	% Change in Per Capita Land Consumption, 2000-2010 (PER CAPITA SPRAWL)	% Change in Overall Land Consumption, 2000-2010 (OVERALL SPRAWL)
Conroe--The Woodlands	19%	220%
Corpus Christi	0%	9%
Dallas--Fort Worth--	2%	26%
Denton--Lewisville	-2%	19%
El Paso	-4%	14%
Harlingen	14%	40%
Houston	-1%	28%
Killeen	2%	32%
Lake Jackson--Angleton	21%	23%
Laredo	15%	55%
Longview	30%	64%
Lubbock	10%	29%
McAllen	-18%	14%
McKinney	-12%	173%
Midland	-2%	17%
Odessa	-2%	11%
Port Arthur	72%	130%
San Angelo	-3%	2%
San Antonio	11%	47%
San Marcos	-5%	6%
Sherman	2%	13%
Temple	4%	31%
Texarkana	3%	11%
Texas City	18%	30%

Urbanized Area	% Change in Per Capita Land Consumption, 2000-2010 (PER CAPITA SPRAWL)	% Change in Overall Land Consumption, 2000-2010 (OVERALL SPRAWL)
Tyler	22%	57%
Victoria	-45%	-43%
Waco	15%	29%
Wichita Falls	-3%	-3%
Weighted Average (Mean)	**2%**	**19%**

3.1.2 Per Capita Sprawl vs. Population Growth

Since all 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.

Figure 18 aggregates the 34 UAs in Texas and finds that their average population change was 28% while their per capita land change was 2%. Thus we can see that the rate of population growth was much larger factor than the rate of per capita land consumption change in urban sprawl in Texas from 2000 to 2010.

Even after just a cursory examination of Figures 17 and 18**,** 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.

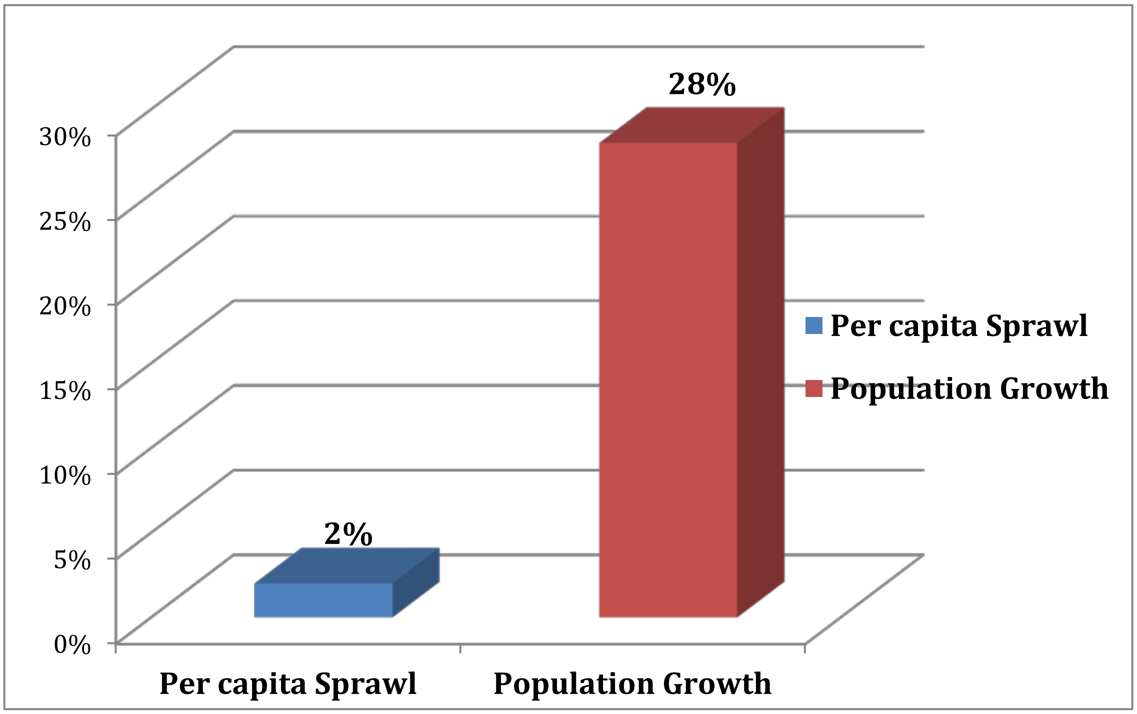

Figure 18. Per Capita Sprawl vs. Population Growth in 34 Texas UAs, 2000-2010

Description**:** When comparing the growth rates of the two factors behind Overall Sprawl we find that population growth was much greater than per growth in capita land consumption from 2000 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 updated study broadly reinforce one of the conclusions of our original sprawl studies a decade and a half ago – 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 exclusively nor declining density exclusively, 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 Texas especially, the population growth factor substantially outweighs the Per Capita Sprawl factor in importance.

Figure 19 compares the rates of sprawl when Texas 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 18 cities that experienced 10-30 percent population growth sprawled almost three times as much on average (29 percent) as those cities that experienced below 10 percent population growth (11 percent sprawl or increase in urban area). Cities whose populations grew between 31 and 50 percent experienced mean sprawl of 49 percent between 2000 and 2010. And the three cities whose populations grew by more than 50 percent sprawled by a whopping mean of 173 percent, though this high number is a bit misleading, biased by the small sample size (just three UAs).

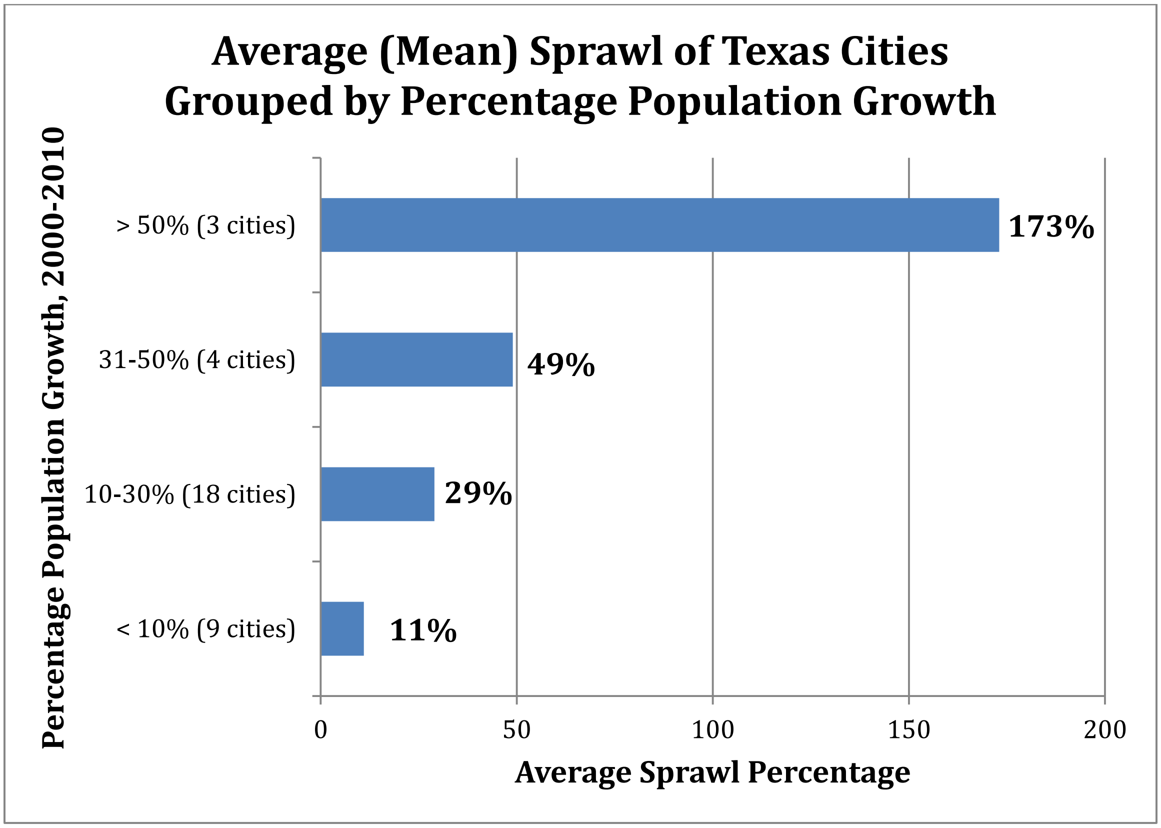

Figure 19. Texas Cities with More Population Growth Generated More Sprawl

Figure 20 displays the results of another grouping that once again demonstrates population growth's preeminent role in driving sprawl in Texas. This figure highlights the amount of population growth in the top ten of sprawling cities versus the bottom ten sprawling cities.

The 10 cities in Texas with the most sprawl (144 square miles on average) between 2000 and 2010 had average population growth of approximately 355,000. In contrast, the 10 cities with the least sprawl (just six square miles on average) averaged about 10,400 population growth during the same decade.

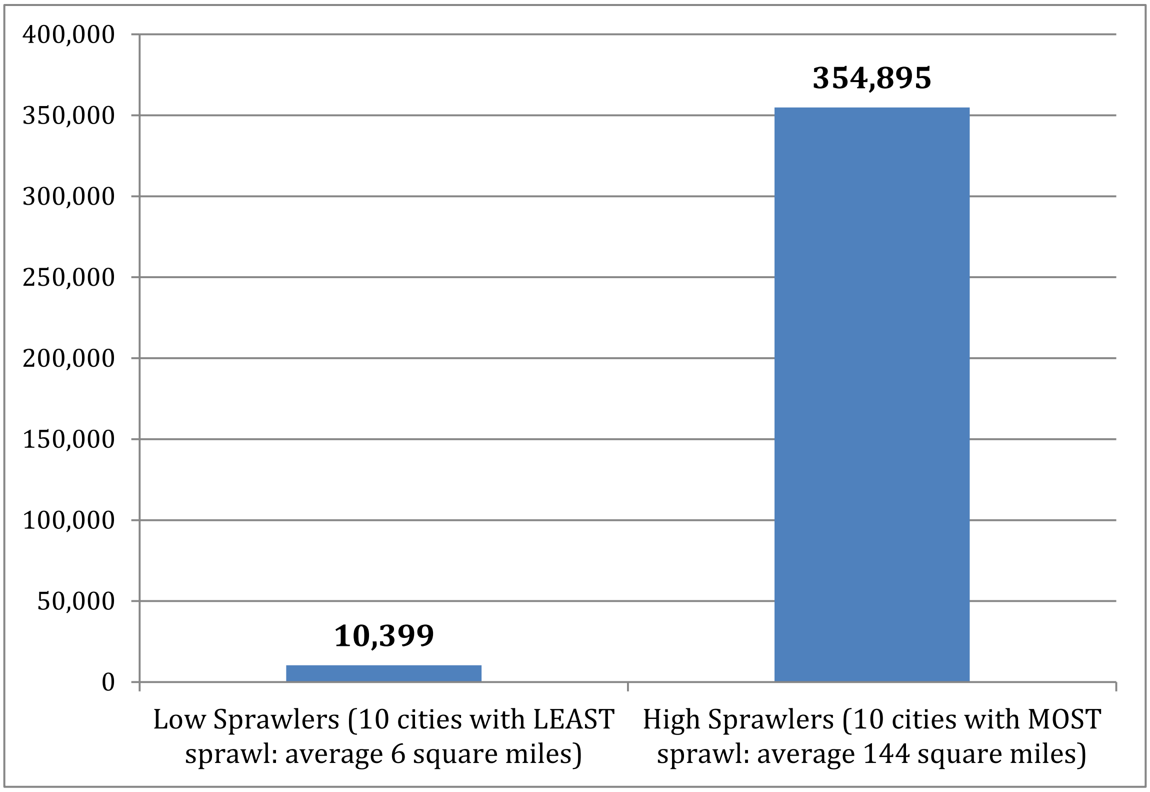

Figure 20. Average Population Growth in Texas in Top-Ten Sprawlers versus Bottom-Ten Sprawlers, 2000-2010

Note: 10 Texas Urbanized Areas that sprawled the least between 2000 and 2010, averaging just six square miles, had average population growth of 10,399. In contrast, those ten UAs that sprawled the most between 2000 and 2010, averaging 144 square miles of sprawl during the decade, grew by an average (mean) of 354,895 residents during the decade.

3.1.3 Relative Weight of Sprawl Factors in Texas 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. Physicist John Holdren, Ph.D., former Director of the White House Office of Science and Technology Policy and former president of the American Association for the Advancement of Science (AAAS), 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.[55] This "Holdren method" can be applied

[55] John P. Holdren. 1991. "Population and the Energy Problem." *Population and Environment*, Vol. 12, No. 3, Spring 1991. Prior to being Director of the White House Office of Science and Technology Policy in the Obama Administration between 2009 and 2017, 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

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.

This study, as have our other studies over the past decade and a half, applies this method to sprawl. Rural, undeveloped land is thus the 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 10 applies the Holdren method to all of the 34 Urbanized Areas in Texas. In the case of Abilene, for example, 26 percent of its Overall Sprawl was related to, or explained by, increases in per capita land consumption, and 74 percent was related to its population growth over the past decade. Table 10 shows how much of the sprawl in Texas towns and cities is related to population growth and how much is related to growth in per capita land consumption (declining population density).

Table 10. Sources of Sprawl in Texas Urbanized Areas, 2000-2010

Urbanized Area	Total Sprawl 2000 to 2010 (square miles)	% of Total Sprawl Related to POPULATION GROWTH	% of Total Sprawl Related to GROWTH IN PER CAPITA LAND CONSUMPTION
Abilene	7.2	22%	88%
Amarillo	7.1	100%	0%
Austin	204.9	83%	17%
Beaumont	10.3	51%	49%
Brownsville	24.2	77%	23%
College Station--Bryan	22.3	69%	31%
Conroe--The Woodlands	91.6	85%	15%
Corpus Christi	10.0	98%	2%

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.

Urbanized Area	Total Sprawl 2000 to 2010 (square miles)	% of Total Sprawl Related to POPULATION GROWTH	% of Total Sprawl Related to GROWTH IN PER CAPITA LAND CONSUMPTION
Dallas--Fort Worth--Arlington	372.1	90%	10%
Denton--Lewisville	23.6	100%	0%
El Paso	31.5	100%	0%
Harlingen	23.6	60%	40%
Houston	364.8	100%	0%
Killeen	20.7	92%	8%
Lake Jackson--Angleton	7.9	9%	81%
Laredo	23.2	68%	32%
Longview	32.4	48%	52%
Lubbock	21.9	62%	38%
McAllen	44.2	100%	0%
McKinney	47.0	100%	0%
Midland	7.6	100%	0%
Odessa	5.7	100%	0%
Port Arthur	59.7	35%	65%
San Angelo	1.1	100%	0%
San Antonio	189.5	74%	26%
San Marcos	1.6	100%	0%
Sherman	4.1	81%	19%
Temple	12.8	85%	15%
Texarkana	6.4	75%	25%
Texas City	17.5	38%	62%
Tyler	32.8	55%	45%
Victoria	-22.0	N/A	N/A

Urbanized Area	Total Sprawl 2000 to 2010 (square miles)	% of Total Sprawl Related to POPULATION GROWTH	% of Total Sprawl Related to GROWTH IN PER CAPITA LAND CONSUMPTION
Waco	20.5	46%	54%
Wichita Falls	-1.6	N/A	N/A
Total Sprawl	**1,725.8**		
Weighted Average (Mean)		**85%**	**15%**

Given this apportionment or breakdown, opponents of sprawl in Texas should know that 85 percent of the sprawl problem is the inability to stabilize the state's population. In contrast, only 15 percent of the problem is the inability to stabilize per capita land use within urban development in the state. Figure 21 displays the relative magnitude of these factors on a pie chart.

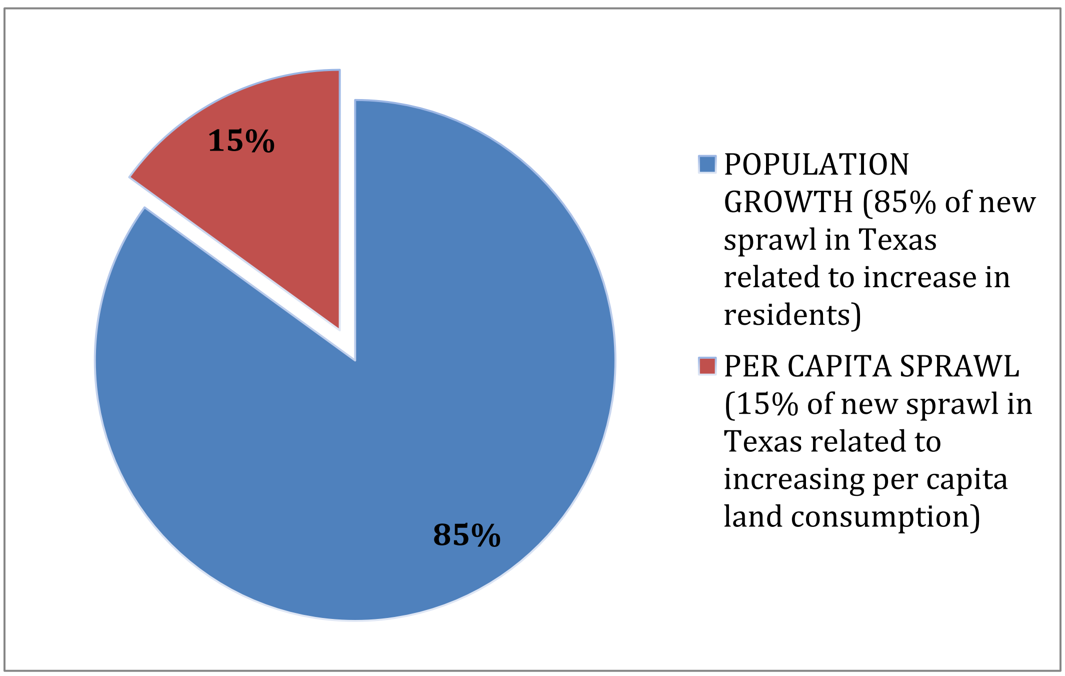

Figure 21. Percentages of Sprawl Related to Population Growth and Per Capita Sprawl in Texas' 34 Urbanized Areas

Source: U.S. Census Bureau, 2000-2010

Description: Approximately 15 percent of the sprawl in Texas' town and cities was related to increasing per capita land consumption. Approximately 85 percent of the sprawl was related to population growth.

Between 2000 and 2010, the 34 UAs in Texas sprawled across and consumed 1,726 additional square miles of land in aggregate. Figure 22 shows that population growth in Texas UAs was responsible for more than five times as much loss of rural land as Per Capita sprawl or rising land consumption per capita: 1,460 square miles vs. 266 square miles.

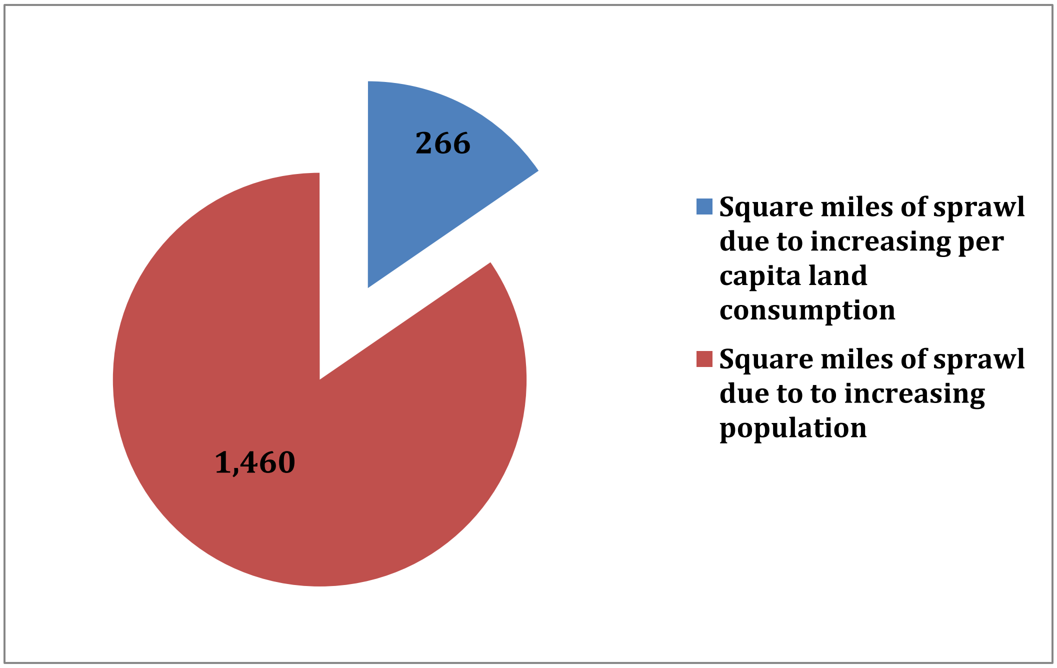

Figure 22. Rural Land Lost to Per Capita Sprawl vs. Population Growth in 34 Texas UAs, 2000-2010

3.1.4 Texas Urbanized Areas Versus Texas 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 fairly similar results, which is a sign of the robustness of our findings and an indication of their probable veracity.

From 2002 to 2012, a slightly different time frame than the Census Bureau's most recent decade (2000 to 2010), the analysis of NRI Developed Land data for Texas shows that population growth accounted for 68 percent of sprawl in the state (Figure 23). This compares to 85 percent for the 2000-2010 Census Bureau UA delineations. It is not surprising that population density would be higher in growing urban areas than outlying rural parts of the state that are also growing, and this accounts for the difference between the 85% and 68% results.

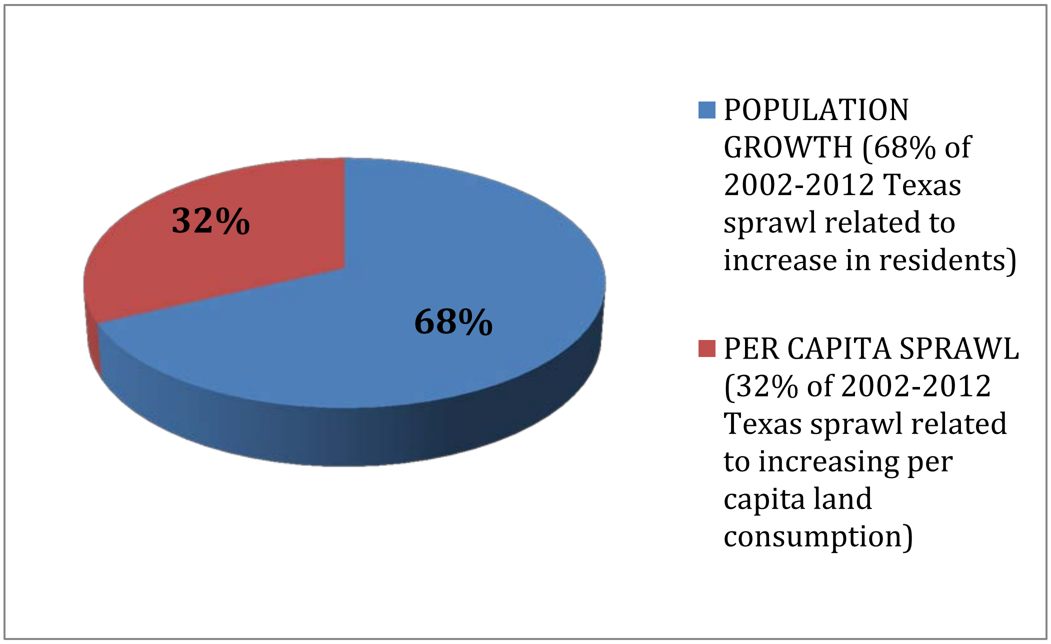

Figure 23. Sprawl Factors (Increasing Population and Increasing Per Capita Land Consumption in all Texas Counties, 2002-2012

Source: Analysis of developed land estimates from NRCS National Resources Inventory, 2012. See footnote #4.

Unlike the Census Bureau data, the NRCS survey encompasses development such as weekend cottages and second homes 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 towns under 50,000 residents. Finally, on a national scale, the NRI category of Developed Land called "Rural Transportation" accounted for almost 20 percent of all developed land in 2012.

3.2 Texas Compared to Other States

It is interesting to compare the relative amounts and causes of sprawl in Texas and other states using the NRI data on Developed Land. Here we do so for two time periods: 1982 to 2012 and 2002-2012. The first covers the entire three-decade period of NRCS NRI land use data, while the second concentrates on the most recent ten-year period.

3.2.1 Developed Land from 1982 to 2012

Figure 24 shows that across the entire 30-year time span between 1982 and 2012, about two-thirds (66%) of all open space developed in the United States was associated with population growth and about one-third of all open space developed (34 percent) was associated with increasing per capita land consumption or Per Capita Sprawl.

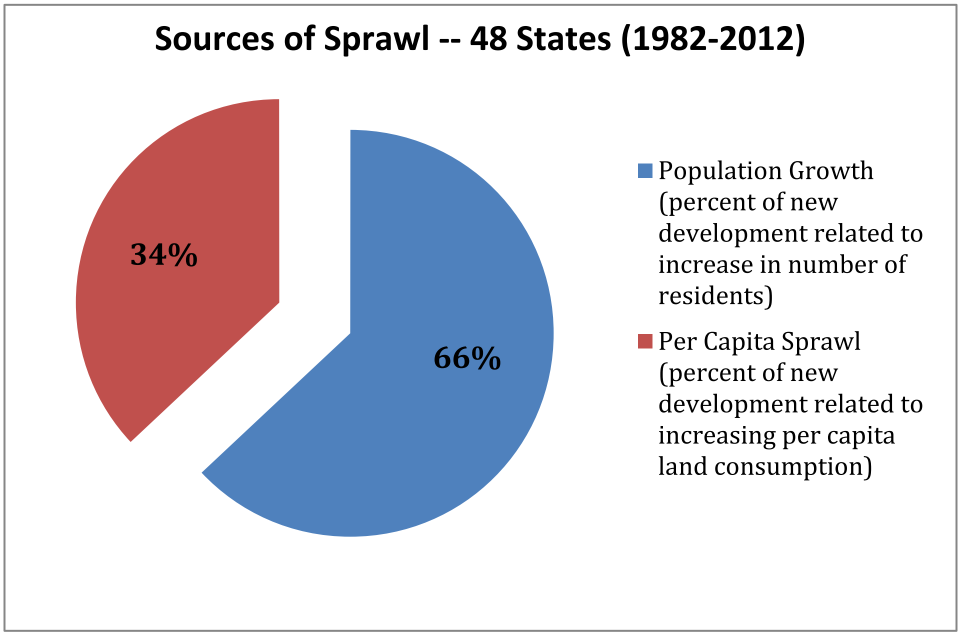

Figure 24. Sources of Sprawl in 48 Contiguous States, 1982-2012
Source: National Resources Inventory, 1982-2012

Table 11 shows total sprawl in the 48 contiguous states from 1982 to 2012, and the percentages of that total sprawl associated with either population growth or Per Capita Sprawl (growth in per capita land consumption). Texas had the dubious distinction of leading the nation in sprawl during these three recent decades, far surpassing the state in second place, Florida. Texas experienced 5,857 square miles of sprawl compared to 4,193 square miles for Florida.

Table 11. Sources of Sprawl in the 48 Contiguous States, 1982-2012

State	Total Sprawl (square miles), 1982-2012	% of Total Sprawl Related to Growth in POPULATION	% of Total Sprawl Related to Growth in PER CAPITA LAND CONSUMPTION
Alabama	1,944	36%	64%
Arizona	1,809	100%	0%
Arkansas	986	60%	40%
California	3,404	100%	0%

State	Total Sprawl (square miles), 1982-2012	% of Total Sprawl Related to Growth in POPULATION	% of Total Sprawl Related to Growth in PER CAPITA LAND CONSUMPTION
Colorado	1,131	100%	0%
Connecticut	376	54%	46%
Delaware	206	71%	29%
Florida	4,193	92%	8%
Georgia	3,740	77%	23%
Idaho	555	100%	0%
Illinois	1,233	45%	55%
Indiana	1,158	51%	49%
Iowa	476	37%	63%
Kansas	604	91%	9%
Kentucky	1,526	28%	72%
Louisiana	1,013	13%	87%
Maine	567	29%	71%
Maryland	841	73%	27%
Massachusetts	1,014	31%	69%
Michigan	2,134	21%	79%
Minnesota	1,092	77%	23%
Mississippi	1,119	32%	68%
Missouri	1,287	62%	38%
Montana	375	88%	12%
Nebraska	234	100%	0%
Nevada	513	100%	0%
New Hampshire	510	56%	44%

State	Total Sprawl (square miles), 1982-2012	% of Total Sprawl Related to Growth in POPULATION	% of Total Sprawl Related to Growth in PER CAPITA LAND CONSUMPTION
New Jersey	1,048	39%	61%
New Mexico	960	68%	32%
New York	1,582	35%	65%
North Carolina	3,818	68%	32%
North Dakota	184	39%	61%
Ohio	2,056	19%	81%
Oklahoma	1,084	46%	54%
Oregon	705	100%	0%
Pennsylvania	2,568	16%	84%
Rhode Island	94	33%	67%
South Carolina	2,080	57%	43%
South Dakota	237	100%	0%
Tennessee	2,280	52%	49%
Texas	**5,857**	**98%**	**2%**
Utah	643	94%	6%
Vermont	211	45%	55%
Virginia	2,076	73%	27%
Washington	1,448	100%	0%
West Virginia	803	0%	100%
Wisconsin	1,200	58%	42%
Wyoming	338	38%	62%
Total Sprawl	**65,312**	**66%**	**34%**

Source: NRCS National Resources Inventory; see footnote #4.

3.2.2 Developed Land from 2002 to 2012

If we examine national-level data for the most recent ten-year period, from 2002-2012, the role of the Population Growth factor is even higher than the average for the entire 30-year period. Whereas the 30-year average was 66 percent from 1982 to 2012, Population Growth accounted for virtually percent of the conversion from rural land to developed land from 2002 to 2012. If we use the weighted average method of calculation, which generates more conservative results that dampen the role of population growth, 85 percent of all sprawl nationally is still related to population (Figure 25). For Texas in particular, population growth was associated with 100 percent of sprawl in the state from 2002 to 2012, or 68 percent using the weighted average method of adjusting results and applying it county by county in the state.

Thus, it is evident that both nationally, and in the case of Texas 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 seven to nine out of every ten acres of land developed or urbanized in both the United States and Texas. 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, longitudinal trend.

Table 12 shows total sprawl in each of the 48 contiguous states from 2002 to 2012, and the percentages of that total sprawl associated with either Population Growth or Per Capita Sprawl (growth in per capita land consumption). As would be expected from Figure 25, which aggregates or lumps all of the states together and shows that the percentage of total sprawl due to population growth was higher from 2002 to 2012 than it was for the entire 30-year period (1982-2012), we observe that in most individual states, the percentage of sprawl related to population growth from 2002 to 2012 is higher than it was across the entire 30-year period (1982-2012). In other words, we can infer that the role of population growth in driving the nation's sprawl has increased over time.

This increase in the role of population growth in driving sprawl in recent decades (1990s, 2000s, and the current decade), compared to those decades immediately after World War II (1950s and 1960s) and those toward the end of the 20th century (1970s, 1980s, 1990s) is likely due to several long-term trends that result in higher average population densities, including Smart Growth initiatives, overall planning and zoning, higher gasoline prices, economic difficulties, and changing consumer housing preferences.

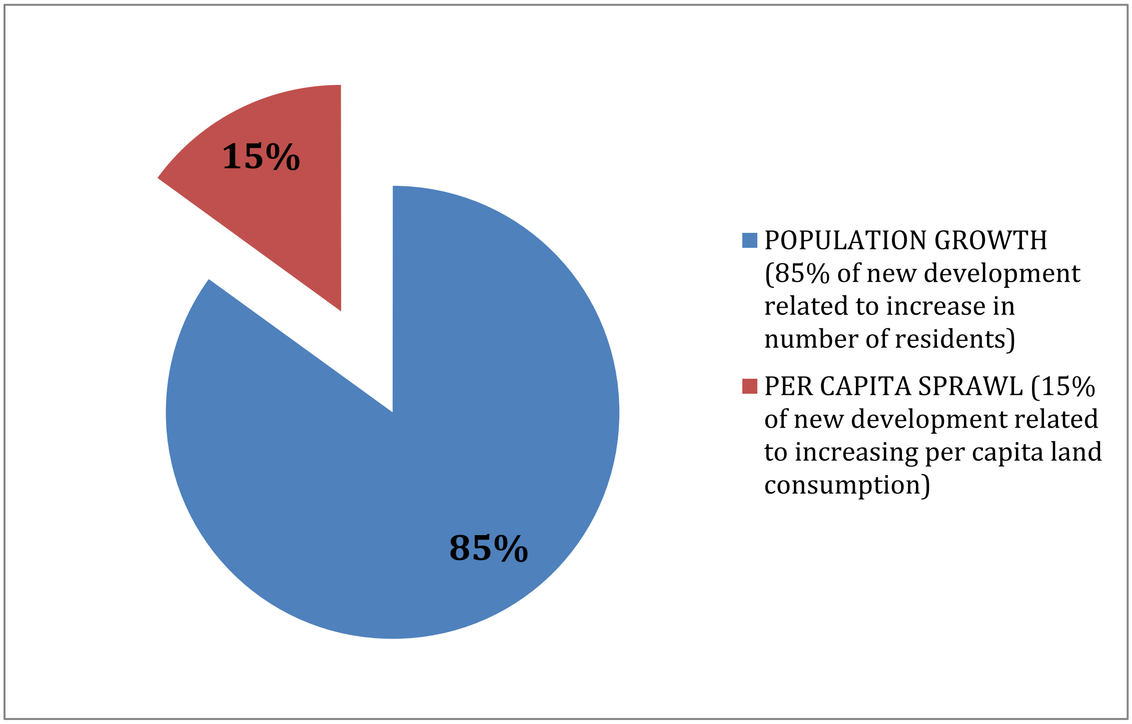

Figure 25. Sources of Recent Sprawl in the 48 Contiguous States, 2002-2012

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 2012 approximately 15% of the loss of rural land nationwide was related to an increase in developed land per person, and about 85% of the loss was related to population growth.

Table 12. Sources of Recent Sprawl in the 48 Contiguous States, 2002-2012

State	Total Sprawl (square miles), 2002-2012	% of Total Sprawl Related to Growth in POPULATION	% of Total Sprawl Related to Growth in PER CAPITA LAND CONSUMPTION
Alabama	403	79%	21%
Arizona	528	100%	0%
Arkansas	295	81%	19%
California	755	100%	0%
Colorado	233	100%	0%
Connecticut	70	95%	5%
Delaware	64	86%	14%
Florida	892	100%	0%

State	Total Sprawl (square miles), 2002-2012	% of Total Sprawl Related to Growth in POPULATION	% of Total Sprawl Related to Growth in PER CAPITA LAND CONSUMPTION
Georgia	648	100%	0%
Idaho	144	100%	0%
Illinois	293	41%	59%
Indiana	295	78%	22%
Iowa	157	91%	9%
Kansas	136	100%	0%
Kentucky	255	87%	13%
Louisiana	226	38%	62%
Maine	122	28%	72%
Maryland	161	100%	0%
Massachusetts	142	65%	35%
Michigan	316	0%	100%
Minnesota	196	100%	0%
Mississippi	299	40%	60%
Missouri	307	88%	12%
Montana	124	100%	0%
Nebraska	69	100%	0%
Nevada	146	100%	0%
New Hampshire	91	45%	55%
New Jersey	120	85%	15%
New Mexico	161	100%	0%
New York	269	53%	47%
North Carolina	643	100%	0%

State	Total Sprawl (square miles), 2002-2012	% of Total Sprawl Related to Growth in POPULATION	% of Total Sprawl Related to Growth in PER CAPITA LAND CONSUMPTION
North Dakota	87	100%	0%
Ohio	404	19%	81%
Oklahoma	373	79%	21%
Oregon	162	100%	0%
Pennsylvania	380	66%	34%
Rhode Island	18	0%	100%
South Carolina	420	100%	0%
South Dakota	42	100%	0%
Tennessee	445	100%	0%
Texas	**1,855**	**100%**	**0%**
Utah	205	100%	0%
Vermont	44	24%	76%
Virginia	458	100%	0%
Washington	282	100%	0%
West Virginia	111	49%	51%
Wisconsin	318	66%	34%
Wyoming	171	95%	5%
Total Sprawl	**14,335**	**100%**	**0%**
Weighted Average	**14,335**	**85%**	**15%**

Source: NRCS, 2015. *Summary Report: 2012 National Resources Inventory;* footnote #4

As Table 12 shows, from 2002 to 2012, according to the NRI, the amount of total sprawl in Texas (1,855 square miles) far exceeded that of any other state. Florida was far behind in second place, with 892 square miles of sprawl in this decade, barely half of what Texas experienced.

3.3 Sprawl in Texas Counties

This section presents results on land development and sprawl in all 254 Texas counties from 1982 to 2012, using USDA NRCS data from the *2012 National Resources Inventory*. Table 13 shows the total sprawl in each county during these three decades, and how much of that sprawl (conversion of rural land to developed land) was attributable to population growth or growth in per capita land consumption.

Table 13. Sprawl in 254 Texas Counties from 1982 to 2012

County	Total Sprawl (square miles), 1982-2012	% of Total Sprawl Related to Growth in POPULATION	% of Total Sprawl Related to Growth in PER CAPITA LAND CONSUMPTION
Anderson	18.4	64%	36%
Andrews	10.0	20%	80%
Angelina	39.5	29%	71%
Aransas	10.0	100%	0%
Archer	3.4	78%	22%
Armstrong	0.2	0%	100%
Atascosa	30.2	63%	37%
Austin	7.2	100%	0%
Bailey	0.2	0%	100%
Bandera	21.6	100%	0%
Bastrop	28.1	100%	0%
Baylor	0.8	0%	100%
Bee	5.2	94%	6%
Bell	95.3	84%	16%
Bexar	195.0	93%	7%
Blanco	4.1	100%	0%
Borden	1.1	0%	100%
Bosque	8.3	86%	14%
Bowie	24.1	66%	34%

County	Total Sprawl (square miles), 1982-2012	% of Total Sprawl Related to Growth in POPULATION	% of Total Sprawl Related to Growth in PER CAPITA LAND CONSUMPTION
Brazoria	98.4	100%	0%
Brazos	84.2	59%	41%
Brewster	-0.5	N/A	N/A
Briscoe	0.6	0%	100%
Brooks	5.5	0%	100%
Brown	2.2	100%	0%
Burleson	9.1	46%	54%
Burnet	29.8	100%	0%
Caldwell	8.3	100%	0%
Calhoun	13.8	3%	97%
Callahan	5.8	35%	65%
Cameron	54.2	100%	0%
Camp	4.5	48%	52%
Carson	5.3	0%	100%
Cass	14.2	0%	100%
Castro	3.1	0%	100%
Chambers	20.3	100%	0%
Cherokee	25.9	36%	64%
Childress	2.3	8%	92%
Clay	3.8	33%	67%
Cochran	0.5	0%	100%
Coke	2.7	0%	100%
Coleman	3.3	0%	100%
Collin	142.8	100%	0%
Collingsworth	0.0	0%	100%

County	Total Sprawl (square miles), 1982-2012	% of Total Sprawl Related to Growth in POPULATION	% of Total Sprawl Related to Growth in PER CAPITA LAND CONSUMPTION
Colorado	8.8	15%	85%
Comal	43.4	100%	0%
Comanche	2.3	42%	58%
Concho	0.6	100%	0%
Cooke	23.4	41%	59%
Coryell	17.2	46%	54%
Cottle	-0.5	N/A	N/A
Crane	0.5	0%	100%
Crockett	4.4	0%	100%
Crosby	2.0	0%	100%
Culberson	0.0	0%	100%
Dallam	0.8	39%	61%
Dallas	158.3	100%	0%
Dawson	4.5	0%	100%
Deaf Smith	4.7	0%	100%
Delta	3.0	16%	84%
Denton	160.3	100%	0%
DeWitt	2.0	21%	79%
Dickens	-0.3	100%	0%
Dimmit	2.0	0%	100%
Donley	0.9	0%	100%
Duval	16.4	0%	100%
Eastland	12.3	0%	100%
Ector	24.1	25%	75%
Edwards	3.8	0%	100%

County	Total Sprawl (square miles), 1982-2012	% of Total Sprawl Related to Growth in POPULATION	% of Total Sprawl Related to Growth in PER CAPITA LAND CONSUMPTION
Ellis	82.5	70%	30%
El Paso	91.9	84%	16%
Erath	16.7	100%	0%
Falls	10.3	0%	100%
Fannin	6.4	100%	0%
Fayette	17.5	31%	69%
Fisher	0.8	0%	100%
Floyd	2.0	0%	100%
Foard	-0.3	N/A	N/A
Fort Bend	112.5	100%	0%
Franklin	7.8	54%	46%
Freestone	33.3	16%	84%
Frio	6.9	68%	32%
Gaines	10.6	75%	25%
Galveston	52.2	95%	5%
Garza	0.8	82%	18%
Gillespie	19.4	100%	0%
Glasscock	5.3	0%	100%
Goliad	2.8	100%	0%
Gonzales	4.2	39%	61%
Gray	3.6	0%	100%
Grayson	46.7	44%	56%
Gregg	37.3	20%	80%
Grimes	19.4	49%	51%
Guadalupe	30.8	100%	0%

County	Total Sprawl (square miles), 1982-2012	% of Total Sprawl Related to Growth in POPULATION	% of Total Sprawl Related to Growth in PER CAPITA LAND CONSUMPTION
Hale	10.6	0%	100%
Hall	0.2	0%	100%
Hamilton	7.5	1%	99%
Hansford	-1.1	N/A	N/A
Hardeman	0.8	0%	100%
Hardin	20.2	94%	6%
Harris	378.3	95%	5%
Harrison	35.0	19%	81%
Hartley	1.3	100%	0%
Haskell	3.1	0%	100%
Hays	65.0	93%	7%
Hemphill	7.3	0%	100%
Henderson	58.8	78%	22%
Hidalgo	118.1	100%	0%
Hill	26.4	43%	57%
Hockley	43.0	0%	100%
Hood	15.2	100%	0%
Hopkins	7.2	82%	18%
Houston	3.4	12%	88%
Howard	10.2	0%	100%
Hudspeth	0.5	100%	0%
Hunt	32.3	79%	81%
Hutchinson	6.6	0%	100%
Irion	1.7	10%	90%
Jack	3.1	82%	18%

County	Total Sprawl (square miles), 1982-2012	% of Total Sprawl Related to Growth in POPULATION	% of Total Sprawl Related to Growth in PER CAPITA LAND CONSUMPTION
Jackson	4.2	12%	88%
Jasper	33.9	17%	83%
Jeff Davis	5.8	50%	50%
Jefferson	70.6	0%	100%
Jim Hogg	-7.2	N/A	N/A
Jim Wells	13.1	15%	85%
Johnson	79.2	66%	34%
Jones	10.6	26%	74%
Karnes	6.7	21%	79%
Kaufman	31.1	100%	0%
Kendall	13.0	100%	0%
Kenedy	-0.8	N/A	N/A
Kent	1.7	0%	100%
Kerr	19.7	100%	0%
Kimble	1.6	41%	59%
King	0.3	0%	100%
Kinney	0.0	0%	100%
Kleberg	13.0	0%	100%
Knox	1.7	0%	100%
Lamar	31.3	31%	69%
Lamb	2.8	0%	100%
Lampasas	6.6	100%	0%
La Salle	-1.3	N/A	N/A
Lavaca	5.0	0%	100%
Lee	4.8	58%	42%

County	Total Sprawl (square miles), 1982-2012	% of Total Sprawl Related to Growth in POPULATION	% of Total Sprawl Related to Growth in PER CAPITA LAND CONSUMPTION
Leon	10.8	100%	0%
Liberty	62.5	48%	52%
Limestone	9.2	35%	65%
Lipscomb	6.4	0%	100%
Live Oak	5.3	74%	26%
Llano	15.6	100%	0%
Loving	2.5	0%	100%
Lubbock	49.7	50%	50%
Lynn	1.6	0%	100%
McCulloch	8.8	0%	100%
McLennan	23.8	100%	0%
McMullen	0.9	0%	100%
Madison	4.2	54%	46%
Marion	6.1	0%	100%
Martin	18.6	0%	100%
Mason	1.9	46%	54%
Matagorda	9.5	0%	100%
Maverick	11.6	100%	0%
Medina	10.6	100%	0%
Menard	1.9	0%	100%
Midland	45.9	73%	27%
Milam	15.3	7%	93%
Mills	1.4	44%	56%
Mitchell	2.0	0%	100%
Montague	8.9	16%	84%

County	Total Sprawl (square miles), 1982-2012	% of Total Sprawl Related to Growth in POPULATION	% of Total Sprawl Related to Growth in PER CAPITA LAND CONSUMPTION
Montgomery	212.3	100%	0%
Moore	10.2	51%	49%
Morris	17.2	0%	100%
Motley	0.0	0%	100%
Nacogdoches	18.0	69%	31%
Navarro	28.1	30%	70%
Newton	6.6	10%	90%
Nolan	5.9	0%	100%
Nueces	42.7	49%	51%
Ochiltree	5.2	0%	100%
Oldham	1.4	0%	100%
Orange	53.9	0%	100%
Palo Pinto	12.3	31%	69%
Panola	20.0	10%	90%
Parker	49.1	100%	0%
Parmer	2.3	0%	100%
Pecos	117.5	0%	100%
Polk	16.1	100%	0%
Potter	33.0	39%	61%
Presidio	1.1	100%	0%
Rains	5.6	100%	0%
Randall	18.4	100%	0%
Reagan	1.9	0%	100%
Real	3.1	89%	11%
Red River	9.4	0%	100%

County	Total Sprawl (square miles), 1982-2012	% of Total Sprawl Related to Growth in POPULATION	% of Total Sprawl Related to Growth in PER CAPITA LAND CONSUMPTION
Reeves	4.4	0%	100%
Refugio	2.2	0%	100%
Roberts	2.2	0%	100%
Robertson	16.6	12%	88%
Rockwall	33.3	100%	0%
Runnels	1.7	0%	100%
Rusk	50.8	25%	75%
Sabine	7.0	20%	80%
San Augustine	34.2	0%	100%
San Jacinto	21.6	100%	0%
San Patricio	23.4	16%	84%
San Saba	0.5	50%	50%
Schleicher	6.9	2%	98%
Scurry	7.5	0%	100%
Shackelford	0.9	0%	100%
Shelby	23.9	9%	91%
Sherman	1.9	0%	100%
Smith	137.8	38%	62%
Somervell	5.6	100%	0%
Starr	32.7	97%	3%
Stephens	1.6	0%	100%
Sterling	1.7	0%	100%
Stonewall	1.3	0%	100%
Sutton	6.7	0%	100%
Swisher	2.7	0%	100%

County	Total Sprawl (square miles), 1982-2012	% of Total Sprawl Related to Growth in POPULATION	% of Total Sprawl Related to Growth in PER CAPITA LAND CONSUMPTION
Tarrant	285.2	100%	0%
Taylor	15.6	37%	63%
Terrell	3.9	0%	100%
Terry	3.4	0%	100%
Throckmorton	0.5	0%	100%
Titus	11.7	52%	48%
Tom Green	18.3	78%	22%
Travis	141.7	100%	0%
Trinity	12.3	54%	46%
Tyler	22.2	45%	55%
Upshur	21.9	30%	70%
Upton	9.7	0%	100%
Uvalde	3.9	88%	12%
Val Verde	10.5	45%	55%
Van Zandt	76.6	39%	61%
Victoria	16.3	74%	26%
Walker	23.0	69%	31%
Waller	19.2	100%	0%
Ward	6.4	0%	100%
Washington	13.9	62%	38%
Webb	57.3	99%	1%
Wharton	25.0	0%	100%
Wheeler	7.0	0%	100%
Wichita	14.4	21%	79%
Wilbarger	1.6	0%	100%

County	Total Sprawl (square miles), 1982-2012	% of Total Sprawl Related to Growth in POPULATION	% of Total Sprawl Related to Growth in PER CAPITA LAND CONSUMPTION
Willacy	1.3	100%	0%
Williamson	58.1	100%	0%
Wilson	10.2	100%	0%
Winkler	4.5	0%	100%
Wise	26.4	100%	0%
Wood	93.6	31%	69%
Yoakum	3.8	0%	100%
Young	3.4	0%	100%
Zapata	10.2	0%	100%
Zavala	8.1	0%	100%
All Texas	**5,857.2**	**92%**	**8%**
Weighted Average		**67%**	**33%**

Note: Counties with a minus sign in front of the square miles of Total Sprawl between 1982 and 2012 are estimated to have experienced a decline in the acreage of Developed Land according to the NRCS NRI sampling procedure. Thus, since there was no net sprawl in that country, there is an "N/A" in both the POPULATION and PER CAPITA LAND CONSUMPTION columns.

One finding of interest that is evident in this table is that there are far more counties (94) in which population growth accounts for zero percent of sprawl than there are counties in which increasing per capita land consumption accounts for zero percent of sprawl (55). These 94 counties are those which, as noted earlier, actually underwent population decline between 1982 and 2012. Since there was no net population growth in these counties, by definition, population growth could not have contributed at all to whatever sprawl that did occur during these three decades. However, these tended to be counties with very little sprawl.

Indeed, in those 55 counties in which all sprawl (100%) was related to population growth, and none to increasing per capita land consumption, there was a total of 2,160 square miles of sprawl between 1982 and 2012. In contrast, in those 94 counties in which increasing per capita land consumption accounted for 100% of sprawl (and population growth zero percent), sprawl totaled only 588 square miles. And overall, depending on the method used, population growth was related to between 67 to 92 percent of all sprawl in Texas counties between 1982 and 2012.

The following figures depict the relative importance of increasing population and increasing per capita land consumption in driving land development and sprawl at the county level in Texas from 1982 to 2012.

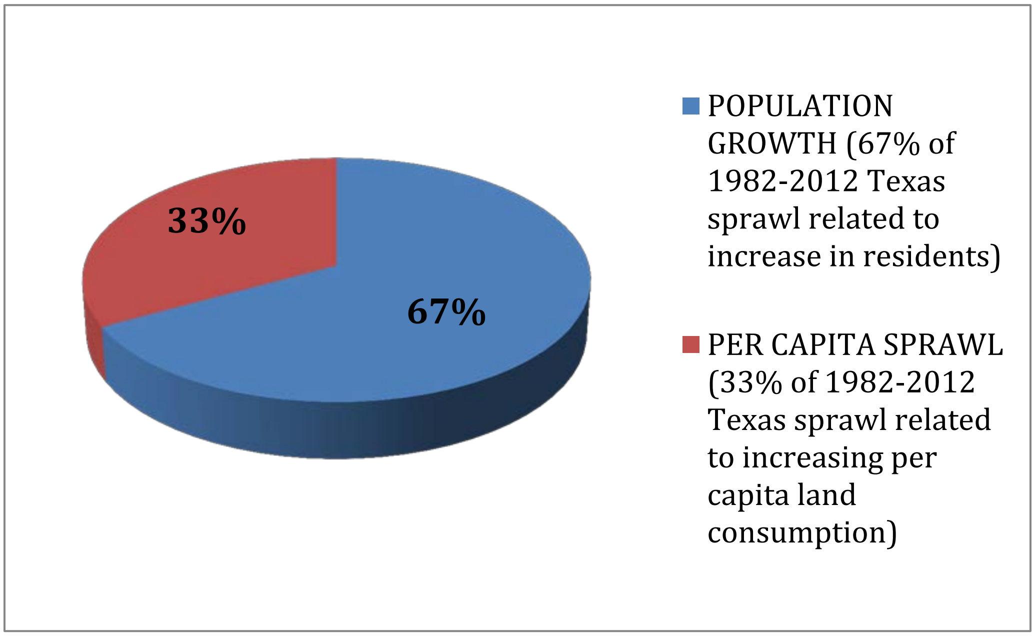

Figure 26. Sources of Sprawl in All 254 Texas Counties, 1982 to 2012

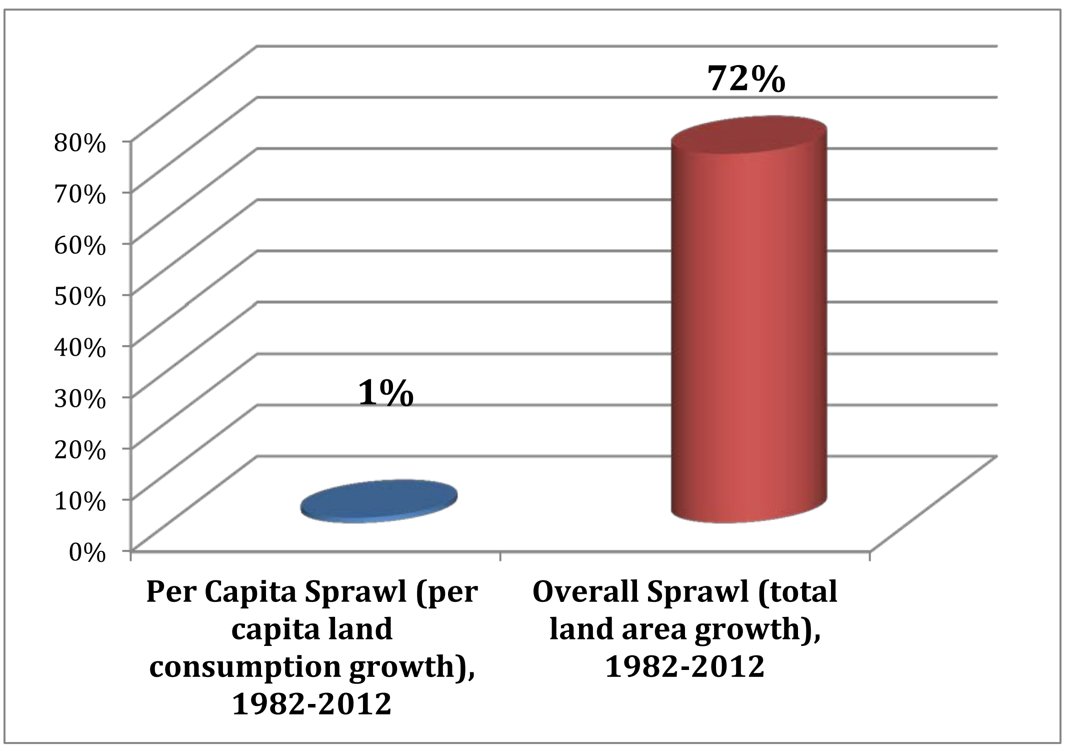

Figure 27. Per Capita Sprawl versus Overall Sprawl in 254 Texas Counties, 1982 to 2012

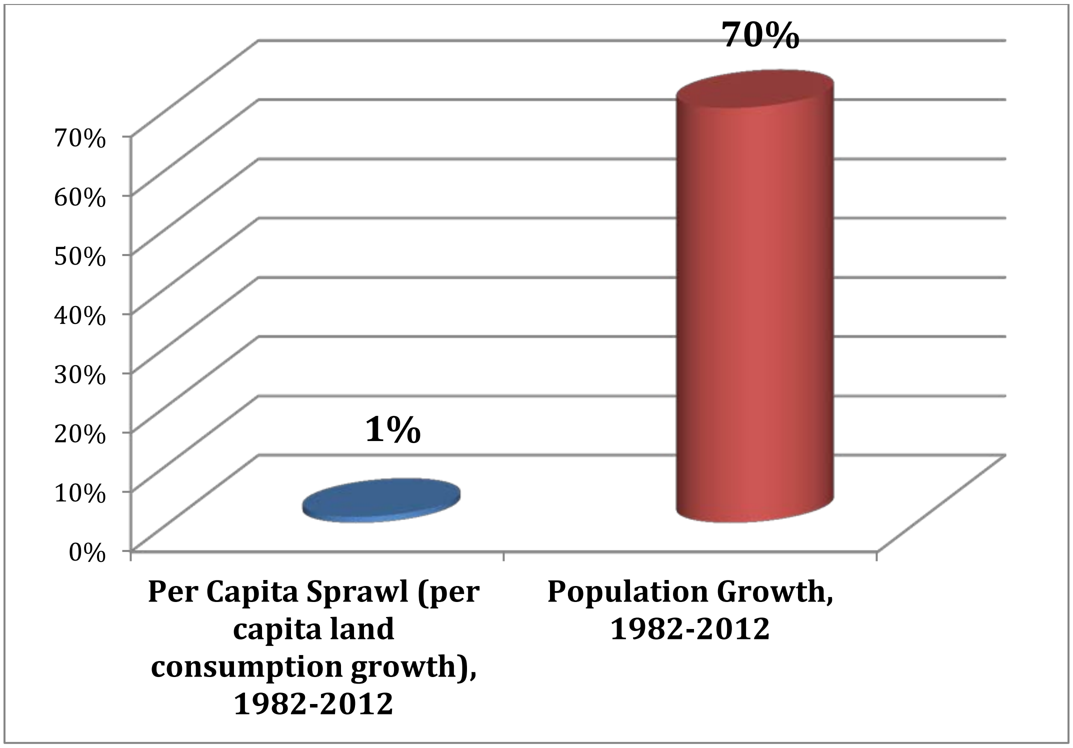

Figure 28. Per Capita Sprawl versus Population Growth in 254 Texas Counties, 1982 to 2012

3.4 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 29 is a scatter plot for Texas 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 "best fit" line for Figure 29 indicates that there is a positive relationship between population increase and Overall Sprawl. Counties with more population growth were also those 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 (sloping downward toward the right instead of upward). While this scatter plot alone does not prove that population growth causes sprawl, it does strongly suggest and reinforce the hypothesis that the two are closely correlated.

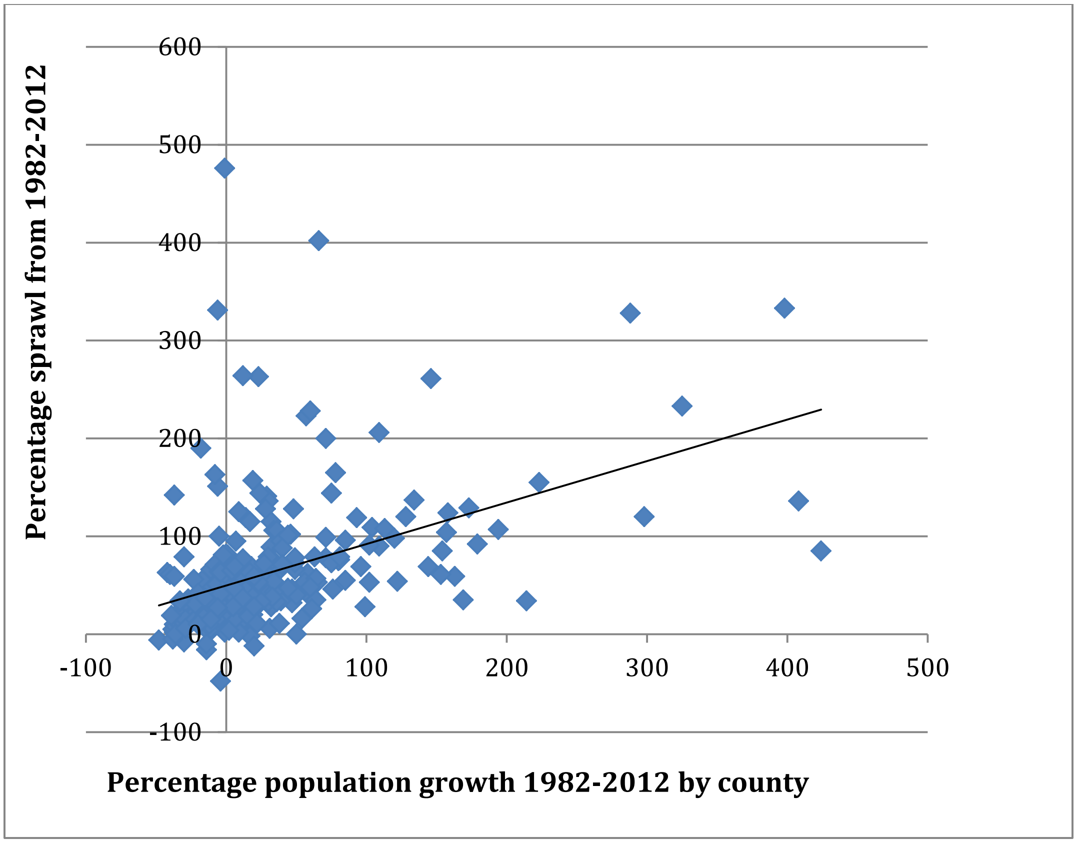

Figure 29. Scatter Plot of Population Growth vs. Sprawl in 254 Texas Counties, 1982-2012
Sources: Census Bureau and National Resources Inventory

Figure 30 is a similar scatter plot showing the population size in 2012 of all Texas counties on the x-axis and the area of Developed Land (i.e., Overall Sprawl) on the y-axis. Once again, there is a clear correlation between population size and the area of developed land needed to accommodate that population, as evidenced by the left-to-right upward (positive) slope of the "best fit" line. Sprawl is clearly a function of population growth.

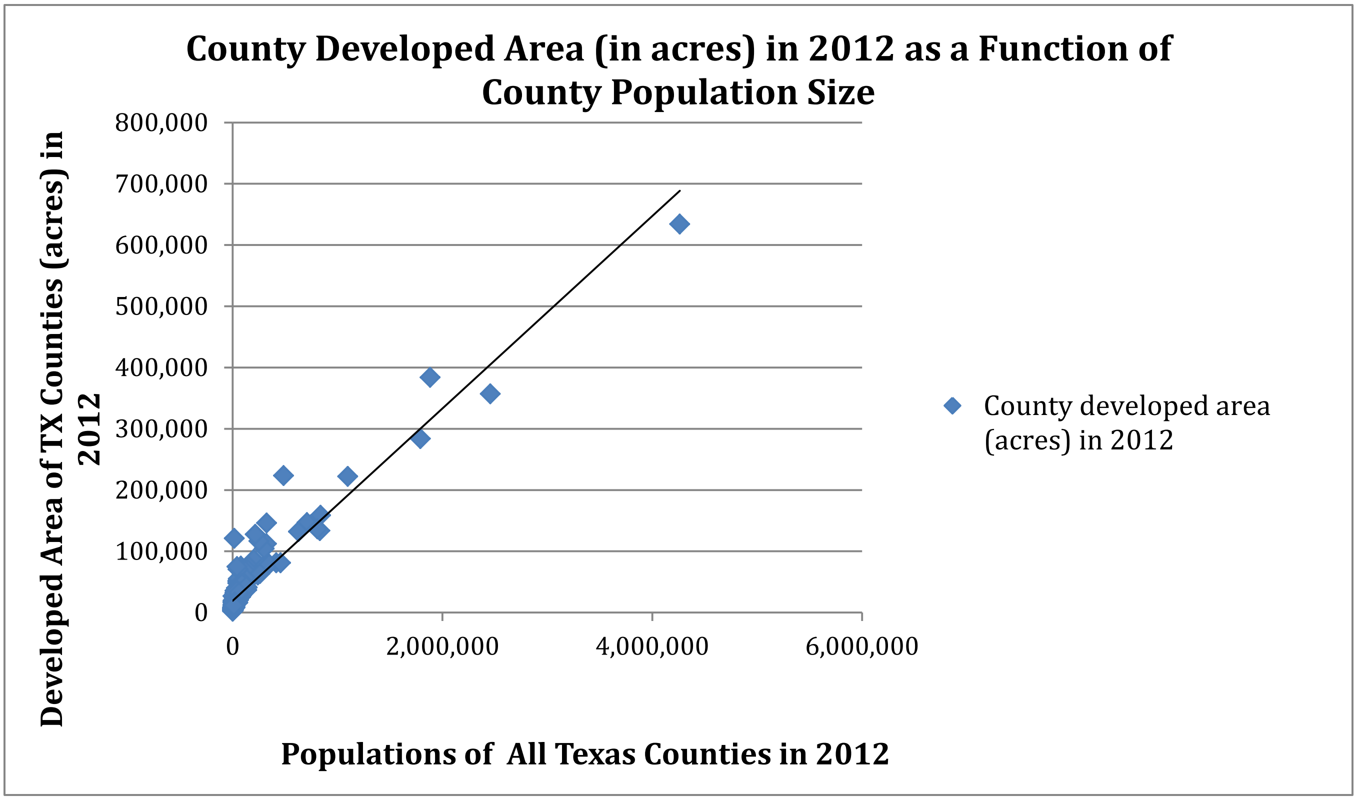

Figure 30. Scatter Plot of Population Size vs. Sprawl or Total Developed Area in All 254 Texas Counties, 2012

3.5 Trends

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 Texas, the addition of 4.2 million new residents to Urbanized Areas between 2000 and 2010 was responsible for at least 85 percent of all sprawl in the Lone Star State.

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. 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 31).

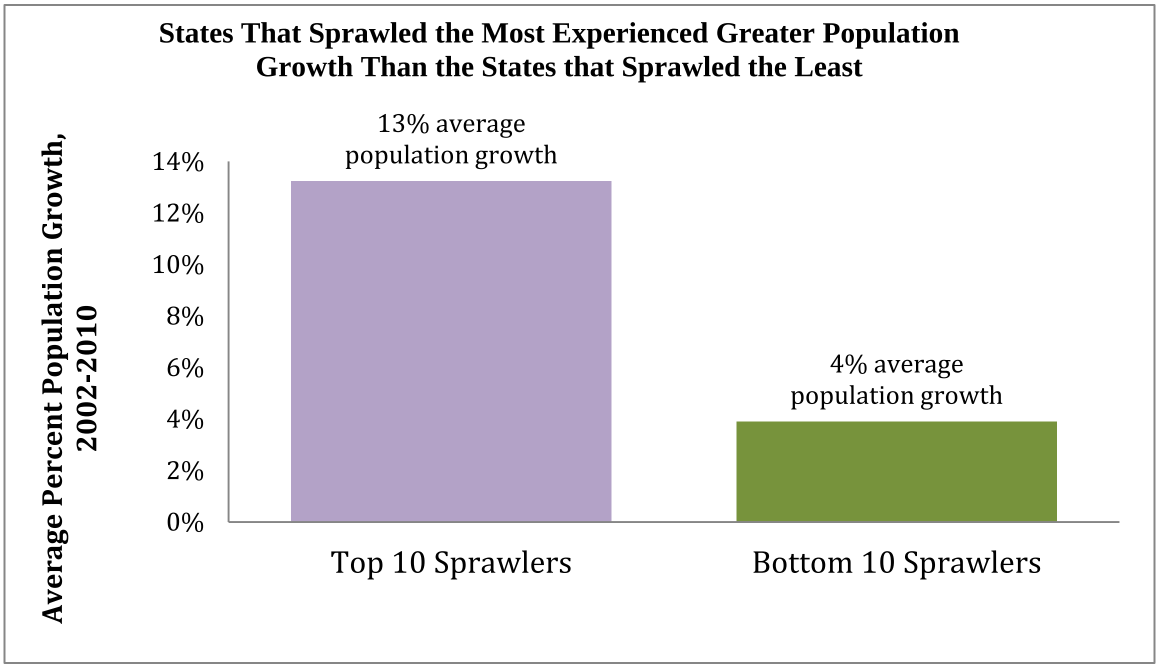

Figure 31. Comparison of Population Growth between High and Low Sprawling States

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

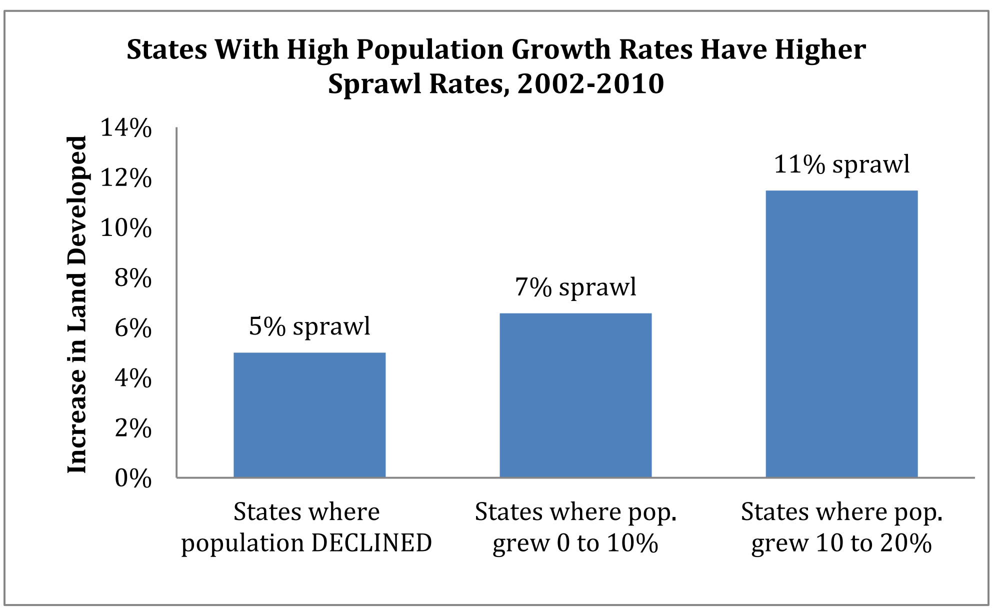

Figure 32. Comparison of Sprawl in Slow-Growing vs. Fast-Growing States

Table 14 ranks the states according to their sprawl rate from 2002 to 2012, from highest to lowest, by percentage. Table 14 also includes the entire 30-year, 1982-2012 period, so that for each state, the percent sprawl and ranking are provided for the entire extended period of study. Texas was in sixth place in the most recent 2002-2012 time period and 17th place for the overall 1982-2012 time period.

Table 14. Sprawl in 48 States, Ranked by Percentage

Ranking (by percentage) 2002-2012	Total Sprawl (percentage), 2002-2012 Recent	State	Total Sprawl (percentage), 1982-2012 Overall	Total Sprawl Ranking by Percentage, 1982-2012
1	20.2%	Nevada	144.6%	1
2	18.7%	Arizona	116.9%	2
3	17.9%	Utah	90.6%	7
4	17.0%	Wyoming	40.3%	36
5	16.4%	Delaware	82.9%	11
6	**15.3%**	**Texas**	**72.3%**	**16**
7	12.2%	Oklahoma	46.5%	31
8	11.6%	Florida	95.4%	6
9	11.5%	Mississippi	62.7%	19
10	11.4%	Arkansas	51.8%	27
11	11.2%	Idaho	63.4%	18
12	11.1%	South Carolina	97.8%	5
13	10.2%	Virginia	72.6%	15
14	10.1%	Tennessee	88.1%	8
15	9.9%	Maine	72.0%	17
16	9.8%	Georgia	106.9%	3
17	9.8%	Alabama	77.0%	14
18	9.4%	North Carolina	103.6%	4

Ranking (by percentage) 2002-2012	Total Sprawl (percentage), 2002-2012 Recent	State	Total Sprawl (percentage), 1982-2012 Overall	Total Sprawl Ranking by Percentage, 1982-2012
19	8.7%	New Hampshire	81.2%	12
20	8.4%	New Mexico	86.1%	9
21	8.4%	Colorado	60.1%	20
22	8.4%	California	53.4%	26
23	8.3%	Kentucky	85.7%	10
24	8.3%	Louisiana	51.8%	28
25	8.1%	Indiana	41.6%	34
26	8.0%	Montana	29.0%	42
27	8.0%	Wisconsin	38.7%	37
28	7.8%	Oregon	46.1%	32
29	7.7%	Vermont	51.2%	29
30	7.7%	Washington	57.4%	23
31	7.3%	Maryland	55.1%	25
32	7.0%	Missouri	38.0%	38
33	6.6%	Ohio	46.0%	33
34	6.6%	West Virginia	81.2%	13
35	5.8%	North Dakota	13.2%	48
36	5.8%	Pennsylvania	59.4%	21
37	5.8%	Illinois	30.1%	41
38	5.5%	Minnesota	40.7%	35
39	5.5%	Iowa	18.6%	46
40	5.4%	Massachusetts	58.1%	22
41	5.3%	Rhode Island	35.0%	40

Ranking (by percentage) 2002-2012	Total Sprawl (percentage), 2002-2012 Recent	State	Total Sprawl (percentage), 1982-2012 Overall	Total Sprawl Ranking by Percentage, 1982-2012
42	5.0%	Michigan	47.9%	30
43	4.7%	New York	35.8%	39
44	4.3%	Connecticut	28.6%	43
45	4.3%	New Jersey	57.0%	24
46	4.3%	Kansas	22.3%	44
47	3.9%	Nebraska	14.4%	47
48	2.8%	South Dakota	18.7%	45

Sources: 2012 NRCS National Resources Inventory; U.S. Census Bureau

It is interesting to compare the sprawl patterns in the various states for the more recent (2002-2012) and longer (1982-2012) periods, especially for those states that differ markedly between the two periods. For example, Wyoming was in 4th place from 2002 to 2012 but 36th place from 1982 to 2012; this difference is likely a reflection of land development related to the resource boom in the early 2000s, particularly subbituminous coal mining in the Powder River Basin. Similarly, North Dakota moved from 48th (last) place in its sprawl during the overall period (1982-2012) to 35th place for the more recent 2002 to 2012 period, likely an outcome of land development related to the Bakken Formation oil boom.

Table 15 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 15 also includes the entire 30-year, 1982-2012 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, Texas is in first place both for the more recent 2002-2012 time period, as well as the overall 1982-2012 time period. No other state even comes close for either time period. Florida, in second place for both the 2002 to 2012 period and the 1982 to 2012 period, has 48 percent as much sprawl as Texas in the more recent period and 72 percent as much sprawl in the overall period. Both Texas and Florid are rapidly growing, rapidly sprawling states, but what this comparison means is the sprawl has accelerated even faster in Texas than it has in Florida.

Table 15. Sprawl in 48 States, Ranked by Area

Ranking (by area) 2002-2012	Total Sprawl (square miles), 2002-2012 Recent	State	Total Sprawl (square miles), 1982-2012 Overall	Total Sprawl Ranking by Area, 1982-2012
1	**1,855**	**Texas**	**5,857**	**1**
2	892	Florida	4,193	2
3	755	California	3,404	5
4	648	Georgia	3,740	4
5	643	North Carolina	3,818	3
6	528	Arizona	1,809	13
7	458	Virginia	2,076	10
8	445	Tennessee	2,280	7
9	420	South Carolina	2,080	9
10	404	Ohio	2,056	11
11	403	Alabama	1,944	12
12	380	Pennsylvania	2,568	6
13	373	Oklahoma	1,084	24
14	318	Wisconsin	1,200	19
15	316	Michigan	2,134	8
16	307	Missouri	1,287	17
17	299	Mississippi	1,119	22
18	295	Indiana	1,158	20
19	295	Arkansas	986	28
20	293	Illinois	1,233	18
21	282	Washington	1,448	16
22	269	New York	1,582	14

Ranking (by area) 2002-2012	Total Sprawl (square miles), 2002-2012 Recent	State	Total Sprawl (square miles), 1982-2012 Overall	Total Sprawl Ranking by Area, 1982-2012
23	255	Kentucky	1,526	15
24	233	Colorado	1,131	21
25	226	Louisiana	1,013	27
26	205	Utah	643	33
27	196	Minnesota	1,092	23
28	171	Wyoming	338	42
29	162	Oregon	705	32
30	161	Maryland	841	30
31	161	New Mexico	960	29
32	157	Iowa	476	39
33	146	Nevada	513	38
34	144	Idaho	555	36
35	142	Massachusetts	1,014	26
36	136	Kansas	604	34
37	124	Montana	375	41
38	122	Maine	567	35
39	120	New Jersey	1,048	25
40	111	West Virginia	803	31
41	91	New Hampshire	510	37
42	87	North Dakota	184	47
43	70	Connecticut	376	40
44	69	Nebraska	234	44
45	64	Delaware	206	46

Ranking (by area) 2002-2012	Total Sprawl (square miles), 2002-2012 Recent	State	Total Sprawl (square miles), 1982-2012 Overall	Total Sprawl Ranking by Area, 1982-2012
46	44	Vermont	211	45
47	42	South Dakota	237	43
48	18	Rhode Island	94	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 which 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% in the 2000s. The Census Bureau and NRCS data, obtained in such different manners, are remarkably consistent in this regard.

Sprawl trends in Texas are broadly similar to those of the nation at large. According to Table 4, drawing on the 2012 NRI, the average daily rate of sprawl (conversion from rural to urban land) in Texas in five-year periods from 1982 to 2012 was as follows:

- 1982-1987: 282 acres/day
- 1987-1992: 299 acres/day
- 1992-1997: 369 acres/day
- 1997-2002: 453 acres/day
- 2002-2007: 406 acres/day
- 2007-2012: 244 acres/day

The sprawl average during this 3-decade period was 342 acres per day, or more than 14 acres of open space devoured every hour. The sprawl rate peaked from 1997 to 2002. In the most recent period for which NRI data are available (2007 to 2012), the rate of sprawl had plunged to 244 acres/day from 406 acres/day in 2000 to 2007. It should be remembered that the 2007 to 2012 period corresponds with the Great Recession, a crisis instigated by the subprime mortgage crisis, housing bubble, and unsustainable household debt. During the Great Recession, land development and sprawl were drastically curtailed around the United States.

4. CONCLUSIONS AND POLICY IMPLICATIONS

4.1 Conclusions

At both the state level of Texas and the national level there is a broad correlation between population size and sprawl: generally, the larger a city, county, or state's population, the larger the land area it will sprawl across.

This is shown clearly in Figure 33, a simple scatter plot of the 48 contiguous states' cumulative populations and developed land areas in 2010. The positive (upward tilting toward the right) slope of the best-fit line means that as a state'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 little or no connection between population size or growth rates and environmental impact.

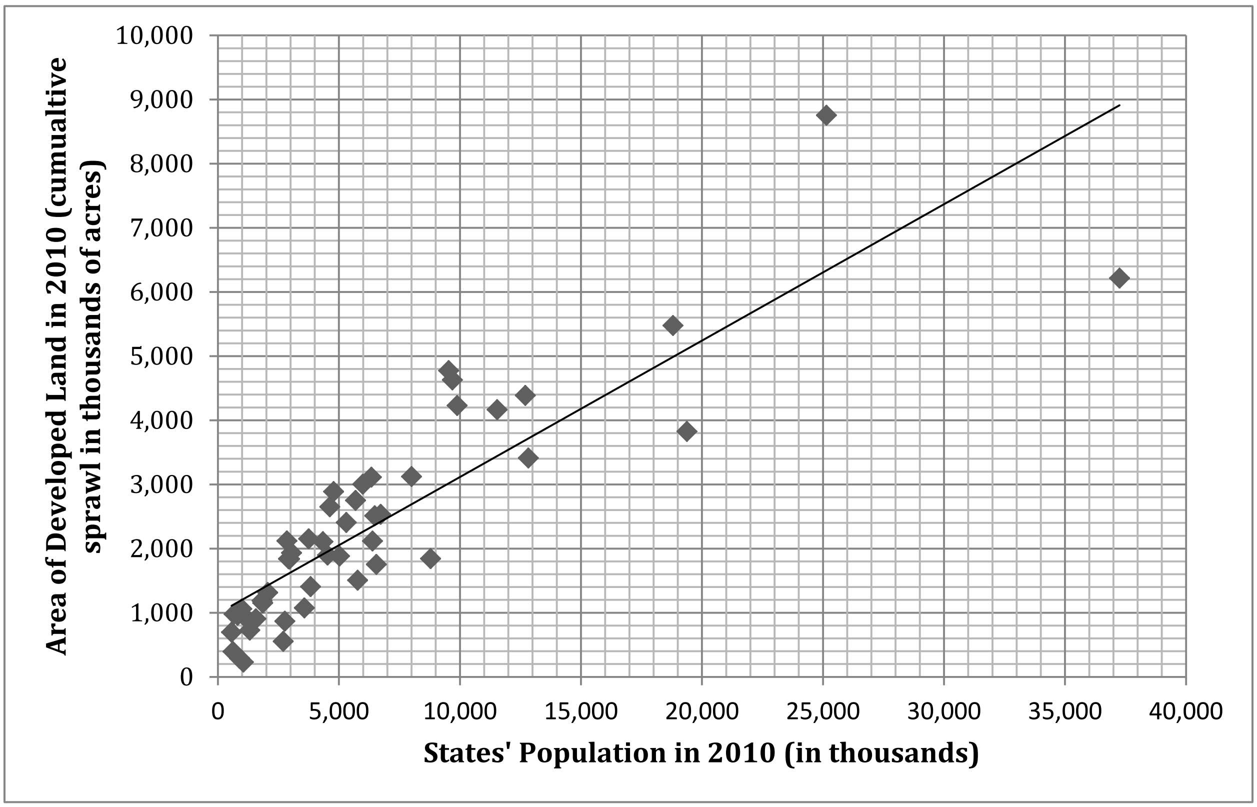

Figure 33. Cumulative Developed Land Area (Sprawl) Is a Function of Population Size
Source: U.S. Census Bureau; NRCS, 2013. *Summary Report: 2010 National Resources Inventory*

Sprawl continues to devour rural land around Texas cities at a very rapid rate.

Although the pace of sprawl in Texas may have peaked in the late 1990s and early 2000s, our most recent data show that it continues to devour open space at a rate of 244 acres per day, or more than one square mile every three days, and over 140 square miles or 89,000 acres per year. And in all likelihood, this rate has accelerated with the gradual waning of the Great Recession, though we don't yet have the data to confirm this hypothesis. Even at this reduced rate, sprawl would continue to convert an additional 1,400 square miles or nearly 900,000 acres of Texas' valuable agricultural land and wildlife habitat into pavement and buildings every decade. By 2050, another 4,600 square miles (2.9 million acres) of Texas' rural lands will have been paved or covered with subdivisions; hotels; industrial, office and theme parks; schools; and commercial strips, a great and permanent loss to Texas agricultural potential, wildlife habitat, natural heritage, 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 Texas' 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 of Rural Texas succumbs 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 crop and pastureland; national and state parks, forests, and wildlife refuges; mines; watersheds and reservoir buffer zones; utility corridors; U.S. military bases and arsenals – will represent a larger and larger fraction of the remaining undeveloped land. To some extent, water scarcity may also restrict far-flung, never-ending development in Texas.

The role of population growth in driving sprawl in Texas has stayed consistently high over the last several decades, but has gradually increased.

In the eighties and nineties, population growth accounted for approximately 86 percent of sprawl in Texas (or 64 percent using the weighted average approach). In this century, it has accounted for between almost 70 percent (weighted average) to 100 percent of sprawl. In both Texas and nationwide, down through the decades, the role of population growth as a driver of sprawl rose, while the role of increasing per capita land consumption (what we have referred to as "land use choices") fell.

In our 2014 study of national sprawl, *Vanishing Open Spaces*, using data from the same two federal agencies (U.S. Census Bureau and NRCS) 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.

Attempts to concentrate and direct development into confined areas are not enough to offset the pressures from population growth.

A central goal of Smart Growth is to preserve open space, farmland, natural beauty, wildlife habitat, and critical environmental areas by preventing declining population density. Thus, places where population density increases should be hailed as success stories. Between 2000 and 2010 in Texas, there were 13 out of 34 Urbanized Areas (i.e., more than one-third of all Texas UAs) whose density either remained constant or increased – in other words, their per capita land consumption remained constant or decreased. However, many of these cities still experienced appreciable sprawl, totaling 534 square miles between 2000 and 2010. This was about 30 percent of combined sprawl in all Texas UAs.

No city in Texas has come close to **Portland, Oregon** in the lengths it has gone to control sprawl, and perhaps no city in America better exemplifies the shortcoming and limitations of the Smart Growth approach as 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 5.31% from 0.19 acre per person to 0.18 acre per person. (By comparison, the average per capita 2010 land consumption in Texas Urbanized Areas was 0.24 acre/person, 33 percent higher than Portland.)

However, despite its modest gain in population density (reduction in per capita land consumption) over the decade, the Portland UA still sprawled outward an additional 50.4 square miles between 2000 and 2010. The addition of 266,760 people during the decade was more than enough to wipe out 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 and along the scenic Willamette Valley 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 percent from 2000 to 2010, and which has quickly become the second largest city in Oregon.

Of the 192 Urbanized Areas in the United States which over the last decade experienced a decline in per capita land area, **Raleigh, North Carolina** is another informative example of the limits of gradually shrinking the acreage afforded to each person in which to live, work, shop, play. Its per capita land consumption decreased by 0.003 acre. At the same time, the population grew by over 300,000 people, causing the Raleigh UA to become more densely populated. But despite Raleigh's drop in per capita acreage, its 63 percent increase in population caused it to sprawl out across an additional 198.5 square miles in these 10 years.

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 Texas, the **Houston UA** reduced its per capita land use (increased its density) slightly from 0.2169 acre/person in 2000 to 0.2149 acre/person in 2010, a decrease of almost one percent. According to the conventional wisdom espoused by Smart Growthers, because density increased, by definition there was no sprawl on the Houston UA periphery from 2000 to 2010, yet the region still lost over 365 square miles of open space during this period.

In the first of our sprawl studies more than a decade and a half ago, 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.

Throughout the country, 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.[56]

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 had an unemployment level well below the national rate in 2009 after the Great Recession. Energized largely by strong gains in the education, healthcare, financial, and natural gas industries, Pittsburgh has been able to

[56] 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.

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 contaminated "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.

If current population trends are allowed to continue, Texas will experience enormous amounts of sprawl over the next half century.

If current demographic trends in Texas – characterized by the most rapid population growth of any state in the Union – continue as projected by official state demographers and shown in Figure 34, Texas will have a population of about 50 million in 2070, up from approximately 30 million in 2020, and 20.9 million in 2000. The Texas population will still be growing rapidly in 2070 with no end in sight.

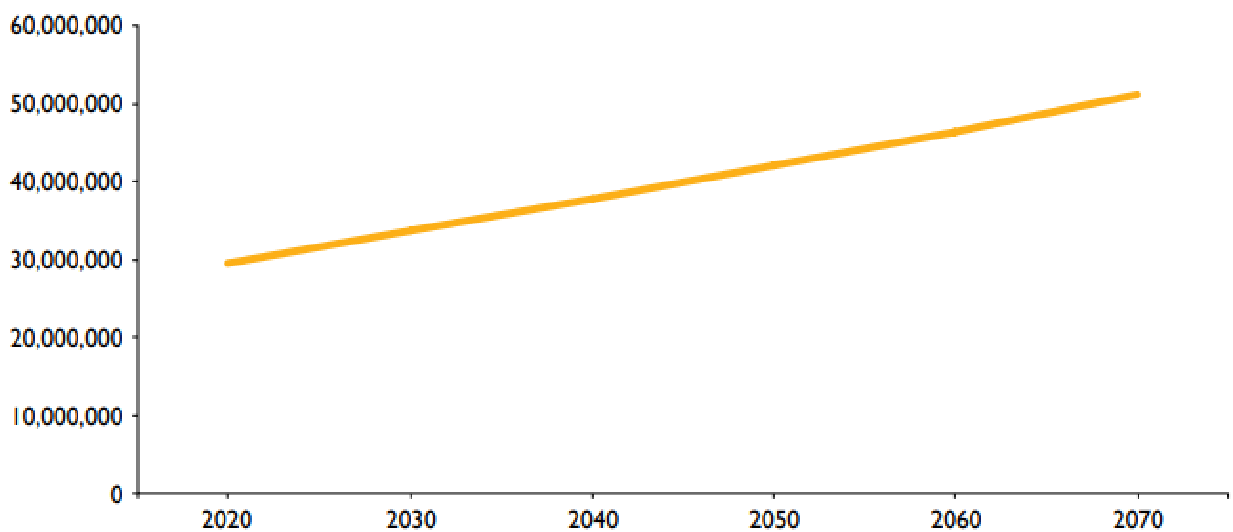

Figure 34. Projected Population Growth in Texas, 2020 to 2070
Source: Texas Water Development Board[57]

[57] Texas Water Development Board. 2016. *Water for Texas: 2017 State Water Plan.* Adopted 5-19-16. Accessed May 23, 2016 at: http://www.twdb.texas.gov/waterplanning/swp/2017/.

Combining these demographic trends and current sprawl development patterns, Texans can expect to see millions of additional acres of their state's remaining open space converted to urbanized and developed lands in the coming decades. In 2012, the average Texas consumed or accounted for about one-third of an acre of developed land. If the 20 million additional Texans projected by 2070 continue to use land at the same rate as the average resident in 2012, approximately 6.8 million acres (over 10,600 square miles, an area about the size of Massachusetts) of additional open space – e.g., farmland, pastureland, ranchland, wildlife habitat – in the state will be converted from rural to developed land. Not many Texans, we believe, would proclaim that this permanent loss of open space amounts to "progress."

People continue to flock en masse to the Lone Star State.

According to Texas State Demographer Lloyd Potter, the Texas population is growing by 1,000 people per day (a rate of 365,000 people per year, or more than a million additional people every three years).[58] Approximately half of these new Texans are migrants who come from other states and countries, while Texas births comprise the other half. According to the U.S. Census Bureau, net migration to Texas was 187,545 people between July 2017 and July 2018.

For the second year in a row, more than half of the net migration came from other countries (foreign migration) rather than from other U.S. states. In 2018, nearly 105,000 immigrants to Texas were foreigners.[59] Previously, domestic migration had dominated the migration input to Texas growth.

4.2 Policy Implications

In order for Texas policy makers 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 in 2000 and 2001, and using the same analysis of U.S. Census Bureau and 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 Texas. Furthermore this study found that the role of population growth in contributing to Overall Sprawl has remained high in Texas 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 growth that persists in our country as a whole and in Texas 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

[58] María Méndez. 2019. Where is Texas' growing population coming from? Texas Tribune. May 8. https://www.texastribune.org/2019/05/08/texas-keeps-growing-where-are-newest-transplants-coming/
[59] Ibid.

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 Texas less than a third 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 remaining undeveloped lands of Texas.

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 state of Texas. Only California exceeds Texas in total population size, but in the past three decades, Texas’ population growth has exceeded even California’s (Table 1). Between July 1, 2015 and July 1, 2016, according to Census Bureau estimates, Texas added nearly 400,000 people, which is a rate of 4 million per decade.[60]

At this rate, 28 million Texans at present will have increased to more than 40 million by 2050. In fact, the Texas Office of the State Demographer has published population projections to 2050 under three migration scenarios (0.0, 0.5, 1.0) for all counties and the entire state.[61] The 2050 population projections for Texas ranged from 31,246,355 under the no in-migration scenario (0.0), through 40,502,749 for the middle scenario (0.5, in which in-migration occurs at half the rate as during the high in-migration 2000-2010 period), up to 54,369,297 in the high 1.0 series. The 1.0 projection assumes that migration into Texas from all sources (foreign and domestic) would continue all the way to 2050 at the same rapid rate that occurred during the 2000 to 2010 decade. In the 1.0 scenario, the population of Texas will have approximately doubled in just 33 years.

Based on the results of our study, urban sprawl will engulf perhaps another four million acres or 6,000 square miles of farmland and wildlife habitat in Texas by 2050 if current population growth trends continue.

Population is growing fastest in the “Texas Triangle Megaregion,” those Texas counties located in the triangle formed by the Dallas – Fort Worth Metroplex to the north, Houston to the southeast, and San Antonio to the southwest. These Urbanized Areas are connected by Interstate 35 (Dallas-Ft. Forth to San Antonio), I-40 (San Antonio to Houston), and I-45 (Houston to Dallas-Ft. Worth). The triangle also includes the UAs for Austin, Waco, College Station-Bryan, and Temple.

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[60] U.S. Census Bureau. 2017. QuickFacts Texas. Accessed online April 22, 2017 at: https://www.census.gov/quickfacts/table/PST045216/48,00.

[61] Texas Data Center and Office of the State Demographer. Accessed online April 22, 2017 at: http://txsdc.utsa.edu/data/TPEPP/Projections/Index.

The Texas Triangle is also the area of the state most threatened by urban sprawl. Figures 35 through 37 show the percentages of developed land in each county, in 1982 (Figure 35), 2012 (Figure 36), and projected to 2050 (Figure 37) given prevailing rates of population growth and sprawl in each county. It should be stressed that Figure 35 is a projection, not a *fait accompli*. It is the future towards which Texans are presently headed, but Texans, with the assistance of Americans and our political leaders, can still opt for a better, more sustainable course.

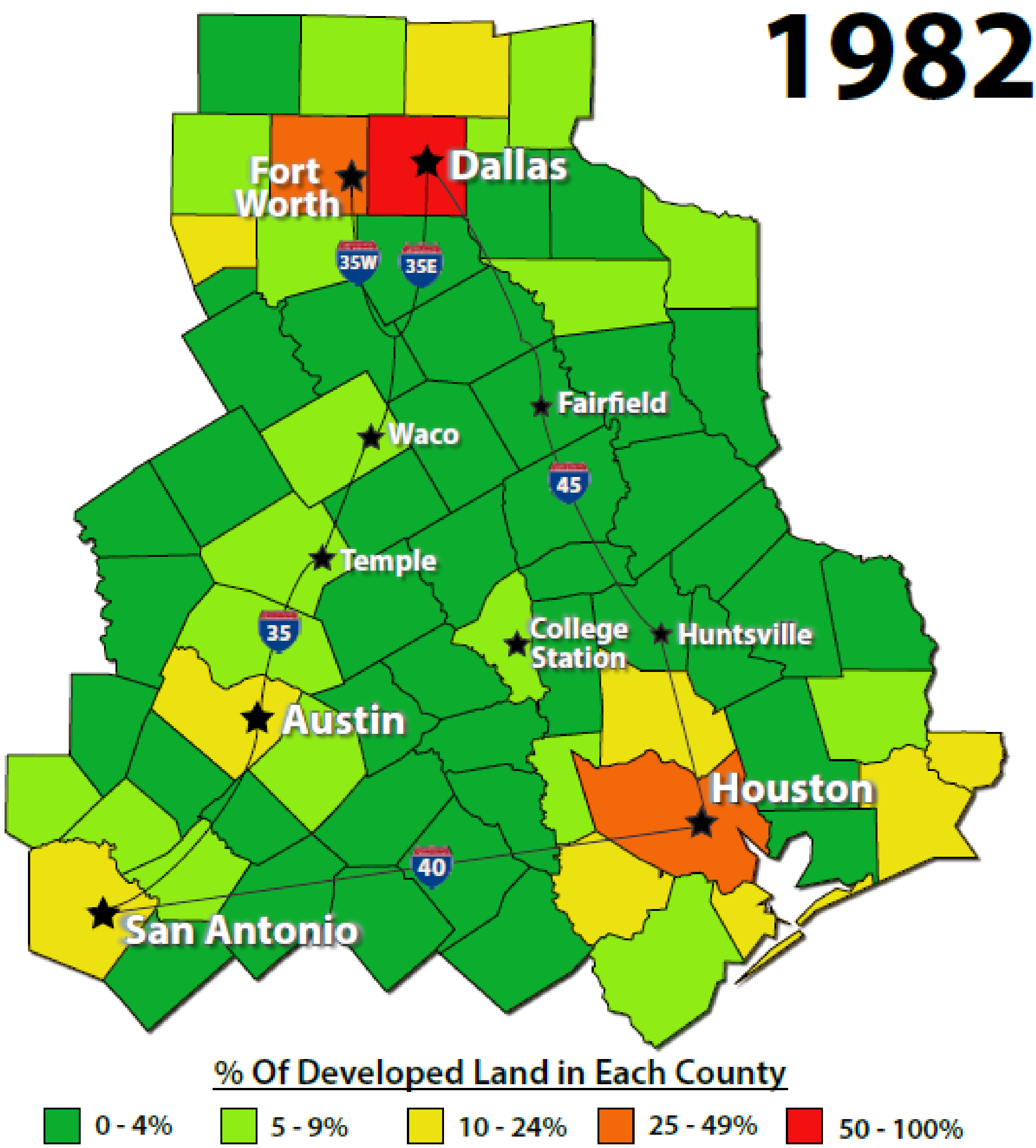

Figure 35. Percent of Developed Land in Texas Triangle Counties in 1982

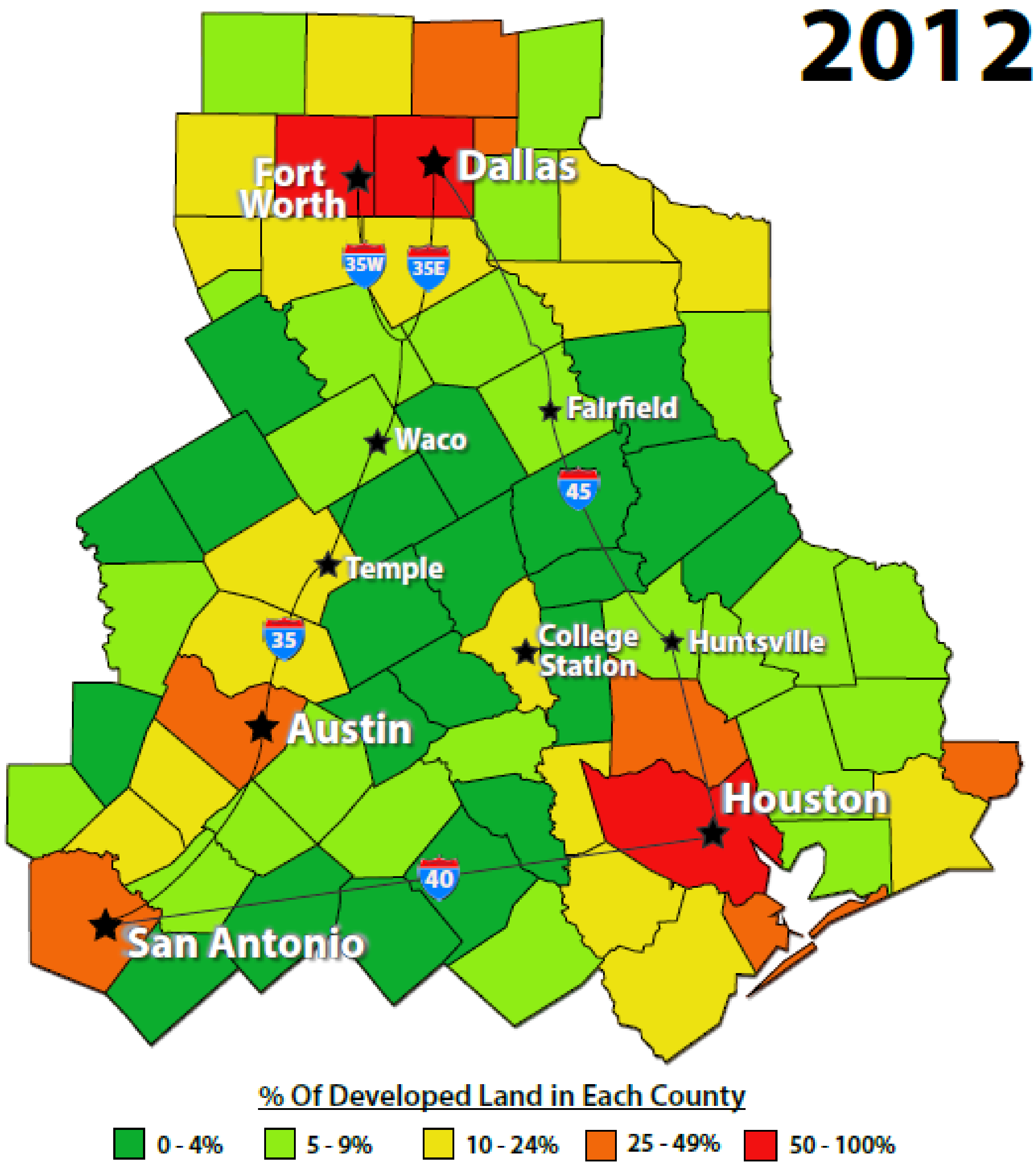

Figure 36. Percent of Developed Land in Texas Triangle Counties in 2012

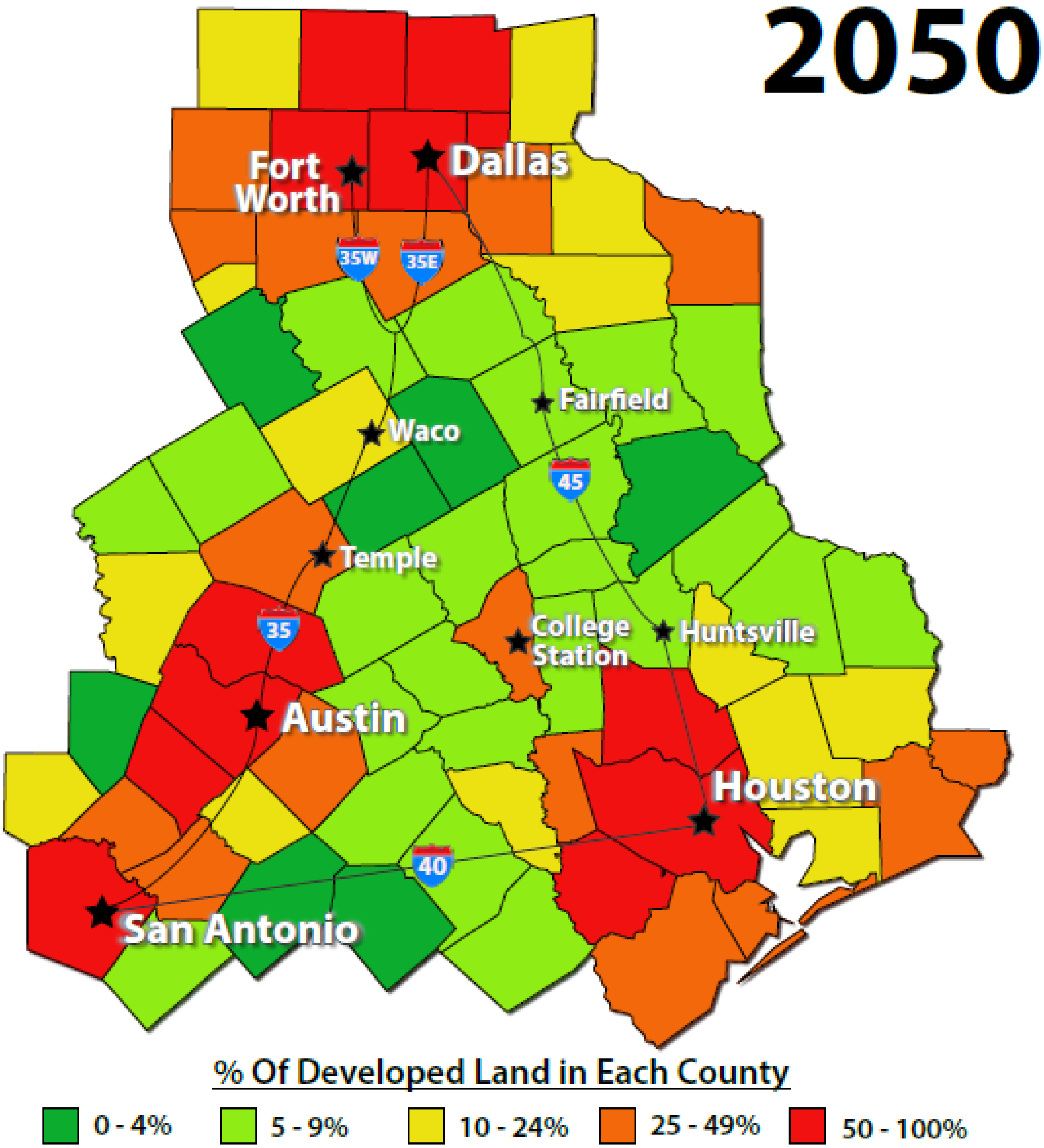

Figure 37. Percent of Developed Land in Texas Triangle Counties Projected to 2050

4.2.1 Local Influence on Sprawl

Local policy makers truly trying to curb sprawl in Texas cities have a number of policy actions and instruments 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*, challenged this very notion in his 2010 study “Relationship between Growth and Prosperity in 100 Largest U.S. Metropolitan Areas.” [62]

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 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 energy grids ever farther from the urban core.

Many cities have overly complicated zoning laws that drive up home prices. New immigrants and low income families are being priced out and into the more affordable suburbs and Sunbelt cities. Sprawl in the Sunbelt is of particular concern because its growth puts added strain on already scarce water resources. 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.

The U.S. Environmental Protection Agency (EPA) has a website devoted to Smart Growth at: https://www.epa.gov/smartgrowth. It contains a number of practical resources for planners, activists, developers, and local officials to help promote smart growth, which EPA defines as: “a range of development and conservation strategies that help protect our health and natural environment and make our communities more attractive, economically stronger, and more socially diverse.”

The EPA Smart Growth website lists the 10 principles of smart growth developed in 1996 by the Smart Growth Network, an alliance of environmental, affordable housing, real estate and

[62] Eben Fodor. See note #59.

development, historic preservation, public health, government, and other groups. The ten principles of Smart Growth are:

- Mix land uses
- Take advantage of compact building design
- Create a range of housing opportunities and choices
- Create walkable neighborhoods
- Foster distinctive, attractive communities with a strong sense of place
- Preserve open space, farmland, natural beauty, and critical environmental areas
- Strengthen and direct development toward existing communities
- Provide a variety of transportation choices
- Make development decisions predictable, fair, and cost effective
- Encourage community and stakeholder collaboration in development decisions

In the authors' view, these Smart Growth principles and strategies should be pursued for the sake of environmental sustainability and neighborhood livability in any case, regardless of the amount of population growth that is occurring. From the findings of this study however, as well as recent experience around the country, it is quite evident that Smart Growth alone will not stop urban sprawl from devouring the countryside. Physicist and famed population activist Dr. Albert Bartlett wrote that: "smart growth will destroy the environment, but it will do it in a sensitive way." The authors would phrase this idea somewhat differently: smart growth is necessary but not sufficient to save the environment and open spaces.

Figure 38. Legacy Town Center in Plano, Texas – a Good Example of Mixed Land Uses, One of the Ten Smart Growth Principles

4.2.2 National Influence of Population Growth

Beyond the short term, local Texas 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 nearly all settle in some community, inevitably leading to additional sprawl as far and as long as the eye can see. Many of these added millions will choose to seek a home in Texas, as indicated by the Texas Office of the State Demographer's projections.

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 approximately 1.9 births per woman, the total fertility rate (TFR) of the United States 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 births to those same immigrants, which now comprise a substantial fraction of total births in the country as well as in Texas.

Thus, long-term population growth in the United States and Texas is in the hands of federal policy makers and lawmakers. It is they who have increased the annual settlement of immigrants in the U.S. 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 Texas must include reducing the volume of population growth, which requires lowering the level of immigrants entering the country each year unless Americans and immigrants decide to move to 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.

That would appear to be a popular option among most Americans. A poll of America's likely voters in 2014 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 H for the full survey questions and results).

QUESTION: 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

QUESTION: 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: 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

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 keeping it at one million or increasing it. But 63 percent of voters said they preferred to cut immigration by at least half, which would put immigration at about the level advocated by the Jordan Commission.

This lower level of immigration at around 500,000 a year would drive far less 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, sprawl, and environmental degradation indefinitely.[63]

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."[64]

> **QUESTION:** 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?
>
> 11% More likely
> 56% Less likely
> 26% It wouldn't make much difference
> 7% Not sure

In our 2003 national-level 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.[65] 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

[63] Camarota, Steve, *Projecting Immigration's Impact on the Size and Age Structure of the 21st Century American Population*, Center for Immigration Studies, December 2012
[64] 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.
[65] 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: https://www.brookings.edu/research/immigrants-in-2010-metropolitan-americaa-decade-of-change/

incomes were causing immigrants to move to the edges of cities and even to rural settlements beyond the cities to find cheaper housing.

Nonetheless, it is important to note that the sprawl that occurs because of high immigration levels has nothing to do with the quality of immigrants as people or individuals but everything to do with the quantity of population growth that occurs because of immigration. This can be seen by simply observing that 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 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.

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 2012 Texas had 26,089,741 residents and approximately 8,936,600 developed acres. Thus, per capita developed land use for all purposes was around 0.346 acre (slightly more than a third 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) *Population share of growth =* $\dfrac{\textit{(Overall percentage population growth)}}{\textit{(Overall percentage land area growth)}}$

The same form applies for per capita land use:

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

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 Texas from 1982 to 2012, this formula would appear as:

(14) ln (*26,089,741 residents / 15,331,048 residents*) + ln (*0.34253 acre per resident / 0.33839 acre per resident*) = ln (*8,936,600 acres / 5,188,000 acres*)

Computing the ratios yields:

(15) ln (1.70172) + ln (1.01224) = ln (1.72255)

0.53164 + 0.01217 = 0.54381

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 0.54381:

$$(16)\quad \frac{0.53164}{0.54381} + \frac{0.01217}{0.54381} = \frac{0.54381}{0.54381}$$

Performing these divisions yields:

(17) 0.98 + 0.02 = 1.0

Thus, we note that in the case of Texas from 1982 to 2012, the share of sprawl due to population growth was 98 percent [100 percent x (0.53164 / 0.54381)], while declining density (i.e., an increase in land area per capita) accounted for 2 percent [100 percent x (0.01217 / 0.54381)]. Note that the sum of both percentages equals 100 percent.

In the main body of this report we modify this gross state-wide percentage of sprawl related to population growth by using a county-by-county weighting approach. This approach accounts for the sprawl that occurs in each county and lends a proportionately greater weight to those counties with greater amounts of sprawl. In essence, sprawl in counties around Dallas, for example, should not be attributed to population growth in counties around Houston. In this method, the amount of sprawl related to population growth in each county is summed for all 254 counties in the state. This sum or aggregate is then divided by the total amount of sprawl in the state. Using this procedure, 67 percent of the sprawl in Texas between 1982 and 2012 is shown to be associated with population growth, which the authors believe is a more accurate rendering of population growth's role than 98 percent, which exaggerates population's role, and implies that virtually all sprawl in Texas is related to population growth; this is not the case.

Appendix D

Anomalies – Urbanized Areas with populations that grew but areas that supposedly shrank, or populations that shrank

From 2000 to 2010 Panama City and Titusville, in Florida, 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 Census Bureau. 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 Census Bureau shows as having decreased in land area from 2000 to 2010.

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.

In Texas, among the 34 UAs delineated in 2000 and 2010, there are two that had increasing populations but decreasing areas. The two UAs in question – Victoria and Wichita Falls – each had essentially no population growth, i.e., stable or slightly growing populations. Their urbanized areas decreased, or apparently decreased, by 43 percent in the case of Victoria (from 51

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.

square miles to 29 square miles in just a decade). Per capita land use, in turn apparently shrank by 43 percent, from 0.53 acres per person to 0.29 acres per person, a putative decrease of 45 percent. But as noted above, this is more a function of a change in the delineation criteria (using census tracts rather than block groups for establishing initial urban cores) than an indication that Victoria residents abruptly reduced their home and yard sizes.

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.

Appendix E
State and National Rankings of Texas Urbanized Areas by Total Sprawl, 2000-2010

Table E-1. Alphabetical List of all 34 Texas Urbanized Areas as Designated by the U.S. Census Bureau, Their Sprawl 2000-2010, and Shares Apportioned between Population Growth and Per Capita Sprawl

Urbanized Area	Total Sprawl (square miles), 2000-2010	National/ State Sprawl Ranking* (No. 1 is worst)	% of Total Sprawl Related to POPULATION GROWTH	% of Total Sprawl Related to GROWTH IN PER CAPITA LAND CONSUMPTION
Abilene	7.2	319 / 26	22%	88%
Amarillo	7.1	323 / 27	100%	0%
Austin	204.9	7 / 3	83%	17%
Beaumont	10.3	263 / 22	51%	49%
Brownsville	24.2	142 / 12	77%	23%
College Station--Bryan	22.3	161 / 16	69%	31%
Conroe--The Woodlands	91.6	36 / 5	85%	15%
Corpus Christi	10.0	267 / 23	98%	2%
Dallas--Fort Worth--Arlington	372.1	2 / 1	90%	10%
Denton--Lewisville	23.6	148 / 14	100%	0%
El Paso	31.5	106 / 11	100%	0%
Harlingen	23.6	147 / 13	60%	40%
Houston	364.8	3 / 2	100%	0%
Killeen	20.7	172 / 18	92%	8%
Lake Jackson--Angleton	7.9	301 / 24	9%	81%
Laredo	23.2	154 / 15	68%	32%
Longview	32.4	105 / 10	48%	52%
Lubbock	21.9	162 / 17	62%	38%

Urbanized Area	**Total Sprawl (square miles), 2000-2010**	**National/ State Sprawl Ranking* (No. 1 is worst)**	**% of Total Sprawl Related to POPULATION GROWTH**	**% of Total Sprawl Related to GROWTH IN PER CAPITA LAND CONSUMPTION**
McAllen	44.2	87 / 8	100%	0%
McKinney	47.0	81 / 7	100%	0%
Midland	7.6	308 / 25	100%	0%
Odessa	5.7	344 / 29	100%	0%
Port Arthur	59.7	56 / 6	35%	65%
San Angelo	1.1	424 / 32	100%	0%
San Antonio	189.5	9 / 4	74%	26%
San Marcos	1.6	419 / 32	100%	0%
Sherman	4.1	373 / 30	81%	19%
Temple	12.8	231 / 21	85%	15%
Texarkana	6.4	331 / 28	75%	25%
Texas City	17.5	194 / 20	38%	62%
Tyler	32.8	103 / 9	55%	45%
Victoria	-22.0	489 / 34	N/A	N/A
Waco	20.5	173 / 19	46%	54%
Wichita Falls	-1.6	454 / 33	N/A	N/A

* These cities are not ranked because the Census Bureau reports they had no sprawl in the decade. In fact, they are shown as having less developed land in 2010 than in 2000. While it is possible for an Urbanized Area to reduce its developed land by converting large swaths of previously developed acreage to a natural state, the reduction shown in most of the Urbanized Areas was on paper only, the result of changes in calculations by the government.
**No comparable data for Census 2000
Source: U.S. Census Bureau, http://www.census.gov/geo/reference/ua/urban-rural-2010.html

Appendix F
Population Growth in Texas Counties, 1982-2012

Table F-1. Population Growth in Texas Counties – 1982 to 2002 and 2012

County	Population in 1982	Population in 2002	Population in 2012	% growth 1982-2012
Anderson	41,873	54,740	58,010	39%
Andrews	15,142	13,022	16,121	6%
Angelina	67,879	80,803	87,623	29%
Aransas	16,105	22,616	23,688	47%
Archer	7,651	8,942	8,781	15%
Armstrong	1,967	2,036	1,945	-1%
Atascosa	26,475	40,767	46,452	75%
Austin	19,408	24,818	28,560	47%
Bailey	8,138	6,637	7,136	-12%
Bandera	7,559	18,652	20,616	173%
Bastrop	28,439	63,508	74,886	163%
Baylor	5,229	3,897	3,616	-31%
Bee	27,262	31,804	32,440	19%
Bell	167,053	249,671	323,096	93%
Bexar	1,046,457	1,446,755	1,789,834	71%
Blanco	4,791	8,950	10,622	122%
Borden	975	685	613	-37%
Bosque	13,779	17,474	18,114	31%
Bowie	76,898	88,813	93,006	21%
Brazoria	179,584	255,246	324,503	81%
Brazos	112,349	159,297	200,327	78%
Brewster	7,878	8,945	9,247	17%
Briscoe	2,471	1,746	1,564	-37%

County	Population in 1982	Population in 2002	Population in 2012	% growth 1982-2012
Brooks	8,630	7,668	7,184	-17%
Brown	34,849	37,766	37,865	9%
Burleson	14,670	16,666	17,326	18%
Burnet	19,116	36,850	43,588	74%
Caldwell	24,538	34,715	38,711	58%
Calhoun	21,181	20,550	21,559	2%
Callahan	11,796	12,799	13,519	15%
Cameron	230,718	350,194	415,977	80%
Camp	9,797	11,549	12,461	27%
Carson	7,325	6,508	6,110	-17%
Cass	30,710	30,120	30,184	-2%
Castro	10,474	8,083	8,194	-22%
Chambers	19,676	27,490	36,406	85%
Cherokee	38,856	47,136	51,218	32%
Childress	6,937	7,428	7,083	2%
Clay	10,016	11,292	10,517	5%
Cochran	4,890	3,521	3,020	-38%
Coke	3,546	3,732	3,221	-9%
Coleman	10,578	8,937	8,667	-18%
Collin	164,703	563,565	837,480	408%
Collingsworth	4,596	3,093	3,027	-34%
Colorado	19,884	20,328	20,692	4%
Comal	39,057	82,797	114,931	194%
Comanche	13,119	13,582	13,727	5%
Concho	3,096	3,959	4,065	31%
Cooke	28,894	37,390	38,790	34%

County	Population in 1982	Population in 2002	Population in 2012	% growth 1982-2012
Coryell	59,496	73,135	76,860	29%
Cottle	2,845	1,726	1,485	-48%
Crane	5,115	3,891	4,564	-11%
Crockett	5,155	3,841	3,711	-28%
Crosby	8,560	6,852	6,096	-29%
Culberson	3,574	2,829	2,307	-35%
Dallam	6,587	6,159	6,983	6%
Dallas	1,637,637	2,250,326	2,456,444	50%
Dawson	16,645	14,429	13,648	-18%
Deaf Smith	20,566	18,439	19,373	-6%
Delta	4,855	5,366	5,298	9%
Denton	166,463	487,617	708,300	325%
DeWitt	19,670	20,015	20,455	4%
Dickens	3,317	2,679	2,314	-30%
Dimmit	11,948	10,042	10,471	-12%
Donley	4,169	3,825	3,657	-12%
Duval	13,083	12,707	11,582	-11%
Eastland	20,841	18,252	18,410	-12%
Ector	135,501	122,199	144,552	7%
Edwards	2,218	2,056	1,972	-11%
Ellis	62,621	118,737	153,779	146%
El Paso	511,892	696,446	831,864	63%
Erath	23,921	33,619	39,470	65%
Falls	18,321	18,090	17,605	-4%
Fannin	24,324	31,808	33,692	39%
Fayette	20,962	22,668	24,725	18%

County	Population in 1982	Population in 2002	Population in 2012	% growth 1982-2012
Fisher	5,833	4,242	3,837	-34%
Floyd	9,526	7,289	6,365	-33%
Foard	2,125	1,536	1,308	-38%
Fort Bend	157,335	397,943	626,808	298%
Franklin	7,259	9,536	10,626	46%
Freestone	15,825	18,395	19,439	23%
Frio	14,155	16,467	17,836	26%
Gaines	14,011	14,453	18,381	31%
Galveston	208,781	260,096	301,395	44%
Garza	5,802	5,385	6,456	11%
Gillespie	14,409	21,585	25,159	75%
Glasscock	1,298	1,339	1,258	-40
Goliad	5,541	7,051	7,338	1,797
Gonzales	18,569	18,882	19,936	1,367
Gray	28,243	21,940	22,818	-5,425
Grayson	91,857	113,239	121,601	29,744
Gregg	109,624	112,767	122,942	13,318
Grimes	15,659	24,736	26,705	11,046
Guadalupe	50,038	95,246	139,733	89,695
Hale	38,023	35,598	36,329	-4%
Hall	5,226	3,709	3,278	-37%
Hamilton	8,239	8,069	8,294	1%
Hansford	6,389	5,242	5,523	-14%
Hardeman	6,472	4,547	4,055	-37%
Hardin	42,235	49,045	55,102	30%
Harris	2,696,632	3,536,682	4,262,504	58%

County	Population in 1982	Population in 2002	Population in 2012	% growth 1982-2012
Harrison	55,528	62,062	66,300	19%
Hartley	3,992	5,364	6,153	54%
Haskell	7,657	5,915	5,894	-23%
Hays	43,502	111,397	168,571	288%
Hemphill	6,427	3,357	4,069	-37%
Henderson	46,057	74,712	78,953	71%
Hidalgo	313,256	610,520	807,776	158%
Hill	25,748	33,120	35,086	36%
Hockley	24,679	22,745	23,120	-6%
Hood	19,418	43,344	52,149	169%
Hopkins	26,366	32,335	35,398	34%
Houston	22,509	23,257	23,134	3%
Howard	36,541	33,479	35,523	-3%
Hudspeth	3,057	3,398	3,337	9%
Hunt	58,758	80,234	87,266	49%
Hutchinson	29,899	23,116	21,954	-27%
Irion	1,549	1,697	1,574	2%
Jack	7,953	8,916	9,007	13%
Jackson	13,905	14,172	14,253	3%
Jasper	31,449	35,692	35,846	14%
Jeff Davis	1,650	2,201	2,301	39%
Jefferson	256,258	250,146	251,394	-2%
Jim Hogg	5,467	5,220	5,256	-4%
Jim Wells	38,677	39,821	41,660	8%
Johnson	73,412	133,399	153,394	109%
Jones	17,693	20,293	19,858	12%

County	Population in 1982	Population in 2002	Population in 2012	% growth 1982-2012
Karnes	13,777	15,178	14,878	8%
Kaufman	41,570	77,693	106,675	157%
Kendall	11,390	24,975	35,732	214%
Kenedy	514	429	441	-14%
Kent	1,177	815	834	-29%
Kerr	30,292	44,894	49,771	64%
Kimble	4,171	4,521	4,540	9%
King	420	308	270	-36%
Kinney	2,408	3,463	3,620	50%
Kleberg	34,743	31,413	32,129	-8%
Knox	5,617	4,044	3,761	-33%
Lamar	42,676	48,826	49,770	17%
Lamb	18,661	14,658	13,916	-25%
Lampasas	12,499	18,425	20,117	61%
La Salle	5,926	6,098	7,133	20%
Lavaca	19,578	19,101	19,451	-1%
Lee	14,048	16,131	16,548	18%
Leon	10,719	15,718	16,738	56%
Liberty	51,576	73,280	76,471	48%
Limestone	20,688	22,486	23,623	14%
Lipscomb	4,465	3,033	3,441	-23%
Live Oak	9,932	11,955	11,678	18%
Llano	10,567	17,872	19,086	81%
Loving	84	75	81	-4%
Lubbock	215,688	249,407	286,098	33%
Lynn	8,245	6,421	5,773	-30%

County	Population in 1982	Population in 2002	Population in 2012	% growth 1982-2012
McCulloch	8,890	7,927	8,281	-7%
McLennan	175,640	216,571	239,416	36%
McMullen	828	795	736	-11%
Madison	11,547	12,797	13,726	19%
Marion	10,825	11,032	10,308	-5%
Martin	5,306	4,654	4,993	-6%
Mason	3,657	3,725	4,048	11%
Matagorda	37,325	37,662	36,554	-2%
Maverick	34,029	48,408	55,853	64%
Medina	23,569	40,707	46,830	99%
Menard	2,313	2,340	2,225	-4%
Midland	98,653	117,717	147,185	49%
Milam	23,255	24,981	24,143	4%
Mills	4,554	4,973	4,835	6%
Mitchell	9,605	9,420	9,317	-3%
Montague	18,529	19,170	19,527	5%
Montgomery	150,025	326,466	485,004	223%
Moore	17,756	20,155	22,449	26%
Morris	15,464	13,170	12,740	-18%
Motley	1,871	1,311	1,200	-36%
Nacogdoches	48,978	59,422	65,863	34%
Navarro	37,097	45,937	48,087	30%
Newton	13,405	14,945	14,323	7%
Nolan	18,163	15,194	14,891	-18%
Nueces	282,413	316,256	347,926	23%
Ochiltree	11,057	9,106	10,611	-4%

County	Population in 1982	Population in 2002	Population in 2012	% growth 1982-2012
Oldham	2,350	2,069	2,047	-13%
Orange	87,402	83,813	82,959	-5%
Palo Pinto	25,605	27,144	27,820	9%
Panola	22,067	22,953	24,014	9%
Parker	47,243	94,092	119,790	154%
Parmer	10,943	10,032	10,153	-7%
Pecos	16,946	16,084	15,586	-8%
Polk	26,044	43,928	45,802	76%
Potter	102,612	115,427	122,894	20%
Presidio	5,475	7,534	7,564	38%
Rains	5,247	9,985	10,943	109%
Randall	78,305	106,286	124,919	60%
Reagan	4,899	3,189	3,466	-29%
Real	2,524	3,020	3,368	33%
Red River	15,803	13,914	12,714	-20%
Reeves	17,257	13,017	13,911	-19%
Refugio	9,379	7,665	7,236	-23%
Roberts	1,224	862	951	-22%
Robertson	15,452	16,053	16,455	6%
Rockwall	16,644	50,078	82,928	398%
Runnels	12,206	11,002	10,421	-15%
Rusk	43,274	48,244	53,835	24%
Sabine	8,955	10,477	10,464	17%
San Augustine	8,929	8,985	8,840	-1%
San Jacinto	12,297	23,415	27,003	120%
San Patricio	61,470	66,820	65,344	6%

County	Population in 1982	Population in 2002	Population in 2012	% growth 1982-2012
San Saba	5,847	6,042	5,983	2%
Schleicher	3,219	3,036	3,252	1%
Scurry	20,018	15,982	17,094	-15%
Shackelford	4,235	3,388	3,370	-20%
Shelby	23,263	25,155	26,029	12%
Sherman	3,234	3,164	3,064	-5%
Smith	137,348	181,107	215,088	57%
Somervell	4,373	7,229	8,586	96%
Starr	30,442	55,412	62,023	104%
Stephens	10,895	9,374	9,579	-12%
Sterling	1,401	1,326	1,189	-15%
Stonewall	2,424	1,487	1,468	-39%
Sutton	5,878	4,072	3,931	-33%
Swisher	9,261	8,071	7,878	-15%
Tarrant	933,829	1,524,249	1,882,338	102%
Taylor	119,410	125,920	134,201	12%
Terrell	1,568	1,009	914	-42%
Terry	15,015	12,559	12,598	-16%
Throckmorton	2,250	1,739	1,605	-29%
Titus	22,606	28,387	32,631	44%
Tom Green	90,883	104,035	113,493	25%
Travis	449,814	848,090	1,096,661	144%
Trinity	10,214	14,033	14,319	40%
Tyler	16,531	20,825	21,450	30%
Upshur	31,213	36,739	39,945	28%
Upton	5,387	3,273	3,259	-40%

County	Population in 1982	Population in 2002	Population in 2012	% growth 1982-2012
Uvalde	23,096	26,309	26,775	16%
Val Verde	38,388	45,495	48,939	27%
Van Zandt	32,776	49,953	52,303	60%
Victoria	74,178	84,573	89,291	20%
Walker	46,011	62,216	68,497	49%
Waller	21,913	35,060	44,337	102%
Ward	16,211	10,337	10,865	-33%
Washington	24,240	30,741	33,880	40%
Webb	111,106	206,001	260,015	134%
Wharton	41,247	40,915	41,151	0%
Wheeler	7,999	5,094	5,589	-30%
Wichita	125,166	130,761	131,787	5%
Wilbarger	16,493	14,248	13,254	-20%
Willacy	18,146	20,198	22,120	22%
Williamson	87,159	290,112	456,469	424%
Wilson	17,591	34,254	44,450	153%
Winkler	11,654	6,960	7,336	-37%
Wise	28,373	52,381	60,430	113%
Wood	25,610	37,633	42,511	66%
Yoakum	8,510	7,212	8,038	-6%
Young	20,546	17,665	18,299	-11%
Zapata	7,690	12,514	14,250	85%
Zavala	12,197	11,616	11,943	-2%
All Texas Counties	**15,331,408**	**21,690,325**	**26,089,741**	**70%**

Appendix G
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 H
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 I
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"[1] and "Outsmarting Smart Growth: Population Growth, Immigration, and the Problem of Sprawl."[2] 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 I-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.

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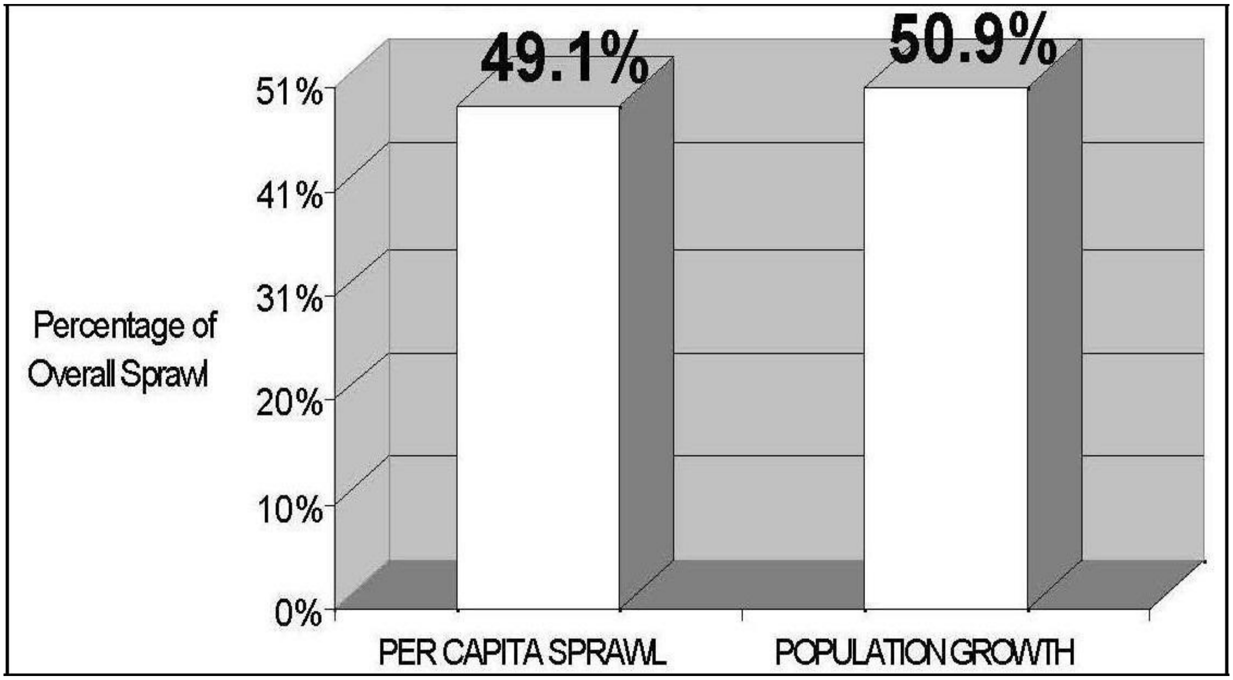
[1] Kolankiewicz, L. and R. Beck. 2001. Weighing Sprawl Factors in Large U.S. Cities: A report on the nearly equal roles played by population growth and land use choices in the loss of farmland and natural habitat to urbanization. Analysis of U.S. Bureau of the Census Data on the 100 Largest Urbanized 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.

[2] 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 I-1. Sources of Urban Sprawl in 100 Largest Cities, 1970-1990



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

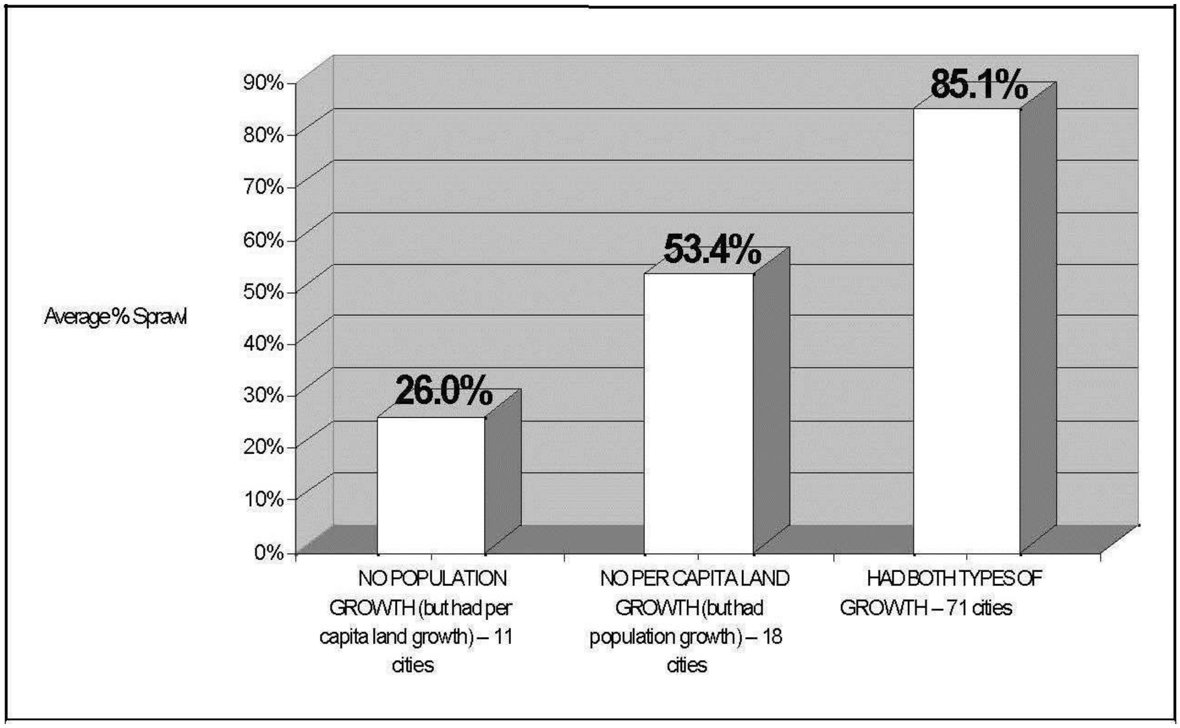
- Although the circumstances of each city are different, the power of both sprawl factors is potentially the same in each. Every city that wishes to restrain its land expansion will need to continually keep in mind the impacts on sprawl of both growth factors. Cities with no recent per capita land consumption 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 I-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 I-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 I-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.

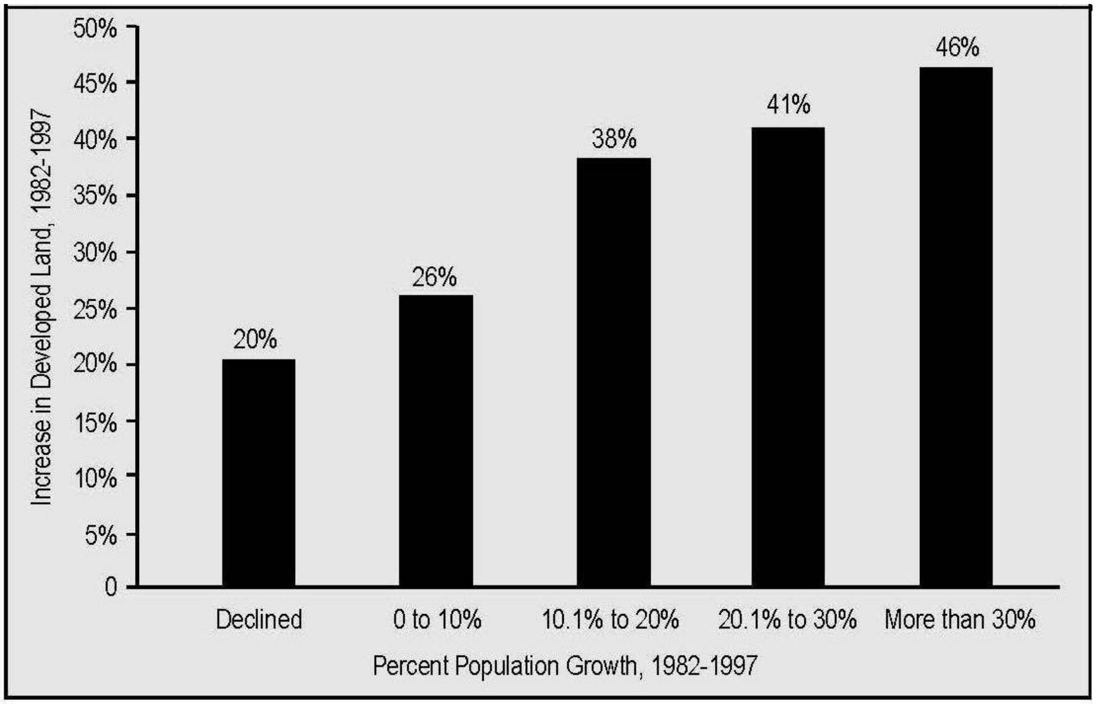
- On average, each 10,000-person increase in a state's population resulted in 1,600 acres of undeveloped rural land being developed, even controlling for other factors such as changes in population density.

- 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 I-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.

POPULATION GROWTH AND SPRAWL IN TEXAS