TEXAS SPRAWL

Population Growth and Sprawl in Texas

and Agricultural Land in the Lone Star State

How an Exploding Population Consumes Natural Habitat

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NumbersUSA

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I got the ramblin' fever, said goodbye to ma and pa
Crossed that ol' red river and this is what I saw
I saw miles and miles of Texas

– Asleep At The Wheel

Most outsiders look at the Lone Star State and see what the Asleep At The Wheel band saw in its classic hit: an unending expanse of just "miles and miles of Texas," vast open spaces which can appear to the uninformed as suggesting the state has room for continued rapid population growth from other states and other nations for many decades to come.

Indeed, America's second largest land-mass state (after Alaska) still has enough *physical* room for populations of whole countries to move here.

But after adding its **30 millionth resident** in 2022, Texas has already run out of sustainable *ecological* room, our study explains.

- The bio-regions of the western two-thirds of the state are mostly semi-arid and arid-desert lands with water resources incapable of supporting urban concentrations.
- The decades-long tidal wave of human migration into Texas has crashed down mainly on the wetter eastern third, particularly inside and near the Dallas-San Antonio-Houston "Urban Triangle." Besides the increased congestion's deterioration of human quality of life there, some experts conclude that the surviving "biocapacity" of the eastern bio-regions already is too small to sustainably handle the current size of the population.
- The threat of environmental crisis is made even worse as the overall square mileage of eastern Texas ecosystems continues to rapidly shrink under unrelenting construction and other development to accommodate millions upon millions of additional newcomers from other states and nations.

The Losses & Their Causes

Our study examines the most recent 35 years of federal government data on the explosive human expansion in Texas.

- Over the full period (1982-2017), Texas **lost more than 6,600 additional square miles** of natural habitat and agricultural land to provide for housing, commerce, jobs, education, health care, transportation, recreation, waste disposal, and other human needs for the state's growing population.

- The pace of loss has remained rapid during the last of this data period (between 2002 and 2017), with more than 2,600 square miles of rural land cleared, scraped, and paved for development.

This massive scale of losses was not due to the stereotype of the Texas culture demanding excessive elbow room for its individualistic citizens. The average Texan actually requires a little *less* developed land per person than the average American nationwide.

- All developed land in Texas, divided by the number of residents, was about **0.340 acre** (about one-third of an acre) per Texan.

- The per capita developed land for all Americans was **0.356 acre**.

In the most recent 15 years of government data, we find **a seven percent *reduction* in developed land for the average Texan**.

Yet, during that same period, **overall developed areas expanded by 21 percent** beyond what they already covered in Texas in 2002, sprawling ever further out across the countryside, converting precious farmland and natural habitat into asphalt, concrete, buildings, and artificial landscaping.

The amount of developed land per Texan shrank but the number of Texans grew rapidly. The conservation value of the decline in "per capita" land consumption (minus 7%) was negated by much larger growth in the number of "capitas" (plus 30%).

In 1982, the state's bio-systems were supporting 15.3 million residents. Over the next 20 years, **another 6 million people** were added to Texas, overwhelmingly because of migration from other countries and states.

And between 2002 and 2017 – the end of the government's latest land-loss data – the population that had to be supported by the state's bio-systems grew by **yet another 6 million people** to a total of more than 28 million – on its way to more than 30 million today.

As in all of our national, regional and state sprawl studies since 2000, we calculated the role of population growth in the loss of natural habitat and agricultural land in Texas. We found that:

- Over the 35-year data period, Texas population growth was responsible for more than twice as much loss of rural land than all other factors combined (those other factors contribute to changes in per capita land development). We found that **4,637 square miles of loss was related to population growth, and 1,997 square miles of loss was related to per capita development growth.**

- The role of population growth has been even more pronounced in the most recent 15 years of the data, accounting for **almost three times as much** development of rural land as all other factors: 1,910 square miles of loss was related to population growth, and 706 square miles was related to growth in per capita development.

Massive habitat loss like that in Texas is not some kind of *secondary* regional and global environmental issue; it may be **the *most critical* environmental issue**. According to the World Wildlife Fund, habitat loss poses the single greatest threat to endangered species around the world. 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.

A frightening example is the plummeting size of bird populations, many of which depend on Texas wetlands in their migrations. In North America, scientists estimate that the size of the flocks has dwindled by approximately three billion birds since 1970, a decline of around 30 percent.

The long Texas population boom has made the state a perennial leader in the loss of habitat needed for regional and global environmental health. For instance, between 2002 and 2012, Texas lost more than twice as much habitat and farmland to sprawl as the second worst state, Florida.

If the pace of population and urban expansion continues, many species will cease to exist in Texas (and anywhere for some), joining a long list of former natural residents. The rapidly developing North Central Texas region, for example, used to be home to the plains bison, red and gray wolves, black and grizzly bears, passenger pigeon, ivory-billed woodpecker, and pronghorn antelope. But over the last century and a half, each of those has become either extinct, federally-designated as threatened/endangered, or extirpated (eliminated) from North Central Texas. They are/were all animals that need large habitat expanses which are no longer available.

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.

- 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** ecological area once covered 17.9 million acres. Within this ecoregion, some counties have experienced more than 200 percent population growth just since 1970.

Responding With More Dense Living?

Some people alarmed by how population growth results in so much destruction of natural habitat have suggested that further damage could be alleviated by requiring that housing and all other needs for future additional residents take place within existing urban/suburban boundaries. The idea is that moving most Texans toward New York City-style, high-rise-density living might enable the continued flow of migrants from other states and nations to occur without further destruction of the state's ecosystems.

Is there political will for such a solution? **Polling** conducted for this study found 42% of "likely voters" in Texas said they favor changing "zoning and other regulations to funnel more current and future residents into apartments and condo buildings instead of single-family houses with yards" (49% said they opposed it).

However, the polling failed to find much interest in voters wanting to live in more density themselves. A much larger percentage were Texans who said they would prefer to live in less-dense localities than where they currently live.

- While 27% of Texans currently live in a "major city," only 17% said that is where they prefer to live.
- Even the suburbs (currently with 34% of the poll respondents) would lose people if they could live where they prefer (30% chose "suburbs").
- The majority of Texans said they prefer to live (in order) in a rural area, a small city, or a town.

Informed that Texas demographers project that the state's population is on pace to grow by another 14 million by 2060, only 21% of Texans said they expect their governments to be able to accommodate the extra traffic without more congestion than already experienced on the state's streets and roads. Nearly three-quarters (73%) said traffic would "become much worse." By nearly a 2-to-1 margin, they said the population increase would be negative for the state.

Even if Texans were much more inclined toward New York City-style living, the idea that more density in itself can be a solution to habitat loss disregards the essential understanding of the **"ecological footprint."** If all new population could somehow be added to cities without the cities expanding over any new ground, each additional Texas resident still adds another ecological footprint beyond an urban area's boundaries.

All human beings and every American – even those who are conscientious and profess to be conservationists or environmentally aware – inexorably impose certain demands (or what ecologists call a "load") on the land and resources of the biosphere through consumption and waste production and emissions (including carbon dioxide). The mere act of living with the comforts and conveniences of the modern world necessarily incurs environmental impacts, which can be reduced or mitigated through better technologies and more environmentally enlightened behaviors and virtues, but never entirely eliminated. No amount of wishful thinking or technical wizardry will ever erase our ecological footprint completely.

The 0.340-acre of urban land developed for the average Texas resident does not include relatively unpopulated rural lands – cropland, pasture, rangeland, forests, reservoirs, and mines – that furnish crucial raw materials and products used by every consumer/resident, namely for food, fiber, fuels, water, energy, metals, and minerals. Nor does the per capita 0.340-acre include the forestlands needed to absorb each Texas resident's carbon dioxide (CO2) emissions from fossil fuel combustion to produce electricity and propel their vehicles.

That total ecological footprint for the average American entails approximately 20 acres per person, according to the Global Footprint Network (GFN).

The land inside Texas boundaries does not – and cannot – sustainably provide for all those current needs of its 30 million residents. The GFN calculates that the **current population of Texans greatly exceeds the "biocapacity" of the state's ecologically productive lands** that have not been plowed under and paved over.

According to the GFN, Texas suffers a large "**ecological deficit**." That deficit occurs when the Ecological Footprint of a given population exceeds the "biocapacity" (ecologically productive lands capable of large-scale photosynthesis) of the area available to that population. Texas meets its needs by importing biocapacity through trade from elsewhere, by "liquidating" the state's ecological assets in ways that cannot be sustained, and by emitting CO_2 waste into the atmosphere that cannot be absorbed by the state's ecosystems. (In contrast, an "ecological reserve" exists when the biocapacity of a region exceeds its population's Ecological Footprint.)

In 2015, GFN calculated that the per capita Ecological Footprint of Texans was 18.5 global acres while the biocapacity of Texas lands was only 6.7 global acres per resident. That left a net ecological deficit of 11.8 acres on average for each Texan. Texas is not alone in exceeding natural limits. Most states are ecologically overpopulated, but Texas is among the highest.

Responding By Limiting Population Growth

If Texans won't try to mitigate the habitat loss of population growth through density mandates, how do they feel about continuing the ecosystem losses?

The survey for this study showed great support for preservation. Two-thirds (67%) of respondents said it is "very important" to them to "preserve Texas' woodlands, natural wetlands, rivers, grasslands, and mountains." Only 6% said it is not very, or not at all, important to them. (The rest said "somewhat important.")

Texans also like to personally encounter and experience these natural assets. The majority (54%) said it is "very important" that they "can easily get to natural areas and open space." Only 9% said it isn't very, or not at all, important. One of the direct human problems of urban sprawl is that the natural areas that are destroyed tend to be the ones closest to where people live, the very areas residents previously enjoyed before the chain saws and bulldozers came.

So, it may not be surprising that most Texans don't want to divert scarce water resources to accommodate additional populations from other states and nations.

- Only 20% supported diverting water from streams to accommodate the population growth; 69% said the water should be "kept in streams to support forested wildlife habitats, fish and birds."

- 25% supported diverting water from agriculture to provide for new residents; 57% opposed the diversion.

The options in the survey that received the highest support for preserving habitat and farmland were about limiting future population growth.

- Four out of five Texans said their state's pace of population growth should be slowed (46%) or ended (37%). Only 13% said they wanted the population growth to continue at recent rates.

Because births per woman have to be over 2.1 to drive long-term population growth, the Texas birth rate of around 1.8 per woman is not a long-term factor in causing the state's population growth. The net in-migration of people from other states and other nations, plus net births over deaths among these migrants once they arrive, are the overwhelming factors driving Texas' future population growth.

One major cause of rapid growth in an urban area's population is the result of enticing residents and businesses to relocate from elsewhere. Local and state governments can and do create many incentives that encourage people and businesses 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 new 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.

Texans apparently would like to see a change in the pro-growth philosophy of Texas governments, based on survey results.

- 46% of Texans supported local and state Texas governments making it "more difficult for people to move to Texas from other states by restricting development;" 37% opposed that option.

U.S. population growth in recent decades has been driven primarily by migration from other countries (and the net births over deaths among those who come). Over the last two decades, authorized permanent migration to the United States has averaged around a million a year, with illegal migration varying from a few hundred thousand a year to more than a million. The survey found that the majority of Texans prefer less immigration.

- 57% of Texans supported the federal government reducing "annual immigration to slow down Texas population growth;" 28% supported keeping immigration at its current level, and 8% supported increasing annual immigration.

Whether future generations of Texans will ever experience a large part of the remaining natural topography, ecosystems, flora and fauna of the 2020s is primarily in the hands of today's leaders and voters. Texans can slow down habitat degradation somewhat by individually and voluntarily adopting less impactful lifestyles. But it appears that the destruction of hundreds of square miles of Texas ecosystems for urban development each decade can only be significantly mitigated by greatly restraining Texas population growth or by forcing Texans to live in ever-increasing density, or some combination of both.

To refuse to choose an action option in the present is to make a choice against protecting "miles and miles of Texas" ecosystems and their non-human inhabitants for decades and generations of Texans to come.

Population Growth and Sprawl in Texas

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1. INTRODUCTION – SPRAWL'S TOLL ON TEXAS, AMERICA, AND THE EARTH

Since 1990, Texas has added 13 million people to its population, far 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 (13 million versus 9 million), as well as much faster in terms of percentage growth (77% versus 31%).

Table 1. Ten Highest Population Growth States in the U.S., 1990 to 2022

Top 10 states by rank	Population in 1990[1]	Population in 2022[2]	Growth, 1990-2022	Annual Growth 1990-2022	% growth, 1990 to 2022
1. Texas	16,986,510	30,029,572	13,043,062	407,596	77%
2. California	29,760,021	39,029,342	9,269,321	289,666	31%
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, 2022 estimates 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) 2002-2017	Total Sprawl (square miles), 2002-2017	State	Total Sprawl (square miles), 1982-2017	Total Sprawl Ranking by Area, 1982-2017
1	**2,616**	**Texas**	**6,634**	**1**
2	1,065	Florida	4,353	2
3	846	Georgia	3,910	4
4	831	California	3,421	5
5	821	North Carolina	3,996	3
6	560	Virginia	2,180	9
7	557	Arizona	1,744	13
8	543	Tennessee	2,354	7
9	496	Pennsylvania	2,686	6
10	490	Ohio	2,149	10

Source: USDA Natural Resources Conservation Service, *2017 National Resources Inventory, Summary Report* (September 2020)

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

[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.

impacts of ever-expanding cities and the nation's steadily disappearing rural land.[2] Two decades later, sprawl is still devouring valuable farmland and wildlife habitat, both in Texas and 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 apparently passé; it is no longer seen as "sexy."

Despite our country's various economic setbacks since the Great Recession of 2008, sprawl continues to be a major threat to rural land, open space, farmland, and natural habitats in the United States. Nationally, in just the 15 years from 2002 to 2017, approximately 18,000 square miles (11.4 million acres – 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 2020 survey of 1,500 likely American voters revealed that 79 percent thought that the destruction of farmland and natural habitat because of urban sprawl was a "major problem" (44%) or "somewhat of a problem" (35%). Eighty percent responded that it was "unethical to pave over and build on good cropland" even to provide more housing.[3]

In the 1982-2017 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 6,634 square miles (4.2 million 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

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[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.

[3] Pulse Opinion Research. 2020. National Survey of 1,500 Likely Voters. Conducted May 25-27, 2020. Margin of Sampling Error, +/- 2.5 percentage points with a 95% level of confidence. Appendix G in L. Kolankiewicz, R. Beck, and E. Ruark, 2022, *From Sea to Sprawling Sea: Quantifying the Loss of Open Space in America* . Arlington, VA: NumbersUSA. Available online at: https://sprawlusa.com/wp-content/uploads/2022/03/NatlSprawl.pdf

[4] USDA Natural Resources Conservation Service (NRCS). 2020. *2017 National Resources Inventory, Summary Report* (September). Accessed online January 2023 at: https://www.nrcs.usda.gov/sites/default/files/2022-10/2017NRISummary_Final.pdf

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 four national-level studies (2001, 2003, 2014, 2022), two on Florida (2000 and 2015), one on California (2000), one on the Chesapeake Bay watershed (2003), one on the Southern Piedmont (portions of North Carolina, South Carolina, and Georgia) in 2015-2016, an earlier one on Texas in 2017, one on Oregon in 2020, one on Arizona in 2021, and one on Colorado in 2022. These studies are available at the NumbersUSA website, www.numbersusa.com, our www.sprawlusa.com site, and state sprawl sites for Arizona and Colorado. Our sprawl studies have been cited many times in the technical and popular literature.

This report, our second focused on sprawl in Texas, is an update to our earlier 2017 study. It examines the quantity and rate of rural land lost to development (or rural land converted to urban land) in the state's 254 counties. We also examine the two principal factors behind this sprawl, determining the extent (i.e., quantifying) to which population growth and growth in per capita land consumption (decreasing population density) each "drove" sprawl from 1982 to 2017 and from 2002 to 2017. The second time period (2002-2017) is the most recent 15-year subset of the entire 35-year time span of the dataset. All of our county-specific data on developed land come from the most recent NRI, published by the USDA NRCS in September 2020, and including data on land use through 2017. In addition, we use official U.S. Census Bureau population estimates for Texas counties in 1982, 2002, and 2017 to look at changes in population (growth / increase, stability / no change, or decline / decrease) and consider how these are related to changes in developed land area county-by-county.

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, while now a bit dated, provides a sense of scale, depicting the size, shape, and location of Texas' 34 Urbanized Areas (UAs) and scores of Urban Clusters (smaller urban zones/population centers also designated and delineated by the Census Bureau) – as delineated by the U.S. Census Bureau – within the state as a whole in 2010, after more than a century of population growth and urban expansion.

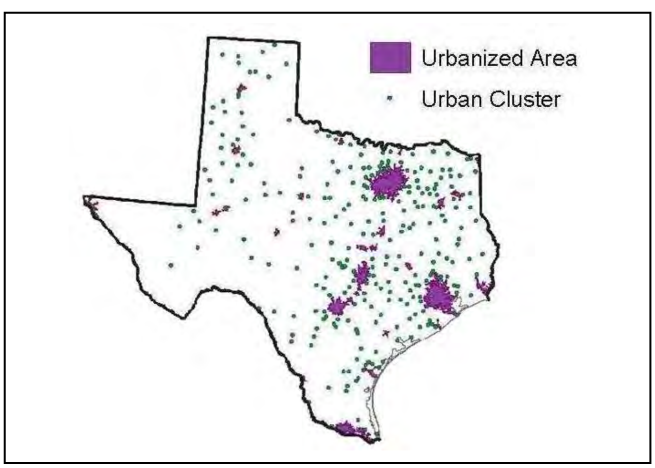

Figure 1. Urbanized Areas (UAs) and Urban Clusters in Texas, 2010

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 and San Antonio, with 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 some astronomers have stated 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 populous 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 Sprawl Versus Ecological Footprint

All human beings and every American – even those who are conscientious and profess to be conservationists or environmentally aware – inexorably impose certain demands (or what ecologists call a "load") on the land and resources of the biosphere through consumption and waste production and emissions (including carbon dioxide). The mere act of living with the comforts and conveniences of the modern world necessarily incurs environmental impacts, which can be reduced or mitigated through better technologies and more environmentally enlightened behaviors and virtues, but never entirely eliminated. No amount of wishful thinking or technical wizardry will ever erase our ecological footprint completely (**Figures 4 and 5**).

Figure 4. Every human being has an ecological footprint, imposing an environmental load on the ecosystems and renewable and nonrenewable natural resources of the biosphere

Figure 5. Heavy per capita use of natural resources in high-consumption, affluent societies results in each consumer becoming, in effect, a "Bigfoot" in terms of his or her ecological footprint

Developed land includes much more than urban residential areas alone. It also includes other built-up land uses, including transportation, light and heavy industrial, commercial retail and office, institutional, and even urban park space. In 2017, American consumers/residents on average used or "consumed" 0.356 acre of developed land per capita, or a little over one-third of an acre per person. (Mean per capita developed land consumption in Texas in 2017 was very similar to the national mean at 0.34 acre per resident.) This 0.356-acre/resident metric does not include relatively unpopulated rural lands – farmlands (cropland, pasture, and rangeland), forests, scrub-shrub habitat, grasslands, reservoirs, mines – that furnish crucial raw materials and products used by every consumer/resident, namely food, fiber, fuels, water, energy, metals, and minerals.

Nor does it include the forestlands needed to absorb each American resident's or consumer's carbon dioxide (CO_2) emissions from fossil fuel combustion to produce electricity and propel our vehicles. All of these ecologically productive lands not covered with pavement and buildings, but used indirectly by each and every U.S. resident (and all human consumers), contribute to each average American's per capita ecological footprint. This entails a much larger amount of land, 56 times greater as much in fact, or approximately 20 global acres (8.0 global hectares) per person, according to the Global Footprint Network (GFN) (**Figure 6**).[5]

In 2017, the United States had a per capita ecological deficit of 4.6 global hectares (one hectare equals 2.47 acres). According to the GFN, an ecological deficit occurs when the Ecological Footprint of a given population exceeds the "biocapacity" (ecologically productive lands capable of large-scale photosynthesis) of the area available to that population. A national ecological deficit means that the United States is importing biocapacity through trade, "liquidating" national ecological assets or emitting the CO_2 waste product or "residual" into the atmosphere. (In contrast, an ecological reserve exists when the biocapacity of a region or country exceeds its population's Ecological Footprint.)

According to the GFN, in 2015 the per capita Ecological Footprint of Texans was 18.5 global acres while the per capita biocapacity was 6.7 global acres, for a net deficit of 11.8 acres. Texas enjoyed the dubious distinction of having one of the three highest ecological deficits in the country, along with California and Florida.[6] Not so coincidentally, these are also the three most populous states in the United States of America.

[5] Global Footprint Network. 2021. Accessed online June 5, 2021 at: https://data.footprintnetwork.org/#/.
[6] Global Footprint Network. 2015. *State of the States Report*. Available online at: https://www.footprintnetwork.org/2015/07/14/states/.

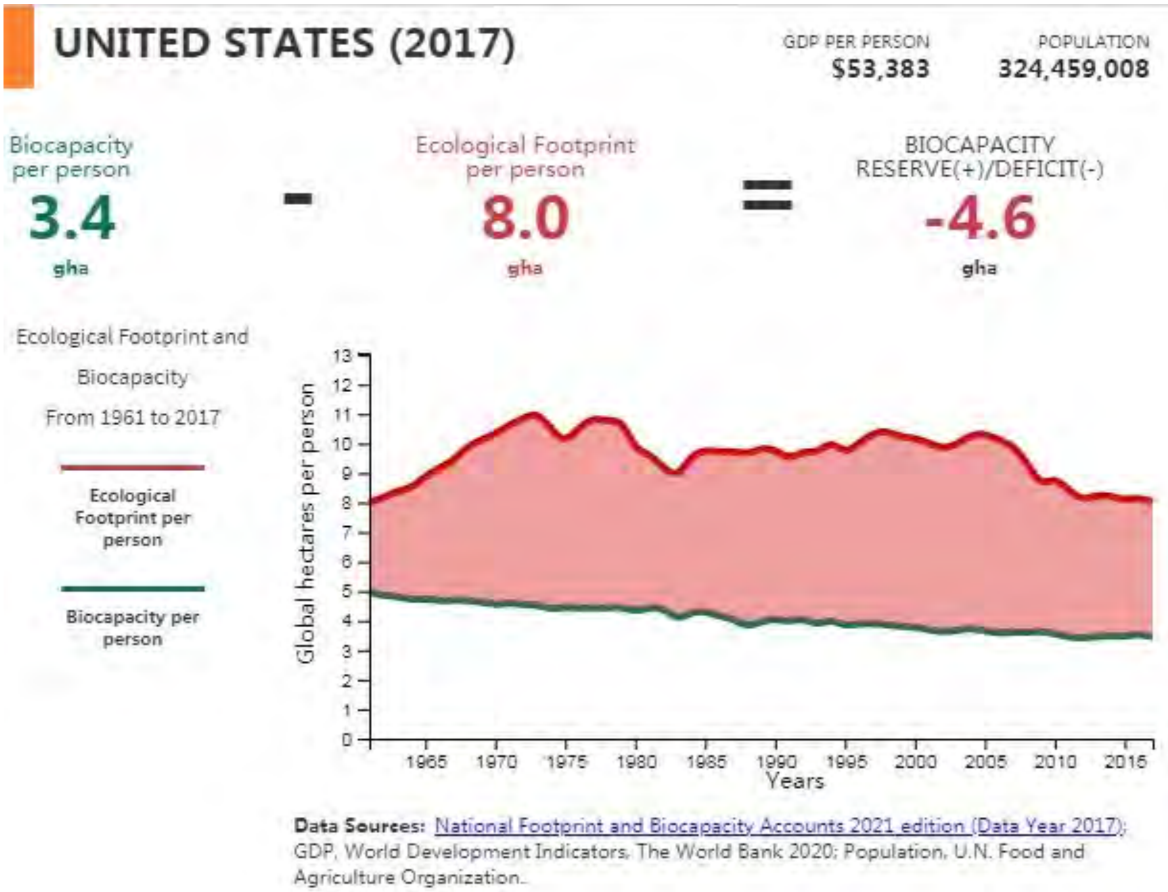

Figure 6. Per Capita Ecological Footprint of the United States in 2017
Source: Global Footprint Network

The United States has the second-largest aggregate Ecological Footprint on Earth. Only China's is larger (**Figure 7**). But China's population is roughly four times that of America's. The per capita Ecological Footprint of the U.S. is twice that of China's and seven times that of India's.[7]

[7] Ibid.

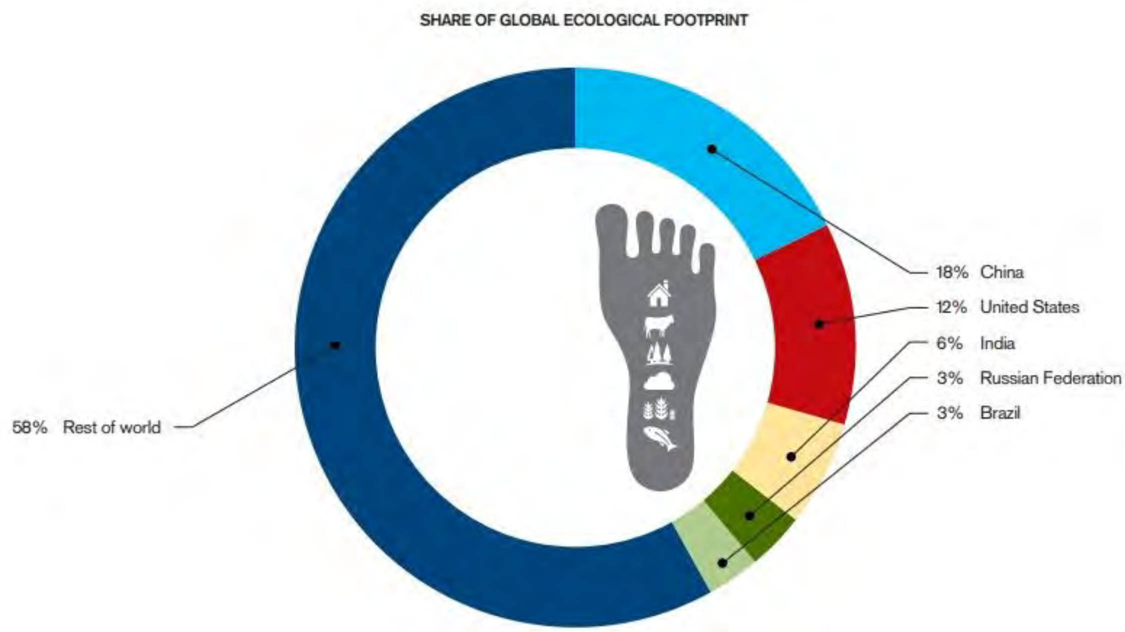

Figure 7. Shares of Global Ecological Footprint in 2015
Source: Global Footprint Network. 2015. State of the States.

1.3 Loss of Farmland, Wildlife Habitat, and Open Space

1.3.1 Developing and Losing Farmland

One of the primary concerns about urban sprawl has been that it is replacing our nation's prime farmland, forests, wetlands, and wildlife habitat with subdivisions, new and expanded roads, strip malls, and business parks. As the NRCS put it in the 2007 NRI summary report, reviewing the previous 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.[8]

Nationwide, from 1982 to 2017, about 69,000 square miles (44,175,300 acres) – an area larger than Florida – of previously undeveloped, non-federal rural land was paved over to accommodate our growing cities and towns (**Figure 8**). The total amount of developed land was 72.1 million acres in 1982. By 2017, this had climbed to 116.3 million acres.

[8] Natural Resources Conservation Service (NRCS). 2013. 2007 National Resources Inventory: Development of Non-Federal Rural Land. March.

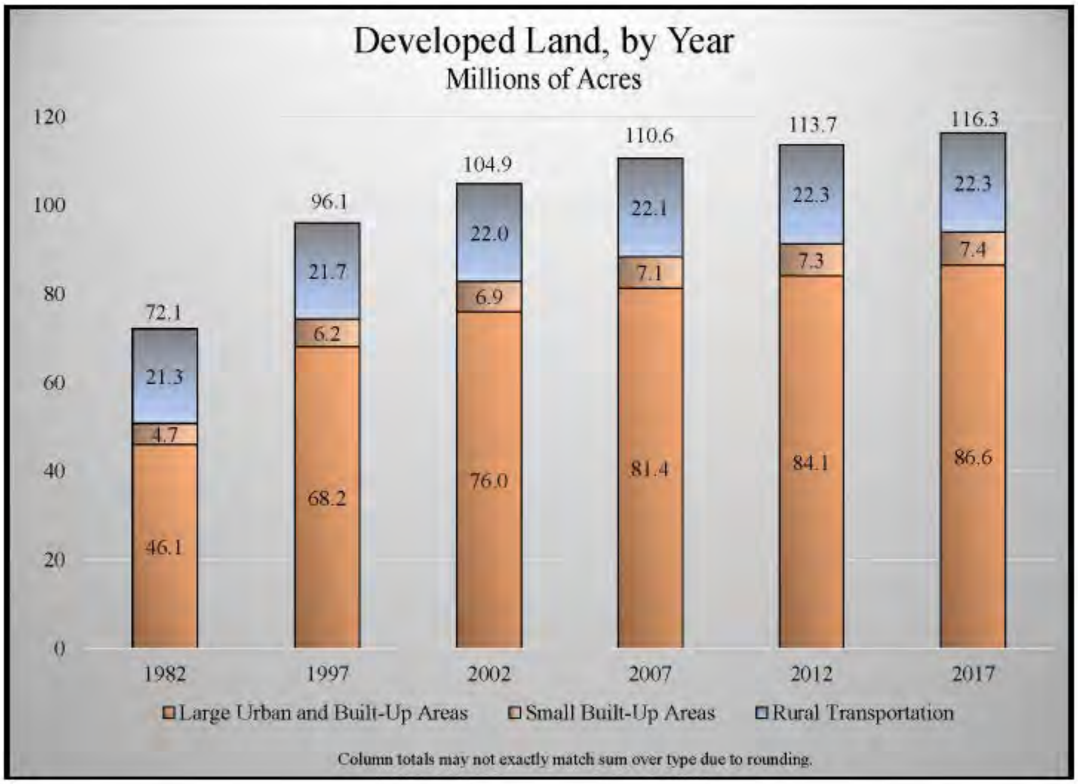

Figure 8. Cumulative Growth in Area of Developed Land Nationwide, 1982-2017
Source: *2017 National Resources Inventory, Summary Report*, p. 2-6.

In Texas alone, the area of developed land grew by 80 percent from 5,284,800 acres (8,258 square miles) in 1982 to 9,530,400 acres (14,891 square miles) in 2017 (**Table 3** and **Figure 10**).

Table 3. Cumulative Increase in Developed Land in Texas, 1982-2017

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	5,284.8			
1987	5,812.5	1982-1987	105,540	289
1992	6,372.5	1987-1992	112,000	307

1997	7,054.1	1992-1997	136,320	373
2002	7,856.0	1997-2002	160,380	439
2007	8,544.3	2002-2007	137,660	377
2012	8,988.8	2007-2012	88,900	244
2017	9,530.4	2012-2017	108,320	297
Average		**1982-2017**	**121,303**	**332**

Source: USDA Natural Resources Conservation Service, *2017 National Resources Inventory, Summary Report* (September 2020)

Figure 9. Rio Grande flows through Big Bend National Park in Texas

Credit: David Mark from Pixabay

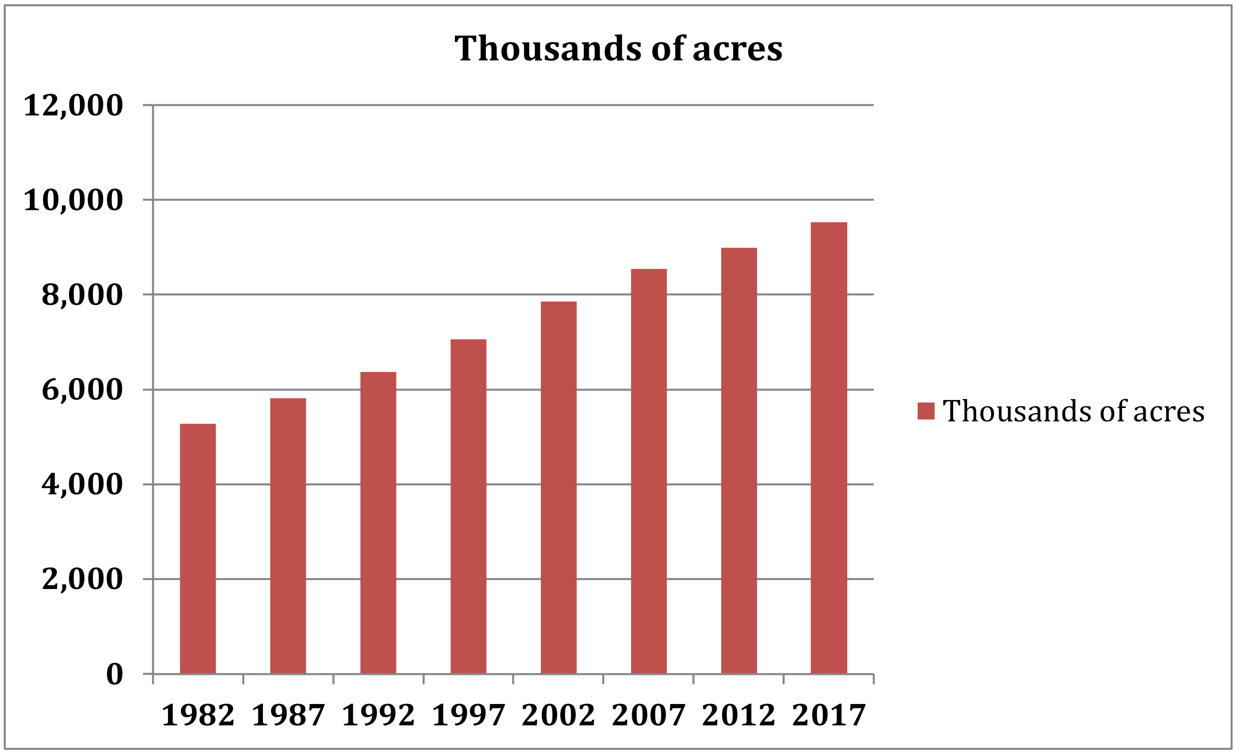

Figure 10. Cumulative Growth in Area of Developed Land in Texas, 1982-2017
Source: *2017 National Resources Inventory, Summary Report*, p. 3-19.

Where did these developed lands come from? What types of rural land uses were converted into developed land? At the national level, these are quantified in **Figure 12**, the sources of newly developed land, including cropland, pastureland, rangeland, forestland, and other rural lands.

Figure 11. Abandoned grain elevator in ghost town of Wastella, Texas

Credit: David Mark from Pixabay

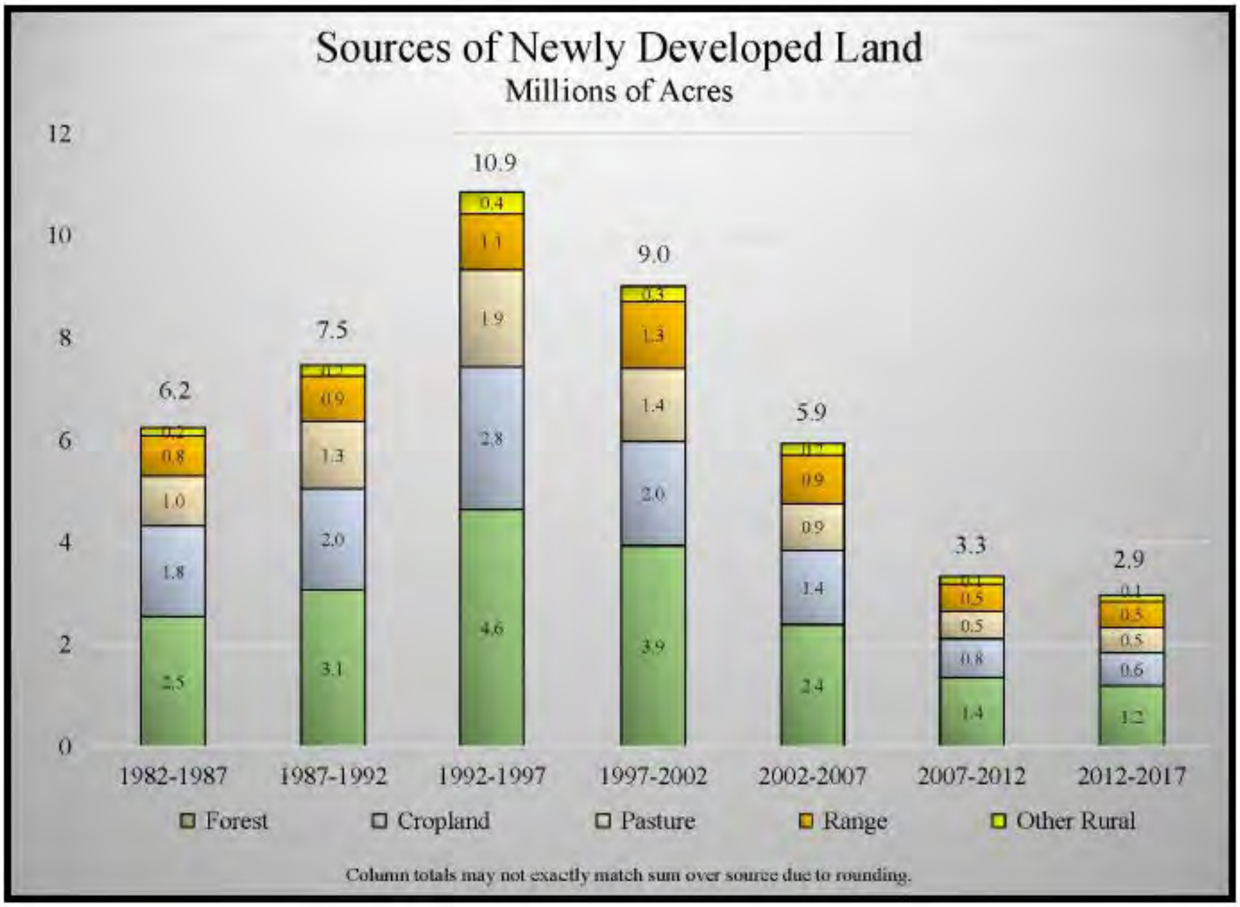

Figure 12. Sources of Newly Developed Land Nationwide, 1982 to 2017
Source: *2017 National Resources Inventory, Summary Report*, p. 2-7.

Of these 44 million acres lost across the nation – or "converted" as land managers and planners generally refer to it – approximately 11.1 million acres were cropland, 13.1 million acres were pasture and rangeland, and 18.8 million acres were forestland. "Other Rural" comprised 0.15 acre.

However, "as the population has increased, the acres developed per person has [sic] dropped off" notes the NRCS. The five-year period from 1992 to 1997 experienced the greatest loss of open space because of development, at 10.9 million acres. A decade later, from 2002 to 2007, this figure had dropped by almost half to 5.9 million acres. Population growth at 5-year intervals over the same 35-year time frame is shown by NRCS in **Figure 13.** The U.S. population grew by nearly 90 million during this period, at a rate of about 27 million new residents per decade, a very rapid (and unsustainable) rate of increase that adds nearly a new Texas (our second-most populous state after California) to the U.S. population every decade.

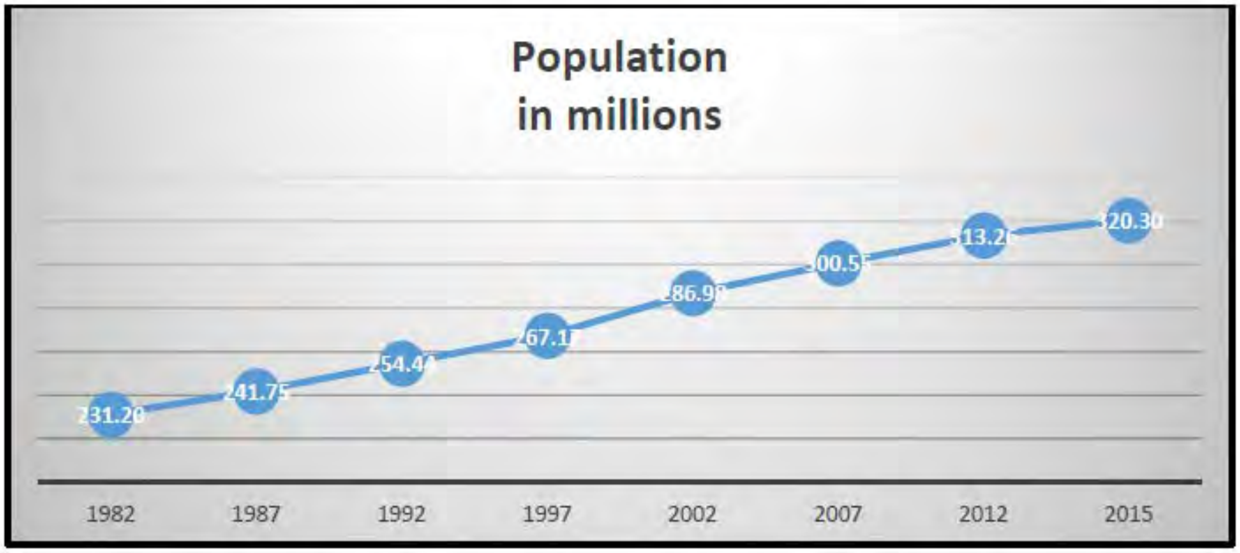

Figure 13. U.S. Population Growth from 1982 to 2015

Source: *2017 National Resources Inventory, Summary Report*, p. 2-7 (Footnote #6).

Figure 8 shows the increase in the cumulative total of developed land in the United States from 1982 to 2017. By 2017, approximately 116.3 million acres of land (or 181,720 square miles) had been developed in the 48 conterminous states, Hawaii, Puerto Rico, and the U.S. Virgin Islands. Thus, more than one-third (38 percent) of all land developed in our nation's entire history has been developed in just the last 35 years. This is a rapid, accelerating rate of change. If this rate (1.26 million acres developed/year) had persisted for the entire 245-year history of the United States (since 1776), the total area of developed land in the country would be 309 million acres rather than 116 million acres, over two-and-a-half times as much. Another way of stating this is that the annual rate of land development in the U.S. in recent decades is 2.66 times greater than the average rate throughout our history as a country.

As noted above, the aggregate area of developed land in 2017 was about equal in size to the 10 states of Maine, New Hampshire, Vermont, Massachusetts, Connecticut, Rhode Island, Delaware, New Jersey, New York, and Pennsylvania combined, that is, all of New England and much of the Mid-Atlantic States.

On average, on each of the 12,785 days in the 35 years between 1982 and 2017, approximately 3,455 acres (5.4 square miles) of open space in United States succumbed to the bulldozer's blade, asphalt, concrete, and buildings (**Table 4**). It is noteworthy that the amount of rural land converted to developed land rose and fell significantly during the 35-year time period. It went from 3,301 acres per day in the mid-1980s to a peak of 5,858 acres per day in the mid-1990s, and back down to 1,439 acres per day by 2012 to 2017, a reflection of increasing residential population density and also a response to the Great Recession of 2008 and its aftermath.

Table 4. Cumulative Increase in Developed Land in the United States, 1982-2017

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	72,127.7			
1987	78,152.7	1982-1987	1,205,000	3,301
1992	85,399.2	1987-1992	1,449,300	3,971
1997	96,090.4	1992-1997	2,138,240	5,858
2002	104,880.8	1997-2002	1,758,080	4,817
2007	110,606.1	2002-2007	1,145,060	3,137
2012	113,676.2	2007-2012	614,020	1,682
2017	116,303.0	2012-2017	525,360	1,439
Average		**1982-2017**	**1,262,151**	**3,455**

Source: Calculated from NRCS, 2020. *Summary Report: 2017 National Resources Inventory*, Table 1.

The area of cropland in the United States decreased from 420.3 million acres in 1982 to 367.5 million acres in 2017, a reduction of 13 percent. Some of this former cropland (16 million acres in 2017) was temporarily protected under the federal Conservation Reserve Program (CRP)[9] – administered by USDA's Farm Service Agency (FSA) – the acreage of which rose from 14 million acres in 1987 to 33 million acres in 1997 before falling back down to 16 million acres in 2017. However, CRP lands are considered more "environmentally sensitive" or ecologically marginal lands, often on steeper slopes more vulnerable to erosion, or more generally vulnerable to degradation from plowing, tilling, planting, harvesting, irrigation, fertilization, and other modern industrial farming practices.

[9] From the CRP website: "CRP is a land conservation program administered by FSA. In exchange for a yearly rental payment, farmers enrolled in the program agree to remove environmentally sensitive land from agricultural production and plant species that will improve environmental health and quality. Contracts for land enrolled in CRP are 10-15 years in length. The long-term goal of the program is to re-establish valuable land cover to help improve water quality, prevent soil erosion, and reduce loss of wildlife habitat. Signed into law by President Ronald Reagan in 1985, CRP is one of the largest private-lands conservation program [sic] in the United States. Thanks to voluntary participation by farmers and landowners, CRP has improved water quality, reduced soil erosion, and increased habitat for endangered and threatened species." https://www.fsa.usda.gov/programs-and-services/conservation-programs/conservation-reserve-program/index

Other former croplands were retired from cultivation and converted to pastureland, rangeland, and other rural land categories. However, some cropland was also developed: 11.1 million acres from 1982 to 2017, according to the NRI. "Asphalt is the land's last crop," remarked former U.S. Assistant Secretary of Agriculture and conservationist Rupert Cutler back in the 1970s.[10] Once a tract of farmland with its soils and the micro and macro-ecosystems they support are paved over, the probability of that patch of the Earth being restored within the foreseeable future to a functioning ecological habitat or productive agricultural land is miniscule.

Figure 14. America's Bountiful Cropland: Productive Wheatfield under the Big Skies of the Great Plains

The area of U.S. pastureland (**Figure 15**) declined from 131.2 million acres in 1982 to 121.6 million acres in 2017, a decrease of seven percent. The much larger area of non-federal (state and private) rangeland declined slightly over these 35 years, from 418.6 million acres to 403.9 million acres, a decrease of four percent. However, the NRI does not indicate whether the quality of that rangeland may have changed, either positively from implementation of conservation measures, or negatively from agents such as erosion or invasive species like the inedible creosote bush (*Larrea tridentata*), the spread of which in arid Southwestern rangeland has been facilitated by overgrazing of livestock (**Figure 16**).

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

Figure 15. Cattle Grazing on Pastureland in Fannin County, Texas

Figure 16. Stand of Creosote Bush on rangeland – while a native species, it is inedible by livestock and is considered invasive because it is an aggressive competitor

While the NRCS estimates that rates of erosion on the nation's cropland decreased by 35 percent on average between 1982 and 2017, staggering amounts of topsoil are still being lost in spite of improved awareness and soil conservation measures. Every year, more than four and a half tons per acre are washed or blown away from the nation's cultivated and non-cultivated croplands. This totaled 1.7 billion tons in aggregate at the national scale in 2017. Sheet and rill erosion from water accounted for 58 percent of this, while wind erosion was responsible for the other 42 percent.[11]

Most soil scientists concur that it takes at least 100 years for natural processes to form just one inch of soil; the specific rate of soil formation depends on climate, vegetation, slope gradient, and other factors.[12] Overall, scientists estimate that we are losing soils some 10 to 40 times faster than the rate of soil formation or renewal.[13] Obviously, this is unsustainable.

Texas Cropland in Decline

The NRI documents the decline in the acreage of cropland in Texas in recent decades, as seen in **Table 5**. From 1982 to 2017, the area of cropland in the state fell by some 9.9 million acres, or 30 percent, one of the steepest declines of any state in the country.

Table 5. Acreage of Texas Cropland, 1982-2017

Year	Area of TX Cropland (thousand acres)
1982	33,550.7
1987	31,489.2
1992	28,502.7
1997	27,181.3
2002	25,750.0
2007	24,195.6
2012	23,612.9

[11] Op cit. Note #17. Page 2-8.
[12] Natural Resources Conservation Service. No date. Soil Formation. Accessed online 6-12-2021 at: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/wa/soils/?cid=nrcs144p2_036333.
[13] David Pimentel. 2006. Soil Erosion: A Food and Environmental Threat. *Environment, Development and Sustainability*. 8: 119-137. Available online at: http://saveoursoils.com/userfiles/downloads/1368007451-Soil%20Erosion-David%20Pimentel.pdf.

2017	23,624.6

Source: NRCS, 2020. *Summary Report: 2017 National Resources Inventory*, Table 2

A large state (second in the country after just Alaska), Texas leads the nation in the number of both farms and ranches (**Figure 17**). The main crops are cotton, corn, feed grains (e.g., sorghum, milo), rice, and wheat; other important crops in Texas include peanuts, sunflowers, and sugarcane.[14]

Figure 17. Texas Farmland
Credit: David Mark from Pixabay

1.3.2 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 to some 1,700 endangered or threatened animal and plant species and sub-species, which are seriously harmed by ever-encroaching development (and related anthropogenic causes) and the number of listed species is increasing (**Table 6**).[15]

[14] Texas Film Commission. 2023. Crop Information – Planting and Harvesting. Accessed online 1-28-23 at: https://gov.texas.gov/film/page/crop_information#:~:text=While%20the%20primary%20crops%20of,sunflowers%20to%20sugarcane%20and%20more.

[15] U.S. Fish and Wildlife Service. 2023. U.S. Federal Endangered and Threatened Species by Calendar Year. Available online at: https://ecos.fws.gov/ecp/report/species-listings-by-year-totals.

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*) (**Figure 18**) and golden-cheeked warbler (*Setophaga chrysoparia*) (**Figure 19**). Two examples of state-listed species are the Texas horned lizard or horny toad (*Phrynosoma cornutum*) (**Figure 20**) and the Texas kangaroo rat (*Dipodomys elator*) (**Figure 21**).[16]

Table 6. Cumulative Growth in Number of Federally-Listed Species

Year	Total Number of Listed Species*
1970	114
1980	286
1990	612
2000	1,272
2010	1,384
2020	1,680
2023	1,700

*"Federally-listed" refers to species or sub-species that have been officially listed by the U.S. Fish and Wildlife Service as threatened or endangered
Source: U.S. Fish and Wildlife Service. 2023. : https://ecos.fws.gov/ecp/report/species-listings-by-year-totals

[16] Texas Parks and Wildlife Department. Threatened and Endangered Species. Accessed Jan 2023 at: http://tpwd.texas.gov/landwater/land/habitats/cross_timbers/endangered_species/ .

Figure 18. Male Black-Capped Vireo

Credit: Texas Park and Wildlife Department

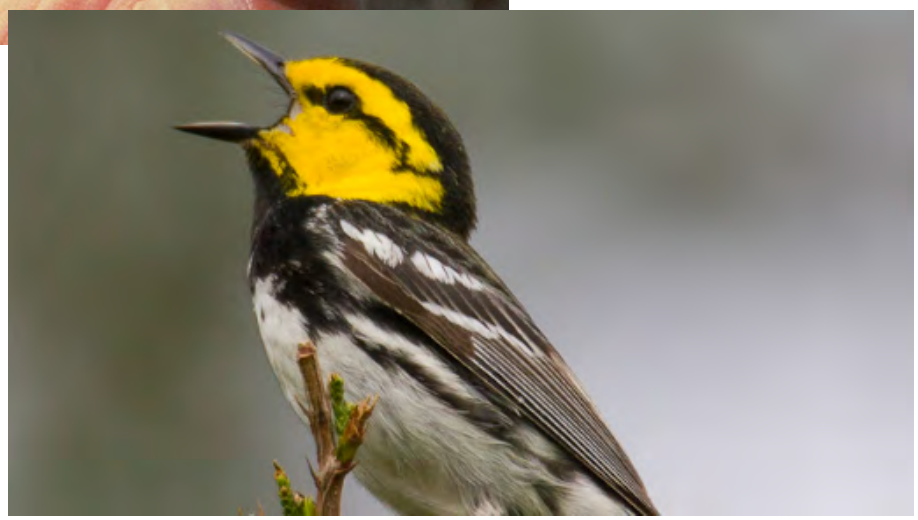

Figure 19. Golden-Cheeked Warbler at Balcones Canyonlands National Wildlife Refuge in Texas

Photo credit: U.S. Fish and Wildlife Service

Figure 20. Texas Horned Lizard

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

Figure 21. Texas Kangaroo Rat

Photo credit: U.S. Fish and Wildlife Service

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 (**Figure 22**).[17] For 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.

Figure 22. Habitat Fragmentation Cobbles and Compromises Ecosystems

[17] Ibid.

Many 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.[18]

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 ecoregions (**Figure 23**). Historically the Blackland Prairie ecoregion – virgin tallgrass prairie – extended across 10.6 million acres. Conservative estimates are that only 200,000 acres remain. The Cross Timbers ecoregion once covered 17.9 million acres. Within this ecoregion, some counties have experienced more than 200 percent population growth just since 1970.[19]

[18] Ibid.
[19] Ibid.


Gould Ecoregions of Texas
Blackland Prairie
Cross Timbers
Edwards Plateau
Gulf Prairies
High Plains
Piney Woods
Post Oak Savanah
Rolling Plains
South Texas Plains
Trans-Pecos
Source: Gould, F. W., Hoffman, G. O., and Rechenthin, C. A. 1960. Vegetational areas of Texas,
Texas A & M University. Texas Agricultural Experiment Station, Leaflet No. 492
(here modified by the Texas Parks and Wildlife Department).

Figure 23. 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.[20]

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 (**Figure 24**). 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.[21]

[20] 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.
[21] Ibid.

Figure 24. The Unbroken Expanses of Habitat That Once Covered North-Central Texas

Photo credit: Texas Parks and Wildlife Department

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.[22]

Other habitats and ecoregions in Texas are threatened by urban sprawl as well, including the Piney Woods, Post Oak Savannah, and Gulf Prairies (**Figure 25**).

[22] 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 25. Flock of wintering snow geese takes flight at San Bernard National Wildlife Refuge on the Texas Gulf Coast

1.4 Stability of Ecosystems, the Biosphere, and Biodiversity

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 and later releasing them gradually once peak flows have passed. In addition, nearly two-thirds of all marine fish species we eat spend some portion of their lives in wetlands, which often serve as "nurseries" for the rearing of juveniles (**Figure 26**). 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.

Figure 26. Coastal wetlands and estuaries provide crucial "nurseries" for the rearing of commercially-important fish species. Snow-capped, 18,009 ft. Mt. Saint Elias presides over marshes nurturing juvenile coho salmon near Yakutat, Alaska

In addition, sprawl in the United States is more than a domestic environmental or quality-of-life issue. It also has global ramifications. The relentless and accelerating disappearance of natural habitats dominated by communities of wild plants and animals, replaced by biologically impoverished artificial habitats dominated by manmade 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 could 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."[23]

In 2017, the population of 49 of America's 50 states (all but Alaska) – 324 million strong – sprawled across an area of 179,807 square miles (115.1 million acres) of developed land, according to the NRCS and its NRI. Much of this developed land was not occupied by

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

residential areas per se, but by the widespread artificial structures, facilities, and infrastructure needed to support modern, high-consumption human settlements. The average land consumption per person (per capita) in 2017 in the United States was 0.356 acre. That is, on average, each American resident accounted for more than a third of an acre of developed land. This area, which is about 15,050 square feet, is much larger (5 or 10 times) than the size (in square footage) of a typical American dwelling (private single family home).

For every three residents in America then, on average, slightly more than one acre of land has been converted from open space – both natural habitat and agricultural land – to asphalt and concrete, a wide variety of standing structures, and artificial landscaping. As noted earlier, the average Texas resident utilizes or consumes 0.34 acre, also about one-third of an acre, just slightly below the national average of 0.356 acre/capita.

As noted in Section 1.2, this 0.356-acre/resident metric does not include relatively unpopulated rural lands – farmlands (cropland, pasture, and rangeland), forests, reservoirs, mines – that furnish crucial raw materials and products used by every resident, namely food, fiber, fuels, water, energy, metals, and minerals. Nor does it include the bioproductive (photosynthesizing) forestlands needed to absorb or assimilate each resident's carbon dioxide (CO_2) emissions from fossil fuel combustion to produce electricity and propel our vehicles.

Globally, human civilization as a whole is also already well into ecological overshoot of planetary carrying capacity, according to EF analysis conducted by the GFN. **Figure 27** illustrates that it would take the biocapacity of approximately 1.7 Planet Earths to sustainably provide for the aggregate resource consumption of some 8 billion human consumers on the planet.[24]

The elimination of forest, grassland, desert, and wetland habitat from sprawl not only threatens native species, but has serious human health, safety, and economic consequences as well. Wild habitats and ecosystems perform "ecosystem services," such as those of wetlands described above.

[24] Global Footprint Network. 2019. Data/Methodology. https://www.footprintnetwork.org/resources/data/

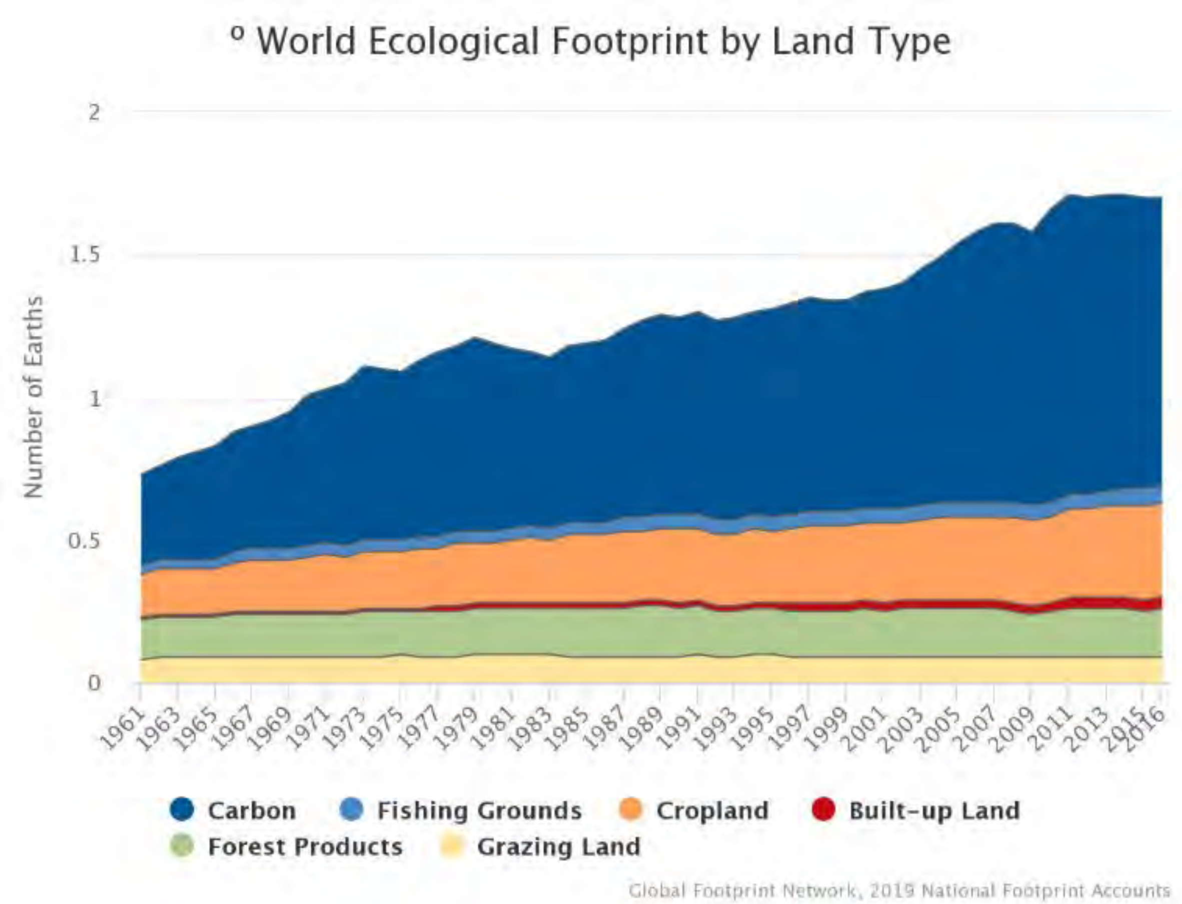

Figure 27. World Ecological Footprint in 2016 by Land Type

Documented declines or collapses in insect, bird, and vertebrate populations in recent decades as a result of the ever-increasing human appropriation of the biosphere's habitats, spaces, energy flows, and water are a sign that human civilization may be surpassing certain "planetary boundaries."[25] Ten such boundaries have been identified and quantified, and we are approaching of have already exceeded four of them: climate change, nitrate pollution, phosphorus pollution, and biodiversity loss (**Figure 28**). A massive extinction of species is now underway and accelerating – the sixth in the history of life on Earth, and the first caused entirely by a single species: man.[26]

[25] Rockstrom, J., Steffen, W., Noone, K. et al. 2009. Planetary boundaries: Exploring the safe operating space for humanity. *Ecology and Society*, *14*(2): 32; Steffen, W., Richardson, K., Rockström, J. et al. (2015). Planetary boundaries: Guiding human development on a changing planet. *Science*, *347*(6223).
[26] Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). 2019, Media Release: Nature's Dangerous Decline 'Unprecedented'; Species Extinction Rates 'Accelerating'. Retrieved 1-5-2020 at: https://ipbes.net/news/Media-Release-Global-Assessment.

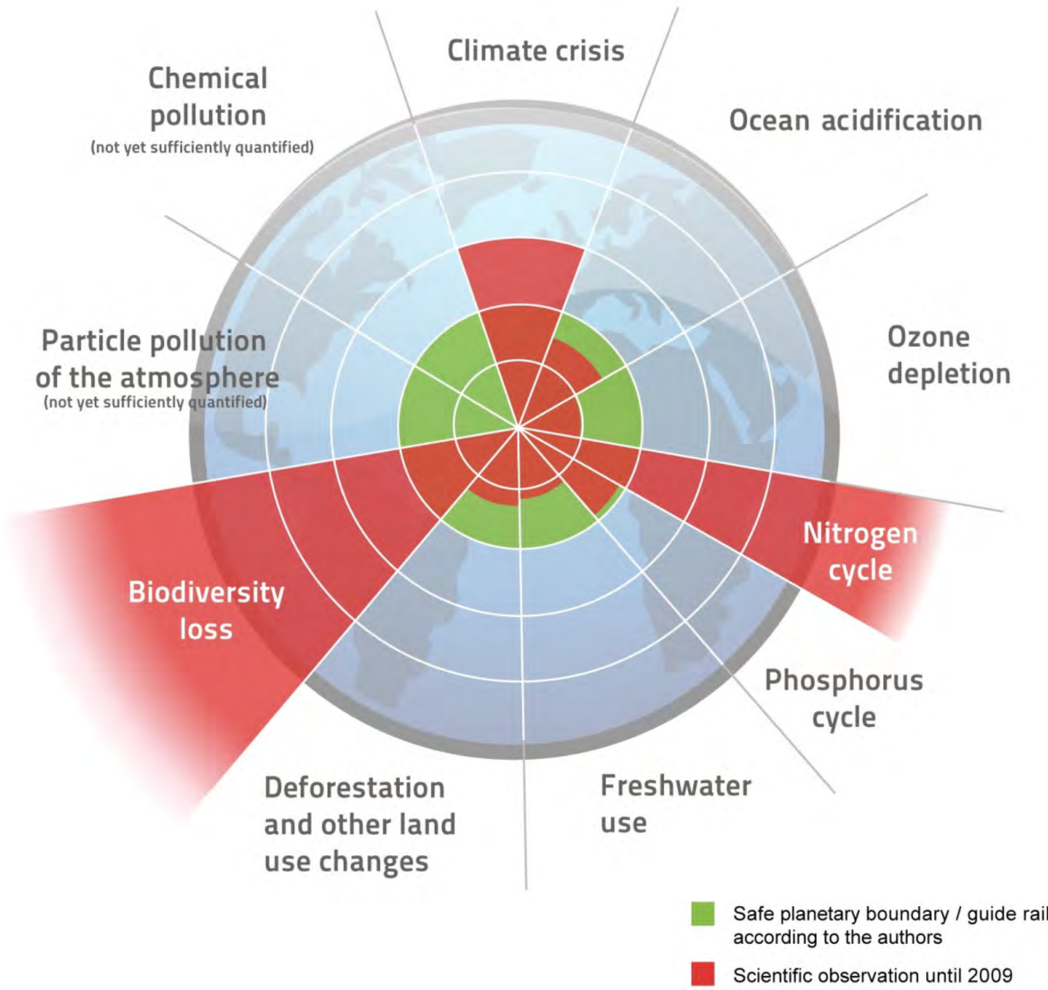

Figure 28. Planetary Boundaries
Source: Rockstrom et al. (2009); Footnote #25

Biodiversity scholars have predicted that the world could lose up to half or two-thirds of its species of wild flora and fauna by 2100, if not sooner.[27] In North America, scientists estimate that the number of birds has dwindled by approximately 30 percent since 1970. About three billion fewer birds now grace our skies, lawns, forests, prairies, deserts, and wetlands than just half a century ago. The number of breeding birds in the United States and Canada was estimated at 10 billion in 1970. Today that number has plunged to approximately 7.1 billion.[28]

[27] Wilson, E.O. 2003. *The Future of Life*. New York: Vintage Books; Raven, P., Chase, J. & Pires, J. 2011. Introduction to special issue on biodiversity. *American Journal of Botany*, *98*, 333-335; Chivian, E. & A. Bernstein, eds. 2008. *Sustaining Life: How Human Health Depends on Biodiversity*. Center for Health and the Global Environment. New York: Oxford University Press.
[28] Kenneth V. Rosenberg et al. 2019. Decline of the North American Avifauna. *Science*, 04 Oct 2019, Vol. 366, Issue 6461, pp. 120-124. DOI: 10.1126/science.aaw1313; Carl Zimmer. 2019. Birds Are

Globally, the Worldwide Fund for Nature (WWF) estimates that there has been nearly a 70 percent decrease in the size of 32,000 monitored vertebrate (mammals, birds, fish, reptiles, amphibians) wildlife populations from 1970 to 2022 (**Figure 29**).[29]

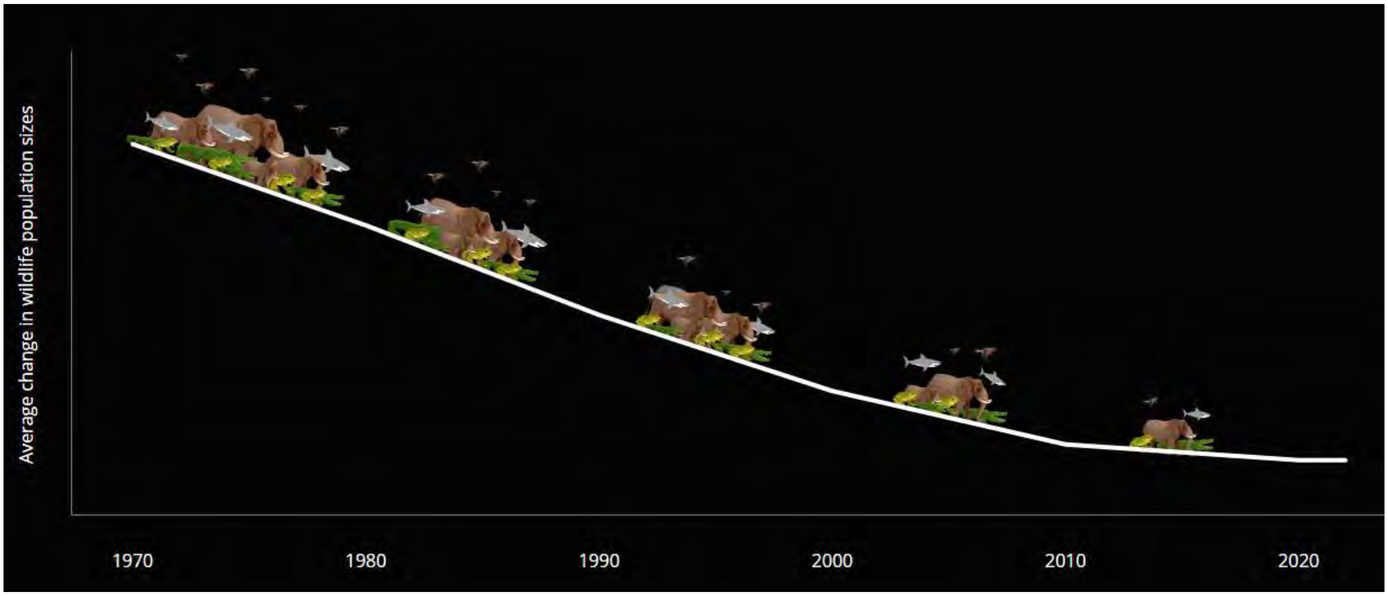

Figure 29. Living Planet Index trend from 1970 to 2022
Source: WWF, *Living Planet Report*, 2022

1.5 NATIONAL SECURITY IMPLICATIONS OF FARMLAND LOSS

Development is not the only factor responsible for the degradation and disappearance of high-quality agricultural land. Arable land is also vulnerable to other damaging natural and anthropogenic forces such as soil erosion from wind and water (**Figure 30**), and salinization and waterlogging from irrigation, which can compromise the fertility, productivity, and depth of soils, and possibly even lead to their premature withdrawal from agriculture. Many of these adverse effects are due to over-exploitation by intensive agricultural practices needed to constantly raise agricultural productivity (yield per acre) in order to provide ever more food for the world's ever-increasing populations and more meat- and dairy-intensive diets.

Vanishing From North America. *New York Times*. Available online at: https://www.nytimes.com/2019/09/19/science/bird-populations-america-canada.html.
[29] Worldwide Fund for Nature. 2022. *Living Planet Report 2022*. Available online at: https://livingplanet.panda.org/en-US/.

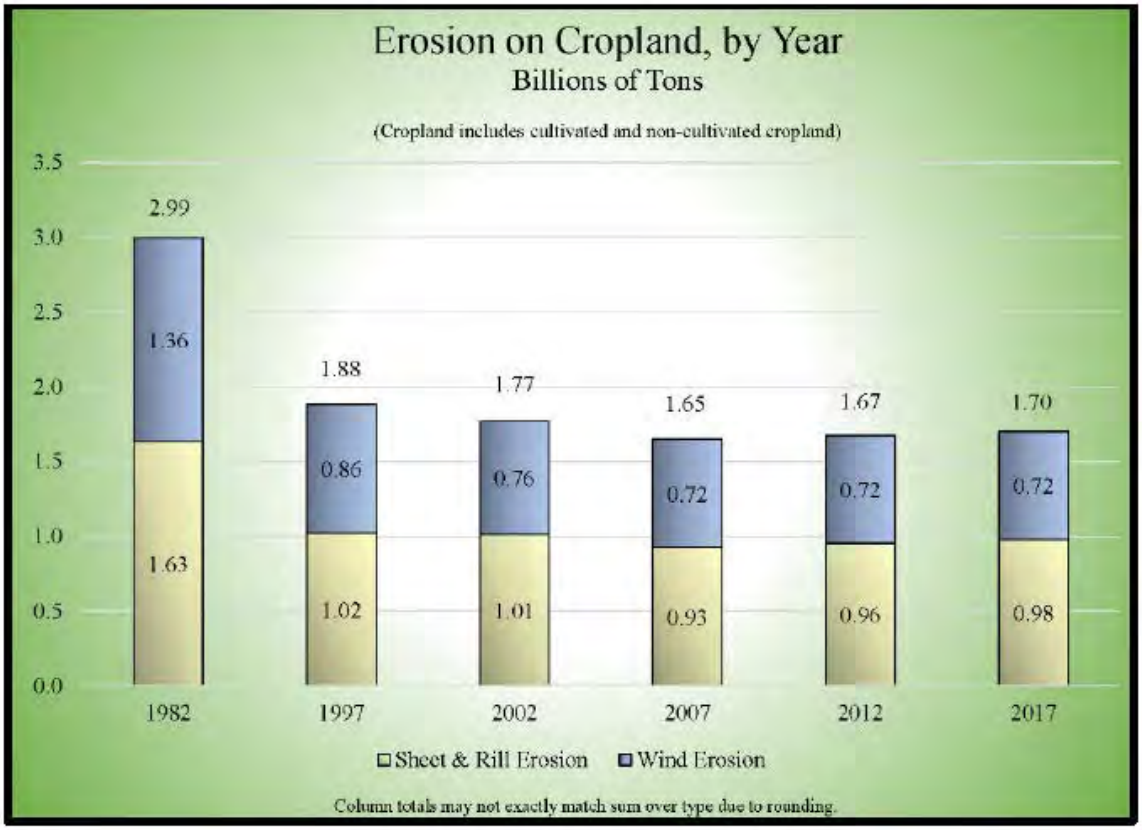

Figure 30. Annual Erosion on America's Croplands in Billions of Tons

Thus, the potent combination of unrelenting development and land degradation from soil erosion and other factors is reducing America's productive agricultural land base even as the demands on that same land base from a growing population are increasing. As noted above, the 2017 NRI estimated that the amount of cropland in the United States declined from 420.3 million acres in 1982 to 367.5 million acres in 2017, a decrease of 53 million acres (13 percent) in 35 years (**Figure 31**), an average (mean) of 1.5 million acres per year.

Some of this cropland (cumulatively, 27 million acres in 2010) was withheld from active farming with federal government support and subsidies and placed into the Conservation Reserve Program (CRP), but these tend to be marginal or fragile sites on which cultivation is not deemed to be sustainable or recommended. With the federal ethanol mandate and strong financial incentives over much of the few decades to grow corn in order to produce ethanol as fuel for vehicles, and with higher food and grain prices overall, farmers had tangible motivation to convert CRP land and pastureland into cropland from 2012 to 2017 as shown in **Figure 32**. Approximately 89 percent of the modest 3.3% gain in cropland area from 2012 to 2017 (5.6 million acres) came from pastureland and CRP land.

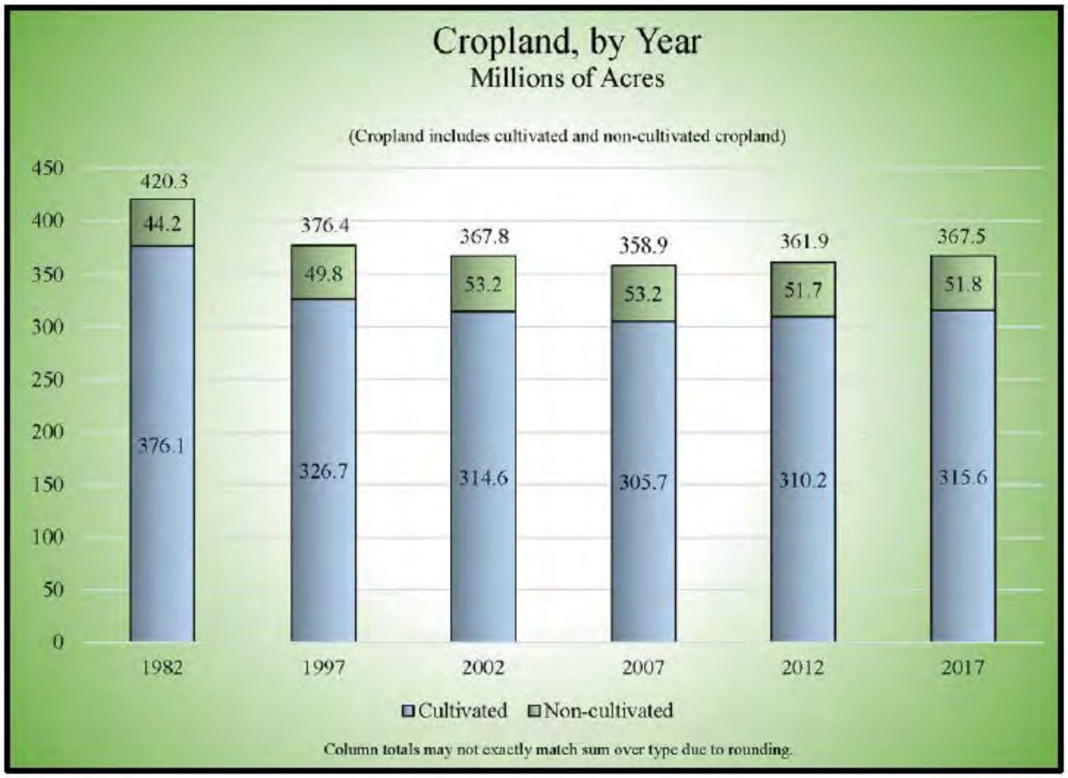

Figure 31. Area of Cropland in the United States, 1982-2017

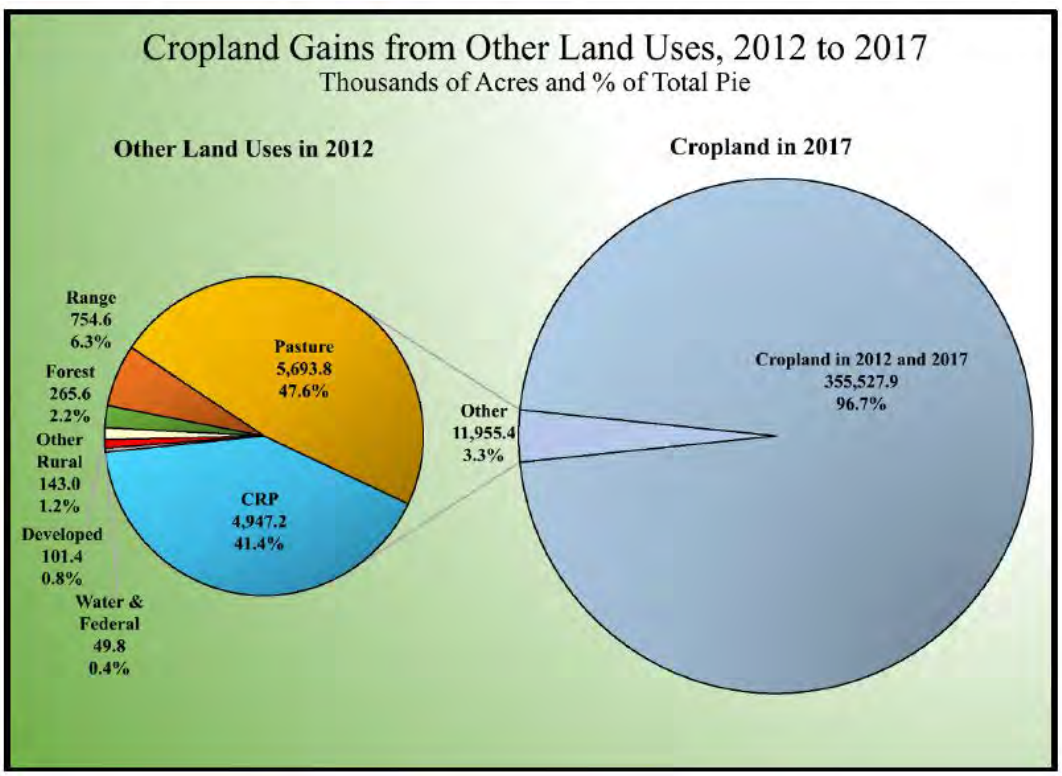

Figure 32. Cropland Gains from other Land Uses from 2012 to 2017

Source: NRCS, 2017. *Summary Report: 2017 National Resources Inventory*. P. 2-4.

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

Table 7 shows the amount of cropland per capita in the United States in 1982, 2010, and projected to 2050 and 2100, assuming the same rate of cropland decline from 1982 to 2010 and using Census Bureau projections to 2100. Available cropland would have declined from 1.9 acres per person in 1982 to 0.3 acre per person in 2100, an 84 percent decrease. **Figure 33** graphically depicts this striking loss in the form of a bar chart.

Table 7. Projected Long-term Decline in Cropland per Person

Year	Cropland in 48 contiguous states (millions of acres)	U.S. Population in Millions (48 states)	Acres of cropland per capita
1982	420	225	1.9
2010	361	306	1.2
2050	276[1]	400[2]	0.7
2100[3]	168[1]	571[2]	0.3

[1]Projected using annual rate of cropland loss from 1982-2010 (2.1 million acres)
[2]Most recent projections from the United States Census Bureau
[3]Hollmann et al., 2000.[30]

[30] Frederick W. Hollmann, Tammany J. Mulder, and Jeffrey E. Kallan. 2000. "Methodology and Assumptions for the Population Projections of the United States: 1999 to 2100": U.S. Census Bureau, Population Division Working Paper No. 38. Issued January 13, 2000.

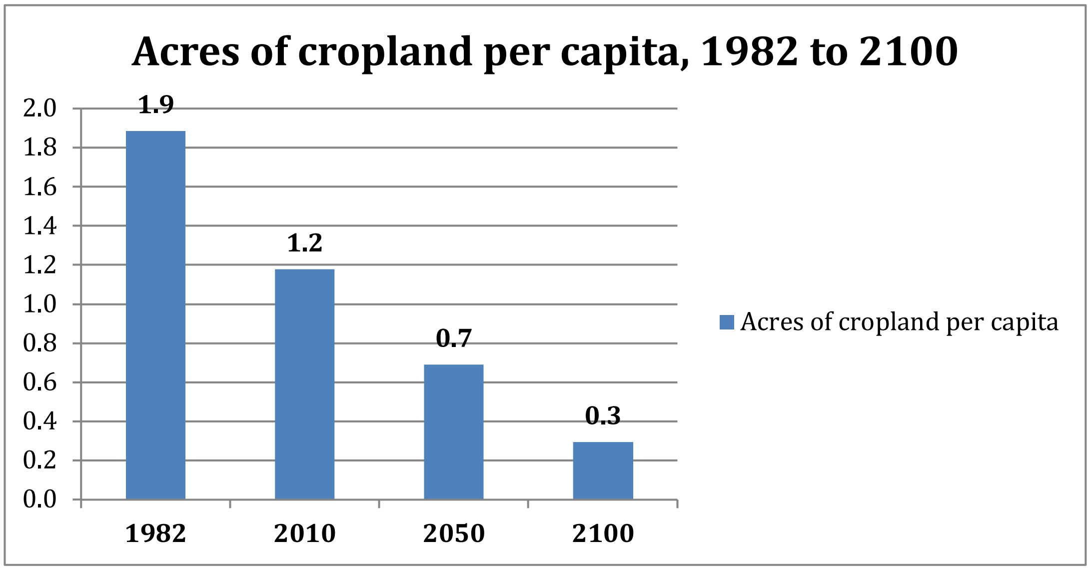

Figure 33. Projected Long-term Decline in Cropland per Person

However, this dire scenario is unlikely to come to pass, even if the United States continues to reject population stabilization as an acceptable course of action or to enact more aggressive farmland protection measures. This because rising demand and prices for foodstuffs would increase the value of land maintained as cropland vis-à-vis developed land, and because conversion from other types of lands to cropland, including pastureland, rangeland, forested land and other natural areas, would certainly occur (**Figure 32**).

As noted above, this actually did occur from 2012 to 2017, during which the area in cropland increased by 5.6 million acres; most of this was pastureland or CRP land pulled back into production because high agricultural commodity prices encouraged farmers to plant it. Again, in an ideal world, erosive or sensitive CRP lands and steeper, suboptimal pasturelands should *not* be cultivated and would best be conserved as wildlife habitat and for pasture and grazing; that is why the voluntary Conservation Reserve Program was established in the first place in the 1980s.

Furthermore, the decrease from 1982 to 2017 in the acreage of highest quality soils classified as Prime Farmland, which NRCS defines as "land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is also available for these uses." Designated Prime Farmland constitutes only 21 percent (or 313.7 million acres) of the non-Federal rural land base. The 1982-2017 loss was "only" 15.2 million acres, compared to the 52.8-million-acre decrease in overall cropland area (**Figure 34**). NRCS states that "most of this loss was due to development." As shown in **Figure 35,** not all designated Prime Farmland is actually cultivated as cropland. Indeed, only 65 percent of it is cropland; the rest is in other non-developed land uses or cover types.

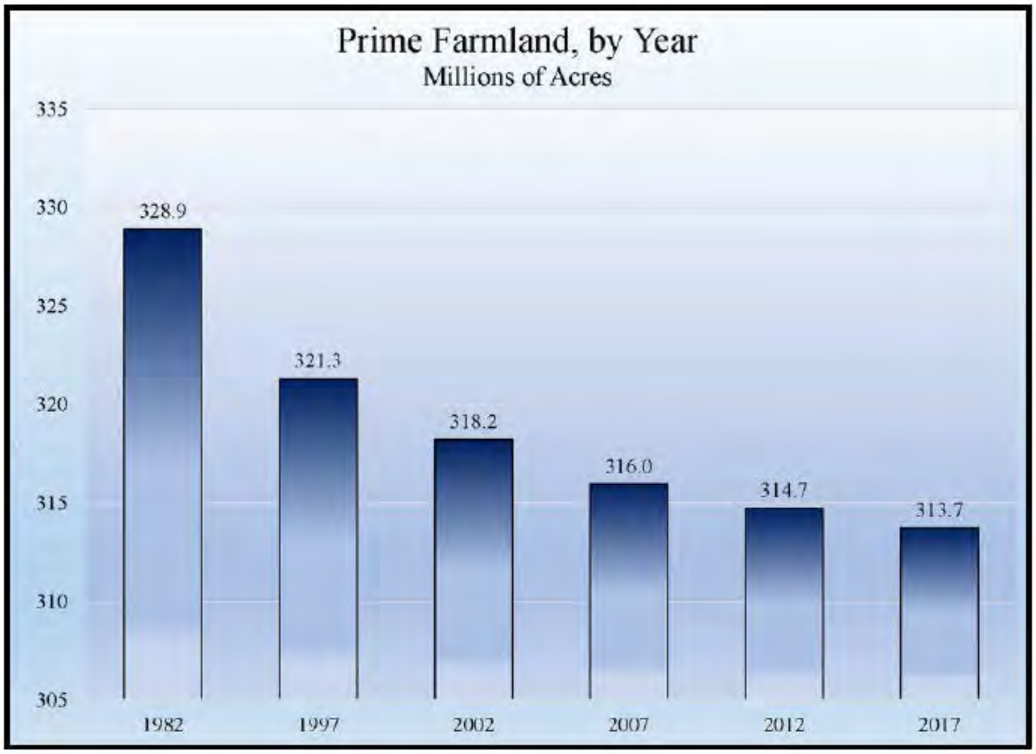

Figure 34. Decrease in Nation's Inventory of Prime Farmland, 1982-2017

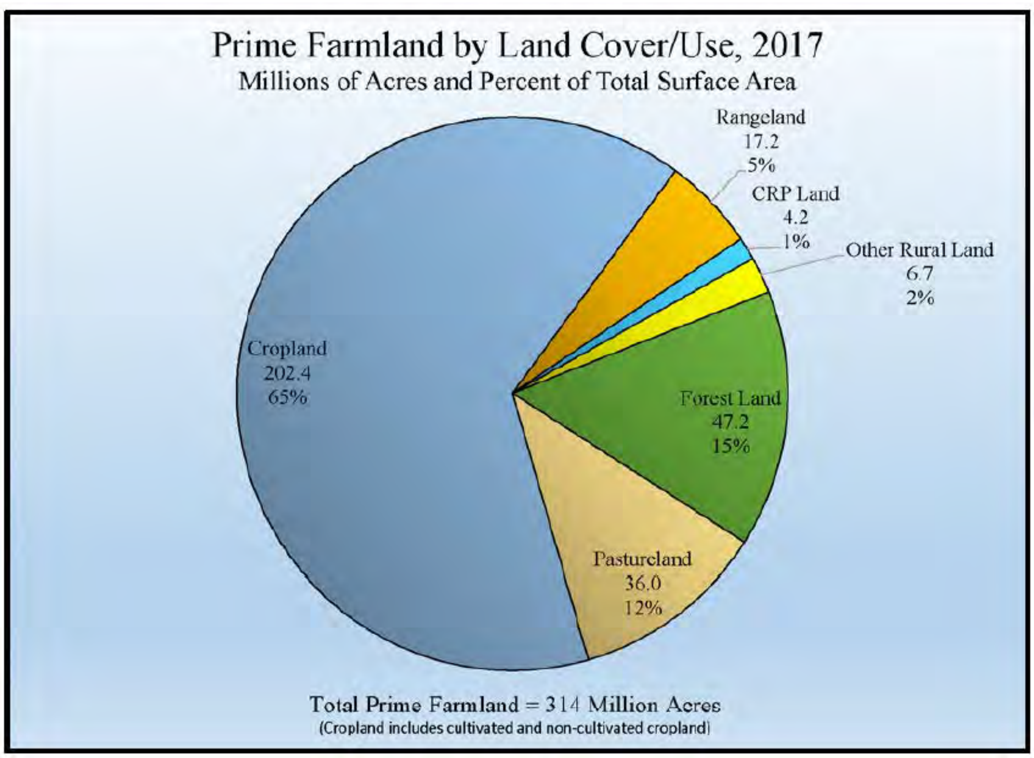

Figure 35. Prime Farmland by Type in 2017

Source: NRCS, 2020. *Summary Report: 2017National Resources Inventory*. *P. 5-2*

Nevertheless, given the projected decline in cropland per capita, that is, the acreage of land on which to cultivate grains and other crops for each resident, biotechnology would have to work miracles in constantly raising yields per acre in order to maintain the diverse, meat-and-dairy-rich diet Americans came to expect in the late 20th and early 21st centuries.

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 fuel supplies – have led some scientists to conclude that someday within this century the United States may cease to be a net food exporter.[31] 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."[32] While this may in fact constitute a healthier diet, it would also represent a significant loss of choice for a country that has always prided itself on its abundant agriculture, plentiful consumer options, and comparative freedom from want.

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.[33] 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.[34] As the late Oxford ecology professor Norman Meyers noted in a now-classic 1986 article:

[31] 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.

[32] Ibid.

[33] 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.

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

> "…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…"[35]

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

> "Increased pressures on natural resources, water scarcity, export restrictions imposed by major producers when food prices were high, and growing distrust in the functioning of regional and global markets have pushed countries short in land and water to find alternative means of producing food."[36]

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.[37] Between 2000 and 2013, more than 1,200 deals had taken place, selling more than 205 million acres (320,313 square miles) of land to foreign investors; 62 percent of these deals took place in hungry Africa, encompassing 138 million acres (215,625 square miles), an area almost twice the size of Nevada, the 7th largest U.S. state.[38] And it isn't just Third World farmland that is being bought by well-heeled foreigners. "'American Soil' Is Increasingly Foreign Owned was the headline on a 2019 story on NPR's *All Things Considered*.[39] As of 2019, almost 30 million acres of American farmland was owned by foreign investors, a figure which had doubled in the last two decades.

Finally, U.S. agriculture and related food industries contribute nearly $1 trillion to our national economy annually. They comprise more than 13 percent of the GDP and employ 17 percent of the labor force. World demand for U.S. agricultural exports is only expected to increase

[35] 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.

[36] 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.

[37] 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/.

[38] Brian Bienkowski. 2013. Corporations Grabbing Land and Water Overseas. *Scientific American*. Available online at: https://www.scientificamerican.com/article/corporations-grabbing-land-and-water-overseas/.

[39] National Public Radio. 2019. 'American Soil' Is Increasingly Foreign Owned. Accessed online on 6-30-21 at: https://www.npr.org/2019/05/27/723501793/american-soil-is-increasingly-foreign-owned.

over the foreseeable future due to a rapidly growing world population, increasing demand for meat and dairy products, and expanding global markets.[40]

Americans are well aware of these food security implications, according to a national poll[41] of 1,500 likely voters in 2020 conducted for another recent NUSA sprawl study. The very first question showed that 79 percent overall believed that the destruction of farmland and natural habitat because of urban sprawl in the United States was a "major problem" (44%) or "somewhat of a problem" (35%). In that fourth question of that same poll, when asked if it "is unethical to pave over and build on good cropland," or if "the need to for more housing is a legitimate reason to eliminate cropland," 62% responded that it is unethical to do so, more than three times the percentage (18%) who thought that the need for more housing is a legitimate reason.[42]

Questions two and three from the 2020 survey are reproduced here:

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?

62% Very important
27% Somewhat important
6% Not very important
1% Not important at all
3% Not sure

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?

32% Very important
45% Somewhat important
16% Not very important
4% Not important at all
3% Not sure

[40] American Farmland Trust. 2013. Farmland Protection. Available on the World Wide Web at: http://www.farmland.org/programs/protection/.
[41] Op. cit. Footnote #3, Pulse Opinion Research.
[42] Op. cit. Footnote #3.

1.6. 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 36**) – and the assurance that this open space will outlast us – serves to counter-balance the stress and strain of modern life.

Figure 36. Wildlife and humans enjoying park in Austin, Texas

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.[43] 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.[44] In studies of hospital patients, recovery was faster, there were fewer negative evaluations in patient reports, and there was less use of analgesic drugs among post-surgery patients with views of exterior greenery than among control group patients with views of buildings.[45]

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.[46] At the end of three months, the experimental group showed significant improvements in attention and self-reported quality of life measures; they had begun a variety of new projects. Control group members, meanwhile, who had been given no advice regarding nature exposure activities, continued with deficits in measures of attention, had started no new projects, and had lower scores on quality of life measures. This research underscored that difference between nature as an amenity and as a human need. As one reviewer of the study observed:

> "People often say that they like nature; yet they often fail to recognize that they need it...Nature is not merely 'nice.' It is not just a matter of improving one's mood, rather it is a vital ingredient in healthy human functioning."[47]

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

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[43] 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.

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

[45] 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.

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

[47] Kaplan, S. (1992). The Restorative Environment: Nature and human experience. In D. Relf (ed.), *The Role of horticulture in human well-being and social development: A National Symposium* [Proceedings of Conference Held 19-21 April 1990, Arlington, VA] (pp. 134-142). Portland, OR: Timber Press.

> "Viewed as an amenity, nature may be readily replaced by some greater technological achievement. Viewed as an essential bond between human and other living things, the natural environment has no substitutes."[48]

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.[49] 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."[50]

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 2020 national survey[51] 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, wetlands, and grasslands?

73% - Yes
16% - No
11% - 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?

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[48] Kaplan, R., & Kaplan, S. (1989). *The Experience of nature: A Psychological perspective*. New York: Cambridge University Press.
[49] Op. cit. Footnote #43, Rubenstein.
[50] John Muir. *The Mountains of California*. First published in 1894.
[51] Op. cit. Footnote #3. Pulse Opinion Research, 2020.

45% - Very important
40% - Somewhat important
10% - Not very important
2% - Not important at all
3% - Not sure

GROUPINGS: 85% - Very or somewhat important
12% - Not very or at all important

Texans are avid outdoorsmen and women (**Figure 37**). 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) (**Figure 38**) 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 limited space and resources will increase.

Figure 37. Texans are avid users of the Great Outdoors and their State Parks

Figure 38. Male White-tailed deer (buck) with antlers, popular with hunters and wildlife enthusiasts alike

1.7 Americans (and Texans) Love Their Open Space

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.[52] 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.[53]

In 2018, the Trust for Public Land helped communities draft and campaign for 18 ballot measures on Election Day 2018. Voters approved all but one of the 18. In total, of some 61

[52] 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.

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

ballot measures vote on nationwide in 2018, 52 passed. Nationwide, on Election Day in 2019, voters approved 33 of 41 ballot measures, raising over $900 million in funding for conservation. Overall, between 1988 and 2019, American voters passed 2,096 of the 2,758 open space ballot measures (76 percent) they voted on.[54]

While these were not anti-sprawl measures per se, they do indicate that the American public cares deeply about preserving open space, wildlands, and wildlife, and is willing to "put its money where its mouth is."

Urban sprawl also imposes significant economic and financial costs on the public. These costs are often hidden in the form of taxpayer subsidies to build new roads, water supply systems, sewage collection and treatment systems, and schools to accommodate runaway growth.[55]

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 2020 polling[56] 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.

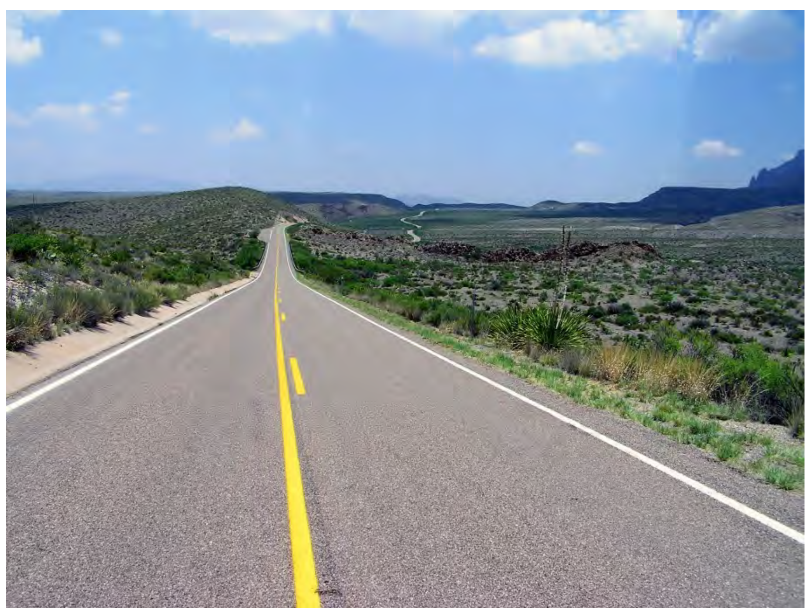


Figure 39. Open roads and open space still beckon in rural Texas (Big Bend region)

Credit: David Mark on Pixabay

[54] Ibid.
[55] 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.
[56] Op. cit. Footnote #3, Pulse Opinion Research.

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, we can measure or quantify 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 (or UAs, now Urban Areas) every 10 years for more than a half a century (since 1950), while the NRCS has estimated county-level changes in the amount of America’s Developed Lands in inventories conducted every five years since 1982. These National Resources Inventories or NRIs now run for 35 years, from 1982 to 2017).

The Census Bureau uses a rather complicated set of conditions and thresholds to measure the spread of cities into surrounding rural land. The Bureau defines the contiguous developed land of a central city and its suburbs as an “Urban Area”, formerly called Urbanized Areas (for the larger areas) and Urban Clusters (for the smaller ones). Previously, it was possible to measure sprawl from decade to decade by calculating the change in overall acreage of a specific UA. Unfortunately, methodological changes in the Bureau’s most recent urban-rural delineations based on the 2020 Census preclude our using these most recent data because they do no longer permit an “apples versus apples” comparison with 2010 and earlier urban-rural delineations. Therefore, the 2023 study on sprawl in Texas cannot avail itself of these newest data, and refer only in passing to previous UA delineations, namely those of 2000 and 2010, which are now becoming dated.

The NRCS uses remote sensing, survey, and statistical techniques to derive estimates of changes in land use on the nation’s non-federal (private and state-owned) lands. Built-up or developed lands are one of the categories of land use NRCS delineates. The NRI allows for consistent, quantitative, longitudinal (through time) measures of expanding development – converting rural lands to urban or developed lands – by cities and towns in all regions of the country.

2.2 Our Data Sources

Available NRI Developed Land estimates span an uninterrupted 35-year period from 1982-2017 in seven 5-year intervals (1982-1987, 1987-1992, 1992-1997, 1997-2002, 2002-2007, 2007-2012, 2012-2017). These estimates quantify how much rural land was converted into developed or built-up land over these discrete, sequential time intervals, as well as over the 35-year time period in its entirety. Census Bureau Urbanized Area delineations are available for 2000 to 2010, so we can see how much the nation's UA's grew or changed during that decade, but not in the 2010-2020 decade, as a result of methodological changes in the 2020 delineation procedures that prevent an accurate, direct comparison between the physical size of Urban Areas in 2020 with UA's in 2010 or 2000.

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

The NRI is based on rigorous scientific and survey protocols. The U.S. Department of Agriculture's NRCS began developing the NRI in 1977 in response to several Congressional mandates. The first NRI published in 1982 used most of the survey methodology and protocols utilized by earlier inventories. However, the scope and sample size of the 1982 NRI were expanded to meet the demands of the Soil and Water Resources Conservation Act (RCA) of 1977, as well as to better address emerging issues like the permanent loss of agricultural lands to nonagricultural uses, such as transportation, industry, commercial and residential land uses.[57]

The NRI covers the entire surface area (both land and water) of the United States, except Alaska, including 49 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, Department of Defense 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)

[57] 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.

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.[58]

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.[59]

Data for the initial 1982 NRI were collected by thousands of field staff of the Soil Conservation Service (SCS – predecessor agency to NRCS), whose efforts were supplemented by contractors and employees of other agencies working under SCS supervision. Data collection began in the spring of 1980 and ran for more than two years, finishing in the autumn of 1982. For the 1987 NRI, data were also collected by teams of trained personnel. Remote sensing techniques (via aircraft or satellite) were used to update 1982 conditions for about 30 percent of the sample sites. Reliance upon remote sensing increased during the 1990s. Beginning in 2000, special high-resolution imagery was obtained for each NRI sample site.[60]

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.[61]

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

[58] Ibid.
[59] Ibid.
[60] Ibid.
[61] Ibid.

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 2017, 1997, and 1982 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.[62]

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

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

Since 1982, the NRI has inventoried land use in all 3,000+ counties in the contiguous 48 states plus Hawaii. It does not, however, count population, and for that our study relies on U.S. Census Bureau population estimates by county. Thus, we can observe how the area of developed land and population size have changed over time, county by county, and how these two fundamental variables are correlated…or not.

2.2.2 Census Bureau's Urbanized Areas

Our previous (2017) sprawl study for Texas, as well as our many studies conducted since 2000 for other states, regions, and the nation as a whole relied heavily on the U.S. Census Bureau's delineations of urbanized areas and changes in their respective populations over time, as well as the NRCS's NRI discussed just above. However, and unfortunately, in the current study for Texas, we are unable to use the Bureau's recent (December 2022) urban / rural delineations

[62] Ibid.

based on the 2020 Census. This is because changes in criteria and definitions between 2020 and 2010 prevent the comparison of the geographic sizes and population sizes of 2020's urban areas with those delineated in the earlier 2010 and 2000 Censuses.

Figure 40. El Paso, Texas
Credit: David Mark on Pixabay

First, a little background is in order. The 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. 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.

The Bureau adopted the 2010 minimum population threshold for urban areas of 2,500 a century earlier 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.

The Bureau started designating and delineating densely populated Urbanized Areas (UAs) of 50,000 or more residents beginning with the 1950 Census, accounting for the increased presence of densely inhabited suburban development on the expanding 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.

In both the 2000 and 2010 Census urban versus rural delineations, the Bureau introduced the concept of "urban clusters" (UCs), representing smaller urban places located outside of UAs. These were defined based on the same criteria as UAs, but represented built-up areas containing at least 2,500 and less than 50,000 people. "Rural" areas continued 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 consisted 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." In essence, these represented America's "urban footprint."

For the 2020 Census, the Bureau's urban / rural classification delineates all geographic areas, identifying both individual urban areas and the nation's rural area outside of those urban areas. As the Bureau states: "…urban areas represent densely developed territory, and encompass residential, commercial, and other non-residential urban land uses. 'Rural' encompasses all population, housing, and territory not included within an urban area."[63]

In the 2020 Census, areas classified as "urban" comprise a densely-settled core of census blocks that meet minimum housing unit density and/or population density requirements. Adjacent territories containing non-residential urban land uses are included. To qualify as an urban area, the territory identified according to criteria must include at least 2,000 housing units or a population of at least 5,000.[64]

Tables 8, 9, and 10 display some basic facts on Census-delineated Urban Areas from the 2020 Census. The first row of Table 9 shows that the total geographic size (land area) of all Urban Areas in the U.S. actually declined by 2.4% between 2010 and 2020, even though the population of those same UA's grew by almost 16 million. It is highly unlikely that these areas actually shrank in reality, "on the ground," and much more likely that recent changes in the Bureau's criteria for what qualifies as "urban" account for this apparent change.

Table 8. 2020 Census Urban Areas in U.S. by the Numbers

[63] U.S. Census Bureau. 2023. Urban And Rural. Accessed online 2-17-23 at: https://www.census.gov/programs-surveys/geography/guidance/geo-areas/urban-rural.html.
[64] Ibid.

Total number of 2020 Census Urban Areas	2,612
Total urban population	265,149,027
Percent population living within urban areas	80.0%
Total rural population	66,300,254
Percent population living within rural areas	20.0%

Source: https://www.census.gov/programs-surveys/geography/guidance/geo-areas/urban-rural/2020-ua-facts.html

Table 9. Urban Area / Population Change in U.S. Over Time	
Land area change for urban areas between 2010 and 2020	-2.4%
Population density change for urban areas between 2010 and 2020	9.0%
Total urban population change between 2010 and 2020	6.4%
Total population change between 2010 and 2020	7.4%
Total 2020 urban population	265,149,027
Total 2010 urban population	249,253,271
Total population - 2020	331,449,281
Total population - 2010	308,754,538

Source: Same as for Table 8.

Table 10. Ten Most Populous 2020 Urban Areas in the United States

Urban Area	Population	Land Area (square miles)	Population Density
New York--Jersey City--Newark, NY--NJ	19,426,449	3,248.12	5,981
Los Angeles--Long Beach--Anaheim, CA	12,237,376	1,636.83	7,476
Chicago, IL--IN	8,671,746	2,337.89	3,709
Miami--Fort Lauderdale, FL	6,077,522	1,244.18	4,885
Houston, TX	**5,853,575**	**1,752.69**	**3,340**
Dallas--Fort Worth--Arlington, TX	**5,732,354**	**1,746.90**	**3,281**
Philadelphia, PA--NJ--DE--MD	5,696,125	1,898.19	3,001
Washington--Arlington, DC--VA--MD	5,174,759	1,294.51	3,997
Atlanta, GA	4,999,259	2,450.52	2,040
Boston, MA--NH	4,382,009	1,655.89	2,646

Source: Same as for Table 8.

As shown in **Table 10**, Texas has two of the top 10 most populous Urban Areas in the country: Houston and Dallas--Fort Worth--Arlington, in fifth and sixth place, respectively. No other state, not even the nation's most populous state – California – has more than one in the top ten.

Table 11 from the Census Bureau illustrates the differences in the criteria used for the 2010 and 2020 Urban Area delineations.[65] It is these differences, or some of them, that account for why the geographic size of ostensibly decreased between 2010 and 2020, when in actuality, the opposite occurred on the ground, as shown by the NRI's county-level estimates, which are based on consistent survey methods.

Table 11. Differences between the 2010 and 2020 Census Urban Area Criteria

Criteria	2010 Census Criteria	2020 Census Criteria
Identification of Initial Urban Area Cores	Census tracts and blocks meeting population density, count, and size thresholds. Use of land cover data to identify territory with a high degree of impervious land cover.	Census block or aggregation of census blocks with a housing unit density of 425. Use of land cover data to identify territory with a high degree of impervious land cover.
Qualifying Urban Areas	Based on a minimum threshold of 2,500 people.	Based on a minimum threshold of 2,000 housing units or 5,000 people.
Urban Area Type	Urbanized areas and urban clusters identified using a 50,000-population threshold.	Urban areas are no longer distinguished as either an "urbanized area" or an "urban cluster." All qualifying areas are designated as an "urban area."
Group Quarters Blocks	No additional criteria to specifically account for group quarters qualifying as urban.	Census blocks that do not meet the minimum housing unit density threshold but contain group quarters and a population density of at least 500 population per square mile adjacent to already qualified urban

[65] U.S. Census Bureau. 2022. This table summarizes the key differences between the final 2020 Census Urban Area criteria described in the March 24, 2022, *Federal Register* (87 FR 16706) and the *Federal Register* Notice Clarification (scheduled publication December 29, 2022), and the 2010 Census Urban Area criteria. Available online at: https://www2.census.gov/geo/pdfs/reference/ua/Census_UA_CritDiff_2010_2020.pdf.

Criteria	2010 Census Criteria	2020 Census Criteria
		blocks will be included in an urban area.
Inclusion of Noncontiguous Territory via Hops and Jumps	Maximum hop distance 0.5 miles, maximum jump distance 2.5 miles. Intervening low-density jump corridor blocks included in urban area.	Maximum hop distance 0.5 miles, maximum jump distance 1.5 miles. Intervening low-density jump corridor blocks not included in urban area.
Inclusion of Noncontiguous Territory Separated by Exempted Territory	Bodies of water.	Bodies of water and wetlands as identified in land cover data. The intervening, low-density blocks of water and/or wetlands are not included in the urban area.
Additional Nonresidential Urban Territory	Inclusion of groups of census blocks with a high degree of impervious land cover and are within 0.25 miles of an urban area and have a total area of at least 0.15 square miles.	Inclusion of groups of census blocks with a high degree of impervious land cover or contain a three-year average of at least 1,000 commuter destinations that are within 0.5 miles of an urban area and have a total area of at least 0.15 square miles.
Inclusion of Airports	Currently functioning airport with an annual enplanement of at least 2,500 passengers and is within 0.5 miles of an urban area.	Currently functioning airport with an annual enplanement of at least 2,500 passengers and is within 0.5 miles of an urban area or is a qualified cargo airport within 0.5 miles of an urban area. Additional census blocks adjacent to an urban area not initially identified by automated delineation that have a high association with airports.
Merging Individual Urban Areas	Merge qualifying territory from separately defined 2010 Census urban cores that share territory contained within the boundaries of the same Census 2000 urban area. Merge only occurs if an area is at risk of losing urbanized	Merge qualifying territory from separately defined 2020 Census Urban Areas in cases where the combined territory contains at least one area with a high-density nucleus and one without, the component areas are within 0.25 miles,

Criteria	2010 Census Criteria	2020 Census Criteria
	area or urban status and is preventable by the merge.	both have at least 1,000 housing units or 2,500 population, and there is a 3-year mean worker-flow of at least 50 percent between candidate urban area pairs.
Splitting Large Urban Agglomerations	Split location is guided by location of Census 2000 urbanized area boundaries. Potential split locations also consider metropolitan statistical area, county, incorporated place, census designated place, and/or minor civil division boundaries as well as distance from each component urbanized area.	2010 Census Urban Areas and areas connected via low density fill during the 2020 Census Urban Area delineation are used to identify split candidates. The location of the split boundary is identified using worker flow data between candidate urban area pairs. If necessary, split location is further guided by other commuter-based communities and secondarily by other geographic area boundaries and/or physical features.
Assigning Urban Area Titles (Names)	Clear, unambiguous name based on commonly recognized place names derived from incorporated places, census designated places, minor civil divisions, and the Geographic Names Information System.	Clear, unambiguous name primarily based on commonly recognized names of places within a high- density nucleus, derived from incorporated places, census designated places, governmental minor civil divisions, and the Geographic Names Information System.

Source:
https://www2.census.gov/geo/pdfs/reference/ua/Census_UA_CritDiff_2010_2020.pdf

As noted above, one or more of the changes in the criteria listed and described in Table 11 are responsible for the total or aggregate geographic area in the United States classified as Urban *decreasing* by 2.4% from 2010 to 2020, even as the number of residents living in these designated Urban Areas *increased* by 15,895,756 or 6.4%. We are uncertain as to precisely which of the modified criteria account for this counterintuitive outcome, and thus preclude us from being able to compare on an even footing the land areas and populations of 2020 Urban

Areas with those of 2010 (and earlier) Urbanized Areas, but one of the likely suspects is the criterion labeled "Inclusion of Noncontiguous Territory via Hops and Jumps." The Census Bureau describes this modified criterion in the following manner:

> The Census Bureau reduces the maximum jump distance from 2.5 miles in 2010 to 1.5 miles in 2020. Data users, analysts, and some urban geographers expressed concern that the 2.5-mile maximum jump distance adopted for the 2000 Census was too generous and resulted in overextension of urban areas. The Census Bureau proposed reverting to 1.5 miles in the proposed criteria for the 2010 Census, but responses from commenters were inconclusive and, as a result, no change was made. The impervious surface criteria adopted in 2010 better accounted for non-residential urban land uses, many of which also were in mind when extending the jump distance to 2.5 miles for the 2000 Census. Thus, the two criteria serve largely the same purpose, but are applied separately, and when taken together, they can **result in overextension of urban territory** [emphasis added].
>
> The Census Bureau also no longer includes within an urban area the low-density territory intervening between the main body of the urban area and the outlying qualifying urban territory that is the destination of a hop or a jump. Review of 2010 Census Urban Areas indicates that, due to their often irregular and relatively large geographic extent, **including the corridor blocks resulted in the inclusion of population, housing, and territory that is otherwise of a rural nature and contains land uses that are not consistent with those found in the densely developed urban blocks on either end of the hop or jump corridor** [emphasis added]. A primary reason in the past for including the corridor blocks was to create contiguous geographic areas that were easier for cartographers to map rather than for any reason to improve the urban-rural classification and its resulting data. Geospatial cartographic tools and technology have progressed and some degree of noncontiguity is no longer as significant of an issue.

In essence, the Bureau decided that its earlier 2010 criterion with regard to "jumps" and "hops" resulted in an "overextension of urban territory," in other words, it exaggerated the actual size of Urban Areas; delineated Urbanized Areas were being made artificially larger on their ragged peripheries than they actually are on the ground, in reality. Thus, the net effect of the change in the 2020 delineation / classification criteria is to reduce the delineated extent of certain Urban Areas in a manner that the Bureau believes is more faithful to the concept and character of what an urban area actually is. That is all well and good, but it means that the both the geographic sizes (land areas) and population sizes of the 2020 Census' Urban Areas cannot be compared and contrasted with 2010 or 2000 Urbanized Areas, because they are not being measured consistently.

As shown in Table 9, on average, the population density of all Urban Areas in the country increased by nine percent between 2010 and 2020. This is consistent with an aggregate Urban-classified land area that shrunk by 2.4% at the same time that the aggregate Urban population grew by 6.4%. Applying our methodology for attributing shares of sprawl to the population growth factor and the growth in per capita land consumption factor (explained later), the mere fact that the total area of land in the U.S. occupied by urban land cover decreased by 2.4% on an aggregate national scale, would mean that no sprawl had occurred at all between 2010 and 2020. Anyone who has lived in America since 2010 knows that this is patently false. Enormous expanses of open space and countryside have been converted to concrete, asphalt, subdivisions, and strip malls since 2010.

The upshot of the foregoing discussion is that in this 2023 Texas sprawl study, we are unable to use the Urban Area data from the 2020 Census to examine how much those areas have sprawled and their populations have grown and changed since 2010 or 2000. We will still refer to the sprawl that occurred in Texas Urbanized Areas from 2000 to 2010, but as that decade recedes further into the past, its findings become ever more dated and ever less relevant.

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 Counties

Table 12 shows population growth in all Texas counties from 1982 to 2017. On average, these 254 counties grew by 85 percent in these 35 years, at an annual compound (exponential) rate of 1.77%. Yet during these three and a half 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 even as the state as a whole grew rapidly.

Indeed, 90 (35 percent or about one-third) of the 254 counties in Texas actually lost population between 1982 and 2017. These population declines did not happen as a result of the death rate exceeding the birth rate, but as a result of out-migration from rural areas toward jobs and greater economic, social, and cultural opportunities elsewhere, typically the state's growing urban areas. Out-migration from these rural counties tended to be towards larger towns and cities, rather than out of the state altogether; they represent 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.[66]

Table 12. Population Growth in Texas Counties – 1982 to 2002 and 2017

County	Population in 1982	Population in 2002	Population in 2017	% growth 1982-2017
Anderson	41,873	54,740	58,175	39%
Andrews	15,142	13,022	17,603	16%
Angelina	67,879	80,803	87,572	29%
Aransas	16,105	22,616	25,392	58%
Archer	7,651	8,942	8,783	15%
Armstrong	1,967	2,036	1,867	-5%
Atascosa	26,475	40,767	49,083	85%
Austin	19,408	24,818	29,722	53%
Bailey	8,138	6,637	7,066	-13%
Bandera	7,559	18,652	22,327	195%
Bastrop	28,439	63,508	84,585	197%
Baylor	5,229	3,897	3,555	-32%
Bee	27,262	31,804	32,592	20%
Bell	167,053	249,671	347,377	108%
Bexar	1,046,457	1,446,755	1,956,988	87%
Blanco	4,791	8,950	11,481	140%

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

County	Population in 1982	Population in 2002	Population in 2017	% growth 1982-2017
Borden	975	685	670	-31%
Bosque	13,779	17,474	18,295	33%
Bowie	76,898	88,813	93,458	22%
Brazoria	179,584	255,246	361,853	101%
Brazos	112,349	159,297	223,917	99%
Brewster	7,878	8,945	9,325	18%
Briscoe	2,471	1,746	1,514	-39%
Brooks	8,630	7,668	7,132	-17%
Brown	34,849	37,766	37,815	9%
Burleson	14,670	16,666	18,053	23%
Burnet	19,116	36,850	46,600	144%
Caldwell	24,538	34,715	42,328	72%
Calhoun	21,181	20,550	21,712	3%
Callahan	11,796	12,799	13,968	18%
Cameron	230,718	350,194	422,227	83%
Camp	9,797	11,549	12,845	31%
Carson	7,325	6,508	6,005	-18%
Cass	30,710	30,120	29,966	-2%
Castro	10,474	8,083	7,696	-27%
Chambers	19,676	27,490	41,269	110%
Cherokee	38,856	47,136	52,116	34%
Childress	6,937	7,428	7,269	5%
Clay	10,016	11,292	10,484	5%
Cochran	4,890	3,521	2,853	-42%
Coke	3,546	3,732	3,285	-7%
Coleman	10,578	8,937	8,399	-21%

County	Population in 1982	Population in 2002	Population in 2017	% growth 1982-2017
Collin	164,703	563,565	971,864	490%
Collingsworth	4,596	3,093	2,964	-36%
Colorado	19,884	20,328	21,291	7%
Comal	39,057	82,797	140,721	260%
Comanche	13,119	13,582	13,533	3%
Concho	3,096	3,959	2,707	-13%
Cooke	28,894	37,390	39,932	38%
Coryell	59,496	73,135	74,760	26%
Cottle	2,845	1,726	1,375	-52%
Crane	5,115	3,891	4,685	-8%
Crockett	5,155	3,841	3,535	-31%
Crosby	8,560	6,852	5,849	-32%
Culberson	3,574	2,829	2,230	-38%
Dallam	6,587	6,159	7,272	10%
Dallas	1,637,637	2,250,326	2,620,154	60%
Dawson	16,645	14,429	12,744	-23%
Deaf Smith	20,566	18,439	18,753	-9%
Delta	4,855	5,366	5,276	9%
Denton	166,463	487,617	835,364	402%
DeWitt	19,670	20,015	20,180	3%
Dickens	3,317	2,679	2,190	-34%
Dimmit	11,948	10,042	10,282	-14%
Donley	4,169	3,825	3,340	-20%
Duval	13,083	12,707	11,270	-14%
Eastland	20,841	18,252	18,294	-12%
Ector	135,501	122,199	156,951	16%

County	Population in 1982	Population in 2002	Population in 2017	% growth 1982-2017
Edwards	2,218	2,056	1,929	-13%
Ellis	62,621	118,737	173,405	177%
El Paso	511,892	696,446	837,401	64%
Erath	23,921	33,619	41,723	74%
Falls	18,321	18,090	17,340	-5%
Fannin	24,324	31,808	34,550	42%
Fayette	20,962	22,668	25,119	20%
Fisher	5,833	4,242	3,874	-34%
Floyd	9,526	7,289	5,830	-39%
Foard	2,125	1,536	1,202	-43%
Fort Bend	157,335	397,943	767,712	388%
Franklin	7,259	9,536	10,798	49%
Freestone	15,825	18,395	19,649	24%
Frio	14,155	16,467	19,895	41%
Gaines	14,011	14,453	20,553	47%
Galveston	208,781	260,096	334,633	60%
Garza	5,802	5,385	6,490	12%
Gillespie	14,409	21,585	26,483	84%
Glasscock	1,298	1,339	1,363	5%
Goliad	5,541	7,051	7,552	36%
Gonzales	18,569	18,882	20,742	12%
Gray	28,243	21,940	22,106	-22%
Grayson	91,857	113,239	131,152	43%
Gregg	109,624	112,767	122,852	12%
Grimes	15,659	24,736	27,955	79%
Guadalupe	50,038	95,246	159,639	219%

County	Population in 1982	Population in 2002	Population in 2017	% growth 1982-2017
Hale	38,023	35,598	33,954	-11%
Hall	5,226	3,709	3,042	-42%
Hamilton	8,239	8,069	8,407	2%
Hansford	6,389	5,242	5,485	-14%
Hardeman	6,472	4,547	3,959	-39%
Hardin	42,235	49,045	57,117	35%
Harris	2,696,632	3,536,682	4,657,972	73%
Harrison	55,528	62,062	66,468	20%
Hartley	3,992	5,364	5,716	43%
Haskell	7,657	5,915	5,699	-26%
Hays	43,502	111,397	214,726	394%
Hemphill	6,427	3,357	3,929	-39%
Henderson	46,057	74,712	80,954	76%
Hidalgo	313,256	610,520	856,249	173%
Hill	25,748	33,120	35,703	39%
Hockley	24,679	22,745	22,977	-7%
Hood	19,418	43,344	57,973	199%
Hopkins	26,366	32,335	36,451	38%
Houston	22,509	23,257	23,089	3%
Howard	36,541	33,479	35,817	-2%
Hudspeth	3,057	3,398	4,604	51%
Hunt	58,758	80,234	94,046	60%
Hutchinson	29,899	23,116	21,343	-29%
Irion	1,549	1,697	1,512	-2%
Jack	7,953	8,916	8,828	11%
Jackson	13,905	14,172	14,806	6%

County	Population in 1982	Population in 2002	Population in 2017	% growth 1982-2017
Jasper	31,449	35,692	35,549	13%
Jeff Davis	1,650	2,201	2,260	37%
Jefferson	256,258	250,146	256,041	0%
Jim Hogg	5,467	5,220	5,212	-5%
Jim Wells	38,677	39,821	40,920	6%
Johnson	73,412	133,399	167,012	127%
Jones	17,693	20,293	19,827	12%
Karnes	13,777	15,178	15,556	13%
Kaufman	41,570	77,693	122,628	195%
Kendall	11,390	24,975	43,969	286%
Kenedy	514	429	427	-17%
Kent	1,177	815	759	-36%
Kerr	30,292	44,894	51,892	71%
Kimble	4,171	4,521	4,385	5%
King	420	308	289	-31%
Kinney	2,408	3,463	3,711	54%
Kleberg	34,743	31,413	30,752	-11%
Knox	5,617	4,044	3,674	-35%
Lamar	42,676	48,826	49,568	16%
Lamb	18,661	14,658	13,165	-29%
Lampasas	12,499	18,425	20,861	67%
La Salle	5,926	6,098	7,530	27%
Lavaca	19,578	19,101	20,028	2%
Lee	14,048	16,131	17,109	22%
Leon	10,719	15,718	17,235	61%
Liberty	51,576	73,280	83,597	62%

County	Population in 1982	Population in 2002	Population in 2017	% growth 1982-2017
Limestone	20,688	22,486	23,391	13%
Lipscomb	4,465	3,033	3,364	-25%
Live Oak	9,932	11,955	12,146	22%
Llano	10,567	17,872	21,167	100%
Loving	84	75	133	58%
Lubbock	215,688	249,407	305,413	42%
Lynn	8,245	6,421	5,832	-29%
McCulloch	8,890	7,927	7,941	-11%
McLennan	175,640	216,571	251,631	43%
McMullen	828	795	765	-8%
Madison	11,547	12,797	14,251	23%
Marion	10,825	11,032	10,057	-7%
Martin	5,306	4,654	5,531	4%
Mason	3,657	3,725	4,179	14%
Matagorda	37,325	37,662	36,805	-1%
Maverick	34,029	48,408	58,111	71%
Medina	23,569	40,707	50,183	113%
Menard	2,313	2,340	2,110	-9%
Midland	98,653	117,717	165,318	68%
Milam	23,255	24,981	24,939	7%
Mills	4,554	4,973	4,917	8%
Mitchell	9,605	9,420	8,215	-14%
Montague	18,529	19,170	19,399	5%
Montgomery	150,025	326,466	571,615	281%
Moore	17,756	20,155	21,604	22%
Morris	15,464	13,170	12,375	-20%

County	Population in 1982	Population in 2002	Population in 2017	% growth 1982-2017
Motley	1,871	1,311	1,226	-34%
Nacogdoches	48,978	59,422	65,317	33%
Navarro	37,097	45,937	48,739	31%
Newton	13,405	14,945	13,908	4%
Nolan	18,163	15,194	14,854	-18%
Nueces	282,413	316,256	361,235	28%
Ochiltree	11,057	9,106	9,996	-10%
Oldham	2,350	2,069	2,104	-10%
Orange	87,402	83,813	84,971	-3%
Palo Pinto	25,605	27,144	28,544	11%
Panola	22,067	22,953	23,211	5%
Parker	47,243	94,092	133,501	183%
Parmer	10,943	10,032	9,710	-11%
Pecos	16,946	16,084	15,634	-8%
Polk	26,044	43,928	48,990	88%
Potter	102,612	115,427	120,340	17%
Presidio	5,475	7,534	7,100	30%
Rains	5,247	9,985	11,730	124%
Randall	78,305	106,286	134,015	71%
Reagan	4,899	3,189	3,712	-24%
Real	2,524	3,020	3,417	35%
Red River	15,803	13,914	12,164	-23%
Reeves	17,257	13,017	15,166	-12%
Refugio	9,379	7,665	7,180	-23%
Roberts	1,224	862	941	-23%
Robertson	15,452	16,053	17,153	11%

County	Population in 1982	Population in 2002	Population in 2017	% growth 1982-2017
Rockwall	16,644	50,078	96,824	482%
Runnels	12,206	11,002	10,282	-16%
Rusk	43,274	48,244	54,213	25%
Sabine	8,955	10,477	10,417	16%
San Augustine	8,929	8,985	8,302	-7%
San Jacinto	12,297	23,415	28,231	130%
San Patricio	61,470	66,820	67,210	9%
San Saba	5,847	6,042	5,996	3%
Schleicher	3,219	3,036	2,989	-7%
Scurry	20,018	15,982	17,003	-15%
Shackelford	4,235	3,388	3,289	-22%
Shelby	23,263	25,155	25,225	8%
Sherman	3,234	3,164	3,046	-6%
Smith	137,348	181,107	227,195	65%
Somervell	4,373	7,229	8,855	102%
Starr	30,442	55,412	64,130	111%
Stephens	10,895	9,374	9,287	-15%
Sterling	1,401	1,326	1,287	-8%
Stonewall	2,424	1,487	1,376	-43%
Sutton	5,878	4,072	3,792	-35%
Swisher	9,261	8,071	7,446	-20%
Tarrant	933,829	1,524,249	2,056,451	120%
Taylor	119,410	125,920	136,634	14%
Terrell	1,568	1,009	814	-48%
Terry	15,015	12,559	12,429	-17%
Throckmorton	2,250	1,739	1,510	-33%

County	Population in 1982	Population in 2002	Population in 2017	% growth 1982-2017
Titus	22,606	28,387	32,619	44%
Tom Green	90,883	104,035	117,566	29%
Travis	449,814	848,090	1,227,585	173%
Trinity	10,214	14,033	14,677	44%
Tyler	16,531	20,825	21,517	30%
Upshur	31,213	36,739	41,069	32%
Upton	5,387	3,273	3,658	-32%
Uvalde	23,096	26,309	27,043	17%
Val Verde	38,388	45,495	49,028	28%
Van Zandt	32,776	49,953	55,163	68%
Victoria	74,178	84,573	92,045	24%
Walker	46,011	62,216	72,816	58%
Waller	21,913	35,060	51,717	136%
Ward	16,211	10,337	11,383	-30%
Washington	24,240	30,741	34,861	44%
Webb	111,106	206,001	273,691	146%
Wharton	41,247	40,915	41,837	1%
Wheeler	7,999	5,094	5,300	-34%
Wichita	125,166	130,761	131,689	5%
Wilbarger	16,493	14,248	12,683	-23%
Willacy	18,146	20,198	21,508	19%
Williamson	87,159	290,112	546,251	527%
Wilson	17,591	34,254	49,211	180%
Winkler	11,654	6,960	7,605	-35%
Wise	28,373	52,381	65,848	132%
Wood	25,610	37,633	44,263	73%

County	Population in 1982	Population in 2002	Population in 2017	% growth 1982-2017
Yoakum	8,510	7,212	8,557	1%
Young	20,546	17,665	17,922	-13%
Zapata	7,690	12,514	14,254	85%
Zavala	12,197	11,616	11,957	-2%
All Texas Counties	**15,331,408**	**21,690,325**	**28,295,273**	**85%**

2.3.2 Population Growth in Texas Urbanized Areas

As discussed above, methodological inconsistencies (differing criteria) prevent us from comparing 2020 Census Urban Areas with 2010 and 2020 Urbanized Areas in Texas (and indeed the entire country), so the most recent consistent data available cover the now-receding 2000 to 2010 time period. On average, the 34 UAs in Texas grew by 28 percent in these ten years, from 14.8 million to 19 million, at an annual compound (exponential) rate of 2.5%.

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 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.[67]

2.4 Per Capita Developed Land Consumption

Per capita developed land consumption statistics are a useful way to understand the combined power of numerous land use, consumption, political, and policy choices that can lead to urban sprawl. See Table 13 for the per capita numbers for the Developed Land in Texas counties and Appendices B and C for how this statistic is calculated. When the NRI Developed Land estimate and Census Bureau population estimate for Anderson County in 2017 show, for example, that per capita land consumption there is 0.54 acre, it means that it takes approximately one-half of an acre to provide the average Anderson County resident with space for housing, work, retail, transportation, education, religious assembly, government, recreation, utilities, and all other urban needs.

Our per capita land consumption factor is somewhat complicated by two factors: 1) not all of the 58,175 residents that the Census Bureau estimated lived in Anderson County in 2017 actually lived on the county's NRI Developed Land category; an unknown but small fraction would have lived in a more dispersed fashion on rural land; and 2) not all of the Developed Land detected and documented by the NRI in Anderson County (or any one county) would be provide specifically for the urban needs of Anderson County residents alone; indeed, much of the infrastructure and facilities in any given county serve a wider regional, or even national population. This would include transportation facilities (roads, streets, interstates, parking lots, airports, railroad tracks), utilities (e.g., power plants and power lines, water and wastewater treatment) commercial, office, higher education, and industrial facilities, and so forth.

An extreme example or outlier of a rural county with a perhaps distorted per capita land consumption profile is Borden County in West Texas. According to the 2020 Census, Borden County had a population of just 631, down from a historic high of 1,505 in 1930, nearly a century earlier. As a hinterland county like this loses population due to long-term out-migration, legacy developed land areas would tend to remain behind (i.e., structures not demolished or torn down; asphalt not torn up and removed), which would have the net effect of increasing putative per capita developed land consumption (i.e., lowering population density). According to the NRI, the estimated area of developed land in Borden County increased slightly from approximately 3,900 acres in 1982 to 5,200 acres in 2017, both amounts below one percent of the total land area of the county (587,900 acres). At the same time, estimated population fell from 975 in 1982 to 670 in 2017. The net effect of these long-term

[67] 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/

changes on per capita developed land consumption was to nearly double it from 4.00 acres per capita in 1982 to 7.76 per capita in 2017. During the same time period, average per capita land consumption in Texas as a whole was both much smaller and almost unchanged: from 0.345 acre / person in 1982 to 0.337 / person in 2017.

Overall, as would be expected, the per capita land consumption data in Table 13 show that there is a higher population density (lower land consumption per capita) in more developed or urbanized Texas counties. This is consistent with a greater percentage of residents in larger towns and cities residing in apartments, condos, high-rises, townhouses, homes with small yards or no yards, and other high-density arrangements than in smaller towns and rural areas, where private family dwellings, larger yards, and lot sizes are more prevalent and affordable.

Table 13. Per Capita Developed Land Consumption in Texas Counties – 1982 and 2017

County	Per Capita Land Consumption – 1982 (acre)	Per Capita Land Consumption - 2017 (acre)	% Change in Per Capita Land Consumption, 1982-2017
Anderson	0.43	0.54	27%
Andrews	1.19	1.81	52%
Angelina	0.27	0.51	91%
Aransas	0.89	0.87	-2%
Archer	1.50	1.55	3%
Armstrong	2.08	2.30	10%
Atascosa	0.51	0.97	89%
Austin	0.75	0.70	-7%
Bailey	0.60	0.75	25%
Bandera	1.43	1.13	-21%
Bastrop	0.98	0.66	-33%
Baylor	1.70	2.78	64%
Bee	0.60	0.65	8%
Bell	0.32	0.35	11%
Bexar	0.16	0.16	0%
Blanco	1.04	0.72	-31%

County	Per Capita Land Consumption – 1982 (acre)	Per Capita Land Consumption - 2017 (acre)	% Change in Per Capita Land Consumption, 1982-2017
Borden	4.00	7.76	94%
Bosque	1.05	1.18	12%
Bowie	0.62	0.69	11%
Brazoria	0.48	0.45	-6%
Brazos	0.30	0.36	19%
Brewster	1.97	1.68	-14%
Briscoe	1.62	3.04	88%
Brooks	0.74	1.49	100%
Brown	0.51	0.57	11%
Burleson	0.93	1.15	24%
Burnet	0.84	0.69	-18%
Caldwell	0.53	0.56	7%
Calhoun	0.63	1.10	75%
Callahan	0.66	0.76	15%
Cameron	0.21	0.20	-2%
Camp	0.47	0.61	29%
Carson	1.76	2.66	51%
Cass	0.50	0.89	77%
Castro	0.87	1.39	60%
Chambers	1.24	0.97	-22%
Cherokee	0.35	0.60	71%
Childress	0.68	0.87	28%
Clay	1.54	1.77	15%
Cochran	1.19	2.14	80%

County	Per Capita Land Consumption – 1982 (acre)	Per Capita Land Consumption - 2017 (acre)	% Change in Per Capita Land Consumption, 1982-2017
Coke	2.37	3.17	34%
Coleman	1.45	2.14	48%
Collin	0.42	0.18	-57%
Collingsworth	1.13	1.82	61%
Colorado	0.94	1.14	21%
Comal	0.68	0.52	-24%
Comanche	1.01	1.11	10%
Concho	2.26	2.96	31%
Cooke	0.50	0.74	48%
Coryell	0.25	0.38	53%
Cottle	1.69	3.35	98%
Crane	1.00	1.52	52%
Crockett	4.69	8.23	75%
Crosby	0.76	1.38	82%
Culberson	1.65	2.69	63%
Dallam	0.47	0.48	2%
Dallas	0.16	0.14	-11%
Dawson	0.69	1.16	68%
Deaf Smith	0.53	0.74	39%
Delta	0.56	0.85	53%
Denton	0.27	0.18	-33%
DeWitt	0.33	0.61	87%
Dickens	0.81	1.32	63%
Dimmit	0.49	1.47	197%

County	Per Capita Land Consumption – 1982 (acre)	Per Capita Land Consumption - 2017 (acre)	% Change in Per Capita Land Consumption, 1982-2017
Donley	1.03	1.53	48%
Duval	1.20	2.06	72%
Eastland	0.84	1.14	35%
Ector	0.40	0.46	16%
Edwards	3.52	5.29	50%
Ellis	0.33	0.53	62%
El Paso	0.15	0.18	22%
Erath	0.84	0.76	-10%
Falls	0.73	1.16	60%
Fannin	0.51	0.49	-4%
Fayette	0.77	1.13	47%
Fisher	1.13	1.78	57%
Floyd	0.75	1.44	93%
Foard	2.07	3.33	61%
Fort Bend	0.39	0.20	-48%
Franklin	0.69	1.02	48%
Freestone	0.52	0.94	81%
Frio	0.76	0.87	15%
Gaines	1.16	1.22	6%
Galveston	0.35	0.33	-6%
Garza	0.62	0.54	-13%
Gillespie	1.19	1.25	4%
Glasscock	3.78	8.51	125%
Goliad	1.17	1.31	12%

County	Per Capita Land Consumption – 1982 (acre)	Per Capita Land Consumption - 2017 (acre)	% Change in Per Capita Land Consumption, 1982-2017
Gonzales	0.74	0.82	11%
Gray	0.59	0.87	47%
Grayson	0.37	0.55	48%
Gregg	0.29	0.48	66%
Grimes	0.40	0.72	83%
Guadalupe	0.43	0.29	-33%
Hale	0.34	0.58	68%
Hall	0.96	1.58	65%
Hamilton	0.96	1.18	23%
Hansford	0.70	0.66	-7%
Hardeman	1.58	2.78	76%
Hardin	0.96	0.95	-1%
Harris	0.15	0.15	-3%
Harrison	0.26	0.62	140%
Hartley	1.28	1.03	-19%
Haskell	1.49	2.33	57%
Hays	0.30	0.33	7%
Hemphill	0.53	2.72	415%
Henderson	0.85	0.86	2%
Hidalgo	0.20	0.17	-12%
Hill	0.63	0.98	54%
Hockley	0.34	0.65	92%
Hood	1.45	0.67	-54%
Hopkins	0.41	0.45	10%

County	Per Capita Land Consumption – 1982 (acre)	Per Capita Land Consumption - 2017 (acre)	% Change in Per Capita Land Consumption, 1982-2017
Houston	0.37	0.56	50%
Howard	0.34	0.77	126%
Hudspeth	3.96	2.72	-31%
Hunt	0.54	0.61	13%
Hutchinson	0.40	0.79	96%
Irion	3.81	5.95	56%
Jack	1.57	1.82	16%
Jackson	0.86	1.05	22%
Jasper	0.59	1.22	106%
Jeff Davis	2.36	3.36	42%
Jefferson	0.29	0.48	66%
Jim Hogg	1.74	0.98	-44%
Jim Wells	0.36	0.53	47%
Johnson	0.34	0.51	48%
Jones	0.69	1.04	51%
Karnes	0.70	1.28	84%
Kaufman	0.48	0.33	-30%
Kendall	2.21	0.84	-62%
Kenedy	9.73	16.39	69%
Kent	2.72	6.98	157%
Kerr	1.20	0.98	-18%
Kimble	1.03	1.30	26%
King	5.48	8.30	52%
Kinney	2.37	1.54	-35%

County	Per Capita Land Consumption – 1982 (acre)	Per Capita Land Consumption - 2017 (acre)	% Change in Per Capita Land Consumption, 1982-2017
Kleberg	0.34	0.69	103%
Knox	1.98	3.38	71%
Lamar	0.75	1.04	39%
Lamb	0.57	0.99	72%
Lampasas	1.31	1.03	-21%
La Salle	1.11	1.47	32%
Lavaca	0.92	1.13	23%
Lee	0.68	0.78	15%
Leon	1.20	1.36	13%
Liberty	0.62	0.83	34%
Limestone	0.64	0.91	43%
Lipscomb	1.66	3.92	137%
Live Oak	1.42	1.83	29%
Llano	1.21	1.14	-6%
Loving	33.33	49.62	49%
Lubbock	0.20	0.27	33%
Lynn	1.07	1.71	61%
McCulloch	1.26	2.18	73%
McLennan	0.27	0.26	-2%
McMullen	4.71	10.72	128%
Madison	0.61	0.83	35%
Marion	0.57	0.92	61%
Martin	1.53	4.56	198%
Mason	1.31	1.56	19%

County	Per Capita Land Consumption – 1982 (acre)	Per Capita Land Consumption - 2017 (acre)	% Change in Per Capita Land Consumption, 1982-2017
Matagorda	0.60	0.79	31%
Maverick	0.38	0.45	17%
Medina	1.01	0.66	-34%
Menard	0.82	1.04	27%
Midland	0.42	0.52	25%
Milam	0.65	0.95	45%
Mills	1.36	1.46	8%
Mitchell	0.71	1.12	58%
Montague	0.81	1.12	38%
Montgomery	0.60	0.40	-33%
Moore	0.65	0.85	30%
Morris	0.38	1.15	201%
Motley	1.12	1.79	60%
Nacogdoches	0.45	0.54	20%
Navarro	0.36	0.57	58%
Newton	0.34	0.74	116%
Nolan	0.61	1.06	74%
Nueces	0.18	0.25	38%
Ochiltree	0.73	1.06	45%
Oldham	2.21	2.90	31%
Orange	0.41	0.85	109%
Palo Pinto	1.02	1.24	21%
Panola	0.48	1.10	131%
Parker	0.81	0.57	-30%

County	Per Capita Land Consumption – 1982 (acre)	Per Capita Land Consumption - 2017 (acre)	% Change in Per Capita Land Consumption, 1982-2017
Parmer	0.91	1.14	25%
Pecos	2.75	8.03	192%
Polk	0.88	0.71	-19%
Potter	0.36	0.50	41%
Presidio	1.21	0.96	-21%
Rains	0.76	0.66	-14%
Randall	0.32	0.29	-9%
Reagan	1.59	3.04	91%
Real	2.10	2.22	6%
Red River	0.91	1.68	84%
Reeves	0.80	1.78	123%
Refugio	1.04	1.66	59%
Roberts	3.76	6.38	70%
Robertson	1.00	1.38	38%
Rockwall	0.40	0.30	-24%
Runnels	0.59	0.96	63%
Rusk	0.53	1.01	89%
Sabine	0.42	0.83	95%
San Augustine	0.53	2.16	310%
San Jacinto	1.17	1.01	-14%
San Patricio	0.51	0.79	55%
San Saba	1.16	1.25	8%
Schleicher	1.68	3.78	125%
Scurry	0.66	1.39	110%

County	Per Capita Land Consumption – 1982 (acre)	Per Capita Land Consumption - 2017 (acre)	% Change in Per Capita Land Consumption, 1982-2017
Shackelford	1.28	1.76	38%
Shelby	0.27	0.77	189%
Sherman	1.48	1.94	31%
Smith	0.29	0.45	54%
Somervell	1.14	0.98	-14%
Starr	0.62	0.53	-15%
Stephens	0.90	1.21	34%
Sterling	5.00	6.60	32%
Stonewall	1.77	3.49	97%
Sutton	2.25	6.75	201%
Swisher	0.98	1.44	46%
Tarrant	0.22	0.19	-13%
Taylor	0.23	0.28	21%
Terrell	2.55	8.11	218%
Terry	0.91	1.31	44%
Throckmorton	2.09	3.58	71%
Titus	0.34	0.49	47%
Tom Green	0.40	0.42	4%
Travis	0.30	0.20	-32%
Trinity	0.90	1.33	48%
Tyler	1.12	1.46	31%
Upshur	0.35	0.65	86%
Upton	1.91	6.40	235%
Uvalde	0.60	0.59	-1%

County	Per Capita Land Consumption – 1982 (acre)	Per Capita Land Consumption - 2017 (acre)	% Change in Per Capita Land Consumption, 1982-2017
Val Verde	0.24	0.34	39%
Van Zandt	0.67	1.22	81%
Victoria	0.51	0.54	7%
Walker	0.42	0.53	27%
Waller	1.09	0.85	-22%
Ward	0.74	1.51	104%
Washington	0.52	0.61	17%
Webb	0.23	0.26	12%
Wharton	0.49	0.65	33%
Wheeler	0.71	1.96	175%
Wichita	0.27	0.34	25%
Wilbarger	0.63	0.88	39%
Willacy	0.41	0.42	3%
Williamson	0.51	0.19	-62%
Wilson	0.61	0.41	-33%
Winkler	0.42	1.08	156%
Wise	0.56	0.52	-8%
Wood	0.60	1.11	85%
Yoakum	1.08	1.51	39%
Young	0.74	1.00	34%
Zapata	0.88	1.12	26%
Zavala	0.51	0.90	78%
All Texas Counties	**0.34**	**0.34**	**-2%**

In general, around the United States, the increase in per capita developed or urbanized land consumption (Per Capita Sprawl) is an important cause of Overall Sprawl in many urban or developed areas. At a minimum, the per capita land consumption figure reflects the combined outcome of all the following individual and institutional choices and factors:

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

2.5 Population versus Per Capita Developed Land Consumption

Table 14 compares growth in population to growth in per capita developed land consumption in Texas counties from 1982 to 2017. On average, during these 35 years, Texas counties grew in population by 85 percent, while their per capita developed land consumption fell by two percent. That is, on average, each Texas resident used two percent less developed land in 2017 than in 1982, but the number of Texas residents grew enormously.

Table 14. Percent Change in Population versus Percent Change in Per Capita Developed Land Consumption in Texas Counties, 1982-2017

County	Population Growth, 1982-2017	% Change in Per Capita Land Consumption, 1982-2017
Anderson	39%	27%
Andrews	16%	52%
Angelina	29%	91%
Aransas	58%	-2%
Archer	15%	3%
Armstrong	-5%	10%
Atascosa	85%	89%
Austin	53%	-7%
Bailey	-13%	25%
Bandera	195%	-21%
Bastrop	197%	-33%
Baylor	-32%	64%
Bee	20%	8%
Bell	108%	11%
Bexar	87%	0%
Blanco	140%	-31%
Borden	-31%	94%
Bosque	33%	12%
Bowie	22%	11%
Brazoria	101%	-6%
Brazos	99%	19%
Brewster	18%	-14%
Briscoe	-39%	88%

County	Population Growth, 1982-2017	% Change in Per Capita Land Consumption, 1982-2017
Brooks	-17%	100%
Brown	9%	11%
Burleson	23%	24%
Burnet	144%	-18%
Caldwell	72%	7%
Calhoun	3%	75%
Callahan	18%	15%
Cameron	83%	-2%
Camp	31%	29%
Carson	-18%	51%
Cass	-2%	77%
Castro	-27%	60%
Chambers	110%	-22%
Cherokee	34%	71%
Childress	5%	28%
Clay	5%	15%
Cochran	-42%	80%
Coke	-7%	34%
Coleman	-21%	48%
Collin	490%	-57%
Collingsworth	-36%	61%
Colorado	7%	21%
Comal	260%	-24%
Comanche	3%	10%

County	Population Growth, 1982-2017	% Change in Per Capita Land Consumption, 1982-2017
Concho	-13%	31%
Cooke	38%	48%
Coryell	26%	53%
Cottle	-52%	98%
Crane	-8%	52%
Crockett	-31%	75%
Crosby	-32%	82%
Culberson	-38%	63%
Dallam	10%	2%
Dallas	60%	-11%
Dawson	-23%	68%
Deaf Smith	-9%	39%
Delta	9%	53%
Denton	402%	-33%
DeWitt	3%	87%
Dickens	-34%	63%
Dimmit	-14%	197%
Donley	-20%	48%
Duval	-14%	72%
Eastland	-12%	35%
Ector	16%	16%
Edwards	-13%	50%
Ellis	177%	62%
El Paso	64%	22%

County	Population Growth, 1982-2017	% Change in Per Capita Land Consumption, 1982-2017
Erath	74%	-10%
Falls	-5%	60%
Fannin	42%	-4%
Fayette	20%	47%
Fisher	-34%	57%
Floyd	-39%	93%
Foard	-43%	61%
Fort Bend	388%	-48%
Franklin	49%	48%
Freestone	24%	81%
Frio	41%	15%
Gaines	47%	6%
Galveston	60%	-6%
Garza	12%	-13%
Gillespie	84%	4%
Glasscock	5%	125%
Goliad	36%	12%
Gonzales	12%	11%
Gray	-22%	47%
Grayson	43%	48%
Gregg	12%	66%
Grimes	79%	83%
Guadalupe	219%	-33%
Hale	-11%	68%

County	Population Growth, 1982-2017	% Change in Per Capita Land Consumption, 1982-2017
Hall	-42%	65%
Hamilton	2%	23%
Hansford	-14%	-7%
Hardeman	-39%	76%
Hardin	35%	-1%
Harris	73%	-3%
Harrison	20%	140%
Hartley	43%	-19%
Haskell	-26%	57%
Hays	394%	7%
Hemphill	-39%	415%
Henderson	76%	2%
Hidalgo	173%	-12%
Hill	39%	54%
Hockley	-7%	92%
Hood	199%	-54%
Hopkins	38%	10%
Houston	3%	50%
Howard	-2%	126%
Hudspeth	51%	-31%
Hunt	60%	13%
Hutchinson	-29%	96%
Irion	-2%	56%
Jack	11%	16%

County	Population Growth, 1982-2017	% Change in Per Capita Land Consumption, 1982-2017
Jackson	6%	22%
Jasper	13%	106%
Jeff Davis	37%	42%
Jefferson	0%	66%
Jim Hogg	-5%	-44%
Jim Wells	6%	47%
Johnson	127%	48%
Jones	12%	51%
Karnes	13%	84%
Kaufman	195%	-30%
Kendall	286%	-62%
Kenedy	-17%	69%
Kent	-36%	157%
Kerr	71%	-18%
Kimble	5%	26%
King	-31%	52%
Kinney	54%	-35%
Kleberg	-11%	103%
Knox	-35%	71%
Lamar	16%	39%
Lamb	-29%	72%
Lampasas	67%	-21%
La Salle	27%	32%
Lavaca	2%	23%

County	Population Growth, 1982-2017	% Change in Per Capita Land Consumption, 1982-2017
Lee	22%	15%
Leon	61%	13%
Liberty	62%	34%
Limestone	13%	43%
Lipscomb	-25%	137%
Live Oak	22%	29%
Llano	100%	-6%
Loving	58%	49%
Lubbock	42%	33%
Lynn	-29%	61%
McCulloch	-11%	73%
McLennan	43%	-2%
McMullen	-8%	128%
Madison	23%	35%
Marion	-7%	61%
Martin	4%	198%
Mason	14%	19%
Matagorda	-1%	31%
Maverick	71%	17%
Medina	113%	-34%
Menard	-9%	27%
Midland	68%	25%
Milam	7%	45%
Mills	8%	8%

County	Population Growth, 1982-2017	% Change in Per Capita Land Consumption, 1982-2017
Mitchell	-14%	58%
Montague	5%	38%
Montgomery	281%	-33%
Moore	22%	30%
Morris	-20%	201%
Motley	-34%	60%
Nacogdoches	33%	20%
Navarro	31%	58%
Newton	4%	116%
Nolan	-18%	74%
Nueces	28%	38%
Ochiltree	-10%	45%
Oldham	-10%	31%
Orange	-3%	109%
Palo Pinto	11%	21%
Panola	5%	131%
Parker	183%	-30%
Parmer	-11%	25%
Pecos	-8%	192%
Polk	88%	-19%
Potter	17%	41%
Presidio	30%	-21%
Rains	124%	-14%
Randall	71%	-9%

County	Population Growth, 1982-2017	% Change in Per Capita Land Consumption, 1982-2017
Reagan	-24%	91%
Real	35%	6%
Red River	-23%	84%
Reeves	-12%	123%
Refugio	-23%	59%
Roberts	-23%	70%
Robertson	11%	38%
Rockwall	482%	-24%
Runnels	-16%	63%
Rusk	25%	89%
Sabine	16%	95%
San Augustine	-7%	310%
San Jacinto	130%	-14%
San Patricio	9%	55%
San Saba	3%	8%
Schleicher	-7%	125%
Scurry	-15%	110%
Shackelford	-22%	38%
Shelby	8%	189%
Sherman	-6%	31%
Smith	65%	54%
Somervell	102%	-14%
Starr	111%	-15%
Stephens	-15%	34%

County	Population Growth, 1982-2017	% Change in Per Capita Land Consumption, 1982-2017
Sterling	-8%	32%
Stonewall	-43%	97%
Sutton	-35%	201%
Swisher	-20%	46%
Tarrant	120%	-13%
Taylor	14%	21%
Terrell	-48%	218%
Terry	-17%	44%
Throckmorton	-33%	71%
Titus	44%	47%
Tom Green	29%	4%
Travis	173%	-32%
Trinity	44%	48%
Tyler	30%	31%
Upshur	32%	86%
Upton	-32%	235%
Uvalde	17%	-1%
Val Verde	28%	39%
Van Zandt	68%	81%
Victoria	24%	7%
Walker	58%	27%
Waller	136%	-22%
Ward	-30%	104%
Washington	44%	17%

County	Population Growth, 1982-2017	% Change in Per Capita Land Consumption, 1982-2017
Webb	146%	12%
Wharton	1%	33%
Wheeler	-34%	175%
Wichita	5%	25%
Wilbarger	-23%	39%
Willacy	19%	3%
Williamson	527%	-62%
Wilson	180%	-33%
Winkler	-35%	156%
Wise	132%	-8%
Wood	73%	85%
Yoakum	1%	39%
Young	-13%	34%
Zapata	85%	26%
Zavala	-2%	78%
All Texas Counties	**85%**	**-2%**

Understandably, those Texas counties that experienced a decrease in population between 1982 and 2017 underwent a larger than average increase in per capita developed land consumption. That is because built facilities and infrastructure tend to remain abandoned on the ground well after populations that they served have moved away and no longer use them. The built environment does not typically revert to nature or open space on its own. Demolition or habitat / open space restoration both cost money that many not be available.

Urbanized Areas in Texas showed a similar pattern to developed areas of Texas counties (**Figure 41**). From 2000 to 2010, they grew in population by 28 percent, and while per capita urbanized land consumption also grew, it was only by two percent.

Figure 41. Suburban sprawl in the Austin UA, the third most sprawling city in Texas

Figures 42 and 43 show the comparative magnitudes of Population Growth and Per Capita Sprawl (growth in per capita developed or urbanized land consumption) in Texas countries and urbanized areas in the 1982-2017 and 2000-2010 time periods, respectively.

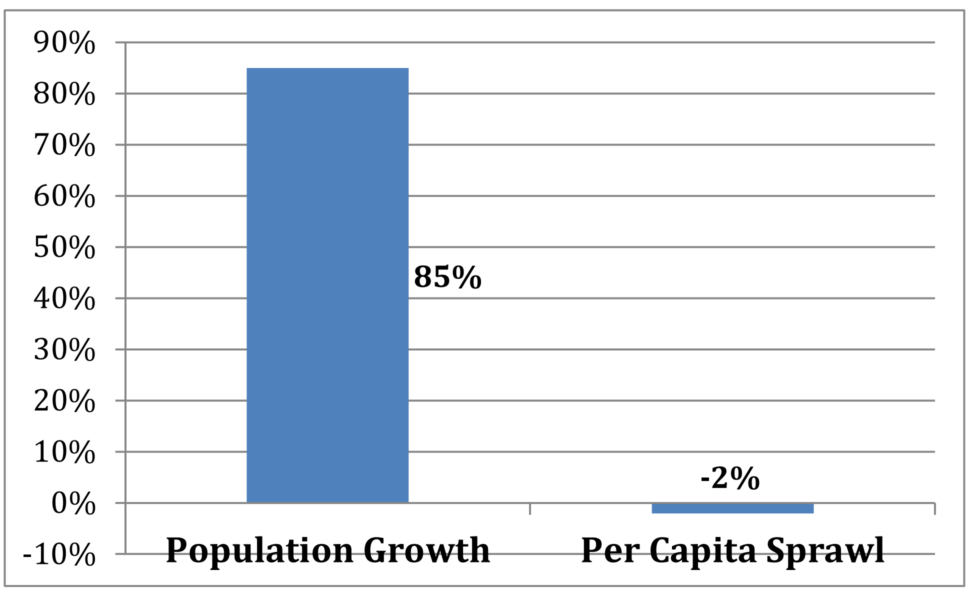
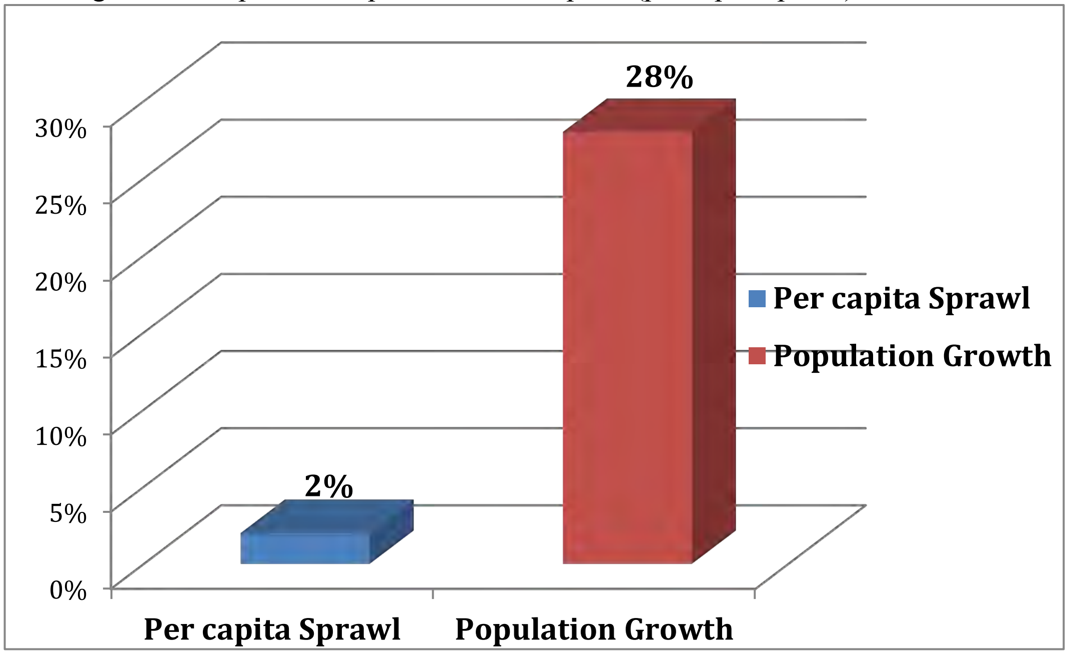


Figure 42. Per Capita Sprawl vs. Population Growth in Texas Counties, 1982-2017

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 developed land consumption (per capita sprawl) in Texas



from 1982 to 2017.

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Figure 43. 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 urbanized land consumption (per capita sprawl) in Texas from 2000 to 2010.

2.6 Measuring Overall Sprawl

By measuring the change in the amount of NRI Developed Land from 1982 to 2017 in each of the 254 counties in Texas, we were able to measure sprawl – defined as increase in the amount of developed land – in each county. Then, by using U.S. Census Bureau population estimates for those same counties, we could estimate the fraction or percentage of that sprawl attributable or related to population growth and, in contrast, what portion was a result of an increase in per capita use of developed land. These findings are presented in Chapter 3.

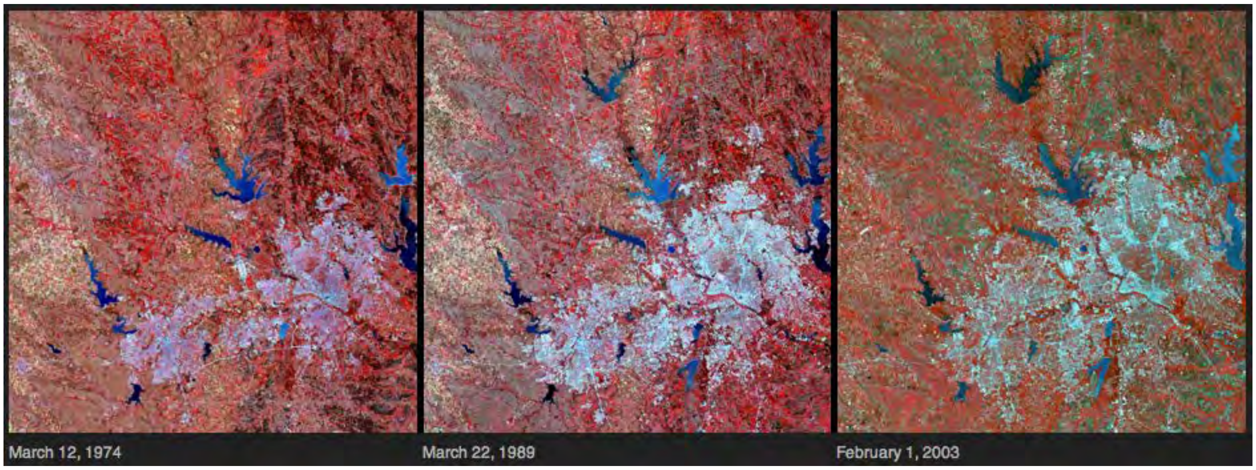

Figure 44. Dallas-Fort Worth Metroplex in 1974, 1989, and 2003
Images: NASA

3. FINDINGS

This study focuses on the loss of previously undeveloped, rural lands (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 Per Capita Sprawl versus Overall Sprawl

Many respected environmental organizations, urban planners, and "new urbanists" contend that implementing Smart Growth, New Urbanism, and LEED[68] building strategies into our new, existing, and ever-evolving cities is the best way to curb sprawl and promote sustainability. However, this is based on the premise that it is only or primarily our land-use choices that cause sprawl. As our multiple studies over the past two decades show conclusively, Per Capita Sprawl by itself could not explain Overall Sprawl in the great majority of America's Developed and Urbanized Areas.

Texas is no exception. By comparing the percentage growth of per capita developed or urbanized land consumption with the percentage growth of Overall Sprawl in all 254 Texas counties from 1982 to 2017 and 34 Urbanized Areas from 2000 to 2010 in **Figures 45 and 46**, we find that the Per Capita Sprawl percentage is much smaller than the Overall Sprawl percentage: -2 percent versus 80 percent (**Figure 45**) and 2 percent versus 19 percent (**Figure 46**). 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 15 compares the percentages of Per Capita Sprawl and Overall Sprawl from 1982 to 2017 in all 254 counties the state of Texas. In most cases, Per Capita Sprawl is only a small fraction of Overall Sprawl.

[68] 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

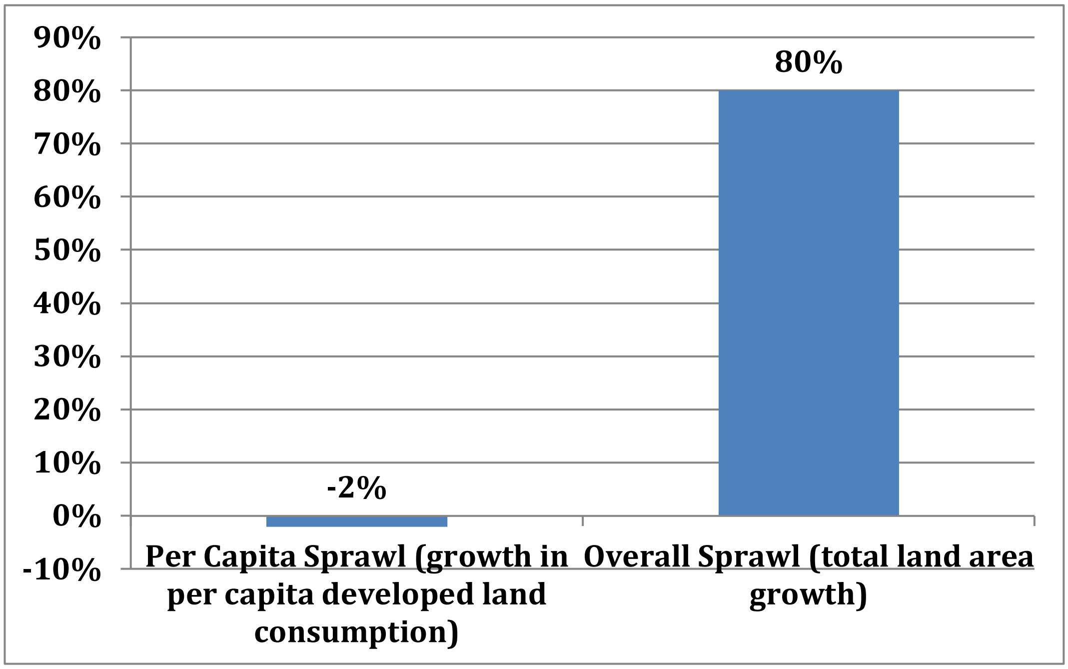

Figure 45. Per Capita Sprawl vs. Overall Sprawl in Texas Counties, 1982-2017
Note: Per Capita Sprawl is % growth in per capita developed land consumption and Overall Sprawl is % growth in developed land area.

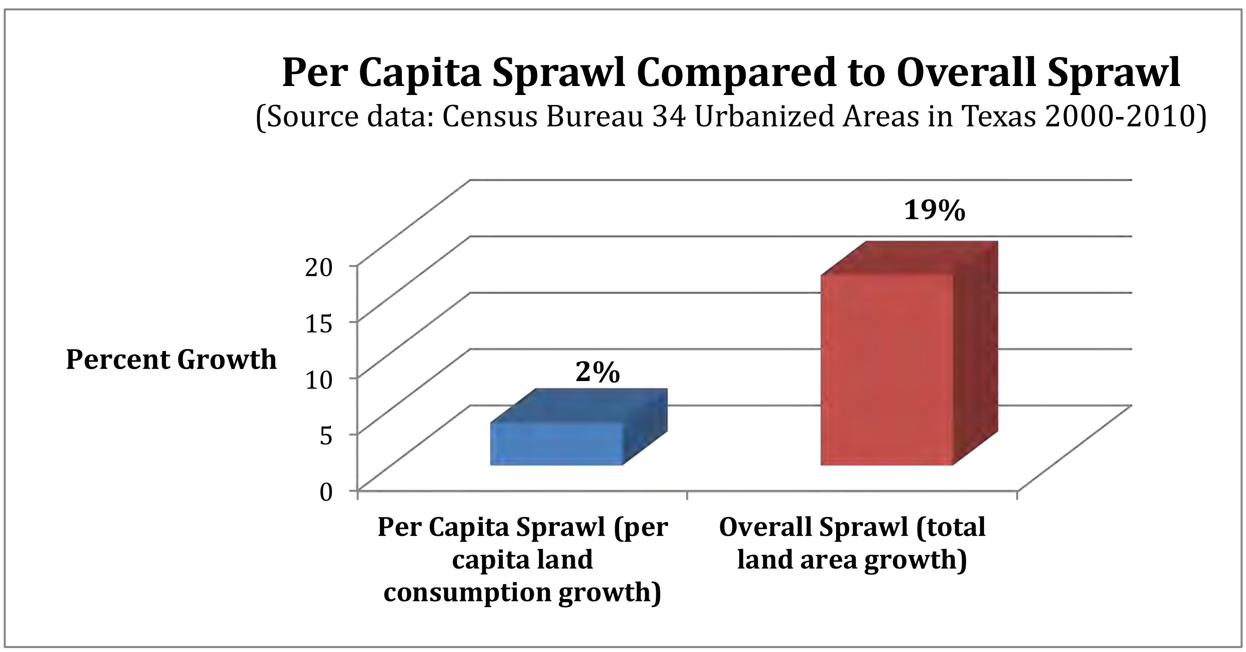

Figure 46. Per Capita Sprawl vs. Overall Sprawl in Texas UAs, 2000-2010
Note: Per Capita Sprawl is % growth in per capita urbanized land consumption and Overall Sprawl is % growth in urbanized land area.

Table 15. Per Capita Sprawl vs. Overall Sprawl
in Texas Counties, 1982-2017

County	% Change in Per Capita Land Consumption, 1982-2017 (PER CAPITA SPRAWL)	% Change in Overall Land Consumption, 1982-2017 (OVERALL SPRAWL)
Anderson	27%	77%
Andrews	52%	77%
Angelina	91%	147%
Aransas	-2%	54%
Archer	3%	18%
Armstrong	10%	5%
Atascosa	89%	251%
Austin	-7%	43%
Bailey	25%	8%
Bandera	-21%	134%
Bastrop	-33%	100%
Baylor	64%	11%
Bee	8%	29%
Bell	11%	130%
Bexar	0%	86%
Blanco	-31%	66%
Borden	94%	33%
Bosque	12%	49%
Bowie	11%	35%
Brazoria	-6%	90%
Brazos	19%	137%
Brewster	-14%	1%

County	% Change in Per Capita Land Consumption, 1982-2017 (PER CAPITA SPRAWL)	% Change in Overall Land Consumption, 1982-2017 (OVERALL SPRAWL)
Briscoe	88%	15%
Brooks	100%	66%
Brown	11%	21%
Burleson	24%	52%
Burnet	-18%	101%
Caldwell	7%	85%
Calhoun	75%	80%
Callahan	15%	36%
Cameron	-2%	80%
Camp	29%	70%
Carson	51%	24%
Cass	77%	73%
Castro	60%	18%
Chambers	-22%	64%
Cherokee	71%	129%
Childress	28%	34%
Clay	15%	21%
Cochran	80%	5%
Coke	34%	24%
Coleman	48%	18%
Collin	-57%	154%
Collingsworth	61%	4%
Colorado	21%	30%

County	% Change in Per Capita Land Consumption, 1982-2017 (PER CAPITA SPRAWL)	% Change in Overall Land Consumption, 1982-2017 (OVERALL SPRAWL)
Comal	-24%	175%
Comanche	10%	14%
Concho	31%	14%
Cooke	48%	105%
Coryell	53%	93%
Cottle	98%	-4%
Crane	52%	39%
Crockett	75%	20%
Crosby	82%	25%
Culberson	63%	2%
Dallam	2%	13%
Dallas	-11%	42%
Dawson	68%	29%
Deaf Smith	39%	27%
Delta	53%	67%
Denton	-33%	238%
DeWitt	87%	92%
Dickens	63%	7%
Dimmit	197%	156%
Donley	48%	19%
Duval	72%	48%
Eastland	35%	18%
Ector	16%	34%

County	% Change in Per Capita Land Consumption, 1982-2017 (PER CAPITA SPRAWL)	% Change in Overall Land Consumption, 1982-2017 (OVERALL SPRAWL)
Edwards	50%	31%
Ellis	62%	348%
El Paso	22%	100%
Erath	-10%	56%
Falls	60%	51%
Fannin	-4%	37%
Fayette	47%	76%
Fisher	57%	5%
Floyd	93%	18%
Foard	61%	-9%
Fort Bend	-48%	152%
Franklin	48%	120%
Freestone	81%	124%
Frio	15%	61%
Gaines	6%	55%
Galveston	-6%	51%
Garza	-13%	-3%
Gillespie	4%	92%
Glasscock	125%	137%
Goliad	12%	52%
Gonzales	11%	24%
Gray	47%	15%
Grayson	48%	111%

County	% Change in Per Capita Land Consumption, 1982-2017 (PER CAPITA SPRAWL)	% Change in Overall Land Consumption, 1982-2017 (OVERALL SPRAWL)
Gregg	66%	86%
Grimes	83%	226%
Guadalupe	-33%	114%
Hale	68%	50%
Hall	65%	-4%
Hamilton	23%	25%
Hansford	-7%	-20%
Hardeman	76%	8%
Hardin	-1%	34%
Harris	-3%	68%
Harrison	140%	187%
Hartley	-19%	16%
Haskell	57%	17%
Hays	7%	429%
Hemphill	415%	215%
Henderson	2%	79%
Hidalgo	-12%	140%
Hill	54%	114%
Hockley	92%	79%
Hood	-54%	38%
Hopkins	10%	52%
Houston	50%	54%
Howard	126%	122%

County	% Change in Per Capita Land Consumption, 1982-2017 (PER CAPITA SPRAWL)	% Change in Overall Land Consumption, 1982-2017 (OVERALL SPRAWL)
Hudspeth	-31%	3%
Hunt	13%	81%
Hutchinson	96%	40%
Irion	56%	53%
Jack	16%	29%
Jackson	22%	30%
Jasper	106%	133%
Jeff Davis	42%	95%
Jefferson	66%	66%
Jim Hogg	-44%	-46%
Jim Wells	47%	56%
Johnson	48%	237%
Jones	51%	70%
Karnes	84%	107%
Kaufman	-30%	105%
Kendall	-62%	47%
Kenedy	69%	40%
Kent	157%	66%
Kerr	-18%	40%
Kimble	26%	33%
King	52%	4%
Kinney	-35%	0%
Kleberg	103%	80%

County	% Change in Per Capita Land Consumption, 1982-2017 (PER CAPITA SPRAWL)	% Change in Overall Land Consumption, 1982-2017 (OVERALL SPRAWL)
Knox	71%	12%
Lamar	39%	61%
Lamb	72%	21%
Lampasas	-21%	31%
La Salle	32%	68%
Lavaca	23%	26%
Lee	15%	40%
Leon	13%	82%
Liberty	34%	118%
Limestone	43%	62%
Lipscomb	137%	78%
Live Oak	29%	57%
Llano	-6%	89%
Loving	49%	136%
Lubbock	33%	89%
Lynn	61%	14%
McCulloch	73%	54%
McLennan	-2%	40%
McMullen	128%	110%
Madison	35%	66%
Marion	61%	50%
Martin	198%	211%
Mason	19%	35%

County	% Change in Per Capita Land Consumption, 1982-2017 (PER CAPITA SPRAWL)	% Change in Overall Land Consumption, 1982-2017 (OVERALL SPRAWL)
Matagorda	31%	29%
Maverick	17%	99%
Medina	-34%	40%
Menard	27%	16%
Midland	25%	109%
Milam	45%	56%
Mills	8%	16%
Mitchell	58%	35%
Montague	38%	45%
Montgomery	-33%	156%
Moore	30%	59%
Morris	201%	141%
Motley	60%	5%
Nacogdoches	20%	60%
Navarro	58%	108%
Newton	116%	124%
Nolan	74%	42%
Nueces	38%	77%
Ochiltree	45%	31%
Oldham	31%	17%
Orange	109%	103%
Palo Pinto	21%	35%
Panola	131%	143%

County	% Change in Per Capita Land Consumption, 1982-2017 (PER CAPITA SPRAWL)	% Change in Overall Land Consumption, 1982-2017 (OVERALL SPRAWL)
Parker	-30%	99%
Parmer	25%	11%
Pecos	192%	170%
Polk	-19%	52%
Potter	41%	65%
Presidio	-21%	3%
Rains	-14%	93%
Randall	-9%	56%
Reagan	91%	45%
Real	6%	43%
Red River	84%	42%
Reeves	123%	96%
Refugio	59%	21%
Roberts	70%	30%
Robertson	38%	53%
Rockwall	-24%	339%
Runnels	63%	38%
Rusk	89%	137%
Sabine	95%	126%
San Augustine	310%	281%
San Jacinto	-14%	98%
San Patricio	55%	69%
San Saba	8%	10%

County	% Change in Per Capita Land Consumption, 1982-2017 (PER CAPITA SPRAWL)	% Change in Overall Land Consumption, 1982-2017 (OVERALL SPRAWL)
Schleicher	125%	109%
Scurry	110%	78%
Shackelford	38%	7%
Shelby	189%	213%
Sherman	31%	23%
Smith	54%	155%
Somervell	-14%	74%
Starr	-15%	80%
Stephens	34%	14%
Sterling	32%	21%
Stonewall	97%	12%
Sutton	201%	94%
Swisher	46%	18%
Tarrant	-13%	91%
Taylor	21%	39%
Terrell	218%	65%
Terry	44%	19%
Throckmorton	71%	15%
Titus	47%	112%
Tom Green	4%	34%
Travis	-32%	85%
Trinity	48%	112%
Tyler	31%	70%

County	% Change in Per Capita Land Consumption, 1982-2017 (PER CAPITA SPRAWL)	% Change in Overall Land Consumption, 1982-2017 (OVERALL SPRAWL)
Upshur	86%	145%
Upton	235%	127%
Uvalde	-1%	16%
Val Verde	39%	77%
Van Zandt	81%	205%
Victoria	7%	32%
Walker	27%	101%
Waller	-22%	84%
Ward	104%	43%
Washington	17%	69%
Webb	12%	176%
Wharton	33%	35%
Wheeler	175%	82%
Wichita	25%	31%
Wilbarger	39%	7%
Willacy	3%	22%
Williamson	-62%	135%
Wilson	-33%	86%
Winkler	156%	67%
Wise	-8%	113%
Wood	85%	220%
Yoakum	39%	40%
Young	34%	17%

County	% Change in Per Capita Land Consumption, 1982-2017 (PER CAPITA SPRAWL)	% Change in Overall Land Consumption, 1982-2017 (OVERALL SPRAWL)
Zapata	26%	134%
Zavala	78%	74%
All Texas Counties	**-2%**	**80%**

Table 16. 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%
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%

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

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 absorbed by Texas cities will almost certainly continue to grow.

Figure 47 and **Table 17** examine a more recent subset of the long-term 1982-2017, 35-year time period of our study. This figure and table focus on the most recent 15-year period in the growth of Developed Land, from 2002 to 2017. In 2017, the average Texas resident actually used seven percent less developed land than just 15 years earlier in 2002. Yet because of rampant population growth, developed areas still expanded by 21 percent beyond the area they already covered in 2002, sprawling ever further out across the Texas countryside, converting precious farmland and natural habitat into asphalt, concrete, buildings, and artificial landscaping.

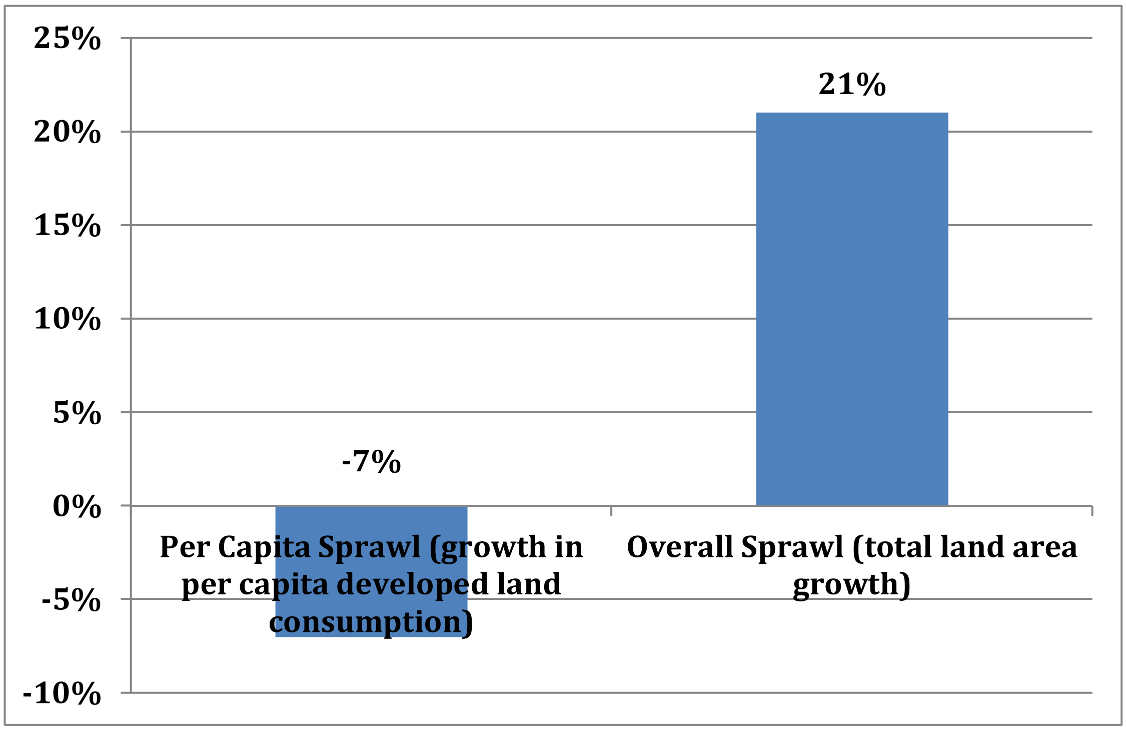

Figure 47. Per Capita Sprawl vs. Overall Sprawl in Texas Counties, 2002-2017

Table 17. Per Capita Sprawl vs. Overall Sprawl
in Texas Counties, 2002-2017

County	% Change in Per Capita Land Consumption, 2002-2017 (PER CAPITA SPRAWL)	% Change in Overall Land Consumption, 2002-2017 (OVERALL SPRAWL)
Anderson	6%	13%
Andrews	13%	52%

County	% Change in Per Capita Land Consumption, 2002-2017 (PER CAPITA SPRAWL)	% Change in Overall Land Consumption, 2002-2017 (OVERALL SPRAWL)
Angelina	8%	17%
Aransas	-2%	10%
Archer	5%	3%
Armstrong	12%	2%
Atascosa	37%	65%
Austin	-4%	15%
Bailey	-2%	4%
Bandera	-9%	10%
Bastrop	-2%	30%
Baylor	11%	1%
Bee	8%	11%
Bell	-4%	33%
Bexar	-10%	21%
Blanco	3%	32%
Borden	30%	27%
Bosque	10%	16%
Bowie	1%	6%
Brazoria	-13%	23%
Brazos	-9%	28%
Brewster	0%	4%
Briscoe	15%	0%
Brooks	30%	20%
Brown	11%	11%

County	% Change in Per Capita Land Consumption, 2002-2017 (PER CAPITA SPRAWL)	% Change in Overall Land Consumption, 2002-2017 (OVERALL SPRAWL)
Burleson	2%	10%
Burnet	-6%	19%
Caldwell	12%	37%
Calhoun	5%	11%
Callahan	-2%	7%
Cameron	1%	22%
Camp	15%	28%
Carson	9%	1%
Cass	16%	15%
Castro	11%	6%
Chambers	-23%	15%
Cherokee	2%	13%
Childress	2%	0%
Clay	11%	3%
Cochran	28%	3%
Coke	19%	5%
Coleman	13%	7%
Collin	-19%	40%
Collingsworth	6%	2%
Colorado	9%	14%
Comal	3%	75%
Comanche	2%	2%
Concho	60%	10%

County	% Change in Per Capita Land Consumption, 2002-2017 (PER CAPITA SPRAWL)	% Change in Overall Land Consumption, 2002-2017 (OVERALL SPRAWL)
Cooke	12%	19%
Coryell	19%	22%
Cottle	28%	2%
Crane	9%	31%
Crockett	31%	21%
Crosby	23%	5%
Culberson	29%	2%
Dallam	-13%	3%
Dallas	-8%	7%
Dawson	22%	8%
Deaf Smith	4%	5%
Delta	14%	13%
Denton	-21%	36%
DeWitt	91%	92%
Dickens	27%	4%
Dimmit	78%	82%
Donley	19%	4%
Duval	28%	14%
Eastland	9%	9%
Ector	-11%	14%
Edwards	22%	15%
Ellis	-1%	45%
El Paso	11%	34%

County	% Change in Per Capita Land Consumption, 2002-2017 (PER CAPITA SPRAWL)	% Change in Overall Land Consumption, 2002-2017 (OVERALL SPRAWL)
Erath	-10%	12%
Falls	7%	3%
Fannin	-1%	7%
Fayette	13%	26%
Fisher	9%	0%
Floyd	30%	4%
Foard	25%	-2%
Fort Bend	-28%	40%
Franklin	28%	45%
Freestone	25%	33%
Frio	1%	23%
Gaines	-15%	21%
Galveston	-13%	12%
Garza	-24%	-8%
Gillespie	0%	23%
Glasscock	78%	81%
Goliad	2%	9%
Gonzales	2%	12%
Gray	1%	2%
Grayson	7%	24%
Gregg	7%	17%
Grimes	17%	32%
Guadalupe	-21%	32%

County	% Change in Per Capita Land Consumption, 2002-2017 (PER CAPITA SPRAWL)	% Change in Overall Land Consumption, 2002-2017 (OVERALL SPRAWL)
Hale	21%	15%
Hall	19%	-2%
Hamilton	3%	8%
Hansford	-2%	3%
Hardeman	17%	2%
Hardin	-8%	8%
Harris	-10%	18%
Harrison	23%	32%
Hartley	1%	7%
Haskell	11%	7%
Hays	-25%	44%
Hemphill	87%	118%
Henderson	5%	14%
Hidalgo	-9%	28%
Hill	8%	16%
Hockley	19%	20%
Hood	-22%	5%
Hopkins	13%	27%
Houston	31%	30%
Howard	43%	53%
Hudspeth	-26%	1%
Hunt	3%	20%
Hutchinson	14%	6%

County	% Change in Per Capita Land Consumption, 2002-2017 (PER CAPITA SPRAWL)	% Change in Overall Land Consumption, 2002-2017 (OVERALL SPRAWL)
Irion	53%	36%
Jack	8%	7%
Jackson	9%	14%
Jasper	19%	18%
Jeff Davis	90%	95%
Jefferson	6%	9%
Jim Hogg	4%	4%
Jim Wells	15%	18%
Johnson	7%	34%
Jones	25%	22%
Karnes	78%	83%
Kaufman	-24%	19%
Kendall	-33%	17%
Kenedy	38%	37%
Kent	72%	61%
Kerr	-6%	8%
Kimble	18%	14%
King	2%	-4%
Kinney	-7%	0%
Kleberg	10%	8%
Knox	14%	3%
Lamar	9%	11%
Lamb	19%	7%

County	% Change in Per Capita Land Consumption, 2002-2017 (PER CAPITA SPRAWL)	% Change in Overall Land Consumption, 2002-2017 (OVERALL SPRAWL)
Lampasas	-5%	8%
La Salle	30%	61%
Lavaca	3%	8%
Lee	6%	13%
Leon	19%	31%
Liberty	13%	29%
Limestone	22%	27%
Lipscomb	20%	33%
Live Oak	28%	30%
Llano	-8%	9%
Loving	13%	100%
Lubbock	1%	24%
Lynn	16%	5%
McCulloch	14%	15%
McLennan	-6%	10%
McMullen	119%	110%
Madison	20%	34%
Marion	23%	12%
Martin	91%	127%
Mason	-2%	10%
Matagorda	12%	9%
Maverick	7%	29%
Medina	-6%	16%

County	% Change in Per Capita Land Consumption, 2002-2017 (PER CAPITA SPRAWL)	% Change in Overall Land Consumption, 2002-2017 (OVERALL SPRAWL)
Menard	28%	16%
Midland	-2%	37%
Milam	18%	17%
Mills	0%	-1%
Mitchell	53%	33%
Montague	10%	11%
Montgomery	-26%	30%
Moore	14%	22%
Morris	13%	6%
Motley	7%	0%
Nacogdoches	7%	18%
Navarro	4%	10%
Newton	35%	26%
Nolan	8%	6%
Nueces	0%	14%
Ochiltree	3%	13%
Oldham	0%	2%
Orange	8%	10%
Palo Pinto	4%	9%
Panola	76%	78%
Parker	-13%	23%
Parmer	4%	1%
Pecos	21%	17%

County	% Change in Per Capita Land Consumption, 2002-2017 (PER CAPITA SPRAWL)	% Change in Overall Land Consumption, 2002-2017 (OVERALL SPRAWL)
Polk	-9%	1%
Potter	10%	14%
Presidio	6%	0%
Rains	7%	26%
Randall	-5%	19%
Reagan	14%	33%
Real	5%	19%
Red River	21%	6%
Reeves	64%	91%
Refugio	12%	5%
Roberts	-4%	5%
Robertson	19%	27%
Rockwall	-22%	51%
Runnels	58%	48%
Rusk	3%	15%
Sabine	7%	6%
San Augustine	26%	16%
San Jacinto	5%	27%
San Patricio	17%	17%
San Saba	11%	10%
Schleicher	109%	105%
Scurry	42%	51%
Shackelford	9%	5%

County	% Change in Per Capita Land Consumption, 2002-2017 (PER CAPITA SPRAWL)	% Change in Overall Land Consumption, 2002-2017 (OVERALL SPRAWL)
Shelby	20%	20%
Sherman	6%	2%
Smith	-1%	25%
Somervell	-3%	19%
Starr	-1%	15%
Stephens	4%	3%
Sterling	11%	8%
Stonewall	10%	2%
Sutton	80%	67%
Swisher	9%	1%
Tarrant	-11%	20%
Taylor	0%	9%
Terrell	34%	8%
Terry	7%	6%
Throckmorton	32%	15%
Titus	11%	28%
Tom Green	-7%	6%
Travis	-14%	24%
Trinity	29%	35%
Tyler	12%	15%
Upshur	19%	33%
Upton	44%	61%
Uvalde	2%	5%

County	% Change in Per Capita Land Consumption, 2002-2017 (PER CAPITA SPRAWL)	% Change in Overall Land Consumption, 2002-2017 (OVERALL SPRAWL)
Val Verde	28%	38%
Van Zandt	17%	29%
Victoria	-2%	7%
Walker	7%	25%
Waller	-13%	29%
Ward	8%	19%
Washington	1%	14%
Webb	-3%	29%
Wharton	11%	14%
Wheeler	54%	60%
Wichita	3%	4%
Wilbarger	13%	1%
Willacy	3%	10%
Williamson	-26%	40%
Wilson	-10%	30%
Winkler	6%	15%
Wise	10%	38%
Wood	20%	41%
Yoakum	0%	18%
Young	3%	4%
Zapata	12%	27%
Zavala	10%	14%
All Texas Counties	**-7%**	**21%**

3.2 Population Size X Per Capita Sprawl = Overall Sprawl

The change in the number of residents (population size) times the change in the average amount of developed land consumed or used per resident (per capita sprawl) equals the change in total developed area in a given county, or what we call "overall sprawl" in this study on sprawl in Texas. **Table 18** shows the cumulative total developed area (not the change) by county in the years 1982, 2002, and 2017. Overall, the cumulative area of total developed land in the state increased from 8,257.5 square miles (5,284,800 acres) in 1982, to 12,275.0 square miles (7,856,000 acres) in 2002, up to 14,891.3 square miles (9,530,400 acres) in 2017. Cumulative developed land in Texas sprawls over a far greater area than any other state in the country. California is in second place at 9,822 square miles of cumulative developed land area, and Florida in third place at 8,750 square miles.[69]

Table 18. Cumulative Area of Total Developed Land (in square miles) **in Texas Counties – 1982, 2002, 2017**

County	Total Developed Land Area in 1982	Total Developed Land Area in 2002	Total Developed Land Area in 2017
Anderson	27.8	43.8	49.2
Andrews	28.1	32.7	49.7
Angelina	28.4	59.8	70.2
Aransas	22.5	31.4	34.7
Archer	18.0	20.6	21.3
Armstrong	6.4	6.6	6.7
Atascosa	21.1	44.8	74.1
Austin	22.8	28.4	32.7
Bailey	7.7	8.0	8.3
Bandera	16.9	36.1	39.5
Bastrop	43.4	66.6	86.7
Baylor	13.9	15.3	15.5

[69] Leon Kolankiewicz, Roy Beck, and Eric Ruark. 2022. *From Sea to ~~Shining~~ Sprawling Sea: Quantifying the Loss of Open Space in America*. Arlington, VA: NumbersUSA. 529 pp. Available online at: https://sprawlusa.com/wp-content/uploads/2022/03/NatlSprawl.pdf.

County	Total Developed Land Area in 1982	Total Developed Land Area in 2002	Total Developed Land Area in 2017
Bee	25.5	29.7	33.0
Bell	82.3	142.3	189.7
Bexar	255.5	392.8	475.9
Blanco	7.8	9.8	13.0
Borden	6.1	6.4	8.1
Bosque	22.7	29.2	33.8
Bowie	74.2	94.4	100.2
Brazoria	134.1	206.9	254.4
Brazos	52.5	97.5	124.5
Brewster	24.2	23.6	24.5
Briscoe	6.3	7.2	7.2
Brooks	10.0	13.8	16.6
Brown	27.8	30.2	33.6
Burleson	21.3	29.4	32.3
Burnet	25.0	42.2	50.2
Caldwell	20.2	27.3	37.3
Calhoun	20.8	33.6	37.3
Callahan	12.2	15.5	16.6
Cameron	74.8	110.6	134.5
Camp	7.2	9.5	12.2
Carson	20.2	24.8	25.0
Cass	24.2	36.4	41.9
Castro	14.2	15.8	16.7
Chambers	38.0	54.2	62.3

County	Total Developed Land Area in 1982	Total Developed Land Area in 2002	Total Developed Land Area in 2017
Cherokee	21.4	43.4	49.1
Childress	7.3	9.8	9.8
Clay	24.1	28.3	29.1
Cochran	9.1	9.2	9.5
Coke	13.1	15.5	16.3
Coleman	23.9	26.4	28.1
Collin	108.0	196.1	274.7
Collingsworth	8.1	8.3	8.4
Colorado	29.2	33.3	38.0
Comal	41.3	64.7	113.3
Comanche	20.6	23.0	23.4
Concho	10.9	11.4	12.5
Cooke	22.5	38.6	46.1
Coryell	23.1	36.6	44.5
Cottle	7.5	7.0	7.2
Crane	8.0	8.4	11.1
Crockett	37.8	37.7	45.5
Crosby	10.2	12.0	12.7
Culberson	9.2	9.2	9.4
Dallam	4.8	5.3	5.5
Dallas	411.4	544.2	582.8
Dawson	18.0	21.4	23.1
Deaf Smith	17.0	20.5	21.6
Delta	4.2	6.3	7.0

County	Total Developed Land Area in 1982	Total Developed Land Area in 2002	Total Developed Land Area in 2017
Denton	71.3	177.5	240.9
DeWitt	10.0	10.0	19.2
Dickens	4.2	4.4	4.5
Dimmit	9.2	13.0	23.6
Donley	6.7	7.7	8.0
Duval	24.5	31.9	36.3
Eastland	27.5	29.8	32.5
Ector	85.0	99.5	113.9
Edwards	12.2	13.9	15.9
Ellis	32.2	99.5	144.2
El Paso	120.2	179.4	240.2
Erath	31.6	44.2	49.4
Falls	20.8	30.6	31.4
Fannin	19.2	24.5	26.3
Fayette	25.3	35.5	44.5
Fisher	10.3	10.8	10.8
Floyd	11.1	12.7	13.1
Foard	6.9	6.4	6.3
Fort Bend	96.1	173.6	242.5
Franklin	7.8	11.9	17.2
Freestone	12.8	21.6	28.8
Frio	16.9	22.2	27.2
Gaines	25.3	32.3	39.2
Galveston	114.2	154.4	172.3

County	Total Developed Land Area in 1982	Total Developed Land Area in 2002	Total Developed Land Area in 2017
Garza	5.6	5.9	5.5
Gillespie	26.9	42.0	51.6
Glasscock	7.7	10.0	18.1
Goliad	10.2	14.2	15.5
Gonzales	21.6	23.9	26.7
Gray	26.3	29.5	30.2
Grayson	53.8	91.7	113.6
Gregg	49.2	78.4	91.7
Grimes	9.7	23.9	31.6
Guadalupe	33.9	54.8	72.7
Hale	20.5	26.6	30.6
Hall	7.8	7.7	7.5
Hamilton	12.3	14.4	15.5
Hansford	7.0	5.5	5.6
Hardeman	15.9	16.9	17.2
Hardin	63.3	78.9	85.0
Harris	629.5	892.7	1,055.6
Harrison	22.5	49.1	64.5
Hartley	8.0	8.6	9.2
Haskell	17.8	19.4	20.8
Hays	20.6	75.6	109.1
Hemphill	5.3	7.7	16.7
Henderson	60.9	95.5	108.9
Hidalgo	96.7	181.6	232.5

County	Total Developed Land Area in 1982	Total Developed Land Area in 2002	Total Developed Land Area in 2017
Hill	25.5	46.9	54.5
Hockley	13.1	19.5	23.4
Hood	43.9	57.7	60.5
Hopkins	16.7	20.0	25.5
Houston	13.1	15.5	20.2
Howard	19.4	28.1	43.0
Hudspeth	18.9	19.4	19.5
Hunt	50.0	75.2	90.3
Hutchinson	18.8	24.8	26.3
Irion	9.2	10.3	14.1
Jack	19.5	23.6	25.2
Jackson	18.8	21.4	24.4
Jasper	29.1	57.3	67.8
Jeff Davis	6.1	6.1	11.9
Jefferson	115.0	175.6	191.3
Jim Hogg	14.8	7.7	8.0
Jim Wells	21.6	28.4	33.6
Johnson	39.4	99.1	132.5
Jones	19.1	26.4	32.3
Karnes	15.0	17.0	31.1
Kaufman	30.9	53.1	63.4
Kendall	39.4	49.4	57.8
Kenedy	7.8	8.0	10.9
Kent	5.0	5.2	8.3

County	Total Developed Land Area in 1982	Total Developed Land Area in 2002	Total Developed Land Area in 2017
Kerr	57.0	73.6	79.8
Kimble	6.7	7.8	8.9
King	3.6	3.9	3.8
Kinney	8.9	8.9	8.9
Kleberg	18.4	30.6	33.1
Knox	17.3	18.8	19.4
Lamar	49.8	72.3	80.3
Lamb	16.7	19.1	20.3
Lampasas	25.6	31.3	33.6
La Salle	10.3	10.8	17.3
Lavaca	28.1	32.8	35.3
Lee	14.8	18.4	20.8
Leon	20.2	28.1	36.7
Liberty	49.8	84.1	108.6
Limestone	20.6	26.4	33.4
Lipscomb	11.6	15.5	20.6
Live Oak	22.0	26.7	34.7
Llano	20.0	34.8	37.8
Loving	4.4	5.2	10.3
Lubbock	67.2	102.0	126.7
Lynn	13.8	14.8	15.6
McCulloch	17.5	23.6	27.0
McLennan	74.2	95.0	104.1
McMullen	6.1	6.1	12.8

County	Total Developed Land Area in 1982	Total Developed Land Area in 2002	Total Developed Land Area in 2017
Madison	11.1	13.8	18.4
Marion	9.7	13.0	14.5
Martin	12.7	17.3	39.4
Mason	7.5	9.2	10.2
Matagorda	35.2	41.7	45.5
Maverick	20.5	31.7	40.8
Medina	37.2	44.7	52.0
Menard	3.0	3.0	3.4
Midland	64.1	97.8	134.1
Milam	23.8	31.6	37.0
Mills	9.7	11.4	11.3
Mitchell	10.6	10.8	14.4
Montague	23.4	30.5	33.9
Montgomery	140.5	276.7	359.2
Moore	18.1	23.6	28.8
Morris	9.2	20.9	22.2
Motley	3.3	3.4	3.4
Nacogdoches	34.4	46.7	55.0
Navarro	20.8	39.1	43.1
Newton	7.2	12.8	16.1
Nolan	17.3	23.3	24.7
Nueces	80.0	123.6	141.4
Ochiltree	12.7	14.7	16.6
Oldham	8.1	9.4	9.5

County	Total Developed Land Area in 1982	Total Developed Land Area in 2002	Total Developed Land Area in 2017
Orange	55.3	102.7	112.5
Palo Pinto	40.9	50.6	55.3
Panola	16.4	22.3	39.8
Parker	59.8	96.4	118.9
Parmer	15.6	17.2	17.3
Pecos	72.8	167.3	196.3
Polk	35.9	53.9	54.5
Potter	57.0	82.3	94.1
Presidio	10.3	10.6	10.6
Rains	6.3	9.5	12.0
Randall	38.9	50.9	60.8
Reagan	12.2	13.3	17.7
Real	8.3	10.0	11.9
Red River	22.5	30.2	31.9
Reeves	21.6	22.0	42.2
Refugio	15.3	17.7	18.6
Roberts	7.2	8.9	9.4
Robertson	24.2	29.1	37.0
Rockwall	10.3	30.0	45.3
Runnels	11.3	10.5	15.5
Rusk	35.9	73.8	85.2
Sabine	5.9	12.7	13.4
San Augustine	7.3	24.1	28.0
San Jacinto	22.5	35.2	44.5

County	Total Developed Land Area in 1982	Total Developed Land Area in 2002	Total Developed Land Area in 2017
San Patricio	48.8	70.3	82.5
San Saba	10.6	10.6	11.7
Schleicher	8.4	8.6	17.7
Scurry	20.8	24.5	37.0
Shackelford	8.4	8.6	9.1
Shelby	9.7	25.2	30.3
Sherman	7.5	9.1	9.2
Smith	63.0	128.8	160.5
Somervell	7.8	11.4	13.6
Starr	29.7	46.6	53.4
Stephens	15.3	17.0	17.5
Sterling	10.9	12.3	13.3
Stonewall	6.7	7.3	7.5
Sutton	20.6	23.9	40.0
Swisher	14.2	16.6	16.7
Tarrant	324.8	515.6	621.1
Taylor	43.0	54.7	59.5
Terrell	6.3	9.5	10.3
Terry	21.4	24.1	25.5
Throckmorton	7.3	7.3	8.4
Titus	11.9	19.7	25.2
Tom Green	57.3	73.0	77.0
Travis	210.2	312.0	388.4
Trinity	14.4	22.5	30.5

County	Total Developed Land Area in 1982	Total Developed Land Area in 2002	Total Developed Land Area in 2017
Tyler	28.9	42.7	49.2
Upshur	17.2	31.7	42.0
Upton	16.1	22.7	36.6
Uvalde	21.6	23.9	25.0
Val Verde	14.5	18.8	25.8
Van Zandt	34.4	81.4	105.0
Victoria	58.8	72.7	77.8
Walker	30.2	48.4	60.5
Waller	37.2	53.1	68.4
Ward	18.8	22.5	26.9
Washington	19.5	28.9	33.0
Webb	40.5	86.9	111.9
Wharton	31.4	37.2	42.3
Wheeler	8.9	10.2	16.3
Wichita	53.3	67.2	69.8
Wilbarger	16.3	17.2	17.3
Willacy	11.6	12.8	14.1
Williamson	70.0	117.8	164.7
Wilson	16.9	24.2	31.4
Winkler	7.7	11.1	12.8
Wise	25.0	38.6	53.3
Wood	23.9	54.4	76.6
Yoakum	14.4	17.0	20.2
Young	23.9	26.9	28.0

County	Total Developed Land Area in 1982	Total Developed Land Area in 2002	Total Developed Land Area in 2017
Zapata	10.6	19.5	24.8
Zavala	9.7	14.8	16.9
All Texas Counties	**8,257.5**	**12,275.0**	**14,891.3**

Table 19 shows the *change* in developed land area from 1982 to 2017 and from 2002 to 2017, or what we term "overall sprawl" during those two time periods, the second one a subset of the first.

Table 19. Overall Sprawl (in square miles)
in Texas Counties – 1982-2017 and 2002-2017

County	Change in Total Developed Land Area (OVERALL SPRAWL) 1982-2017	Change in Total Developed Land Area (OVERALL SPRAWL) 2002-2017
Anderson	21.4	5.5
Andrews	21.6	17.0
Angelina	41.7	10.3
Aransas	12.2	3.3
Archer	3.3	0.6
Armstrong	0.3	0.2
Atascosa	53.0	29.2
Austin	9.8	4.2
Bailey	0.6	0.3
Bandera	22.7	3.4
Bastrop	43.3	20.2
Baylor	1.6	0.2
Bee	7.5	3.3
Bell	107.3	47.3

County	Change in Total Developed Land Area (OVERALL SPRAWL) 1982-2017	Change in Total Developed Land Area (OVERALL SPRAWL) 2002-2017
Bexar	220.5	83.1
Blanco	5.2	3.1
Borden	2.0	1.7
Bosque	11.1	4.5
Bowie	25.9	5.8
Brazoria	120.3	47.5
Brazos	72.0	27.0
Brewster	0.3	0.9
Briscoe	0.9	0.0
Brooks	6.6	2.8
Brown	5.8	3.4
Burleson	11.1	3.0
Burnet	25.2	8.0
Caldwell	17.2	10.0
Calhoun	16.6	3.8
Callahan	4.4	1.1
Cameron	59.7	23.9
Camp	5.0	2.7
Carson	4.8	0.2
Cass	17.7	5.5
Castro	2.5	0.9
Chambers	24.4	8.1
Cherokee	27.7	5.6

County	Change in Total Developed Land Area (OVERALL SPRAWL) 1982-2017	Change in Total Developed Land Area (OVERALL SPRAWL) 2002-2017
Childress	2.5	0.0
Clay	5.0	0.8
Cochran	0.5	0.3
Coke	3.1	0.8
Coleman	4.2	1.7
Collin	166.7	78.6
Collingsworth	0.3	0.2
Colorado	8.8	4.7
Comal	72.0	48.6
Comanche	2.8	0.5
Concho	1.6	1.1
Cooke	23.6	7.5
Coryell	21.4	8.0
Cottle	-0.3	0.2
Crane	3.1	2.7
Crockett	7.7	7.8
Crosby	2.5	0.6
Culberson	0.2	0.2
Dallam	0.6	0.2
Dallas	171.4	38.6
Dawson	5.2	1.7
Deaf Smith	4.5	1.1
Delta	2.8	0.8

County	Change in Total Developed Land Area (OVERALL SPRAWL) 1982-2017	Change in Total Developed Land Area (OVERALL SPRAWL) 2002-2017
Denton	169.7	63.4
DeWitt	9.2	9.2
Dickens	0.3	0.2
Dimmit	14.4	10.6
Donley	1.3	0.3
Duval	11.7	4.4
Eastland	5.0	2.7
Ector	28.9	14.4
Edwards	3.8	2.0
Ellis	112.0	44.7
El Paso	120.0	60.8
Erath	17.8	5.2
Falls	10.6	0.8
Fannin	7.0	1.7
Fayette	19.2	9.1
Fisher	0.5	0.0
Floyd	2.0	0.5
Foard	-0.6	-0.2
Fort Bend	146.4	68.9
Franklin	9.4	5.3
Freestone	15.9	7.2
Frio	10.3	5.0
Gaines	13.9	6.9

County	Change in Total Developed Land Area (OVERALL SPRAWL) 1982-2017	Change in Total Developed Land Area (OVERALL SPRAWL) 2002-2017
Galveston	58.1	18.0
Garza	-0.2	-0.5
Gillespie	24.7	9.5
Glasscock	10.5	8.1
Goliad	5.3	1.3
Gonzales	5.2	2.8
Gray	3.9	0.6
Grayson	59.8	21.9
Gregg	42.5	13.3
Grimes	21.9	7.7
Guadalupe	38.8	17.8
Hale	10.2	4.1
Hall	-0.3	-0.2
Hamilton	3.1	1.1
Hansford	-1.4	0.2
Hardeman	1.3	0.3
Hardin	21.7	6.1
Harris	426.1	163.0
Harrison	42.0	15.5
Hartley	1.3	0.6
Haskell	3.0	1.4
Hays	88.4	33.4
Hemphill	11.4	9.1

County	Change in Total Developed Land Area (OVERALL SPRAWL) 1982-2017	Change in Total Developed Land Area (OVERALL SPRAWL) 2002-2017
Henderson	48.0	13.4
Hidalgo	135.8	50.9
Hill	29.1	7.7
Hockley	10.3	3.9
Hood	16.6	2.8
Hopkins	8.8	5.5
Houston	7.0	4.7
Howard	23.6	14.8
Hudspeth	0.6	0.2
Hunt	40.3	15.2
Hutchinson	7.5	1.4
Irion	4.8	3.8
Jack	5.6	1.6
Jackson	5.6	3.0
Jasper	38.8	10.5
Jeff Davis	5.8	5.8
Jefferson	76.3	15.6
Jim Hogg	-6.9	0.3
Jim Wells	12.0	5.2
Johnson	93.1	33.4
Jones	13.3	5.9
Karnes	16.1	14.1
Kaufman	32.5	10.3

County	Change in Total Developed Land Area (OVERALL SPRAWL) 1982-2017	Change in Total Developed Land Area (OVERALL SPRAWL) 2002-2017
Kendall	18.4	8.4
Kenedy	3.1	3.0
Kent	3.3	3.1
Kerr	22.8	6.3
Kimble	2.2	1.1
King	0.2	-0.2
Kinney	0.0	0.0
Kleberg	14.7	2.5
Knox	2.0	0.6
Lamar	30.5	8.0
Lamb	3.6	1.3
Lampasas	8.0	2.3
La Salle	7.0	6.6
Lavaca	7.2	2.5
Lee	5.9	2.3
Leon	16.6	8.6
Liberty	58.8	24.5
Limestone	12.8	7.0
Lipscomb	9.1	5.2
Live Oak	12.7	8.0
Llano	17.8	3.0
Loving	5.9	5.2
Lubbock	59.5	24.7

County	Change in Total Developed Land Area (OVERALL SPRAWL) 1982-2017	Change in Total Developed Land Area (OVERALL SPRAWL) 2002-2017
Lynn	1.9	0.8
McCulloch	9.5	3.4
McLennan	29.8	9.1
McMullen	6.7	6.7
Madison	7.3	4.7
Marion	4.8	1.6
Martin	26.7	22.0
Mason	2.7	0.9
Matagorda	10.3	3.8
Maverick	20.3	9.1
Medina	14.8	7.3
Menard	0.5	0.5
Midland	70.0	36.3
Milam	13.3	5.5
Mills	1.6	-0.2
Mitchell	3.8	3.6
Montague	10.5	3.4
Montgomery	218.8	82.5
Moore	10.6	5.2
Morris	13.0	1.3
Motley	0.2	0.0
Nacogdoches	20.6	8.3
Navarro	22.3	4.1

County	Change in Total Developed Land Area (OVERALL SPRAWL) 1982-2017	Change in Total Developed Land Area (OVERALL SPRAWL) 2002-2017
Newton	8.9	3.3
Nolan	7.3	1.4
Nueces	61.4	17.8
Ochiltree	3.9	1.9
Oldham	1.4	0.2
Orange	57.2	9.8
Palo Pinto	14.4	4.7
Panola	23.4	17.5
Parker	59.1	22.5
Parmer	1.7	0.2
Pecos	123.4	28.9
Polk	18.6	0.6
Potter	37.0	11.7
Presidio	0.3	0.0
Rains	5.8	2.5
Randall	21.9	9.8
Reagan	5.5	4.4
Real	3.6	1.9
Red River	9.4	1.7
Reeves	20.6	20.2
Refugio	3.3	0.9
Roberts	2.2	0.5
Robertson	12.8	8.0

County	Change in Total Developed Land Area (OVERALL SPRAWL) 1982-2017	Change in Total Developed Land Area (OVERALL SPRAWL) 2002-2017
Rockwall	35.0	15.3
Runnels	4.2	5.0
Rusk	49.2	11.4
Sabine	7.5	0.8
San Augustine	20.6	3.9
San Jacinto	22.0	9.4
San Patricio	33.8	12.2
San Saba	1.1	1.1
Schleicher	9.2	9.1
Scurry	16.3	12.5
Shackelford	0.6	0.5
Shelby	20.6	5.2
Sherman	1.7	0.2
Smith	97.5	31.7
Somervell	5.8	2.2
Starr	23.8	6.9
Stephens	2.2	0.5
Sterling	2.3	0.9
Stonewall	0.8	0.2
Sutton	19.4	16.1
Swisher	2.5	0.2
Tarrant	296.3	105.5
Taylor	16.6	4.8

County	Change in Total Developed Land Area (OVERALL SPRAWL) 1982-2017	Change in Total Developed Land Area (OVERALL SPRAWL) 2002-2017
Terrell	4.1	0.8
Terry	4.1	1.4
Throckmorton	1.1	1.1
Titus	13.3	5.5
Tom Green	19.7	4.1
Travis	178.3	76.4
Trinity	16.1	8.0
Tyler	20.3	6.6
Upshur	24.8	10.3
Upton	20.5	13.9
Uvalde	3.4	1.1
Val Verde	11.3	7.0
Van Zandt	70.6	23.6
Victoria	19.1	5.2
Walker	30.3	12.0
Waller	31.3	15.3
Ward	8.1	4.4
Washington	13.4	4.1
Webb	71.4	25.0
Wharton	10.9	5.2
Wheeler	7.3	6.1
Wichita	16.6	2.7
Wilbarger	1.1	0.2

County	Change in Total Developed Land Area (OVERALL SPRAWL) 1982-2017	Change in Total Developed Land Area (OVERALL SPRAWL) 2002-2017
Willacy	2.5	1.3
Williamson	94.7	46.9
Wilson	14.5	7.2
Winkler	5.2	1.7
Wise	28.3	14.7
Wood	52.7	22.2
Yoakum	5.8	3.1
Young	4.1	1.1
Zapata	14.2	5.3
Zavala	7.2	2.0
All Texas	**6,633.8**	**2,616.3**

From 1982 to 2017, Texas counties sprawled by 6,633.8 square miles, an average of approximately 190 square miles (121,304 acres) per year. During the most recent 15-year period of those 35 years, Texas counties sprawled by 2,261.3 square miles, an average of 151 square miles (96,482 acres) per year. Thus, we can see that the annual rate of sprawl in Texas has diminished somewhat (by 21 percent) in recent years, but it remains very high, the highest in the nation, in fact.

Since our primary concern as conservationists 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 more than two decades 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.

3.3 RELATIVE WEIGHT OF SPRAWL FACTORS IN TEXAS

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), used this methodology in a scientific paper for a peer-reviewed journal in the early 1990s 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.[70] This approach can be applied to virtually any type of resource in which use of the resource in question is increasing over time, and the number of resource consumers is changing, the amount of the resource being used by each consumer on average is changing, or both.

This study, as have our other studies over the past two decades, applies this method to urban sprawl. Rural, undeveloped land (open space) 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 20 applies this method to the change (almost entirely growth rather than decline) in the area of developed land (sprawl) of all of 254 counties 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).

[70] 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 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.

Table 20. Sources of Sprawl in Texas Counties, 1982-2017

County	Overall Sprawl 1982 to 2017 (square miles)	% of Overall Sprawl Related to POPULATION GROWTH	% of Overall Sprawl Related to GROWTH IN PER CAPITA LAND CONSUMPTION
Anderson	21.4	58%	42%
Andrews	21.6	26%	74%
Angelina	41.7	28%	72%
Aransas	12.2	100%	0%
Archer	3.3	82%	18%
Armstrong	0.3	0%	100%
Atascosa	53.0	49%	51%
Austin	9.8	100%	0%
Bailey	0.6	0%	100%
Bandera	22.7	100%	0%
Bastrop	43.3	100%	0%
Baylor	1.6	0%	100%
Bee	7.5	69%	31%
Bell	107.3	88%	12%
Bexar	220.5	100%	0%
Blanco	5.2	100%	0%
Borden	2.0	0%	100%
Bosque	11.1	71%	29%
Bowie	25.9	65%	35%
Brazoria	120.3	100%	0%
Brazos	72.0	80%	20%

County	Overall Sprawl 1982 to 2017 (square miles)	% of Overall Sprawl Related to POPULATION GROWTH	% of Overall Sprawl Related to GROWTH IN PER CAPITA LAND CONSUMPTION
Brewster	0.3	100%	0%
Briscoe	0.9	0%	100%
Brooks	6.6	0%	100%
Brown	5.8	43%	57%
Burleson	11.1	49%	51%
Burnet	25.2	100%	0%
Caldwell	17.2	88%	12%
Calhoun	16.6	4%	96%
Callahan	4.4	55%	45%
Cameron	59.7	100%	0%
Camp	5.0	51%	49%
Carson	4.8	0%	100%
Cass	17.7	0%	100%
Castro	2.5	0%	100%
Chambers	24.4	100%	0%
Cherokee	27.7	35%	65%
Childress	2.5	16%	94%
Clay	5.0	24%	76%
Cochran	0.5	0%	100%
Coke	3.1	0%	100%
Coleman	4.2	0%	100%
Collin	166.7	100%	0%

County	Overall Sprawl 1982 to 2017 (square miles)	% of Overall Sprawl Related to POPULATION GROWTH	% of Overall Sprawl Related to GROWTH IN PER CAPITA LAND CONSUMPTION
Collingsworth	0.3	0%	100%
Colorado	8.8	26%	74%
Comal	72.0	100%	0%
Comanche	2.8	24%	76%
Concho	1.6	0%	100%
Cooke	23.6	45%	55%
Coryell	21.4	35%	65%
Cottle	-0.3	0%	100%
Crane	3.1	0%	100%
Crockett	7.7	0%	100%
Crosby	2.5	0%	100%
Culberson	0.2	0%	100%
Dallam	0.6	82%	18%
Dallas	171.4	100%	0%
Dawson	5.2	0%	100%
Deaf Smith	4.5	0%	100%
Delta	2.8	16%	84%
Denton	169.7	100%	0%
DeWitt	9.2	4%	96%
Dickens	0.3	0%	100%
Dimmit	14.4	0%	100%
Donley	1.3	0%	100%

County	Overall Sprawl 1982 to 2017 (square miles)	% of Overall Sprawl Related to POPULATION GROWTH	% of Overall Sprawl Related to GROWTH IN PER CAPITA LAND CONSUMPTION
Duval	11.7	0%	100%
Eastland	5.0	0%	100%
Ector	28.9	50%	50%
Edwards	3.8	0%	100%
Ellis	112.0	68%	32%
El Paso	120.0	71%	29%
Erath	17.8	100%	0%
Falls	10.6	0%	100%
Fannin	7.0	100%	0%
Fayette	19.2	32%	68%
Fisher	0.5	0%	100%
Floyd	2.0	0%	100%
Foard	-0.6	0%	100%
Fort Bend	146.4	100%	0%
Franklin	9.4	50%	50%
Freestone	15.9	27%	73%
Frio	10.3	71%	29%
Gaines	13.9	88%	12%
Galveston	58.1	100%	0%
Garza	-0.2	0%	100%
Gillespie	24.7	93%	7%
Glasscock	10.5	6%	94%

County	Overall Sprawl 1982 to 2017 (square miles)	% of Overall Sprawl Related to POPULATION GROWTH	% of Overall Sprawl Related to GROWTH IN PER CAPITA LAND CONSUMPTION
Goliad	5.3	74%	26%
Gonzales	5.2	52%	48%
Gray	3.9	0%	100%
Grayson	59.8	48%	52%
Gregg	42.5	18%	82%
Grimes	21.9	49%	51%
Guadalupe	38.8	100%	0%
Hale	10.2	0%	100%
Hall	-0.3	0%	100%
Hamilton	3.1	9%	91%
Hansford	-1.4	68%	32%
Hardeman	1.3	0%	100%
Hardin	21.7	100%	0%
Harris	426.1	100%	0%
Harrison	42.0	17%	83%
Hartley	1.3	100%	0%
Haskell	3.0	0%	100%
Hays	88.4	96%	4%
Hemphill	11.4	0%	100%
Henderson	48.0	97%	3%
Hidalgo	135.8	100%	0%
Hill	29.1	43%	57%

County	Overall Sprawl 1982 to 2017 (square miles)	% of Overall Sprawl Related to POPULATION GROWTH	% of Overall Sprawl Related to GROWTH IN PER CAPITA LAND CONSUMPTION
Hockley	10.3	0%	100%
Hood	16.6	100%	0%
Hopkins	8.8	77%	23%
Houston	7.0	6%	94%
Howard	23.6	0%	100%
Hudspeth	0.6	100%	0%
Hunt	40.3	80%	20%
Hutchinson	7.5	0%	100%
Irion	4.8	0%	100%
Jack	5.6	41%	59%
Jackson	5.6	24%	76%
Jasper	38.8	14%	86%
Jeff Davis	5.8	47%	53%
Jefferson	76.3	0%	100%
Jim Hogg	-6.9	8%	92%
Jim Wells	12.0	13%	87%
Johnson	93.1	68%	32%
Jones	13.3	22%	78%
Karnes	16.1	17%	87%
Kaufman	32.5	100%	0%
Kendall	18.4	100%	0%
Kenedy	3.1	0%	100%

County	Overall Sprawl 1982 to 2017 (square miles)	% of Overall Sprawl Related to POPULATION GROWTH	% of Overall Sprawl Related to GROWTH IN PER CAPITA LAND CONSUMPTION
Kent	3.3	0%	100%
Kerr	22.8	100%	0%
Kimble	2.2	18%	82%
King	0.2	0%	100%
Kinney	0.0	0%	100%
Kleberg	14.7	0%	100%
Knox	2.0	0%	100%
Lamar	30.5	31%	69%
Lamb	3.6	0%	100%
Lampasas	8.0	100%	0%
La Salle	7.0	46%	64%
Lavaca	7.2	10%	90%
Lee	5.9	59%	41%
Leon	16.6	79%	21%
Liberty	58.8	62%	38%
Limestone	12.8	25%	75%
Lipscomb	9.1	0%	100%
Live Oak	12.7	44%	56%
Llano	17.8	100%	0%
Loving	5.9	54%	46%
Lubbock	59.5	55%	45%
Lynn	1.9	0%	100%

County	Overall Sprawl 1982 to 2017 (square miles)	% of Overall Sprawl Related to POPULATION GROWTH	% of Overall Sprawl Related to GROWTH IN PER CAPITA LAND CONSUMPTION
McCulloch	9.5	0%	100%
McLennan	29.8	100%	0%
McMullen	6.7	0%	100%
Madison	7.3	41%	59%
Marion	4.8	0%	100%
Martin	26.7	4%	96%
Mason	2.7	44%	56%
Matagorda	10.3	0%	100%
Maverick	20.3	78%	22%
Medina	14.8	100%	0%
Menard	0.5	0%	100%
Midland	70.0	70%	30%
Milam	13.3	16%	84%
Mills	1.6	51%	49%
Mitchell	3.8	0%	100%
Montague	10.5	12%	88%
Montgomery	218.8	100%	0%
Moore	10.6	43%	57%
Morris	13.0	0%	100%
Motley	0.2	0%	100%
Nacogdoches	20.6	61%	39%
Navarro	22.3	37%	63%

County	Overall Sprawl 1982 to 2017 (square miles)	% of Overall Sprawl Related to POPULATION GROWTH	% of Overall Sprawl Related to GROWTH IN PER CAPITA LAND CONSUMPTION
Newton	8.9	5	95%
Nolan	7.3	0%	100%
Nueces	61.4	43%	57%
Ochiltree	3.9	0%	100%
Oldham	1.4	0%	100%
Orange	57.2	0%	100%
Palo Pinto	14.4	36%	64%
Panola	23.4	6%	94%
Parker	59.1	100%	0%
Parmer	1.7	0%	100%
Pecos	123.4	0%	100%
Polk	18.6	100%	0%
Potter	37.0	32%	68%
Presidio	0.3	100%	0%
Rains	5.8	100%	0%
Randall	21.9	100%	0%
Reagan	5.5	0%	100%
Real	3.6	84%	16%
Red River	9.4	0%	100%
Reeves	20.6	0%	100%
Refugio	3.3	0%	100%
Roberts	2.2	0%	100%

County	Overall Sprawl 1982 to 2017 (square miles)	% of Overall Sprawl Related to POPULATION GROWTH	% of Overall Sprawl Related to GROWTH IN PER CAPITA LAND CONSUMPTION
Robertson	12.8	25%	75%
Rockwall	35.0	100%	0%
Runnels	4.2	0%	100%
Rusk	49.2	26%	74%
Sabine	7.5	19%	81%
San Augustine	20.6	0%	100%
San Jacinto	22.0	100%	0%
San Patricio	33.8	17%	83%
San Saba	1.1	26%	74%
Schleicher	9.2	0%	100%
Scurry	16.3	0%	100%
Shackelford	0.6	0%	100%
Shelby	20.6	7%	93%
Sherman	1.7	0%	100%
Smith	97.5	54%	46%
Somervell	5.8	100%	0%
Starr	23.8	100%	0%
Stephens	2.2	0%	100%
Sterling	2.3	0%	100%
Stonewall	0.8	0%	100%
Sutton	19.4	0%	100%
Swisher	2.5	0%	100%

County	Overall Sprawl 1982 to 2017 (square miles)	% of Overall Sprawl Related to POPULATION GROWTH	% of Overall Sprawl Related to GROWTH IN PER CAPITA LAND CONSUMPTION
Tarrant	296.3	100%	0%
Taylor	16.6	41%	59%
Terrell	4.1	0%	100%
Terry	4.1	0%	100%
Throckmorton	1.1	0%	100%
Titus	13.3	49%	51%
Tom Green	19.7	87%	13%
Travis	178.3	100%	0%
Trinity	16.1	48%	52%
Tyler	20.3	50%	50%
Upshur	24.8	31%	69%
Upton	20.5	0%	100%
Uvalde	3.4	100%	0%
Val Verde	11.3	43%	57%
Van Zandt	70.6	47%	53%
Victoria	19.1	77%	23%
Walker	30.3	66%	34%
Waller	31.3	100%	0%
Ward	8.1	0%	100%
Washington	13.4	69%	31%
Webb	71.4	89%	11%
Wharton	10.9	5%	95%

County	Overall Sprawl 1982 to 2017 (square miles)	% of Overall Sprawl Related to POPULATION GROWTH	% of Overall Sprawl Related to GROWTH IN PER CAPITA LAND CONSUMPTION
Wheeler	7.3	0%	100%
Wichita	16.6	19%	81%
Wilbarger	1.1	0%	100%
Willacy	2.5	87%	13%
Williamson	94.7	100%	0%
Wilson	14.5	100%	0%
Winkler	5.2	0%	100%
Wise	28.3	100%	0%
Wood	52.7	47%	53%
Yoakum	5.8	2%	98%
Young	4.1	0%	100%
Zapata	14.2	73%	27%
Zavala	7.2	0%	100%
All Texas Counties	**6,633.8**	**70%**	**30%**

Figure 48 graphically portrays the final row in **Table 19**, showing that 70 percent of the sprawl in Texas counties from 1982 to 2017 is related to population growth, and 30 percent is related to growth in per capita land consumption.

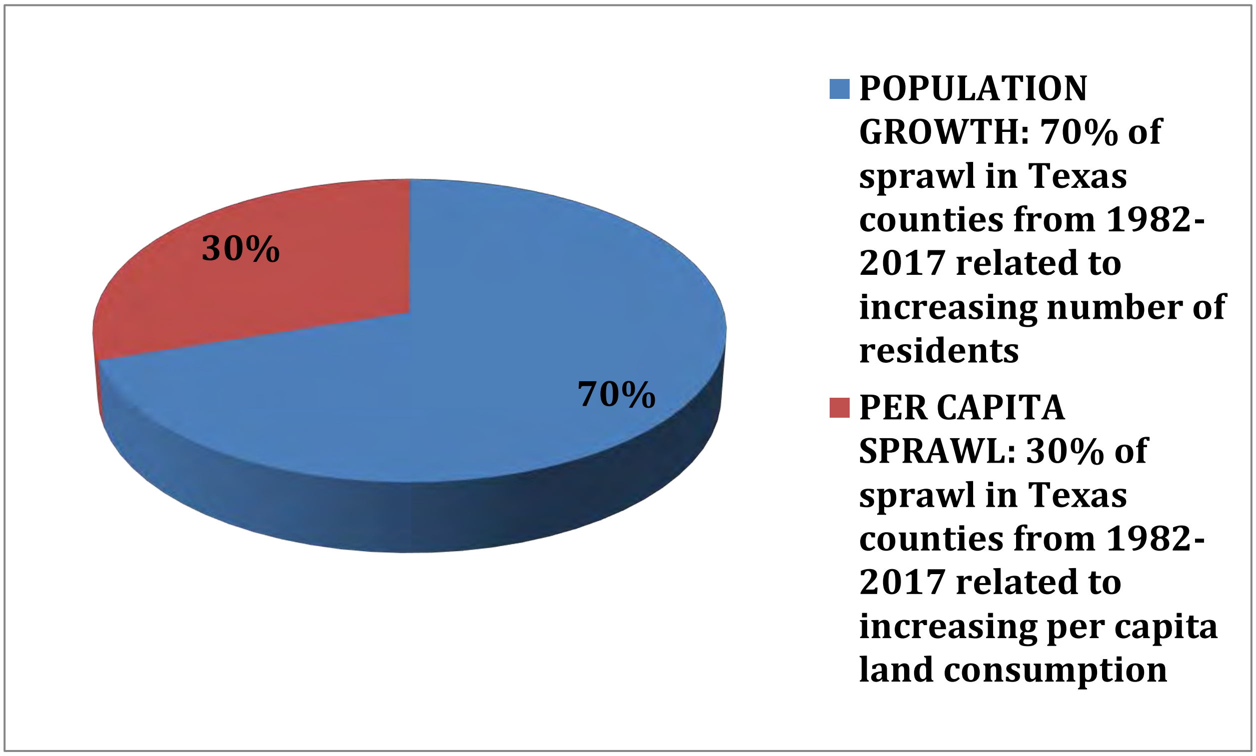

Figure 48. Percentages of Sprawl Related to Population Growth and Per Capita Sprawl in Texas, 1982 to 2017

Sources: USDA NRC National Resources Inventory, 1982-2017; Census Bureau population estimates to Texas countries, 1982 and 2017.
Description: Approximately 30 percent of the sprawl in Texas' 256 counties was related to increasing per capita land consumption. Approximately 70 percent of the sprawl was related to population growth.

Between 1982 and 2017, land development in Texas engulfed approximately 6,634 additional square miles of rural land in aggregate. **Figure 49** shows that population growth was responsible for more than twice as much loss of rural land as per capita sprawl or rising land consumption per capita: 4,637 square miles vs. 1,997 square miles.

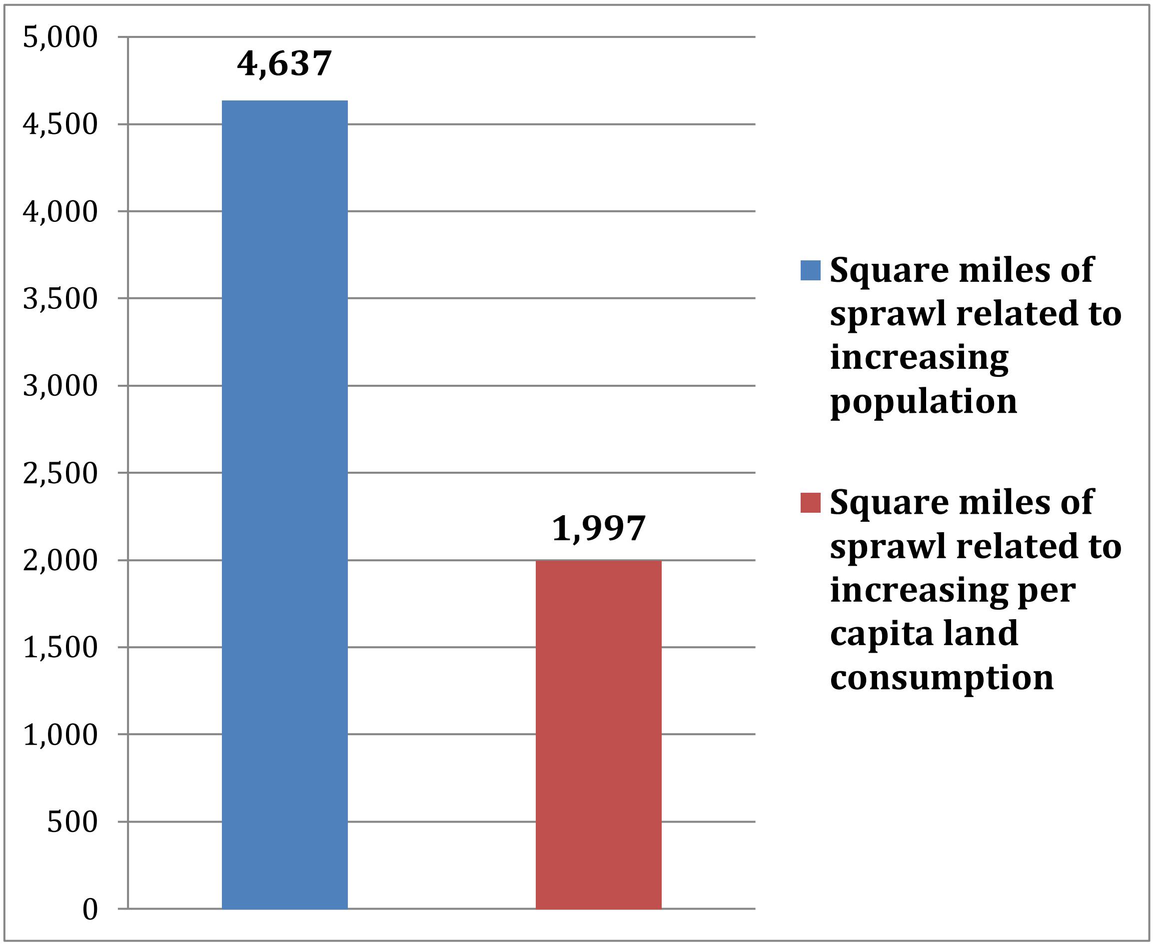

Figure 49. Rural Land Lost to Population Growth vs. Per Capita Sprawl in Texas, 1982-2017

Table 21 shows the county-by-county percentages of sprawl related to growth in population and growth in per capita land consumption in the 256 Texas counties for the most recent 15-year time period, 2002 to 2017.

Table 21. Sources of Sprawl in Texas Counties, 2002-2017

County	Overall Sprawl 2002 to 2017 (square miles)	% of Overall Sprawl Related to POPULATION GROWTH	% of Overall Sprawl Related to GROWTH IN PER CAPITA LAND CONSUMPTION
Anderson	5.5	52%	48%

County	Overall Sprawl 2002 to 2017 (square miles)	% of Overall Sprawl Related to POPULATION GROWTH	% of Overall Sprawl Related to GROWTH IN PER CAPITA LAND CONSUMPTION
Andrews	17.0	72%	28%
Angelina	10.3	51%	49%
Aransas	3.3	100%	0%
Archer	0.6	0%	100%
Armstrong	0.2	0%	100%
Atascosa	29.2	37%	73%
Austin	4.2	100%	0%
Bailey	0.3	100%	0%
Bandera	3.4	100%	0%
Bastrop	20.2	100%	0%
Baylor	0.2	0%	100%
Bee	3.3	23%	77%
Bell	47.3	100%	0%
Bexar	83.1	100%	0%
Blanco	3.1	90%	10%
Borden	1.7	0%	100%
Bosque	4.5	32%	68%
Bowie	5.8	86%	14%
Brazoria	47.5	100%	0%
Brazos	27.0	100%	0%
Brewster	0.9	100%	0%
Briscoe	0.0	0%	100%
Brooks	2.8	0%	100%

County	Overall Sprawl 2002 to 2017 (square miles)	% of Overall Sprawl Related to POPULATION GROWTH	% of Overall Sprawl Related to GROWTH IN PER CAPITA LAND CONSUMPTION
Brown	3.4	1%	99%
Burleson	3.0	83%	17%
Burnet	8.0	100%	0%
Caldwell	10.0	64%	36%
Calhoun	3.8	52%	48%
Callahan	1.1	100%	0%
Cameron	23.9	96%	4%
Camp	2.7	43%	57%
Carson	0.2	0%	100%
Cass	5.5	0%	100%
Castro	0.9	0%	100%
Chambers	8.1	100%	0%
Cherokee	5.6	82%	18%
Childress	0.0	0%	100%
Clay	0.8	0%	100%
Cochran	0.3	0%	100%
Coke	0.8	0%	100%
Coleman	1.7	0%	100%
Collin	78.6	100%	0%
Collingsworth	0.2	0%	100%
Colorado	4.7	35%	65%
Comal	48.6	95%	5%

County	Overall Sprawl 2002 to 2017 (square miles)	% of Overall Sprawl Related to POPULATION GROWTH	% of Overall Sprawl Related to GROWTH IN PER CAPITA LAND CONSUMPTION
Comanche	0.5	0%	100%
Concho	1.1	0%	100%
Cooke	7.5	37%	63%
Coryell	8.0	11%	89%
Cottle	0.2	0%	100%
Crane	2.7	68%	32%
Crockett	7.8	0%	100%
Crosby	0.6	0%	100%
Culberson	0.2	0%	100%
Dallam	0.2	100%	0%
Dallas	38.6	100%	0%
Dawson	1.7	0%	100%
Deaf Smith	1.1	32%	68%
Delta	0.8	0%	100%
Denton	63.4	100%	0%
DeWitt	9.2	1%	99%
Dickens	0.2	0%	100%
Dimmit	10.6	4%	96%
Donley	0.3	0%	100%
Duval	4.4	0%	100%
Eastland	2.7	3%	97%
Ector	14.4	100%	0%

County	Overall Sprawl 2002 to 2017 (square miles)	% of Overall Sprawl Related to POPULATION GROWTH	% of Overall Sprawl Related to GROWTH IN PER CAPITA LAND CONSUMPTION
Edwards	2.0	0%	100%
Ellis	44.7	100%	0%
El Paso	60.8	63%	27%
Erath	5.2	0%	100%
Falls	0.8	0%	100%
Fannin	1.7	100%	0%
Fayette	9.1	45%	55%
Fisher	0.0	0%	100%
Floyd	0.5	0%	100%
Foard	-0.2	0%	100%
Fort Bend	68.9	100%	0%
Franklin	5.3	34%	66%
Freestone	7.2	23%	77%
Frio	5.0	93%	7%
Gaines	6.9	100%	0%
Galveston	18.0	100%	0%
Garza	-0.5	0%	100%
Gillespie	9.5	100%	0%
Glasscock	8.1	3%	97%
Goliad	1.3	81%	19%
Gonzales	2.8	84%	16%
Gray	0.6	36%	64%

County	Overall Sprawl 2002 to 2017 (square miles)	% of Overall Sprawl Related to POPULATION GROWTH	% of Overall Sprawl Related to GROWTH IN PER CAPITA LAND CONSUMPTION
Grayson	21.9	69%	31%
Gregg	13.3	55%	45%
Grimes	7.7	44%	56%
Guadalupe	17.8	100%	0%
Hale	4.1	0%	100%
Hall	-0.2	0%	100%
Hamilton	1.1	56%	44%
Hansford	0.2	100%	0%
Hardeman	0.3	0%	100%
Hardin	6.1	100%	0%
Harris	163.0	100%	0%
Harrison	15.5	25%	75%
Hartley	0.6	91%	9%
Haskell	1.4	0%	100%
Hays	33.4	100%	0%
Hemphill	9.1	20%	80%
Henderson	13.4	61%	39%
Hidalgo	50.9	100%	0%
Hill	7.7	50%	50%
Hockley	3.9	6%	94%
Hood	2.8	100%	0%
Hopkins	5.5	50%	50%

County	Overall Sprawl 2002 to 2017 (square miles)	% of Overall Sprawl Related to POPULATION GROWTH	% of Overall Sprawl Related to GROWTH IN PER CAPITA LAND CONSUMPTION
Houston	4.7	0%	100%
Howard	14.8	16%	84%
Hudspeth	0.2	100%	0%
Hunt	15.2	86%	14%
Hutchinson	1.4	0%	100%
Irion	3.8	0%	100%
Jack	1.6	0%	100%
Jackson	3.0	34%	66%
Jasper	10.5	0%	100%
Jeff Davis	5.8	4%	96%
Jefferson	15.6	27%	73%
Jim Hogg	0.3	0%	100%
Jim Wells	5.2	16%	84%
Johnson	33.4	77%	23%
Jones	5.9	0%	100%
Karnes	14.1	4%	96%
Kaufman	10.3	100%	0%
Kendall	8.4	100%	0%
Kenedy	3.0	0%	100%
Kent	3.1	0%	100%
Kerr	6.3	100%	0%
Kimble	1.1	0%	100%

County	Overall Sprawl 2002 to 2017 (square miles)	% of Overall Sprawl Related to POPULATION GROWTH	% of Overall Sprawl Related to GROWTH IN PER CAPITA LAND CONSUMPTION
King	-0.2	0%	100%
Kinney	0.0	0%	100%
Kleberg	2.5	0%	100%
Knox	0.6	0%	100%
Lamar	8.0	14%	86%
Lamb	1.3	0%	100%
Lampasas	2.3	100%	0%
La Salle	6.6	44%	56%
Lavaca	2.5	65%	35%
Lee	2.3	49%	51%
Leon	8.6	35%	65%
Liberty	24.5	51%	49%
Limestone	7.0	17%	83%
Lipscomb	5.2	36%	64%
Live Oak	8.0	6%	94%
Llano	3.0	100%	0%
Loving	5.2	83%	17%
Lubbock	24.7	93%	7%
Lynn	0.8	0%	100%
McCulloch	3.4	1%	99%
McLennan	9.1	100%	0%
McMullen	6.7	0%	100%

County	Overall Sprawl 2002 to 2017 (square miles)	% of Overall Sprawl Related to POPULATION GROWTH	% of Overall Sprawl Related to GROWTH IN PER CAPITA LAND CONSUMPTION
Madison	4.7	37%	63%
Marion	1.6	0%	100%
Martin	22.0	21%	79%
Mason	0.9	100%	0%
Matagorda	3.8	0%	100%
Maverick	9.1	73%	27%
Medina	7.3	100%	0%
Menard	0.5	0%	100%
Midland	36.3	100%	0%
Milam	5.5	0%	100%
Mills	-0.2	82%	18%
Mitchell	3.6	0%	100%
Montague	3.4	11%	89%
Montgomery	82.5	100%	0%
Moore	5.2	35%	65%
Morris	1.3	0%	100%
Motley	0.0	0%	100%
Nacogdoches	8.3	58%	42%
Navarro	4.1	60%	40%
Newton	3.3	0%	100%
Nolan	1.4	0%	100%
Nueces	17.8	99%	1%

County	Overall Sprawl 2002 to 2017 (square miles)	% of Overall Sprawl Related to POPULATION GROWTH	% of Overall Sprawl Related to GROWTH IN PER CAPITA LAND CONSUMPTION
Ochiltree	1.9	78%	22%
Oldham	0.2	100%	0%
Orange	9.8	15%	85%
Palo Pinto	4.7	57%	63%
Panola	17.5	2%	98%
Parker	22.5	100%	0%
Parmer	0.2	0%	100%
Pecos	28.9	0%	100%
Polk	0.6	100%	0%
Potter	11.7	31%	69%
Presidio	0.0	0%	100%
Rains	2.5	69%	31%
Randall	9.8	100%	0%
Reagan	4.4	53%	47%
Real	1.9	72%	28%
Red River	1.7	0%	100%
Reeves	20.2	24%	76%
Refugio	0.9	0%	100%
Roberts	0.5	100%	0%
Robertson	8.0	27%	73%
Rockwall	15.3	100%	0%
Runnels	5.0	0%	100%

County	Overall Sprawl 2002 to 2017 (square miles)	% of Overall Sprawl Related to POPULATION GROWTH	% of Overall Sprawl Related to GROWTH IN PER CAPITA LAND CONSUMPTION
Rusk	11.4	81%	19%
Sabine	0.8	0%	100%
San Augustine	3.9	0%	100%
San Jacinto	9.4	79%	21%
San Patricio	12.2	4%	96%
San Saba	1.1	0%	100%
Schleicher	9.1	0%	100%
Scurry	12.5	15%	85%
Shackelford	0.5	0%	100%
Shelby	5.2	1%	99%
Sherman	0.2	0%	100%
Smith	31.7	100%	0%
Somervell	2.2	100%	0%
Starr	6.9	100%	0%
Stephens	0.5	0%	100%
Sterling	0.9	0%	100%
Stonewall	0.2	0%	100%
Sutton	16.1	0%	100%
Swisher	0.2	0%	100%
Tarrant	105.5	100%	0%
Taylor	4.8	96%	4%
Terrell	0.8	0%	100%

County	Overall Sprawl 2002 to 2017 (square miles)	% of Overall Sprawl Related to POPULATION GROWTH	% of Overall Sprawl Related to GROWTH IN PER CAPITA LAND CONSUMPTION
Terry	1.4	0%	100%
Throckmorton	1.1	0%	100%
Titus	5.5	57%	43%
Tom Green	4.1	100%	0%
Travis	76.4	100%	0%
Trinity	8.0	15%	85%
Tyler	6.6	23%	77%
Upshur	10.3	40%	60%
Upton	13.9	23%	77%
Uvalde	1.1	62%	38%
Val Verde	7.0	23%	77%
Van Zandt	23.6	39%	61%
Victoria	5.2	100%	0%
Walker	12.0	71%	29%
Waller	15.3	100%	0%
Ward	4.4	54%	46%
Washington	4.1	96%	4%
Webb	25.0	100%	0%
Wharton	5.2	17%	83%
Wheeler	6.1	8%	92%
Wichita	2.7	18%	82%
Wilbarger	0.2	0%	100%

County	Overall Sprawl 2002 to 2017 (square miles)	% of Overall Sprawl Related to POPULATION GROWTH	% of Overall Sprawl Related to GROWTH IN PER CAPITA LAND CONSUMPTION
Willacy	1.3	68%	32%
Williamson	46.9	100%	0%
Wilson	7.2	100%	0%
Winkler	1.7	62%	38%
Wise	14.7	71%	29%
Wood	22.2	47%	53%
Yoakum	3.1	100%	0%
Young	1.1	36%	74%
Zapata	5.3	54%	46%
Zavala	2.0	23%	77%
All Texas Counties	**2,616.3**	**73%**	**27%**

Overall, from 2002 to 2017, population growth in Texas accounted for almost three times the loss of rural land and open space as growth in per capita land consumption, 73 percent versus 27 percent. This is captured graphically in **Figure 50**. These numbers reveal that in the most recent 15-year period of our overall 35-year period of study, the share of urban sprawl in Texas associated with population growth increased slightly. This parallels the national trend: while the annual or decadal rate of sprawl – conversion of rural land to developed land – has decreased somewhat, the percentage of that sprawl related to population growth has increased somewhat.

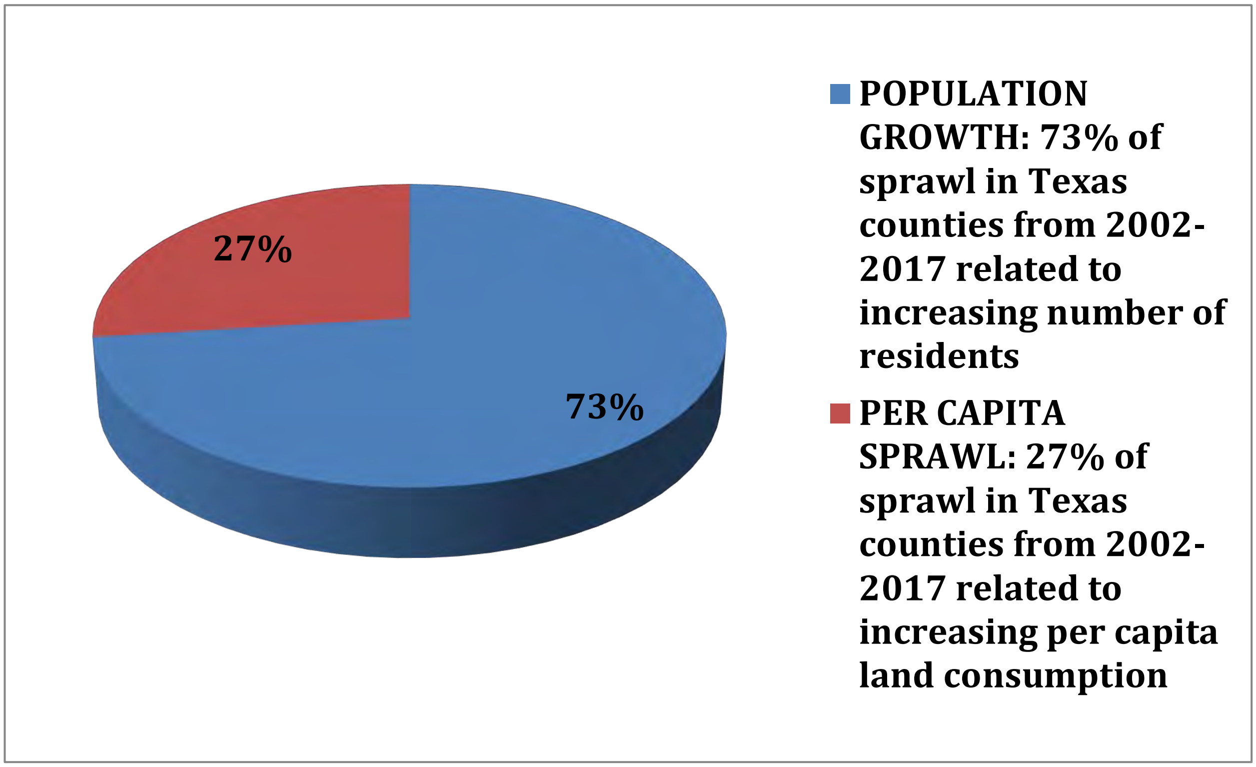

Figure 50. Percentages of Sprawl Related to Population Growth and Per Capita Sprawl in Texas, 2002 to 2017

Sources: USDA NRC National Resources Inventory, 2002-2017; Census Bureau population estimates to Texas countries, 2002 and 2017.

Description: Approximately 27 percent of the sprawl in Texas' 256 counties was related to increasing per capita land consumption. Approximately 73 percent of the sprawl was related to population growth.

Between 2002 and 2017, land development in Texas enveloped approximately 2,616 additional square miles of rural land in aggregate. **Figure 51** shows that population growth accounted almost three times as much development of rural land as per capita sprawl or rising land consumption per capita: 1,910 square miles vs. 706 square miles.

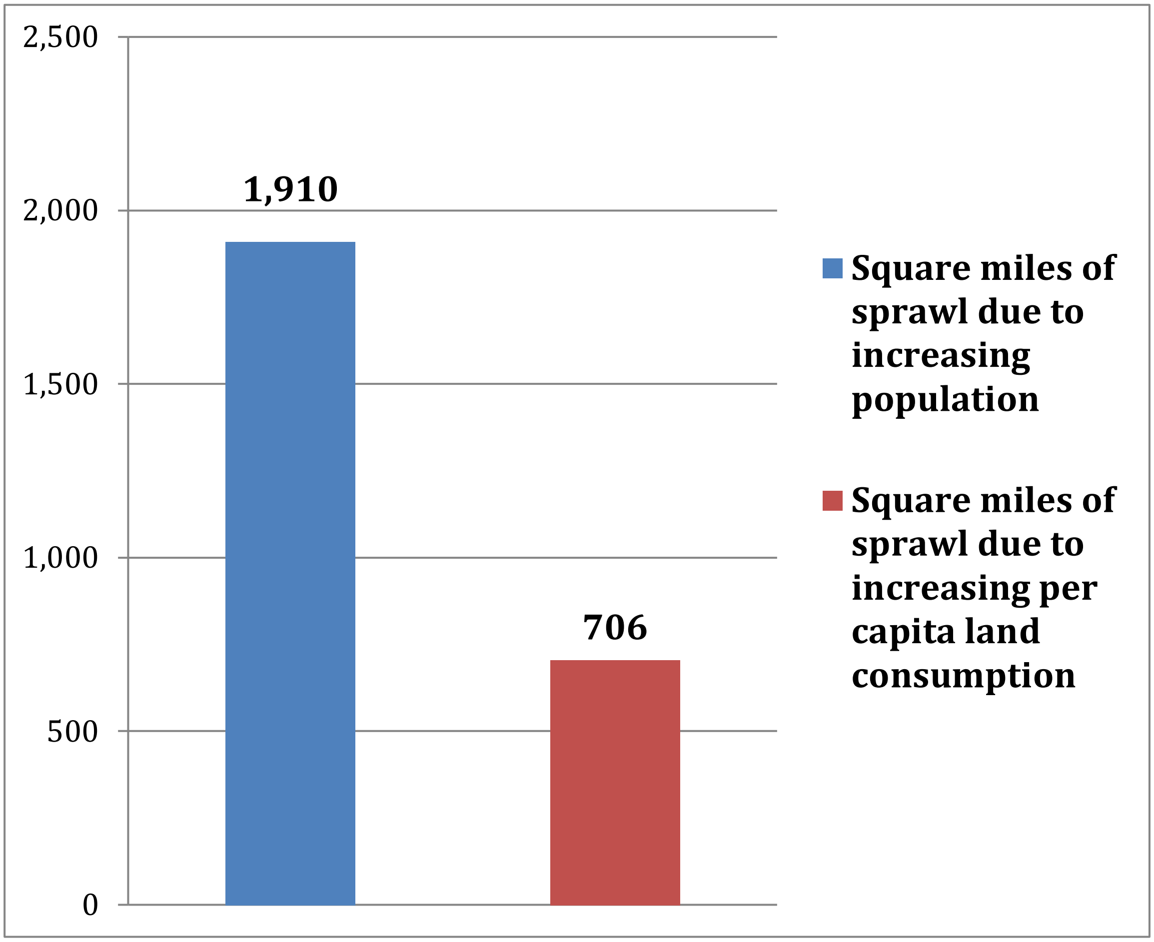

Figure 51. Rural Land Lost to Population Growth vs. Per Capita Sprawl in Texas, 2002-2017

These results are broadly similar to that shown for the Census Bureau's delineated Urbanized Areas in Texas from 2000 to 2010, as shown in **Table 22** and **Figure 52.** Bear in mind that these two approaches to measuring the growth of urbanized or developed areas over time and the criteria and thresholds for distinguishing them from rural areas are based on entirely different datasets and methodologies. Yet the results are in the same broad ballpark, which suggests that our findings are robust.

Table 22. 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%
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%

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
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
Waco	20.5	46%	54%
Wichita Falls	-1.6	N/A	N/A
Total Sprawl	**1,725.8**		
Weighted Average (Mean)		**85%**	**15%**

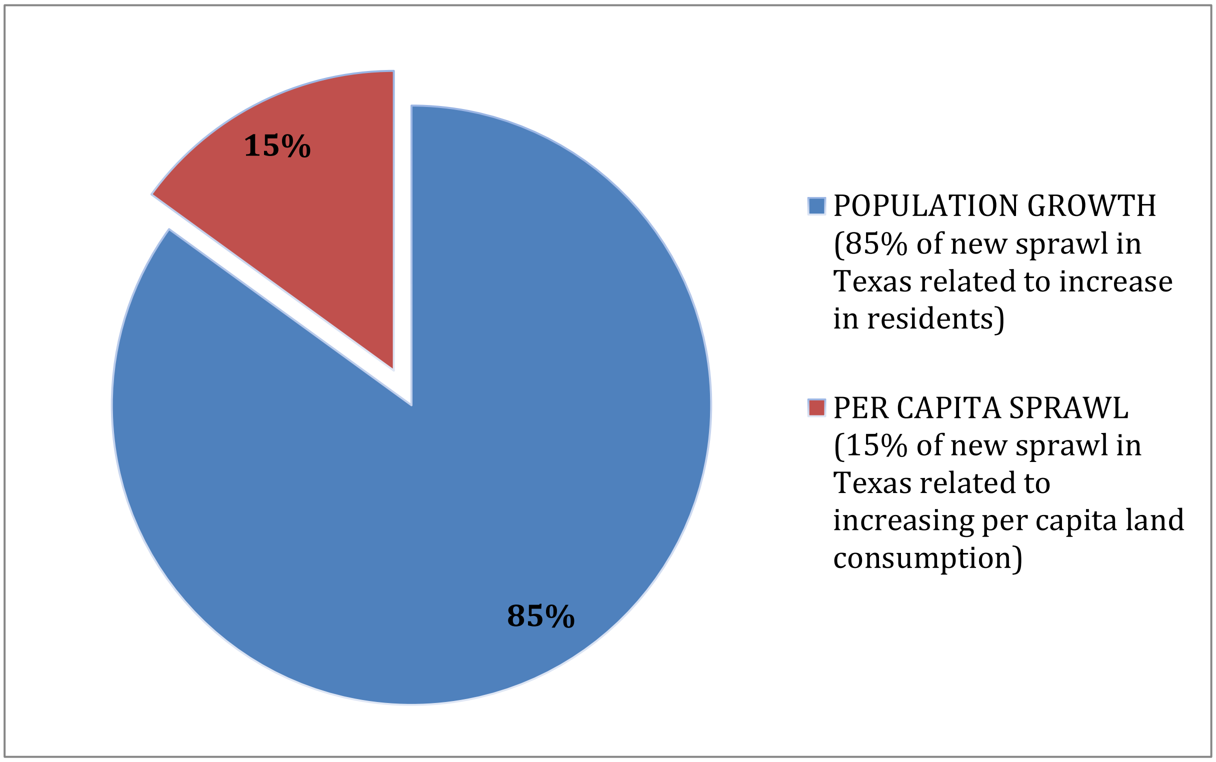

Figure 52. Percentages of Sprawl Related to Population Growth and Per Capita Sprawl in Texas' 34 Urbanized Areas

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 53** 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.

Given this apportionment or breakdown, opponents of sprawl and open space advocates in Texas should know that on the order of three-quarters or more of the sprawl problem in recent years is the inability to stabilize the state's population. In contrast, only about one-quarter of the problem is the inability to stabilize per capita land use within urban development in the state. Figure 53 displays the relative magnitude of these factors on a pie chart.

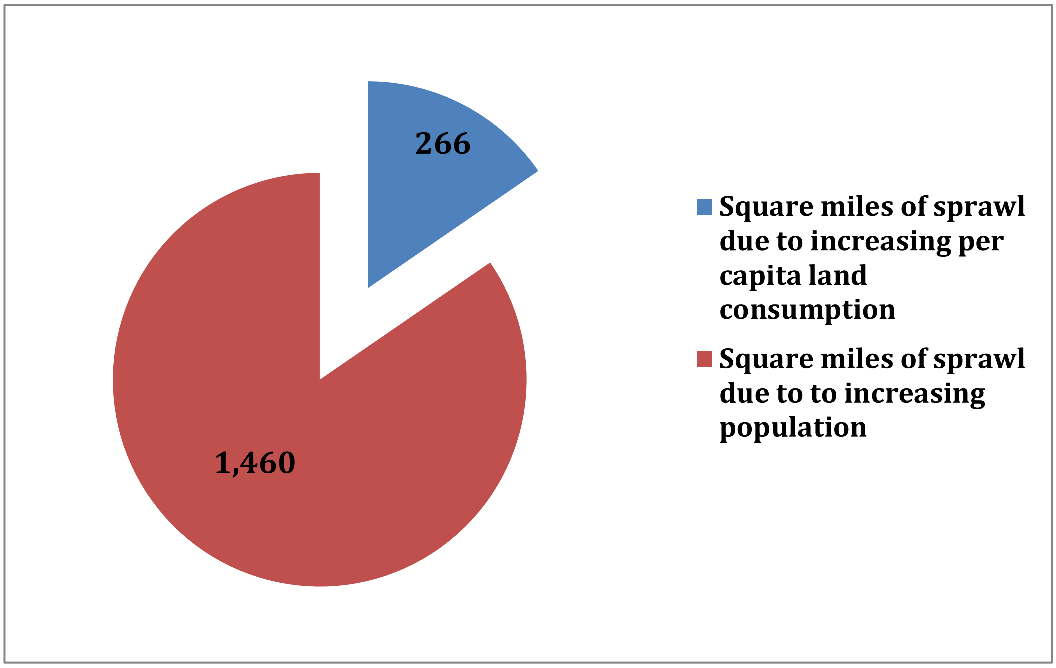

Figure 53. Rural Land Lost to Per Capita Sprawl vs. Population Growth in 34 Texas UAs, 2000-2010

3.4 Texas Compared to Other States

It is interesting to compare the relative amounts sprawl in Texas – and the two main factors behind it – with other states using the NRI data on Developed Land. Here we do so for two time periods: 1982 to 2017 and 2002-2017. The first covers the entire 35-year period of NRCS NRI land use data, while the second concentrates on the most recent 15-year subset of that period.

3.4.1 Developed Land from 1982 to 2017

Figure 54 shows that across the entire 35-year time span between 1982 and 2017, approximately 60 percent of all open space developed in the United States was associated with population growth and 40 percent was associated with increasing per capita land consumption or Per Capita Sprawl.

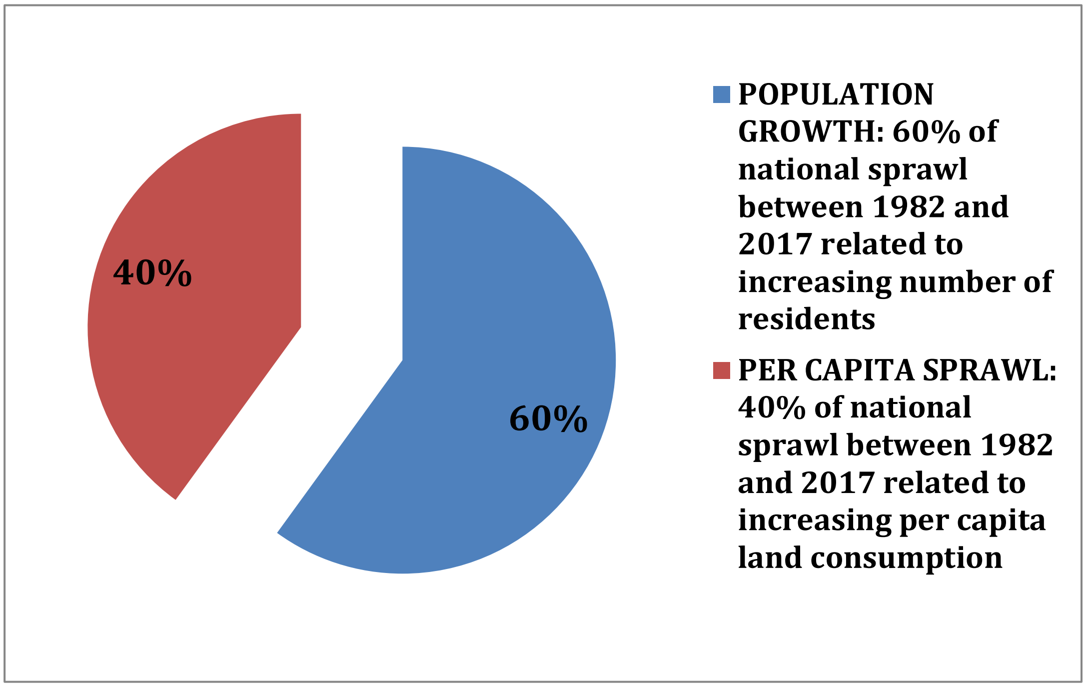

Figure 54. Sprawl Factors (Increasing Population and Increasing Per Capita Land Consumption) in 49 States, 1982-2017

Sources: Analysis of Developed Land estimates from NRCS National Resources Inventory, 2017; population estimates for 1982 and 2017 for each American county and state from U.S. Census Bureau population estimates.

Description: Approximately 40 percent of the sprawl in America's town and cities was related to increasing per capita land consumption. Approximately 60 percent of the sprawl was related to population growth.

Table 23 disaggregates and presents these results state by state, arranged in alphabetical order.

Table 23. Percentage of Sprawl by State Related to Population Growth, 1982-2017

State	Total Sprawl 1982 to 2017 (square miles)	Sprawl Related to POPULATION GROWTH (square miles)	% Sprawl from Population Growth
Alabama	2,023	760	38%
Arizona	1,744	1,614	93%
Arkansas	1,035	600	58%
California	3,420	3,166	93%

State	Total Sprawl 1982 to 2017 (square miles)	Sprawl Related to POPULATION GROWTH (square miles)	% Sprawl from Population Growth
Colorado	1,206	1,039	86%
Connecticut	382	204	53%
Delaware	217	184	85%
Florida	4,353	3,888	89%
Georgia	3,910	2,553	65%
Hawaii	136	127	93%
Idaho	583	450	77%
Illinois	1,332	672	50%
Indiana	1,203	615	51%
Iowa	505	213	42%
Kansas	627	326	52%
Kentucky	1,583	550	35%
Louisiana	1,192	364	31%
Maine	581	158	27%
Maryland	877	701	80%
Massachusetts	1,038	410	39%
Michigan	2,208	941	43%
Minnesota	1,146	805	70%
Mississippi	1,217	466	38%
Missouri	1,330	880	66%
Montana	416	244	59%

State	Total Sprawl 1982 to 2017 (square miles)	Sprawl Related to POPULATION GROWTH (square miles)	% Sprawl from Population Growth
Nebraska	270	159	59%
Nevada	514	425	83%
New Hampshire	525	295	56%
New Jersey	1,077	502	47%
New Mexico	1,019	482	47%
New York	1,642	424	26%
North Carolina	3,995	2,405	60%
North Dakota	233	95	41%
Ohio	2,149	722	34%
Oklahoma	1,133	467	41%
Oregon	688	574	83%
Pennsylvania	2,686	879	33%
Rhode Island	99	36	37%
South Carolina	2,136	1,262	59%
South Dakota	252	143	57%
Tennessee	2,354	1,291	55%
Texas	**6,634**	**4,637**	**70%**
Utah	713	587	82%
Vermont	224	83	37%
Virginia	2,180	1,438	66%
Washington	1,436	1,306	91%

State	Total Sprawl 1982 to 2017 (square miles)	Sprawl Related to POPULATION GROWTH (square miles)	% Sprawl from Population Growth
West Virginia	827	151	18%
Wisconsin	1,261	735	58%
Wyoming	251	118	47%
Entire USA	**68,561**	**41,140**	**60%**

Table 24 ranks the 49 states in the study by area of population-growth-related sprawl from 1982 to 2017. Texas is number one in the country, with 749 more square miles of rural land and open space lost to population growth than its nearest rival, Florida.

Table 24. States Ranked by Open Space Lost to Population-Growth-Related Sprawl, 1982-2017

Ranking	State	Sprawl Related to POPULATION GROWTH (square miles)	Total Sprawl 1982 to 2017 (square miles)	% Sprawl from Population Growth
1	**Texas**	**4,637**	**6,634**	**70%**
2	Florida	3,888	4,353	89%
3	California	3,166	3,420	93%
4	Georgia	2,553	3,910	65%
5	North Carolina	2,405	3,995	60%
6	Arizona	1,614	1,744	93%
7	Virginia	1,438	2,180	66%
8	Washington	1,306	1,436	91%
9	Tennessee	1,291	2,354	55%

Ranking	State	Sprawl Related to POPULATION GROWTH (square miles)	Total Sprawl 1982 to 2017 (square miles)	% Sprawl from Population Growth
10	South Carolina	1,262	2,136	59%
11	Colorado	1,039	1,206	86%
12	Michigan	941	2,208	43%
13	Missouri	880	1,330	66%
14	Pennsylvania	879	2,686	33%
15	Minnesota	805	1,146	70%
16	Alabama	760	2,023	38%
17	Wisconsin	735	1,261	58%
18	Ohio	722	2,149	34%
19	Maryland	701	877	80%
20	Illinois	672	1,332	50%
21	Indiana	615	1,203	51%
22	Arkansas	600	1,035	58%
23	Utah	587	713	82%
24	Oregon	574	688	83%
25	Kentucky	550	1,583	35%
26	New Jersey	502	1,077	47%
27	New Mexico	482	1,019	47%
28	Oklahoma	467	1,133	41%
29	Mississippi	466	1,217	38%
30	Idaho	450	583	77%

Ranking	State	Sprawl Related to POPULATION GROWTH (square miles)	Total Sprawl 1982 to 2017 (square miles)	% Sprawl from Population Growth
31	Nevada	425	514	83%
32	New York	424	1,642	26%
33	Massachusetts	410	1,038	39%
34	Louisiana	364	1,192	31%
35	Kansas	326	627	52%
36	New Hampshire	295	525	56%
37	Montana	244	416	59%
38	Iowa	213	505	42%
39	Connecticut	204	382	53%
40	Delaware	184	217	85%
41	Nebraska	159	270	59%
42	Maine	158	581	27%
43	West Virginia	151	827	18%
44	South Dakota	143	252	57%
45	Hawaii	127	136	93%
46	Wyoming	118	251	47%
47	North Dakota	95	233	41%
48	Vermont	83	224	37%
49	Rhode Island	36	99	37%
	Entire USA	**68,561**	**41,140**	**60%**

3.4.2 Developed Land from 2002 to 2017

Figure 55 shows that in the most recent 15-year time span in the period of study, between 2002 and 2017, approximately 67 percent of all open space developed in the United States was associated with population growth and 33 percent was associated with increasing per capita land consumption or Per Capita Sprawl. The share of the nation's sprawl and its loss of rural land / open space / natural habitat / farmland rose by 7% from the 60 percent average for the entire 1982 to 2017 time period, to 67 percent for the most recent period.

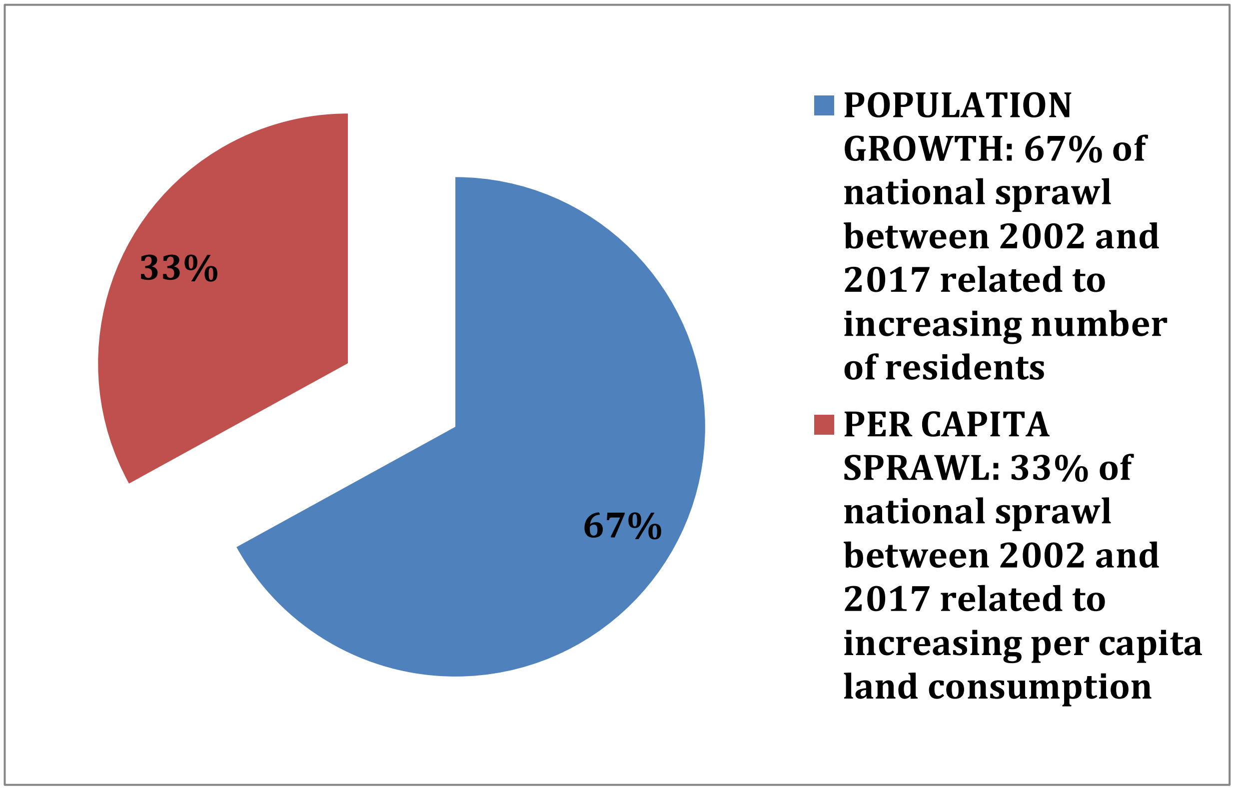

Figure 55. Sprawl Factors (Increasing Population and Increasing Per Capita Land Consumption) in 49 States, 2002-2017

Sources: Analysis of Developed Land estimates from NRCS National Resources Inventory, 2017; population estimates for 2002 and 2017 for each American county and state from U.S. Census Bureau population estimates.

Description: Approximately 33 percent of the sprawl in America's town and cities was related to increasing per capita land consumption. Approximately 67 percent of the sprawl was related to population growth

Table 25 disaggregates and presents these results state by state for 2002 to 2017, arranged in alphabetical order.

Table 25. Percentage of Sprawl by State Related to Population Growth, 2002-2017

State	Total Sprawl 2002 to 2017 (square miles)	Sprawl Related to POPULATION GROWTH (square miles)	% Sprawl from Population Growth
Alabama	481	259	54%
Arizona	557	465	84%
Arkansas	348	197	57%
California	831	718	86%
Colorado	321	277	86%
Connecticut	75	42	56%
Delaware	81	69	85%
Florida	1,065	1,012	95%
Georgia	846	673	80%
Hawaii	58	57	98%
Idaho	176	146	83%
Illinois	391	183	47%
Indiana	341	168	49%
Iowa	189	95	50%
Kansas	162	79	49%
Kentucky	311	156	50%
Louisiana	362	175	48%
Maine	139	37	26%
Maryland	192	172	90%
Massachusetts	163	110	67%

State	Total Sprawl 2002 to 2017 (square miles)	Sprawl Related to POPULATION GROWTH (square miles)	% Sprawl from Population Growth
Michigan	426	167	39%
Minnesota	266	170	64%
Mississippi	385	158	41%
Missouri	365	243	67%
Montana	160	105	65%
Nebraska	94	55	59%
Nevada	181	138	76%
New Hampshire	102	65	63%
New Jersey	153	76	50%
New Mexico	232	129	55%
New York	346	75	22%
North Carolina	821	628	76%
North Dakota	132	94	72%
Ohio	490	176	36%
Oklahoma	431	231	54%
Oregon	141	124	87%
Pennsylvania	496	254	51%
Rhode Island	23	0	2%
South Carolina	487	393	81%
South Dakota	51	39	76%
Tennessee	534	358	67%

State	Total Sprawl 2002 to 2017 (square miles)	Sprawl Related to POPULATION GROWTH (square miles)	% Sprawl from Population Growth
Texas	**2,616**	**1,910**	**73%**
Utah	299	278	93%
Vermont	55	12	21%
Virginia	560	393	70%
Washington	288	276	96%
West Virginia	129	49	38%
Wisconsin	362	193	53%
Wyoming	84	69	82%
Entire USA	**17,793**	**11,945**	**67%**

As noted above, during this more recent period (2002-2017), population growth accounted for a higher percentage of sprawl – 67 percent, or two-thirds (**Figure 55**) – than the 60 percent of the entire period (1982-2017). In the 21st century to date, the rate of sprawl has decreased somewhat from that of the last two decades of the 20th century because of a variety of factors, but the percentage of that sprawl due to population growth has increased. These are mixed findings. On the one hand, it is good that the rate of sprawl has slowed, but on the other hand, for those who eschew population growth as irrelevant in sprawl, these findings contradict their dismissiveness.

Table 26 ranks the 49 states in the study by area of population-growth-related sprawl from 2002 to 2017. As it was for the entire 1982-2017 period of study, Texas is once again number one in the country for the most recent 15-year subset of that period (2002-2017), with 1,910 square miles of sprawl related to population growth (73% of all sprawl), 898 more square miles of rural land and open space lost to population growth than its nearest rival, Florida, at 1,012 square miles.

Table 26. States Ranked by Open Space Lost to Population-Growth-Related Sprawl, 2002-2017

Ranking	State	Sprawl Related to POPULATION GROWTH (square miles)	Total Sprawl 2002 to 2017 (square miles)	% Sprawl from Population Growth
1	**Texas**	**1,910**	**2,616**	**73%**
2	Florida	1,012	1,065	95%
3	California	718	831	86%
4	Georgia	673	846	80%
5	North Carolina	628	821	76%
6	Arizona	465	557	84%
7	South Carolina	393	487	81%
8	Virginia	393	560	70%
9	Tennessee	358	534	67%
10	Utah	278	299	93%
11	Colorado	277	321	86%
12	Washington	276	288	96%
13	Alabama	259	481	54%
14	Pennsylvania	254	496	51%
15	Missouri	243	365	67%
16	Oklahoma	231	431	54%
17	Arkansas	197	348	57%
18	Wisconsin	193	362	53%
19	Ohio	176	490	36%
20	Louisiana	175	362	48%

Ranking	State	Sprawl Related to POPULATION GROWTH (square miles)	Total Sprawl 2002 to 2017 (square miles)	% Sprawl from Population Growth
21	Maryland	172	192	90%
22	Minnesota	170	266	64%
23	Illinois	183	391	47%
24	Indiana	168	341	49%
25	Michigan	167	426	39%
26	Mississippi	158	385	41%
27	Kentucky	156	311	50%
28	Idaho	146	176	83%
29	Nevada	138	181	76%
30	New Mexico	129	232	55%
31	Oregon	124	141	87%
32	Massachusetts	110	163	67%
33	Montana	105	160	65%
34	Iowa	95	189	50%
35	North Dakota	94	132	72%
36	Kansas	79	162	49%
37	New Jersey	76	153	50%
38	New York	75	346	22%
39	Delaware	69	81	85%
40	Wyoming	69	84	82%
41	New Hampshire	65	102	63%

Ranking	State	Sprawl Related to POPULATION GROWTH (square miles)	Total Sprawl 2002 to 2017 (square miles)	% Sprawl from Population Growth
42	Hawaii	57	58	98%
43	Nebraska	55	94	59%
44	Connecticut	42	75	56%
45	West Virginia	49	129	38%
46	South Dakota	39	51	76%
47	Maine	37	139	26%
48	Vermont	12	55	21%
49	Rhode Island	0.4	23	2%
	Entire USA	**11,945**	**17,793**	**67%**

3.4.3 Texas Leads All States in Sprawl

Figure 56 and **Figure 57** graphically compare the amount of sprawl in Texas (in square miles) to the other 48 states for the entire 1982-2017 study period (**Figure 56**) and the most recent 15-year subset of that entire period (2002-2017, **Figure 57**). In both time periods Texas has far and away the most overall sprawl of all states. In the 2002-2017 period, Texas had more than twice as much overall sprawl as the next closest state (Florida).

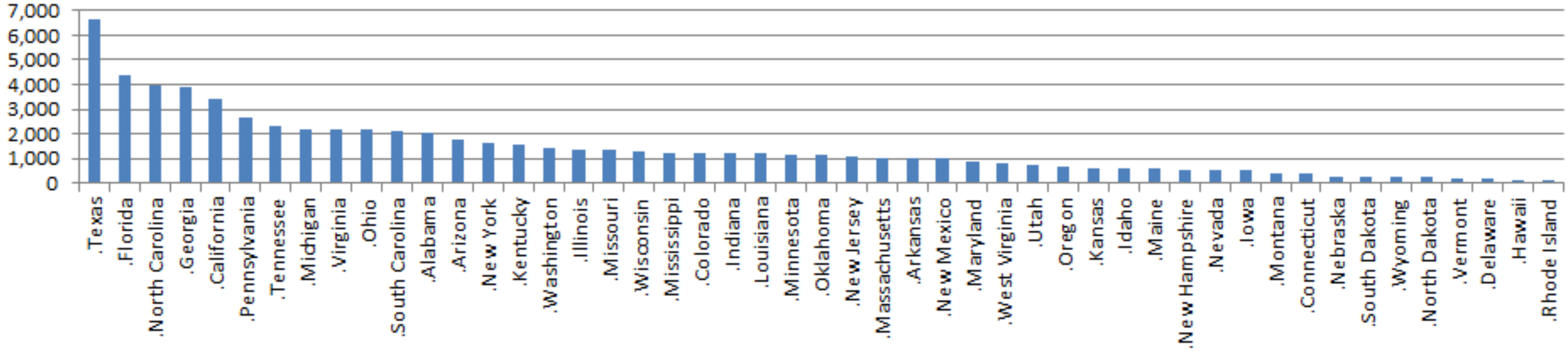

Figure 56. Overall Sprawl (square miles) in 49 States, 1982-2017

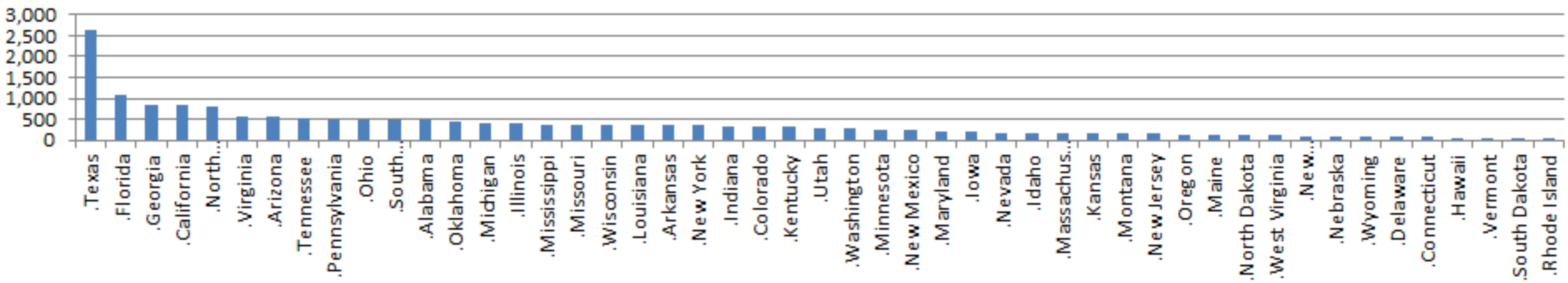

Figure 57. Overall Sprawl (square miles) in 49 States, 2002-2017

3.5 Scatter Plot of Population Growth and Sprawl

Another useful way to examine and graphically display the relationships between the factors in sprawl is by using scatter plot analysis. **Figure 58** is a scatter plot for Texas that examines the relationship between each county's population size on the x-axis (horizontal axis) and the cumulative area of developed land (i.e., cumulative overall 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 58** indicates that there is a positive relationship between population increase and Overall Sprawl. Counties with larger populations are also those where more land has been developed and sprawled across. These results are not surprising, but if sprawl and population growth were minimally correlated or not related at all, 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 and the best-fit line alone do not prove that population growth causes sprawl, they do strongly suggest and reinforce the hypothesis that the two are closely correlated.

We also used a common statistical test to measure how closely population size is correlated with the area of developed land (cumulative sprawl) in Texas counties. Correlation coefficients are widely employed in the natural and social sciences to measure how strong a relationship is between two variables.[71] In this case, one variable is population size and the other variable is the "footprint" (area of developed land) that population size imposes on a given county in Texas.

In general, correlation coefficients are used to find how strong a relationship is between data. The various formulas render an "r-value" between -1 and 1, where:

- 1 indicates a strong positive relationship.
- -1 indicates a strong negative relationship.
- A result of zero indicates no relationship at all.

Applying this statistical tool to the data (values) used for the 254 Texas counties in **Figure 58**, the correlation coefficient is **0.95**, indicating a very strong statistical relationship between population size and developed land area (cumulative overall sprawl).

[71] Statistics How To: Correlation Coefficient. Available online at: https://www.statisticshowto.com/probability-and-statistics/correlation-coefficient-formula/#definition.

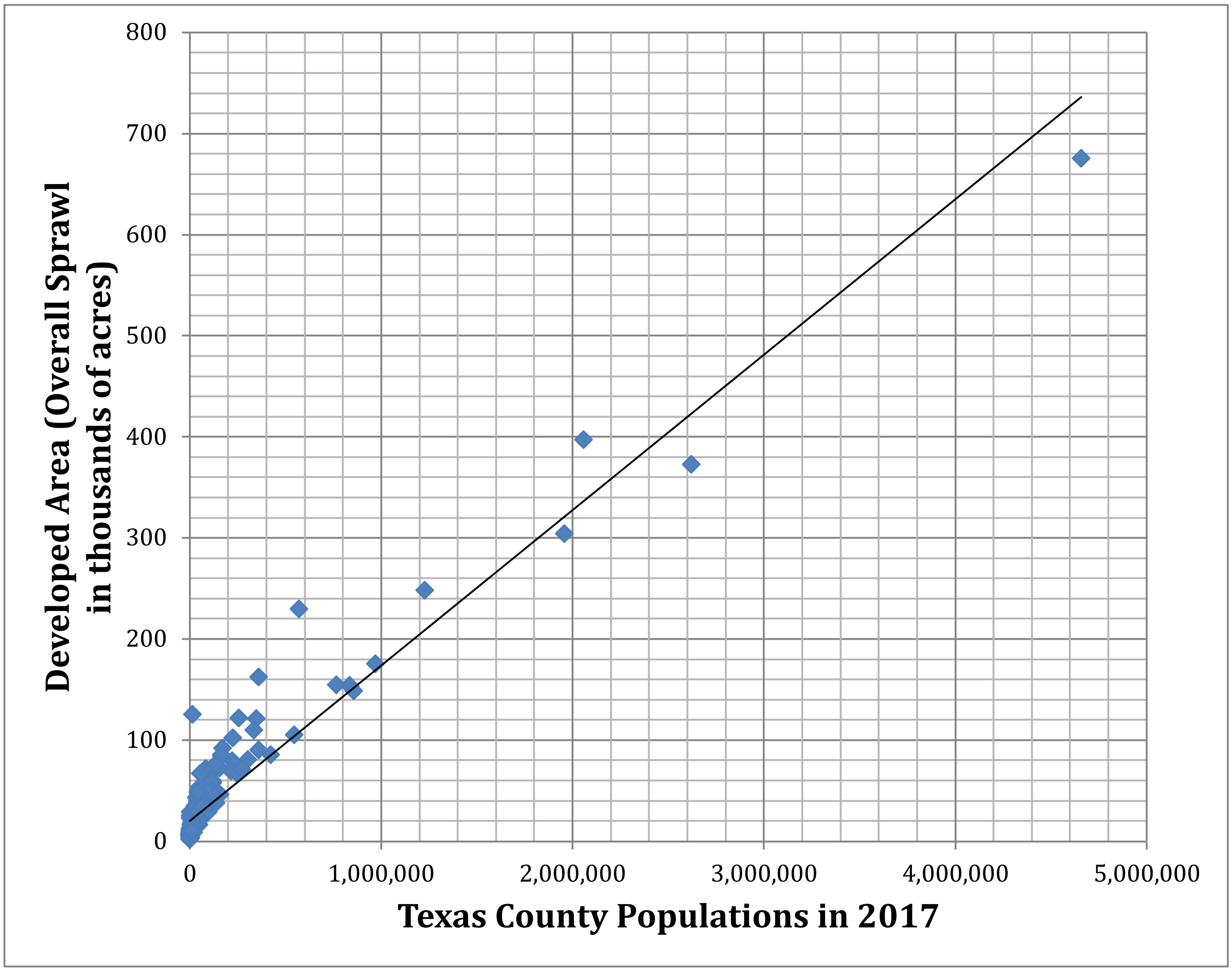

Figure 58. Scatter Plot of 2017 Population Size vs. Developed Land Area (Cumulative Sprawl) in 254 Texas Counties

Sources: Census Bureau and National Resources Inventory

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 59,** a simple scatter plot of the 49 states' cumulative populations and developed land areas in 2017. 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.

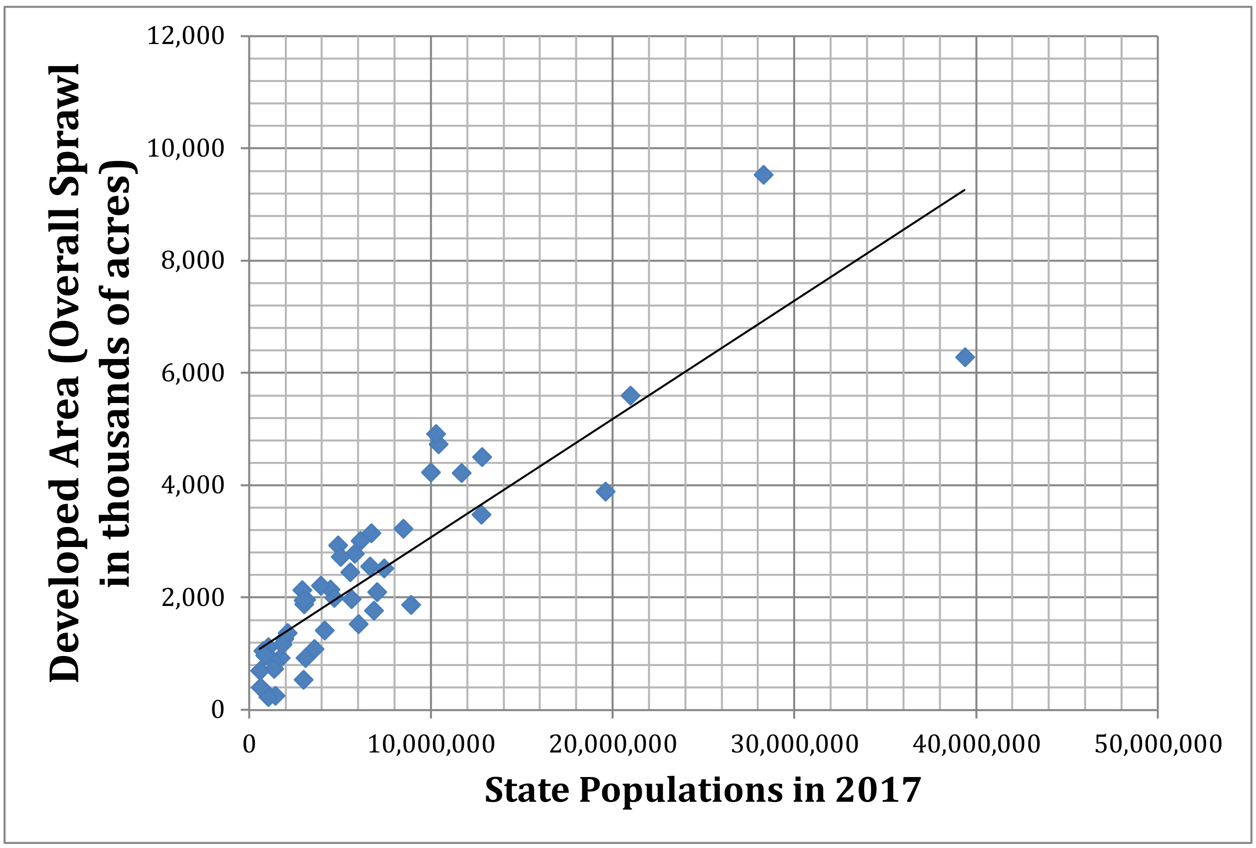

Figure 59. Scatter Plot of Population Size vs. Cumulative Sprawl in 49 States, 2017
Sources: Census Bureau state population estimates and National Resources Inventory (2017)

The r-value correlation coefficient for the 49 states (48 contiguous states plus Hawaii) is 0.87, which is considered a very strong association.

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 almost 300 acres (roughly 300 football fields) per day (12 acres or football fields per hour), or almost than one square mile every two days, and over 170 square miles or 108,320 acres per year. The rate appears to have accelerated with the gradual waning of the Great Recession that began in 2008. From 2007 to 2012, 88,900 acres of rural land was developed annually in Texas, while from 2012 to 2017, the rate increased to 108,320 acres per year.

These rates are far below the 1997-2002 peak sprawl rate in Texas of 160,380 acres per year. Yet even at the reduced 2012-2017 rate (108,320 acres/year), sprawl would continue to convert an additional 1,700 square miles or almost a million acres of Texas' valuable agricultural land and wildlife habitat into pavement and buildings every decade. By 2050, another 4,570 square miles (almost 3 million acres) of Texas' rural lands will have been paved or covered with subdivisions; electrical substations; hotels; highways; industrial, office and theme parks; schools; and commercial strips. This represents a great and permanent loss to Texas' agricultural potential, wildlife habitat, natural heritage, quality of life, and environmental sustainability.

Smart growth efforts, generally higher gasoline prices, fiscal and budgetary constraints (limiting new road-building, for example), and the recession-inducing mortgage meltdown all played roles in slowing Texas' rate of sprawl late in the first decade of this century. As noted, that rate has picked up again, although not back to the levels of the 1990s. 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.

Texas and its more business and freedom-friendly climate have managed to entice many residents of more highly regulated states like (overpopulated) California to settle in the Lone Star State, but the extent to which these disparities will continue as the developed areas of Texas itself invariably grow more crowded, congested, expensive, or resource-constrained (as with water shortages), is uncertain. Another source of uncertainty is anxiety about density in the aftermath of the Covid-19 pandemic. This could conceivably increase urban sprawl pressures, since many Americans and Texans experienced firsthand the downside of living in more densely populated urban cores. Here infectious and communicable diseases can more easily spread, and here is where city officials often felt compelled to enact onerous restrictions on personal freedom and mobility with mandatory lockdowns, closures, and mask mandates, which deeply harmed businesses such as restaurants, pubs, and hair salons.

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 even the current 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; oil and gas development; 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, future water scarcity may also restrict dispersed, never-ending development in Texas.

Figure 60. Sprawling Houston
Source: Google Earth image from January 2023

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

Over the past four decades, seven in ten acres converted from rural land to developed land were due to population growth. 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.

In Texas, the role of population growth has increased gradually and steadily, and that of per capita developed land consumption has decreased commensurately.

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, in 13 out of 34 Urbanized Areas (i.e., more than one-third of all Texas UAs) 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 urbanized 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 assertion 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 two decades 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 subduing sprawl if our rural land base is not to continue dwindling.

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 vitality 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.[72]

[72] 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.

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 saw from a stabilized population in this era 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 was able to distance itself from both the image of the "smoky city" of belching steel mills and the image of the rust-belt city of shuttered steel mills and long unemployment lines.

Pittsburgh also made 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 53 square miles from 2000 to 2010. 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 thus 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 and inner suburbs abandoned as contaminated "brownfields", driving new and existing residents and the suburbs outwards. Cases like Pittsburgh highlight the necessity of a two-pronged approach that addresses both population growth – undertaken primarily at a national level, not a local one – and per capita consumption sprawl.

Figure 61. Permian Basin oil wells and access roads in West Texas

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

If recent 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 62**, 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.

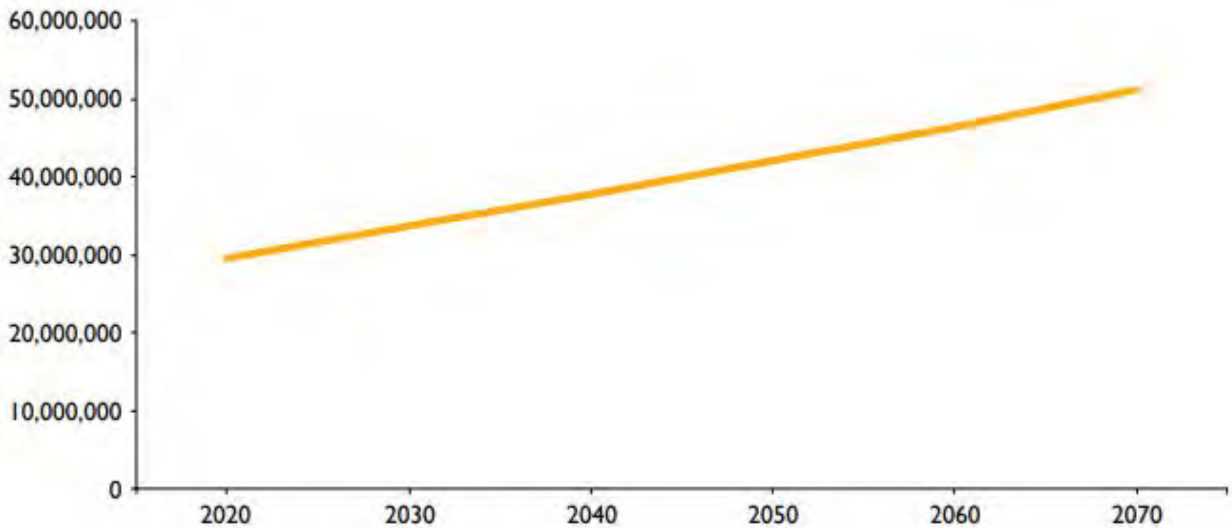

Figure 62. Projected Population Growth in Texas, 2020 to 2070
Source: Texas Water Development Board[73]

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."

In a March 2023 poll of 1,020 Texas likely voters by Rasmussen Reports and NumbersUSA conducted in conjunction with this study, only 12 percent of respondees indicated "not enough" when asked: "Has Texas developed its open land into cities, housing, and highways too much, too little, for about as much as it should?"[74]

[73] 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/.
[74] Rasmussen Reports. 2023. Toplines – NUSA March 2023 – Texas. Texans Want Slower Growth, Limited Immigration. This survey of 1,020 Texas Likely Voters was conducted on March 8, 2023 by

As for the rapid population growth that is driving the lion's share of this sprawling development, Texans are also quite emphatic. The March 2023 survey posed this question: "The population of Texas has more than doubled since 1980. Would you prefer that the Texas population continue to rapidly grow, that it grow more slowly, that it stay about the same size, or that it become smaller?"[75] These were the responses, depicted graphically in **Figure 63**:

- 13% continue to grow rapidly
- 46% grow more slowly
- 24% stay about the same
- 13% become smaller
- 3% not sure

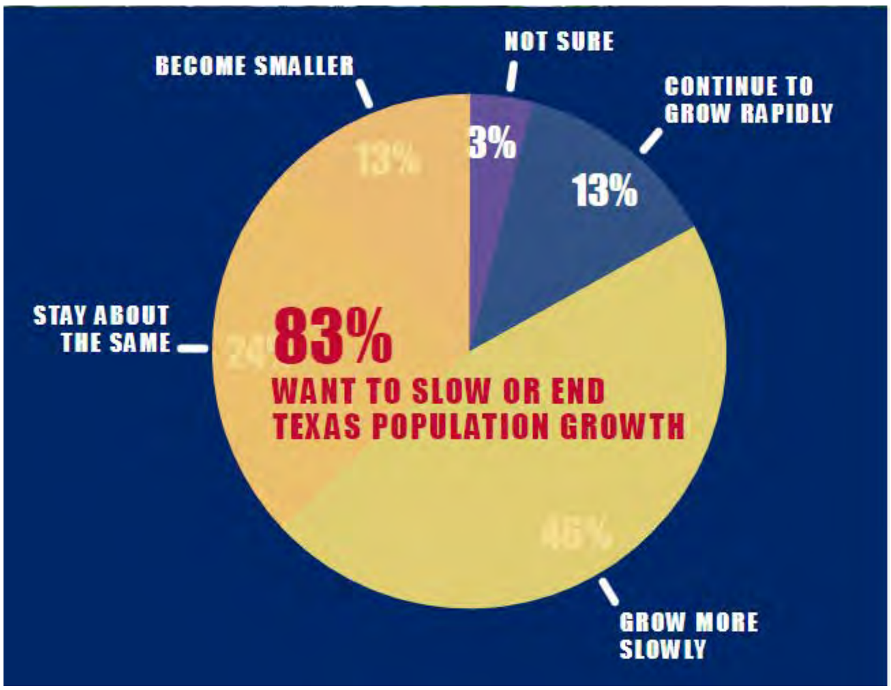

Figure 63. Responses to March 2023 Poll of 1,020 Texas Likely Voters

Eighty-three percent overall wanted to slow or end population growth in Texas.

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

According to Texas State Demographer Lloyd Potter, several years ago the Texas population was growing by 1,000 people per day (a rate of 365,000 people per year, or more than a million

Rasmussen Reports and NumbersUSA. The margin of sampling error is +/- 3 percentage points with a 95% level of confidence. Field work for all Rasmussen Reports surveys is conducted by Pulse Opinion Research.
https://www.rasmussenreports.com/public_content/politics/partner_surveys/toplines_2_nusa_march_2023_texas

75 Ibid.

additional people every three years).[76] 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.[77] Previously, domestic migration had dominated the migration input to Texas growth.

From 2020 to 2023, during the height of the Covid-19 pandemic, Texas grew by approximately 1.5 million – from 29.7 million to 31.2 million – averaging 0.5 million (500,000) news residents per year.[78] Certain Texas pundits and political and business leaders found themselves gloating that this population growth – some of which came at the expense of political and economic rival California – was a sign of better governance during the pandemic and a generally more business-friendly political climate and "bigger is better" philosophy. Prominent celebrities such as podcaster Joe Rogan and wealthy entrepreneur Elon Musk joined the exodus from California to Texas (or at least Austin, the most liberal city in Texas). There seemed to be little discussion publicly about the potential downside of or limits to such rapid growth and development, although many Texans feel these concerns, as expressed in the public opinion survey conducted by Rasmussen for NumbersUSA in March 2023.[79]

Increasing residential density is not a cure-all for sprawl.

As noted in Chapter 3, even the best Smart Growth, New Urbanism, and LEED strategies are able to engineer only so much population density. With the Covid-19 pandemic in 2020-2021 **(Figure 64**), millions of Americans became all too acquainted with two of the perils of density: the much easier spread of contagious diseases and the unprecedented, economically and socially costly restraints on personal and economic freedom deemed crucial to containing epidemics. More populous and more densely populated states like California and New York suffered far more from the pandemic, and the draconian government response to it, than lower-density states. As long as population is still growing, the land area taken up by American towns and cities will continue to grow.

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[76] 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/

[77] Ibid.

[78] Texas Demographic Center. Accessed April 10, 2023. Available at: https://demographics.texas.gov/Data/TPEPP/Projections/Report.aspx?id=9aaddb2cff7741ceb0b55fcc42288465.

[79] Op. cit. Footnote #74.

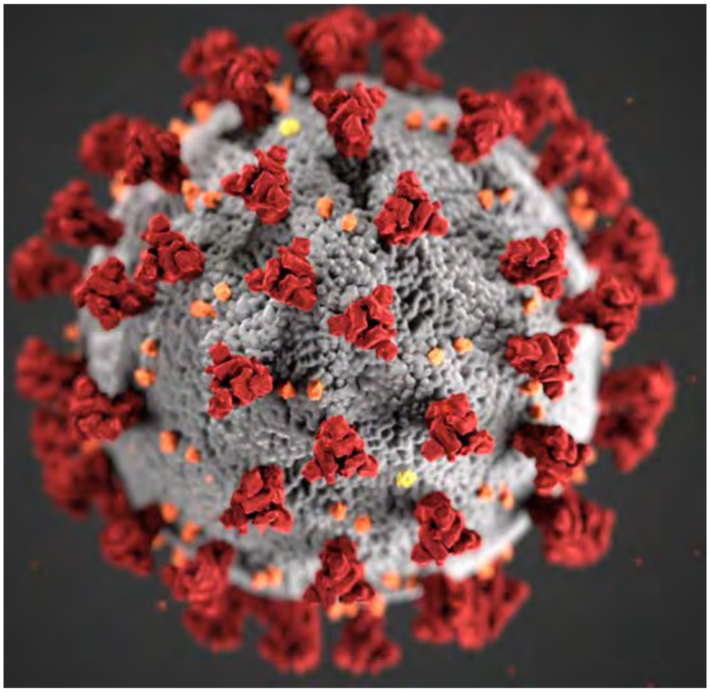

Figure 64. SARS-CoV-2, discovered in 2019, is the coronavirus that causes the respiratory disease called COVID-19. In 2020, a global pandemic exploded, costing millions of lives and posing myriad implications for societies, including on development, population density, and sprawl.

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 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. Between 2020 and 2023, Texas has added 500,000 people per year, at a rate of 5 million per decade. At this rate, 31 million Texans at present will have increased to well over 40 million by 2050.

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. **Figures 65 through 67** show the percentages of developed land in each county, in 1982 (**Figure 65**), 2017 **(Figure 66**), and projected to 2050 (**Figure 67**) given prevailing rates of population growth and sprawl in each county. It should be stressed that Figure 65 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.

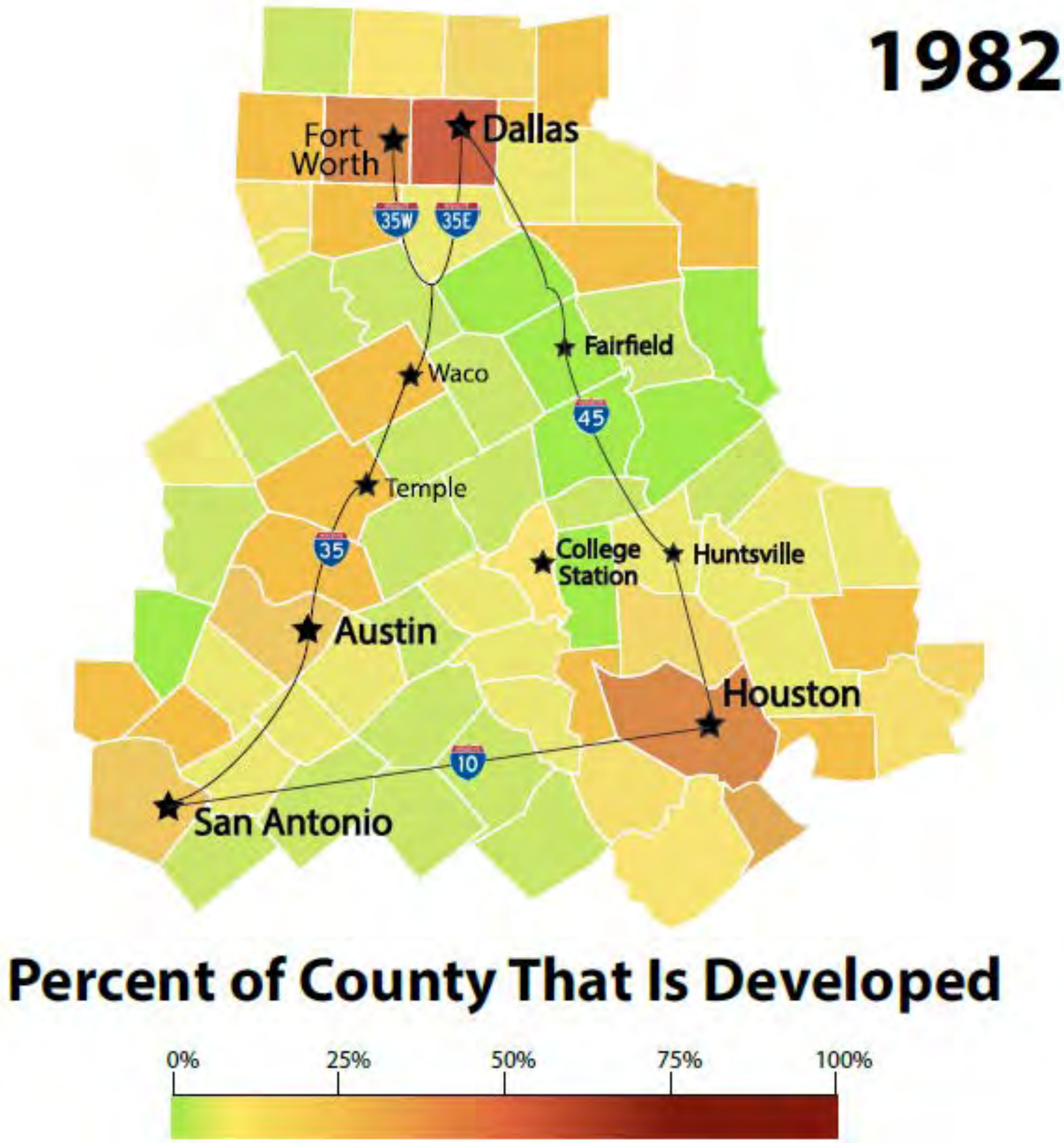

Figure 65. Percent of Developed Land in Texas Triangle Counties in 1982

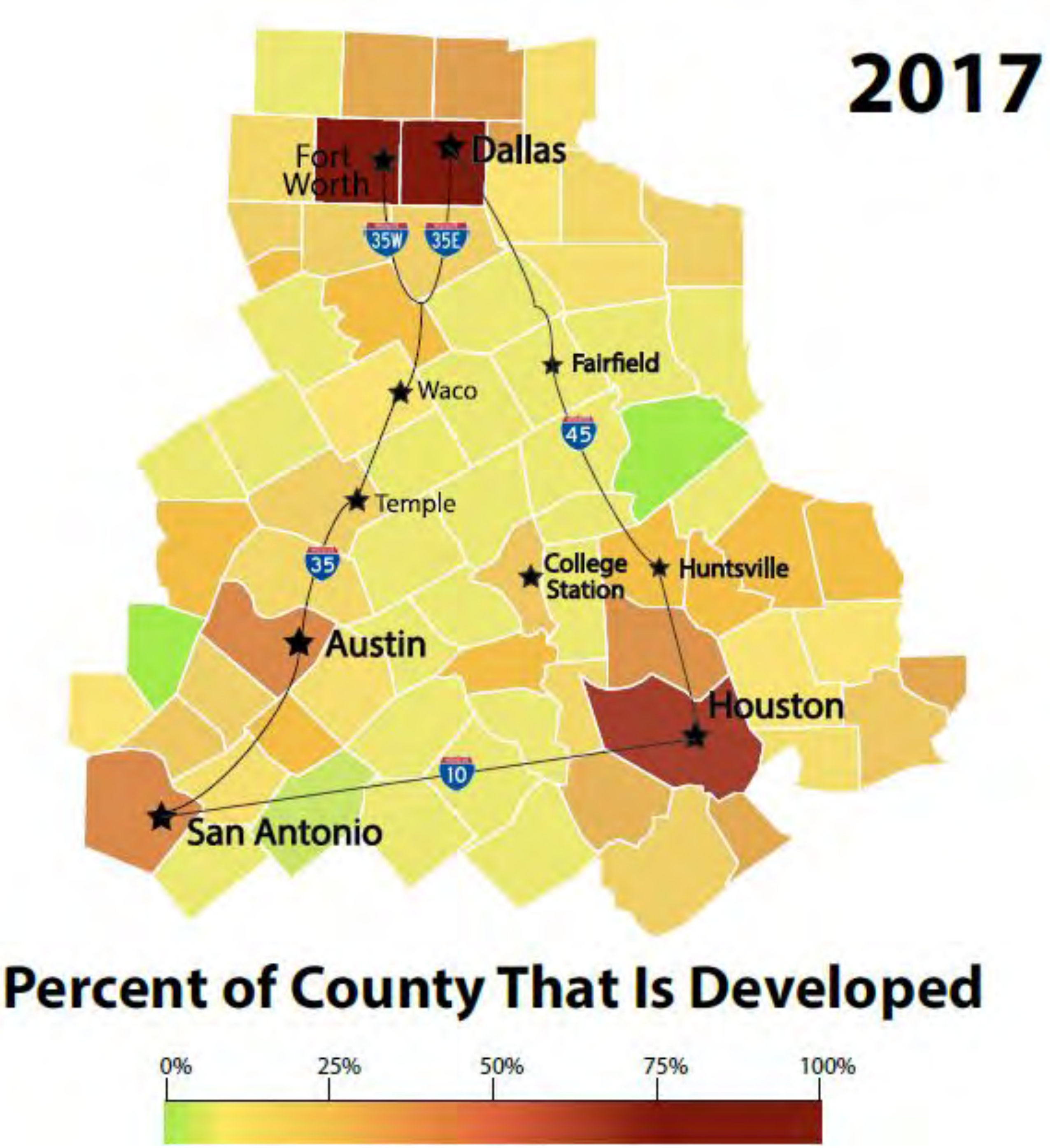

Figure 66. Percent of Developed Land in Texas Triangle Counties in 2017

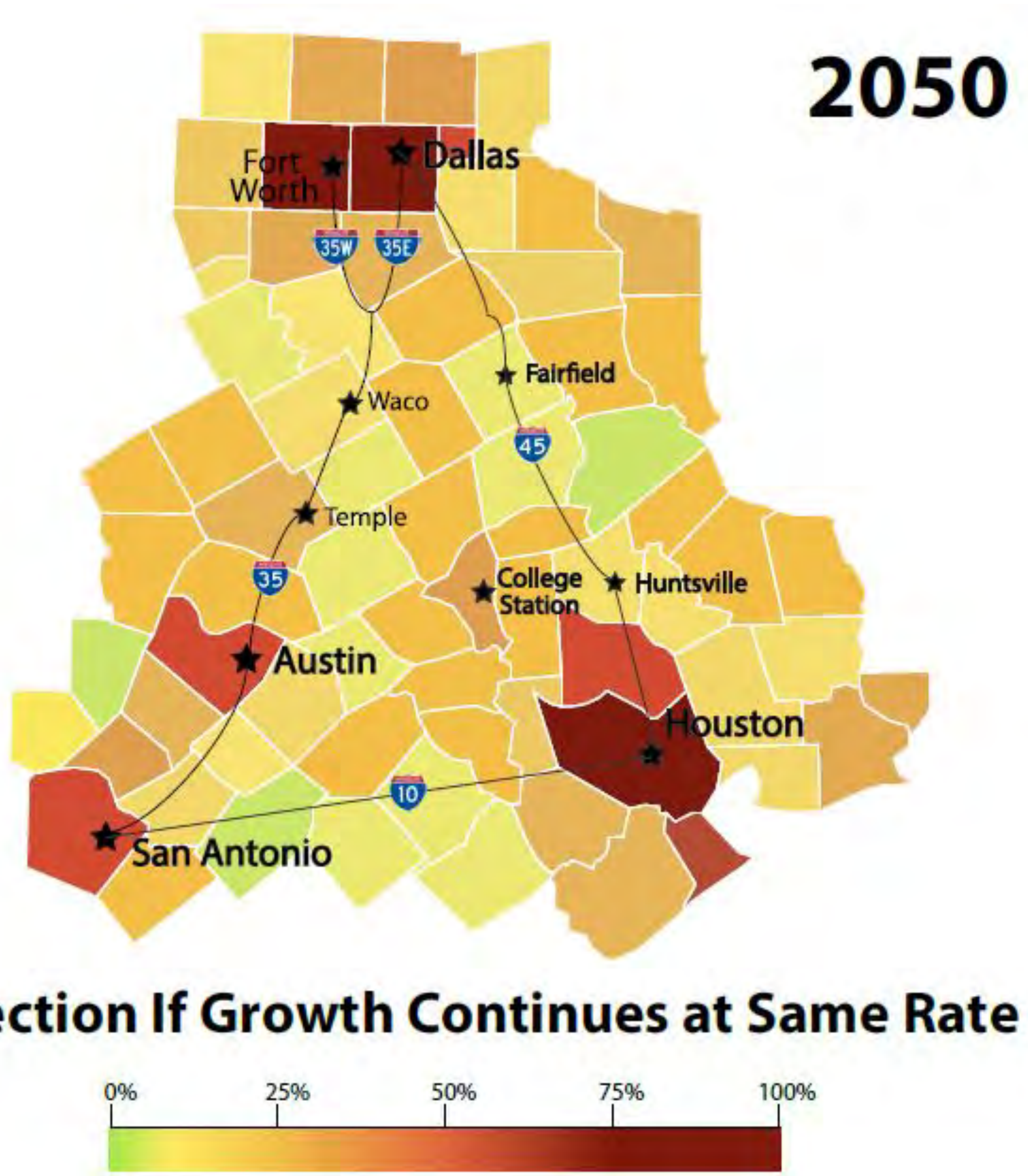

Figure 67. Percent of Developed Land in Texas Triangle Counties Projected to 2050

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." [80]

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

[80] 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 68. 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 2.0 to 2.5 million additional residents each year. These 20-25 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 1.7 births per woman, the total fertility rate (TFR) of the United States remains well below the replacement level of 2.1 and has not been a source of long-term population growth in the U.S since 1971.

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

Thus, long-term population growth in the United States and Texas is in the hands of federal policy makers. It is they who have increased the annual intake and settlement of immigrants from one-quarter million in the 1950s and 1960s to over a million since 1990, fluctuating between one million and nearly two million, once net illegal immigration is included. Until the numerical level of national immigration is lowered, even the best local plans and political commitment will be unable to stop sprawl. Yet the Biden administration has been moving in the opposite direction, opening the southern border to any from around the world who wish to enter and signaling that it wants to pass one or more amnesties as well as increase legal immigration rates.

Any serious efforts to halt the loss of open space, farmland, and wildlife habitat in both Texas and the United States as a whole must include reducing the volume of future 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 Democratic Congresswoman Barbara

Jordan. That would move annual immigration back to around the level that was the norm as recently as the 1980s.

A poll of 1,500 America's likely voters in May 2020 by Pulse Opinion Research found that reducing immigration had the support of about half the U.S. population when linked with the goal of slowing down U.S. population growth (see Appendix G for the full survey questions and results). Approximately an equal number of respondees favored maintaining or increasing immigration level and associated population growth. Thus, Americans are more or less evenly divided over immigration levels and population growth.

12* Census data shows that since 1970, annual immigration has tripled and is now the cause of nearly all long-term population growth. Should the federal government reduce annual immigration to slow down population growth, keep immigration and population growth at the current level, or increase annual immigration and population growth?

47% Reduce annual immigration to slow down population growth
33% Keep annual immigration and population growth at the current level
12% Increase annual immigration and population growth
8% Not sure

In a more recent (March 2023) poll of more than 1,000 Texas likely voters by Rasmussen, conducted in conjunction with this study, the following two questions were asked:

14. Another major source of Texas population growth is immigration from other countries. Should the federal government reduce annual immigration to slow down Texas population growth, keep immigration and population growth at the current level, or increase annual immigration and population growth?

57% reduce annual immigration
28% keep immigration at its current level
8% increase immigration
7% not sure

15. Currently the federal government adds about one million legal permanent immigrants to the country each year. What annual level would you prefer: increase to two million or more per year, increase to one and a half million, keep it at around one million, reduce it to a half-million, or reduce it to 100,000 or less?

10% two million or more
13% one and a half million
24% one million
20% half a million
23% 100 thousand or less
9% not sure

It appears that nearly 6 in 10 Texans – 10% higher than Americans in general – wish to see immigration reduced somewhat to slow population growth.

A lower immigration rate at around 500,000 (half a million) per 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.[81]

That is why another federal commission recommended far greater reductions in immigration. In 1996, the President's Council on Sustainable Development 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."[82]

It is important to underscore that the additional sprawl that occurs because of high immigration levels has nothing to do with the caliber 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.

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 larger or smaller 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

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

[82] 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.

suburbs where the sprawl occurs.[83] 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 incomes were causing immigrants to move to the edges of cities and even to rural settlements beyond the cities to find cheaper housing.

In parts of the country, regions are undergoing rapid population growth from internal migration of U.S. residents and citizens fleeing from cities and states heavily affected by immigration. This then, is a secondary or indirect effect of mass immigration. This is especially true in the West and Southwest, and the long-running exodus of native-born working-class and middle-class Californians out of that state and into the neighboring states of Nevada, Arizona, Oregon, Washington, Idaho, and beyond. Texas too has received many former California residents.

Arizona's, Oregon's, Nevada's, and Texas' population growth, for example, is heavily influenced by immigration in a major way not involving the actual immigrants settling in these states. Because their neighbor California has experienced so many negative quality-of-life and economic consequences from its massive, immigration-fueled population growth, for decades these states have received a large number of California "refugees" fleeing the effects of this overpopulation.

This has been going on for a long time: as far back as the 1970s, Oregon's governor Tom McCall pleaded: "Don't Californicate Oregon!" His plea went unheeded. Because nearly all of California's population growth is due to immigration, much of the California migration into neighboring states and Texas must be considered yet another consequence of the quadrupled level of annual immigration rates since 1970. Political and business leaders and pundits in Texas generally seem to have taken a more welcoming posture to those leaving California for greener pastures than did Oregon's Tom McCall in the 1970s, some of them even appearing to gloat that Texas is gaining at California's expense. But a booming population has its downsides regardless of the source or sources of that growth. Our 2023 Rasmussen survey of likely Texas voters shows that most are well aware of this.

On a local level, the sprawl pressures of population growth are similar regardless of where the new residents originate. But very few counties, cities, and towns are likely to be able to subdue population growth and sprawl if the federal government continues policies that add around 20 million or more 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 irrigated agricultural lands or irreplaceable natural habitats.

[83] 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/

This is not a sustainable path, and it is not one we believe that fully informed Texans would voluntarily choose.

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 developed land consumption in a county or state 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 county
P = Population of that county

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 developed land consumption (*viz*., a). This second equation (2) is the basis for attributing or apportioning the shares of sprawl (viz. growth in *A*) back onto two contributing factors, the growth in *P* and the growth in *a*.

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

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

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

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

(1) $A = P \times a$

Where:

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

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

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

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

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

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

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

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

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

The same form applies for per capita land use:

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

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

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

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

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

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

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

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

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

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

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

(12) $gP + g_a = g_A$

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

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

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

In the case of 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) $$\frac{0.53164}{0.54381} + \frac{0.01217}{0.54381} = \frac{0.54381}{0.54381}$$

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
March 2023 Public Opinion Poll about Sprawl in Texas

March 2023 Poll of 1,020 Texas Likely Voters
Conducted by Rasmussen Reports and NumbersUSA

1. How would you rate the job Joe Biden has been doing as President… do you strongly approve, somewhat approve, somewhat disapprove, or strongly disapprove of the job he's been doing?

   24% strongly approve
   19% somewhat approve
   10% somewhat disapprove
   46% strongly disapprove
   2% not sure

2. Has Texas developed its open land into cities, housing, and highways too much, too little, for about as much as it should?

   36% too much
   12% too little
   42% about right
   10% not sure

3. Government data show that the United States now has about one-third less cropland for each American than it did 30 years ago. How important is it to protect U.S. farmland from development so the United States is able to produce enough food to feed its own human population in the future?

   74% very important
   19% somewhat important
   4% not very important
   1% not at all important
   2% not sure

4. If recent migration and fertility trends continue, Texas demographers project that the state's population of 30 million will reach about 44 million by 2060. Do you find the prospect of adding another 14 million residents to be more positive or more negative?

   30% more positive
   55% more negative
   15% not sure

5. If Texas adds another 14 million residents, do you expect traffic to become much worse or would the state Department of Transportation be able to build enough extra road capacity to accommodate the extra residents without more congestion?

   73% traffic will become much worse
   21% the Department of Transportation could accommodate the extra residents without more congestion
   6% not sure

6. Texas ranks third in the U.S. in agricultural acres irrigated, and irrigation is crucial to food production in the state. Texas cities compete for scarce water with agriculture. Should water used to irrigate farmland be diverted to support additional human population growth in Texas?

   25% water should be diverted from agriculture to support more residents
   57% water should not be diverted from agriculture to support more residents
   18% not sure

7. Texas has limited water flows in its undammed streams and rivers. Is it more important for the remaining amount of water in free-flowing streams and rivers to be used to support forested wildlife habitat, fish and birds, or is it more important to use the remaining water in Texas streams to support the projected increase of residents in the state?

   69% water should be kept in streams to support forested wildlife habitats, fish and birds
   20% water in streams should be used to support more residents
   11% not sure

8. From an environmental standpoint, how important is it to preserve Texas' woodlands, natural wetlands, rivers, grasslands, and mountains?

   67% very important
   25% somewhat important
   5% not very important
   1% not at all important
   2% not sure

9. How important is it to you that you can easily get to Natural Areas and Open Space?

   54% very important
   34% somewhat important
   8% not very important
   1% not at all important
   3% not sure

10. A study of government data found that 70% of the loss of Texas's Open Space, natural habitat, and farmland in recent decades was related to the state's rapid population growth. Would continuing this level of population growth into the future make Texas better, worse or not much different?

15% better
58% worse
19% not much different
8% not sure

11. In recent years, have you sensed that Texas's cities, parks, neighborhoods, schools, and roads have become much more crowded, somewhat more crowded, somewhat less crowded, or much less crowded?

54% much more crowded
36% somewhat more crowded
5% somewhat less crowded
1% much less crowded
5% not sure

12. The population of Texas has more than doubled since 1980. Would you prefer that the Texas population continue to rapidly grow, that it grow more slowly, that it stay about the same size, or that it become smaller?

13% continue to grow rapidly
46% grow more slowly
24% stay about the same
13% become smaller
3% not sure

13. A major source of Texas population growth is people moving in from other states, especially places like California. Should local and state governments in Texas make it more difficult for people to move to Texas from other states by restricting development?

46% yes
37% no
17% not sure

15. Another major source of Texas population growth is immigration from other countries. Should the federal government reduce annual immigration to slow down Texas population growth, keep immigration and population growth at the current level, or increase annual immigration and population growth?

    57% reduce annual immigration
    28% keep immigration at its current level
    8% increase immigration
    7% not sure

16. Currently the federal government adds about one million legal permanent immigrants to the country each year. What annual level would you prefer: increase to two million or more per year, increase to one and a half million, keep it at around one million, reduce it to a half-million, or reduce it to 100,000 or less?

    10% two million or more
    13% one and a half million
    24% one million
    20% half a million
    23% 100 thousand or less
    9% not sure

16. One way to handle continued population growth without losing as much open space, natural habitat, and farmland in Texas is to change zoning and other regulations to funnel more current and future residents into apartments and condo buildings instead of single-family houses with yards. Do you strongly favor that change, somewhat favor it, somewhat oppose it or strongly oppose it?

    13% strongly favor
    29% somewhat favor
    25% somewhat oppose
    24% strongly oppose
    9% not sure

17. In trying to control illegal immigration, should the government mandate that all employers use the federal electronic E-Verify system to help ensure that they hire only legal workers for U.S. jobs?

    71% yes
    17% no
    12% not sure

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

27% a major city
34% the suburbs
16% a small city
7% a town
14% a rural area
1% not sure

19. Where would you prefer to live – in a major city, the suburbs, a small city, a town or a rural area?

17% a major city
30% the suburbs
20% a small city
10% a town
21% a rural area
2% not sure

20. Have you lived in Texas since childhood or did you move to Texas as an adult?

67% since childhood
33% you moved in as an adult

21. About how long have you lived in Texas, less than 10 years, 10 to 20 years, 20 to 30 years, or more than 30 years?

10% less than 10 years
16% 10 to 20 years
14% 20 to 30 years
60% more than 30 years

22. Were you born in Texas, in another state, or another country?

56% Texas
39% another state
5% another country

NOTE: Margin of Sampling Error, +/- 3 percentage points with a 95% level of confidence

Appendix E
National Sprawl Survey of 1,500 Likely Voters
Conducted May 25-27, 2020
By Pulse Opinion Research

1* The U.S. Department of Agriculture calculates that in recent decades urban sprawl has destroyed 43 million acres of farmland and natural habitat, an area about equal in size to all of New England. If this trend were to continue, would it be a major problem, somewhat of a problem, not much of a problem, or not a problem at all?

44% A major problem
35% Somewhat of a problem
11% Not much of a problem
4% Not a problem at all
6% Not sure

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?

62% Very important
27% Somewhat important
6% Not very important
1% Not important at all
3% Not sure

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?

32% Very important
45% Somewhat important
16% Not very important
4% Not important at all
3% Not sure

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?

62% It is unethical to pave over and build on good cropland
18% The need for more housing is a legitimate reason to eliminate cropland
20% Not sure

5* The government reports that to make room for growing cities the last three decades, 19 million acres of surrounding woodlands have been cut down. How significant a problem is this loss of natural wildlife habitat?

51% Very significant
34% Somewhat significant
9% Not very significant
2% Not significant at all
4% Not sure

6* Does the U.S. have a responsibility to the rest of the world to preserve a certain amount of its natural habitat or is preserving the U.S. natural habitat not a matter of global concern?

62% The U.S. has a responsibility to the rest of world to preserve its natural habitat
27% Preserving the natural habitat is not a matter of global concern
11% Not sure

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

73% Yes
16% No
11% Not sure

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

45% Very important
40% Somewhat important
10% Not very important
2% Not important at all
3% Not sure

9* A study of government data found that most of the development destruction of farmland and natural habitat in the last decade has been related to the country's population growing by 22 million people. The Census Bureau projects the population is on pace to add another 86 million in the next 40 years. Would this rate of population growth in YOUR area make it a better place to live, a worse place to live, or would it not make much difference?

16% A better place to live
50% A worse place to live
25% Not make much difference
9% Not sure

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

28% The government would be able to build enough extra transportation capacity to accommodate the extra people
61% Traffic likely would become much worse
12% Not sure

11* Over the rest of this century, would you prefer that the nation's population continue to grow toward 500 million, grow much more slowly, stay about the same as it is now at 331 million, or slowly become smaller?

17% Continue to grow toward 500 million
43% Grow much more slowly
22% Stay about the same at 331 million
10% Slowly become smaller
8% Not sure

12* Census data shows that since 1970, annual immigration has tripled and is now the cause of nearly all long-term population growth. Should the federal government reduce annual immigration to slow down population growth, keep immigration and population growth at the current level, or increase annual immigration and population growth?

47% Reduce annual immigration to slow down population growth
33% Keep annual immigration and population growth at the current level
12% Increase annual immigration and population growth
8% Not sure

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

17% Two million or more
27% One million
21% Half a million
22% 100,000 or less
14% Not sure

14* One way to handle continued population growth without losing as much natural habitat and farmland would be to increase population density by changing zoning and other regulations so more residents live in apartments and condo buildings instead of single-family houses. Do you strongly favor, somewhat favor, somewhat oppose or strongly oppose this kind of change?

16% Strongly favor
32% Somewhat favor
24% Somewhat oppose
17% Strongly oppose
12% Not sure

15* Which best describes your current neighborhood -- is it higher population-density with at least some apartments or townhouses, is it less-densely populated with mostly single-family houses, or is it rural?

32% Your neighborhood is higher population-density with at least some apartments or townhouses
50% Less-densely populated with mostly single-family houses
14% If rural
3% Not sure

16* Would you prefer to live in a mixed higher-density neighborhood of stores, townhouses, apartments and condos, a neighborhood of single-family houses, or a rural area?

26% Mixed higher-density neighborhood of stores, townhouses, apartments and condos
45% Neighborhood of single-family houses
24% Rural area
5% Not sure

17* As a result of the coronavirus pandemic, does living in a more densely populated area appear more attractive, less attractive or has it not made much difference?

14% More attractive
50% Less attractive
32% It has not made much difference
3% Not sure

NOTE: *Margin of Sampling Error, +/- 2.5 percentage points with a 95% level of confidence*

Appendix F
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 (1925-2019), *Ph.D., professor of ecology and agricultural sciences,* Cornell University
Diana Hull (1924-2017)*, 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 (1923-2020), *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 G
Advisors to the 2022 NUSA national sprawl study
"From Sea to ~~Shining~~ Sprawling Sea:
Quantifying the Loss of Open Space in America"

Bruce D. Anderson, U.S. Forest Service and Minnesota Department of Natural Resources, retired

Phil Cafaro, Philosophy Professor and affiliated member of School of Global Environmental Sustainability, Colorado State University; author, *Thoreau's Living Ethics: Walden and the Pursuit of Virtue* and *Life on the Brink: Environmentalists Confront Overpopulation*; host, EarthX TV, The Population Factor

Trammell S. Crow, Founder of EarthX, the nation's largest annual exposition and forum showcasing/inspiring environmental leadership and innovations across non-profit, corporate and party lines

Herman E. Daly (1938-2022), Ecological economist and emeritus professor at the University of Maryland School of Public Policy

Bob Fireovid, Executive Director, Better (not bigger) Vermont

Dave Foreman (1946-2022), Founder, The Rewilding Institute; author and leading continental-scale conservation advocate

Maria Fotopoulos, Founder, TurboDog Communications and syndicated columnist

Alice Friedemann, Founder, http://www.energyskeptic.com/ ; author of *Life After Fossil Fuels: A Reality Check on Alternative Energy*

Tom Horton, Author and former journalist, *The Baltimore Sun*

Reed Noss, Chief Science Advisor, Southeastern Grasslands Initiative; past President, Society for Conservation Biology; elected Fellow, American Association for the Advancement of Science (AAAS)

Tim Palmer, Photographer and award-winning author of 31 books about rivers, conservation and adventure travel

David Paxson, Founder and past President, World Population Balance

W.J. Van Ry, Founder, Foundation for Human Conservation

Howie Wolke, Author and nationally recognized wilderness advocate

VISIT: www.TexasSprawl.com