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Second Printing

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Sprawl in Florida
EXECUTIVE SUMMARY

KEY OVERALL FINDINGS

- Florida's phenomenal population growth has been the No. 1 factor in the state's urban sprawl.
- The supposedly gluttonous appetite of Florida's citizens for more and more urban space per resident has in fact played little role in the sprawl. In most Urbanized Areas, the amount of land per resident did not grow at all and, thus, growth in per capita consumption was not a factor in any of the sprawl in those cities.
- The volatile growth of Florida's population far outweighed the sprawl effect of all other factors combined.
- To effectively bring relief to Floridians, anti-sprawl efforts must try to limit population growth while continuing to try to limit the many factors that increase the per capita urban land consumption – factors such as public decisions about zoning, land-use planning and transportation, and the choices made by developers and consumers.

[The period of study was the most recent two decades for which comprehensive government data are available (1970-90).]

THE REASON FOR THIS STUDY

Florida's urban areas sprawled out over an additional 1,600 square miles (one million acres) of formerly rural land of natural habitats, farmland and scenic open spaces during the two decades that were examined by this study.

A major movement of governmental agencies, public officials, think tanks, corporations and advocacy groups is devoting more and more resources to taming Florida's relentless urban sprawl.

To be effective, anti-sprawl efforts must target the factors that are most responsible for the encroachment on the rural land. The relative contributions of the factors must be understood if anti-sprawl resources are to be used efficiently and effectively. This study quantifies those relative contributions.

The authors embarked upon this study after a literature search found that media stories, advocacy programs, governmental reports and political statements about sprawl rarely consider population growth as a factor that could be modified to reduce sprawl. This seemed surprising in light of Florida's population nearly doubling during the period of study – from 6.8 million to 12.9 million. The half-century view is even more startling; the state's human inhabitants have expanded from around 2.8 million in 1950 to 16 million in 2000.

WHAT WAS MEASURED

Sprawl can be measured qualitatively and quantitatively. This study looks exclusively at the quantitative measure of the amount of sprawl – the actual square miles of rural land that are converted to urban use as cities and suburbs expand beyond their boundaries. (We call this "Overall Sprawl.")

To determine how that has happened, the authors solely relied on the U.S. Bureau of Census's painstaking calculations for each Urbanized Area (which must have a minimum of 50,000 residents). This is done only once a decade, a couple of years after the national census. Nearly every organization that addresses sprawl relies on these data. What they haven't done is use those same data to quantify the relative roles of major growth factors.

‘PER CAPITA SPRAWL’ ALONE CANNOT EXPLAIN OVERALL SPRAWL

The study first checked to see if the data support the apparent assumption of most anti-sprawl efforts that per capita consumption factors are responsible for all or most sprawl.

The effect of all urban planning, development, transportation, business and consumer decisions that affect consumption shows up in the figure that tells us how much urban land is used on average for each resident. If that amount of land (about one-quarter to one-half acre per current resident in most Florida cities) grows, a city has “Per Capita Sprawl.” A city can have no population growth at all, and still have considerable Overall Sprawl if the amount of land per resident is growing.

If Per Capita Sprawl were the sole factor in Overall Sprawl in Florida, the percentage growth of one would be the same for the other; for example, if per capita land consumption grew by 13%, total land consumption would also grow by 13%. Or if per capita land consumption growth were the overwhelming factor, its percentage growth would at least be close to that of Overall Sprawl.

But when we found these two percentages in Census Bureau data and placed them side by side [see Tables 2a and 2b], we learned:

- Not a single one of Florida’s 20 Urbanized Areas had a Per Capita Sprawl percentage that was even close to being as high as the Overall Sprawl percentage. In the Tampa area, for example, Per Capita Sprawl was 13%, but the total land consumption rose by 123%.

- Overall Sprawl in the average older Florida Urbanized Area, for example, was 114% while Per Capita Sprawl was only 9%.

This simple comparison of U.S. Census Bureau data starkly reveals why Smart Growth efforts in Florida are likely to fail to stop sprawl if they focus virtually entirely on factors that cause per capita land consumption growth.

It is not that Smart Growth efforts are focused on the wrong factors but that many of them are focused too narrowly. Obviously, there is another factor involved in sprawl, and that factor is population growth.

COMPARING POPULATION GROWTH TO PER CAPITA LAND CONSUMPTION GROWTH

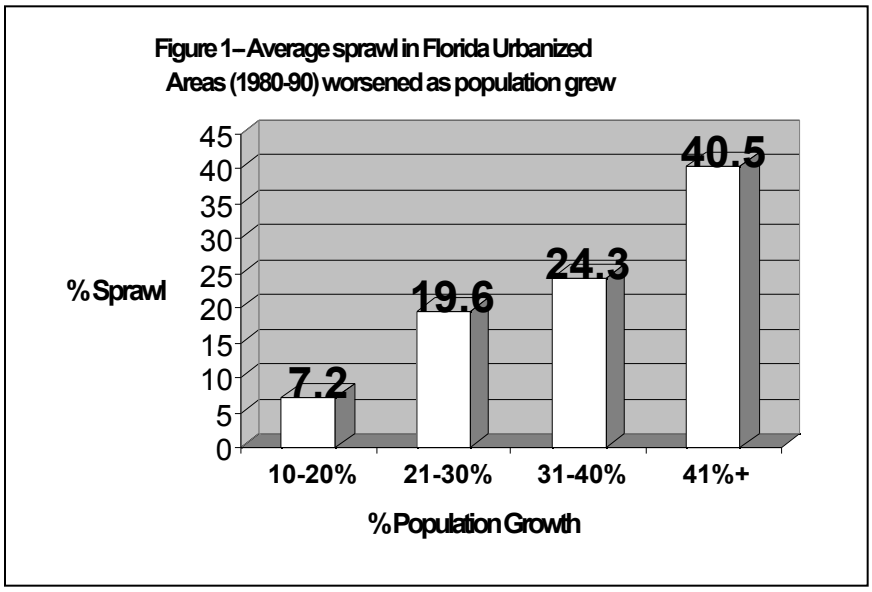
When Per Capita Sprawl (which is the net result of all personal, business and governmental consumption decisions) cannot explain all of the total increase in urbanized land, the only other explanation for the rest of that increase has to be “population growth.” Despite the considerable complexity of sprawl in an urban area, nearly all of the complexity can be boiled down into what end up being two rather simple factors in an equation: The amount of Overall Sprawl in an area is equal to the change in per capita land consumption times the change in population.

We can learn a lot about the relative importance of each of these two factors in Florida’s sprawl by lining up the growth percentages side by side. [See Tables 3a and 3b.] An observer of these tables doesn’t have to be a mathematician to see that population growth has been a far greater factor in Florida’s Urbanized Areas than has been per capita land consumption growth.

- Per capita land consumption growth was larger than population growth only in Pensacola (54% vs. 52%).

- The average older Urbanized Area of Florida had 9% growth in per capita land consumption and 100% growth in population.

- The comparison may be more revealing among the average new Urbanized Areas (those which didn’t meet Census Bureau criteria until 1980). They had a 10% reduction in per capita land consumption, but had 43% population growth.



COMPARISONS BY CATEGORY OF POPULATION GROWTH LENT CREDENCE TO COMMON SENSE VIEW OF ITS IMPORTANCE

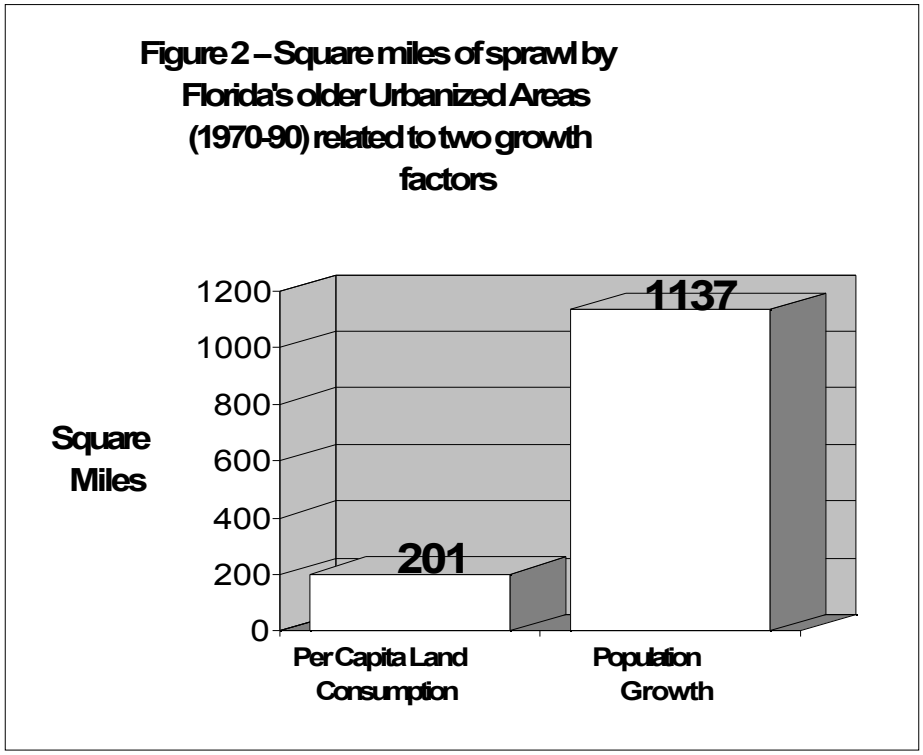
The strong effect of population growth on sprawl could also be found when we clustered all 20 of Florida's Urbanized Areas according to their percentage of population growth during the 1980s. Figure 1 shows a relationship that many observers would consider to be simple common sense.

In this Florida study – as well as in a study of the 100 largest Urbanized Areas of the United States released in February, 2001– we found that one city with higher population growth will not necessarily have more sprawl than another city with lower population growth. But we found that on average the rate of sprawl rises significantly as the rate of population growth rises.

Average sprawl was 7.2% in cities with 10-20% population growth; average sprawl was nearly six times higher (40.5%) in the cities in the highest population category.

APPORTIONING RELATIVE CONTRIBUTIONS OF EACH FACTOR TO OVERALL SPRAWL

With percentages for the two growth factors available, it is possible to look at their ratio to each other to get an idea of their relative contribution to Overall Sprawl. We used a standard method of calculating those ratios.



- In 19 of the 28 Urbanized Areas of the state, growth in per capita land consumption did not appear to be related to *any* of the sprawl – because there *was* no growth in consumption by the average resident.

- Despite stopping all *per capita* sprawl, though, those 19 still suffered major *overall* sprawl.

The results were striking:

- Population growth was related to 85% of the

sprawl in the average older Florida Urbanized Area, and to 99.7% of the sprawl in the average new Urbanized Area.

- Increased per capita land consumption, on the other hand, was related to 15% of sprawl in the average older area and 0.3% of the sprawl in the average new area.

Figure 2 considers the 1,338 square miles of sprawl in those nine older Urbanized Areas between 1970 and 1990. When the proportions of 15% and 85% for the average city are applied to that sprawl, it suggests that 201 square miles of lost rural land was explained by increases in per capita land consumption and that 1,137 square miles of lost rural land was explained by population growth.

IMPLICATIONS

These findings suggest that those who would stop sprawl in Florida will need to address three levels of government: (a) local incentives that entice more people to move into particular cities, (b) state policies that attract residents from other states, and (c) federal policies that add population to Florida and the nation as a whole.

Although per capita land consumption growth has played very little role in driving sprawl in Florida, it would be a mistake to suggest that efforts to stop such growth or to reduce per capita land consumption are misplaced. For example, because the Ft. Lauderdale area's population grew by 102%, the Urbanized Area would have sprawled by 102% if per capita land consumption had stayed exactly the same. But the area actually sprawled by considerably less (54%). Why? Because land consumption for the average resident was reduced sharply by 24%. Whether residents of Ft. Lauderdale thought the quality of their lives was improved or deteriorated from living so much more densely is a question for another study. But decreasing the living, working and traveling space for each resident definitely reduced the amount of Overall Sprawl.

Of course, it is theoretically possible for a while to have strong population growth and no sprawl by forcing all new and old residents to remain within the confines of current urban land boundaries. Nothing in the state's history, however, suggests the ability or willingness to do this even for one year, let alone in perpetuity. While the majority of Florida's Urbanized Areas did pack more residents into the average square mile, that extra density didn't come close to handling the additional residents that were being added at the same time.

According to the Census Bureau, current immigration, fertility and domestic migration trends will drive Florida's population to 20.7 million residents by 2025, with no peak in sight. Nothing that has occurred in Florida's cities thus far suggests that sprawl will not continue its march across the state's ever-more beleaguered rural and open spaces. In the process, the state's environment and quality of life for residents will pay an ever-higher price for the government's unwillingness to allow the population to stabilize.

These population policies, phenomena and trends – as has been shown by this study – are central to understanding the future of sprawl in Florida. Studies and plans from state commissions, think tanks, universities and advocacy groups that purport to offer blueprints for combating sprawl without dealing with population growth look either naïve, foolish or deceptive in light of the findings of this study.

This study builds on work done in another study, "Sprawl in California," presented in August of 2000 at a conference at the University of Southern California, and on a study of the 100 largest U.S. Urbanized Areas released in February, 2001.

Sprawl in Florida

A report quantifying the impact of Florida's population boom on sprawl

1. INTRODUCTION

Urban sprawl continues to destroy Florida's natural habitats and farmland at an accelerated pace. From 1970 to 1990 alone, the state's urban areas spread relentlessly into surrounding countryside to devour more than 1,600 additional square miles (one million acres) of formerly rural land.

Florida is the home to six of the nation's 21 most imperiled ecosystems: South Florida landscape, longleaf pine forest, large streams and rivers, Florida scrub, and Southern forested wetlands.[1]

Approximately 10,000 acres of prime Florida cropland are permanently lost each year from a combination of soil erosion and the spread of industrial, recreational, commercial and residential development.[2] At this rate, half of the state's cropland will be gone in 50 years.

1.1. Sprawl as sign of economic vitality or ecological threat

Many organizations and media commentators defend the ever-expanding encroachment of rural land as a sign of the vitality of the economy and say that it should be embraced and even encouraged. [3]

That is not the view of most Americans, however, according to polls which find that sprawl is among their greatest concerns.[4] The non-human inhabitants of the state's ecosystems have not been polled, but the ecological health of the region is closely monitored and reveals deep problems largely due to sprawl and other human intervention into the natural habitat:

- More than 40% of the state's natural habitats have already been converted to urban and agricultural uses.
- Native flora and fauna in the state are suffering beneath the heels, wheels, asphalt and outboard motors of the dominant mammal – *Homo sapiens*. More than 600 species are considered rare or imperiled in South Florida.
- 68 species are listed by the federal government as threatened or endangered, including the Florida panther, American crocodile, the gentle manatee, and five species of sea turtles.[5]
- In addition, the tiny Key deer, the wood stork and the bald eagle are just three of 99 species of animals and plants designated by state officials as threatened or endangered.[6]
- South Florida's fabled Everglades was first brought to the attention of the broad American public in 1947 with the publication of Marjory Stoneman Douglas' conservation classic *The Everglades: River of Grass*. But agricultural development around the 'glades, massive water diversions, and the explosive growth of Miami and other South Florida cities have all taken their toll on this natural wonder and its wildlife. The Everglades is now considered by many to be the nation's most threatened national park.
- Just to the south, Florida Bay is succumbing to algal blooms, while the coral reefs in the Florida Keys are in a precarious state from light-robbing, oxygen-depleting algal blooms and diseases that flourish in polluted waters.

- Adding insult to injury, the fragile corals are battered and broken by propellers, boat keels, anchors, and even diving flippers.[7]

All of this has occurred at the same time that Florida's population has expanded from around 2.8 million in 1950, to 6.8 million in 1970[8], to 16 million in 2000[9], with no end in sight.

1.2. Most anti-sprawl efforts focus on growth in per capita land consumption, not population growth

Were the two Florida phenomena —massive population growth and massive sprawl— related? Or was it primarily coincidental that they have occurred at the same time?

Coincidental, say most anti-sprawl and Smart Growth enthusiasts. They argue that the primary causes of sprawl have been (1) the increasingly gluttonous appetite of individual residents for bigger houses, bigger lots, more cars, more parking lots and more roads, and (2) badly planned development and transportation systems heavily subsidized by government and corporations that waste land and force people to live less densely. In other words, their claim is that sprawl is caused overwhelmingly by factors of land-consumption behavior.

Others argue that simple common sense suggests that population is also a major factor in sprawl. After all, those new subdivisions spreading like crabgrass across the state are not being built just for the heck of it but to house more people – roughly 2.5 million more each decade.

To be effective, anti-sprawl efforts must be targeted at the factors that are most responsible for the encroachment on open spaces, natural habitats and farmland. The relative contributions of the factors must be understood if anti-sprawl resources are to be used efficiently and effectively. And understanding is difficult without quantification.

The authors embarked upon this study after a literature search found that most anti-sprawl efforts are based on the belief that population growth is not a significant factor in the worsening sprawl. Most anti-sprawl leaders have decided that curbing population growth is not one of many possible solutions to sprawl problems.

Is the decision to focus almost exclusively on consumption factors a wise one? The first challenge of this study is to determine if per capita consumption growth alone is responsible for all or most of the increased urbanization of rural land in Florida.

To do that, we must be clear what we are measuring as sprawl.

2. DEFINING AND MEASURING 'OVERALL SPRAWL'

The word "sprawl" is not a precise term. But we use the term "Overall Sprawl" in a precise way in this study.

2.1. Quality vs. quantity measurements

Sprawl can be measured for both quality and quantity (amount). Measures for the quality of urban expansion include:

1) its low-density character, in contrast to compact urban cores;
2) its chaotic, or unplanned nature;
3) its dependence on the automobile; and
4) its connection with the decay of inner cities.

This study of the urban areas in Florida, though, limits itself to quantification – measuring the amount of urban sprawl.

We use the term "Overall Sprawl" to refer to the increase of the total size of the land area of a city and its suburbs. If an urban area covered 10 square miles previously and now covers 12 square miles, we say that the city and its suburbs over that period of time have "sprawled 2 square miles."
Overall Sprawl is the loss of rural land at the periphery of a city. This involves the conversion of open space or rural land into built-up, developed, or urbanized land over time, no matter the quality of that conversion.

We believe this measurement by amount closely resembles the most common American understanding of sprawl. If 25 square miles of open spaces around a city are urbanized, most Americans would consider that to be 25 square miles of sprawl, regardless of whether it was developed tastefully or not. They might be more offended by the sprawl if it included ugly development, but the amount of sprawl – and the number of rural acres lost – would be the same. Thus, using this measure, it is possible to have well-planned sprawl or chaotic sprawl, to have high-density or low-density sprawl, to have auto-dependent or mass-transit-oriented sprawl. But regardless of the quality of the sprawl, the amount of sprawl is measured by the square miles of rural land eliminated by urban development.

The quantity of sprawl is of great importance to environmental and agricultural considerations. But it also is significant in the quality of life of urban dwellers. The larger an urban area, the more difficult it will be for the average resident to reach the open spaces beyond the urban perimeter; the increase in urban distances can also affect commuting time, mobility and a resident's feeling of being "trapped."

2.2. Using the Census Bureau's 'Urbanized Areas'

Fortunately, it is easy to approximate the amount of Overall Sprawl because of a painstaking process conducted by the U.S. Bureau of the Census for a half-century. Our study relies solely on Census data on Urbanized Areas of the United States to measure Overall Sprawl.[10]

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

This study looks at all 20 of the Urbanized Areas in Florida for which at least one decade of data exists. The Census Bureau does not classify a settlement as an Urbanized Area unless it is a continuously built-up area with a population of at least 50,000. An Urbanized Area consists of one or more "central places" as well as relatively densely settled surrounding areas that the Bureau terms the "urban fringe." The central place(s) and urban fringe may be thought of as the urban core and suburbs of a given Urbanized Area. In the West Palm Beach area, for example, the "central places" are West Palm Beach, Boca Raton and Delray Beach. All the rest of the developed area is classified as "urban fringe."

The Bureau introduced the Urbanized Area concept in the 1950 Census as part of its efforts to differentiate the urban and rural portions of the nation's population. It recognized 405 Urbanized Areas in the United States as of the 1990 Census.

[For further explanations of the Census Bureau's methods in measuring Urbanized Areas, see Appendix B]

Table 1a – Overall Sprawl in Florida's Older Urbanized Areas (1970 to 1990)*

Urbanized Area	Sprawl (sq. miles)
Ft. Lauderdale - Hollywood- Pompano Beach	114.9
Gainesville	32.2
Jacksonville	156.4
Miami-Hialeah	94.0
Orlando	262.9
Pensacola	88.9
Tallahassee	59.2
Tampa-Saint Petersburg- Clearwater	358.7
W. Palm Beach- Boca Raton- Delray Beach	170.2
Total	**1,337.4**

* *The Census Bureau classified these as Urbanized Areas in 1970 or earlier.*

Nearly every organization that addresses sprawl relies on these Urbanized Area data as the foundation of any quantification of total sprawl. What they haven't done is use those same data to quantify the relative roles of population growth and per capita land consumption in generating that sprawl.

2.3. Period of study

This study measures sprawl over the most recent two decades for which comprehensive government data are available (1970-90). But 11 of the 1980 Urbanized Areas were not large enough in 1970 to be counted as such. The data for those 11 cover only the 1980 to 1990 period; we will refer to them as "new Urbanized Areas."

Urbanized Area data are calculated only once every 10 years. Thus, our study can assess the march of sprawl only through 1990. The calculations from the 2000 Census will not be available for a couple of years, at which time we will update this report. Although it may be tempting to try to estimate sprawl for the 1990s, the authors feel the Census Bureau's Urbanized Area data are so superior to all other sources that the use of other sources to estimate sprawl would compromise the reliability of this study. An exception would be a regular land survey by the Natural Resources Conservation Service of the U.S. Department of Agriculture, which in 2001 released its latest data through 1997. This survey— the National Resources Inventory—does not look at specific Urbanized Areas but surveys the conversion of rural land into development throughout whole states, providing a useful comparison for the urban-only data of the Census Bureau. We examine this data further in our national study. We have found nothing in the data suggesting that the trends of the 1970s and 1980s are substantially different in the 1990s.

Table 1b – Overall Sprawl in Florida's New Urbanized Areas (1980 to 1990) *

Urbanized Area	Sprawl (sq. miles)
Daytona Beach	22.8
Fort Myers-Cape Coral	29.2
Fort Pierce	44.6
Fort Walton Beach	11.3
Lakeland	18.2
Melbourne-Palm Bay	66.2
Naples	6.9
Ocala	7.3
Panama City	18.5
Sarasota-Bradenton	43.0
Winter Haven	2.1
Total	**270.1**

** These did not meet Census Bureau criteria as Urbanized Areas until 1980.*

3. 'PER CAPITA SPRAWL' ALONE CANNOT EXPLAIN OVERALL SPRAWL

Most anti-sprawl publications and programs focus on factors that increase the average consumption of urban land by residents. We call this increase "per capita land consumption growth" or "Per Capita Sprawl."

3.1. Many reasons for Per Capita Sprawl

Per capita urban land consumption is not limited to the size of a person's house lot or to a person's proportion of the land covered by an apartment complex. It also includes a portion of all the other land that has been converted from rural to urban use to provide for jobs, recreation and entertainment, shopping, parking, transportation, storage, government services, religious and cultural opportunities, waste handling, and education.

So the level of per capita land consumption is based both on direct individual decisions and behavior, and on collective decisions made through the government and the marketplace. The effect of all urban planning, development and transportation decisions shows up in the per capita land consumption figure.

In the end, per capita land consumption is calculated by dividing the total urban land area by the total number of residents. The resulting per capita figure provides a net result view of at least two dozen major factors that have been suggested as causes of consumption changes.

[See Appendix C for more on calculating per capita land consumption.]

The factors that drive Per Capita Sprawl include:

- price of gasoline,
- inadequate urban planning and zoning,
- local and federal tax incentives and subsidies,
- crime and quality of schools in the central cities,
- mortgage interest tax deductions,
- racial and ethnic tensions,
- the Interstate Highway system and other transportation decisions,
- developer preferences,
- declining size of households caused by factors such as increased divorce rate, lowered marriage rate, later marriages, increased independence of young adults, increased longevity for women,
- consumer preferences for larger houses and yards,
- and affluence.

A nationwide "Smart Growth" movement has emerged to fight sprawl by going after some of those many causes of Per Capita Sprawl, which is measured in the middle column of Tables 2a and 2b. The Smart Growth movement is composed of a broad-based collection of urban planners, environmentalists, charitable foundations, historic preservationists, "new urbanists," affordable housing advocates, local, state and federal government agencies and elected officials, churches, local growth control activists, and even some of the home building industry. Many variations can be found among their proposals but all advocate tools that would stop the increase in per capita land consumption.

It is very difficult to measure precise effects of trying to change each of the planning, consumption and other behavioral factors mentioned above. But we can know the overall effect of all those factors together by looking at the simple statistic of the average amount of urban land per resident in an Urbanized Area. If that per capita land consumption figure goes up markedly, then we know that Smart Growth efforts related to the above factors are failing to achieve their desired result. But if the per capita figure grows only slightly, or remains the same, and especially if it goes down, the above factors are collectively moving in the direction desired by the anti-sprawl leaders. It is difficult to know whether their efforts made the difference, but we do know in such cases that per capita land consumption patterns are being brought under control.

The per capita consumption figure is a crucial gauge of the nature of sprawl in any Urbanized Area.

3.2. Per capita land consumption growth falls far short of total land growth percentage

When we look at the Per Capita Sprawl figures for Florida's cities in Tables 2a and 2b, we find that – for whatever reasons – the goal of anti-sprawl programs to stop per capita growth has been substantially met.

Table 2a – Per Capita Sprawl Compared with Overall Sprawl in Older Areas (Florida 1970-1990)*

Urbanized Area	% Growth in Per Capita Land Consumption	% Growth in Total Land Area
Ft. Lauderdale-Hollywood-Pompano Beach	- 24%	54%
Gainesville	16%	111%
Jacksonville	4%	45%
Miami-Hialeah	-13%	36%
Orlando	3%	200%
Pensacola	54%	134%
Tallahassee	49%	199%
Tampa-Saint Petersburg-Clearwater	13%	123%
W. Palm Beach-Boca Raton-Delray Beach	- 19%	125%
**Average Urbanized Area ** **	**9%**	**114%**
Weighted average***	**0%**	**89%**

** The Census Bureau classified these as Urbanized Areas in 1970 or earlier.*
*** Mean of the percentages.*

In only five of the 20 Urbanized Areas, is Per Capita Sprawl significant. If stopping Per Capita Sprawl were the entire goal of the anti-sprawl movement, then Florida could be declared a victory.

Table 2b – Per Capita Sprawl Compared with Overall Sprawl in New Areas (Florida 1980 - 1990)*

Urbanized Area	% Growth in Per Capita Land Consumption	% Growth in Total Land Area
Daytona Beach	-6%	22%
Fort Myers-Cape Coral	-16%	31%
Fort Pierce	1%	81%
Fort Walton Beach	-10%	19%
Lakeland	-4%	24%
Melbourne-Palm Bay	-3%	40%
Naples	-35%	14%
Ocala	-12%	18%
Panama City	0%	32%
Sarasota-Bradenton	-12%	29%
Winter Haven	-12%	5%
Average Urbanized Area**	**-10%**	**28%**
Weighted average***	**-9%**	**30%**

** These did not meet Census Bureau criteria as Urbanized Areas until 1980.*
*** Mean of the percentages.*
**** Land and population for all cities are calculated together.*

But, as was demonstrated in Tables 1a and 1b, Overall Sprawl in Florida's 20 Urbanized Areas continued at a raging pace – consuming more than 1,600 square miles of rural land during the period of study.

It appears that anti-Per Capita Sprawl efforts in Florida (results reflected in the Tables' middle column) may have been largely successful. But anti-Overall Sprawl efforts (results shown in the right-hand column) have been an abysmal failure.

If Per Capita Sprawl were the sole cause of Overall Sprawl, the percentage growth would be the same in both the middle and right-hand columns; for example, if per capita land consumption grew by 13%, total land consumption would also grow by 13%.

But in the Tampa Urbanized Area, per capita land consumption grew by 13% while the total land in the urban area grew by the far larger 123%. Growth in per capita land consumption hardly explains any of Tampa's Overall Sprawl.

Tallahassee had a major increase in urban land per resident, rising by 49%. But the overall increase in urban land area soared by 199%.

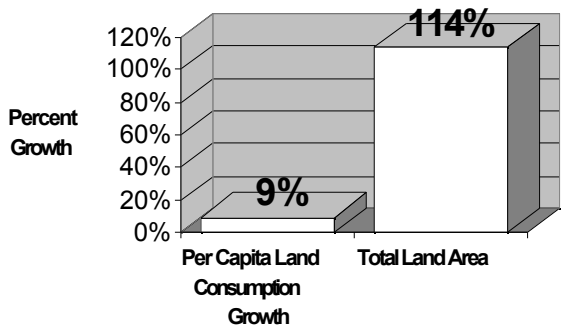
In fact, not a single one of Florida's 20 Urbanized Areas had a Per Capita Sprawl percentage that was even close to the Overall Sprawl percentage. No city had a Per Capita Sprawl percentage that was equal to even half of Overall Sprawl. Pensacola came the closest with 54% Per Capita Sprawl and 134% Overall Sprawl.

The relationship between Overall Sprawl and per capita consumption growth was significantly less in the new Urbanized Areas – those that reached the 50,000 Census Bureau threshold for the first time in 1980. Only one of them – Fort Pierce – had Per Capita Sprawl. And that was 1%, in an area that had 81% Overall Sprawl.

In 12 of Florida's older and new Urbanized Areas, growth in per capita land consumption can't explain any of the Overall Sprawl – because there was no growth in average land consumption.

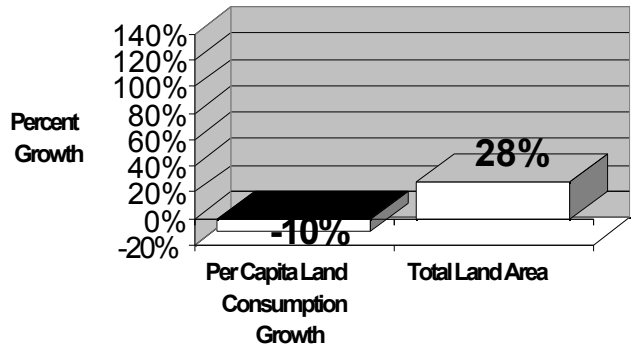
For example, per capita land consumption fell by 24% in the Ft. Lauderdale area, but total land

Figure 3a-- Overall Sprawl rate in the average older Florida Urbanized Area was more than 12 times higher than the Per Capita Sprawl rate



consumption increased by 54%. Average land use fell by 13% in Miami, but total land use grew by 36%.

Graph 3b- Average new Florida Urbanized Area had considerable Overall Sprawl even though per capita land consumption was falling



The average older Urbanized Area had Per Capita Sprawl of 9%, but Overall Sprawl advanced by more than 12 times as much – 114%.

The average new Urbanized Area had no Per Capita Sprawl at all. Per capita land consumption was reduced by 10%, while the average new Urbanized Area had 28% Overall Sprawl.

These tables of Census data starkly reveal why nearly all Smart Growth efforts are failing – and will continue to fail – to stop sprawl as long as they focus virtually entirely on factors that cause per capita land consumption growth.

It is not that Smart Growth efforts are focused on the wrong factors but that they are focused too narrowly. Obviously, there is another factor involved in sprawl. Without addressing that factor, Smart Growth programs as currently envisioned are designed to fall short of protecting the agricultural land and natural habitats surrounding cities.

4. WHEN PER CAPITA CONSUMPTION CAN'T EXPLAIN SPRAWL, WHAT FACTOR IS LEFT?

For some reason, many otherwise intelligent observers seem to have a mental block that keeps them from understanding that the other factor in sprawl is population growth. The only factor that can make Overall Sprawl grow at a faster rate than the increase in per capita land consumption is population growth.

Perhaps if we visualize sprawl in terms of a small village, this truth will become more apparent. Consider a village of 100 people that spreads out over 20 acres of land. Per capita land consumption in that case is 0.20 acre (20 acres divided by 100 residents equals 0.20 acre).

Now imagine that we revisit that village later and find that it has grown 5 acres to a total of 25 acres (a 25% growth). This happened while its population remained static and its per capita land consumption has increased by 0.05 to 0.25 acre (a 25% growth). From that, we can know that the increase in per capita consumption has caused all of the Overall Sprawl. We know that not only because the rate of growth is the same for each, but because the 0.05 acre of growth multiplied times the village's 100 residents equals the 5 acres of Overall Sprawl.

Such a village is precisely the situation that most Smart Growth programs are designed to address.

But in Florida's cities, we find a very different situation. In some, it is as if we re-visit the village and find that the total land has increased to 25 acres but the per capita land consumption has stayed exactly the same at 0.20 acre. There can be only
one explanation for how that has occurred: The town has to have added residents. After all, the previous population of 100 times, multiplied times the static per capita consumption of 0.20 acre, equals 20 acres of land, not the 25 acres we now find.

The only explanation possible for the 5 acres of Overall Sprawl when per capita consumption remains constant is that the village's population has grown by 25 residents (125 residents times 0.20 acre equals 25 acres).

Table 3a – Population Growth Compared with Per Capita Sprawl in Older Areas (Florida 1970 - 1990)*

Urbanized Area	% Growth in Per Capita Land Consumption	% Growth in Population
Ft. Lauderdale-Hollywood-Pompano Beach	- 24%	102%
Gainesville	16%	82%
Jacksonville	4%	39%
Miami-Hialeah	-13%	57%
Orlando	3%	190%
Pensacola	54%	52%
Tallahassee	49%	100%
Tampa-Saint Petersburg-Clearwater	13%	98%
W. Palm Beach-Boca Raton-Delray Beach	- 19%	176%
Average Urbanized Area**	**9%**	**100%**
Weighted average***	**0%**	**89%**

* *The Census Bureau classified these as Urbanized Areas in 1970 or earlier.*
** *Mean of the percentages.*
*** *Land and population for all cities are calculated together.*

each Florida Urbanized Area are readily available from the Census Bureau.

An observer doesn't have to be a mathematician to see that population growth has been a far greater factor in Florida's Urbanized Areas than has been per capita land consumption growth.

Per capita consumption growth was larger than population growth only in Pensacola. It also was a significant factor in Tallahassee, and a moderate factor in Gainesville and Tampa.

When comparing the two columns of growth in Tables 3a and 3b, it becomes apparent that any anti-sprawl effort in Florida that does not place a major emphasis on slowing population growth is failing to control the primary engine of Overall Sprawl in the state.

Despite the considerable complexity of sprawl in an urban area, nearly all of the complexity can be boiled down to what end up being two rather simple factors in an equation: The amount of Overall Sprawl in an area is equal to the change in per capita land consumption times the change in population. In most American cities, growth has occurred in both factors.

We can learn a lot about the relative importance of each of these factors in Florida's sprawl by lining up the growth percentages side by side. Fortunately, both the per capita land consumption change and the population change for

Figure 4a - Population growth in average older Florida Urbanized Area was more than 10 times higher than growth in per capita consumption

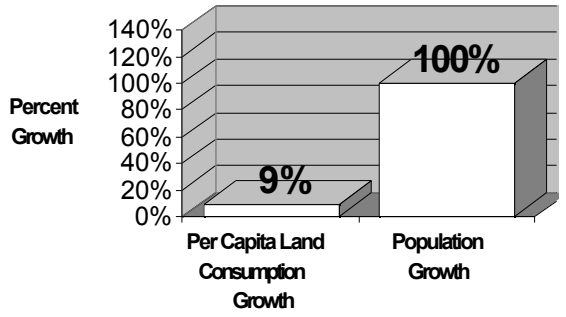


Table 3b – Population Growth Compared with Per Capita Sprawl in New Areas (Florida 1980-1990)**

Urbanized Area	% Growth in Per Capita Land Consumption	% Growth in Population
Daytona Beach	-6%	30%
Fort Myers-Cape Coral	-16%	56%
Fort Pierce	1%	79%
Fort Walton Beach	-10%	32%
Lakeland	-4%	29%
Melbourne-Palm Bay	-3%	44%
Naples	-35%	76%
Ocala	-12%	34%
Panama City	0%	31%
Sarasota-Bradenton	-12%	45%
Winter Haven	-12%	19%
Average Urbanized Area**	**-10%**	**43%**
Weighted average***	**-9%**	**42%**

** These did not meet Census Bureau criteria as Urbanized Areas until 1980.*
*** Mean of the percentages.*
**** Land and population for all cities are calculated together.*

The average older Urbanized Area had 9% growth in per capita land consumption and 100% growth in population.

The density increased in the average new Urbanized Area which had a 10% reduction in per capita land consumption. By themselves, the factors that affect the amount of urban land per resident should not have created any Overall Sprawl.

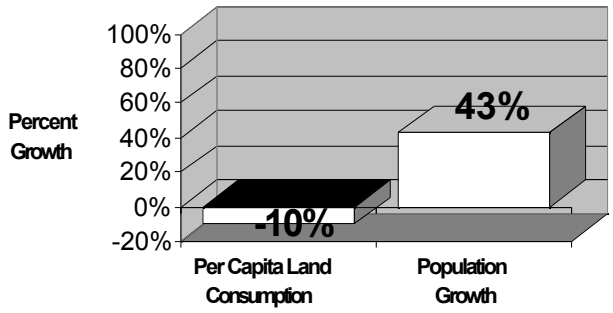
But the average new Urbanized Area also had 43% population growth.

5. APPORTIONING RELATIVE CONTRIBUTIONS OF EACH FACTOR TO OVERALL SPRAWL

With percentages for the two overall growth factors available, it is possible to look at their ratio to each other to get an idea of their relative contribution to Overall Sprawl on a 100% scale.

This apportioning of "shares" of sprawl is an important tool for helping policy makers – and the people who elect or appoint them – know where to look for solutions.

Figure 4b - Population growth grew while per capita consumption shrank in average new Urbanized Area



5.1. Simple ratio calculation

A simple way to calculate the ratio of any two figures to each other is to add them together to obtain a sum, which can then be divided into each figure to yield a percentage. The two percentages thus obtained will add up to 100%.

In the case of the Jacksonville Urbanized Area, we add the per capita consumption growth percentage of 4 to the population growth percentage of 39, yielding a sum of 43. When we divide 43 into each growth figure we find that:

- per capita consumption growth is 9% of the combined power of the two growth factors.
- population growth is 91% of the combined power of the two growth factors.

Based on that, we can say that 9% of Jacksonville's sprawl is explained by, or related to, per capita consumption growth, and that 91% of Jacksonville's sprawl is explained by, or related to, population growth.

From a common-sense perspective, this finding is not that surprising. One might reasonably expect that the addition of more than 200,000 people to Jacksonville during the period of study would spur a massive construction cycle of homes, streets, workplaces and commercial districts that would sprawl over large chunks of the surrounding countryside. In fact, Jacksonville sprawled by more than 150 additional square miles, primarily in response to its population expansion.

The percentages shown in parentheses in Tables 4a and 4b are the result of applying this simple method of calculating "shares of sprawl" for all 20 of Florida's Urbanized Areas. Those tables also show the shares as calculated in a more sophisticated way that is described in the next section. Although the latter method is designed to provide a more accurate view of the roles of the two kinds of growth, we have included the simple-ratio results for those who prefer a more straightforward method of calculation.

5.2. Calculating ratios with a scientific method

To test the foregoing very simple mathematical exercise, we can run the numbers through a more complex scientific methodology that is commonly applied to total consumption of various resources. Harvard physicist John Holdren – internationally honored in 2000 for his achievements in environmental science – has particularly developed, described and worked with this methodology.[11] It can be applied to virtually any type of resource use. Perhaps its best-known application has been in understanding how total U.S. energy use has risen in recent decades. The methodology has enabled analysts to apportion shares of the total increase of energy in a country to (1) the change in per capita energy use and to (2) the change in population.

The unique contribution of the present study is that it appears to be the first to apply these methods to sprawl. As in the case of looking at energy consumption, the question here was how much of the increased total consumption of rural land (Overall Sprawl) was related to per capita change in land consumption (Per Capita Sprawl) and how much was related to the increase in number of land consumers (Population Growth). [See Appendix D for further description.]

But for all the complexity of this methodology and the use of logarithms, it produces only slightly different results than the more transparent calculation explained in the previous section which almost anybody can do on the back of a napkin.

However one calculates the ratio of the growth factors to Overall Sprawl in Florida's cities, the results are dramatic. They show that, far from being an insignificant factor in Florida's massive sprawl, population growth is related to the overwhelming majority of that sprawl.

Read Table 4a like this, using the second line of the table as an example:

(1) In the Gainesville Urbanized Area, 20% of the sprawl was related to the growth in per capita land consumption (16% if you use the simple ratio method to calculate).

(2) 80% of Gainesville's sprawl was related to population growth (84% under the simple ratio method).

[The actual percentages of population growth and of Per Capita Sprawl are not included in these tables. They can be found in Tables 3a and 3b.]

The more sophisticated Holdren method finds that:

- Population growth was related to 85% of the sprawl in the average older Florida Urbanized Area, and to 99.7% of the sprawl in the average new Urbanized Area.

- Increased per capita land consumption, was related to 15% of sprawl in the average older area and 0.3% of sprawl in the average new area.

Table 4a – Sources of Sprawl in Florida's Older Urbanized Areas

Results from the Holdren method (and in parentheses the simple ratio method)*

Urbanized Area	% of Total Sprawl related to GROWTH IN PER CAPITA LAND CONSUMPTION was:		% of Total Sprawl related to POPULATION GROWTH was:	
Ft. Lauderdale-Hollywood-Pompano Beach	(0%)	0%	100%	(100%)
Gainesville	(16%)	20%	80%	(84%)
Jacksonville	(9%)	10%	90%	(91%)
Miami-Hialeah	(0%)	0%	100%	(100%)
Orlando	(2%)	3%	97%	(98%)
Pensacola	(51%)	51%	49%	(49%)
Tallahassee	(33%)	37%	63%	(67%)
Tampa-Saint Petersburg-Clearwater	(12%)	15%	85%	(88%)
W. Palm Beach-Boca Raton-Delray Beach	(0%)	0%	100%	(100%)
Mean of percentages	**(14%)**	**15%**	**85%**	**(86%)**
Weighted average**	**(0%)**	**0%**	**100%**	**(100%)**

** Holdren method explained in Appendix D. Simple ratio method described in Section 5.1.*

*** Land and population for all cities are calculated together.*

5.3. Population growth related to 100% of sprawl in most cities

Rather incredibly, population growth was associated with 100% of the sprawl in 12 of Florida's 20 Urbanized Areas.

Attributing 100% of any phenomenon to a single factor can be unsettling and sound extreme. It may be difficult to look at the sprawling Ft. Lauderdale Urbanized Area, for example, and conclude that the only factor in all that additional urbanized land was the increase in population. What about decisions concerning planning, zoning, consumption, transportation, etc.? Is it possible that they played no role at all? The answer is that the two dozen major factors that affect the level of per capita land consumption certainly were in play in Ft. Lauderdale. But the first question we ask about an area is: Was the increase in per capita land consumption as large as the Overall Sprawl percentage? In the case of Ft. Lauderdale, there was no increase in per capita land consumption. That means none of Ft. Lauderdale's 114.9 square miles of sprawl can be explained by per capita consumption growth. As we learned in our example of the village, that leaves only an increase of residents to explain why the urban area grew.

In this exercise, to say that per capita land consumption growth did not create any of the sprawl is not to say that the factors that affect per capita land consumption had no effect on the level of sprawl. Because Ft. Lauderdale's population grew by 102%, the Urbanized Area would have sprawled by 102% if per capita land consumption had stayed exactly the same. But the area actually only sprawled by 54%. Why? Because land consumption for the average resident was reduced sharply by 24%.

Those 12 areas in which 100% of sprawl was explained by population growth are bold reminders

Table 4b – Sources of Sprawl in Florida's New Urbanized Areas

Results from the Holdren method (and in parentheses the simple ratio method)*

Urbanized Area	% of Total Sprawl related to GROWTH IN PER CAPITA LAND CONSUMPTION was:		% of Total Sprawl related to POPULATION GROWTH was:	
Daytona Beach	(0%)	0%	100%	(100%)
Fort Myers-Cape Coral	(0%)	0%	100%	(100%)
Fort Pierce	(1%)	2%	98%	(99%)
Fort Walton Beach	(0%)	0%	100%	(100%)
Lakeland	(0%)	0%	100%	(100%)
Melbourne-Palm Bay	(0%)	0%	100%	(100%)
Naples	(0%)	0%	100%	(100%)
Ocala	(0%)	0%	100%	(100%)
Panama City	(1%)	1%	99%	(99%)
Sarasota-Bradenton	(0%)	0%	100%	(100%)
Winter Haven	(0%)	0%	100%	(100%)
Mean of percentages	**(0.2%)**	**0.3%**	**99.7%**	**(99.8%)**
Weighted average**	**(0%)**	**0%**	**100%**	**(100%)**

**Holdren method explained in Appendix D. Simple ratio method described in Section*

of the limitation of current anti-sprawl and Smart Growth efforts. Their tools for fighting sprawl are woefully inadequate because they rarely address population growth. Although their goal of stopping Per Capita Sprawl was met in all 12 Urbanized Areas, Overall Sprawl has still been rampant in most of those cities.

For example, Melbourne-Palm Bay encroached on another 66.2 square miles of ecosystems and farmland, Miami-Hialeah paved over another 94 square miles, and West Palm Beach-Boca Raton-Delray Beach urbanized another 170.2 square miles of rural land. Yet, the Smart Growth goal of stopping Per Capita Sprawl had been met in each one of them.

For some smaller Urbanized Areas, the Overall Sprawl in actual square miles may look relatively insignificant compared to that of the large cities. But the percentage sprawl in most of those was quite large, usually running well over 20 percent in a single decade.

Those 12 Urbanized Areas provide conclusive evidence that simply stopping the growth in per capita land consumption will not stop sprawl. Furthermore, large-scale sprawl continues even when residents are persuaded and pushed to live far more densely – if population growth continues unabated.

5.4. Results show necessity of two-factor attack on sprawl

Florida's sprawl, with its overwhelming relationship to explosive population growth, is significantly different from that of the United States as a whole.

The average Urbanized Area of the 100 largest across the country has both growth in population and growth in per capita land consumption. Each of the two types of growth is correlated to about half the sprawl of an average Urbanized Area.

Thus, anti-sprawl efforts in the average American city that deal only with one of the two growth factors will fail because they ignore half of the conditions leading to the sprawl. Our study of the 100 largest Urbanized Areas found that:

- Urbanized Areas with no growth in population, but with growth in per capita land consumption, have continued to sprawl.

- Those with growth in population, but with no growth in per capita land consumption, also continued to sprawl.

- The majority of Urbanized Areas that continued growth in both factors sprawled by a far higher percentage than those in the first two categories.

In Florida, no Urbanized Area halted population growth. But the 12 that halted per capita consumption growth followed the national pattern of continuing to sprawl – most by a substantial amount. The West Palm Beach Urbanized Area, for example, reduced per capita land consumption by 19% but still sprawled by 176%, as more than a half-million new residents overwhelmed any efforts at rural land conservation.

All of the older Florida areas sprawled at high rates. And only Winter Haven among the new Urbanized Areas came close to controlling its sprawl during the single decade measured. With the lowest population growth of those 11 new areas, Winter Haven spread out into its surrounding countryside by 5%.

The dominant role of population growth in Florida's sprawl should not negate concerns about per capita land consumption. Despite the overwhelming importance of population growth in Florida's sprawl, per capita consumption growth continued to provide significantly to Overall Sprawl in five of the 20 Urbanized Areas. The relationship of the Per Capita Sprawl to Overall Sprawl was 10% in the Jacksonville area, 15% in the Tampa area, 20% in the Gainesville area, 37% in the Tallahassee area and 51% in the Pensacola area. Pensacola most closely resembled the average American Urbanized Area in its nearly even split between the role of population growth and Per Capita Sprawl as the culprits in its Overall Sprawl.

5.5. Comparisons by category of population growth lend extra credence to ratio analyses

When we cluster Florida's Urbanized Areas by their percentage population growth, we see yet another high correlation between population growth and Overall Sprawl.

We examined the 20 Urbanized Areas during the 1980s. None of them had population decline or growth below 10%. Here is what we found:

Cities with Population Growth of:	Had Average Sprawl of :
10% to 20%	7.2%
21% to 30%	19.6%
31% to 40%	24.3%
41% and up	40.6%

We have found in our study of the 100 largest Urbanized Areas of the United States, as well as our study of all Urbanized Areas of Florida, that one city with higher population growth will not necessarily have more sprawl than another city with lower population growth. But we find that on average the rate of sprawl rises significantly as the rate of population growth rises.

6. CONCLUSIONS

From 1970 to 1990, Florida's nine older Urbanized Areas sprawled out over 1,337.4 square miles of agricultural land, natural ecosystems and scenic open space. Those cities received the bulk of the more than 6 million new people added to Florida during those two decades.

6.1. Florida sprawl explained primarily by population growth

When comparing the rates of growth in population and in per capita land consumption, the study found that about 85% of the sprawl in the average older Urbanized Area was related to population growth.

Most of Florida's cities stopped the trend of increasing per capita urban land use. But Per Capita Sprawl continued to be a factor in 15% of Overall Sprawl in the nine older Urbanized Areas.

In the average of the 11 other cities – the ones first declared Urbanized Areas in 1980 – Per Capita Sprawl was found to have been a factor in only 0.3% of the Overall Sprawl. Population growth was related to 99.7% of the Overall Sprawl.

In the majority of Florida's 20 Urbanized Areas, population growth was the only sprawl-inducing factor.

6.2. Addressing national and state population growth

These findings suggest that those who would stop sprawl in Florida will need to address (a) local incentives that entice more people to move into particular cities, (b) state policies that attract residents from other states, and (c) federal policies that add population to Florida and the nation as a whole.

National population trends play a role in Florida's population growth. Between 1950 and 2000, the population of the United States rose from about 150 million to 281 million. The Census Bureau projects that if current fertility and immigration trends continue, the U.S. population will rise to over 400 million in 2050 and over 570 million by the end of this century.

The two primary factors in a nation's population growth are immigration and births to natives. Native fertility is not a factor in long-term future U.S. population growth. The native fertility rate has been below the replacement level of 2.1 children per woman since 1972. Nearly all short-term growth in this category is due to the 1946-64 Baby

Boomers moving through their child-bearing years. The native-born mothers are having small families, but there are so many more mothers than in the previous generation that net growth will continue for awhile. Growth from immigration comes from two sources: new immigrants and births to immigrants. The latest Current Population Survey of the Census Bureau reports that 11.2 million foreign-born residents settled and stayed in the United States during the 1990s. It also reports that all immigrants – with an average fertility rate much higher than replacement level – had 6.4 million births during the decade. Those two immigration sub-factors were equal to 69.5% of the total U.S. population growth during the 1990s.[12]

Florida's population between 1970 and 1990, the period of analysis, rose from 6.8 million to 12.9 million. Although Florida's population boom continued to be partly fueled by a large number of American natives moving from other states, immigration has come to play the central role in the state's expanding population. In the most recent decade (the 1990s), the Florida population grew by a total of 2.1 million from all sources. During the same time, 1.1 million immigrants arrived and there were 395,000 births to immigrants. These two immigration sub-factors were equal to just over 70% of Florida's population growth.[13]

According to the Census Bureau, current immigration, fertility and domestic migration rates would cause Florida to grow to 20.7 million residents by 2025.

Nothing that has occurred in Florida's cities thus far suggests that – if federal policies driving national population growth remain intact – Florida will be able to stop sprawl's march across the state's ever-more beleaguered rural and open spaces well beyond the year 2025. In the process, the state's environment and quality of life for residents will pay an ever-higher price for the government's unwillingness to allow the population to stabilize.

6.3. Inability to contain population growth within existing urban boundaries

In every one of Florida's Urbanized Areas, sprawl has accompanied the increase in population. In most cases, the additional residents either require extra rural land for their urban needs, or they facilitate the movement of existing residents (e.g., by buying their houses) who then urbanize more rural land, or they create rapid demographic change which motivates existing residents to flee to the urban edges, converting rural land to accommodate their needs.

But few anti-sprawl efforts include suggestions for slowing or stopping Florida's population growth as a way to control sprawl. When population growth is addressed, it usually is in the context that growth in the number of residents can continue in perpetuity without any urban sprawl if all additional residents are forced to live within existing urban boundaries, while preventing out-flight of the present population. This would mean that Florida city dwellers each year would have less and less land, on average.

Nothing in the state's political history suggests the ability or willingness to do this even for one year, let alone in perpetuity. While the majority of Florida's Urbanized Areas did pack more residents into the average square mile, that extra density didn't come close to handling the additional residents that were being added at the same time.

6.4. The 'ecological footprint' effect of additional population beyond the urban boundaries

Even if Florida's citizens were to accept the escalating governmental regulations that would be required to handle each year's population growth within existing boundaries, such a success would not ease the massive "ecological footprint" on the rest of the state.

It is important to recognize that the per capita land consumption figure upon which all conventional anti-sprawl efforts focus includes only the land consumed by an average resident inside his/her own Urbanized Area. It does not include all the rural land in other parts of Florida and other states that is required to obtain the food, fiber, minerals and energy for that resident, and to dispose of that resident's wastes. The urban land is only a tiny fraction of the impact on the Earth that each new Floridian makes. In fact, each person in an urban area has tentacles that extend far outward, pulling in natural resources from a variety of productive lands and waters of the biosphere.

Another way of expressing this is that every person has an "ecological footprint," the area of biologically productive land he or she co-opts or exploits to satisfy the above-mentioned demands. The average American has an ecological footprint of 12.6 acres.[14] This impacted area is roughly 25-50 times greater than the built-up space (i.e. developed or urbanized land) of one-fourth to one-half acre for each resident inside most Florida Urbanized Areas.

Thus, even if we were able to control urban sprawl in the face of rapid population growth, the impact on the state's environment of rapidly growing numbers of Floridians would still be enormous.

6.5. Study results provide measure for seriousness of future anti-sprawl efforts

These population policies, phenomena and trends – as has been shown by this study – are central to understanding the future of sprawl in Florida. Studies and plans from state commissions, think tanks, universities and advocacy groups that purport to offer blueprints for combating sprawl without talking about dealing with population growth look either naïve, foolish or deceptive in light of the findings of this study.

This study has provided the quantitative evidence in support of the common-sense perception: Population growth is the No. 1 factor related to Florida's deplorable sprawl problem.

APPENDIX A

1970-1990 Florida Older Urbanized Areas Raw Data
Population, per capita land use and total land area
from 1970 and1990 U.S. Census Bureau reports

Urbanized Area	1970 Population	1990 Population	1970 Per Capita Land Use (acres/person)	1990 Per Capita Land Use (acres/person)	1970 Total Land Area (sq. miles)	1990 Total Land Area (sq. miles)
Ft. Lauderdale-Hollywood-Pompano B.	613,797	1,238,134	0.2213	0.1691	212.2	327.1
Gainesville	69,327	126,215	0.2677	0.3103	29.0	61.2
Jacksonville	529,585	738,413	0.4245	0.4400	351.3	507.7
Miami-Hialeah	1,219,661	1,914,660	0.1357	0.1179	258.7	352.7
Orlando	305,479	887,126	0.2759	0.2847	131.7	394.6
Pensacola	166,619	253,558	0.2550	0.3920	66.4	155.3
Tallahassee	77,851	155,884	0.2450	0.3654	29.8	89.0
Tampa-Saint Petersburg-Clearwater	863,901	1,708,710	0.2156	0.2433	291.0	649.7
W. Palm Beach-Boca Raton-Delray Beach	287,561	794,848	0.3036	0.2469	136.4	306.6

1980-1990 Florida New Urbanized Areas Raw Data
Population, per capita land use and total land area
from 1980 and1990 U.S. Census Bureau reports

Urbanized Area	1980 Population	1990 Population	1980 Per Capita Land Use (acres/person)	1990 Per Capita Land Use (acres/person)	1980 Total Land Area (sq. miles)	1990 Total Land Area (sq. miles)
Daytona Beach	170,749	221,341	0.3936	0.3695	105.0	127.8
Fort Myers-Cape Coral	140,958	220,552	0.4313	0.3604	95.0	124.2
Fort Pierce	70,450	126,342	0.4996	0.5045	55.0	99.6
Ft. Walton B.	85,318	112,522	0.4576	0.4112	61.0	72.3
Lakeland	114,360	147,628	0.4309	0.4127	77.0	95.2
Melbourne-Palm Bay	212,917	305,978	0.5020	0.4878	167.0	233.2
Naples	53,675	94,344	0.5962	0.3860	50.0	56.9
Ocala	50,860	68,004	0.5160	0.4546	41.0	48.3
Panama City	78,886	103,667	0.4706	0.4722	58.0	76.5
Sarasota-Bradenton	305,431	444,385	0.3143	0.2780	150.0	193.0
Winter Haven	72,560	86,427	0.4057	0.3562	46.0	48.1

APPENDIX B

The Census Bureau's Urbanized Areas Data

Generally speaking, an Urbanized Area must exhibit a pattern of continuous development outward from a central core. Although there are special provisions for "jumps," and certain other exceptions, by and large, new areas added every 10 years by the Census Bureau to the adjacent urban fringe must be contiguous to that fringe and must have a population density of at least 1,000 people per square mile.

Difference from MSA designation

Urbanized Areas are smaller in area than the Metropolitan Statistical Areas (MSA) that are mentioned far more commonly in the media and other public discussion. The Census Bureau describes an MSA as "a large population nucleus, together with adjacent communities having a high degree of social and economic integration with that core."[15] The major difference between the Urbanized Area and the MSA is that the latter includes the entire land mass of every county that contains a part of a city and its suburbs. That means the outer parts of an MSA are rural. An Urbanized Area, on the other hand, includes whole counties only if every square mile of them is urbanized. And in the outer counties, only the land that is indeed urbanized is counted.

An MSA often lumps together cities that have substantially grown out toward each other but which may still contain some rural land between them. For example, Los Angeles and its contiguous suburbs in Orange and Los Angeles counties, Simi Valley and its suburbs, Oxnard-Ventura and their suburbs, and San Bernardino and Riverside and *their* suburbs are all classified as a single CMSA (Consolidated Metropolitan Statistical Area). But because there is some rural land remaining between the suburbs of one and the suburbs of another, these places are considered to be four separate Urbanized Areas.

Usefulness as a measuring tool

The 1,000-people-per-square-mile threshold for classification as part of an Urbanized Area is not without its critics. For example, urban expert David Rusk believes that the growth in Urbanized Land Areas since 1950, as documented in successive Census Bureau reports, understates the actual loss of rural environments to sprawl.[16] The 1,000 density threshold (equal to about one dwelling per two acres) is arguably too dense to convey a rural "feel" and allow for unfettered rural livelihoods, like farming. On the other hand, there is still a substantial amount of open space left when there is an average of two acres (about two football fields) for each house. Nonetheless, the practice of designating a given site as either urban or rural, with no intermediate classification, is indeed an over-simplification.

Yet for the purposes of this study, shortcomings of the Census designations have little effect on the outcome. Since this study has defined sprawl as the progressive loss of open space to built-up space – unpaved lands to paved-over ground in other words – the 1,000-per-square-mile criterion is as defensible a threshold between urban and rural zones as any. Moreover, it allows use of the Census Bureau's nationwide, unrivalled stock of information. The strength of the Census Bureau's
uniform data set lies in calculating changes from rural to urban areas rather than in precisely defining the line that divides them. The shortcoming of the Census Bureau measurement is in calculating total development, not in calculating change. This study focuses on the change.

APPENDIX C

Calculating Per Capita Land Consumption

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

$$a = A / P \qquad (1)$$

where:

a = area of urbanized land for the average resident
A= Area of total urbanized land in a city and its suburbs
P = Population of that city and its suburbs

For example, the West Palm Beach Urbanized Area in 1990 had 794,848 residents living on about 196,000 acres. Thus, the per capita land use was around 0.25 acre (one-quarter of an acre) per resident.

Put simply: The land used per person is the total 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.

Land consumption in most Florida Urbanized Areas ranges between one-quarter and one-half of an acre for each resident (see figures in Appendix A).

The total land area occupied by the built-up Urbanized Area can be expressed as:

$$A = P \; x \; a \qquad (2)$$

This can be stated as: the total square miles (or acres) of an Urbanized Area can be simply expressed or "factored" into the product of the Population of the Urbanized Area (*viz*., *P*) multiplied by the per capita urban land consumption (*viz*., a). 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 D

The Holdren Apportioning Methodology

A method for quantifying the respective contributions of population growth and changes in consumption per capita of any type of resource consumption was laid out in a landmark 1991 paper by Harvard physicist Prof. John Holdren[17]. Although Dr. Holdren's paper dealt specifically with the role of population growth in rising energy consumption, the method can be applied to many types of population/ resource consumption analyses. In the case of sprawl, the resource under consideration is rural land, namely the expansion over time of the Urbanized Area into rural areas.

As stated in Appendix C, the total land area occupied by the built-up Urbanized Area can be expressed as:

$$A = P \text{ x } a \qquad (1)$$

Where*:*

A = Area of total urbanized land in a city and its suburbs
a = area of urbanized land used by the average resident (per capita land use)
P = Population of that city and its suburbs

Following the logic in Holdren's paper, if over a period of time t (e.g., a year or decade), the population grows by an increment P and the per capita land use changes by a, the total urbanized land area grows by A which is given by substituting in eqn. (1):

$$A + \Delta A = (P + \Delta P) \text{ x } (a + \Delta a) \qquad (2)$$

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 t, yields:

$$\Delta A/A = \Delta P/P + \Delta a/a + (\Delta P/P) \text{ x } (\Delta a/a) \qquad (3)$$

Now eqn. (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 eqn. (3) can be ignored. Hence following the Holdren paradigm, eqn. (3) states that the percentage growth in urbanized land area (viz., 100% x A/A) is the sum of the percentage growth in the population (100% x P/P) plus the percentage growth in the per capita land use
(100% x a/a). Stated in words, eqn. (3) becomes:

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

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:

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

The same form applies for per capita land use:

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

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

$$P(t) = P_0 \ (1 + g_P)^t \quad (7)$$

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:

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

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

$$g_P = (1/t) \ln (P(t)/P_0). \quad (9)$$

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

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

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

These three equations for the growth rates allow you to restate the Holdren result of eqn. (4) as:

$$g_p + g_a = g_A \qquad (12)$$

Substituting the formulae (eqns. 9 thru 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 eqn. (12), the actual calculational relationship becomes:

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*) (13)

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 the San Francisco-Oakland Urbanized Area from 1970 to 1990, this formula would appear as:

ln (*3,629,516 residents / 2,987,850 residents*) +

ln (*0.15413 acre per resident / 0.14587 acre per resident*) =

ln (*874.1 square miles / 681.0 square miles*) (14)

Computing the ratios yields:

ln (1.215) + ln (1.057) = ln (1.284)

0.1950 + 0.0555 = 0.250 (15)

Then applying eqns. (5) and (6), the percentage contributions of population growth and per capita land area growth are obtained by dividing (i.e., normalizing to 100%) each side by 0.250:

$$\frac{0.1950}{0.2500} + \frac{0.0555}{0.2500} = \frac{0.2500}{0.2500} \qquad (16)$$

Performing these divisions yields:

0.78 + 0.22 = 1.0 (17)

Thus, we see that in the case of the San Francisco-Oakland Urbanized Area from 1970 to 1990, the share of sprawl due to population growth was 78% [100 % x (0.1950 / 0.250)], while declining density (i.e., an increase in land area per capita) accounted for 22% [100% x (0.0555 / 0.250)]. Note that the sum of both percentages equals 100%.

In a number of cases (12 out of the 20), the results of the Holdren method showed that population growth actually explained more than 100% of the sprawl that occurred, while the per capita land area growth share was less than 0% (i.e., a negative number due to higher population densities or a decrease in land use per capita). Still in these instances, the sum of the percentage numbers – one positive and one negative – adds up to 100%. These are the cases in which overall population density increased throughout a given Urbanized Area (i.e. per capita land consumption went down), so that if there had been no population growth, total urbanized land area taken up by that city and its suburbs would have actually declined. In the Tables 4a and 4b of this report, a conscious decision was made to limit the calculated share of the total growth rate to only 100% of sprawl for population growth and to

report 0% as the growth in land consumption per capita in these cases to avoid the confusion of negative growth rates. (After all, the question is what percentage of a fixed number of square miles of sprawl was caused by population growth. In layman's terms, 100% of those fixed square miles is the highest possible number.) Yet, strictly speaking, this means that in some Urbanized Areas, population growth was so great that it simply overwhelmed the decline in per capita land use, thus leading to positive overall sprawl.

APPENDIX E

Accounting for Distortions Disguised by Aggregate Data

We note that our analysis, when applied at the level of the aggregate Urbanized Area, including one or more central places and an urban fringe, may not capture shifting population within urban boundaries. This requires additional measurements to ensure that such hypothetical shifts have not distorted the conclusions.

Hypothetically, it is possible that much or most of an Urbanized Area's population growth occurred on a small fraction of the already built-up central place (i.e. urban core) or older portions of the urban fringe (i.e. inner suburbs) of the Urbanized Land Area, while a small minority of residents building 4,000 sq. ft. single-family dwellings on half-acre lots actually accounted for most of the increase in urban/suburban land. In such a scenario, the population growth would not be directly responsible for much of the sprawl since all of the population growth was occurring in the core of the city – not on the periphery of the suburbs.

So if an Urbanized Area's population growth is occurring primarily in the urban core while densities are falling in the suburbs, the proportion of sprawl attributed by the Holdren method to population growth may be misleading.

Fortunately, the Census Bureau provides separate data for the urban cores and the suburban fringes. This makes it possible to test for the hypothetical distortion just stated. We have performed the test and found little to indicate that the sprawl our formula has associated with population growth was instead really caused by affluent suburbanites with gluttonous appetites for land.

We examined all those cities in which the mathematical model related 100% of sprawl to population growth at the level of the aggregate Urbanized Area, in order to detect the pattern of change in urban and suburban densities. The sign that population growth really wasn't that much of a culprit (i.e. linked to 100% of sprawl) would be the meeting of each of two conditions: (1) an increase in urban density, and (2) a simultaneous decrease in suburban density. No Florida Urbanized Area met that condition.

APPENDIX F

Population Growth Without Sprawl

The apportioning formula shows that 100% of the 94 square miles of sprawl in the Miami Urbanized Area was associated with population growth. But theoretically, the Miami area could have had no sprawl at all if every one of the 695,000 additional residents had settled within the existing urban boundary. For example, Miami could have avoided sprawl during the study period if the following had occurred:

(1) If all pre-existing residents were forbidden from moving from inside the city to rural land just outside the city. They would have had to remain within the old boundaries of the Urbanized Area or moved inside the boundaries of another city.

(2) If arriving immigrants and residents of other parts of the country were required to settle inside existing city boundaries.

(3) If vacant land inside the urban boundary were used for providing places of work and commerce for the new residents.

(4) If the leftover business, commerce and entertainment needs plus the residential needs of the extra residents were met by a combination of the following: (a) large numbers of pre-existing residents in single-family dwellings would either divide their houses into duplexes or tear down their homes, allow apartment buildings to be built on their land and then move into one of the apartments; (b) the scarce remaining public parks would be converted into apartment complexes; (c) more low-level apartment buildings would be replaced with high-rises; (d) local teens and people in their early 20s on the verge of household formation would continue living with their parents or double up with someone else already living within the old urban boundaries.

(5) If the new residents placed no further demands for non-urban recreation, waste disposal, worksites, shopping or roads just beyond the urban boundary.

Those five requirements would necessitate a level of government control, personal sacrifice, voluntary lifestyle change, loss of personal freedom, and expense that no city in America has come close to talking about – let alone fulfilling. But something that drastic would be needed to force one of the three most densely populated Urbanized Areas in America to greatly increase its density. If one were to design a city from scratch, one would be far more likely to achieve such a density with public approval. But, as is obvious from the above five requirements, it is extremely expensive, disruptive and personally difficult to quickly achieve major density enhancements in already-built areas.

The United States provides no models of Urbanized Areas which succeeded in accommodating population growth without sprawl. There were no such successes in the short-term, let alone long-term.

ENDNOTES

[1] Florida PIRG and Sierra Club. 1997. "Florida PIRG and Sierra Club Release Report Detailing
[2] David Pimentel and Marcia Pimentel. 1997. "Florida Agriculture Threatened by Population Growth." Washington, D.C.: Carrying Capacity Network.
[3] See, for example: Daniel T. Griswold. 2000. "FAIR Ads Unfairly Blame Immigrants for Urban Sprawl, Traffic Jams." CATO Today's Commentary, October 5. Distributed nationally on the Knight-Ridder news wire.
[4] See, for example: "Straight Talk From Americans – 2000." National Survey for the Pew Center for Civic Journalism, conducted by Princeton Survey Research Associates. Released February 15, 2000. Available on the Internet at http://www.pewcenter.org/doingcj/research/r_ST2000nat1.html. Also see polls of Maryland and Virginia voters released in September, 2000 by Negative Population Growth, Inc. that showed significant majorities concerned about the effects of sprawl on the environment and quality of life. Available at www.npg.org.
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[6] Florida Conservation Foundation. No date. Accessed on the World Wide Web at http://sundial.sundial.net/~florida/page47.html.
[7] Carrying Capacity Network. 1998. "Burgeoning Populations Collide with Valuable Coastal Resources." *Network Bulletin*, 8(1):4.
[8] U.S. Census Bureau at www.census.gov/population/censusdata/table-16.pdf B(CPH-2-1, Table 16. Population: 1790 to 1990)
[9] Census 2000. Table 2 Resident Population of the 50 States, the District of Columbia and Puerto Rico.
[10] The U.S. Census Bureau data sources used in this study are: *1990 Census of Population and Housing, Summary Population and Housing Characteristics -- United States*, Table 8 – Land Area and Population Density; *1980 Census of Population, Number of Inhabitants, United States Summary*, Table 34 – Population, Land Area, and Population Density of Urbanized Areas: 1980; *1970 Census of Population, Volume 1 Characteristics of the Population, Part 1, United States Summary* (issued June 1973), Table 20 – Population and Land Area of Urbanized Areas: 1970 and 1960. All of these are available from the Statistical Information Office (Population Division) of the U.S. Department of Commerce's Bureau of the Census in Maryland (301-457-2422).
[11] John P. Holdren. 1991. "Population and the Energy Problem." *Population and Environment*, Vol. 12, No. 3, Spring 1991. Holdren is 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 Harvard University. Trained in aeronautics/astronautics and plasma physics at MIT and Stanford, he previously co-founded and co-led for 23 years 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 of world-wide importance.

[12] "Immigrants in the United States – 2000: A Snapshot of America's Foreign-born Population," by Steven A. Camarota, Center for Immigration Studies, Washington D.C. (forthcoming). The U.S. Census Bureau sources for this study were the 1990 Census (as later corrected by the Census Bureau) and the March 2000 Current Population Survey of the Census Bureau. Number of foreign-born added during the 1990s is based on year of arrival indicated in the CPS for persons still in the United States as of March 2000. Births to foreign-born in the 1990s includes only children listed by the CPS as born in the United States during the 1990s who still lived in the United States as of March 2000. To avoid double-counting, only births to immigrant women are reported.

[13] ibid.

[14] Mathis Wackernagel and William Rees. 1996. *Our Ecological Footprint: Reducing Human Impact on the Earth*. Gabriola Island, B.C. and Philadelphia, PA: New Society Publishers. The New Catalyst Bioregional Series.

[15] Found at http://www.census.gov/population/www/estimates/metroareas.html on 7 August 2000.

[16] David Rusk. 1999. Letter to Ms. Georgia Masters, Department of Community Economic Development, State of Pennsylvania, Harrisburg. July 12. Rusk is an independent consultant on urban and suburban policy, the author of *Cities without Suburbs*, and the former mayor of Albuquerque, New Mexico.

[17] See note 11.