The Evolution of Built Landscapes in Metropolitan Regions

Stephen M. Wheeler

Journal of Planning Education and Research 2008; 27; 400
DOI: 10.1177/0739456X08315889

The Evolution of Built Landscapes in Metropolitan Regions

Stephen M. Wheeler

Abstract

This article analyzes the evolution of built landscapes in six U.S. metropolitan regions using historic maps, aerial photographs, and GIS software. The analysis identifies seven main historic patterns of urban form and nine types created in the 1980-2005 period. This recent period was characterized by a proliferation and fragmentation of built landscape types, rapid spatial expansion, and falling densities. These trends raise the question of whether the public sector should more proactively shape urban form. Rural sprawl accounts for much of the land now being urbanized, representing a new planning challenge. The Portland Urban Growth Boundary is found to be effective at limiting this type of development. The New Urbanist neighborhood form is still extremely rare.

Keywords: *urban form; metropolitan regions; urban morphology; urban growth; land use*

Stephen M. Wheeler, PhD, AICP, is an assistant professor in the Landscape Architecture Program at the University of California, Davis. He is the author of *Planning for sustainability* (Routledge, 2004) and coeditor of *The sustainable urban development reader* (with Tim Beatley; 2nd ed. to be published by Routledge in 2008).

▶ Introduction

The design of our built landscapes affects our ability to meet a range of social and environmental goals, including reduction of motor vehicle usage, creation of more walkable communities, integration of housing for different income groups, preservation of open space and ecosystems, more cost-effective infrastructure and service provision by local government, and enhancement of civic life and sense of place. Movements such as the New Urbanism and Smart Growth have argued for different ways of designing urban fabrics to meet such goals.

In recent years, a number of researchers have begun the process of helping us understand the nature and consequences of different types of urban form. Detailed knowledge of the spatial evolution of our cities, towns, and regions is still developing, however, as are understandings of how best to design and manage future growth. To add to such knowledge, this article investigates the evolution of built landscapes in six U.S. metropolitan regions from their founding until the present. This research takes advantage of recent tools such as Google Earth and GIS software to map spatial patterns of development. By taking a comprehensive, historical approach to studying the evolution of form in these regions, my aim is to shed light on the dominant patterns that have contributed to the physical form of U.S. regions throughout time and the patterns that are being used to create regions currently.

In particular, a profusion of built landscape types is now contributing to the rapid expansion of metropolitan regions. This range of built forms is quite different than it was during previous periods of U.S. history, which were generally characterized by one or two dominant subdivision patterns. It reflects the wide range of economic, political, social, and cultural influences at work in postmodern society (Ellin 1996), and raises troubling questions about the future as metropolitan regions grow into vastly larger and more fragmented urban constellations in some cases now identified as *megaregions* (Carbonell and Yaro 2005; Lang and Dhavale 2005; Dewar and Epstein 2006). Will the emerging range of built forms be well suited to reducing motor vehicle use and greenhouse gas emissions, for example? Will it promote social capital and mutual understanding across demographic strata of society? Will it provide sufficient locations for affordable housing and help integrate this into communities as a whole?

The approach here is to analyze typical arrangements of streets, blocks, lots, buildings, land use, and open space at a neighborhood scale. Landscape patterns cover a

Journal of Planning Education and Research 27:400-416
DOI: 10.1177/0739456X08315889

territory corresponding to at least several city blocks and typically repeat themselves across a metropolitan region. At least 80 percent of built landscapes within most regions are residential in nature. Historically in the United States, one main type of built landscape was generally dominant at any given time. Typically, landowners repeated this pattern until some significant factor changed in terms of technologies, regulations, economics, environment, or cultural tastes. But in recent decades, we have entered a different era in which morphological patterns have proliferated simultaneously. Traditional concepts such as "suburban sprawl" may need to be rethought, because the public often associates these with a single morphological type such as single-family tract housing on cul-de-sac streets.

This built landscape–oriented analysis has not been common within the urban planning field in the past half-century, in particular within growth management research, which tends to be quantitative in nature or else focuses on regulatory and institutional processes. An emphasis on large-scale morphology will, however, be familiar to those from architectural or urban design traditions, especially those trained in Europe (Moudon 1994). Because it uses maps, graphics, and photographs in addition to statistics to convey information, such an approach can provide a new tool for planners to help the public understand urban growth issues.

▶ Existing Literature

Many strands of planning literature have addressed urban form historically and should be briefly mentioned here. One main tradition has been normative and visionary, aimed at developing ideal types of form. Many early planning visionaries such as Ildefons Cerdá ([1867] 1999), Frederick Law Olmsted (1971), Ebenezer Howard ([1898] 1902), Patrick Geddes (1915), John Nolan (1916), and Lewis Mumford (1938) wrote in this vein. Much of Kevin Lynch's work, especially *A Theory of Good City Form* (1981), followed in this tradition. After a decades-long eclipse, the visionary urban design tradition reemerged recently through movements such as the New Urbanism and Smart Growth, and through more general public interest in walkable, livable, or sustainable communities. Leading recent authors addressing normative urban morphology include Peter Calthorpe (1993); Calthorpe and William Fulton (2001); Andres Duany, Elizabeth Plater-Zyberk, and Jeff Speck (2000); Peter Katz (1994); and the Congress for the New Urbanism (1999). Their works enumerate problems with suburban sprawl and propose a variety of alternative design principles, chiefly focusing on more connected, fine-grained street patterns; more pedestrian-oriented streets; more mixed land uses; more compact development; and better integration of land use and public transit.

A second main type of literature on urban form is historical and descriptive, chronicling a wide variety of built morphologies throughout history. Historians of form include A. E. J. Morris (1979), Spiro Kostof (1991, 1992), Edmund Bacon (1967), and John Reps (1965, 1979), and were best at illustrating ancient or premodern urban form. A more recent wave of researchers has sought to analyze current urban morphology through a variety of methods. Michael Southworth and Peter Owens (1993) studied the development of towns in the San Francisco Bay area, developing typologies of evolving street patterns. Anne Vernez Moudon and Paul Hess (2000) used GIS software to study the clustering of multifamily housing in the Puget Sound area. Jill Grant (2003) has investigated the influence of the New Urbanism in changing the form of Canadian neighborhoods. Dolores Hayden (2004) and Julie Campoli, Elizabeth Humstone, and Alex MacLean (2002) provide useful illustrated analyses of current suburban development using aerial photography.

A number of researchers have undertaken quantitative analyses of urban sprawl. In particular, Reid Ewing, Rolf Pendall, and Don Chen (2002) developed a numerical index of sprawl for eighty-three U.S. cities based on four main factors: residential density; neighborhood mix of homes, jobs, and services; strength of activity centers and downtowns; and accessibility of the street network. This scoring system allowed them to rank metropolitan regions and also to show strong correlations between sprawl and variables such as motor vehicle ownership, average distance driven per capita, transit use, and ozone levels. In a similar vein, George Galster and his coauthors (2001) identify eight characteristics of land use patterns associated with suburban sprawl (density, continuity, concentration, clustering, centrality, nuclearity, mixed uses, and proximity) and calculate these variables for residential portions of thirteen U.S. urban areas. This process also allows them to rank cities, finding Atlanta, Miami, Detroit, and Denver the top culprits in sprawl. This ranking conflicts somewhat with the findings of Ewing, Pendall, and Chen (2002), who, for example, found Denver to be relatively low in sprawl (seventy-third out of eighty-three). Yan Song and Gerrit-Jan Knaap (2004) analyze neighborhoods with the Portland, Oregon, region using fifteen different urban form variables and examine how these indices have changed throughout time. They find increases, especially after 1990, in single-family-home density and internal neighborhood connectivity, although a continued decline in external connectivity and mix of land uses.

Such quantitative analyses are incorporating an increasing number of urban form variables and are useful for many sorts of statistical analysis. They can, however, be subject to questions about specific weighting and definition of variables (producing disparities such as those between Galster et al. [2001] and Ewing, Pendall, and Chen [2002]), and, more importantly, perform their analysis in a relatively abstract and

complex way that is difficult for many members of the public to understand. A landscape analysis, as pursued here, represents a different, complementary way of measuring urban form.

Social historians have added a further dimension to our understanding of the evolution of urban form by showing how politics, culture, and economy shaped urban form during different periods. For example, Sam Bass Warner's book *Streetcar Suburbs* (1962) provides a wonderfully detailed description of how early suburbs were built near Boston in the late 1800s. Kenneth Jackson's *Crabgrass Frontier* (1985) and Dolores Hayden's *Building Suburbia* (2005) analyze political, social, and economic factors behind the rise of suburbia across a broader sweep of history. Mumford's work and that of Lynch also shed light on these factors.

Perhaps the least developed literature related to urban form investigates how people use and subjectively experience different types of form. Jane Jacobs (1961), Amos Rapoport (1977), Hayden (1984), Edward Relph (1987), Tony Hiss (1990), and James Howard Kunstler (1993) have been among the leaders in this regard, as well as other researchers within the environmental design field. Understanding the subjective experience of place is crucial for improving design elements that would not be addressed by large-scale quantitative analysis alone, such as the pedestrian experience along streets or the use of built environments by children at play.

▶ Method

To understand more systematically than has yet been attempted how the built landscapes of metropolitan regions have evolved, I have sought to document the growth of selected metropolitan areas at twenty-year intervals, choosing a standard set of decades (1860, 1880, 1900, 1920, 1940, 1960, and 1980) to facilitate comparison. To bring the analysis closer to the present, I defined the final time period as 1980-2005. The present article focuses in particular on this most recent period, with previous eras included to provide perspective. For these time periods, the aim was to map the extent and types of built landscapes created. This analysis does not attempt to measure infill development, in part because most infill does not affect urban form on the neighborhood scale.

I selected a convenience sample of six U.S. metropolitan regions with the aim of attaining a reasonable geographic distribution of cases across the country. The intent was to develop a series of case studies of regional development rather than to select truly representative locations. Because unique local factors almost always affect urban form, no selection of cities is going to be truly representative of different parts of the country; the effort was to develop a reasonable range of cases and to learn from their commonalities and differences. The cases selected are in any case important U.S. metropolitan regions, and analyzing each is useful in its own right.

The regions studied were Boston (the northeastern United States), Atlanta (the Southeast), Minneapolis (the Midwest), Albuquerque and Las Vegas (the Southwest), and Portland, Oregon (the Northwest). These regions also represent a diversity of political and institutional climates, with two (Portland and Minneapolis) being known for progressive regional planning and others (Atlanta and Las Vegas) widely seen as examples of pro-growth jurisdictions. For each region, I sought to determine (1) what geographical areas were urbanized during which historical periods, and (2) what characteristics of neighborhood form and landscape were created during those times.

I defined *urbanization* as the "subdivision of land for primarily non-agricultural use." The assumption was that subdivision particularly for residential purposes tends to produce built landscapes that are highly persistent throughout time, because ownership becomes fragmented among many small landowners who have a stake in maintaining their properties for many years. Historically, residential landscapes have often remained unchanged for centuries in terms of basic road, lot, and building patterns.

This research relies on two main sources of data. The first consists of historical maps of each metropolitan area, digitally photographed in the Library of Congress map collection and in the map libraries of the University of California, Berkeley, and the University of New Mexico in Albuquerque. These maps were of many types: road maps; maps of infrastructure, parks, or other facilities; subdivision plats; and U.S. Geological Survey quad sheets and related materials. A few historical maps were also available from online sources. I collected map images from within a year or two of each target interval (1860, 1880, 1900, etc.). By looking at these, my research assistants and I sought to determine when each neighborhood or substantial increment of development was added. Because parcel lines are not contained on most maps, we inferred the process of subdivision through the creation of two or more new local streets within an area one half mile in each dimension. Admittedly, this represents an approximation of urbanization, but it is probably a reasonably accurate one because road access is essential for developed land.

The second main source of data was aerial photography. This is increasingly available online from local, regional, or state government Web sites. But by far, the most valuable research tool was Google Earth, a service that has been available only since late 2004 and that provides the ability to view continuous aerial photographic images over the earth's surface without the need to piece together much smaller, locally provided images. I used such aerial images to examine present-day development on any site in question and to verify the relative age of development in the area, deducing approximate dates of urbanization from lot configuration, building form, the presence and location of garages, and many other detailed urban design factors. Examining aerials was also useful in

weeding out speculative subdivisions that may have shown up on historical maps but were never built.

We used 2005 U.S. Census Bureau TIGER county-level street, rail, hydrology, and water body files to construct a GIS base map for each region (U.S. Census Bureau 2005b), and then using the historical map images for visual reference manually digitized ArcGIS shapefiles for each twenty-year increment of urban growth plus the 1980-2005 period. We created polygons to denote land areas subdivided during each time period, omitting open space including parkland, which does not play a role in later calculations. To ensure standardization, the principal investigator visually checked all work of research assistants.

In addition to these historical growth data, we manually digitized shapefiles representing types of 1980-2005 landscape form based on visual analysis of aerials. This analysis referred to a standard typology of forms developed for this project based on the existing literature as well as initial inspection of the data. Each form was identified according to a specific mix of attributes including street pattern, lot size and shape, building footprint, site design, and land use mix. Some of these features such as streets and building footprints were immediately visible on aerials; others such as lot size and shape are not directly indicated on aerials but can be easily inferred from the arrangement of structures, fences, and landscaping. All developed land in the 1980-2005 time period was allocated to one of these urban form types. (See figure 1.)

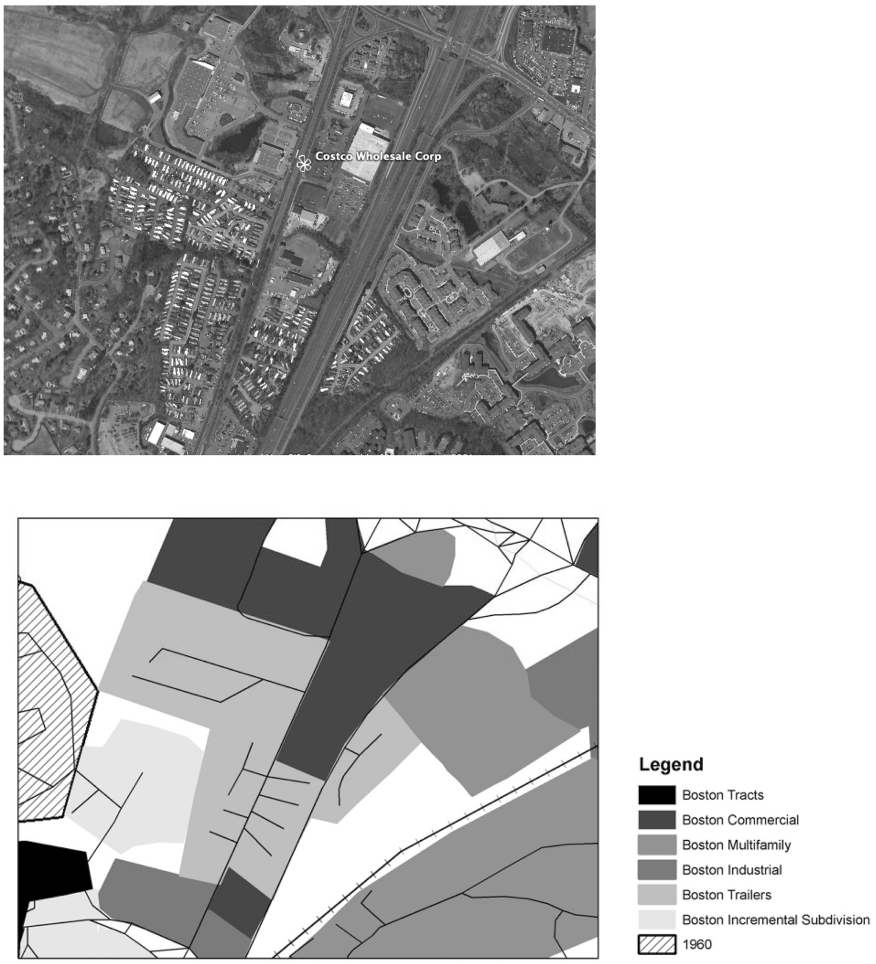

Figure 1. *Detail of GIS mapping of built landscapes (near Peabody, Massachusetts).*

The edge of each metropolitan area was determined to be the place where substantial land subdivision had no longer occurred. For five of the six metro regions, this zone was relatively clear, even strikingly so in the case of western cities such as Las Vegas and Albuquerque, where subdivisions abruptly abut large expanses of desert or rangeland. But for the Boston area, determining an edge was much more problematic, a finding that fits with Gottmann's (1961) concept of a megalopolis stretching between Boston and Washington, D.C. During the mapping process, determinations had to be made to stop in locations that were relatively but not completely rural, for example in sparsely subdivided areas some twenty-five miles east of downtown Boston, rather than continuing west to include the Worcester metropolitan area. To the south and north, the edges of the Boston area are especially problematic; substantial urbanization continues to the Providence, Rhode Island, metropolitan area on the south, and toward Portland, Maine, on the north. It seems likely that much of southern New Hampshire and southern Maine will eventually be considered part of the east coast megalopolis. Identifying the extent of urbanized area for such east coast cities, then, is to some extent a subjective decision.

Among the results were many beautiful full-color regional growth maps that unfortunately cannot be reproduced here. Because of GIS's quantitative analysis abilities, I was also able to compare across and within regions the amounts of land urbanized during different periods or with different typical forms. The intent was to identify particular dominant types of built landscapes within both historic and recent urban growth, and to quantify amounts of land covered by different types of urbanization within different historical periods.

▶ Historical Development Patterns

As the work of Reps, Hayden, Southworth and Owens, Moudon, and others has shown, the built landscapes around us have taken distinctive forms during different historical periods. These forms tend to be used repeatedly for many decades until other dominant forms take their place, typically by adding a new layer of urban fabric at the metropolitan fringe. An understanding of the past progression of form is essential to appreciate the current proliferation of built landscape types in the postmodern metropolis.

Seven main types of historic urban landscapes can be identified within the case study regions.

Organic Urban Landscapes

Largely the result of transportation by foot or animal, this old-world pattern of urban form features tightly packed winding streets, small block sizes, incremental addition of streets and structures, and a high mix of land uses. In the metropolitan regions surveyed, it is found only in the North End of Boston. Created primarily in the 1600s, it is present in a few other locations in North America such as the Greenwich Village portion of New York, Québec's Old Town, and the core of Santa Fe, New Mexico. These built landscapes are very distinctive and are much loved by urbanists and tourists alike.

Incremental Subdivision

In communities that grew slowly throughout time, streets and lots were often added incrementally, creating a somewhat haphazard built landscape with a variety of block sizes, land uses, and building forms. This form occurs mainly in the eastern United States, where towns were not gridded out on a large scale as were communities in the Midwest and West. In the regions studied, it is found mainly in the small towns that surround Boston and that have now been incorporated into the metropolitan area, and in the Rio Grande Valley portion of the Albuquerque region, where agricultural lands were slowly subdivided throughout time. This style of built landscape occurred primarily because of slow, small-scale processes of land subdivision, and continues today primarily in rural or semirural locations where these processes linger, often creating a haphazard branching of residential streets off of a previously rural road.

Downtown Grids

In five of the six metropolitan regions studied (all except Boston), development in the mid-nineteenth century took the form of a square-block grid. This landscape pattern occurred in part because it was easy and quick for large landowners to survey land in this way for rapid development. Standard design templates, including the Spanish Laws of the Indies and railroad company materials, also promoted this form. Block sizes were small, typically from 200 to 300 feet on a side, and land uses were highly mixed, because there was no zoning at this time to require their separation. This very pedestrian-friendly pattern still characterizes the downtown area of most U.S. cities and towns, although it may have been modified throughout time with some streets closed off and built on. Individual buildings, of course, may have been taken down and replaced several times.

Streetcar Suburbs

By the late nineteenth century, a second main grid form had taken over in most of these regions: the "streetcar suburb" pattern of larger, rectangular blocks, often around 300 feet by 600 feet and typically oriented perpendicular to horse car or streetcar lines. Changing transportation technologies fueled this new pattern, which began to emerge in the Boston area as early as the 1860s, and lingered in places such as Albuquerque and Las Vegas well into the 1930s. In regions such as Portland that boomed in the late nineteenth century, the streetcar suburb pattern still characterizes a large portion of the metropolitan area. These streetcar suburbs are often among the most popular residential neighborhoods today, featuring relatively walkable neighborhoods due to high street connectivity, a clearly legible layout, and corridors of retail uses.

Degenerate Grids

As time went on, the spread of the automobile freed developers to experiment with looser, more decentralized development forms no longer tied to public transportation. The streetcar suburb grid began to degenerate in most places, with fewer connecting streets, longer blocks, less regular forms, and new semigridded forms such as what Southworth and Owens (1993) identify as "warped parallels" and "interrupted parallels." In all six metropolitan areas, an area of "degenerate grid" urban fabric, often influenced by topography as well as the whim of individual developers, can be identified surrounding the more tightly gridded downtown and streetcar suburb neighborhoods. In Albuquerque, which experienced rapid growth between the 1940s and 1980s, this form occupies large amounts of the current region.

Garden Suburbs

Between the late 1800s and the 1940s, every region except Las Vegas, which was a tiny settlement until much later, saw a

few experiments with "garden suburb" neighborhoods. Influenced by picturesque urban design traditions seeking to escape gritty urbanity and emulate the aristocratic milieu of the English countryside, these upper-middle-class subdivisions sought to establish a more pastoral, exclusive atmosphere. Design strategies to achieve this included the use of gently curving streets, boulevard-like main axes, larger lots and building setbacks, and design details such as gateposts, statues, and lighting. Although these neighborhoods occupy a small amount of land (like New Urbanist neighborhoods today), they were influential in establishing design ideas that were then taken up and modified by mainstream builders who created vast numbers of automobile-oriented subdivisions after the Second World War.

Suburban Tracts

Fueled by the rise of mass production homebuilding techniques and large development companies, suburban tracts dominated suburbs in the case study regions during the late twentieth century. These built landscapes feature medium- to large-scale, inwardly focused subdivisions with curving streets and cul-de-sacs that Southworth and Owens (1993) refer to as "loops and lollipops." Net densities were generally 4-8 dwelling units per acre early in this period and somewhat higher in more recent decades. Tracts are exclusively residential and have relatively little connection to any surrounding urban form. They came about simply because a developer was able to obtain a particular parcel of land, because there were either few controls on how he or she developed that land or else standards enforcing tract design (Southworth and Ben-Joseph 1997), and because potential residents could use expanding highway infrastructure to get there by motor vehicle.

► Findings about 1980-2005 Development

1. The Proliferation of Built Landscape Forms

Whereas in the nineteenth and early twentieth centuries, a single built landscape form typically dominated development practices, in recent decades builders have created a much wider variety of suburban or exurban landscapes. Reasons for this shift most likely include the segregation of land uses under zoning, the fragmentation of the housing market into an increasing variety of niches, and technologies such as the automobile and telecommunications that facilitate long-distance commuting and thus the creation of enclaves and lower density development patterns. (See figures 2, 3, and 4.)

Our mapping of the case study regions identified seven suburban residential landscape forms during this most recent period. Their characteristics are listed in table 1. When commercial and industrial/office landscapes were added, these

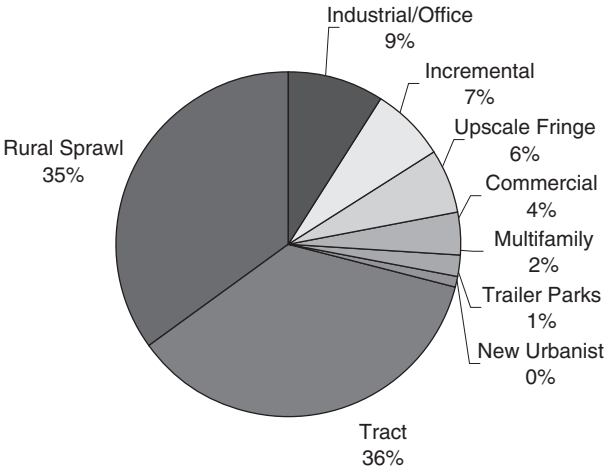

Figure 2. *Average area covered by built landscape types for six regions from 1980-2005.*

forms accounted for all urbanized land in our analysis; the incremental form served as a catchall for irregular forms that did not fit any of the other patterns (see table 2).

Rural Sprawl

One of the most dramatic findings is the rapid growth of rural sprawl within most of the regions studied. This form of very low-density development features very large lots of between one and five acres, a loose and haphazard street pattern, and large areas of open land that are passed over between subdivisions. Typically, modest-sized houses of varying form are spaced at least 100 feet away from one another. Where the land is flat, rural sprawl may take the form of ranchettes built incrementally after a master subdivision process. Where the land is hilly or swampy, homes may be tucked less regularly into the terrain along winding roads. Many rural sprawl homes in mountains or around lakes may serve as second homes for urban or suburban residents.

For five of the six regions studied, this type of landscape accounts for between 20 and 70 percent of land developed between 1980 and 2005. Somewhat surprisingly, Boston provides the most extreme example of rural sprawl, with very low-density subdivisions providing 71 percent of new development within a metropolitan region that has now grown to at least 1,239 square miles. Las Vegas shows the least amount of rural sprawl, with this form accounting for just 5 percent of its development during this period. Such differences are discussed further below.

Tract Development

Tract housing represents the second largest consumer of land in these metropolitan regions between 1980 and 2005. The dominant characteristic of this form is the repetition of

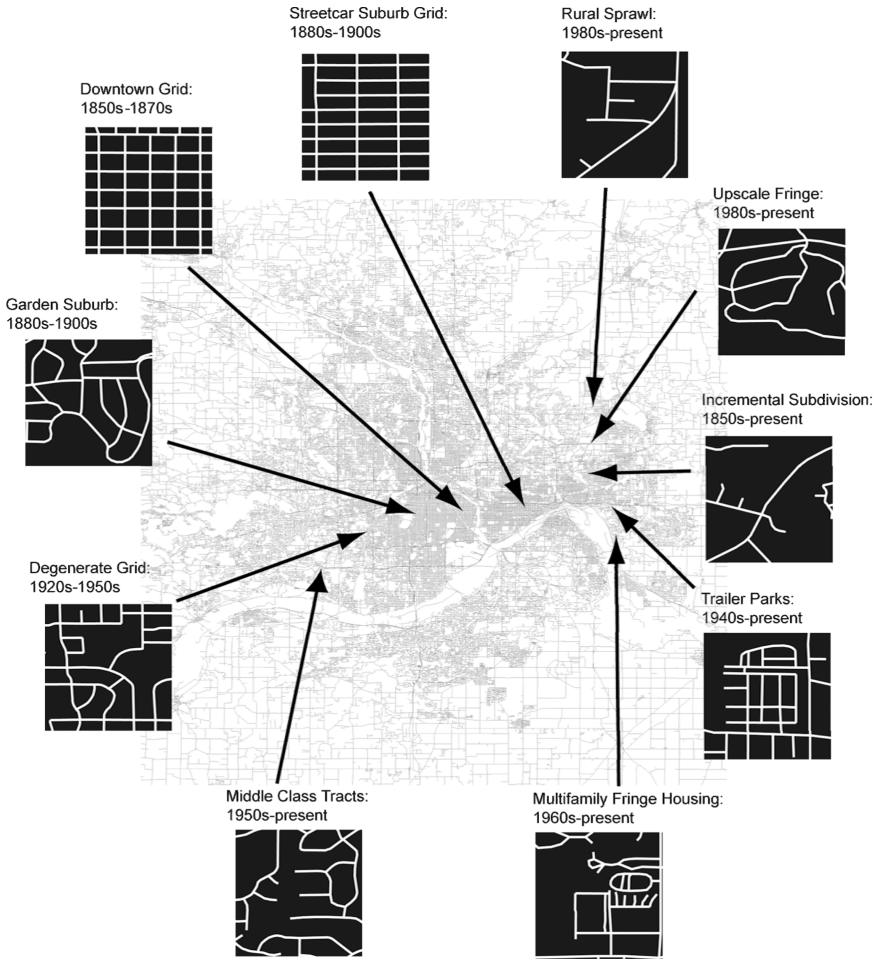

Figure 3. *Residential landscapes in the Minneapolis–St. Paul region.*

standardized building footprints and lot layout. Typical lot sizes were smaller during this period than in the past, usually between 4,000 and 6,000 square feet (one-seventh to one-tenth of an acre), and were smaller for the western cities studied than the eastern ones. In parts of the Atlanta, Boston, and Minneapolis areas, larger tract lots of 10,000 square feet or more are still found. Streets are primarily curvilinear, with the loops-and-lollipops layout. Street connectivity is low; typically, each subdivision has only one or two road connections with surrounding areas. Blocks are irregular and variable in size. Land use is primarily single-family residential, although in some tract subdivisions land appears to have been reserved at the center or at one edge of the development for commercial buildings and multifamily housing, and spaces are reserved for schools and parks as well. Because of its strikingly large scale, rapid development, and uniformity, this is the type of landscape that many people associate with the term *suburban sprawl.*

Upscale Fringe

A substantial amount of developed land—5 to 10 percent in most of the regions studied—is devoted to upper-income housing. These developments feature larger lots, bigger houses, greater variation in housing form and lot configuration, more open space, and amenities such as golf courses, swimming pools, tennis courts, and hiking trails. Open space is sometimes preserved between the residential streets, and elements of the natural landscape are often retained as visual and/or recreational amenities or to give the development an ecological character. Although the large new houses sometimes referred to as *McMansions* can be found anywhere within the region, they are often clustered within these upscale developments on the urban fringe. Some upscale fringe developments (as well as some tracts) may be gated, but it is not possible to determine this reliably from aerials.

Multifamily Housing

Multifamily housing—buildings containing multiple, attached housing units—almost always appears in clusters within recently developed parts of these metropolitan regions, showing that the nucleation of multifamily housing that Moudon and Hess (2000) documented for the Seattle area applies to other regions as well. Typically, multifamily housing is clustered at one side of large single-family home developments, often in less desirable locations next to freeways, large arterial streets, railroad tracks, shopping centers, or industrial areas. Multifamily clusters typically contain several large buildings surrounded by parking and landscaping, often with a pool and tot lot as amenities. As with most other recent development patterns, these multifamily clusters are inwardly focused, with just one or two streets connecting with surrounding locations.

Much additional multifamily housing was certainly provided during the 1980-2005 period within new or rehabilitated individual buildings in infill locations, but such development falls below the scale of development examined in this study and does not constitute a new built landscape form.

Incremental Subdivision

Some of the metropolitan areas studied—principally, Albuquerque and Las Vegas—retain large areas in which

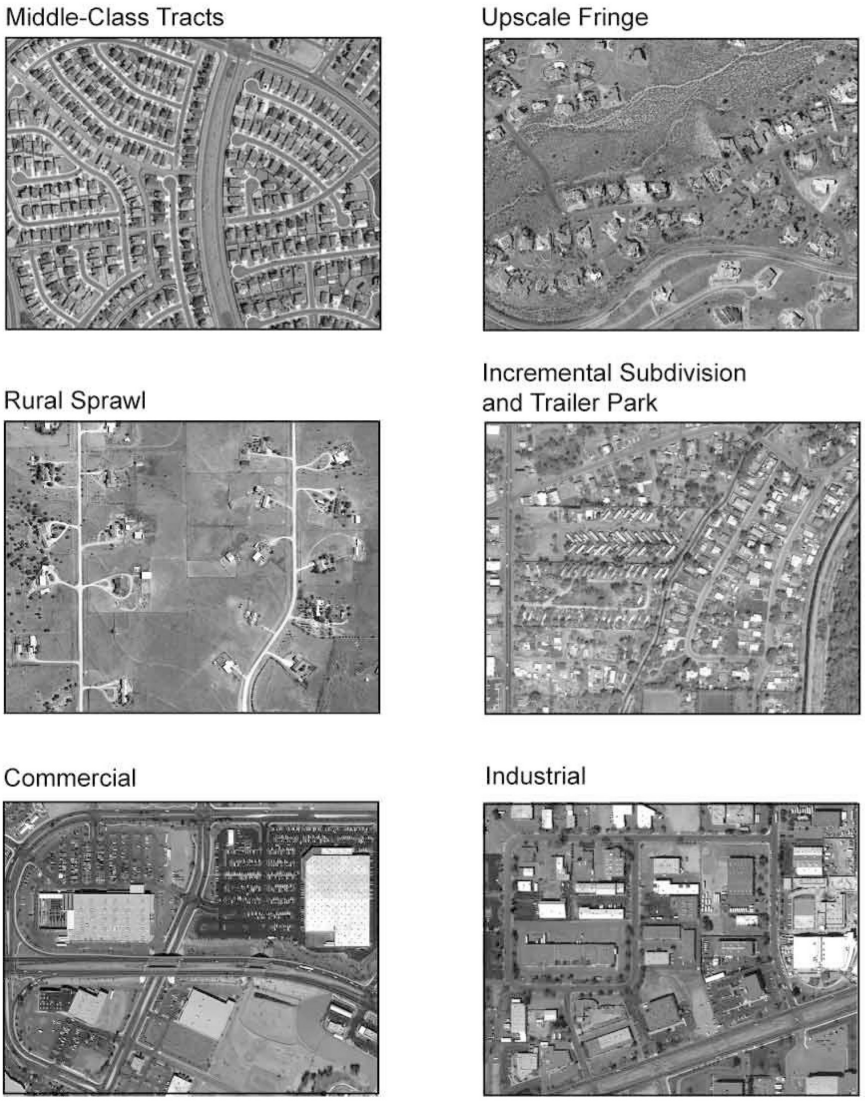

Figure 4. *Recent landscape patterns in the Albuquerque area.*
Note: All images at same scale (2,000 feet across).

development takes place through the small-scale, incremental subdivision of land. Incrementally developed landscapes tend to have varied or haphazard street patterns and a diversity of block sizes, housing forms, lot configurations, residential densities, and land uses. Two main types of incremental landscapes appear to exist. In the first, land held by local families in relatively small agricultural parcels is sold off piecemeal for small-scale development, resulting in a disparate mix of buildings, streets, and blocks. In the second, earlier land speculation had platted a large area with a similar street and lot pattern, but then buildings were added only slowly throughout many years in a variety of forms and lot configurations. This latter mode includes some of the land scams that plagued many western U.S. cities. Incremental built landscapes are reminiscent of earlier development around many cities, when land subdivision and building construction often took place at a smaller scale.

Trailer Parks

Although a small percentage of the overall urban landscape in these regions, typically 1 percent or less, trailer parks represent a distinct built form that J. B. Jackson (1994) argued is an underappreciated element of American vernacular landscapes. Mobile homes represent the fastest growing form of housing, accommodate one in fifteen Americans, and represent a main form of affordable housing in many locations (Kilgannon 2003). Trailer parks are characterized by very tight street networks, narrow streets, very small lots (often around 30 × 80 feet), and diagonal lot and building orientation to facilitate installing and removing the units. Like multifamily housing, trailer parks tend to occupy less desirable locations near freeways, railroad tracks, or industrial areas. They are also highly inwardly focused, having few street connections to the outside, and are frequently concealed by fences or dense landscaping.

New Urbanist Landscapes

Despite receiving an enormous amount of attention within planning circles, New Urbanist neighborhoods were extremely rare within the regions studied. New Urbanist ideas are influencing the revision of zoning codes and subdivision ordinances nationally, especially through the adoption of form-based codes. Yet such ideas have yet to influence the vast majority of development in these regions. In none of the six metropolitan areas studied—including Portland, often cited as one of the most progressive planning jurisdictions in the country—do New Urbanist landscapes account for even 1 percent of development in the 1980-2005 period. (If the Oregon portion of the region is considered separately, Portland does just barely meet this level, with 516 acres of New Urbanist development during this time frame.) That being said, the percentage of New Urbanist residential landscapes may well increase in the future, because it takes many years for changes to zoning codes and planning documents to show up in the built landscape, and there is often many years' backlog of previously approved projects waiting to be

Table 1.
Characteristics of 1980-2005 residential landscapes in the United States.

Current Residential Forms	*Street Pattern/Block Size*	*Land Use Mix*	*Residential Density*	*Typical Unit Size and Lot Layout*	*Subdivision Scale*
Rural sprawl	Haphazard street pattern; street connectivity varies; little or no block structure	Low	Very low density; lot sizes typically between 1 and 5 acres	Small to midsized houses; 1,000-2,500 square feet; wide variety of structure types and lot layouts	Small scale; 1-20 lots
Upscale fringe	"Loops and lollipops"; loose street patterns; low connectivity; large, irregular blocks; high amenity level (pools, golf courses, trails, etc.)	Low	Low density; lots typically 10,000-40,000 square feet	Large houses; 2,000-5,000 square feet; lot layouts often vary due to custom construction	Small to medium scale; 10-100 lots
Suburban tracts	"Loops and lollipops"; tight street patterns; low connectivity; moderate block size; irregular blocks	Low	Low to moderate density; lots typically 4,000-10,000 square feet	Midsized houses; 1,500-3,000 square feet; repetitive housing forms and lot layouts	Medium to large scale; 20-1,000+ lots
Multifamily	Looping access roads; moderate block size and street connectivity	Low	Moderate to high density; 8-60+ dwelling units per acre	Small to midsized apartments and condos; 500-1,500 square feet	Medium scale; 20-500 lots
Trailer parks	Very tight, linear lanes; small blocks; moderate connectivity	Low	Moderate to high density; lots typically 1,500-3,000 square feet	Small units; 500-1000 square feet	Medium scale; 50-200 lots
New Urbanist	Grid-like street pattern; small blocks; high street connectivity	Low but some addition of retail and offices	Moderate density; lots typically 2,500-6,000 square feet	Varying housing forms including second units and row houses; a range of lot configurations	Large scale; 100-1,000+ lots
Incremental subdivision	Haphazard street pattern; incremental addition of streets; block size and street connectivity vary	Low to moderate; frequently has a variety of small businesses	Low to moderate density; lots are irregular and sizes vary	Small to midsized; 1,000-2,500 square feet	Small scale; 1-20 lots

Table 2.
Relative amounts of land covered by built landscapes for six U.S. metropolitan regions.

Form (1980-2005 Period)	*Albuquerque (%)*	*Atlanta (%)*	*Boston (%)*	*Las Vegas (%)*	*Minneapolis–St. Paul (%)*	*Portland (%)*	*Average (%)*
Tract	16	58	15	51	39	44	37
Rural sprawl	52	20	71	5	40	20	35
Upscale fringe	10	4	2	5	10	5	6
Multifamily	1	3	1	3	1	3	2
Trailer parks	1	1	0	0	0	1	1
Incremental	12	1	2	21	1	5	7
Commercial	4	4	3	6	2	5	4
Industrial/office	4	9	6	9	7	19	9
New Urbanist	0	0	0	0	0	0	0

developed in any jurisdiction. Also, much of the influence of the New Urbanism has been on infill development and the revitalization of urban downtowns. Such development was not included in this study unless it constituted the creation of entire new neighborhoods.

Commercial Landscapes

Although the focus of this study is on residential landscapes, we identified general commercial and industrial/office categories as well. During the 1980-2005 period, commercial land uses represented about 4 percent of new land developed in the regions studied. Although this percentage is relatively low, these landscapes often occupy highly visible locations along freeways and arterial roads. Three main subtypes of commercial form can be identified: free-standing big-box stores, enclosed malls, and strip development with smaller scale businesses. All include large amounts of surface parking. The floor plates of buildings are usually large, often in excess of 50,000 square feet, and more than 200,000 square feet for Wal-Mart Supercenters. Commercial developments were almost always adjacent to arterial roads or freeways, and featured few if any street connections with surrounding neighborhoods.

Industrial and Office Landscapes

Other sorts of workplaces accounted for an average of 9 percent of newly urbanized land across the six sample regions in the 1980-2005 period. This category typically consists of clusters of buildings near an arterial road or freeway. Building floor plates are large, but parking areas are smaller than for comparable commercial development and within office parks are often separated into several landscaped pods. New industrial/office landscapes are often adjacent to areas of commercial development. Somewhat different types of industrial/office landscapes exist for different forms of industry. Large but tightly packed single-story warehouses and light manufacturing facilities often cover many square miles of land near airports, whereas upscale sides of town may feature widely spaced multistory office towers with extensive landscaping.

Although Joel Garreau's (1991) concept of "edge cities"—large concentrations of commercial and office space in suburban locations—has become well-known, few obvious examples can be visually identified within the metropolitan regions studied. But Robert Lang's (2003) counterconcept of the "edgeless city," characterized by very dispersed office space and isolated buildings, also does not appear completely borne out within the case study regions. Instead, much office space occurs within small clusters or linear corridors, or is combined with commercial and industrial space in somewhat larger clusters, although these are still smaller than Garreau's definition of edge cities (at least 5 million square feet of office space as well as large amounts of retail space and some housing).

2. The Expanding Size and Falling Densities of Metropolitan Regions

A second dramatic finding from these case studies is just how rapid the expansion of metropolitan regions has become. The amount of developed land within each of these six regions grew at least 130 percent—more than doubling—in the 1980-2005 period. To put it another way, an average of 56 percent of the land area of these metropolitan regions has been developed since 1980, and an astounding 88 percent has been developed since 1940, well within the lifetimes of many people living today. Almost all of this land has been developed in motor vehicle–dependent forms, which does not bode well for future attempts to promote public transit, reduce fuel consumption, or lower carbon dioxide emissions.

Measured in terms of their urbanized land area, these metropolitan regions now range in size from 284 square miles (Las Vegas) to almost 1,800 square miles (Atlanta). (See table 3.) These enormous geographical areas typically incorporate dozens or even hundreds of local governments. Urbanized land around Atlanta, for example, now covers parts of some seventeen counties, each containing numerous towns and special districts. The official regional planning agency, the Atlanta Regional Commission, covers only ten of those counties, and the more recent Georgia Regional Transportation Authority works with thirteen counties. Around Boston, urbanization touches portions of four states, and there is no regional agency that even remotely covers this whole territory. In such cases, action by state government or several states working together seems the only way to manage growth.

The spatial expansion of these regions is far beyond the rate of population growth. Exact correlation of developed land with population growth is difficult for a number of reasons. Most importantly, the U.S. Census Bureau does not map population spatially according to address or street block, for privacy reasons, but rather uses the broader scale of census tracts and block groups. These do not necessarily correspond to built form; many include large areas of undeveloped and rural land along with adjacent built areas. So there is no good way to geocode population in a way that can be correlated with observed urbanized landscape forms.

At a regional scale, other methodological difficulties emerge. The Census Bureau has varied its definitions of metropolitan statistical areas throughout time to account for new growth, so metropolitan population counts do not reflect a consistent geographical region. Metropolitan population statistics did not appear at all until the 1950 census, when the bureau introduced the term *standard metropolitan area* (SMA).

Table 3.
Growth in regional urbanization by period (in square miles and % of current total).

Period	*Albuquerque*	*Atlanta*	*Boston*	*Las Vegas*	*Minneapolis–St. Paul*	*Portland*	*Average % of Current Urban Area*
<1860	0.1 (0%)	0.9 (0%)	31.3 (3%)		4.8 (0%)	2.4 (1%)	1
1860-1880	1.0 (0%)	7.6 (0%)	30.0 (2%)		25.7 (3%)	5.8 (2%)	1
1880-1900	4.6 (1%)	18.9 (1%)	51.6 (4%)	0.3 (0%)	69.1 (7%)	23.0 (6%)	3
1900-1920	3.4 (1%)	24.6 (1%)	29.9 (2%)	0.8 (0%)	42.5 (4%)	28.7 (8%)	3
1920-1940	9.6 (3%)	26.6 (2%)	90.9 (7%)	2.1 (1%)	35.4 (4%)	22.9 (6%)	4%
1940-1960	36.1 (11%)	238.6 (13%)	338.3 (27%)	30.6 (11%)	143.3 (14%)	44.6 (13%)	15%
1960-1980	30.1 (10%)	330.6 (18%)	146.3 (12%)	57.7 (20%)	193.5 (19%)	60.9 (17%)	17%
1980-2005	218.6 (70%)	1,131.5 (63%)	521.0 (42%)	192.5 (68%)	487.0 (49%)	169.3 (47%)	56%
Currently urbanized land	314.4 (100%)	1,799.3 (100%)	1,239.3 (100%)	284.0 (100%)	1,001.3 (100%)	357.6 (100%)	

This term was changed to *standard metropolitan statistical area* (SMSA) in 1959, and *metropolitan statistical area* (MSA) in 1983. The agency introduced a new term, *metropolitan area* (MA), in 1990 to include MSAs as well as *consolidated metropolitan statistical areas* (CMSAs) and *primary metropolitan statistical areas* (PMSAs). That term itself was superseded in 2000 by *core-based statistical area* (CBSA) to refer to both metropolitan and micropolitan urban areas (U.S. Census Bureau 2007). A separate census term, *urbanized area* (UA), appeared in the 1990 and 2000 censuses to indicate certain levels of population density at the scale of block groups, although the definition of this term changed between the two decades. Because definitions and geographical extents have changed so much, and because all U.S. Census geographical levels contain both unbuilt and rural land, it is very difficult to develop consistent comparisons of urbanized population and densities throughout time.

But in general, population density has decreased as metropolitan areas have grown. (See tables 4 and 5.) Figure 5 gives approximate density figures for 1980 and 2005, comparing census MSA population figures with the urbanized area determined in this study. Overall densities in five of the six case study regions decreased during that time. The exception, Las Vegas, is a unique case, as will be discussed below. Density decreases were quite significant, ranging from 16 percent to 43 percent. Densities ranged from about 2,500 persons per square mile (3.9 persons per acre) to about 7,000 persons per square mile (10.9 persons per acre). Because the tabulation of urbanized land presented here doesn't include open space, leftover spaces between developments, or major infrastructure such as freeways, if all land in the metropolitan area were included in the calculation, gross regional population densities would be still lower.

3. Regional Variation in Patterns

The case study metropolitan areas vary significantly in terms of their mix of built landscape patterns and the exact characteristics of some of these forms, although the same basic patterns are found to some extent in all regions. Some variations are predictable. The regions with the most rapidly growing populations (Las Vegas and Atlanta) have the highest proportion of tract development (51 and 58 percent respectively). Such a finding is to be expected, because builders use this form of development to create large numbers of housing units quickly. New Urbanist projects, not surprisingly, are more common in politically progressive and environmentally oriented regions (Portland and Minneapolis) than regions that are less so. Trailer parks are more common in regions with moderate climates, which might be expected because this form of housing is not well adapted to cold or heat.

Many other differences in landscape mix appear due primarily to local conditions. The large amount of industrial/office space in Portland is due in part to the rapid development of large, flat expanses along the Columbia River near the airport, many of them previously used by the military during World War II. The large percentage of incremental development in Albuquerque and Las Vegas is due to the subdivision of small-scale agricultural lands along the Rio Grande in the former case, and the gradual settling of large land areas west of the city that were speculatively subdivided during past decades in the latter case. The fact that the upscale fringe development percentage is small in the Boston area is probably because much upscale development there occurs on very low-density lots that count as rural sprawl.

Population size of the region does not seem to be a major factor in the built landscape mix. The average mix of the three smallest regions is relatively similar to that of the three largest regions, with the exception of incremental development, which is a greater portion of the smaller regions, and rural sprawl, which is a higher percentage for the larger ones. But these differences are probably explained by several notable cases. In general, individual factors seem far more important than size in determining landscape mix.

One surprising finding is Boston's high percentage of rural sprawl. Eastern cities are often thought to be more compact

Table 4.
Population and growth of case study regions (U.S. Census metropolitan statistical areas).[a]

	Albuquerque	*Atlanta*	*Boston*	*Las Vegas*	*Minneapolis–St. Paul*	*Portland*
1970[b]	316	1,684	3,939	273	1,982	1,047
1980[b]	420 (33%)	2,233 (33%)	3,972 (1%)	463 (70%)	2,137 (8%)	1,298 (24%)
1990[c]	599 (43%)	3,069 (37%)	4,134 (4%)	741 (60%)	2,539 (19%)	1,524 (17%)
2000[c]	730 (22%)	4,248 (38%)	4,391 (6%)	1,376 (86%)	2,969 (17%)	1,928 (27%)
2005[d]	784 (7%)	4,829 (14%)	4,271 (-3%)	1,691 (23%)	3,076 (4%)	2,063 (7%)
Change 1980-2005	+364 (87%)	+2,596 (116%)	+299 (8%)	+1,228 (265%)	+939 (44%)	+765 (59%)

Note: All numbers in thousands.
a. These population figures are presented to provide the reader with an indication of the relative size and rate of growth of these metropolitan areas. U.S. Census MSAs are composed of counties and do not correspond exactly with the urbanized areas identified in this article. The specific definitions of many Census MSAs have also changed throughout time, so in some cases part of the expansion of metro area populations is because the boundaries of the MSA were increased.
b. From U.S. Census Bureau (1990, table 48 ["Population and Housing Units, 1970 to 1990, Land Area and Density for Metropolitan Areas, 1990"]).
c. From U.S. Census Bureau (2000, table 1a ["Population in metropolitan and micropolitan statistical areas in alphabetical order and numerical and percent change for the United States and Puerto Rico: 1990 and 2000"]).
d. From U.S. Census Bureau (2005a).

Table 5.
Densities of case study regions, in persons per square mile.[a]

	Albuquerque	*Atlanta*	*Boston*	*Las Vegas*	*Minneapolis–St. Paul*	*Portland*
1980	4,400	3,500	5,500	5,100	4,200	6,900
2005	2,500	2,700	3,400	6,000	3,100	5,800
Change 1980-2005	–43%	–23%	–38%	+18%	–26%	–16%

a. These density figures are approximate and are intended only to indicate general trends. More precise figures are difficult to determine due to (1) changing census definitions of *metropolitan areas*; (2) the fact that census tabulations include populations in rural as well as urbanized locations within the metro area, which are not included in our tabulation of urbanized land; and (3) in general, the lack of population data that can be geocoded to areas of a smaller scale than the block group.

than their western counterparts, and Boston's core area platted before 1920 is in fact quite dense. But in terms of actual percentages of land covered by recent regional development, rural sprawl is strongest in Boston. Reasons may include traditionally larger lot sizes on the east coast, the presence of many small historic towns in New England that can serve as the foci for low-density development, climate, topography, land prices, and regional cultural preferences for country living.

Las Vegas provides the most striking exception to the rural sprawl trend. Although it has been the nation's most rapidly growing large city in many recent years, this metropolis features tightly packed subdivisions even for upscale development. The limits to the city's growth posed by federal land on all sides may be the primary factor, but in a flat, hot desert basin, there may also be less public desire for large yards or multiacre spreads. Much of the city's upscale growth is also within large, master-planned communities that include golf courses, pools, clubhouses, and other recreational amenities that to some extent may serve in place of large private yards.

The character of most landscape patterns is similar across these regions, lending support to James Howard Kunstler's concept of a "geography of nowhere" due to standardized development practices in a global economy (Kunstler 1993). Commercial landscapes outside of Boston are similar to those outside of Portland or Albuquerque; industrial, multifamily, and trailer landscapes are also fairly similar.

Some regional differences in character do exist, however. Tract housing in the West usually takes place on smaller lots and involves less greenery. Likely reasons for the former include low income levels in places like Albuquerque and Las Vegas, meaning that builders keep lot sizes small to ensure affordability, and hot dry climates in the Southwest, which make extensive landscaping or yard use difficult. The scale of tract subdivision tends to be larger in those areas with flatland that was previously held as large farms (e.g., Las Vegas, Albuquerque, and parts of Portland and Minneapolis) than in those regions with hills, swamps, and smaller scale land ownership (e.g., Boston and Atlanta). And of course, the amount of vegetation and typical landscaping practices vary greatly depending on climate.

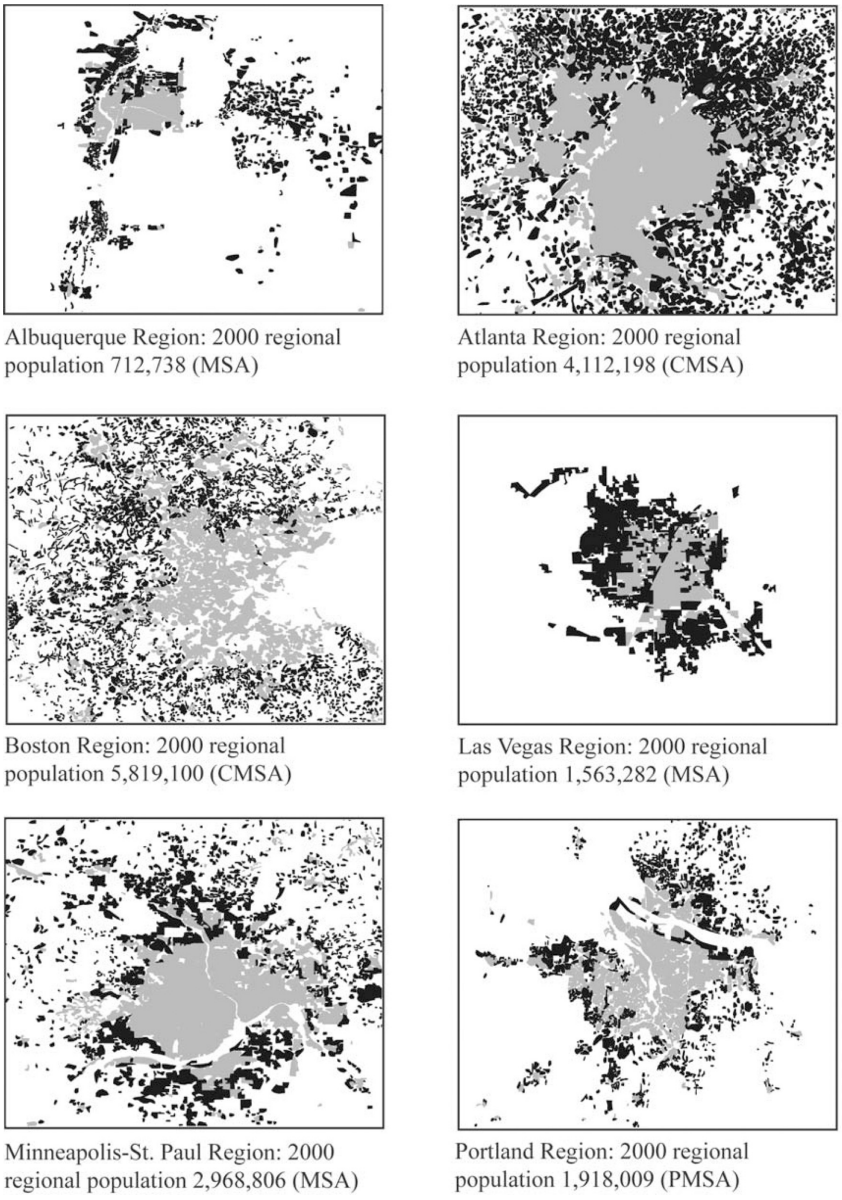

Figure 5. *Regional growth maps of six metropolitan regions showing pre-1980 and 1980-2005 urbanization..*

Note: All images at same scale (approximately 50 miles across).

4. The Effectiveness of Portland's Urban Growth Boundary (UGB)

This analysis shows that the Portland UGB has been remarkably effective at reducing rural sprawl in the Oregon portion of that metropolitan region, as shown in table 4 (see also figure 6). Rural sprawl accounted for only 13 percent of new land urbanized on the Oregon side of the Columbia River, as opposed to 34 percent on the Washington side. (See figure 7 for varieties of rural sprawl.) If just the land under the jurisdiction of Portland's Metro Council regional government is considered, this figure drops to 11 percent, most of it in Clackamas County, where the process of the low-density subdivision of agricultural land was well underway when the UGB was implemented. Interestingly, the Oregon side of the region also saw a much larger share of industrial and office development than the Washington State portion, implying that Oregon jurisdictions zoned more land for such development, that they were more successful at recruiting or promoting business, or that businesses preferred Oregon. (See table 6.)

5. Fragmentation of Regional Spatial Development

The increasingly fragmented character of post-1940 regional development can best be understood by looking at aerial photographs or built landscape maps such as in figure 1. At a large scale, different types of fragmentation appear to have emerged in the case study regions because of natural factors. In the Boston area, developers may have had little choice but to leapfrog relatively small pockets of development across a countryside broken up by topographic features (streams, wetlands, and small hills), jurisdictional elements (the presence of many small towns), and a history of relatively small-scale land ownership when compared to the western United States. In the Atlanta area, somewhat larger tract developments have hopscotched across a hilly landscape probably also characterized by relatively small-scale land ownership. Lakes and stream valleys in the Minneapolis–St. Paul area have helped separate certain developed areas, although the region's abundant flatland has helped produce more contiguous development otherwise. In Albuquerque, a large area of rural sprawl is separated from the main part of the city by the 10,800-foot Sandia mountain range, whereas much of the remaining development is relatively contiguous on flat desert mesas. Las Vegas is likewise relatively contiguous in its desert basin, although individual developments are inwardly focused and do not necessarily connect to one another. The Portland area shows substantially greater dispersion of development on the Washington State side of the Columbia River than the Oregon side, where the growth boundary has exerted some confining pressure.

Table 6.
Proportions of urban form in Oregon versus Washington portions of the Portland metropolitan region.

Type	*Oregon (square miles)*	*% of Total*	*Washington (square miles)*	*% of Total*
Suburban tract	52.3	42	28.2	46
Rural sprawl	15.7	13	20.8	34
Upscale fringe	7.1	6	1.5	2
Multifamily	4.4	4	1.7	3
Trailers	0.7	1	0.3	0
Incremental	5.0	4	2.5	4
Commercial	6.5	5	2.9	5
Industrial/office	30.7	25	3.6	6
New Urbanist	0.8	1	0.0	0
Total	123.2		61.5	

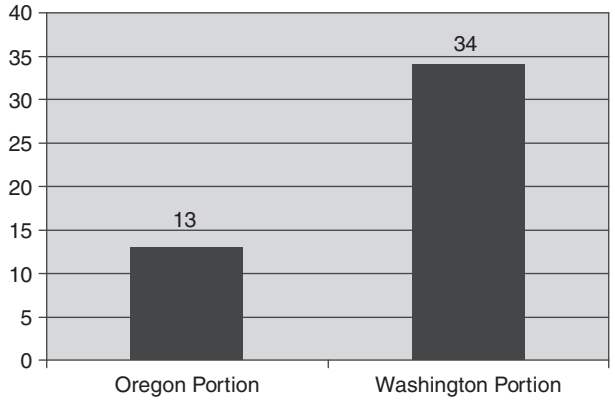

Figure 6. *Percentages of rural sprawl in Oregon and Washington State portions of the Portland metropolitan region.*

At a smaller scale, the adoption of single-use zoning codes in the early twentieth century fostered segregation of land uses in all regions that can now be clearly seen on aerials or maps. Whereas in the nineteenth century, retail space, office space, multifamily housing, and single-family homes all appeared within downtown grid or streetcar suburb landscapes, after the early twentieth century each was required to exist in its own zoned space and consequently took on its own landscape form. The decline of gridded street networks and the rise of larger scale development that aimed to market inwardly focused built spaces to particular market niches also increased the fragmentation of form. The result is that maps of built landscapes in these regions show fractured mosaics in which an increasing variety of forms are separated by many pieces of unbuilt or waste land as well as large-scale infrastructure such as freeways.

▶ Policy Implications

The changes in built landscapes documented in this research have many policy implications that can be only briefly summarized here.

First and foremost, if a compact city model is desired for sustainability and public health reasons, as has been widely proposed (e.g., Beatley 1997; Frey 1999; Ewing, Pendall, and Chen 2002; Kelly-Schwartz et al. 2004; Frank 2006), it appears particularly important for local and regional governments to rein in low-density forms of development such as rural sprawl through urban growth boundaries or revised zoning and subdivision policies. If a UGB such as Portland's is not politically feasible for a particular jurisdiction, it might instead change its zoning codes to prohibit lot sizes between 5,000 square feet (a typical suburban density) and five or ten acres (a rural density) to prevent this form of development. To promote compact development, the municipality might also change its minimum lot sizes to allow small single-family lots of 2,500 to 4,000 square feet, as are being seen in western cities such as Albuquerque, Las Vegas, and Portland.

If local or regional governments see New Urbanist form to be desirable, then stronger initiatives appear necessary to bring it into reality. Zoning and subdivision ordinances may need to be revised to require the desired form, for example by requiring gridlike street patterns, connecting through-streets, mixed-use neighborhood centers, and higher residential densities. Local plans will need to establish the large-scale structure of new portions of the city in advance of development to avoid the sort of fragmented, poorly connected development patterns that have happened without such planning.

Many recent development types do not take ecological landscapes into account. Existing vegetation, drainage features, slope, and presumably fauna disappear under the asphalt of residential tracts and commercial and industrial development. Code changes to protect and integrate natural features into these development types seem needed, for example by requiring stream channels to be preserved as greenways, by requiring natural topography to be retained, and by protecting and restoring wetlands.

The segregation of multifamily housing is a further policy concern. Whereas in the nineteenth century this was relatively well integrated into urban housing stock, in new twenty-first-century landscapes, it appears to occur mainly within isolated enclaves. Again, local plans and codes could require greater integration.

On the positive side, the large amounts of commercial and industrial/office landscape created between 1980 and 2005 offer an opportunity for reuse in the future. The buildings on these sites often have a limited life expectancy and

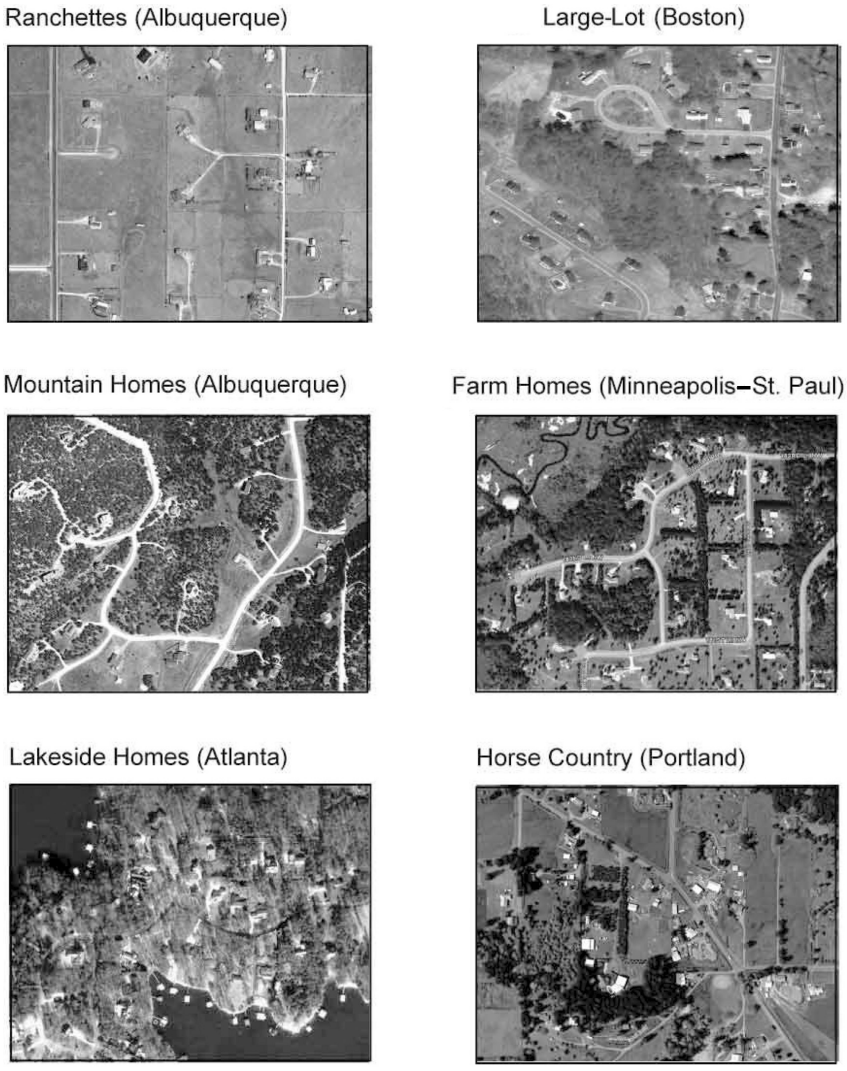

Figure 7. *Varieties of rural sprawl.*
Note: All images at same scale (2,000 feet across).

are located on large parcels, some of which could be turned into entire new neighborhoods. Proactive local government planning is likely to be necessary to ensure that the most is made of these opportunities, for example, by creating specific zoning and urban design requirements for such areas.

Overall, a more proactive public sector role in shaping built landscapes seems needed if twenty-first-century ecological and social objectives are to be met. Nineteenth-century subdivision patterns did not explicitly seek these goals, but established simple and flexible patterns that in an age of small-scale, low-technology building and transportation produced form that we see today as relatively sustainable (Wheeler 2003). In contrast, the rapid and large-scale development of the late twentieth century, oriented around the motor vehicle, quickly produced enormous expanses of far less sustainable built form. Such development processes operated within an extensive planning framework, to be sure, but one that to a large extent codified and facilitated unsustainable modes of development, and that was often reactive rather than proactive in character (e.g., Mollenkopf 1983; Logan and Molotch 1987). A fundamentally different balance seems needed if more sustainable metropolitan development is to come about.

▶ Conclusion

This analysis has sought both to develop an understanding of the evolution of built form in U.S. regions and to explore a new method for evaluating and comparing such form using recent tools such as GIS and Google Earth. Much further analysis could be done to explore some of the questions raised here. In particular, additional case studies could shed light on the strength and consistency of regional differences in development patterns, and could help fine-tune typologies of urban form. The succession of historical morphologies in such metropolitan areas could also be explored and presented in greater detail than was possible in this article, which has concentrated on development within the 1980-2005 period.

There are both strengths and limitations to this method of mapping built form. On the positive side, it allows the creation of physical maps of built form for communities, something that more quantitative analyses of sprawl have a hard time doing. By measuring land area covered with different types of development, as opposed to changes in numbers of people or housing units within census block groups, this method tackles an important variable not covered in other analyses. And by using visual analysis and aerial photographs, it allows researchers and the public to understand urban design elements that may not come through in other methods of analysis, such as the typical scale, placement, and form of buildings; the size, regularity, and character of subdivision; and the historical arrangement of forms over entire metropolitan regions.

On the downside, this method is quite time-consuming; requires consistent, careful coding by researchers; and could be open to variations in classification schemes. The particular typology developed in this article, for example, emphasizes

residential forms on the assumption that these are the largest and most inflexible use of land, and hence an important focus for future regulation and policy. The commercial and industrial categories presented here are catchalls, and could certainly be broken out into more detailed subcategories.

The basic picture painted by this analysis is, however, strong and clear. U.S. metropolitan regions are characterized by a profusion of new built landscape forms, a general fragmentation of form, and an explosive rate of spatial growth when viewed in historical perspective. Many recent development forms are low density, single use, and motor vehicle dependent. Although the Portland growth boundary appears to have substantially limited rural sprawl in that region, such sprawl is rampant elsewhere. The New Urbanist movement has yet to make much headway in terms of affecting the form of new development. Stabilizing the size of metropolitan regions, achieving greater integration of land use, and bringing about built landscapes that reduce driving, fossil fuel use, and greenhouse gas emissions seem enormous challenges that our society has barely begun to tackle.

▶ References

Bacon, Edmund N. 1967. *Design of cities*. New York: Viking.

Beatley, Timothy. 1997. *The ecology of place: Planning for environment, economy, and community*. Washington, DC: Island.

Calthorpe, Peter. 1993. *The next American metropolis: Ecology, community and the American dream*. New York: Princeton Architectural Press.

Calthorpe, Peter, and William Fulton. 2001. *The regional city: Planning for the end of sprawl*. Washington, DC: Island.

Campoli, Julie, Elizabeth Humstone, and Alex MacLean. 2002. *Above and beyond: Visualizing change in small towns and rural areas*. Chicago: Planners Press.

Carbonell, Armando, and Robert Yaro. 2005. American spatial development and the new megalopolis. *Land Lines* 17 (2): 1-4.

Cerdá, Ildefons. [1867] 1999. *Cerda: The five bases of the general theory of urbanization*, ed. Arturo Soria y Puig. Madrid: Electa.

Congress for the New Urbanism. 1999. *Charter of the new urbanism*. New York: McGraw-Hill.

Dewar, Margaret, and David Epstein. 2006. Planning for "megaregions" in the United States. Paper presented at the Association of Collegiate Schools of Planning conference, Fort Worth, TX, November.

Duany, Andres, Elizabeth Plater-Zyberk, and Jeff Speck. 2000. *Suburban nation: The rise of sprawl and the decline of the American dream*. New York: North Point.

Ellin, Nan. 1996. *Postmodern urbanism*. New York: Princeton Architectural Press.

Ewing, Reid, Rolf Pendall, and Don Chen. 2002. *Measuring sprawl and its impact*. Washington, DC: Smart Growth America.

Frank, Lawrence D. 2006. Many pathways from land use to health: Associations between neighborhood walkability and active transportation, body mass index, and air quality. *Journal of the American Planning Association* 72 (1): 75-87.

Frey, Hildebrand. 1999. *Designing the city: Towards a more sustainable urban form*. London: Spon.

Galster, George, Royce Hanson, Michael R. Ratcliffe, Harold Wolman, Stephen Coleman, and Jason Freihage. 2001. Wrestling sprawl to the ground: Defining and measuring an elusive concept. *Housing Policy Debate* 12 (4): 681-717.

Garreau, Joel. 1991. *Edge cities: Life on the new frontier*. New York: Doubleday.

Geddes, Patrick. 1915. *Cities in evolution: An introduction to the town planning movement and to the study of civics*. London: Williams & Norgate.

Gottmann, Jean. 1961. *Megalopolis: The urbanized northeastern seaboard of the United States*. New York: Twentieth Century Fund.

Grant, Jill. 2003. Exploring the influence of new urbanism in community planning practice. *Journal of Architectural and Planning Research* 20 (3): 234-53.

Hayden, Dolores. 1984. *Redesigning the American dream: The future of housing, work, and family life*. New York: Norton.

———. 2004. *A field guide to sprawl*. New York: Norton.

———. 2005. *Building suburbia: Green fields and urban growth 1820-2000*. New York: Pantheon.

Hiss, Tony. 1990. *The experience of place*. New York: Knopf.

Howard, Ebenezer. [1898] 1902. *Garden cities of tomorrow*. London: Sonnenschein.

Jackson, J. B. 1994. The mobile home on the range. In *A sense of place, a sense of time*. New Haven, CT: Yale University Press.

Jackson, Kenneth T. 1985. *Crabgrass frontier: The suburbanization of the United States*. New York: Oxford University Press.

Jacobs, Jane. 1961. *The death and life of great American cities*. New York: Random House.

Katz, Peter. 1994. *The new urbanism: Toward an architecture of community*. New York: McGraw-Hill.

Kelly-Schwartz, Alexia C., Jean Stockard, Scott Doyle, and Marc Schlossberg. 2004. Is sprawl unhealthy? A multilevel analysis of the relationship of metropolitan sprawl to the health of individuals. *Journal of Planning Education and Research* 24(2): 184-96.

Kilgannon, Corey. 2003. "Affordable housing" can mean a trailer. *New York Times*, July 20.

Kostof, Spiro. 1991. *The city shaped: Urban patterns and meanings through history*. Boston: Little, Brown.

———. 1992. *The city assembled: The elements of urban form through history*. Boston: Little, Brown.

Kunstler, James Howard. 1993. *The geography of nowhere: The rise and decline of America's man-made landscape*. New York: Simon & Schuster.

Lang, Robert. 2003. *Edgeless cities: Exploring the elusive metropolis*. Washington, DC: Brookings Institution Press.

Lang, Robert E., and Dawn Dhavale. 2005. *Beyond megalopolis: Exploring America's new "megapolitan" geography*. Alexandria: Metropolitan Institute at Virginia Tech.

Logan, John R., and Harvey L. Molotch. 1987. *Urban fortunes: The political economy of place*. Berkeley: University of California Press.

Lynch, Kevin. 1981. *A theory of good city form*. Cambridge, MA: MIT Press.

Mollenkopf, John H. 1983. *The contested city*. Princeton, NJ: Princeton University Press.

Morris, A. E. J. 1979. *History of urban form: Before the Industrial Revolutions*. London: Godwin.

Moudon, Anne Vernez. 1994. Getting to know the built landscape: Typomorphology. In *Ordering space: Types in architecture and design*, ed. Karen A. Franck and Lynda H. Schneekloth. New York: Van Nostrand Reinhold.

Moudon, Anne Vernez, and Paul Hess. 2000. Suburban clusters: The nucleation of multifamily housing in suburban areas of the Central Puget Sound. *Journal of the American Planning Association* 66 (3): 243-64.

Mumford, Lewis. 1938. *The culture of cities*. New York: Harcourt, Brace.

Nolan, John, ed. 1916. *City planning: A series of papers presenting the essential elements of a city plan*. New York: Appleton.

Olmsted, Frederick Law. 1971. *Civilizing American cities: A selection of Frederick Law Olmsted's writings on city landscapes*, ed. S. B. Sutton. Cambridge, MA: MIT Press.

Rapoport, Amos. 1977. *Human aspects of urban form: Towards a man-environment approach to urban form and design*. New York: Pergamon.

Relph, Edward. 1987. *The modern urban landscape*. London: Croom Helm.

Reps, John W. 1965. *The making of urban America: A history of city planning in the United States*. Princeton, NJ: Princeton University Press.

———. 1979. *Cities of the American West: A history of frontier urban planning*. Princeton, NJ: Princeton University Press.

Song, Yan, and Gerrit-Jan Knaap. 2004. Measuring urban form: Is Portland winning the war on sprawl? *Journal of the American Planning Association* 70 (2): 210-25.

Southworth, Michael, and Eran Ben-Joseph. 1997. *Streets and the shaping of towns and cities*. New York: McGraw-Hill.

Southworth, Michael, and Peter M. Owens. 1993. The evolving metropolis: Studies of community, neighborhood, and street form at the urban edge. *Journal of the American Planning Association* 59 (3): 271-87.

U.S. Census Bureau. 1990. *1990 census of population and housing, population and housing unit counts*. Washington, DC: Government Printing Office.

———. 2000. *U.S. Census 2000 PHC-T-29. ranking tables for population of metropolitan statistical areas, micropolitan statistical areas*. Washington, DC: Government Printing Office.

———. 2005a. *2005 American community survey*. http://factfinder.census.gov (accessed July 13, 2007).

———. 2005b. TIGER®, TIGER/Line® and TIGER®-related products. http://www.census.gov/geo/www/tiger/index.html (accessed February 20, 2008).

———. 2007. About metropolitan and micropolitan statistical areas. Factsheet. http://www.census.gov/population/www/estimates/aboutmetro.html (accessed February 18, 2008).

Warner, Sam Bass. 1962. *Streetcar suburbs: The process of growth in Boston, 1870-1900*. Cambridge, MA: Harvard University Press.

Wheeler, Stephen M. 2003. The evolution of urban form in Portland and Toronto: Implications for sustainability planning. *Local Environment* 8 (3): 317-36.