DEFINING AND MAPPING RURAL SPRAWL: EXAMPLES FROM THE NORTHWEST US*

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Defining rural sprawl

Although urban sprawl is discussed and debated frequently in boardrooms and kitchens throughout the country, what *it is* is generally not well defined. The most common quantitative definition is that urban sprawl occurs when there is a decline in population density over time. For example, Rusk found that for 213 urbanized areas, population grew by 47% between 1960 and 1990, while urbanized land increased by 107%.[1] Thus, the general notion of urban sprawl is that spatial spread of development proceeds at a greater rate than population growth, resulting in dispersed, low-density development.[2] More specific to the Pacific Northwest, in Clark County, Washington, population grew by 106,000 and converted 78,000 acres, and resulted in 23 percent more land conversion per resident than adjacent counties in the Portland, Oregon region.[3]

But how low is low density? Urban density is defined by the Census Bureau as greater than 1,000 people per square mile (about 1.6 people per acre), while rural areas are simply defined as "not urban." It should be noted that "smart growth" density (e.g., the density that would support mass transit) is much higher at 12,500 people per square mile (>19.5 people per acre). Most urban sprawl studies have utilized US Census-defined Urban Areas (UA) and Metropolitan Statistical Areas (MSA), which can both over- and under-bound locations of urban density. That is, the majority of small cities and towns in the US (places) were not located within an UA or MSA, and so many small pockets of urban areas were excluded from analysis. Also, because MSAs are defined by amalgamations of counties, rural areas (very low densities) are often included in urban analyses. The lack of geographic precision exhibited in most urban sprawl studies is one of the main reasons William Alonso has called for a re-thinking of the urban-rural framework: "The existing censal categories are misleading because they present a vision of the United States as a territory tiled with convex, continuous, mutually exclusive types of regions, while the reality is one of a great deal of interpenetration, much of it rather fine-

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[1] Rusk, D. 1997.
[2] Ewing et al. offer a few additional factors are often identified with urban sprawl: segregated land uses, lack of significant centers (e.g., downtowns), and poor street accessibility. See: Ewing, R., R. Pendall, and D. Chen. 2002. *Measuring sprawl and its impact*. www.smartgrowthamerica.com
[3] http://www.northwestwatch.org/press/seagrowth_map5.html

grained."[4] Recent revisions to the 2000 Census have partially addressed this issue, through "urban clusters" which contain between 500-1000 people per mi^2 in blocks adjacent to UAs.

Even though urban sprawl is certainly an important issue, I hope to bring attention to *rural* sprawl. Using fine-grained geography from the 1990 and 2000 Census (blocks and block-group), one can find that there is a great deal of low density residential land use that is located outside of cities and towns. In fact, nationwide, this exurban land use occupies 10 times more area than urban and suburban densities, and has been growing at a rate of about 10-15% per year.[5] The growth rate of exurban development has exceeded urban development.[6]

Daniels defines rural sprawl as low-density residential development scattered outside of suburbs and cities, and as commercial strip development along roads outside cites.[7] Here I roughly equate rural sprawl with rural residential development at exurban densities. That is, I define *urban* and *suburban* areas as those locations with <1.7 acres per housing unit. *Exurban* areas typically have 1.7 to 20 acres per housing unit. In some states, exurban areas are defined as having between 1.7 and 40 acres per housing unit, depending on state land use laws. *Rural* areas have >20 acres per housing unit (or >40 acres).

Urban 0.6 ac/unit **Suburban** 1.7 ac/unit **Exurban** 20 ac/unit **Rural**

Measuring & mapping rural sprawl

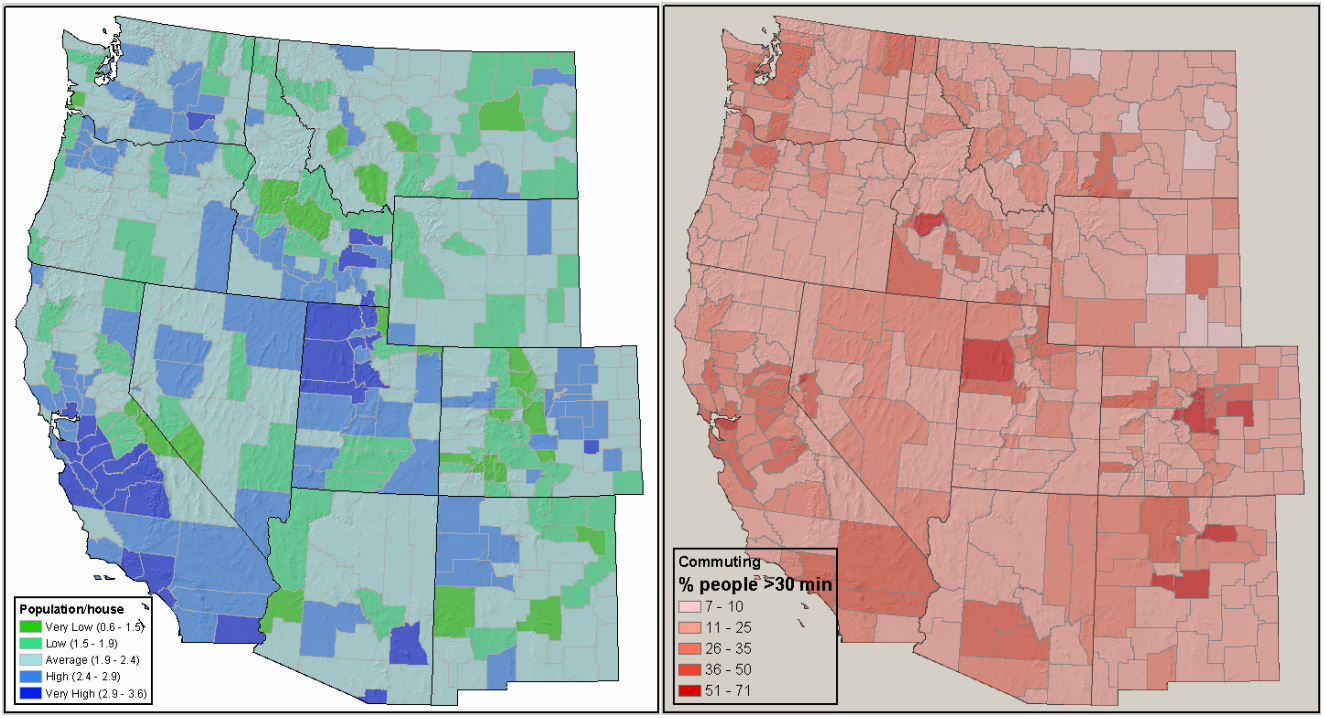
Probably the most common way of measuring and expressing the pattern and extent of development is utilizing population or population density. Because population data from the Census Bureau are tied to the primary place of residence, they underestimate landscape change due to development associated with vacation and second-homes. In 2000, nearly ¼ of western counties had a >25% vacancy rate; 11 counties had a >50% vacancy rate. As a result, the ratio of number of people in a county per house varies widely around the mean of 2.2 for the West, so that ¼ of the counties have a people per unit ratio lower than 1.9 and 8 counties have more housing units than people (see map below, left).

[4] Alonso, W. 1993. The interpenetration of rural and urban America. In Population and Change and the Future of Rural America: A Conference Proceedings, edited by L.L. Swanson and D.L. Brown, 23-28. Report No. AGES 9324.
[5] Theobald, D.M. 2001. Land use dynamics beyond the American urban fringe. *Geographical Review* 91(3):544-564.
[6] USDA Natural Resources Conservation Service NRI 2001.
[7] Daniels, T. 1999. *What to do about rural sprawl?* www.mrsc.org/subjects/planning/rural/daniels.aspx

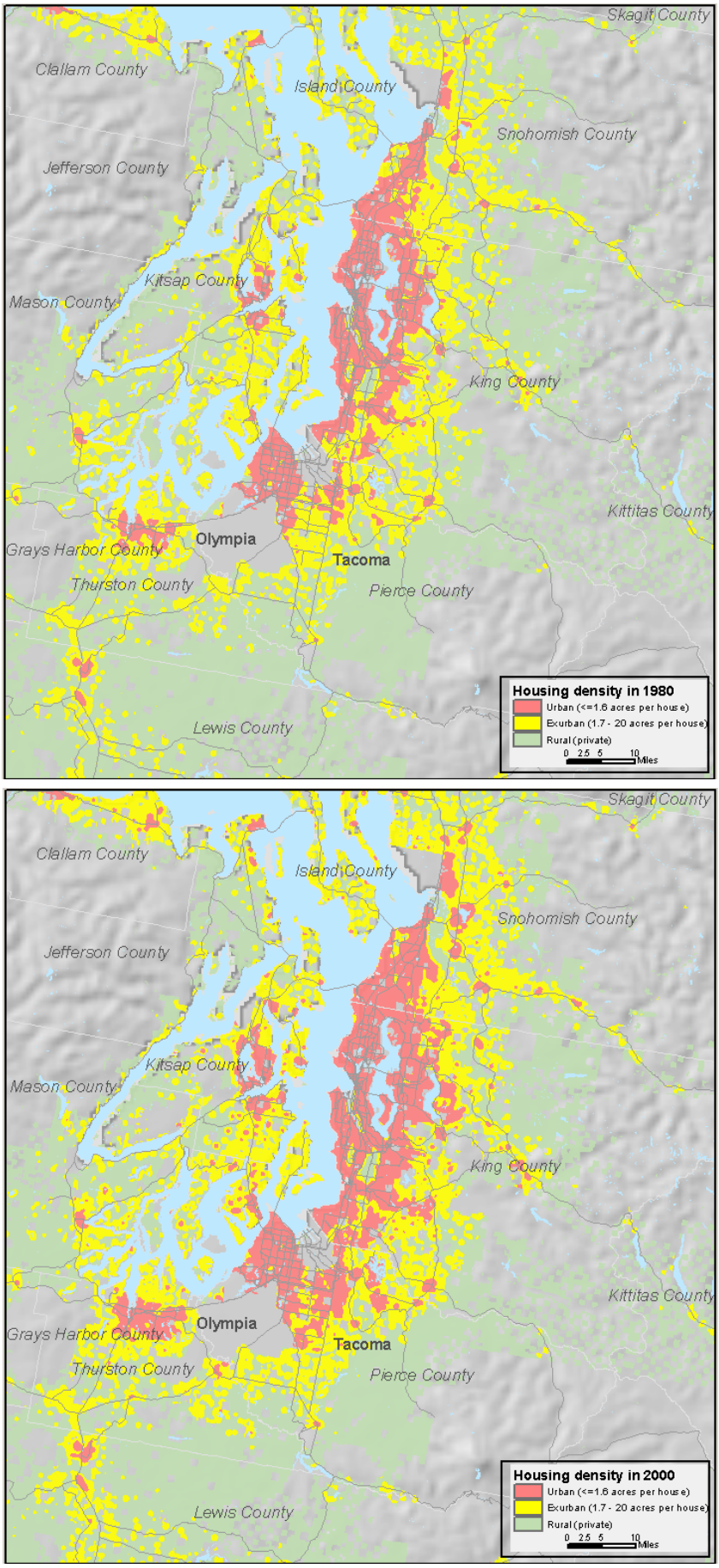
Another interesting indicator of sprawl is commuting time. Over 5 million rural residents spend more than 1 hour per day commuting to work (30 minutes each way), excluding highly urbanized counties (e.g., Denver, CO; King Co., WA; Los Angeles, CA) (see map below, right).

Perhaps the most direct and reliable measure of change on the landscape is the number of housing units, which are most often (in the rural West) single family homes, but can also be townhomes, condominiums or apartments. Broad-scale housing density maps were developed to examine the baseline patterns of exurban and rural development in the western US. The maps are based on 2000 US Census Bureau block-group and block level geography. Housing density was computed by using the centers of block polygons and calculating the average density within a 1,000 acre window (~1135 m radius), using 200 m resolution. The centers were computed for blocks that had the undeveloped portions removed (mostly public but also includes water bodies). Current (2000) patterns of housing density were based directly on the block-level estimates of housing units. Historical patterns (decades prior to 2000) of housing density were based on block-group level estimates of the number of houses, which were then spread to blocks based on the 2000 distribution. Density maps were computed for the entire western 11 states simultaneously to remove boundary effects that would have been introduced in a state-by-state analysis. An example of near Seattle and Tacoma, Washington, is shown below. Also, a summary of the developed area for the northwestern states is provided below. Exurban areas are growing at a faster rate than urban areas in Alaska and Montana. However, in all states, the footprint of exurban development is between 5-10 times larger than urban footprint.

Although population is often used as an indicator of growth and sprawl, changes in housing units are a more robust metric. Population numbers can often belie the magnitude of landscape change due to low-density housing, as shown by the ratio of population to housing units map (below left). Another useful metric is the time residents spend commuting. Over 5 million rural residents spend >1 hour per day (30 minutes each way) commuting to work (below right).



Urban and exurban growth for 1980 and 2000 near Seattle and Tacoma, Washington



		Developed area (mi^2)		
State	Year	1980	2000	% Growth
Alaska	Urban	66.6	114.2	171%
	Exurban	482.1	934.6	194%
Idaho	Urban	191.0	289.6	152%
	Exurban	1,092.2	1,449.0	133%
Montana	Urban	149.7	183.8	123%
	Exurban	841.5	1,203.3	143%
Oregon	Urban	592.5	762.9	129%
	Exurban	2,272.6	2,669.2	117%
Washington	Urban	848.0	1,220.6	144%
	Exurban	3,244.3	4,015.3	124%

Ecological consequences

Although studies of the ecological consequences of exurban growth are relatively recent, there is general consensus that exurban land use is a major threat to biodiversity, especially in the West.[8] Most studies to date have examined loss of habitat, but fragmentation effects and alteration of ecological processes (such as fire hydrologic regimes) are also an important consideration.

Recent studies by Hansen[9], Knight, Odell and others support two generalities about exurban effects: that n*ative species diversity declines with increasing housing density;* and *non-native species increases with higher housing density.* For example, Maestas and Knight[10] examined 3 land uses: exurban residential development, ranches, and protected areas from similar elevation and soil types. They found that songbirds and carnivores were more similar on ranches and protected areas, and ranches had more native and less non-native species, than either protected areas or exurban developments.

We have been employing the notion of a "zone of disturbance" (ZOD)[11] around each home and also driveways that allows us to examine the possible trade-offs between density and pattern of subdivision design. The ZOD captures the changes near houses and driveways such as removal and alteration of the structure (thinning) of native vegetation, introduction of exotic species associated with gardening and landscaping (e.g., Kentucky bluegrass), presence of domestic pets (i.e. cats and dogs), increased human-wildlife conflicts (e.g., bears visiting dumpsters and tearing into houses).

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[8] For example, see: Flather et al. (1994). Species endangerment patterns in the US. USFS Report RM-241. or Stein et al. 2000. *Precious Heritage*. Oxford Press.

[9] Hansen, A. J., R. Rasker, B. Maxwell, J. J. Rotella, J. D. Johnson, A. W. Parmenter, L. Langner, W. B. Cohen, R. L. Lawrence, and M. P. V. Kraska. 2002. Ecological causes and consequences of demographic change in the new west. *Bioscience* **52**:151-162.

[10] Maestas, J. D., R. L. Knight, and W. C. Gilgert. 2001. Biodiversity and land-use change in the American Mountain West. *Geographical Review* **91**:509-524.

[11] Theobald, D.M., J.M. Miller and N.T. Hobbs. 1997. Estimating the cumulative effects of development on wildlife habitat. *Landscape and Urban Planning* 39(1): 25-36.

The extent of the ZOD depends on the activities at a residence (year-round, seasonal, fenced pet, etc.) and the sensitivity of a species to these activities. Odell[12] examined how the abundance of grassland birds changed with distance from houses, and grouped birds into two major categories: human-sensitive and human-adapted species. The abundance of sensitive species declined by up to 50% at distances as far away as 180 m.

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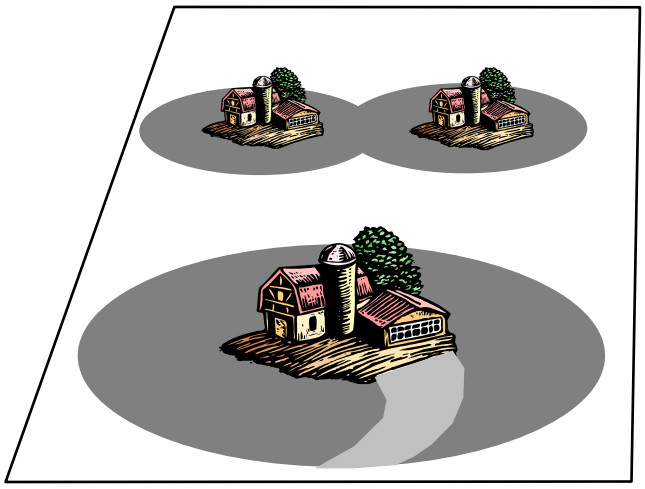

Summary

Recently great progress has been made in understanding the causes and consequences of *urban* sprawl. I have argued here that we need to differentiate *rural* sprawl from urban sprawl. Rural sprawl can be measured by low-density, exurban development (1.7 to 20 or 40 acres per unit), though rural sprawl can be a little more difficult to measure because it occurs as low-density and has weaker ties with population data. The extent of exurban areas in the US is roughly 3 to 11 times the extent of urban areas. Yet, initial ecological research suggests that even at relatively low, exurban densities, declines in species richness, increases in human-adapted species, and modification of critical ecological processes occurs.

[12] Odell, E.A., D.M. Theobald, and R.L. Knight. 2003. Incorporating ecology into land use planning - The songbirds' case for clustered development. *Journal of the American Planning Association* 69:72-82