Understanding landscape fragmentation and parcelization:
An examination of traditional planning tools

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FACTORS INFLUENCING LAND PARCELIZATION IN AMENITY RICH RURAL AREAS AND THE POTENTIAL CONSEQUENCES OF PLANNING AND POLICY VARIABLES

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Rural communities in America provide the food, fiber, and mineral resources for a growing national population. However, ongoing population migration and second home development are transforming the rural landscape from one of resource extraction to one focused on tourism, recreation, and retirement. This rural landscape transformation is characterized by the division of large tracts of land into smaller pieces, known as parcelization. Private land parcelization is a growing concern among planners, as they continuously look for improved growth management tools in rural America (Daniels & Lapping, 1996). As a precursor to rural land use change and landscape fragmentation, rural land division undermines the resource-based uses people rely on and with which many rural economies and communities are identified (Brabec & Smith, 2002; Gobster & Rickenbach, 2003; Holdt, Civco, & Hurd, 2004b; LaPierre & Germain, 2005; Mehmood & Zhang, 2001)). The concern is heightened in non-metropolitan areas with abundant amenities, where waves of growth are associated with recreational and retirement in-migration (McGranahan, 1999). The result of parcelization can be characterized as rural sprawl.

This paper looks at the ways in which planners measure landscape structure and change in a rural context. For exurban and rural communities, traditional measures often obscure the spatial component of landscape fragmentation. The typical metrics we use in urban areas do not do a good job explaining the landscape of a rural area. First, we highlight the shortcomings of traditional planning and land use regulation metrics. In the second part of this paper we present an overview of how and why landscape ecology metrics are attracting more attention and use among urban and regional planners. We are interested in adding to the planner's toolbox, because of the work we do with rural communities in Wisconsin. Community planning is seen as a suspicious activity – a set up to take away the property rights of private landowners.

Rural Sprawl

On August 25, 2002, the Minneapolis Star Tribune ran a story entitled "River Sprawls? Tranquil Wisconsin town now in path of Twin Cities growth." The crux of the story is that three large, proposed developments could nearly double River Falls' current population of 12,000 within the next five to ten years. An additional 6,000 people would be accommodated within these three developments. Fully built out these developments would contain a total of 2,045 units (mostly single family homes) on 845 acres.

The former Mayor Katie Chaffee was quoted as saying "poor planning also has brought developers knocking on River Falls' door." The other factors bringing development to River Falls includes an improved four-lane highway from River Falls to I-94, less expensive land costs in comparison to areas closer to the Twin Cities, proximity to downtown St. Paul (30 miles), a small, charming University town, and a nationally known trout stream that runs through the city. All these factors are not only making River Falls a desirable place to live, but a desirable place to develop (Fiedler 2002).

Clearly many people are concerned about sprawl. But what is it? Generally, people know sprawl when they see it; however, for communities to deal with sprawl we need a more precise definition. Many organizations have attempted to provide a definition, but it turns out that the definition depends on that organization's perspective, usually polarized between a pro-growth and an anti-sprawl viewpoint.

Below are definitions from various organizations:

- The Heritage Foundation: “Sprawl simply refers to the low-density, residential development beyond a city’s limits.”
- National Trust for Historic Preservation, Rural Heritage Program: “Sprawl is dispersed, low-density development that is generally located at the fringe of an existing settlement and over large areas of previously rural landscape. It is characterized by segregated land uses and dominated by the automobile.”
- U.S. Environmental Protection Agency: “[Sprawl is a] pattern of growth [that] has largely occurred in an unplanned, ad hoc fashion.”
- Natural Resources Defense Council: “Sprawling development eats up farms, meadows, and forests, turning them into strip malls and subdivisions that serve cars better than people.”

These definitions primarily focus on areas immediately adjacent to a city. This form of sprawl is often called urban sprawl. From these above definitions we can further characterize urban sprawl as the following:

- *Leapfrog development*
- *Commercial strip development*
- *Low density residential areas*
- *Large expanses of single-use development*
- *Limited transportation alternatives*
- *Lack of public open space*

  (Gillham: 4-7)

If we could examine rural Wisconsin or other rural places from “a bird’s eye view,” we would see many of these characteristics just outside of our urban areas. But looking from above, especially if we could examine the landscape over a twenty year period, we also would see rural areas[1] experiencing scattered development. What is this phenomenon? It is not urban sprawl, since many of these rural areas are far from urban areas and few of the above characteristics apply. So, what are the characteristics of “rural” sprawl? For Wisconsin at least the following characteristics are evident (Haines 2003):

- *Seasonal or recreational homes*

  One phenomenon in rural counties is a striking number of seasonal homes. Across northern Wisconsin, for example, the percentage of seasonal homes can be 50% and higher, especially in areas where there are many lakes and rivers. In some counties, there are more than 10,000 seasonal homes. In Oneida County almost 40% of the housing stock is for seasonal, recreational or occasional use as compared with about 6% for Wisconsin. This is significant when you consider that the seasonal population can be higher than the total year-round county population.

- *Low density residential areas*

  Rural areas may have two types of low density development. Lake development as one type may be similar to an area located outside an urban area, i.e., 2-5 acre lots and or smaller size lots. Outside that lake development ring, low density may be very different and may be characterized by much larger parcel sizes: 10-, 35-, and/or 80- acre residential lots, for example.

- *Inaccessible open space*

  Many seasonal homes are waterfront properties either on a lake or river/stream. When a substantial number of homes circle a lake, there is normally access to the lake itself for boats; however, there is little other public access. The public cannot walk along a shore, since they would be trespassing on private property. Forested land becomes inaccessible if the landowner removes it from one of the state forest tax law programs with public access.

- *Local economy may rely on seasonal residents and tourism*

  The national economy has made a transition from a heavy reliance on manufacturing to a more service-based economy. In Wisconsin where there is an emphasis on tourism, a service-based economy is even more pronounced and can mean boom and bust cycles locally depending on the whims of weather and the national or regional economy. Again using Oneida County as an example, about 25% of the employed civilian population works in this service-based economy; this compares with Wisconsin at 19%.

- *Conflict between residential and working lands may be increasing (agricultural, forested, non-metallic mining).*

  As rural areas become more populated, traditional rural industries are experiencing more conflict with rural residential neighbors. As rural areas become more populated with seasonal and year-round residents, we will likely see more conflict between these rural interests.

Figures 1-6 are various charts, maps and aerial photographs of sprawl.

[Insert Figures 1-6 about here]

Measuring the various characteristics of urban or rural sprawl is difficult. Plenty of literature on urban or suburban sprawl has tried to grapple with the measurement of this phenomenon. So far, however, there is no agreed upon set of metrics.

Planning and Land Use Regulation Metrics

Zoning, which regulates the type of use on the land, was first implemented and legitimized in the early 20th century for urban areas. The bulk of the land use policies are regulated at the community or local level.

One approach that local communities have exercised is through county or town zoning. Large lot zoning is an appealing method for protecting rural open space. This type of zoning was thought to decrease the amount of dense development, thus protecting forests and farmlands. However, requiring that homes have a minimum of five, ten, or even forty acres can have inadvertent consequences, especially in fast growing areas. More productive land gets taken out of farming and the cost to service new development is not covered by the taxes gained (Heimlich & Anderson, 2001). Only where lot sizes are large enough to discourage low density residential development can agricultural land be protected (Daniels & Bowers, 1997).

Easements are a non-regulatory method for protecting certain properties from future activities. They are voluntary legal agreements between landowners and some other party. Typically, easements prohibit certain uses and activities on a parcel of land. In turn, the owner keeps the land and usually is compensated through tax benefits (Schultink, 2007).

Other non-regulatory methods for controlling land use include Transfer of Development Rights (TDR) and Purchase of Development Rights (PDR). The primary difference between the PDR and TDR is what's done with the development rights after they are removed from the parcel. In the case of a PDR program, the development rights are maintained by the purchaser and retired. Usually the purchaser is a government entity or some non-profit organization. In a TDR program, the development rights are transferred from one parcel to another, targeting growth to more appropriate areas (Schultink, 2007).

However, due to poor land management decisions, Wisconsin introduced rural zoning in the 1920s to restrict widespread farmland development on unproductive soils in the north. As a result, landowners and developers sometimes carved out thousands of lakeshore lots for recreational development in remote lake districts just prior to policy adoption (Melli, 1953). Rampant first and second home development took place on lake lots in the 1950s and 1960s. The Wisconsin legislature recognized that uncontrolled lakeshore development was degrading both the water quality and the aesthetic nature of the shoreland area. State legislators worked to pass the state's first shoreland zoning law (Ajzen & Fishbein, 1980) in 1965. However, many parcels and platted lands still remain undeveloped and on the market for a potential buyer with a building permit. Thus, within this particular context, the stage has been set for future development, and these "ghost parcels" represent future development potential.

Land Division

Closely related to zoning, subdivision regulations, which control the division of land into building lots, play a vital role in land use control in Wisconsin. First adopted in 1956, and responding to rampant land sales, subdivision regulations ensure the orderly layout of residential lots (Melli, 1953). This law set minimum lot sizes for new residential parcels as well as special requirements for platted subdivisions. The current statewide subdivision ordinance is defined as: "The division creates five or more parcels or building sites of 1½ acres each or less in an area; or five or more parcels or building sites of 1½ acres each or less in an area are created by successive divisions within a period of 5 years" Wis. Stat. § 236.02(12)). However, the standards in the regulations contained loopholes which landowners and developers often take advantage. Setting minimum acreages unintentionally leads developers and landowners to create parcels just above the state requirements, avoiding more rigorous controls (Melli, 1953). In Wisconsin, communities can adopt their own regulations subdivisions, so long as the policies are stricter than the state guidelines (Ohm, 1996).

Let's step back a moment from the regulatory aspect of subdivision regulations and examine the importance of land division to the creation of human settlements in the United States. The metes and bounds system for describing real property originated in England and is still used there today. Not surprisingly, this method became custom in the thirteen original colonies of the United States (Thrower, 1966). The metes and bounds system refers to known landmarks, such as trees, buildings, or ridge tops that are used for delineating property corners. Since landmarks, roads, streams, and other natural features may disappear over time, reestablishing, selling, or subdividing original property lines can be almost impossible. Following the Revolutionary War, the United States acquired vast amounts of new land, stretching from the Atlantic to the Pacific Ocean. Soon after, land claims and disputes became serious and common not only with U.S. citizens, but also with Native Americans and other countries (H. Johnson, 1976).

Public Land Survey System

After acquiring all the western lands, the U.S. needed an efficient method for dividing and transferring land between government and private ownership. A quick, easy, and long-lasting method was needed because the young government was concerned that native tribes or other nations may claim jurisdiction over the new land (Carson, 2002). The Land Ordinance of 1785 set the stage for settling newly acquired western lands by creating the Public Land Survey System (PLSS). Thomas Jefferson was responsible for developing this new method of describing and dividing real property (Hart, 1975). Unlike the metes and bounds description in eastern parts of the country, the PLSS cadastral system was established to provide an orderly procedure for measuring and defining unambiguous land boundaries. Administered by the General Land Office within the Department of the Interior, professional surveyors were ordered to survey all lands west of Ohio. They divided the land into townships six miles square, then further subdivided townships into one mile sections (640 acres). Ohio and areas west were chosen because that area held the largest block of unclaimed lands (Hart, 1975).

The PLSS was successful in creating an easy way to subdivide large amounts of land and alleviating most property disputes. However, there has been some criticism that the rectangular system has resulted in more money spent on rural services, such as roads, bus routes, and power lines. In addition, conservationists argue that there has been increased landscape fragmentation due to the squaring of agricultural fields and forests (Thrower, 1966).

The continued subdivision of large tracts of land has caused most states to require additional land division regulations that ensure adequate legal descriptions based on accurate survey and monumentation (B. W. Ohm, 1999). A Certified Survey Map is usually required when a piece of property subdivides and does not meet platted subdivision regulations. Another system, called the Lot and Block system, was developed to simplify the legal descriptions of numerous small parcels. This system became popular after WWII when cities began expanding into adjacent farmland, resulting in small dense lots. An official government record keeper recorded approved plats which then became the legal descriptions for all parcels within the approved subdivision (Appraisers, 1983).

Thus, legal descriptions provide spatial coordinates, distances, and directions which "accurately" describe an owner's property. The first step in land ownership is to show who has rights to certain parts of the land. In response to rapid land and population changes and with an old system of legal descriptions resulting in disputes, the legal process of describing land in the United States has undergone changes (Carson, 2002). Property boundaries play a significant role in shaping the landscape, political boundaries, and transportation systems (Hart, 1975).

Traditional Planning Metrics

The normative planning literature provides a place to examine the variety of planning metrics that planners learn through their education and use on the job when preparing or trying to monitor plans. One of the key metrics is density. Kelly and Becker (2000) briefly discuss density in their chapter on the comprehensive planning process. They state "…further analysis includes determining the proportion of land dedicated to different uses and the density of those uses. In residential areas, density is described in terms of dwelling units per gross acre of developed land…" (p.74). Kaiser et al. (1995) defines gross density as the "land area plus associated streets, alleys, and other rights of way, as well as any residual undevelopable land parcels" (p.356). In contrast, net residential density is defined as "the number of dwellings per acre actually in residential use" (ibid.). They also define neighborhood density, which "includes not only the streets and other land included in calculating gross residential density, but also space for local shopping, schools, neighborhood park, streets and pedestrian ways, parking, and more or less permanently vacant land" (ibid.). Kaiser et al. recognize that these concepts are useful for thinking about future land uses and holding capacity or density in areas of a community. Figure 7 shows changes in density for selected communities. We can examine one community over multiple periods to see increased density over time, and we can see density in comparison to other communities.

[Figure 7 about here]

The zoning ordinance is where a community manages density or the intensity of development. Thus, zoning ordinances in practice set the pattern of development in particular districts. In many zoning ordinances density is measured by dwelling units per acre, but minimum lot size is used to establish a threshold. As Kelly and Becker state this creates "an inverse calculation for the number of dwelling units per acre (a quarter-acre minimum lot size implies a density that will not exceed four dwelling units per acre)" (2000, p.207). Figure 8 shows an example from a zoning ordinance where density and minimum lot size are important characteristics of that particular district. These density measures do not give a sense of what is happening on the ground. We could examine density of the development only, but that masks the context within which the development is situated. We can broaden the scope and look at density at the neighborhood or at the scale of the political jurisdiction (which is what planners do when we are creating plans), but this obscures the fragmentation of the landscape and the actual development pattern. Thus, and quite obviously, scale matters when we look at measures of density. Figure 9 shows two examples of the density of rural development. Both examples are at the same density, but show different development and openspace patterns. The densities in the photos are neighborhood focused. If a broader scale was used, the density would decrease because of the evident openspace in the photographs. Finally, Figure 10 shows a density that even at the site scale does not really tell us in an accurate way about the development itself which contains an ample amount of greenspace interspersed with residential buildings.

[Figure 8 about here]

[Figure 9 about here]

[Figure 10 about here]

Another common way of examining land use within a community or specific political jurisdiction is by constructing a table or chart that shows land use classifications and acreage within each class. Figures 11-15 show examples. Figure 11 shows the percentage of land in different land use classes. Figure 12 is a table that shows acreage within different land use classes. Figures 13 and 14 are examples from a comprehensive plan. The idea is to understand if the given community has an appropriate mix of land uses. Figure 15 is the current land use map that can be viewed along with these tables to understand the spatial configuration of land use classes.

[Figures 11-15 about here]

Landscape ecology – A new set of metrics

The focus of landscape ecology is to analyze and understand spatial structure, function and change at multiple scales. Specifically, landscape ecology aims to understand ecological processes from a spatial perspective. Landscape ecology aims to understand ecological systems by focusing on three characteristics of a landscape: structure, function and change (McGarigal 1994: 1-2).

Planning research that has used landscape ecology (LE) metrics tend to use them to understand forest or habitat fragmentation (what they were designed for) rather than using these metrics to understand growth and change at the level of a political jurisdiction like we do with traditional measures, such as housing or population density. Torrens and Alberti (2000) explore how to measure sprawl with a variety of measure including density gradients, models of urban densities, a kernel density estimator, weighted centroids, and fractals. They discuss the use of LE metrics to understand the ecology of sprawl, i.e., the environmental effects, but not exclusively. They suggest that several LE metrics could be useful in measuring sprawl, including mean patch size as a fragmentation index, the contagion index to measure the degree to which like parcels or patches of land are of the same type, the interspersion and juxtaposition index to measure the interspersion or mix? of land uses, and proximity to measure "the degree of isolation and fragmentation of the corresponding patch type. Torrens and Alberti believe that "these metrics offer much promise as practical tools for quantifying the spatial heterogeneity of the urban landscape and help predict the ecological effects of urban sprawl (ibid. p.21).

DiBari (2007) uses LE metrics to examine the changes in landscape structure due to urbanization within the Tuscon, Arizona region. He used five LE metrics: largest patch index, fractal dimension index, Euclidean nearest neighbor, the interspersion and juxtaposition index, and rank-size distribution. He concludes that each metric provides some insight into the change in landscape structure, but the use of multiple metrics is necessary to understanding the complexity of landscape.

Leitão and Ahern (2002) explore the use of LE metrics for sustainable landscape planning, specifically focusing on physical planning. Their purpose is to suggest a core set of metrics that would be useful for physical planning. With hundreds of metrics, many of which are highly correlated, they attempted to suggest a group of metrics that have low correlations between the metrics. Their nine basic metrics include: patch richness and class area proportion, patch number, patch size, patch shape, edge contrast, patch compaction, nearest neighbor distance, mean proximity index, and contagion (ibid. p.75). However, their underlying purpose for these measures is to relate physical planning to ecological processes rather than to understand structure and change of the physical component of a political jurisdiction, for example. Thus, they claim that "the establishment of relationships between landscape structure and functions in the landscape allows planners to model, and therefore to predict the impacts of planned activities on ecological systems" (ibid. p.76).

Our interest in landscape ecology metrics is to explore how rural planners can use them to explain landscape structure and change in a rural community at a town or county level. Thus, we want to take an inductive approach to identify appropriate landscape ecology metrics. The use of these metrics should enhance and add to our current planning metrics, such as housing density. With a variety of metrics that are both aspatial and spatial, in addition to using GIS to display spatial patterns, rural planners in particular may be better able to grapple with both growth and landscape fragmentation.

We suggest the use of a set of filters to help determine a set of LE metrics, including the following:

- Is the metric useful for rural community planning?
- Is the metric understandable to the layperson (planning commission)? Or How much explanation does this metric need to be understandable?
- Are the data needs easily accessible?
- Is the calculation easily done?
- Are the results easily displayed in a table or on a map and are they easily explained?

To examine how parcelization has altered the landscape in three rural Wisconsin townships, we conducted a series of spatial analysis of parcelization and land use change from 1940 – 2005. Because the spatial scale varied between towns, several Fragstats metrics were used in conjunction to describe the change in degree of spatial heterogeneity at the class and landscape level for the multi-temporal datasets. Specifically, we calculated core area, number of patches, patch density, nearest neighbor, and contagion metrics. The calculation of these metrics are fairly straightforward and the general public can easily understand the results.

Conclusion

As technology advances, spatial data is more readily available, and as rural communities become more comfortable with planning, a specific set of landscape ecology metrics may provide a useful addition to the rural planners' toolbox.

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Figure 1

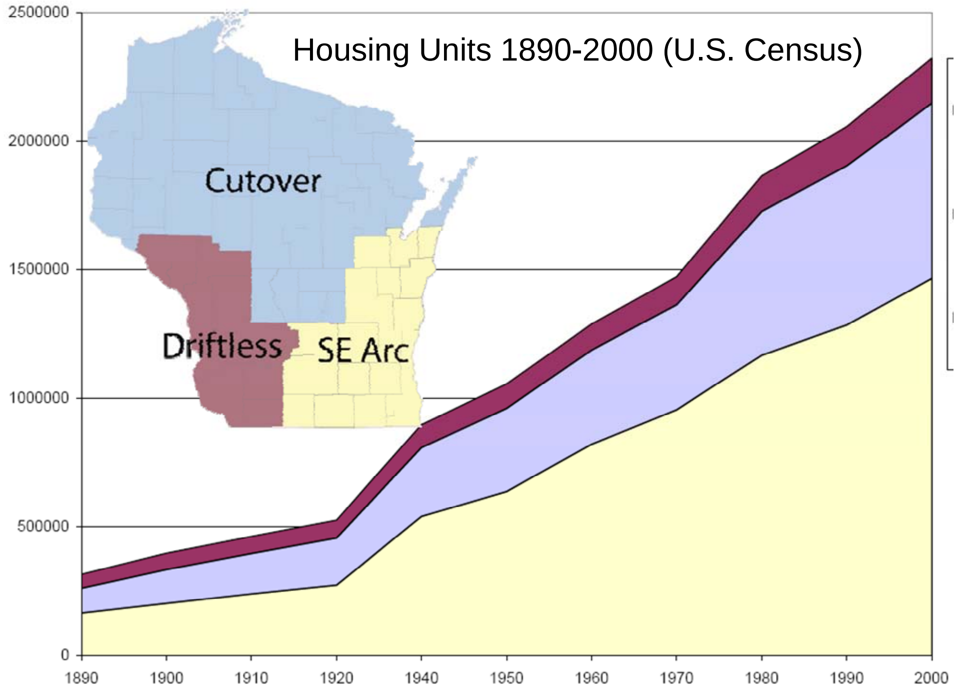


Figure 2

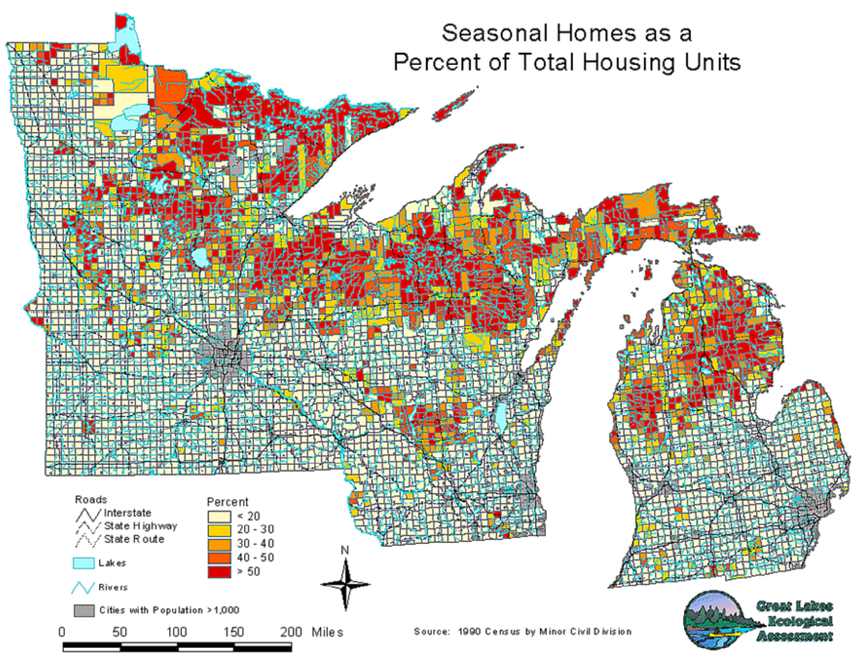


Figure 3

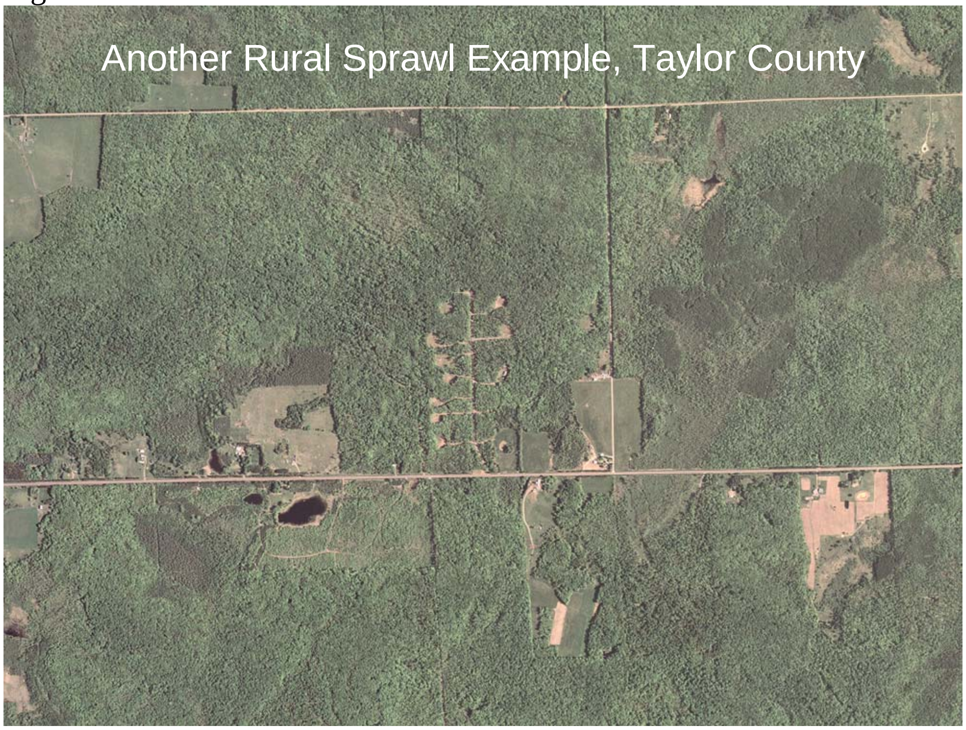
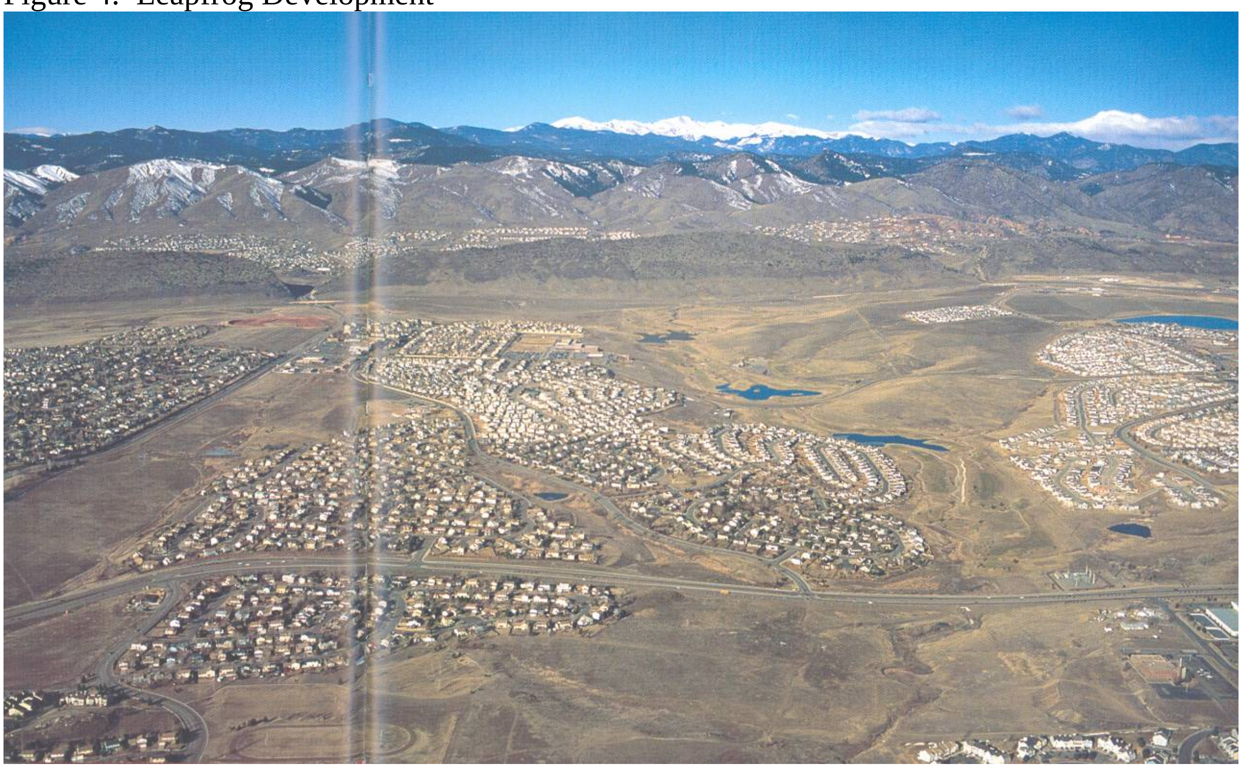


Figure 4: Leapfrog Development

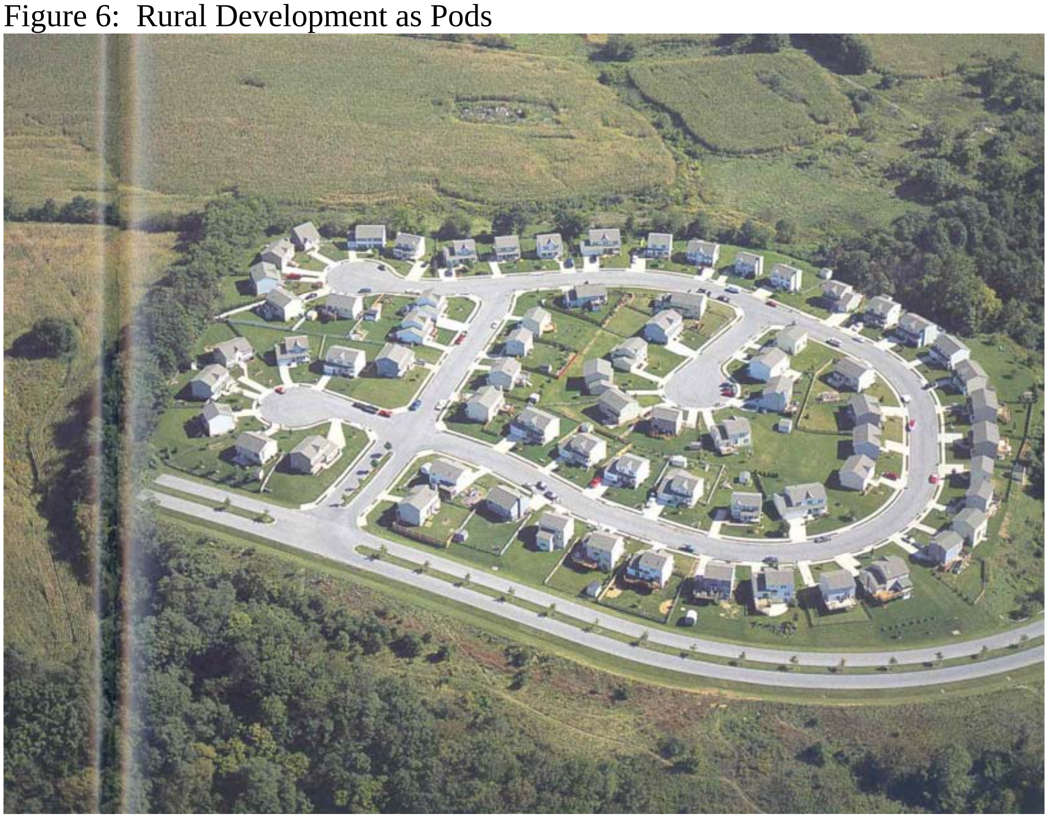


Hayden, 2004.

Figure 5: Low Density Development

Hayden, 2004.

Figure 6: Rural Development as Pods



Hayden, 2004.

Figure 7: Density Changes

Table 11-3
Area and Density Changes in Selected Communities (densities in persons per square mile; areas in square miles)

	1970		1980		1990		2000	
Place	**Area**	**Density**	**Area**	**Density**	**Area**	**Density**	**Area**	**Density**
Boulder	13.0	5143	19.5	3933	22.6	3687	24.37	3884
Livermore	11.9	3168	13.2	3663	19.6	2895	23.92	3066
Petaluma	7.5	3316	9.2	3678	12.3	3511	13.8	3953
Longmont	7.9	2938	9.8	4382	13.1	3935	21.8	3262
Santa Rosa	19.9	2513	26.6	3132	33.7	4773	40.13	3678

Table Sources: Raw data from Bureau of the Census, 2000, *American Fact Finder, Quick Tables*, www.census.gov; Bureau of the Census, 1991, *Census of Population and Housing: Summary Population and Housing Characteristics*, Part 6, Table 18; Bureau of the Census, 1982, *Summary Characteristics by Governmental Units and Standard Metropolitan Statistical Areas*, Part 6, Table 2; Bureau of the Census, 1972, *City and County Data Book*, Table B-2; Bureau of the Census, 1972, *Census of Population, Vol. I: Characteristics of the Population*, Part 7, Table 14, 16 (state) and 32 (Louisville only); percentage computations by author.

Figure 8: Example Residential District from a Local Zoning Ordinance

"R-1" SUBURBAN SINGLE FAMILY RESIDENCE DISTRICT

USE	LOT AREA AND DENSITY	LOT WIDTH	HEIGHT OF STRUCTURE	SIDE YARD	STREET SETBACK	REAR YARD	PARKING	AREA OF STRUCTURE	MINIMUM BUILDING WIDTH
Permitted Uses	Minimum 16,500 s.f.	Minimum 105' (lots of irregular shape due to street layout shall be a minimum of 100' at front bldg. Line)	35 ft.	Total of 25' one side not less than 12 ft.	Minimum 30 ft.	Minimum 30 ft.	Per 23.01(14)	1,200 sq.ft.	22 ft.
Accessory Building			20 ft.	10 ft.	30 ft.	10 ft.			

Figure 9: Two Examples of Low Density Development

Example 1: Hollister, CA – 0.3 units per acre

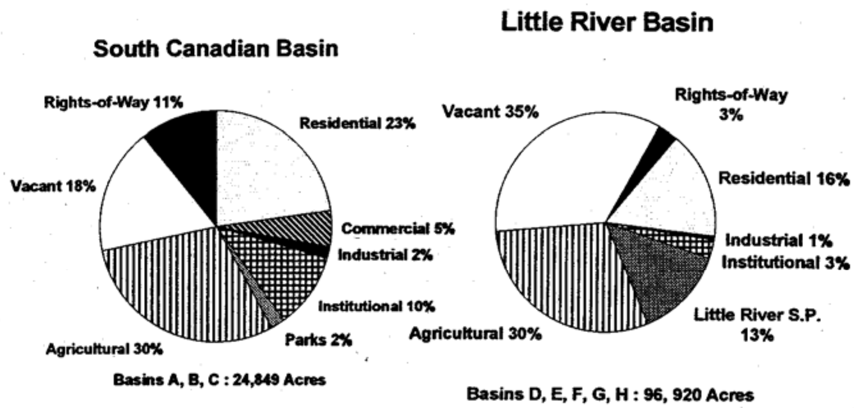
Example 2: Broomfield, CO – 0.3 units per acre

Excerpt from *Visualizing Density* by Julie Campoli and Alex S. MacLean.

Figure 10: Density and Greenspace - Bullhead City, AZ – 1.1 units per acre

Excerpt from *Visualizing Density* by Julie Campoli and Alex S. MacLean.

Figure 11: Pie Chart of Land Uses



This simple pie chart shows how land was used in Norman, Oklahoma, when the 1996 plan was prepared; note the large proportion of vacant land because of the city's aggressive annexation policies. Source: *City of Norman and The Burnham Group, Cincinnati, Little Rock, and Birmingham (1996).*

Figure 12: Land Use Classification

Table 10-1 Sample land use classifications and areas

Land Use Classification	Acres
Residential	45.5
Commercial	11.5
Industrial	8.7
Public	15.0
Buildings	3.0
Parks	10.0
Other	2.0
Institutional	14.0
Private	1.2
Schools	13.8
Unclassified	14.0
Total Developed Land	138.7
Vacant Land	12.0
Incorporated Town Area	150.7

Figure 13: Example of Land Use Classification from a Comprehensive Plan

Table 8.1: City of Stevens Point Existing Land Use Acreage, 2005

Existing Land Use Category	Acres	Percentage
Single Family Residential	1,713	16.2%
Duplex Residential	154	1.5%
Multi-family Residential (3+ units)	216	2.0%
Mobile Home Park	61	0.6%
Commercial	413	3.9%
Professional Office	207	2.0%
Industry	768	7.3%
Institutional/Government	1,684	16.0%
Park	565	5.4%
Restrictive Ownership	826	7.8%
Not Developable	1,261	12.0%
Vacant	796	7.5%
Road Right-of-Way	1,340	12.7%
Water Bodies	545	5.2%
Total Acreage	**10,550**	**100%**

Source: City of Stevens Point and Portage County Planning and Zoning Department.

Figure 14: Land Use Classification Change - Comprehensive Plan Example

Table 8.2: City of Stevens Point Land Use Trends

Land Use Category	1961 Acres	2005 Acres	Change	% Change
Single Family / Mobile Home	1,167	1,773	606	52%
Duplex	65	154	89	137%
Multiple Family (3+ units)	28	216	188	671%
Commercial	117	620	503	430%
Industry	202	768	566	280%
Parks	302	565	263	87%
Institutional / Government	542	1,686	1,144	211%
Road Right-of-Way	951	1,340	389	41%
Total Developed Area	3,374	7,122	3,748	111%
Vacant Area / Restrictive	4,799	2,883	-1,916	-40%
Water Area	756	545	-211	
Total Area	**8,929**	**10,550**	**1,621**	18%

Source: City of Stevens Point 1965 Development Guide, Portage County Planning and Zoning
The 1965 Development Guide utilized 1961 land use data

Figure 15: Existing Land Use Map – Comprehensive Plan Example

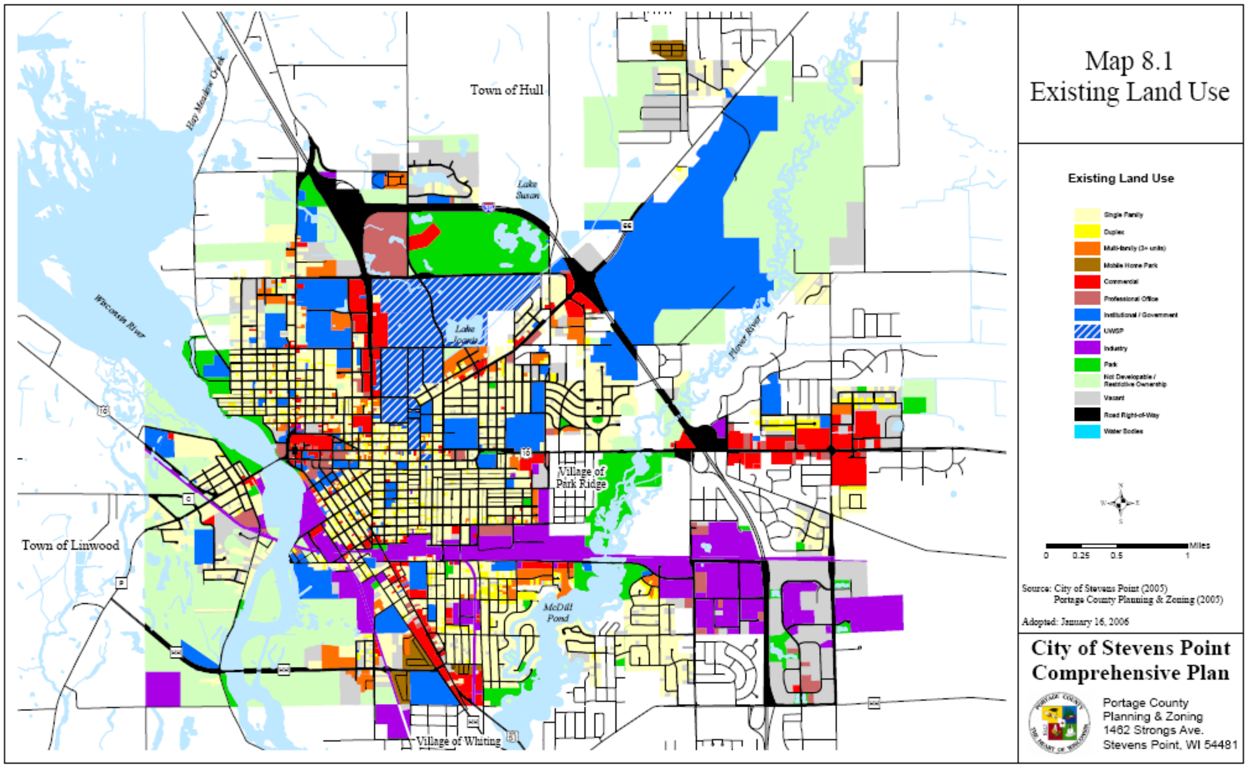


Figure16a: Patterns of Development – Average parcel size

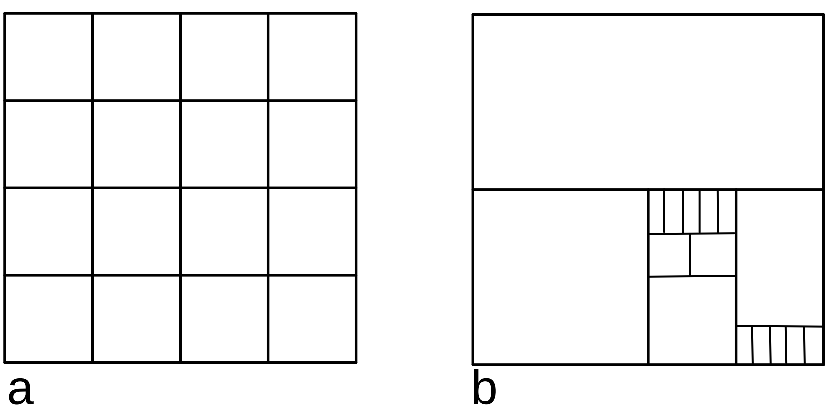


Figure16b: Patterns of Development – Average parcel size

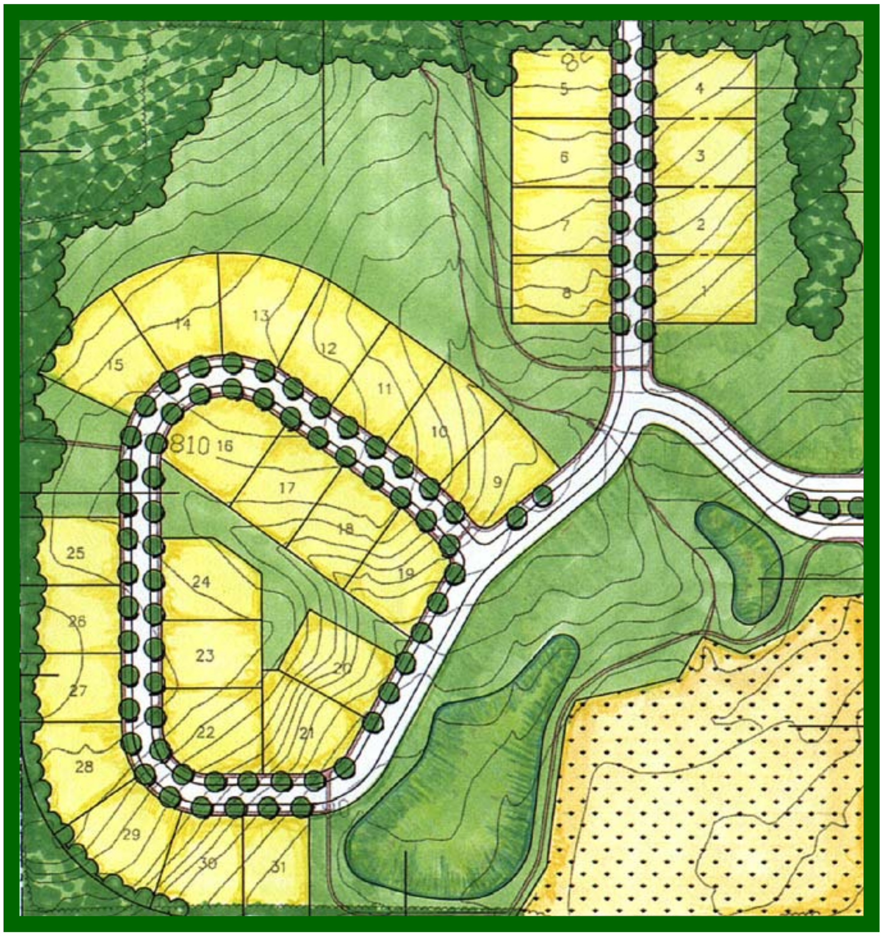


Figure 17: Land Ownership versus Tax Parcels – Example

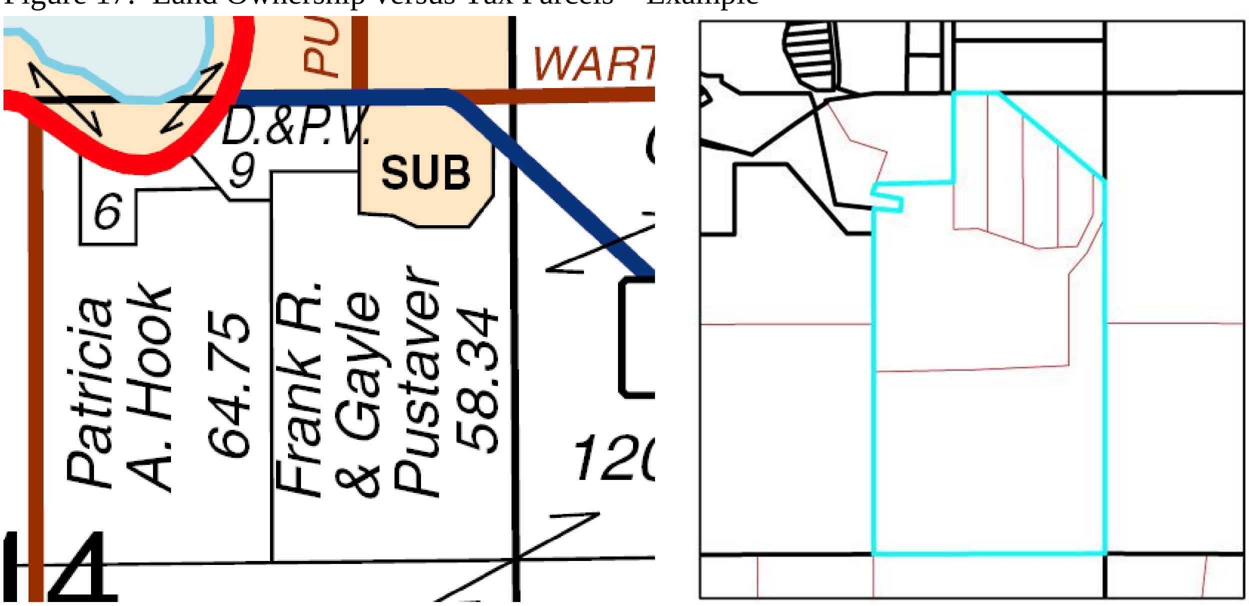


Figure 18: Acres Per Parcel Size Class in Town of Westpoint

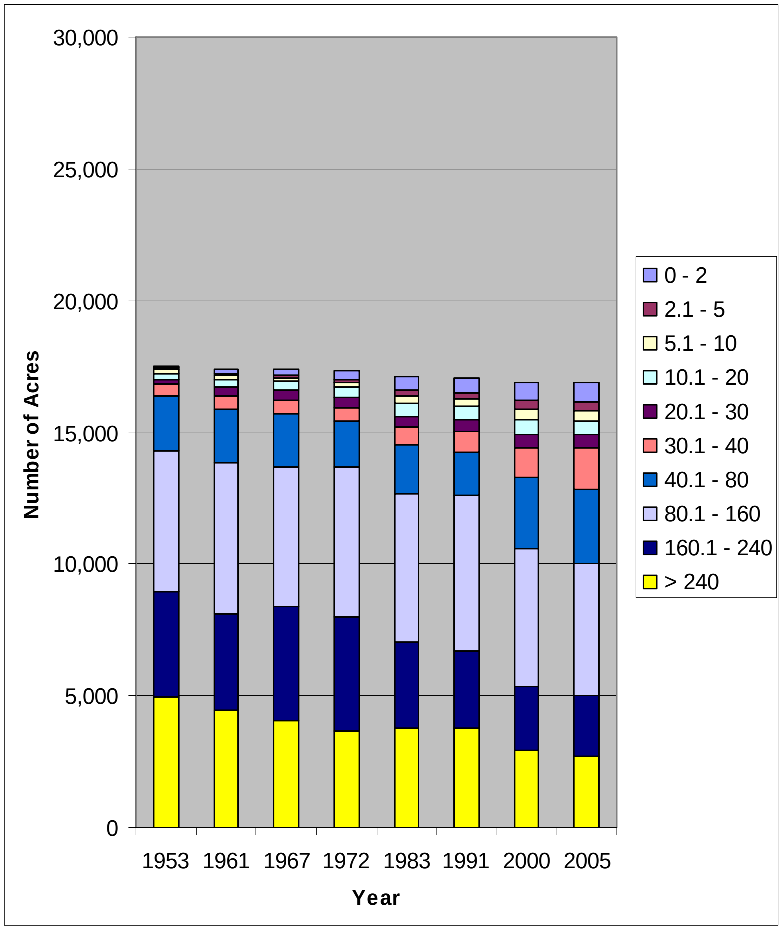


Figure 19: Chart of Growth in Parcels in Town of Westpoint, WI

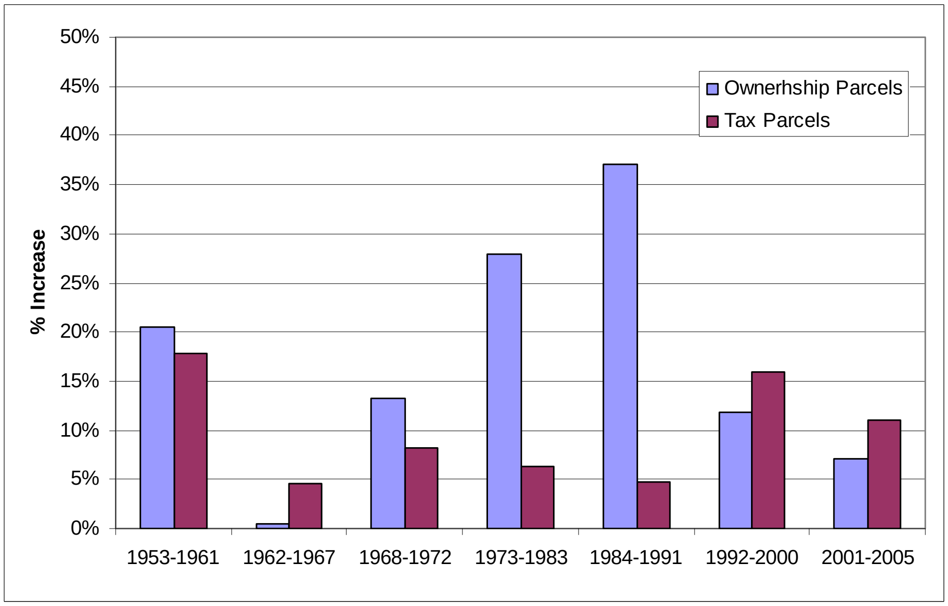
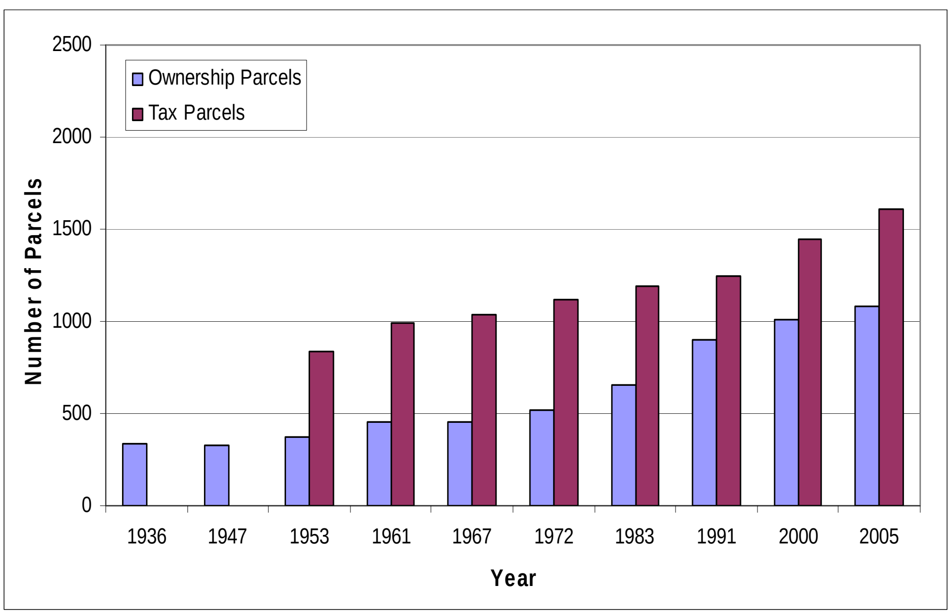
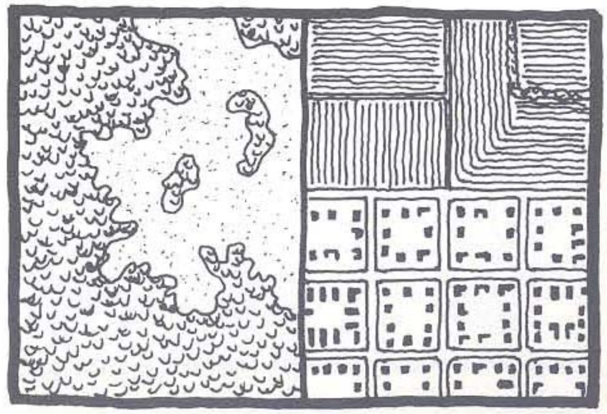


Figure 20: Chart of Increase in Number of Parcels in Town of Westpoint, WI



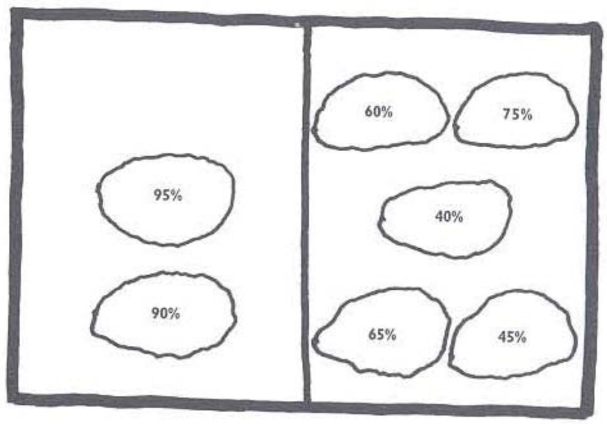
E6. Natural and human edges

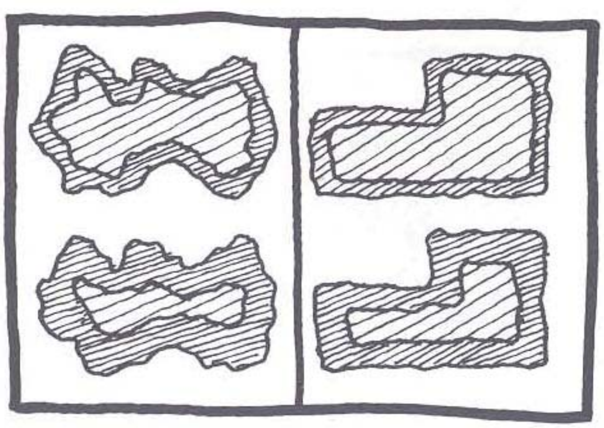
Most natural edges are curvilinear, complex, and soft, whereas humans tend to make straight, simple, and hard edges.



P11. Number of large patches

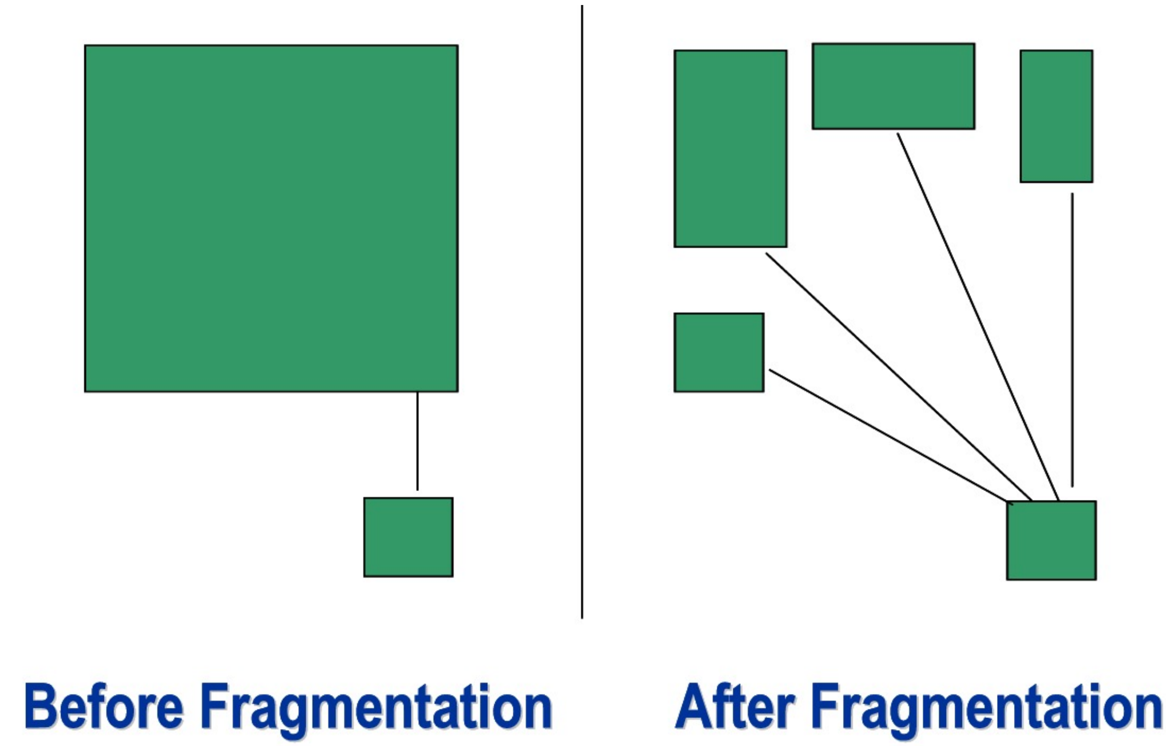
Where one large patch contains almost all the species for that patch type in the landscape, two large patches may be considered the minimum for maintaining species richness. However, where one patch contains a limited portion of the species pool, up to four or five large patches are probably required.

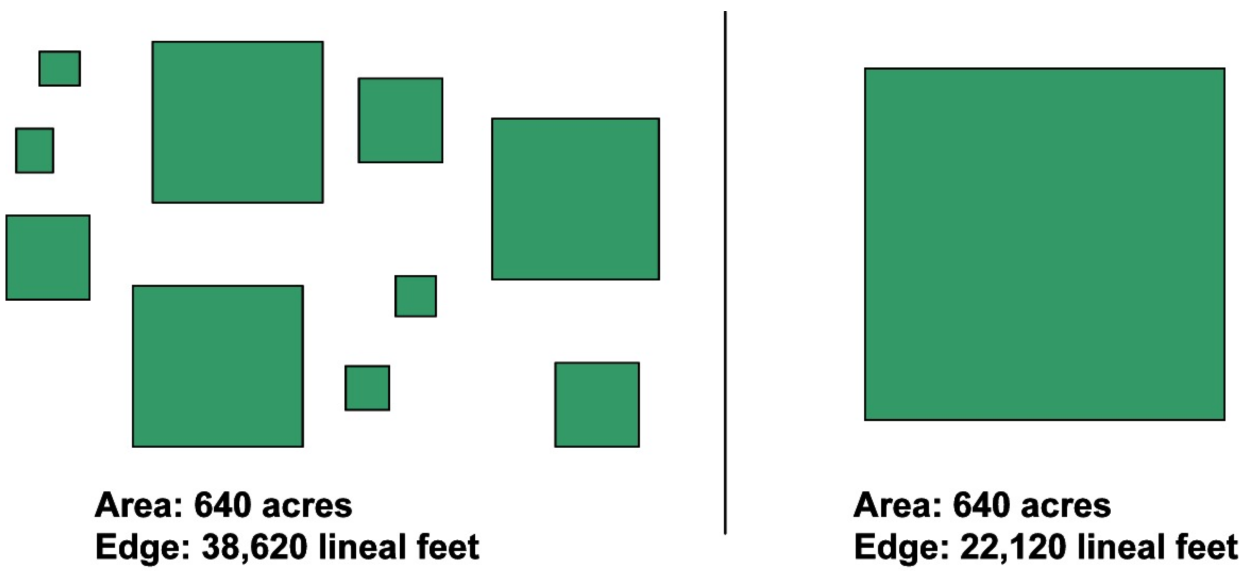




E9. Edge curvilinearity and width

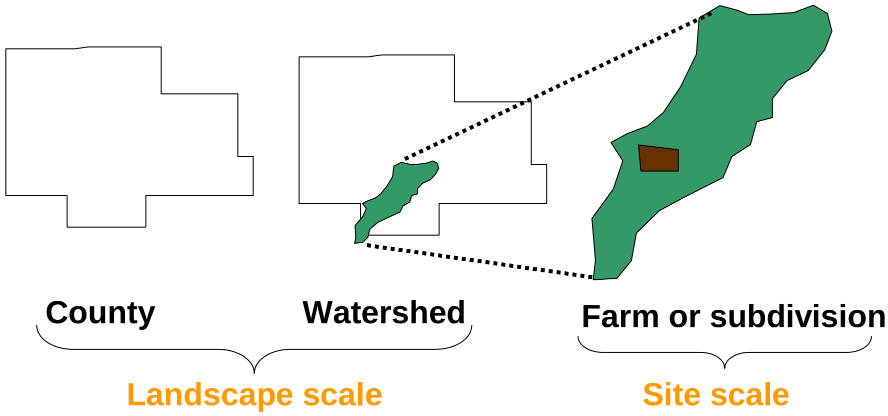
Curvilinearity and width of an edge combine to determine the total amount of edge habitat within a landscape.





Patches creating more edge

Scale



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