

Identifying Parcelization Patterns in Three Rural Wisconsin Towns Columbia County Project Summary





Grant info: USDA's Cooperative State Research, Education, and Extension Service, National Research Initiative for Rural Development.
CONTRACT/GRANT/AGREEMENT NO: 2005-35401-15924
PROPOSAL NO: 2005-01393

Prepared by Daniel McFarlane, Research Specialist
June 2008
www.uwsp.edu/cnr/lancenter

Many thanks to Dr. Anna Haines and Eric Olson of the Center for Land Use Education for their time and helpful comments in reviewing this report

Layout and design by Robert Newby, Center for Land Use Education

Executive Summary

Over the years, rural areas have been considered places of depopulation and economic decline. However, change is underway in rural America, and communities rich with natural amenities such as abundant lakes, forests, and topography are consistently outpacing other areas in terms of population and economic activity. While the consequences of such development are fairly well understood, the process of rural land use change remains somewhat unclear. Unlike traditional residents, new rural migrants pay little attention to the productive capacity of the land. Instead, it is the accessibility and scale of the amenity itself that drives people to rural areas.

The core process of this change is parcelization – the division of land into progressively smaller tracts. As large parcels encompassing fields, forests, and grasslands become subdivided and developed, rural areas face declining returns on farming and logging activities. At the same time, undeveloped parcels become farther apart and face increasing pressure to further subdivide and develop. New roads and other infrastructure that serve these scattered lots perforate productive agricultural areas. Communities then end up paying more for services than they collect from property taxes. In addition, low density rural development fragments wildlife habitat. This loss of connectivity in the landscape has profound implications for certain plants and animals and fosters the spread of invasive species.

Though the parcelization process has been going on in Wisconsin for over 150 years, little attention has been paid to the long term trends and landscape consequences of land division. In this research, we examined the spatial pattern parcelization by mapping historical tax parcels and resulting landscape changes using Geographic Information Systems (GIS) in a set of rural communities within Columbia County, WI. Paper tax assessment rolls were needed to identify parcel splits back to 1953 in the townships of Lodi, Springvale, and West Point. Using the current digital tax parcel layer obtained from the Land Information Officer and working backwards, we accurately reconstructed parcel data at nearly 10 year increments back to 1953 in Lodi, Springvale, and West Point townships.

Analysis of town-level parcelization in an exurban agricultural region shows that the overall rate of parcelization has generally decreased since 1950. In addition, prior to the 1970s, small parcels were generally limited to immediate shoreline areas. More recently, off-lake residential subdivisions have been the source of a larger share of new, small parcels.

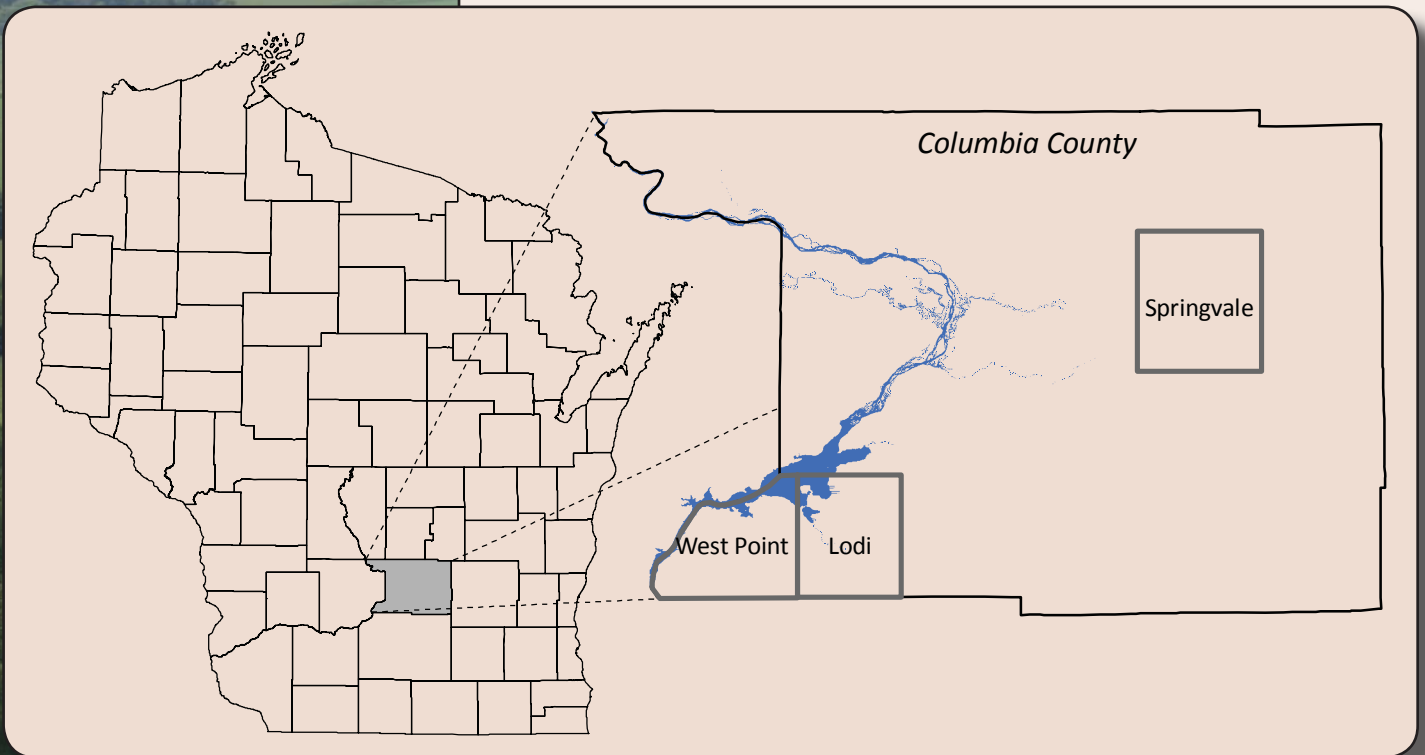
Our results demonstrate the extent of land fragmentation occurring in parcelized areas and support the notion that parcelization leads to land use change. Our data also suggests that parcelization is primarily a precursor to more intensive land development for housing and commercial uses, which corresponds to a decrease in larger agricultural and forested core areas.

We measured changes in the parcel landscape over time using GIS and a set of landscape ecology metrics. We developed a parcelization score that incorporates these metrics into a single value which represents the degree in which new parcels are fragmenting the landscape. Our results show that over time the



rate in which Lodi's parcel landscape is fragmenting is declining. The dense clustering of new lots near Lake Wisconsin and Harmony Grove has kept much of the remaining land intact. On the other hand, West Point's parcelization score is increasing, suggesting that new parcels are being created in a more fragmented or sprawled pattern. In West Point, there lacks a large suburban style development like a Harmony Grove. Therefore, no public utility exists, so lots must be large enough for private onsite septic systems. The relatively small number of parcels being created in Springvale has resulted in a low parcelization score.

Using landscape ecology principles to measure and quantify parcelization over time provides a window of opportunity to planners seeking to preserve large blocks of land for habitat, forest and farmland preservation. With the availability of digital land records growing throughout Wisconsin, the parcelization score can become an important tool for helping citizens recognize whether or not the current planning and policy efforts are protecting key natural resource assets from the negative consequences of parcelization and development. We encourage counties to actively archive their parcel database with associated tax assessment information so that annual parcelization scores can be readily calculated.



Introduction

Many long time residents and visitors of Columbia County may have noticed changes on the land over the past few decades, mostly in the form of new homes and bigger yards. Some call these changes wasteful, while others argue that it is merely community growth spurred by market demand. Whatever we call this trend, one of the earliest indicators of this change is parcelization, the creation of new parcels on the landscape. The division of rural land into smaller parcels is a crucial step in the transformation of communities from places that use the land for farming and forestry in to places that consume the land itself for housing and other forms of development.

Undeveloped rural landscapes such as forests, grasslands, and working farms are important for both city and country residents alike. These areas provide clean water, food, open space, recreation, and wildlife habitat. However, there are concerns among planners and resource managers that increased parcelization and conversion of both productive working lands and sensitive environmental for housing lots areas may negatively impact the economic viability of farming and forestry (Gobster and Rickenbach 2003). Scattered development can ultimately degrade water quality and fragment wildlife habitat.

To better understand the long term trends, consequences, and factors influencing rural parcelization, the United States Department of Agriculture (USDA) awarded the University of Wisconsin-Extension (UWEX) Center for Land Use Education (CLUE) a grant to reconstruct, document, and analyze parcelization and landscape changes over time in a set of Wisconsin communities. The remainder of this article explains in more detail the drivers and consequences of land parcelization in rural communities and includes the results of the long-term study in the Columbia County townships of Lodi, Springvale, and West Point.

Drivers of Parcelization

The drivers of parcelization have evolved over time. While most researchers have focused on contemporary causes of land division, I think it is important to address some of earliest factors, which happen to be the most significant. One of the first drivers of parcelization in Wisconsin was the disposal of public land to private ownership with the passage of the Federal Land Ordinance of 1785 (Throver 1966). At that time, most of the country was in the public domain. The federal government sought to dispose of much of this land because it was viewed as a liability in which it had to watch over and protect. Parcelizing and selling public lands created a direct revenue source for the young country and it put much of the land in to an economic use such as farming, mining, and logging. Selling land to settlers so they could pursue farming also helped to alleviate joblessness that plagued many cities. A quick and efficient method of mapping, describing, and dividing land was needed. The old system, called the Metes and Bounds, was cumbersome and confusing. Thomas Jefferson led this new effort and proposed the Public Land Survey System (PLSS). The PLSS created a mapped grid across the land. Surveyors systematically divided all the U.S. lands west of the original thirteen colonies into six-square mile townships and one-square mile sections. These were further divided into quarter-quarter sections, which measured forty acres in size. This method of land subdivision was arguably the most significant parcelization event in the country's history



and established the foundation of land policy and ownership today in the regions west of the original thirteen colonies (Figure 1).

Other early drivers of parcelization include the Jeffersonian Vision, the Homestead Act of 1862, and the completion of the transcontinental railroad. Thomas Jefferson's vision that land should be owned by individuals, not the government, yielded a migration of people westward into rural America to farm (Potter and Schamel 1997). Legislation such as the Homestead Act, made it relatively easy for anyone to claim up to 160 acres of undeveloped land. Shortly after, the completion of the transcontinental railroad made these lands more accessible as residents and immigrants moved westward to start their new agrarian futures. The establishment of the rectangular PLSS essentially resulted in homesteads being developed at low densities throughout the countryside. Once claimed or purchased, property could not be further subdivided by landowners for at least five years or until the land was entirely paid for. By the end of the 19th century, nearly 270 million acres or roughly 10% of the land in the U.S. had shifted from public property to private ownership.

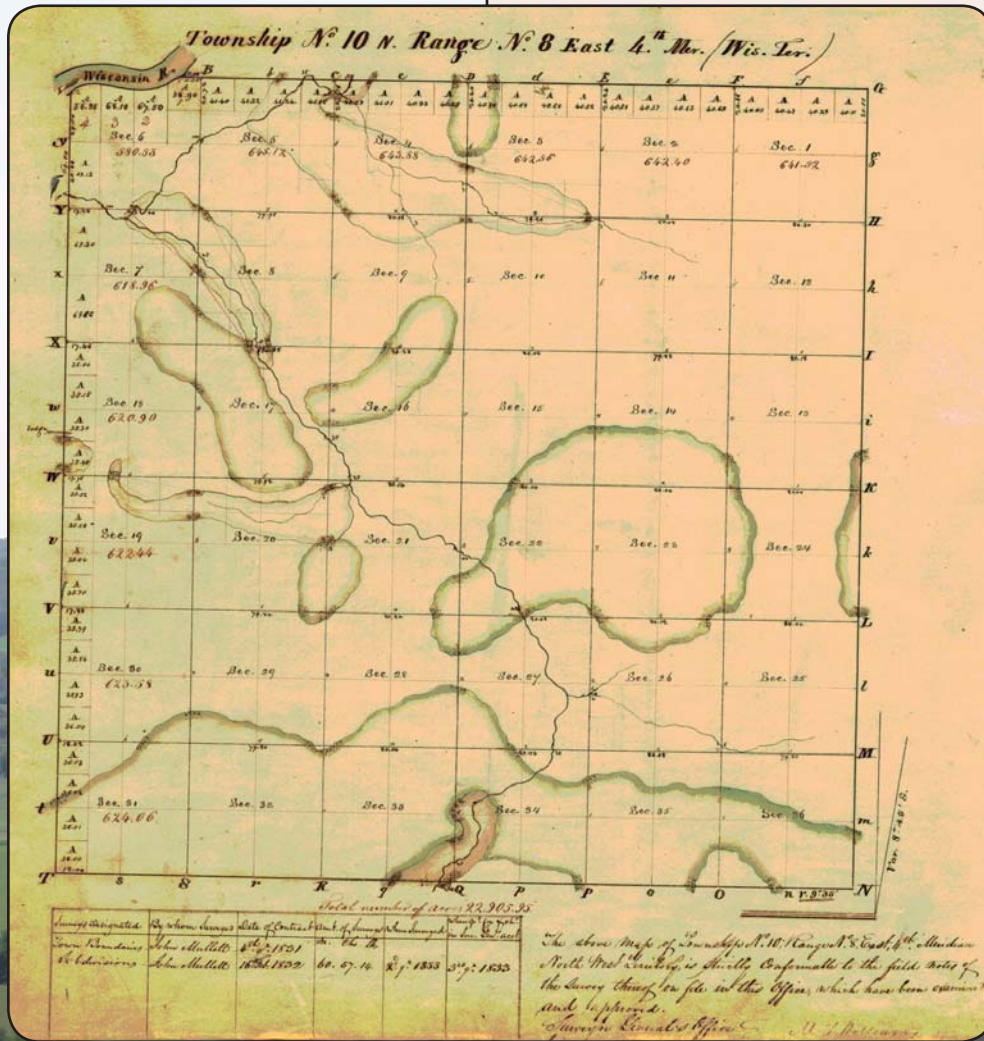


Figure 1. Original survey map of the Town of Lodi in 1832.

In the rural Midwest, much of the land exchange occurring in the 1900s until after World War II suffered from a loss of population and from land abandonment. Driven by the economic effects of the Great Depression, private landowners abandoned marginal lands and joined the urban migration in search for work. In Wisconsin, the number of landowners essentially declined, and in turn, state and local governments acquired large amounts of tax delinquent parcels which now make up much of the county public land system. Tax forfeit had created once again a government liability in many portions of Wisconsin and the U.S.

After WWII, some rural areas began to rebound as more people returned to rural living, but not to the land-based activities like farming and forestry. Instead, they were seeking solitude and open space characteristic of rural areas. Rural areas endowed with natural amenities, such as lakes, rivers, forests, and public lands, experienced the largest population, economic, and development increases (Beale and Johnson 1998).

Amenity-driven parcelization in rural areas continues today, in part, prompted by population growth and the dynamics of nearby urban markets. With the Dot-com explosion and Baby boomers making retirement plans, one can expect the desire for rural property to increase. The demand for such amenities has sparked another driver of parcelizations, land speculation. Developers and landowners take advantage of lax land use controls in rural areas and often are able to carve out suburban-style subdivision patterns, marketing them as ideal second home getaways. As a result, many undeveloped lots invisibly dot the landscape waiting for a new owner and building permit.

A particular concern of parcelization is the increasing landowner age and family dynamics. A large proportion of Wisconsin's farmers and forestland owners are reaching retirement age and much of this land will be passed on to children. Heirs today often have little interest in continuing the farming or forestry operation. Instead, when land is inherited, the property is oftentimes split among multiple heirs. There is also evidence that supports the process in which land is parceled off to pay for inheritance taxes upon a death of a family member (DeCoster 1998).

The adoption of local land use regulations such as shoreland zoning and subdivision regulations can also influence parcel creation. In the case of shoreland zoning in Wisconsin, land speculators rushed to create near-shore lots prior to ordinance adoption in the late 1960s. A good example of this is the Harmony Grove development in the Town of Lodi. In order to create more attractive and lucrative waterfront property, channels were dug inland from Lake Wisconsin and the land was subdivided into small shoreland lots.

Significance of Rural Parcelization

Over the years, the rural parcelization process has set the stage for thousands of new homes in the countryside. The overarching consequence of rural parcelization is subsequent development and then landscape change and fragmentation. This conversion of land signifies the replacement of fields, forests, and pastures with homes, roads, and lawns.

While many acres of private working lands are converted to development, additional lands are being converted to other non-traditional uses, such as land for recreational value or investment for future land subdivision. This type of trend is putting pressure on Wisconsin's 'bread and butter' farming and forestry lands. Because individual land use decisions are made at the parcel level, these 'breaks' tend to follow parcel boundaries. One of the major concerns regarding productive working lands is fragmentation. This refers to the incremental conversion of land to other uses, essentially creating isolated patches of fields and forests. Both human and natural processes, such as tornados or development, can cause fragmentation. However, people deliberately clear vegetation for development or agricultural uses, causing discontinuities in the landscape. Over time, continued land use change and development can generally result in fragmentation. The concept of fragmentation stems from landscape ecology, but can be effectively applied to working lands.





Socioeconomic impacts

Throughout Wisconsin and many other states, amenity-rich rural areas are outpacing most other rural places in terms of population and economic growth. Such growth is not without its costs. The potential for community conflicts increases between long-time residents and new amenity-migrants due to differing views. This conflict can ultimately create challenges for the effective management of farming and forestry lands. The pattern in which new parcels are created on the landscape can fragment productive working lands so that those industries are no longer sustainable. For example, when the amount of contact between residential areas and farmland increases, we oftentimes find the cost of agriculture operations swell. Therefore, one would expect agricultural parcels with the most edge between conflicting land uses to subdivide.

Though many people assume that land division and development pays for itself in the form of tax revenue from property, studies indicate differently. These cost of services studies show that keeping areas in farms, forests, and open lands generate more tax dollars for a community than what is spent on providing public services to those lands. Isolated homes dispersed throughout the countryside can considerably increase the cost of certain services such as school busing, road maintenance, and utilities.

The parcelization of larger properties into smaller parcels and their subsequent sale on the market can have significant impacts on the uses available to the new parcel owner. For example, small parcels are impractical to manage for farming or forestry, while larger parcels may be unreasonable for residential development. In addition, parcel sizes help determine market values: land has not only a per-acre value, but also a value that derives from the necessary parceling for purchase, also known as plattage. When the per-acre value for agriculture or forest land is considerably less than the per-acre value for development potential, parcels oftentimes are subdivided into smaller parcels for residential use.

Ecological impacts

In addition, amenity-led development poses many environmental concerns because the areas that are attracting humans tend to be the most sensitive ecosystem lands and are important for providing environmental services, such as clean water, flood control, and wildlife habitat.

Changes in land ownership, often the result of land subdivision, reshape land management practices which can gradually alter the landscape. People's desire to live in areas with open space increases human densities in rural areas, and, in turn, increases road and building densities. With people come pets, traffic, and invasive species. The cumulative effect of these is landscape fragmentation and each has the potential to drastically alter local biodiversity. Researchers have shown that parcelization alters the spatial pattern of land cover and can ultimately lead to landscape fragmentation. Whether agricultural or forestry-based, rural parcelization signifies potential changes in the ecological sustainability of remote areas (Daniels 1999). Although the effects of parcelization may not be apparent at first, smaller parcel sizes may lead to scattered homes near ecologically sensitive areas, fragmenting large forests and wetlands, and degrading water quality (Hersperger 1994).

The incremental land use changes of the natural and working landscape fragments natural habitats that are essential for the survival of many plants and animals. Fragmentation reduces the ability of the landscape to support healthy populations by decreasing core areas and patch sizes while increasing edge and the distance between patches.

The isolation of particular patches occurs when landscapes become increasingly fragmented through natural or man-made disturbances. As the distance increases between patches of the same type, plants and animals struggle to disperse, mate, and adapt. In turn, genetic diversity and viability is lost ultimately leading to the loss of that particular species.



Institutional impacts

Some of the most immediate consequences of parcelization occur at the local level where records are kept on landownership. Answering the question “whose land is it?” is easy in areas with only a few large landowners. However, the rapid growth in landowners in amenity-rich rural areas can make this question very difficult. As parcel and ownership patterns go from simple (few landowners, large parcels, and few types of land uses) to complex (many landowners, a range of parcel sizes from large to small, and many land use types), so does the work of the local registrar of deeds, tax assessors, planners, and elected officials.

Recent extensive land sales have prompted many states and local communities to adopt aggressive control measures to manage the negative impacts of development. Administering a policy response to parcelization adds further to the local workload. Today, all levels of government, non-profit trusts, and local citizen groups are working to create and implement innovative tools and strategies for keeping important working lands intact to avoid over-development and fragmentation. Through regulations, incentives, and voluntary programs these groups seek to minimize the cumulative effects of parcelization. But these programs require additional record keeping, monitoring, enforcement, and education.

One of the most obvious trends in the last decade is the explosive number of land trusts and the amount of acreage being protected. In 2003, nearly 9.4 million acres have been protected by land trusts in the U.S. This is twice the acreage reported in 1998 (Land Trust Alliance 2005). Local land trusts are currently the fastest-growing and one of the most successful land protection options available. Selling or donating property or development rights to a land trust ensures that future open lands will be maintained and protected.

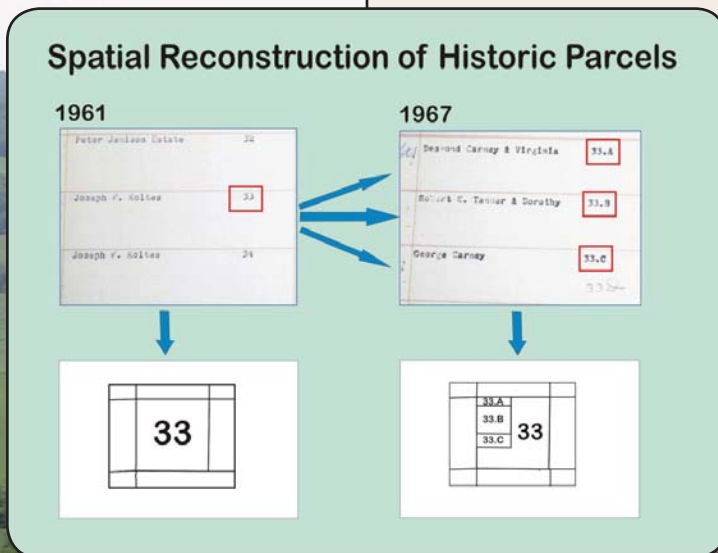
The main goal of this study was to identify and measure parcelization patterns and resulting land use fragmentation in a set of rural communities within Columbia County, Wisconsin. We focused on three townships because of the extensive amount of time necessary to reconstruct and analyze the data.



Understanding the links between parcelization and subsequent landscape fragmentation can help planners and policy makers foresee future changes and provides an opportunity to preserve large blocks of land for habitat, forest, and farmland preservation.

Data Sources and Preparation

This research focuses on rural townships experiencing growth in rural residential development. We selected Columbia County, Wisconsin for this research based on several criteria: availability of a current and complete spatial parcel database of the county, adjacency to a metropolitan county, whether the community is actively engaged in planning, and local officials showing favorable relationships with research personnel. Columbia County, located in south central Wisconsin, represents an area experiencing significant growth from both urban fringe development from nearby Madison (state capitol) and rural recreational development due to the scenic nature of the area.



The process of measuring parcelization began with the digital reconstruction of historic tax parcel layers in a Geographic Information Systems (GIS). We chose to recreate legal tax parcels rather than ownership parcels because of situations where a landowner would subdivide a parcel while still maintaining ownership of each new lot. In cases like this, plat books only show one parcel, while according to tax assessment records, several legal parcels existed. Ideally, all of Columbia County would have been included in our study, but the construction of the database would have consumed years. Consequently, tax parcel reconstruction efforts focused on three rural townships in Columbia County at nearly ten year increments based on data accessibility. To obtain a purposive sample of the area we selected townships with a range

of contemporary parcel densities (high, medium, low). Having a municipality with a low parcel density allows us to compare against baseline trends of parcelization over time.

Parcel layers were generated for the Townships of Lodi, West Point, and Springvale by utilizing the current digital tax parcel layer obtained from the Land Information Officer. Parcel splits were identified by inspecting the parcel number in consecutive year tax assessment documents where this number was inconsistent. We recorded parcel birth dates by photographing pages in their tax rolls that contained new parcels so that we could view them in the lab. Using GIS, the current digital tax parcel layer was edited by merging split parcels into their parcel of origin based on the parcel number that was recorded in both the current tax parcel layer and the archived assessment rolls. Using a process of “reverse parcelization” and working backwards, we created accurate digital parcel layers for the following years: 1953, 1961, 1967, 1972, 1983, 1991, 2000, and 2005.

To identify how parcelization patterns relate to land use change and fragmentation, we mapped land use at various dates for each township as well. Scanned aerial photographs were collected from Columbia County's Land Conservation Department on DVD for the following years: 1955, 1968, 1978, 1992, 2002, and 2005. Individual photos were aligned and stitched together to produce one image covering each township. Land use classes were interpreted and digitized on screen. We categorized land use into five classes: cropped, pasture/open, forest, developed/built-up, and water. The limited quality of some photos made it difficult to delineate certain uses such as cropland or pasture areas, so results may not reflect the actual land use in some areas. However, we feel that through detailed quality control efforts our classification accuracy exceeds 90% for all classes. Developed/built up areas represent the outer extent of people's yards and buildings. For small parcels such as within platted subdivisions, the entire parcel boundary was utilized to map the developed area.

Landscape Change

To quantify the effects of parcelization on landscape change, we compared the changes in landscape structure and composition for these three townships. Patch Analyst, an extension for ArcGIS, was utilized to generate indices for each land use class. By comparing the different landscape indices over time, we could examine the interaction between parcelization and landscape change.

To measure the cumulative effect new parcels had on the entire landscape, we applied a disturbance zone around residential parcels (i.e. parcel 5 acres and less) and calculated the amount of area unaffected by this zone. In general, a small residential parcel has a disturbance zone that extends beyond its boundary. For instance, domestic pets, such as cats, can have a significant impact on the surrounding native bird population. Non-farm residents often complain of dust, odor, and noise due to adjacent farming operations, as well. Over time, the combined disturbance zones of all small parcels, especially developed ones, can substantially decrease the amount of undisturbed land. It is known that clustered development limits the amount of fragmentation due to the overlapping disturbance zones. Therefore, to calculate the loss of core area (both habitat and productive working lands), we applied a 50 meter disturbance zone around each small parcel (< 5 acres) and examined the relationship between percent land area unimpacted by this zone with the percent increase of new small parcels over time.

Characterizing Parcelization

Previous research addressing parcelization uses only non-spatial measurements to characterize changes over time such as the number of parcels, size, or density. While these metrics are fairly simple to calculate, they offer no insight into the resulting pattern of land division. Density, for example, is a straightforward calculation in which the number of features is divided by the total area of the area under study. The problem with density however, is that it can remain constant while the actual pattern of features (parcels) can vary significantly (Figure 2).

Figure 2. Example of how density does not capture the spatial configuration of feature in a landscape. In both examples, the density of homes within the 60-acre pink remains the same, however, the patch size and dispersion of homes is quite different.



Our approach to quantifying the spatial pattern of parcelization (Appendix A) focuses on the characteristics of landscape fragmentation and sprawl. Specifically, we employed five metrics (Table 1) to quantify the pattern of land division from 1953 to 2005.

These metrics were chosen based on their ability to express specific differences in landscape patterns, the lack of correlation among them, and they can be calculated within the ArcGIS environment.

These metrics were computed at each time step for parcels under five acres and separately for new minor land divisions (CSM) parcels and new platted subdivision lots so that the results would not be skewed.

For example, it is obvious that platted subdivision lots will be relatively small and clustered, affecting the average parcel size and nearest neighbor metrics. In addition, local officials have expressed concern about landowners trying to slip past the subdivision review process by creating CSM parcels just below the regulatory minimum number of parcels or just above the regulatory lot size. Therefore, the above metrics were measured separately for CSM parcels and platted subdivisions lots.

Comparing Metrics

Each spatial metric provides valuable information regarding a particular fragmentation or sprawl characteristic. However, because some metrics are calculated in distances and others are areal measurements, individual measures can not be compared. Therefore, normalization of each metric through a Z score calculation results in a value that can be cross compared between municipalities. Since there is little correlation among the metrics, the Z scores for all five metrics can be summed to produce a cumulative value representing the parcelization score for each township. This index generalizes the overall parcelization pattern compared to other municipalities. Positive parcelization index values reflect townships experiencing a more fragmenting pattern of new parcel creation than the three township average. Conversely, negative parcelization index values reveal townships with a less fragmenting parcel pattern.

Results

While digital tax parcel boundaries are becoming more common, they usually portray the most recent snapshot of land ownership because earlier versions have been written over. It took nearly one year to collect, analyze, and spatially reconstruct these parcel maps for all three townships. Appendix B illustrates the 1953 and 2005 tax parcel reconstruction maps for each township. When reviewing the maps, one can easily see that the trend is near-lakeshore lot development in Lodi and West Point. Figure 2 demonstrates this trend by illustrating the number of parcels and distance to water in both Lodi and West Point (Figure 3). The number of parcels and average parcel size is summarized in Table 2.

Table 1. Selected landscape metrics used to quantify parcelization

Metric	Description
Number of Patches	Measures the total number of patches of a particular patch type
Mean Patch Size	Measures the average patch size of a class of patches
Mean Nearest Neighbor	Measure the distance between patches that members of a particular class
Perimeter to Area Ratio	Relates the shape of a patch to its size to express the amount of associated edge

Figure 3. Histogram showing the number of parcels and distance to water in Lodi and West Point between 1953 and 2005.

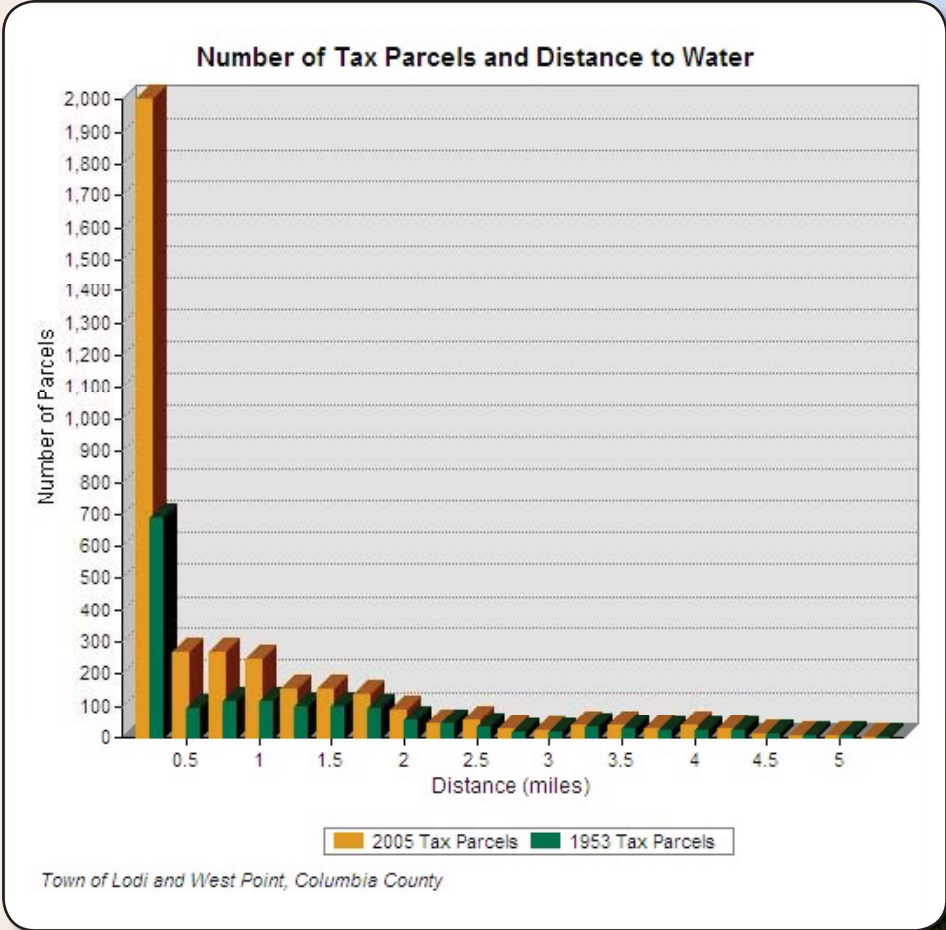


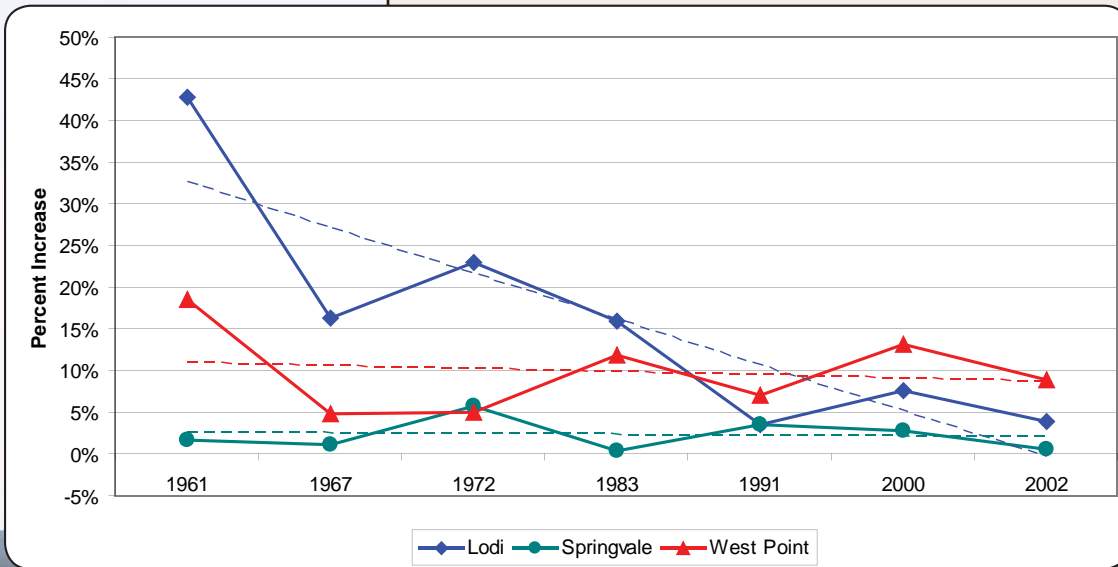
Table 2. Total number and average size (acres) of parcels in each township from 1953 to 2005.

Township		1953	1961	1967	1972	1983	1991	2000	2005
Lodi	Count	749	1,070	1,245	1,530	1,773	1,834	1,972	2,049
	Average Size	22.2	16.4	13.9	11.3	9.7	9.3	8.6	8.2
Springvale	Count	823	837	846	895	899	930	956	961
	Average Size	31.9	31.4	31	29.4	29.3	28.3	27.5	27.4
West Point	Count	834	989	1,036	1,087	1,216	1,301	1,471	1,602
	Average Size	22.1	18.6	17.8	17	15.1	14.1	12.5	11.4

In 1953, Lodi had 749 parcels with an average of 22.2 acres; Springvale had 823 parcels and an average size of 31.9 acres; and West Point had 823 parcels and an average size of 22.1 acres. The total number of parcels increased in every time step, however, Lodi displayed the highest increase in parcel creation over the entire study period, whereas Springvale has exhibited the least amount of land division. A common generalization among many people is an increased

rate of parcelization of rural lands. Our reconstructed parcel data reveals that the overall rate of land division in each township has declined since 1953 (Figure 4).

Figure 4. Parcel growth rates for each township with trendlines.



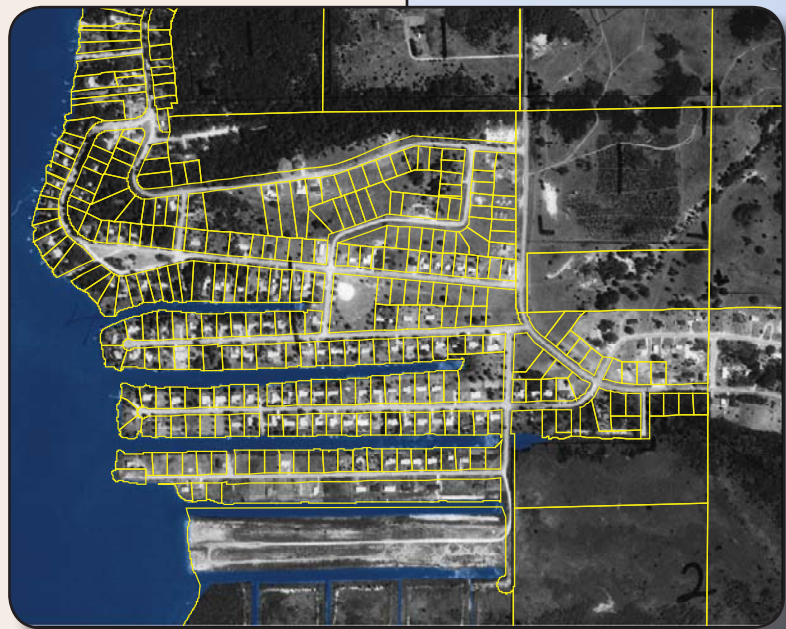
We chose to go far enough back in time so that we could analyze patterns of parcelization both pre and post policy adoption. One such policy of concern is shoreland zoning, which was widely adopted in the late 1960s and sets dimensional standards for lots within a specified distance of a public water body. It remains largely unknown whether this regulation has had any impact on the dimensions of near-shoreland lots. Figure 3 shows evidence that shoreland zoning in Wisconsin did, in fact, have an impact on the size of shoreland zone parcels within Lodi and West Point. The average shoreland zone lots actually more than doubled in size in Lodi and West Point after the shoreland zoning regulations were implemented (Table 3).

Table 3. Summary statistics for parcels within shoreline buffer both pre and post shoreland zoning implementation in Columbia County.

Summary statistics of parcels within 1000 feet of shore					
	TOWN	Count	Minimum Size	Average Size	Standard Deviation
Pre Shoreland Zoning (1967)	Lodi	548	0.01	0.38	0.25
	West Point	200	0.03	0.29	0.19
Post Shoreland Zoning (1972 - 2005)	Lodi	230	0.01	0.88	1.32
	West Point	223	0.02	0.92	0.98

Not only did shoreland zoning affect the size of new lots, but the regulation influenced the pattern of near-shore parcelization trends. The style prior to shoreland zoning in Lodi was to drastically alter the riparian area in order to maximize shoreline frontage. For example, long channels were dug inland from Lake Wisconsin on land owned by the Wisconsin Power and Light Company (Fig 5). The result of these channels was a pattern of small clustered lots with access to water. Due to the strong attraction of waterfront property, one could easily assume that this trend would have continued not only in Lodi,

Figure 5. Example of pre-shoreland zoning parcelization trend in Lodi. Long channels dug inland from Lake Wisconsin created additional shoreline, expensive waterfront property, and a parcel and development pattern that required the construction of a wastewater treatment facility.



but around the state as well had shoreland zoning not been implemented. A sewer and water district now services these lots because the parcels are too small for onsite septic systems. Because of these new services, the growth in small parcels has continued in the area to help offset the cost for the wastewater treatment facility.

Land fragmentation

We used GIS to digitize a total six different years of land use based on the availability of aerial photography. The 1955 and 2005 land use maps are illustrated in Appendix C for each township. From the maps, it is quite obvious that land use change has occurred in each municipality. Table 4 summarizes both the total amount of land use change and the percent of the entire landscape composed by each class. The most apparent change is the increase in the amount of developed land in each township. Over the time period studied, the amount of developed land increased 315, 72, and 252 percent in Lodi, Springvale, and West Point respectively. The large increases in developed land in Lodi and West Point resulted in decreases in cropped and pasture/open lands.



Table 4. Change in the amount and percent of land use classes in each township.

	Land use change in acres							Percent of total township area						
	1955	1968	1978	1992	2002	2005	% Change	1955	1968	1978	1992	2002	2005	
Lodi	Cropped	9,708	9,338	9,094	8,635	8,468	8,405	-13%	53%	51%	49%	47%	46%	46%
	Developed/built-up	289	419	614	874	1,100	1,200	315%	2%	2%	3%	5%	6%	7%
	Forest/wooded	4,127	4,255	4,435	5,459	5,617	5,503	33%	22%	23%	24%	30%	31%	30%
	Pasture/open	3,143	3,179	3,048	2,208	1,975	2,052	-35%	17%	17%	17%	12%	11%	11%
	Water	1,140	1,216	1,216	1,232	1,248	1,248	9%	6%	7%	7%	7%	7%	7%
Springvale	Cropped	15,308	16,157	16,005	15,265	15,270	15,243	0%	58%	61%	61%	58%	58%	58%
	Developed/built-up	257	273	307	407	409	443	72%	1%	1%	1%	2%	2%	2%
	Forest/wooded	3,326	3,293	3,394	3,927	4,139	4,194	26%	13%	13%	13%	15%	16%	16%
	Pasture/open	7,402	6,554	6,571	6,676	6,449	6,387	-14%	28%	25%	25%	25%	25%	24%
	Water	16	32	32	35	42	42	171%	0%	0%	0%	0%	0%	0%
West Point	Cropped	11,985	11,790	11,521	11,284	11,051	10,923	-9%	58%	57%	55%	54%	53%	52%
	Developed/built-up	320	447	596	786	929	1,126	252%	2%	2%	3%	4%	4%	5%
	Forest/wooded	3,658	3,811	4,144	5,001	5,221	5,243	43%	18%	18%	20%	24%	25%	25%
	Pasture/open	2,467	2,321	2,109	1,298	1,131	1,139	-54%	12%	11%	10%	6%	5%	5%
	Water	2,400	2,460	2,460	2,460	2,498	2,398	0%	12%	12%	12%	12%	12%	12%

We compared the number of patches and total edge across all time periods to assess the degree of landscape fragmentation in each community (Figure 6). This study indicates that the land use structure in each township has change over the 52-year time span. Results for the landscape fragmentation metrics for just developed patches are shown in Table 4. Although fragmentation generally increased throughout the period of study, i.e. increase in the number of developed patches, the amount of change varies compared to the change in number of parcels in each township. The changes occurring in Lodi and West Point, where the bulk of the parcelization took place, were significantly higher than that of Springvale. As expected, the number of developed patches increased most dramatically in the towns with the most parcelization. However, even though the number of developed parcels (values in parentheses) in Lodi

Figure 6. Change in number of patches and total edge for associated land use classes in each township from 1955 to 2005.

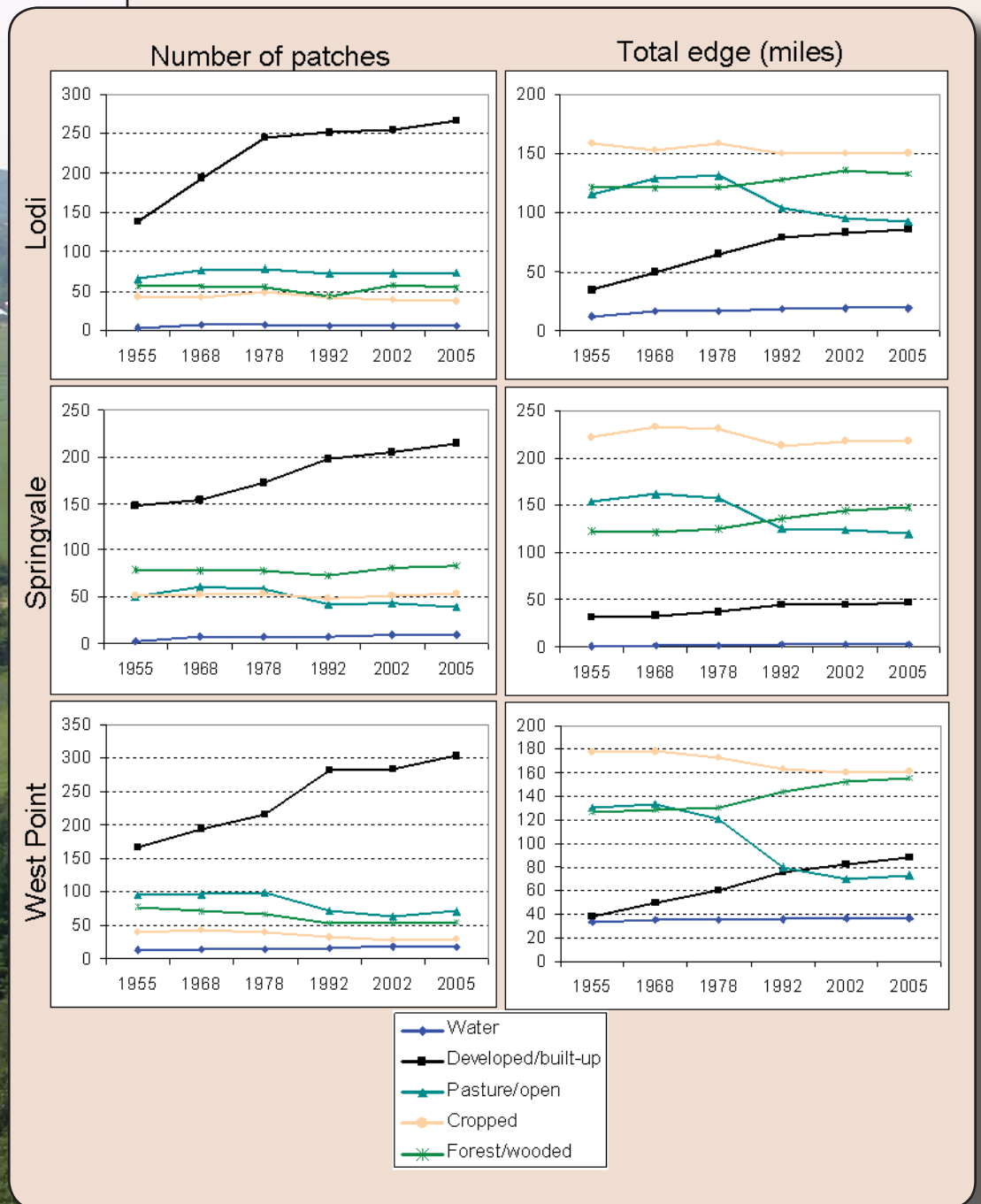


Table 5. Change in the number of patches and total edge associated with developed/built up areas in each township. Numbers in parentheses indicate the number of developed parcels at that time.

Year	Developed Patches					
	Lodi		Springvale		West Point	
	Number	Change	Number	Change	Number	Change
1955	138 (274)		145 (145)		166 (275)	
1968	194 (527)	41%	153 (153)	4%	195 (399)	17%
1978	245 (728)	26%	172 (172)	12%	216 (524)	11%
1992	252 (1038)	3%	198 (198)	15%	281 (650)	30%
2002	255 (1289)	1%	205 (208)	4%	283 (772)	1%
2005	267 (1372)	5%	214 (218)	4%	303 (885)	7%

Year	Total Edge					
	Lodi		Springvale		West Point	
	Miles	Change	Miles	Change	Miles	Change
1955	34		31		38	
1968	50	46%	33	6%	50	30%
1978	65	31%	37	11%	60	21%
1992	79	20%	44	20%	75	25%
2002	83	6%	45	1%	82	9%
2005	85	3%	48	6%	89	8%

is substantially higher than West Point in 2005 (1,372 compared to 885), there are more patches of development in West Point (Table 5). In Springvale, there is virtually a one to one relationship between the number of developed patches and the number of developed parcels. This suggests that all development is essentially isolated and perforating the landscape.

In addition, we also measured the effect that small parcels had on fragmenting the landscape. We quantified parcel fragmentation as (1) the decrease in unparcelized areas beyond a 50-meter disturbance zone and (2) the change in total amount of edge between parcelized and unparcelized areas (Table 6). Overall, with a 50-meter buffer around residential parcels, the unparcelized area was reduced by 9% for both Lodi and West Point and 2% in Springvale. That equates to 1.8, 8.0, and 2.5 acres impacted per residential parcel in Lodi, Springvale, and West Point respectively. Again, the highest percentage of new parcel growth was in Lodi at 334%, however, the cumulative buffer impact, or the amount of undisturbed land, only decreased by 9%. Due to clustering of parcels along Lake Wisconsin, particularly in the Harmony Grove subdivision, the cumulative impact of parcelization of small parcels has limited the effect of fragmentation because of overlap within the disturbance zone. West Point

Table 6. Growth in the number of small parcels and their impact on the landscape.

1953 - 2005					
Township	Change in 0-5 acre parcels	Cumulative buffer impact	Acres impacted per parcel	Change in Total Edge	Edge per parcel (meters)
Lodi	334%	-9%	1.8	101%	57
Springvale	155%	-2%	8.0	104%	709
West Point	261%	-9%	2.5	252%	112

experienced a 251% increase in small parcels and it too had the same cumulative buffer impact as that of Lodi, indicating a less clustered parcel pattern. The amount of acres impacted per parcel in Springvale is much higher than Lodi and West Point, meaning that small residential parcels in Springvale are not adjacent to other residential parcels, thus there is no overlap in the parcel disturbance zones.

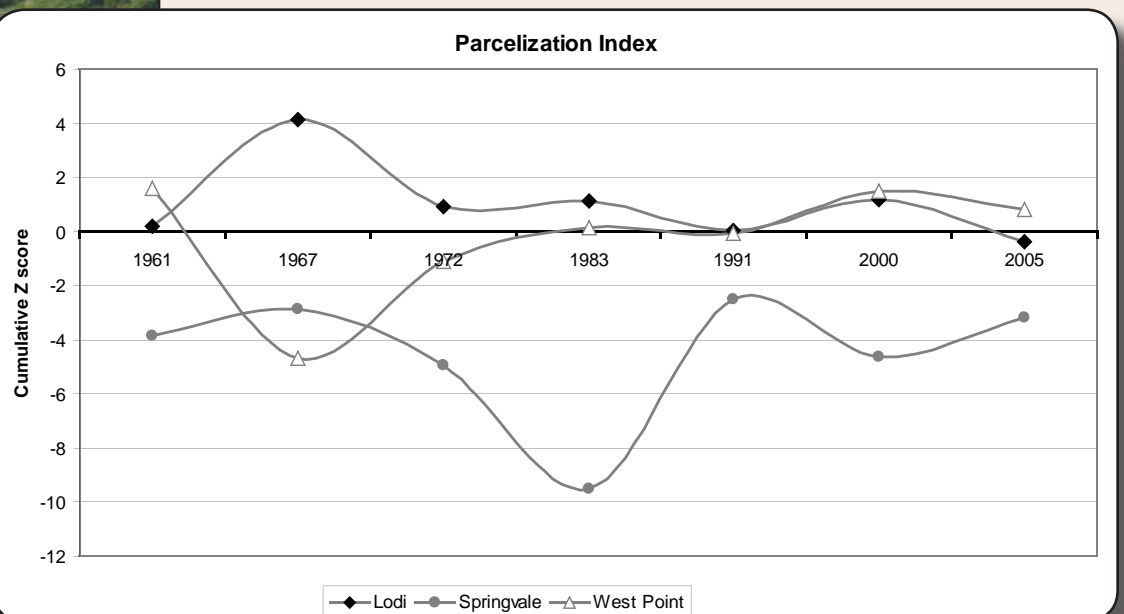
As expected, increased parcelization in each township from 1953 and 2005 caused more total edge between parcelized and unparcelized areas. Over the 52-year period, the change in total edge in Lodi, Springvale, and West Point was 101%, 104%, and 252% respectively. In Lodi, the percent increase in total edge was much lower than the increase in parcel growth. West Point exhibited the most prominent increase in total edge at 252%. Springvale, on the other hand, witnessed little parcel growth over time, but experienced a 104% increase in total edge from 1953 and 2005.

Characterizing Parcelization

Our five individual fragmentation measures revealed varying degrees of fragmentation over time in each township. The combined three township level summary statistics for each period are provided in Appendix D. Though Lodi and West Point experienced the largest increase in parcels over time, some measures find them fragmenting more slowly than the combined three township average. Only the urban distance metric calculated in Springvale had a larger than average value for each time period. That's because Springvale is geographically located farther from a city or village than West Point or Lodi. Therefore, any new parcel in Springvale will result in a large urban distance value.

The average measures for each metric are standardized to allow comparisons and are graphed in Z-scores (standard deviations) from the combined three township average. The standardized values can be summed to produce a single numeric value that represents each community's overall parcelization pattern (Figure 7). The range of values for each township demonstrates the

Figure 7. The Parcelization Index combines the individual fragmentation metrics into a single indicator.




different dimensions of parcelization and fragmentation. Positive Z-scores indicate townships experiencing a more fragmenting parcel pattern compared to the combined three town average, whereas negative Z-scores signify a less fragmenting pattern. The greater the absolute Z-score value, the more/less fragmenting the pattern.

As expected, Lodi had the highest parcelization scores throughout most of the 52-year time period because of the sheer number of new lots. However, since 1967, Lodi's parcelization score has generally declined, mostly due to the location of new parcels over time. The first Harmony Grove subdivision was basically a village in the making. The long man-made channels created additional shoreline in the town and resulted in hundreds of new clustered lots. Numerous additions to Harmony Grove illustrate peoples' desire for living close to water even if that means living close to one another. This type of lot creation produced a dense parcelization pattern, thus a declining parcelization score. The availability of public sewer and water has also allowed for small dense parcel creation. The clustering of parcels and development around Harmony Grove has reduced the rate of fragmentation around the rest of the town. The pattern of development in Lodi would be quite different if these lots were not clustered, but randomly scattered throughout the town.

Particularly interesting is the opposite trend between Lodi's and West Point's parcelization score between 1961 and 1967. Given the similar nature and location of each town, one would expect that the parcelization pattern and subsequent parcelization score to be parallel. However, Lodi's parcelization score jumped dramatically, while at the same time there was a substantial dip in West Point's score. The largest addition to Harmony Grove was established in Lodi during this time period with the creation of hundreds of new waterfront lots, while little platting took place in West Point. The increase in Lodi's parcelization score reveals the large number of newly created parcels and their significant distance from any urbanized area. The dip in West Point's parcelization score during the same period may not reflect the absence of demand for new parcels in that town; it likely means that demand for land was satisfied in Lodi with the availability of near-shore lots. A home buyer would probably be indifferent as to which town they ended up in because of the regional similarities of the two communities.

The parcelization score in West Point eventually surpasses that of Lodi, even though during most time periods there are more new parcels in Lodi. When observing the parcel maps for each township, it becomes evident why this trend is occurring. The pattern of parcel creation in Lodi appears to be more compact and clustered in small-lot subdivisions, resulting in a less fragmenting pattern and a lower parcelization score. In West Point, the pattern of parcelization seems to be more dispersed on larger parcels throughout the entire township. This may be due to more restrictive land division regulations in Lodi, adopted in 1989, to steer development toward existing infrastructure such as public sewer and water. The new parcels in West Point are less clustered than in Lodi and are perforating the landscape. However, a recent subdivision in West Point includes a municipal-type shared septic system that serves nearly one hundred lots. In 2005, the capacity of the treatment system was at 50%, so there maintains potential for additional homes to be serviced by this facility, which would ultimately cluster new development.





The fluctuation of the parcelization score in Springvale can be attributed to the small number of new parcels in each time period compared to the other two towns. Little parcelization has occurred because of Springvale's geographic location and the regional land market. Farmland here is still more valuable than residential land. This area lacks significant natural amenities such as a large water body; therefore there is little demand for rural amenity-led development. Because Springvale lies outside the Madison commutershed, it is not experiencing speculative land division for exurban development. The size of Springvale also plays a considerable role in the difference between parcelization scores. Springvale is a much larger township in area and has more space for new parcels to be created. Therefore, due to the size and location of the town alone, any new parcel that is created will be a significant distance from an urban or subdivision boundary significantly increasing the Z-score for that particular metric.

Discussion and Conclusions

With this research we set out to explore the long term trends and consequences of rural land parcelization in three townships within Columbia County, Wisconsin. We focused on a set of landscape metrics with intuitive explanatory power for planners and citizens looking for something more spatially sophisticated than density or change in the number of parcels to quantify parcelization. We developed a detailed, process-based approach to apply landscape ecology metrics to quantify and measure the spatial dimension of parcelization. Our results demonstrate that the amount and spatial pattern of parcelization has had a distinct influence on the resulting landscape.

The first process of digital parcel reconstruction proved complicated. We were surprised to learn that there lacked a consistent protocol for numbering parcels in the tax assessment rolls, i.e. parcel identification number (PIN). Not only did this make it difficult to recognize parcel splits in the tax assessment rolls, it was complicated to track specific parcels over time.

As far as regulations affecting parcelization, we found that leading up to the implementation of shoreland zoning the average lot size within this shoreline buffer area was 0.38 acres in Lodi and 0.29 acres in West Point. Post shoreland zoning (1972) we find that in both townships the average size more than doubled. In addition, no more shoreline had been drastically altered like it was prior to the regulation in the Harmony Grove subdivision in Lodi.

The number of residential parcels increased dramatically in Lodi and West Point over the 52 years studied. The substantial growth in the number of parcels is cause for concern because local economies in rural areas rely on natural resources. However, the dramatic increase in the number of small parcels in both Lodi and West Point has resulted in only modest losses in the amount of available farmland. This is due to the attractiveness of certain landscape features such as water as well as non landscape features such as the availability of public services. The limited availability of these features has resulted in the clustering of parcels, which has restricted the amount of fragmentation and perforation throughout the rest of the town. The dense creation of parcels near riparian areas such as Lake Wisconsin has negative environmental consequences including habitat loss and increased runoff. However, this development pattern has helped maintained the rural character of the rest of the town.

Despite limited parcelization in Springvale, our least developed town, we still found evidence of landscape fragmentation. This type of change helps us understand the background level of landscape fragmentation above and beyond the parcelization process. In order to document the effect of parcelization in amenity-rich areas, we need to know how much landscape change is occurring in areas experiencing little or no parcelization. Comparing areas of differing parcelization trends helps to illustrate the extent of land fragmentation occurring in parcelized areas. Much of the landscape fragmentation in Springvale is the result of natural processes such as forest regeneration following farmland abandonment. However, the dispersed pattern of parcel creation and ensuing development in Springvale creates isolated developed patches that ultimately perforate the landscape. This type of pattern can increase the cost of public services, particularly road maintenance and school busing. However, the growth rate in Springvale is relatively low; therefore the amount of landscape fragmentation is limited compared to faster growing Lodi and West Point.

Even though the parcelization score provides a convenient single number for characterizing parcel development in municipalities, it should be interpreted carefully. Parcelization is dynamic over both time and space and may be more complex than what a single number can convey. However, the parcelization score encompasses several landscape ecology metrics that are characteristic of fragmentation and provides a new approach to summarizing new parcel creation and potential future changes. Calculating standard deviations from the combined township average allows one to compare townships to each other against larger averages such as the county, region, and state.

The parcelization score we developed in this work can become an important tool for communities to use when evaluating and implementing land use plans. It is in everyone's interest to know if the resources, time, and cost expended during the comprehensive planning process are worthwhile. To evaluate a plan, communities have several questions to address: Have these plans successfully preserved working lands? What policies work best for promoting smart growth? Many rural communities lack a standard approach to answering such questions. With the availability of digital land records growing throughout Wisconsin, the parcelization score can become an important tool for helping citizens recognize whether or not the current planning and policy efforts are protecting key natural resource assets from the negative consequences of parcelization and development. We encourage counties to actively archive their parcel database with associated tax assessment information so that annual parcelization scores can be readily calculated.

The results of our study shed light on some contemporary planning debates in Wisconsin. People throughout the state appear to be looking for a balance between growth and open space protection. The continued parcelization of rural lands can weaken a community's goal for protecting productive farmlands and open space. Therefore, strict enforcement of CSM creation is recommended (perhaps reviewing all lot splits). Many landowners choose to create lots under the statutory minimum size or below the required number of parcels, so that they may avoid a lengthy subdivision review process. This act can create numerous environmental and infrastructure problems in the future, paid for not by the owners of the new lots, but by everyone in the community.

Whether your community's goal is farmland or open space preservation, sliding scale zoning that allows a certain amount of development rights may fragment



the working landscape. This approach essentially allows larger property owners (usually farmers) to split off more parcels than smaller property owners. In Lodi and West Point, this means creating isolated clusters of parcels throughout the core farmland area, distant from existing development and public services. Instead, the clustering of parcelization near existing development is encouraged. However, a Transfer of Development Right (TDR) program internal to the county or town used in conjunction with a sliding scale zoning approach can effectively preserve farmland while shifting development to designated areas with existing public services.

Appendix A

Parcelization Metrics

Number of Patches

The number of patches (NP) in a landscape provides a measure of the number of subdivision or fragmentation of parcels. We measured the number of patches separately for platted subdivision lots and CSM lots. Parcel fragmentation is considered to increase with an increase in the number of new parcels.

$$NP_{\text{Csm/plat}} = \text{ParcelsTime2} - \text{ParcelsTime1}$$

where $NP_{\text{Csm/plat}}$ is the number of new CSM or platted parcels in each township for a given time period, ParcelsTime2 is the number of either CSM or platted parcels at Time 2, and ParcelsTime1 is the number of either CSM or platted parcels at Time 1.

Average New Parcel Size

The average parcel size (AC) component of parcelization measures how much land the average new parcel is consuming. This component provides information on the impact or effectiveness of minimum lot size policies. The average parcel size was calculated by selecting new parcels and summarizing the area. We removed residual or non residential parcels from the selection, such as if a forty acre parcel split into a 2 acre and 38 acre parcel. In this case, the larger parcel was removed. Larger average new parcel sizes would indicate that new lots are consuming more land.

$$AC_{\text{Csm/plat}} = (\sum \text{Pac}) / NP$$

where $AC_{\text{Csm/plat}}$ is the average new parcel size (acres) index for new CSM or platted parcels in each township for a given time period, Pac is the new parcel size, and NP is the total number of parcels in a given municipality.

Distance to Existing High Density Development

New parcels that are created at a large distance from previous urban areas are indicators of future land use change and potential development, commonly known as leapfrogging. Dispersed development like this can be considered rural sprawl and have many negative implications including higher service costs, low density residential development, and perforated working lands. High density development was defined as previously existing platted subdivisions or city/village boundaries. A straight line distance was measured in a GIS for each new parcel and summarized by every township. As the distance between new parcels and existing high density development increases, the pattern can be considered more fragmenting and sprawling.

$$UD_{\text{Csm/plat}} = (\sum \text{Pud}) / NP$$

where $UD_{\text{Csm/plat}}$ is the leapfrog index for new parcels, Pud is the distance from each new parcel to an urban or high density developed patch, NP is the number of new parcels in a given township.

Average Nearest Neighbor Distance Between New Parcels

The fourth metric used to characterize parcelization is the average nearest neighbor. The average nearest neighbor metric gives an indication of the

dispersion of new parcels over the landscape. It was measured similar to the urban distance measure, except straight-line distances were measured between new CSM parcels of the same year. The nearest neighbor was not measured between new subdivision parcels because parcels here are obviously clustered. Larger average nearest neighbor values indicates increased dispersion and potentially more fragmentation.

$$NN_{csm} = (\sum P_{nn})/NP$$

where NN_{csm} is the nearest neighbor index for new CSM parcels, P_{nn} is the distance between each new CSM parcel, and NP is the number of new CSM parcels in a given township.

Perimeter to Area Ratio

Finally, parcel shape can have significant implications on the sustainability of ecological habitats and farming operations. For example, complex shapes increase the amount of edge between the interfaces of neighboring parcels potentially creating more contact between differing land uses. The perimeter to area ratio metric was calculated for each new parcel. This metric is the ratio of the parcel perimeter length to parcel area. It is an indicator of patch shape in which larger values represent parcels with a more complex shape.

$$PAR_{csm/plat} = (\sum P_{perim}/\sum P_{area})/NP$$

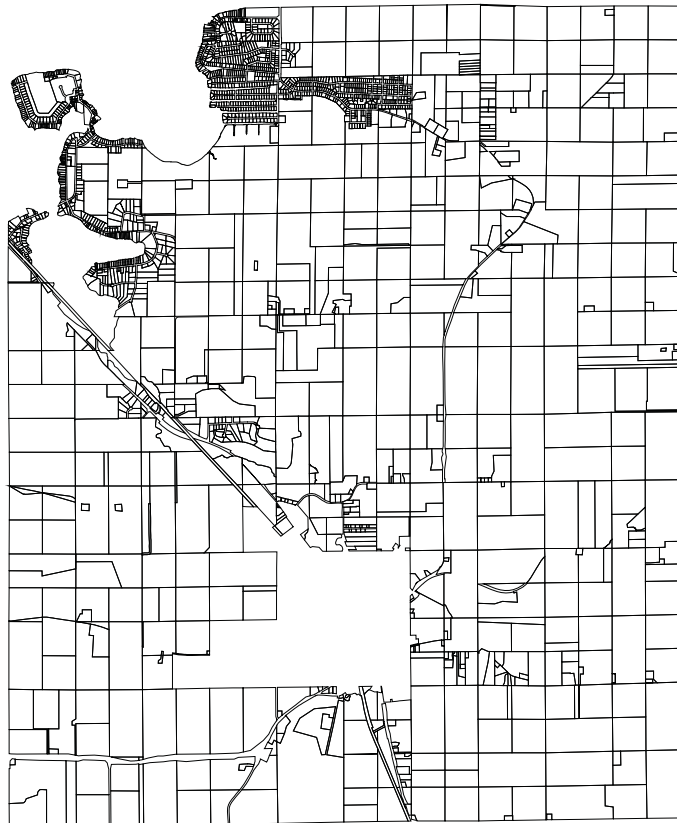
where $PAR_{csm/plat}$ is the perimeter to area ratio index for new parcels, P_{perim} is the perimeter of each new parcel, P_{area} is the area of each new parcel, and NP is the number of new parcels in a given township.

Appendix B Parcel Maps

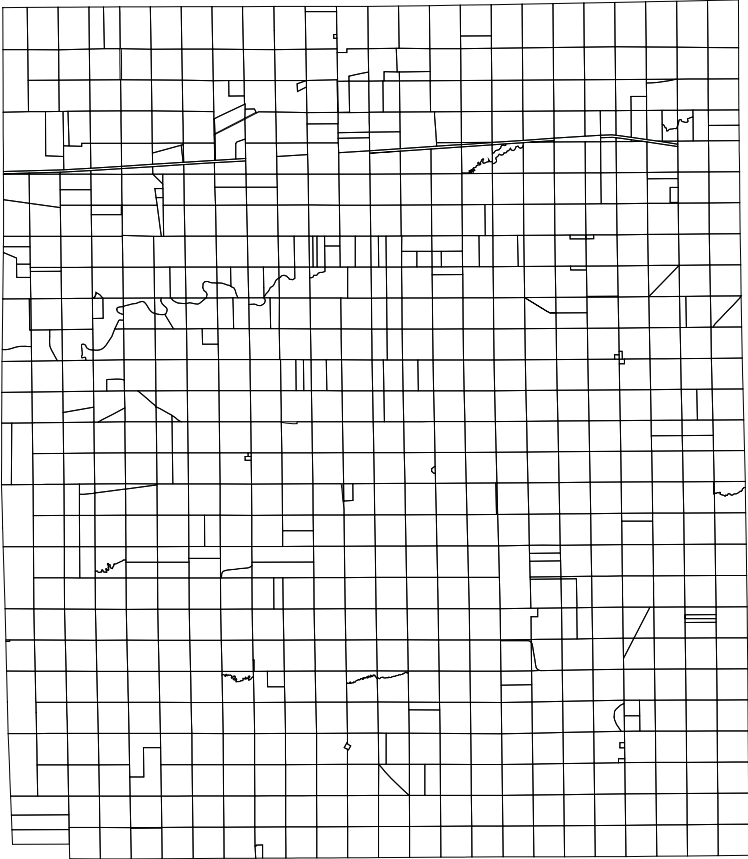
Town of Lodi 1953



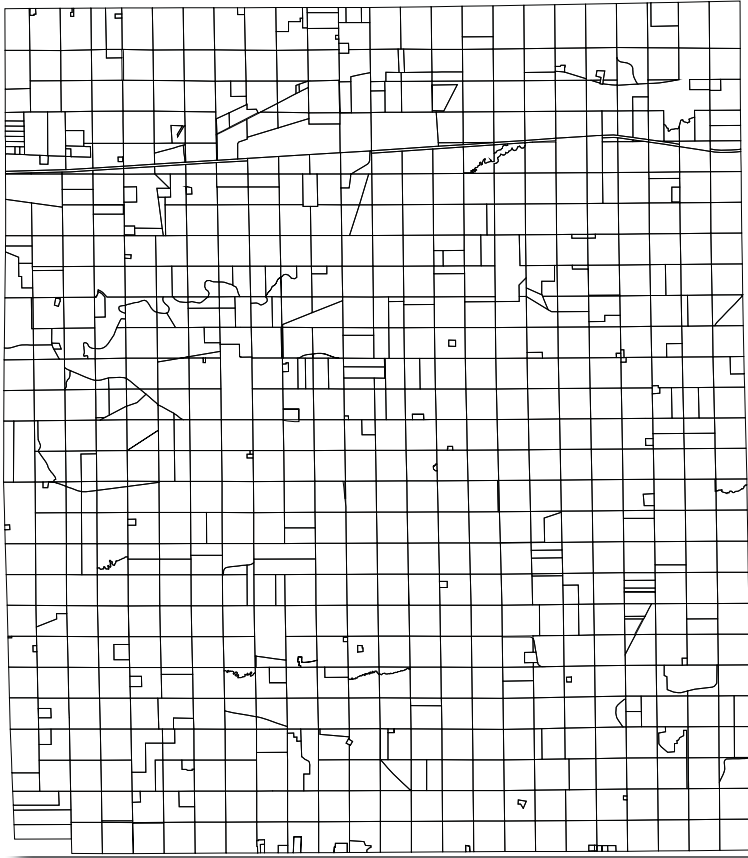
Town of Lodi 2005



Town of Springvale 1953



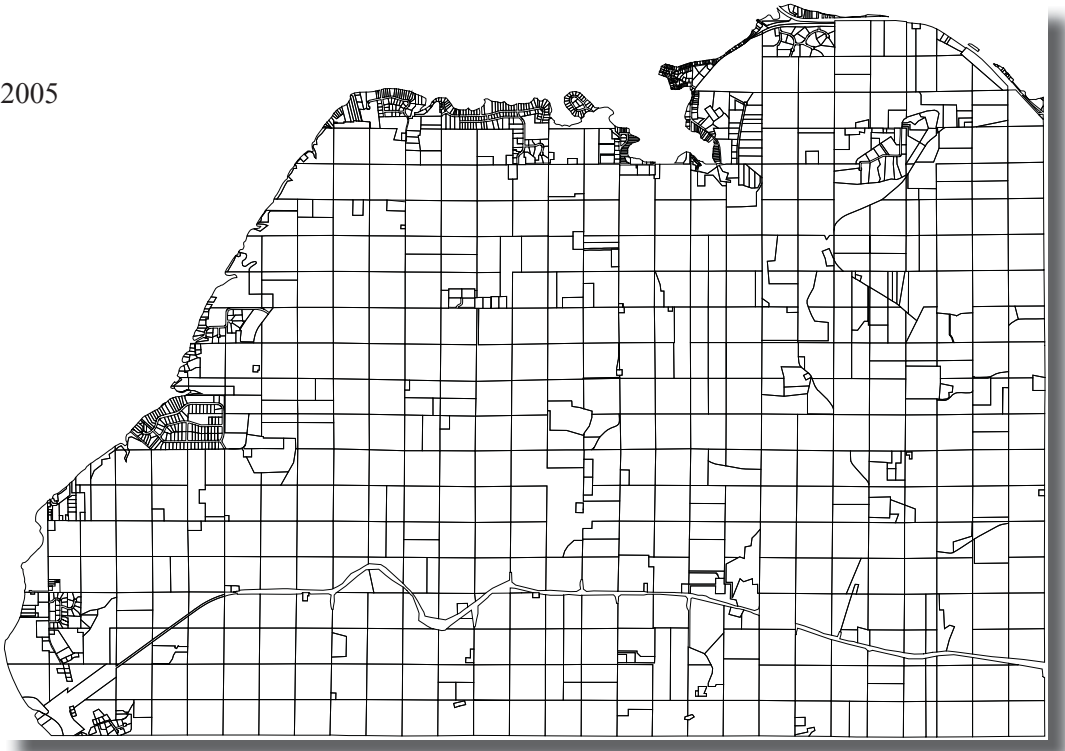
Town of Springvale 2005



Town of West Point 1953



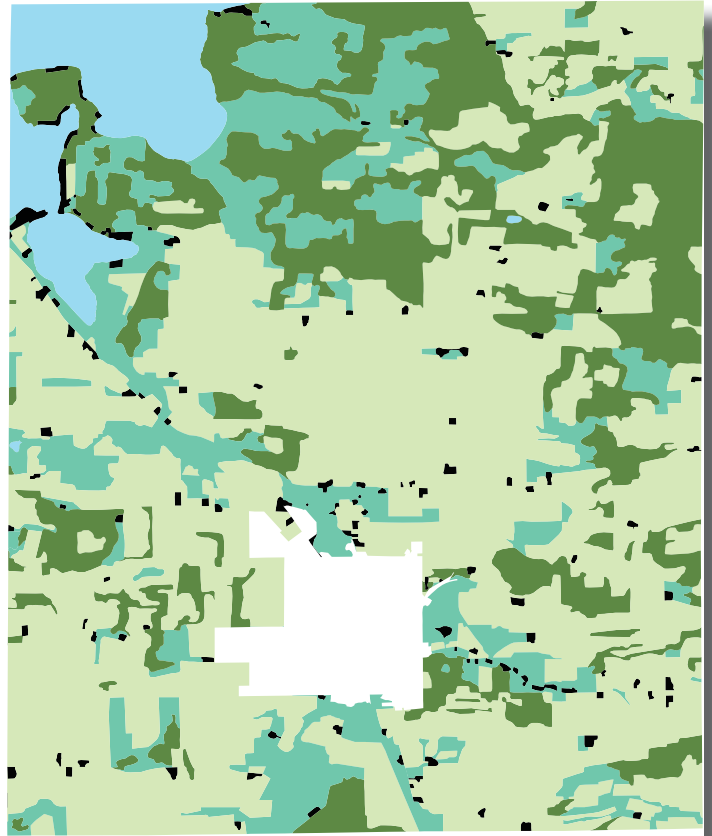
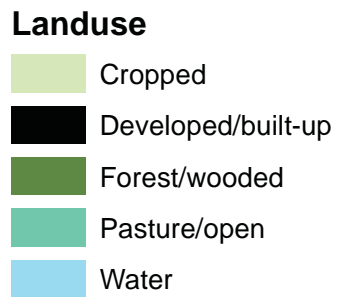
Town of West Point 2005



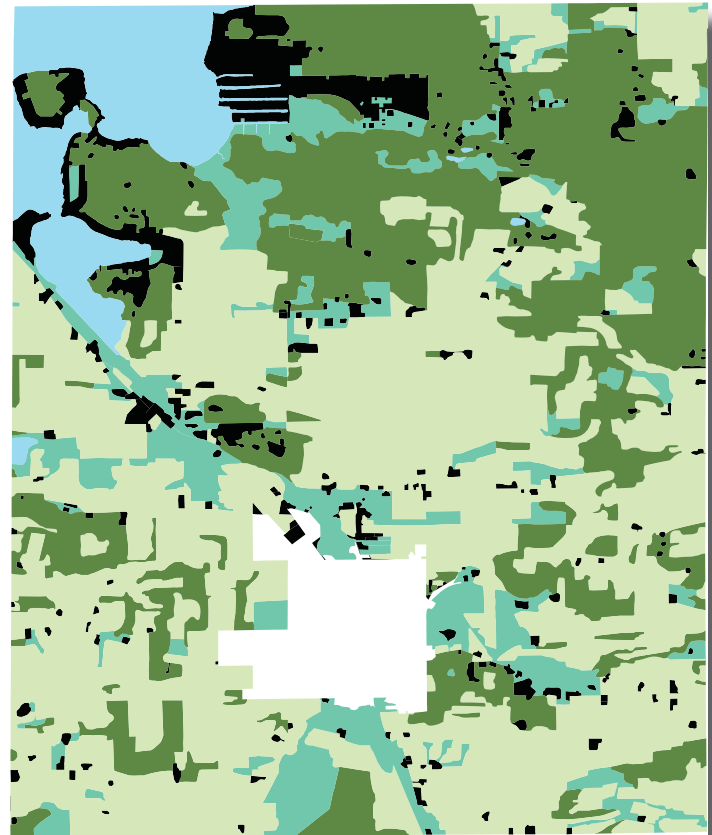
Appendix C

Land Use Maps

Township of Lodi 1955



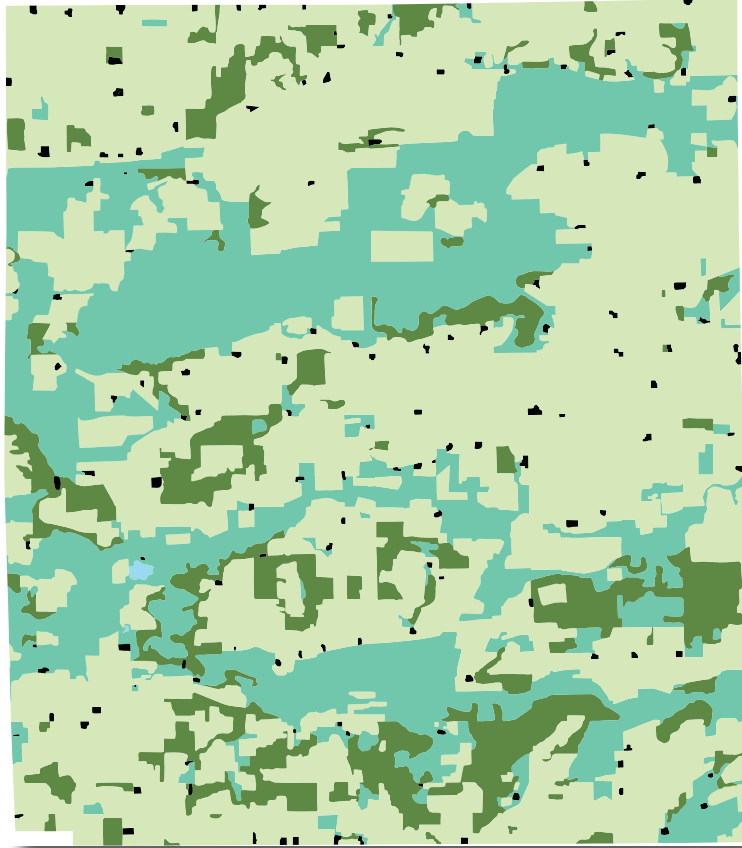
Township of Lodi 2005



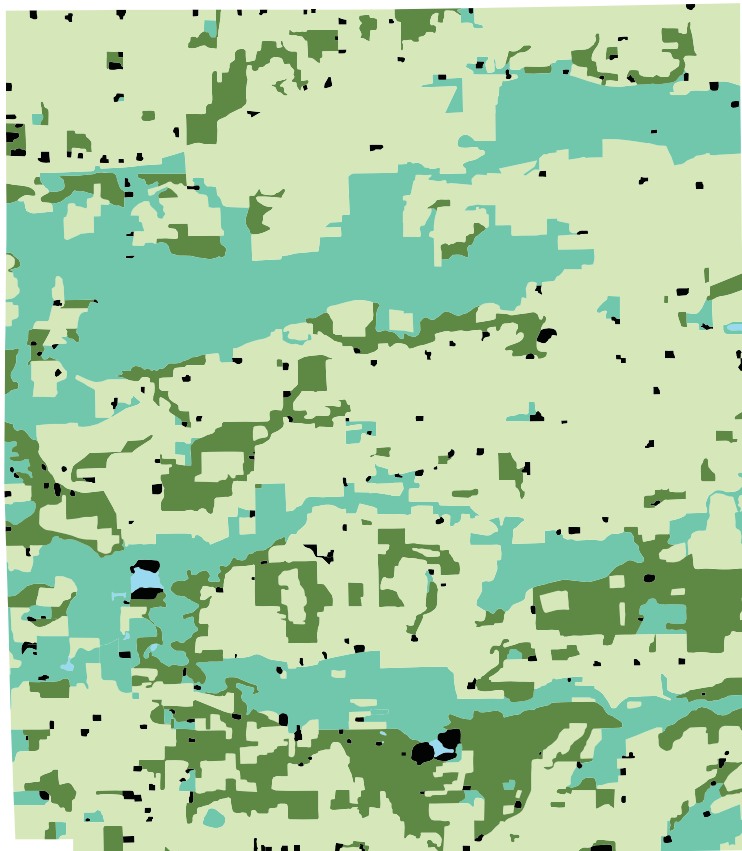
Township of Springvale 1955

Landuse

-  Cropped
-  Developed/built-up
-  Forest/wooded
-  Pasture/open
-  Water




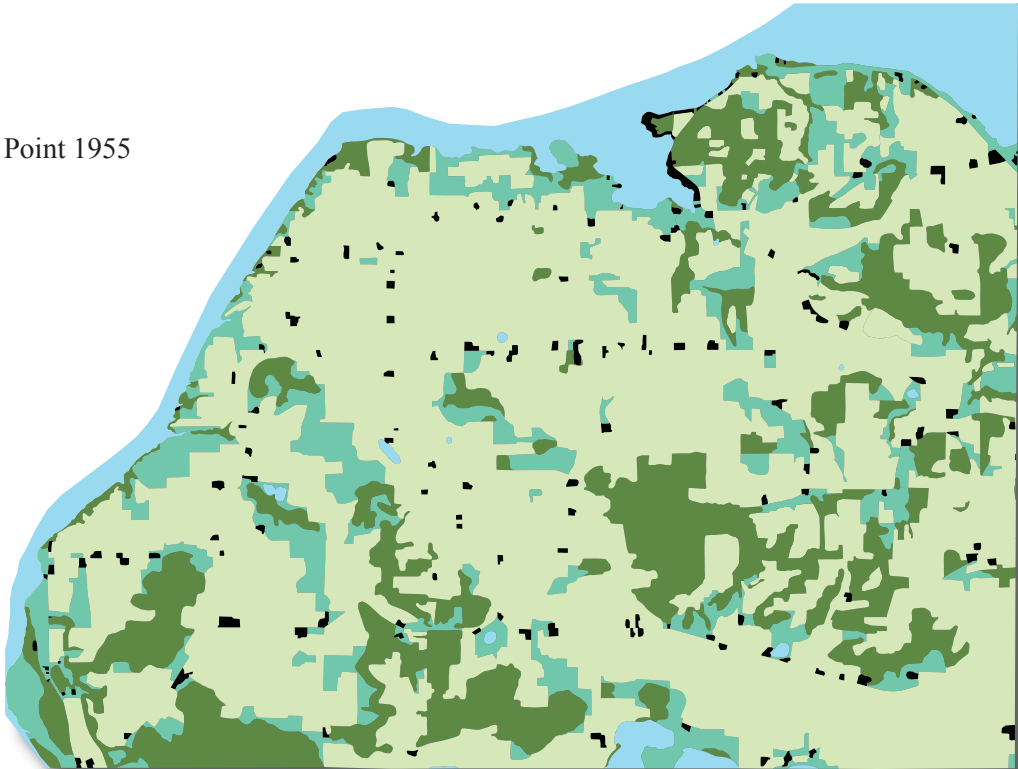
Township of Springvale 2005



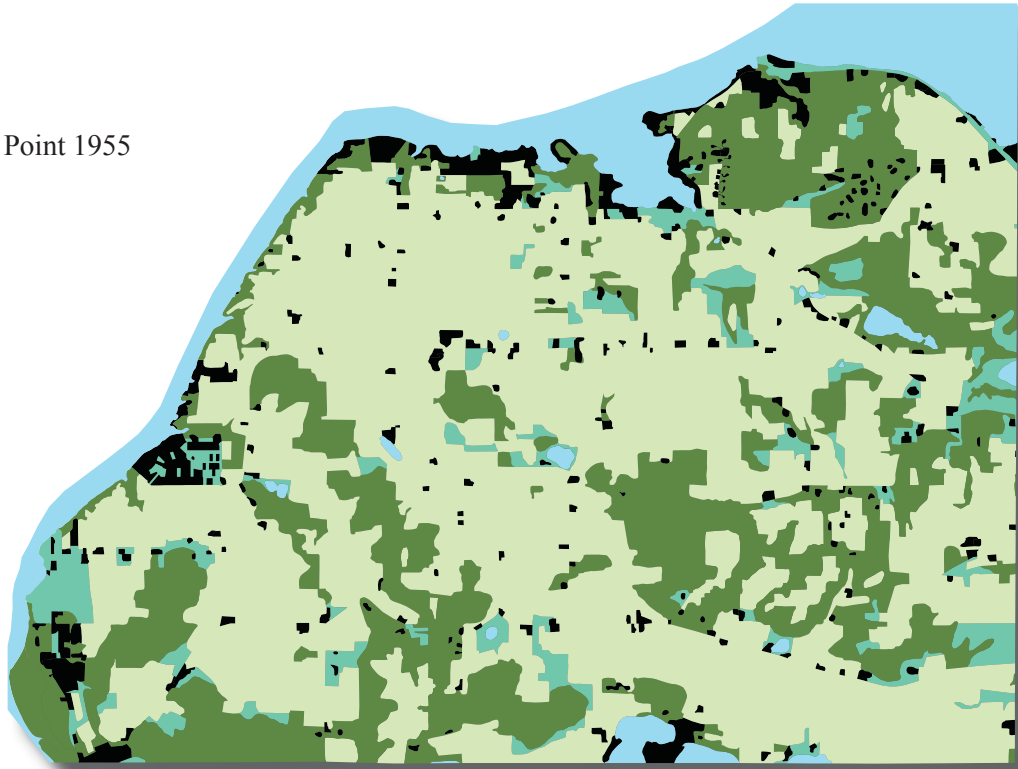
Township of West Point 1955

Landuse

-  Cropped
-  Developed/built-up
-  Forest/wooded
-  Pasture/open
-  Water



Township of West Point 1955



Appendix D

Township Level Metrics

1953 - 1961											Parcelization Score
Town	Total	NP _{csm}	AC _{csm}	HD _{csm}	NN _{csm}	PAR _{csm}	NP _{plat}	AC _{plat}	HD _{plat}	PAR _{plat}	
Lodi	288	49	1.26	4356	908	0.0282	239	0.44	1701	0.07	0.189
		0.046	-0.163	-0.349	-0.407	0.308	1.072	0	-0.469	0.151	
Springvale	3	3	1.71	14236	3545	0.0171	0	0	0	0	-3.836
		-1.0109	1.059	1.589	1.139	-1.1179	-0.879	-1.332	-1.426	-1.857	
West Point	172	90	0.98	6614	353	0.0321	82	0.43	4967	0.049	1.604
		0.98796	-0.923	0.094	-0.732	0.80949	-0.21	-0.030	2.065	-0.457	
1962 - 1967											Parcelization Score
Town	Total	NP _{csm}	AC _{csm}	HD _{csm}	NN _{csm}	PAR _{csm}	NP _{plat}	AC _{plat}	HD _{plat}	PAR _{plat}	
Lodi	117	57	1.34	3704	656	0.0283	60	0.39	364	0.021	4.131
		0.839	0.5031	-0.418	-0.649	0.378	1.156	0	1.155	1.167	
Springvale	6	6	1.36	14289	5824	0.0183	0	0	0	0	-2.892
		-1.1064	0.6533	1.881	1.1517	-1.134	-0.578	-2.6	-0.577	-0.583	
West Point	42	42	1.12	6886	1078	0.0308	0	0	0	0	-4.693
		0.26707	-1.149	0.273	-0.5021	0.756	-0.578	-2.6	-0.577	-0.583	
1968 - 1972											Parcelization Score
Town	Total	NP _{csm}	AC _{csm}	HD _{csm}	NN _{csm}	PAR _{csm}	NP _{plat}	AC _{plat}	HD _{plat}	PAR _{plat}	
Lodi	279	53	1.8	2918	644	0.0235	226	0.36	1399	0.016	0.916
		1.123	-0.268	-0.488	-0.911	0.155	1.138	-0.083	0.05	0.2	
Springvale	21	21	2.72	13931	2722	0.0172	0	0	0	0	-4.947
		-0.7986	1.1002	1.292	1.070	-1.069	-0.739	-1.52	-1.283	-3	
West Point	70	29	1.41	3575	1434	0.0274	41	0.51	1067	0.014	-1.116
		-0.3183	-0.847	-0.381	-0.158	0.913	-0.399	0.542	-0.267	-0.2	
1973 - 1983											Parcelization Score
Town	Total	NP _{csm}	AC _{csm}	HD _{csm}	NN _{csm}	PAR _{csm}	NP _{plat}	AC _{plat}	HD _{plat}	PAR _{plat}	
Lodi	246	119	1.32	2614	401	0.0273	127	0.81	894	0.022	1.140
		0.955	-0.717	-0.361	-0.709	0.707	0.989	-0.037	0.081	0.231	
Springvale	0	0	0	7180	0	0	0	0	0	0	-9.511
		-1.039	-1.274	0.608	-2.137	-2.182	-0.78	-0.633	-0.812	-1.262	
West Point	98	67	2.05	5975	798	0.0203	31	1.27	483	0.011	0.139
		0.084	0.697	0.352	0.705	-0.707	-0.348	0.301	-0.33	-0.615	
1984 - 1991											Parcelization Score
Town	Total	NP _{csm}	AC _{csm}	HD _{csm}	NN _{csm}	PAR _{csm}	NP _{plat}	AC _{plat}	HD _{plat}	PAR _{plat}	
Lodi	96	41	1.32	2551	753	0.0324	55	0.61	352	0.04	0.031
		0.630	-0.901	-0.464	-0.635	0.838	0.91	0	-0.461	0.114	
Springvale	9	9	2.92	12262	7738	0.0201	0	0	0	0	-2.488
		-1.1548	1.074	1.381	1.1528	-1.1069	-1.068	-0.763	-1.208	-0.795	
West Point	73	39	1.9	5157	1215	0.0288	34	1.07	919	0.021	-0.067
		0.51881	-0.185	0.031	-0.5171	0.26883	0.155	-0.763	0.743	-0.318	

1992 - 2000											Parcelization Score
Town	Total	NPcsm	ACcsm	HDcsm	NNcsm	PARcsm	NPplat	ACplat	HDplat	PARplat	
Lodi		60	1.7	3132	740	0.026	107	1.48	443	0.035	
	167	0.914	0.000	-0.324	-0.625	0.926	0.468	0.052	-0.464	0.25	1.197
Springvale		10	1.42	10781	4195	0.0217	0	0	0	0	
	10	-1.0729	-1	1.262	1.1535	-1.0651	-1.148	-0.808	-1.094	-0.844	-4.616
West Point		40	1.98	4808	928	0.0242	121	1.36	1057	0.017	
	161	0.11921	1	0.024	-0.5281	0.09262	0.68	-0.017	0.41	-0.313	1.468
2000 - 2005											Parcelization Score
Town	Total	NPcsm	ACcsm	HDcsm	NNcsm	PARcsm	NPplat	ACplat	HDplat	PARplat	
Lodi	144	52	1.2	3047	831	0.0389	72	0.76	650	0.018	
		0.440	-1.100	-0.626	-0.590	1.005	0.32	-0.118	-0.101	0.4	-0.370
Springvale	49	16	2.32	12526	4910	0.0192	0	0	0	0	
		-1.1446	0.8552	1.016	1.1547	-0.9949	-1.12	-0.863	-0.66	-1.4	-3.157
West Point	197	58	1.97	6395	893	0.029	96	0.98	858	0.009	
		0.70436	0.2443	-0.046	-0.5639	0	0.8	0.098	0.077	-0.5	0.814

References

- Beale, C. L. and K. M. Johnson (1998). "The identification of recreational counties in nonmetropolitan " Population Research and Policy Review 17: 37-53.
- Daniels, T. (1999). *When City and Country Collide*. Washington D.C., Island Press.
- DeCoster, L. A. (1998). "The Boom in Forest Owners--A Bust for Forestry." *Journal of Forestry* 96(5): 25-28.
- Gobster, P. H. and M. G. Rickenbach (2003). "Private Forestland Parcelization and development in Wisconsin's Northwoods: perceptions of resource-oriented stakeholders." *Landscape and Urban Planning* 69: 165-182.
- Hersperger, A. M. (1994). "Landscape Ecology and its Potential Application to Planning." *Journal of Planning Literature* 9(1): 14-30.
- Land Trust Alliance (2005). *2005 National Land Trust Census Report*. E. E. A. W. G. Chris Soto, Consultant. Washington, DC.
- Potter, L. A. and W. Schamel (1997). "The Homestead Act of 1862." *Social Education* 61(6): 359-364.
- Thrower, N. (1966). *Original survey and land subdivision; a comparative study of the form and effect of contrasting cadastral surveys Chicago*, Published for the association of American Geographers by Rand McNally





