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RESIDENTIAL LAND PARCELLATION AND AGRICULTURAL ZONING: THE MINIMUM LOT SIZE METHOD OTTAWA COUNTY, MICHIGAN

by

James Dischinger-Smedes

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ABSTRACT

RESIDENTIAL LAND PARCELLATION AND AGRICULTURAL ZONING:
THE MINIMUM LOT SIZE METHOD
OTTAWA COUNTY, MICHIGAN

By

James P. Dischinger-Smedes

The objectives of this study were to examine the relationship between rural land divisions for residential purposes and the use of the minimum allowable lot size for such developments as stipulated in local zoning ordinances, and to determine any association between lot size ordinances and the extent to which agricultural land is affected in residential parcel creation. A two-stage cluster design was utilized to inventory parcels activated in 213 township quarter sections between 1975 and 1995, with evidence, from aerial photography, of residential use, or that were deemed by the researcher as likely residential use parcels.

Results for the parcel data from the seventeen townships stratified by agricultural zoning district minimum lot sizes indicate that this particular technique may be effective in limiting the amount of rural or agricultural land being parceled for urban use. Analysis of residuals from the regression model showed small lot size requirements to be associated with greater residential parcellation. Townships with small minimum lot sizes also had significantly greater agricultural conversion ratios than townships with minimum lot size ordinances of 10 acres or greater. Among the most significant factors in parcellation were the population growth rate, the extent of agricultural land use, and the acreage of farmland enrolled in Michigan's Farmland and Open Space Preservation Program.

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PURPOSE OF THE STUDY

Introduction

A combination of push and pull factors operating on the supply and demand of rural land for residential development has accelerated the creation of land parcels under 20 acres in Michigan (Norgaard, 1994). Improvements in and additions to the interstate highway systems, increased personal incomes, land use policies, and increased urban social problems were among those factors that spawned new urban developments away from proximity to existing urban centers beginning about fifty years ago (Canty, 1969). Various quality of life amenities associated with the rural area, perceived differences in quality of education between large urban school districts and suburban or rural districts, the difference in unit price of land between urban or subdivision locations and rural areas are among the pull factors leading consumers to purchase land separate from planned housing developments or in smaller developments non-contiguous to other residential land use. Push factors influencing the rate of farmland sales for non-agricultural use include the effect of economies of scale on farm size and investment resultant from disparate increases in farm production costs versus commodity prices. Some farmers have been better able to take advantage of the improved technologies behind the significant increases in productivity while myriad others have sold or no longer cultivate

their land. Market values for land which greatly surpass farmland values and any incentive tax credits to remain in farming are a pull force that leads to parcellation of parts or entire farm parcels for purchase by developers or individual home builders (Ndarusigiye, 1994).

Land use in Michigan is also marked by the increasing rate of conversion to residential use and the extent to which this increase overshadows the actual population growth rate requiring new residential space (MSPO, 1995). This trend can be expressed as a decline in the persons per acres ratio of the population to residential land cover, the population growth rate compared to the rate of increase in land utilized for new housing, or simply, the annual increase in new residential acreage expressed in total acres or percentage of total land area.

Of particular concern to some is the threat that increasing residential land cover poses to the agricultural, ecological, and cultural values contained in rural land and water resources. The trend towards scattered development of large unplatted residential parcels has been associated with the agricultural land conversion phenomenon (Bennett, 1986; Rossol, 1981). One often cited Michigan study reports that the state's farmland is being reduced by urban expansion at a rate of ten acres every hour (Skjaerlund, 1995). While there is ongoing debate regarding any significant relationship between farmland and open space loss and potential effects on food security and agricultural production capabilities, the reduction in agricultural acreage in the urban fringe areas is believed to be significant. In a recent study of land use trends in western Michigan, counties with high forecast population growth (Kent and Ottawa, primarily) were projected to be at risk of losing 30-

40% of their farmland over the next twenty years if current trends in housing density continue (Skjaerlund, ibid.).

Recent changes in the Subdivision Control Act of 1967 (SCA), now the Land Division Act, may result in greater parcellation of rural land. A few local governments in Michigan have been successful in establishing farmland purchase of development rights programs but most township and municipal governments rely on minimum lot size statutes to regulate parcel splits in their agricultural areas.

Problem Statement

Regulation of most rural land use in Michigan has been given to local planning and zoning boards through state enabling acts, leaving local governments as the near sole arbiter of land use decisions within their boundaries. Although there was uniformity across the state for land divisions under ten acres, as set forth in the former SCA, there has been great variation in local regulations governing the size and configuration of lots for residential use. Depending on the demand for new homes in rural or exurban areas and the minimum amount of land required per residential unit, the total acreage devoted to such use may not reflect the appropriate use of land for residential purposes nor as optimal a rate of land conversion for residential use as the land market would otherwise determine. The net effect of the trend in lower density rural residential developments on the total reduction in agricultural land and open space and the contribution to this phenomenon from land parcellation due to expectation of development is not known since most of the data on farmland acreage and parcellation consider only that land that

has been taken out of cultivation and production, and not the loss of productive acreage represented in that land that has been split into smaller parcels.

The growing proportion of rural land in residential use and the possible effects of these small land holdings on important agricultural land has been the focus of research in Michigan. (See Rossol, 1981). The prevalence of 10-11 acre parcel splits associated with the platting requirement for parcels under 10 acres, as set forth in the 1967 Subdivision Control Act (Arthur, 1981; Norgaard, 1994), while not synonymous with the effects of large lot zoning or increased rates of urbanization of farmland, indicate some of the perceived problems of restrictions on unplatted land divisions. Among them: (1) idling of land for up to several years until changes in zoning and/or public water and sewer allow for higher density developments and greater returns on investments in land; (2) the creation of larger than desirable lots and larger than the market would determine unfettered by zoning restrictions; and (3) rendering the majority of land contained in residential parcels unavailable for other use.

The majority of farmland in active production is located within areas of townships zoned as agricultural use. Lots for single family homes is usually a permitted land use in agricultural zoned areas, though it is allowed only at lower densities than in other residential use zones. The minimum lot size ordinance is the most common land control device to limit non-agricultural land use in agricultural zoned areas (Coughlin, 1990). Townships adopting zoning with large minimum lot limits for residential development may do so, reasoning that lot prices and lack of consumer interest in and affordability of large lots will significantly limit the number of homes built in these areas. Viewed from a consumptive perspective of rural land, large lot sizes also serve as a means to maintain

a low density housing pattern, a force that pulls many urban people seeking a rural lifestyle. Many other townships, however, maintain lot size requirements not significantly greater than the third to half acre requirements of residentially zoned areas of the township.

Though it may take fewer sales of parcels in areas employing large lot zoning to equal the same acreage of many parcels created in townships with one acre minimum lot restrictions, there is little information available to indicate that large lot zoning is a greater contributing factor to urbanization of rural land than zoning which allows smaller residential lots. Growth management methods, such as the lot size provision, may have positive, negative, or no impacts whatsoever on farmland or other sensitive lands. Increased residential parcellation may or may not be a good indicator of land that has been converted from agricultural to urban use since it is feasible that large underutilized portions of large residential lots might remain in productive agricultural use.

Objectives of the Study

Land in agricultural use in Ottawa County decreased by 13% and residential land use increased by 30% between 1978-1992 (Koches and Toering, 1996). Land in agricultural use in 1978 accounted for 80% of the acreage converted to new residential developments. Information is lacking, however, with regard to the change in agricultural and residential land use in areas zoned for agricultural use with varying low density residential development requirements.

This study has been motivated by the lack of such information. The principal objectives of this study include:

1. To examine whether the percentage of rural land in residential parcellation in Ottawa County is significantly different in townships with greater or lesser land division restrictions, represented here by local minimum allowable lot sizes.

2. To determine whether large lot zoning and large parcels convert proportionately less farmland than small parcels created under less restrictive zoning.

3. To evaluate whether land use controls regulating lot size requirements are a determining factor in the actual size of parcels that have been converted to a residential use: Does the variability in average residential lot sizes conform to the minimum lot sizes imposed by townships?

4. To test whether, among those factors influencing the rural residential land market, zoning for lot size is a significant determinant of rural land use conversion.

Definitions

The terms "land parcel", "parcel", and "lot" are used interchangeably to denote a determinable area of land, not in a recorded plat, pertaining to a person or persons holding title to that land. These terms do not refer to a group of contiguous lots in single ownership which are shown as a single unit in county plat books. "Tract" differs from a parcel in that it may be comprised of more than one parcel under the same ownership. The process of splitting a parent parcel into two or more smaller parcels of 40 acres or

less, and the cumulative process of such activity, will be referred to as "parcellation" or "parcel creation". "Active parcels" and "inactive parcels" refer to current parcels and to parent parcels which were split or combined into other parcels, respectively. Parcellation also encompasses the creation of larger parcels through combination of parent parcels, though that is occurring at much less frequency than the use of the term here and is not applicable to the intent of the present discussion. "Lot size", "lot area", "minimum lot size" and "lot size requirement" refer to the area of a parcel and the zoning ordinance that stipulates that minimum parcel area necessary in order to build a single family home or other permitted use. "Large lot size zoning" refers to a minimum lot size of at least ten acres. "Residential use" refers to that portion of the parcel where, due to a lack of another predominant use and based on parcel size, the probable future use, if not present use, is residential, irrespective of evidence of actual residential use. "Built-up" use refers to those parcels where there has been evidence of residential use.

Urbanization refers to all change in residential, commercial or other non-farm use of land. Scattered home sites in predominantly agricultural areas may not create an urban environment but the process of migration into rural areas can be described as a process of urbanization. Since this study only calculates land area that has been or may likely be converted to a residential use, and given the high proportion of urban land use in rural areas comprised of single family home sites, the use of the term "urbanization" refers to land that has been converted for residential use.

The terms "agricultural land", "land in agricultural use" and "farmland" refer to land that had some evidence in the aerial photography of agricultural activity. Practices relevant to agricultural use are elaborated in the section on research methods.

CHAPTER 2

GENERAL BACKGROUND

Introduction

The context of this study is land utilization and the mechanisms by which public and private interests in land are maintained. The problem stated here addresses land utilization in the midst of competing forces for land acquisition and the need to preserve certain natural resources from the urbanization process.

Land ownership in the United States is deeply rooted in the common and statutory laws underpinning a strongly held assumption of private property rights. These rights to land use have been described as a bundle of rights (Barlowe, 1973). The largest and most common bundle of rights is that implied in fee simple ownership: the right to possess, use, sell, trade, and within reason, destroy ones land resources. But fee simple and other land possessions are not absolute bundles of rights. Certain restrictions necessary to protect the general welfare, health, and safety of the public limit full acquisition by individuals of all the rights to land, or sticks, represented by the bundle.

Intervening in the land market for purposes of limiting the free exchange of land can serve many purposes. In addressing the control of land parcellation, it is important to acknowledge what is being preserved or protected and for whom. Urban sprawl poses

threats to many, often divergent, land use interests. The fact that local zoning and planning documents often use farmland, open space, and rural character preservation as goals for the same land entities is indicative of the multiple values land represents to society and the potentially competitive nature of land uses.

The parameters analyzed in this study are not limited to changes in farmland acreage, and zoning in rural areas is not intended exclusively for farmland retention. This chapter is a discussion of the varied interests surrounding rural land use preferences and local government mechanisms for controlling land use in rural areas, specifically the minimum lot size regulation. The use of lot size restrictions for purposes of farmland retention is preceded by a summary of the status of farmland loss and the relevance of land division in agricultural areas.

Township Zoning

Michigan has more local governments regulating land use than most other states, including at least 1242 townships by 1990 (MSPO, 1995). The legal basis for township land use controls in Michigan goes back to the passage of the Township Rural Zoning Act (P.A. 184) of 1943. The intent of this and subsequent planning acts, including the Township Planning Act (P.A.168, 1959), was to confer to each community the right and responsibility to provide for all lawful land uses within their boundaries. This is commonly referred to as "home rule" and is notable for its failure to encourage or establish a legal structure for coordinated planning between communities. County or

regional planning and zoning is seen as an alternative to ensure preservation of certain common resources not distinguishable by political boundaries, such as farming communities and prime farmland (MSPO, 1995). Home rule may also work against the likelihood of coordinated zoning used to prevent disammenties, such as might occur when a large residential lot size in one township acts as a push factor increasing demand for residential lots in an adjacent township with a smaller minimum requirement, thereby shifting the loss of prime farmland elsewhere.

Zoning ordinances, by definition, establish regulations for land use for distinct areas (districting) to introduce uniformity into community land use. Ordinances regulate lot area, lot width to depth ratios, lot frontage on roads, setbacks of buildings from lot lines, as well as a myriad of codes specifying acceptable standards for building and infrastructure methods and dimensions.

The zoning board of appeals (ZBA) is the ultimate authority in interpreting the zoning ordinance and is the grantor of special use permits as well as variances to specific restrictions, such as minimum lot size, in cases of proven hardship (VerBurg, 1990). These actions, which may weaken the affect of a provision such as large lot zoning, include rezoning, providing for planned unit developments (PUD), and spot zoning. Rezoning and spot zoning both refer to changes in the zoning district boundary so as to allow land uses incompatible with the intent of zoning district where the parcel is located. They differ in that spot zoning often can involve a single parcel rezoned and situated without regard to future or adjacent land use. Rezoning is more apt to occur near the boundaries of zoning uses and adhere to intentions of the comprehensive plan. The PUD has grown in use in recent years and allows the township greater leverage over particular

land uses and housing services or amenities that may not be specified in the zoning ordinance while also allowing flexibility in design, such as higher densities than zoned (VerBurg, ibid.).

The Planning Act established the comprehensive or master plan as the basis upon which zoning ordinances are developed and is the document that should be the rationale for mapping districts for principal use and allowable densities. The master plan is usually marked by its generality as to future land use. This may mean fewer levels of development density and general, rather than specific, locations where future land use is expected to occur.

The key to zoning, and many of the ZBA and township board decisions is the master plan and zoning maps. The zoning map delineates the boundaries of the various zones or districts for the specified primary and special uses, along with the lot and building dimensions regulations for each district as outlined in the ordinance. Since every parcel must be designated for something, the township zoning map typically includes excessive areas designated for certain uses (MSPO, 1995). This entails frequent changes to the district boundaries in the zoning map. Though the zoning map may work well to preserve developed areas in their present character, it does not work as well in undeveloped areas and represents planner's and township official's best guess as to what landowners will want to do with their land at some future point (Kelly, 1992). The master plan also includes a map of intended or expected future land use for the township, upon which requests for variances or special use permits are judged.

Most zoning in areas of agricultural use is non-exclusionary by allowing non-farm residential and other urban related uses. The extent to which zoning is exclusionary and

to which parcels are split and sold in rural areas is largely dependent on the zoning decision making process and the likelihood that a capital gain can be expected from a zoning change being granted (Mandelker, 1971). Fischel (1990) has characterized zoning as a flexible and decentralized network of restrictions where one ordinance may in effect pose no real restriction due to accompanying ordinances or clauses. This is exemplified in some of the townships in this study where large lot ordinances have been amended by allowing certain exceptions for children or farm employees or by excluding certain parcels from the regulation. (See Table 3.1).

Growth Management

Assuring a timely and ordered process of urban land use expansion is perhaps the primary purpose for limiting development in rural areas, especially for those rural areas in close proximity to important urban centers. Included in the basic tenets of zoning is encouraging a compact pattern of suburban and urban development separate from rural development (Hoataling, 1977; Lyman et al., 1977). This is contrary to the seeming uncontrolled nature of urban sprawl. Sprawl can be thought of as the pattern of development characterized by lower housing densities and a leap-frog like location of residential lots, rather than a continuous in filling of available land contiguous to present development (Kelly, 1992). Maintaining large allowable residential lot sizes may discourage a significant number of purchasers of rural residential land, but those lots created will be larger than equilibrium, thereby contributing to the process of leap-frog development.

Much of zoning in undeveloped areas, including agricultural lands, may actually serve the purpose of regulating growth, rather than preserving agricultural uses indefinitely, and the agricultural zoning district may be simply a holding zone, directing residential development to areas with higher allowable densities (lower minimum lot sizes) (Mandelker, ibid.). This holding function may occur on land that is being actively farmed by a landowner or through a rental agreement, and the land use may show no appearance of conversion to development. According to Mandelker, lot size restrictions may temporarily reduce the number of new homes and subdivisions in rural areas but the land use plan becomes the basis for development expectations for the community and the real work of zoning is often the management of change of the zoning map and ordinance in response to requests for development.

Fischel's (1989) comprehensive review of research on urban growth control measures includes his own appraisal that large minimum lot sizes promote inefficient use of available residential land, displacing people, in sprawl fashion, to areas more distant from established urban centers. He argues that such growth control measures will force developers to build in communities with less restrictive zoning since they wish to maximize their profits by increasing the number of buildable lots per parcel. This assessment would seem to fit large minimum lot agricultural zones in as much as greater restrictions were found in urban fringe townships and lot size regulations were equal or less restrictive, with increasing distance from the urban center

The fiscal impacts of unregulated residential development is a related inefficiency concern with large residential lots. Scattered residential development in rural areas result in part from the disproportionate land area available for such permitted uses in township

agricultural or rural residential zoning districts and the general lack of utility infrastructure that would predetermine the location of residential developments in higher density residential zones. The Costs of Sprawl, a 1974 study by the Council on Environmental Quality, concluded that sprawl leads to higher overall costs for residential development because of the extension of infrastructure improvements to dispersed residences (Council on Environmental Quality, 1974). Cost of community services studies, by the American Farmland Trust, comparing tax revenue and expenditures for public services such as roads, police and fire protection, and schools, found greater efficiency of public expenditures for primarily rural, agricultural areas than for rural areas with significant populations of non-farm residents. The same conclusions have been made between planned, higher density residential development and sprawl developments. (Misseldine, 1987).

Preserving Rural Character and Property Values

Limiting higher density residential development by lot size restrictions, or employing farmland and open space preservation measures, also serves to preserve the environment that attracts rural residential land owners. Kline and Wilchens (1994), in a study of referenda to establish funding for farmland preservation, found that residents of rural property near large urban areas supported the land preservation measures not so much for the preservation of the productive value of farmland but for the open space values, preservation of property values, and other amenities, such as lack of traffic congestion, associated with rural lifestyles.

As a rural township becomes more suburban its zoning may become more restrictive so as to protect the interests of its newcomers. New residents stand to gain from the prevention of further, especially higher density, development near their homes and will likely try to enforce the large lot restrictions they may have previously opposed in hopes of preserving the aforementioned rural residential amenities and keeping a check on property tax increases resulting from growth related public improvements. (Brown and Scales, 1993) Instead of residential development extending to the closest vacant land, adjacent to existing development, zoning often preserves the interests of present homeowners by allowing only equal or lower density developments, thus serving as an impetus for new parcellation in areas previously undeveloped. If, by setting zoning lot size restrictions that increase the price of a single family home site further beyond the equilibrium price than some are willing to pay, the restriction has limited the supply of sites, increasing the price of the remaining sites and maintaining or improving the price of existing homes (Fischel, 1989).

Contrary to the concerns over fiscal inefficiencies of serving rural residential areas, others have found the net effect of rural residential development on large lots to be positive for the local government setting the land use controls (Dueker et. al., 1983). While taxes levied and revenues collected may be low, many of these services (utilities, parks and recreation, and fire and police protection) are either internalized by the land owner or provided at lower levels. As urban growth continues and employment opportunities and the boundary of urban development extends farther from the central business district, land and personal property values increase for rural residences, increasing the tax base for local government.

Land Values

The other side of the coin in this appraisal of lot size and increased land values, and that which is more applicable to single family residential development on unplatted lots, is the oversupply of large, undeveloped lots that reduces costs per acre and creates demand for single family homes in rural areas where low density residential land use is permitted. Lower per unit cost of lots allows rural residential land purchasers larger lots for the same price as a smaller lot in higher density zoned areas (Fischel, ibid.). Empirical studies by Ohls (1974) show that setting a lot size that is greater than the market equilibrium size determined without restrictions increases the supply and demand for larger residential lots and reduces the cost of housing on large lots by reducing the land to building cost ratio.

If, however, the total price of a single family home site exceeds the equilibrium lot price by more than a person is willing to pay due to sheer land area, the restriction has limited the demand for lots in areas of intensive agricultural use (Fischel, ibid.). This is the underlying intention one would expect in townships legislating large lot zoning. The countervailing effect here is that in areas with relatively greater population density there is a consequent limited supply of large lots, which, coupled with increased prices of higher density zoned land, may in time decrease the difference in lot unit prices (Healy and Short, 1981).

Preserving Farmland

Concerns with residential densities and sprawl lead logically to concerns about the preservation of the maximum practicable amount of land for essential non-urban use. There are many reasons for preserving farmland and for judging which farmlands should have priority in preservation efforts. Few would argue, however, that all farmland needs to be protected from other development. As the population continues to increase and trends in farm size and commodity prices and yields continue, more farms will be idled or will be consolidated into other operations, including acreage that is converted for purposes of urban expansion.

Farmland Loss

The importance of the under utilization of land in residential holdings, presumably much of it agricultural land, hinges partly on the conflicting estimates regarding the extent, if any, of a threat to future agriculture productivity from urbanization of rural landscapes (NALS, 1981; Crosson, 1982; Vesterby, et.al., 1994). Estimates for the loss of agricultural land at the national level, and for Michigan, vary considerably. The variability in estimates can be traced to early land measurement errors put into record, inconsistencies within and among agencies in defining land uses, differences in data collection procedures, exclusion of significant sources of land use due to acreage and population limits, and relying on census information or economic surveys in place of physical observations or representations such as satellite imagery (Bennet, 1986; Greene and Harlin, 1995; Vesterby et al., 1994).

The authors of a USDA study of urbanization of rural land (Vesterby, et al., 1994) emphasize the distinction between farmland loss and cropland loss, the former including a large proportion of land in forest, range, or other non-tillable uses. Their estimates of urban related losses of rural land included an annual range for the decade 1970-80 of 740,000 to 1 million acres, considerably less than the 3 million annual loss reported in the National Agricultural Lands Study (NALS, ibid.). They conclude that the actual acreage of cropland removed for urban purposes does not pose a significant threat since additions to cropland, from range land primarily, offset a large percentage of the loss.

Similar variability exists in estimates for Michigan's decline in farmland. Skjaerlund (ibid.) cites a loss of Michigan farmland of 854,00 acres between 1982-1992, the source of the often quoted 10 acres per hour conversion rate. In his 1986 study of farmland conversion in Michigan, Bennett concluded that only three percent of Michigan's good farmland soils were converted during the period under study (1962-78). This is a considerably smaller proportion of total agricultural land than in the estimate cited by Skjaerlund even though this also corresponds to that period when the farmland conversion rate in Michigan was at its peak (Skjaerlund, 1995). Even so, in terms of preserving a future good it is important to emphasize future needs, which are difficult to predict and depend on many factors. One can be certain that a three percent loss in farmland repeated over a relatively short time cycle could be serious when considering the food needs of many generations hence.

Prime Farmland Loss

Preservation of farmland resources may be more easily justified if it can be shown that the threat from urbanization is greater for those soils deemed most valuable for agriculture. At the national level most of the land inventoried as potential cropland has limitations which would necessitate greater conversion costs and negative externalities such as heightened soil loss when compared to most of the land presently in crops. (Healy, in Crosson, ed., 1982). As productive prime farmland is converted to urban use it is often compensated for by increasing the acreage of cropland on more marginal soils. (Nelson, 1990). In the urban fringe area this problem is accentuated by the tendency of spatial correlation of metropolitan areas and prime soils (Vining and Plaut, 1977). Ninety percent of Michigan's population resides in the southern half of the lower peninsula, the location of an equal proportion of the state's prime farmland (Bennett, ibid.).

Estimates also vary on the rate of loss of the state's prime agricultural soils. Bennett's (ibid.) estimate of prime farmland loss (1962-78) was 231,500 acres compared to a loss of 600,00 acres between 1977-82, estimated in the 1982 SCS National Resource Inventory. Bennett's (ibid.) study was limited to southern lower Michigan while the NRI study covered all of Michigan, though the great discrepancy in estimates of the two studies could hardly be attributed to this since Bennett's area contains 90% of the state's prime farmland acreage.

Impermanence syndrome

According to Healy and Short (1981) in The Market for Rural Land, the extent to which agriculture and other rural land uses are affected by urban development in the

present and the significance of future impacts depends not only on conversion from one specified use to another but also on land parcellation, regardless of changes in its use. Fragmented land holdings in farming communities contribute to secondary losses, where effects on adjacent farms and the overall farm economy are manifested over a period of many years (Lockeretz, 1989). Lockeretz and others have referred to this effect as the "impermanence syndrome". As urban migration enters rural areas conflicts arise over land use expectations, and newcomers, whose numbers may become quite disproportionately larger than their non-farm acreage, may be successful in gaining township backing for limitations on farm practices they feel impinge on their quality of life and investment. Farming may become less efficient if practices are adopted by farmers in order to assuage concerns or threats of non-farming neighbors, such as new routes for farm machinery on county roads that become residential corridors.

Whether farmers are attracted by the prices offered for the consumption value of the land, are driven to move the operation or retire because of inefficiencies and production intrusions mentioned, or leave farming for other reasons, the process is not immediate and is dependent on the extent to which residential and other urban developments were allowed to occur in the farming region (Lockeretz, ibid.). Secondary consequences merit emphasis because the decline in farming may be proportionately greater than the decline in farmland due to incompatible land uses and expectations of development. In so much as lot size provisions increase the number of non-farm residences and affect the acreage of farmland taken out of productive use or parceled into residential size lots, secondary effects could be heightened.

Land Fragmentation in Rural Areas

Determining a lot size that does not preclude agricultural use is not a simple matter. With respect to legislating lot sizes, smaller parcels necessarily remove less land from agricultural use though it takes fewer purchasers of large lots to idle an equal amount of land as with smaller lots. Depending on the location of homes on farmed parcels and the willingness of residential landholders to allow continued production, more agricultural production may be likely to continue on large lots than on smaller lots. Many smaller fields, not contiguous to other farmland, may be less efficient for cultivation with larger tractors and implements and will be especially likely to convert to other uses. A viable enterprise comprised of specialty crops will require less acreage than conventional row crops and in turn may be able to utilize additional purchased or rental land of lesser acreage comprising underutilized portions of residential parcels.

A York County, Pennsylvania study (Coulghlin, 1990) defined as unsustainable those farm parcels that were scattered or rented. The study determined that land division outside of the platting mechanism should not occur under 100 acres. In response to a survey regarding the level of non-farm dwelling units at which they felt farm operations would be detrimentally affected, two-thirds of farmers responded that no more than three units per hundred acres should be allowed.

The demand for rural residential lots in some areas, nonetheless, may be so great so as to bid up the price on parcels of 40 acres or even greater, out of the reach of most farmers whose incomes are more apt to be based on per-acre revenues less costs (Coulghlin, ibid.). Arthur (1981) cites a study from Washtenaw County, Michigan

townships in which less than 10% of the 134 ten acre parcels created between 1964 and 1977 remained in large scale agriculture subsequent to parcellation.

Lot Size Zoning and Agricultural Preservation

The majority of Michigan's agricultural zoning is non-exclusionary, with respect to allowing non-agricultural secondary uses in agricultural zoning districts. In as much as a township wishes to discourage residential developments in agricultural zones it usually relies on some form of lot size restriction for non-farm uses. Exclusionary agricultural zoning is the product of ordinances that strictly limit non-farm development to those children or employees directly involved in farming operations (Lyman, 1977).

Minimum lot regulations intended solely to preserve targeted farmland and farmland uses by discouraging non-compatible uses would likely mandate lot sizes sufficiently large so as to discourage such purchases of rural land. While most large lot provisions intended for agricultural preservation are from 10 to 40 acres others can require lots as large as 640 acres (Popp, 1989).

As a tool to preserve farmland or protect farmland from the spillover disamenities of urban encroachment, lot size zoning may generate different results depending on the level of implementation. While this study looks at diverse lot size requirements put in place by individual local governments, much of the research on non-exclusive lot size agricultural zoning examines the use of this technique in counties where land use districts are large and important agricultural areas are bounded together in one zone as opposed to the many township zones not contiguous to each other (Nelson, 1992; Nelson and Daniels, 1986). Nelson (ibid.) evaluates the ability of zoning in Oregon to eliminate or

reduce prices of farmland relative to development values. He theorizes that speculation in farmland is eliminated when market values decline as proximity to urban or exurban areas increases. Rather than reflecting the land prices of non-farm use, effective preservation zoning should lower farmland values with increasing proximity to urban areas and the accompanying expectation of negative externalities on farming activities. Proximity to low density residential districts in the Salem and Portland metropolitan districts with five and ten acre minimum lot sizes resulted in increased values for farmland. Nelson (ibid.) attributed this to the expectation of farmland conversion to residential use, even though the exclusive nature of the zoning would tend to preclude rezoning. In districts with at least twenty acre development requirements, Nelson (ibid.) concluded that farmland value did decline sufficiently to indicate an absence of farmland speculation. He contends that non-exclusionary zoning with similar or greater lot sizes merely creates rural sprawl and extends the impermanence syndrome even farther into the landscape. The higher the lot size, the lower the tendency in effectiveness in farmland preservation.

Evidence from Oregon's farmland preservation program also suggests that loss of acreage in farm production may be masked by the increase in acreage under hobby farm ownership (Nelson and Daniels, ibid.). In the metropolitan counties of the Willamette Valley between 1978-1982 there was a proportionate increase of farms of less than fifty acres and decrease in rented farmland. To the extent that hobby farms increase in number and compete with larger commercial farms for higher quality land, long-term viability of individual commercial farms may be threatened. During this time the number of farms under ten acres and the number of farms between ten and fifty acres increased by 23%

and 14%, but together, the increase in commercial farms in these categories only comprised 5% of the total small farm increase (Nelson and Daniels, ibid).

State Land Division Regulations

Michigan's Subdivision Control Act (SCA) (PA 288, 1967) is similar to a minimum lot size ordinance in that it creates a disincentive for subdividers of land wishing to create parcels under 10 acres from a larger parcel. Arthur (1981) and Norgaard (1994) show a significant increase in the number of rural lots of 10 to 11 acres and an increased percentage of land in small parcels since passage of the Subdivision Control Act. The SCA explained about 40% of the total variation in the amount of sample townships' parcellation acreage between 1963-1977. Changes to the SCA (the Land Division Act, P.A. 591, 1997) may alter the large lot stimulus of the 10 acre minimum though the parcel regulations of the Land Division Act are still subject to the lot size regulations of township zoning. It's possible that in some townships with expectations of significant urban development that the SCA was a greater determinant of the average parcel size and the level of residential parcel activity than was local zoning.

CHAPTER 3
STUDY AREA AND METHODS

Description of the Study Area

Ottawa County comprises many of the characteristics of regions threatened with growth related natural resource loss and is a good laboratory for studying land use change. The county has as its principal population centers, Holland, Grand Haven, and in neighboring Kent County, Grand Rapids and its western suburbs. Three important highways, interstates 96, 196 and US 31 transect the county, reducing commuting times to Grand Rapids, Holland and other employment centers.

Ottawa is one of the state's fastest growing counties. Population grew from 128,181 to 187,768 between 1970 and 1990, a 46% increase. Population increase projections for 1990-2020, range from 66-80% (MSPO, 1995; Koches and Toering, 1995). Based on their population allocation model, this growth in population will entail an additional 32,000 acres of land utilized for residential use (Koches and Toering, 1995). This translates to an area of land equivalent to fifty standard 640 acre township sections. According to the Koches and Toering (1995) study of land use change in Ottawa County from 1978-1992, approximately 77% of the additional 12,630 acres of urban land cover over this time was appropriated for residential use. The actual county growth rates in

population and residential land use acres for this same period were 28% and 31% respectively. This is much less significant than many of the reported disparities between population growth and rates of urbanization of land (MSPO, 1995; Rusk, as cited in Schultink and vanVliet, 1997). Some of the significant differences in the two rates may be masked by the population to land use growth ratios in rural areas, which will be highlighted in a later section of this paper.

The Michigan Society of Planning Official's (MSPO) Future Trend Study places Ottawa County as the top Michigan county in gross revenue from agricultural sales. Ottawa County is a significant producing region of both conventional agricultural commodities and specialty crops, including higher than average state and national sales from fruit, vegetable, nursery and overall agricultural production. Given their proximity to the sand dunes of Lake Michigan's eastern shore, soils of Ottawa County are generally sandier than those of interior Michigan counties. Soil formation has occurred on nearly level and gently sloping dunes, lake and outwash plains, upland moraines and flood plains. Soil associations important in crop production are comprised of loams over sand and gravel in the eastern half of the county; sands, sandy loams and loamy sands in the western half; and bottom-land and organic "muck" soils in the central flood plains (NRCS, 1972). Prime farmland[1], as defined by the U.S.D.A.'s Natural Resources Conservation Service, are found predominantly in the loams of the eastern part of the county. Unique farmland, mapped in the important farmlands inventory (1973), together with the milder winter temperatures of the Lake Michigan regional climate, contribute to

[1] Prime farmland refers to farmland or potential farmland that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber and oilseed crops.

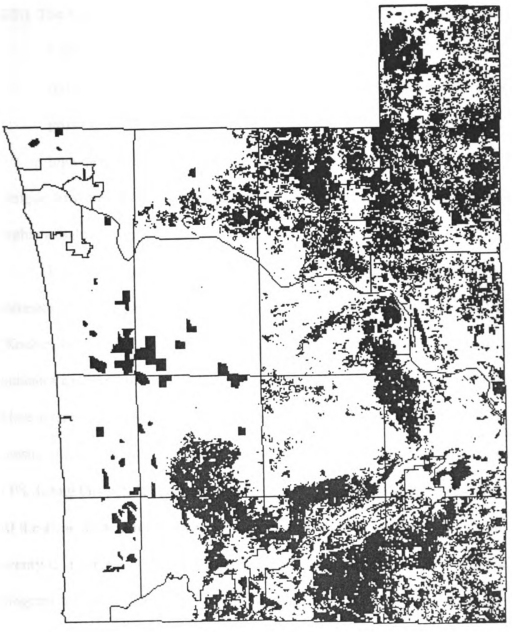


Figure 3.1 Prime and Unique Farmland: Ottawa County (MIRIS, 1978; NRCS, 1973)

Legend: ■ Unique Farmland

Prime Farmland

Ottawa County's predominance in blueberry and nursery crop production. (See Figure 3.1.) The Natural Resources Conservation Service defines unique farmland as :

> " land other than prime farmland that is used for production of specific high-value food and fiber crops. It has the special combination of soil quality, location, growing season, and moisture supply needed to economically produce sustained high quality or yields of specific crops."

Unique farmland, by definition, is in agricultural use while prime farmland need only be highly suitable for such purposes.

Estimates of agricultural loss in the county vary. Grand Valley State University's estimate of losses from 1978-92 is nearly 28,000 acres or 14% of total 1978 farm acreage (Koches and Toering, 1995). The census of agriculture estimates for acres in farms indicates a net loss of about 7,000 acres or 4%, though over a shorter period (1982-92). More interesting is the slight net increase in acreage of harvested crops reported by the census of agriculture for this same period. The number of farms in Ottawa County fell 13% during this period and all the decrease occurred among farms of less than 500 acres. At the same time, non-harvested acreage increased 170% to 9,000 acres. Less than twenty-five percent of this idled farmland can be attributed to Conservation Reserve Program acreage in 1992, which leads one to believe that marginal acreage on smaller farms and fields is being taken out of production and production on larger farms is being increased.

Research Methods

Urbanization of rural land from residential development can be thought of as occurring in a three step process (Lockeretz, 1989). Land is first parceled for sale, exchange of land to non-farm owner occurs and, finally, the new owner converts the parcel in part or whole to residential use.

The objectives of this study can be accomplished by examining the extent of acreage that has been parceled and that which has been converted to residential use. If one can generalize that the conversion of most rural land to residential or urban uses is not immediate and that parcels can be farmed for as much as twenty years in the intervening period before conversion (Brown et al., 1981), the inclusion of parcels characterized as "likely to be developed" may significantly alter the estimate of changes in land use and increase the sample of parcels by which to make comparisons based on minimum lot size statutes.

Study Variables

The principal indicator of residential land use change is the acreage of residential parcels created during the study period in areas zoned for agricultural/rural residential use. This variable is referred to as rural residential parcellation and is expressed as a ratio of total residential parcel acres to total acres in the sample available for residential development, excluding major highway and utility acreage. Parcels included could be as large as 40 acres because one township included a zoning restriction for residential use of this dimension. The primary independent variable for which parcellation ratios were compared is the township minimum lot size restriction pertaining to the sample.

Estimates of entire parcels, or portions thereof, converted from agricultural use to residential use (including idled land) were indicated by four additional variables: parcel acreage in agricultural use interpreted from 1973 aerial photos; agricultural acreage converted or idled by 1994; agricultural acreage considered as likely residential use; and the acreage of the preceding variable that was on prime or unique farmland. Each of these variables is expressed as a ratio of total sample acreage to total sample land area. (Table 5.3)

Zoning is only one among many factors influencing growth in rural residential land use. Previous studies of parcellation in the state (Arthur, 1981; Norgaard, 1994), included well documented analyses of those other determinants of land division. While the author acknowledges the importance of these factors and includes many in a later discussion of the study results, that aspect of previous research of land use in Michigan is not reiterated in the present discussion. Additional independent variables will be included in the regression analysis and appear in Table 4.1.

Conversion and development imply an intentional change in land use away from agricultural or open space use brought on by residential migration into the rural area. This does not imply that eventual reversion back to agricultural production is not feasible as much of the converted or developed parcels are simply idle land. Such a change, however, is assumed to be unlikely. Urban built-up land is typically considered to be taken out of the stock of available farmland in perpetuity.

Study Period

Observations of parcellation were recorded for two periods, 1975-87 and 1988-95, according to the year in which the parcel was registered with the office of Property Mapping and Description. The reason for recording parcel data for two distinct periods is that changes in minimum lot sizes occurred in some townships around 1987. (See Table 3.1) The researcher was also more confident in the stratification of the samples by lot size for the later period because it was difficult to obtain information regarding the exact date of origination of many lot size regulations. There is typically a time lag between a parcel split and the mapping and recording of the parcel in the county department which served as the primary source of data. A parcel created in 1994 may not have been recorded until 1995. For this reason the author felt that the later photo would include most parcels recorded by 1995.

Sources of Data

Black and white 1:200 scale aerial photographs from 1973 and 1994 served as the principal data source for this study. More limited use of 1984 aerial images was employed, mostly in the initial interpretation stage as a check where land cover and use were less clear. Photographs were the property of the Ottawa County office of Property Mapping and Description and a private engineering firm. All photo interpretation took place in the office of Ottawa County Equalization, who provided ownership data on parcels.

Mylar parcel line maps were overlaid on the photographs to indicate where parcels were located with respect to land cover. Determining the exact number and acreage of parcels created for residential use in a period is an impossibility since parcels

Table 3.1 Township Zoning Regulations

TOWNSHIP	LOT AREA (acres)	LOT WIDTH (feet)	ZONING CHANGES EFFECTIVE	POP. DENSITY 1990
Allendale	.35	150	1 ac. NA	190/sq mi
Blendon	1.5	330		104
Chester	2.5	330		57
Crockery[1,2]	10 40	330 660		106
Georgetown	1	200		760
Grand Haven	5	330	20 ac. 1996	244
Holland[2]	5	325		501
Jamestown[3]	1.5 ¼ ¼	200		99
Olive	2		10 ac. 1988	68
Park[4]	20	330	10 ac. 1988	486
Polkton	1	100		50
Port Sheldon	2	200		98
Robinson	.8	150	1.9 ac. 1995	77
Spring Lake	.7	150	2 ac. 1989	405
Tallmadge[5]	10	330		180
Wright[5]	25	NA		93
Zeeland	2.5	165	1 ac. 1985	108

[1] First entry is for Ag-2 and second entry is Ag-1
[2] Lawful, nonconforming splits allowed for children of parcel owner
[3] ¼ ¼ = Quarter-quarter zoning method. Not included in study
[4] Lawful, nonconforming splits allowed, provided remaining parcel meets minimum
[5] Parcels less than specified acreage at time of ordinance not subject to minimum

are being split into and combined with others continuously. Current parcel maps offer information regarding net additions to parcels but they obscure the information regarding the composition of parcels from which present parcels were created, since historical records, apart from legal parcel descriptions, are not kept. Parcels corresponding to either of the study periods were still active at the time of the study. Therefore, any parcels which were split during the first period and subsequently split again before 1995 would be counted as parcellation for the second period since records of the first split would lack a spatial reference. County plat books were a secondary source of information on inactive land parcels but they differ from official county plat maps in one important dimension: parcels under the same ownership are usually indicated in the plat books as a single parcel, regardless of the actual number of parcels comprising the tract of land.

Sample Survey Design

Because the location of land parcels follows the township rectangular survey system, township and range lines served as boundaries for clusters from which random samples could be drawn. The survey design was a two-stage cluster with a complete census of all clusters selected. Additionally, the sample was stratified by township minimum lot size zoning, according to the study objective. (See Figure 3.2)

Stratum 1: townships with minimum lot sizes of less than two acres

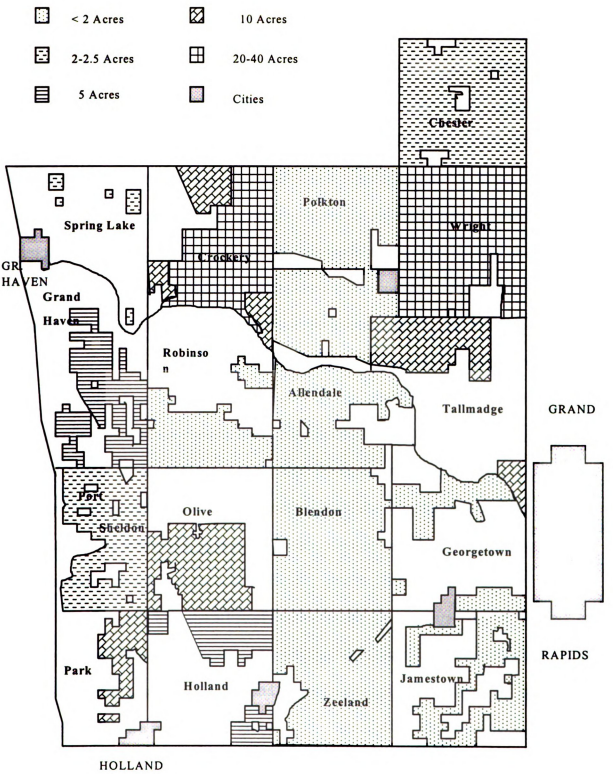
Stratum 2: townships with minimum lot sizes of 2-2.5 acres

Stratum 3: townships with minimum lot sizes of 5 acres

Stratum 4: townships with minimum lot sizes of 10 acres

Stratum 5: townships with minimum lot sizes of 20-40 acres

Figure 3.2 Ottawa County Agricultural Zoning Lot Sizes: 1995



The first stage was to randomly select a proportionate number of sample sections from each township. Proportionality was based on the number of sections in each township's agricultural zoning district as a percentage of total stratum sections. This first stage selection was also systematic since random selections were made, when possible, in each of the six section tiers (north-south or east-west) corresponding to a normal thirty-six section township. The researcher believed this to be an adequate means to disperse the samples so as neither to under represent or over represent the development which occurs along major arterial roads. In order to lessen the inconvenience to assisting agency personnel in filing large photographs and parcel overlay maps, the number of photos and maps necessary to undertake the study was decreased by subsampling. The second stage consisted of randomly selecting two quarter sections from each of the selected sections, which in effect doubled the number of observations for each section.

Acreage measurements included parcel acreage, agricultural land use acreage, acreage of agricultural use converted either by residential development or idling of the land, and prime or unique agricultural acreage. The last measurement is the parcel acreage of agricultural land considered developable which was also prime or unique farmland. Total acreage for all parcels for each of the measured observations served as the basis for computing summary ratios for each quarter section sample.

Parcel records from the office of Ottawa County Equalization and parcel maps included parcel acreage or dimensions for acreage calculation. Dimensions not provided were taken with an engineering scale and the parcel acreage in agricultural use in 1973 was computed with a scale and dot grid overlay. Homes and yards as well as forested

areas, water bodies and other land cover were subtracted from total parcel acres to yield agricultural land cover.

No economic considerations were used to distinguish commercial farming enterprises from hobby farms in interpreting parcels or tracts as farmland. Gardens adjacent to homes were not included as agricultural acreage. Parcels with large fenced portions and buildings indicative of the keeping of horses also were not considered as an agricultural activity. The scale of the images allowed interpretation with reasonable accuracy at this level of land use. A farm or other unit of ownership could be comprised of more than one parcel, a common occurrence where additional acreage is added to a farming operation or when parcellation precedes conversion to a residential or other urbanized use.

Converted agricultural cover by 1994 was computed by the same methods. Parcels included as converted or likely to convert to residential use were compared with locations of prime and unique farmland on the Ottawa County Important Farmlands map (NRCS, 1973) and if prime or unique farmlands were present in the sample quarter section the parcels were delineated on soil survey map sheets (NRCS) for the county and measured for proportion of prime or unique farmland.

Ratios allow a comparative analysis of parcellation incidence across zoning strata and are also useful as percentage comparisons in land use conversion rates for the county for similar periods. The ratio of total residential parcel acreage in the quarter section to the total available land in the sample is:

total parcel acres/total quarter section acres X 100

The standard township quarter section contains 160 acres. Many samples do not contain 160 acres of available land since they include water bodies, areas zoned for commercial or other non-agricultural uses, or are bisected by highways or public utility easements, thereby reducing the available acreage. Partial quarter sections, those with less than eighty acres zoned for agriculture , were excluded from the sample frame.

In most agricultural zoning districts the minimum restriction designates a lower density housing pattern than would occur in residentially zoned areas and in many platted subdivisions. Subdivisions located in agricultural districts, therefore, necessitate a rezoning decision or variance exempting it from the legislated minimum lot size, unless densities conform to the required minimum. The granting of a variance, a planned unit development (PUD), or a rezoning implies that the residential development located in the restricted area not in spite of the ordinance but, in effect, in the absence of the ordinance. For this reason platted subdivisions are not among residential parcels counted in the samples.

Decision Criteria for Developable Parcels

In order to include parcellation of farmland, open space, and other land cover in holding for probable residential sale or use a decision criterion was developed. This criterion also extends to residential parcels in agricultural production but not considered to be a sustainable land use. It was not possible to estimate that agricultural portion of undeveloped parcels that might continue in agricultural production after residential use.

Any agricultural use acreage on undeveloped parcels was therefore considered as developed agricultural acreage, in addition to that portion of the parcel which had already been idled.

The number of parcel divisions and the size of each is a key indicator to the future parcel use. For instance, cultivated fields and farm buildings comprising an 80 acre parcel are more likely to denote a productive, sustainable agricultural enterprise, barring any future sales of the land, than the same farm parceled into four lots of 20 acres each. The classification given the parcel by the township assessor is also an important key to the future use of the parcel. This classification considers a parcel's expected use, based on several criteria, such as zoning and the assessors' subjective estimation of the parcel's highest and best use, noted in the parcel's classification (residential, agriculture, commercial, etc.).

The researcher estimates that roughly 95% of the land parcels in the agricultural zones of the townships under study are classed for tax purposes as either residential or agricultural. The vast majority of working farms and large adjacent, farmer-owned or leased parcels with agricultural cover are classified as agricultural. These parcels are typically greater than twenty and more often than not, greater than forty acres. Only when an agricultural classified parcel of 40 acres or less showed insufficient evidence of ongoing production or the holder of the parcel owned no other agricultural land in the area was the assessor's classification questioned.

Land classified as a residential use is more problematic as this class can include rather large parcels in agricultural use. Classification is also not uniform across all townships. Some township assessors classify land with some regard to the tax rate

differential between agricultural and residential despite the real intentions of the landowner. In practice, the classification should not affect the taxation rate of an individual parcel though it often affects a parcel's market value (Brookhuizen, 1997).

When sampling parcels with no built-up residential use the following criteria were used: parcel size, assessed value, ownership, present use and/or land cover, the number of similar splits created from a common parent parcel, township assessor's classification, and the predominate adjacent land use. Parcels that had no road frontage were not considered developable unless the parent parcel had been systematically split into smaller parcels. The parcel's state equalized value (SEV=50% market value) could not greatly exceed that of other agricultural parcels ($500-$1000/acre) in order not to be considered developed and converted from agriculture. Landowners with no other parcels in the township, real estate or development companies, or someone with a home address in another county were consider to have development intentions for their vacant land holdings since single parcels of the acreage typical of this study would not likely be purchased on the basis of productive value. A large farmed parcel with one split during the study period resulting in a smaller parcel was less likely to be considered a developed use than if multiple parcels were split from a single parent parcel. Since it was assumed that creation of residential parcels was not limited to areas of predominate residential use, surrounding land use was used as a criterion when all other factors were insufficient for making a determination. Additional parcel size considerations were as follows:

1. For all parcels less than eleven acres the parcel acreage was determined an eventual residential use and an agricultural land conversion, if applicable, unless the land was farmed and included farm buildings indicating intensive agricultural

use, such as green houses or other nursery related buildings. If the majority of the parcel had been split into smaller parcels these parcels were counted as if developed even though they were farmed as one unit and under the same ownership. Eleven acres was used because it was believed that many parcels just greater than ten acres would have been created because of the ten acre provision of the original Subdivision Control Act (1967) and it would be important to designate most of these as developed (Norgaard, 1994).

2. Parcels of eleven to forty acres were considered urbanized if they were not in agricultural production during the period or ceased to be by 1994. In order to be considered as primary agricultural use, and therefore not developable, parcels of this category had to include a minimum of 15 acres in cropland or other production related activity and not be characterized by the preceding criteria for developable parcels. Since the majority of parcels of this size were classed as agricultural when that use was predominant, it was felt that the influence of this criterion on the outcome and the chance for overestimating the rate of developed acreage was minimal.

The criterion was somewhat different for determining developable agricultural acreage for those parcels created during the study period where residential development had occurred and was the primary assessed use. It was assumed that agricultural production on a residential lot by someone other than the landowner, as judged by the presence or absence of buildings and machinery, could be a sustainable practice, especially given a history of production activity since residential construction. All parcel

acreage containing homes built since 1975 was considered developed unless the portion of agricultural acreage included was considered a likely ongoing practice. Therefore, agricultural acreage was considered a sustainable activity:

1. When the presence of buildings and other implements served as an indicator of the owner's involvement in the production or when the cultivated field or crop was an evident extension of an adjacent farming operation, usually denoted by crops and/or furrows or other cultural practice spanning the residential lot and farmed parcel.
2. In the case where, after residential construction, agricultural production appeared to shift from a more intensive practice, such as a row crop, to a less intensive practice, such as permanent pasture, that portion of the land was counted among the converted agricultural land. This practice was assumed to indicate a transition away from agricultural production attributed to the change in ownership and principal activity of the land.
3. A home in the middle or rear of a parcel was considered less conducive to ongoing agricultural activities than a home with a comparatively lesser set back.

A common practice in rural areas is the selling of older farm houses and the adjoining yard as a separate parcel from the remainder of the working farm. Since it is probable that a non-farm resident will occupy a farm house or build on the parcel, these parcels and any applicable farm acreage were counted as developed, based on the present discussion. The larger parcel from which the farm house was "pieced off" was not

counted as parceled residential acreage since in most cases the parcel was beyond the scope of the study due to size or was still actively farmed.

Sources of Error

The methodology contains some potential sources of error in this study. They include:

1. Photo interpretation: normal interpretation errors, where a land cover such as a vacant grass field is counted as a farmstead pasture, should be reduced in this study given the scale of the photography (1:200) and the availability of ownership data. The time lapse between the last aerial image and the time of the study made verification of interpretation difficult. In attempting to distinguish, for example, whether land cover from the first image is permanent pasture or open field, the present cover may belie the ability to verify interpretation. In fast urbanizing areas subtle changes in the land cover can occur in a relatively short period, nearly three years in this case.
2. Estimating intended land use: assigning a land use to a parcel that is unlike the present use or land cover may yield a parameter that is of suspect value. The length of time that land parcels are held for speculative purposes, or for development by the owner, may vary so much that including them together as conversions in the same time period may confuse the actual rate of land use succession. Regardless of any wishes on the part of a farmer to sell his/her

land at an attractive premium for urban use, the demand for such uses at prices sufficient to attract farmers away from farming or rural lifestyles must equal the supply of parcel creations. In the intervening period the land use may not change at all. In those cases where the land never is developed it remains in reserve for potential agricultural use. Since it is suspected that a greater proportion of such parcels are created in townships with greater urban growth opportunities than in areas of lesser urban potential, it is also suspected that the proportion over time in the number of parcels created to the number developed will approximately be the same for the different townships.

In a ground check of twenty-nine parcels recorded as likely to be developed for residential use, twenty-two had land uses which were identifiable and the remaining seven parcels' land use or location could not be identified. Of the parcels whose land use could be determined seven, or 32%, had homes constructed since the last aerial photo image and an additional three parcels had a portion or all of the agricultural land use discontinued, and twelve, or 55%, had no evident change in land use.

3. Sampling: given the high incidence of zero or nominally zero values of sample observations and high values for other samples, employing a sample size equation provides little help in the determination of sample size required. In fact, the pilot sample information utilized in the sample size equations indicated sample sizes either greater than the population size or too great to carry out given the time allotted for data collection. In lieu of an adequate determination of sample size the researcher relied on the principal of the

central limit theorem, which suggests a minimum of 30 observations for most parametric statistical analyses.

4. Data Source: there were limitations in obtaining zoning maps for all townships at the same point in time to assure that all samples were zoned for the effect studied for the duration of the study period. Since zoning boundaries changed in some townships over the period studied, later edition maps were preferred over earlier versions. Assuming with urbanization that the agricultural zoned areas would diminish in area, using a more recent map would limit the number of parcels for which rezoning had been likely but not easily verifiable. This would decrease the number of parcels activated in the district but also decrease the number of parcels which neither conform nor are required to conform to the zoning restriction measured. As noted in the zoning chart in the following chapter, changes in degree of zoning restriction, going from a smaller minimum lot restriction to one significantly larger, do not all occur at the same point in time. Most changes in Ottawa County did occur toward the end of the 1975-87 period and, except for one township, the acreage revisions would not be considered as going from a small to a large minimum lot size statute or vice versa. Information on original adoption of minimum lot size regulations is difficult to obtain, especially for those ordinances which did not change over the period of study.

CHAPTER 4

RESEARCH HYPOTHESES AND STATISTICAL METHODS

The previous chapters introduced the problem addressed in this research and the background pertinent to zoning and urban land use expansion in rural areas. The following sections outline the specific hypotheses to be tested and the statistical methods to be used.

Hypotheses

Four hypotheses from the study objectives in Chapter 1 can be statistically validated or refuted and are elaborated in the following paragraphs. Each of these hypotheses involves various tests according to the stratification of the data and the parameters analyzed.

It is important to note here that the relationships between zoning and the parcel and agricultural land cover measures are referred to in the results sections as ratios and proportions. Ratios represent the percentage of the total sample quarter section area that is comprised of a given variable. Proportions represent the extent to which one parcel measure includes another (eg: What proportion of the parcel included land in agricultural use?). The ratios and proportions for each sample are computed for the total

parameter measures (in acres). For example, the proportion of parceled farmland is computed by dividing the sum of all residential parcel acreage in a quarter section sample in a later photo by the sum of all parcel acreage in a sample in agricultural use in the first photo.

Township parcellation ratios

One possible measure of the efficacy of establishing mandatory large lots for non-farm use in agricultural areas is whether land is parceled and developed for residential uses to a lesser extent compared to areas with dissimilar lot size zoning. It is hypothesized that:

> "*The mean of residential parcellation ratios for townships employing large lot agricultural zoning is not significantly different than the mean of parcellation ratios in townships with small lot size zoning.*"

The researcher chose to test the data in a null hypothesis because the apparent prevailing opinion was that large lot size ordinances were not effective in curbing rural residential land use. Because there was no information available to the researcher relevant to such zoning techniques in Michigan, the assumption in the study was that this opinion had some merit. Rejection of this null hypothesis implies the acceptance of the alternative hypothesis: parcellation ratios in townships with small lot size ordinances are either greater or lesser than in townships employing large lot zoning measures. Rejection of this hypothesis leads to the second hypothesis:

Role of Lot Size Zoning in Parcellation

It is hypothesized that:

"*Among the many explanatory factors related to levels of parcellation of land for residential use in areas zoned for agricultural use, lot size zoning is not a significant contributing factor.*"

Testing for the difference in means of parcellation ratios for the zoning lot size strata does not necessitate an analysis of the other factors thought to contribute to the rate at which rural land is parceled into smaller acreage lots for residential use. Ratios of parcellation that differ significantly by lot size zoning category do not indicate a causal relationship between lot size restrictions and levels of parcellation. The independent variables employed in this analysis are among those institutional, economic, and biophysical determinants of rural land parcellation confirmed by previous research (Arthur, 1982; Norgaard, 1995; Alig and Healy, 1987). Including measures of these factors, along with zoning, for each of the samples will provide clues as to the role of lot size zoning in the creation of rural residential parcel levels compared to other determinants of land use change.

Ratio and Proportion of Agricultural Land Use Conversion

Parcellation across townships with varying buildable lot size regulations may also differ in the proportion to which prime and non-prime agricultural land is affected by such parcellation.

It is hypothesized that:

"*The proportions of converted farmland to sample agricultural acreage do not vary to a significant degree according to lot size zoning: samples from townships with large lot zoning do not preserve a greater proportion of agricultural land than samples from townships without this zoning technique.*"

In addition, this analysis will test for any relationship between lot size zoning and the proportion of land parceled for residential use that was either converted farmland or farmland likely to be converted (See decision criteria, Chapter 3).

The second part of the analysis of agricultural land use conversion includes the following hypothesis:

" *The proportion of prime and unique farmland converted to residential land use, or considered converted, to all converted farmland is not significantly different from one township zoning stratum to another.*"

This hypothesis will involve data on all parcels with farmland considered likely to be converted to residential purposes as well as farmland already converted.

Parcel Size

The assumption that actual parcel sizes conform to, and do not greatly exceed, the regulated minimum parcel acreage may not be valid in light of the trend in lower density housing. This has important relevance to the principal objective of zoning and parcellation density since small minimum lot sizes may not guaranty minimum desired housing densities.

It is hypothesized that:

"*The average residential lot size in townships with small lot size zoning is significantly less than the average lot size for townships with large lot size zoning.*"

Hypothesis Testing

Testing for the difference in mean parcellation and farmland conversion ratios and proportions among all lot size zoning strata can be achieved by way of analysis of variance (ANOVA) and the t-test for the difference between two independent sample means. ANOVA tests whether the means of three or more independent random samples are equal, or whether at least one of the sample means is significantly different from the others. ANOVA analyzes variation within the subsamples and compares it to the variation between the subsamples, or zoning strata in this case. The resulting *F* statistic is the ratio obtained by division of the between group variation (zoning strata) by the within group variance (samples within a zoning stratum). If the computed *F* statistic is greater than a critical *F* for a given level of significance and number of observations the null hypothesis of no difference in sample means can be rejected. A ρ value is also given for reference to the probability that the difference could be attributable to random chance alone.

Greater use will be made of the two sample t-test for hypothesis testing regarding differences in parcellation between zoning strata. ANOVA is limited considering that a result that fails to reject a null hypothesis may also fail to indicate a

significant difference between the sample means of two strata. This is important in this study since it is possible that large lot zoning (minimum lot size of 10 or more acres) is a deterrent to residential parcellation when compared to areas with minimum lot size zoning regulations of less than one acre. Rural areas with large lot zoning may not, however, have parcellation ratios significantly less than areas with somewhat larger lot size regulations, for instance 2-5 acres.

All analysis of variance (ANOVA) and two sample t-tests for difference of means will be done at the 95% confidence level, or $\alpha = .05$. In two sample t-tests for the difference of means, results will be reported for two-tail tests of the hull hypotheses of equal sample means. Results which do not show the mean of one parameter to be significantly different from another sample mean may nevertheless indicate a significant difference in a one-tailed t-test. The value of .08 for a two-tailed test is divided by two to obtain the ρ value when one might expect the difference in one mean from another to be in a certain direction, the right or left tail. In this case, .04 is significant at the 95% confidence level while the two-tailed result of .08 is not. For the last hypothesis, regarding mean parcel size among zoning strata, a one-tailed t-test is specified since it is expected that zoning districts with smaller minimum lot sizes are characterized by smaller residential parcels than zoning districts with larger minimum lot size requirements.

Testing whether zoning is a determinant, along with other factors, in parcellation ratios across townships involves correlation and regression analysis. Correlation measures the direction, direct or inverse, of a relationship and its relative strength, while regression fits or predicts values for a dependent variable given values of one or more

independent variables. Significance and relative explanatory power of the regression equation will be based on the *F* statistic and the coefficient of multiple determination, r^2.

The purpose of a regression analysis is to suggest an explanation for the variance in the dependent variable, rural residential parcellation, by showing a systematic relationship, or covariation, in the independent variable or variables, in this case, to show that a certain change in residential parcel creation can be associated with a given change in township zoning lot size. It is possible that the relationship of minimum lot size zoning to the level of residential land use in rural areas is masked by other variables. A few rapidly growing townships which also have small lot size zoning may negate an otherwise significant zoning factor when the role of other explanatory variables are not addressed.

Selecting the most important among several independent variables and determining if zoning is among them can be accomplished with stepwise regression. A correlation coefficient matrix will quantify relationships between all possible pairs of variables and select the independent variable most correlated with the dependent variable as the initial entry in the stepwise regression. Subsequent variables with the highest partial correlation coefficient for the dependent variable are entered into the equation. An alpha (α) value of significance (typically .05), or *F* ratio, is designated for determining variables entered into the equation. Variables once entered are removed if the regression equation results in a partial *F* ratio no longer significant. Variables that do not show significant positive or negative correlation with the dependent variable, or

independent variables highly correlated with others already in the equation, are not included in order to obtain a parsimonious model.

Regression Variables

Various measures of parcel area and land use described in the methods section of the preceding chapter were taken during the data collection phase. The only measure used in the regression analysis as a dependent variable is the ratio of residential parcel acres to total quarter section acres. The square root of this measure, *spacre,* is the dependent variable. Explanatory variables were selected based on evidence in the literature regarding determinants of location of residential and other built-up land use and on the ability of the researcher to access accurate information at the township or sample level given the time limits of the study. Regression analysis is used only for the complete parcel data set since this keeps the number of samples with no observations of residential activity, and the associated skewness of the distribution, at a minimum.

The independent variables, in addition to zoning lot size, used to explain the variation in rural residential parcellation are described in Table 4.1 Land values were not included in the model but are recognized by the researcher as an important factor in land sales. Available information, however, was limited to state equalized values set by township assessors. Previous research by Arthur (1981) on parcellation in Michigan revealed assessed property values to be significantly correlated with the parcellation dependent variables though his was a state-wide, township level analysis where variations by county would be greater. Arthur's coefficients for equalized value also deviated significantly over time. State equalized or assessed values typically do not

Table 4.1 Variable Specification for Residential Parcellation Regression

VARIABLE	DESCRIPTION
distcity	Euclidean distance, in miles, from the center of the quarter section to the nearest of five cities of at least 5,000 population
distg	Distance, as in *distcity*, to the I96, 131 freeway interchange in Grand Rapids
totdist	Sum of the variables *distcity* and *distg*
ag%	Number of acres in the sample that were in agricultural use in 1973
pa116	Number of acres that were under contract in Michigan's Farmland and Open Space Preservation program (PA 116) since at least 1985
farmacre	Number of acres that comprised farm parcels of at least 40 contiguous agricultural acres in 1973
solimit	Percentage of sample underlain with soils with severe limitations for residential septic systems per Ottawa County soil survey assessment
popden	Population density in 1990 (census block group)
lmhi	Log of 1990 median household income (census block group)
zoning	Lot size, in acres, required by township zoning for residential use
mplan	Number of acres of sample designated by township master plan map as higher density residential use than presently allowed
ugrowth	Percentage increase in township population, 1980-90
agdcln	Percentage decrease in township agricultural acreage, 1978-92
primsoil	categorical variable (0, 25, 50, 75, 100%) for the extent of prime soil in the sample

closely follow the variation in sale prices for rural lots purchased for non-farm use and seem to be influenced as much by the assessing party as by the market.

The regression equation which uses all potential explanatory (independent) variables to account for variations in the dependent variable is:

$$Y= \beta_0 +\beta_1 X_1 +\beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 +\beta_5 X_5 + \beta_6 X_6 + \ldots . \varepsilon_7$$

where $\beta_1, \beta_2 \ldots . \beta_n$ are the regression coefficients for each of the independent variables and e_7 is the stochastic element, the increment by which any individual observation, Y, varies from the regression line.

One of the requisites for employing ANOVA, regression, or other parametric tests is that the observed data set approximate a normally distributed population. Many of the quarter section samples in the study exhibited no parcellation of a residential, non-farm nature. Non-normality associated with skewness from many zero values and other large values, including outliers, seemed to be confirmed by histograms and normal probability plots. There is some question as to the relative value of non-parametric tests versus transformed data in cases where normality cannot be assumed (Johnson 1995). Many normal-based or parametric tests have shown high validity when sample sizes were large, generally a minimum of thirty, per the Central Limit Theorem.[1] The t-test is considered an appropriate analysis of non-normal data when the sample size is robust. In many cases with fewer observations, data transformation is preferred to non-parametric tests because smaller and larger observations end up with less influence than moderate observations in non-parametric methods involving the ranking of median values.

[1] This discussion is based largely on commentary in the journal Ecology, Special Feature, 1995, 76:6, pp. 1997-2009.

For regression analysis the required normal distribution is applied to the residuals of the regression line. Square root and log transformations were carried out on the data. From visual observation of histograms and normal probability plots, the square root transformation functioned better in correcting skewness and approximating normality for most cases.

CHAPTER 5

RESULTS

The analysis of parcellation in this chapter encompasses the periods 1975-87 and 1988-95, as well as the summary period 1975-95. A total of 919 parcels were inventoried in 213 quarter section samples. Of this total, 358 parcels, or 39% of all parcels, had no evidence of residential use but were considered likely to be developed for residential use based upon criteria discussed in Chapter 3. At least 55% of the parcels were created before 1988 and 45% were created thereafter. The actual percentage for the earlier period is assumed to be greater but information regarding inactive parcels, those split since 1975 and split again before 1988, was difficult to obtain. This does not represent all parcels created up to the time during which the study occurred. Parcels recorded with the register of deeds in 1996 and 1997 were not used because no information was available regarding land cover and land use for this time.

Parcellation Ratios

The primary objective of this research is to examine the relationship between the splitting and selling of rural land parcels for residential development and local restrictions governing rural land division in Ottawa County. The measure used for residential land

division over time is the ratio of total residential parcel acres to total acres in the sample frame.

Table 5.1 provides a summary of mean and median parcellation ratios for all townships and zoning strata for the different periods. Olive Township is omitted from the summary column of the table and from analysis of the summary data. The zoning change for this township was the most significant, two acres prior to 1988 and ten acres thereafter.

For most of the townships and strata (Table 5.1) the median parcellation ratios are lower than the mean. This either indicates the presence of some parcels significantly larger than the average, which would increase the overall mean, or many quarter sections in a township that had little or no residential parcel activity. For example, the mean and median parcellation ratios for the ten acre zoning stratum for the period 1988-95 are 4.7 and 0.0. This group includes Olive Township and Park Township, although they are located in the table corresponding to their lot size ordinance in the earlier period. Both townships, as well as Crockery Township, included many quarter section samples with no residential development or parcellation during this period.

Several townships with lot size statutes less than two acres had parcellation ratios greater than 20% over the study period, though the mean ratios for the stratum do not reflect the difference seen in individual townships such as Allendale and Blendon. As little as 5.4% to as much as 35% of townships' sampled area was parceled for residential purposes during the period. The stratum with the lowest parcellation, that with the largest minimum lot standards, had approximately 15% residential parcellation. The mean of all samples for 1975-95 suggests that approximately 20 % of the land in the study area was

Table 5.1 Township and Strata Mean and Median Parcellation Ratios

	1975-87		1988-95		1975-95	
	Mean	Median	Mean	Median	Mean	Median
Allendale	16.6	12.7	18.4	18.9	35.0	34.5
Blendon	21.2	21.3	12.6	7.8	33.8	37.5
Georgetown	12.1	11.7	14.0	6.3	26.1	21.8
Jamestown	9.5	7.6	3.4	1.7	13.0	11.9
Polkton	5.2	0.0	0.2	0.0	5.4	0.5
Robinson	10.6	1.0	13.1	3.1	23.7	15.0
Spring Lake	7.9	3.1	12.9	12.4	20.8	15.5
< 2 Acres	***12.4***	***6.3***	***10.0***	***1.7***	***22.9***	***13.9***
Chester	4.7	0.7	2.1	0.0	6.8	1.3
Olive	13.7	4.7	4.8	0.2	*	*
Port Sheldon	18.6	14.7	6.0	0.0	24.6	23.1
Zeeland	11.6	6.3	6.9	1.1	18.5	12.0
2-2.5 Acres	***11.8***	***5.4***	***6.3***	***0.0***	***16.4***	***9.7***
Grand Haven	8.6	2.3	13.4	2.6	22.0	10.4
Holland	10.4	3.3	13.5	4.5	23.9	20.6
5 Acres	***9.5***	***3.1***	***13.5***	***4.5***	***23.0***	***19.0***
Crockery A-2	15.2	16.6	3.7	1.4	18.9	22.6
Tallmadge	4.9	0.9	8.7	6.3	13.6	13.9
10 Acres	***10.3***	***3.1***	***4.7***	***0.0***	***16.4***	***9.4***
Crockery A-1	9.5	0.5	12.5	1.1	22.0	9.4
Park	11.4	3.7	1.8	0.0	13.1	10.4
Wright	4.3	0.2	7.0	0.0	11.3	2.6
20-40 Acres	***7.8***	***0.2***	***9.2***	***0***	***14.9***	***6.8***

* Aggregate mean and median not calculated due to substantial change in minimum lot size

parceled for residential purposes. In his study of land divisions of 20 acres or less in Michigan, Norgaard (1994) estimated a mean parcellation ratio of 11.7% for all townships for the period 1960-90. Ottawa County experienced high parcellation activity during this period (Arthur, 1981), which may explain the difference in mean parcellation ratios.

Nearly nine percent (8.8%) of the parcel acreage was created between 1988 and 1995 and 11.2% of the acreage was parceled in the earlier period. About 44% of all parcellation occurred in the later period, a time which encompassed approximately 39% of the total study period. Since some of the parcels recorded during 1988-95 are thought to have been split from other lots made after 1975, the figures for the earlier period are probably an underestimation and therefore, parcellation acreage appears to have not increased during the period. This, however, is only a cursory estimation.

ANOVA tests whether variability of parcellation ratios among townships within the same stratum is so great that its superior or inferior grouped ratio is deemed insignificant relative to other strata, or that it is an unreliable estimate. It was helpful in most of the tests to group the townships into three zoning lot size strata: less than 2 acres (Stratum 1), 2-5 acres (Stratum 2), and 10 to 40 acres (Stratum 3). This division was based on what the researcher thought was a logical grouping of comparable lot sizes, as well as assuring some proportionality in number of samples per stratum. Decreasing the number of strata increases the number of townships in a particular group, which may mitigate the problem of a single township's effect on the stratum mean as well as increase the confidence of the statistical result. Since much of the statistical analysis involves

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comparison of mean ratios and proportions by way of t-tests rather than ANOVA, limiting the number of strata reduces the number of comparisons needed.

Table 5.2 reports the results of the ANOVA tests on the mean parcellation ratios by zoning strata for each time period. The means are given for the square root transformed data.

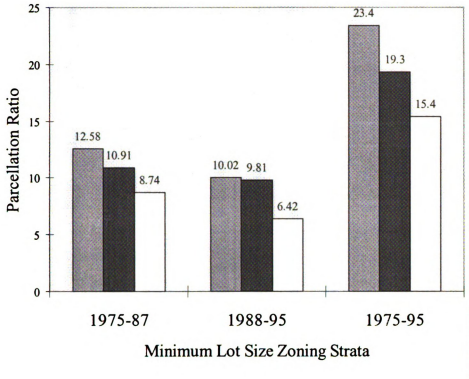
Table 5.2 Results of ANOVA Tests for Parcellation Ratios By Zoning Strata

Zoning Strata	1975-87		1988-95		1975-95	
	n=	Mean	n=	Mean	n=	Mean
< 2 acres	82	2.69	88	2.19	88	3.89
2-2.5 acres	46	2.54	30	1.51	30	3.11
5 acres	29	2.31	29	2.49	29	3.97
10 acres	21	2.34	41	1.26	21	3.38
20-40 acres	35	1.70	25	1.8	35	2.78
F ratio / ρ	**1.22**	**.305**	**1.90**	**.111**	**1.45**	**.218**

The calculated *F* value for the three periods necessary to reject the null hypothesis of no significant difference in means should be greater than the critical value of 3.04 and the ρ value should be less than α=.05 at a 95% confidence level. For no period is the null hypothesis rejected. Aggregating the townships into three zoning lot size strata instead of the five shown in Table 5.2 does not lead to rejection of the null hypothesis, even at α=.10.

The parcellation ratios for Stratum 1 (< 2 acres), Stratum 2 (2-5 acres), and Stratum 3 (10-40 acres) are shown in the graph in Figure 5.1 . Results of the two sample

Figure 5.1 Parcellation Ratios and Township Lot Size Zoning



T-Test Results

1975-87	T	p
Strata 1&2	0.72	0.48
Strata 1&3	1.57	0.12
Strata 2&3	0.88	0.38
1988-95		
Strata 1&2	0.08	0.94
Strata 1&3	1.68	0.09
Strata 2&3	1.28	0.20
1975-95		
Strata 1&2	1.10	0.28
Strata 1&3	2.18	0.03
Strata 2&3	1.04	0.30

t-test are given as well.

Parcellation ratios between townships with small minimum lot zoning (Stratum 1) and large minimum lot zoning (Stratum 3) are significantly different for the aggregate data (1975-95). Since one might expect parcellation to be less when large parcels are required, the alternative hypothesis of $H_1 > H_3$ would be accepted for the later period (ρ= .045). T-tests provide an analysis between zoning strata that may be obscured in the ANOVA results. Based on the statistically supported difference between parcellation in townships with small lot size zoning and large lot size zoning the first hypothesis can be rejected: parcellation ratios are significantly different among township agricultural districts with notably different residential lot size restrictions.

Parcellation Ratios and Conversion of Agricultural Land

A possible rationale for regulating for considerably larger lot sizes in farming areas may be a belief that large farmed parcels split for eventual residential sale will continue to be farmed in the intervening period before residential use, a practice that may be sustained after sale and occupancy of the parcel. If most rural residential homeowners buy more land than they tend to use and do not need nor desire to derive food, fuel, or other resources from their land , allowing farming activities to continue after the land has changed hands may be a welcome or even profitable option for the landowner.

Before analyzing farmland conversion by the lot size zoning factor it was first necessary to determine to what extent residential parcellation was comprised of land with

agricultural activity in 1973. Table 5.3 provides information on four measures of agricultural acreage from the sampled parcels: the *ag acres ratio,* the acreage of residential parcels with agricultural land use in 1973; the *converted ag acres ratio*, the acreage of residential parcels which was discontinued agricultural acreage due to residential use or intention of residential use of the parcel; *developable ag acres ratio*, agricultural acreage discontinued and considered likely to be discontinued due to residential conversion; and *developable prime ag acres ratio*, acreage of prime and unique farmland which was converted since 1973 or considered soon to be converted.

The reader should be reminded that the ratios discussed here are ratios of total residential parcel acreage to the total quarter section acreage. Proportions of one parameter measure to another, for instance the proportion of parcel acreage in agricultural land use, will be reported in the section following the discussion of parcellation ratios for each parameter.

Agricultural Acreage Ratios

The agricultural land cover occurring on parcels counted in the study represent 9.5% of all the sample land area. The greatest amount of parcellation on agricultural land, 12.7% of the sample area, occurred in the less than two acres zoning strata and the least amount, 4.9%, occurred in the 2-2.5 acres stratum. The range of ratios of parcellation involving farmland for individual townships is between 1.2% and 22.5%. For a township with 45% of its agricultural zoned land area in agricultural use a ratio of 22.5% indicates that half of the agricultural land base has been parceled for immediate or eventual residential use.

Table 5.3 Ratios of Residential Parcellation Acreage to Total Quarter Section Land Area: 1975-95

	Parcel acres ratio	Ag acres ratio	Converted Ag acres ratio	Developable Ag acres ratio	Prime developable Ag ratio
Allendale	35.0	22.5	15.1	18.2	2.8
Blendon	33.8	19.6	10.7	15.7	2.1
Georgetown	26.1	16.8	4.9	14.3	11.1
Jamestown	13.0	9.1	3.3	6.6	4.9
Polkton	5.4	2.5	0.4	1.2	1.0
Robinson	23.7	5.4	5.0	5.3	0.1
Spring Lake	20.8	5.1	2.2	5.1	1.6
< 2 Acres	***22.9***	***12.7***	***6.5***	***10***	***3.6***
Chester	6.8	4.1	0.8	2.5	1.1
Port Sheldon	24.6	5.8	4.9	4.9	0.0
Zeeland	18.5	10.4	3.8	7.2	5.7
2-2.5 Acres	***16.4***	***4.9***	***2.5***	***4***	***.9***
Grand Haven	22.0	1.2	0.5	1.1	0.7
Holland	23.9	18.7	9.6	18.4	11.8
5 Acres	**23.0**	**10.2**	**5.2**	**10.1**	**6.4**
Crockery A-2	18.9	4.9	3.9	4.9	2.8
Tallmadge	13.6	7.8	1.5	7.8	5.2
10 Acres	***16.4***	***6.3***	***2.7***	***6.7***	***3.9***
Crockery A-2	22.0	11.8	1.7	11.9	7.5
Park	13.1	1.6	1.5	1.5	0.0
Wright	11.3	7.4	2.9	7.3	5.0
20-40 Acres	***14.9***	***7.0***	***2.2***	***7***	***4.3***

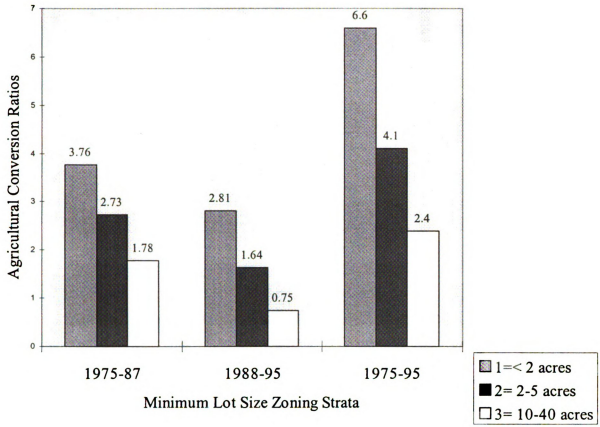
The difference in agricultural acreage ratios for townships grouped < 2 acre, 2-5 acre, and 10-40 acre minimum lot sizes was significant for the aggregate period (ANOVA, p=0.025). The t-test result shows that the mean agricultural acreage ratio for the smallest minimum lot size stratum (12.7) is significantly greater (ρ= 0.018) than that of the 10-40 acres stratum (6.7).

Converted Agricultural Acreage Ratio

The mean *converted ag acres ratio*, the percentage of the quarter section that was agricultural use in 1973 but discontinued, is 4.6% for all samples and ranges from .5% to 15.1% for individual townships and from 2.2% in the 20 to 40 acre zoning stratum to 6.5% in the less than two acre zoning stratum. Allendale and Blendon, two fast growth townships with one and one and a half acre minimum lot size requirements, had more than 10% of their sampled area change from agricultural use to idle or other residential associated use between 1975 and 1995. Three townships had less than 1% of the sampled quarter section area comprised of discontinued agricultural land. Analysis of variance indicates a significant difference (p= 0.012) among the three zoning strata converted agriculture ratios (<2 acres, 2-5 acres, 10-40 acres) for the aggregate data. The t-test results of Figure 5.2 show that the difference can be attributed to the larger mean ratios of the smallest minimum lot size group (Stratum 1) and the small ratios of the 10-40 acre lot size samples (Stratum 2). The differences here are significant for all periods.

For comparative purposes, the estimated loss in agricultural acreage for Ottawa County between 1978 and 1992 was 13.9% (Koches and Toering, 1995). From this same analysis, the proportion of total county land cover in agricultural use in 1978 was nearly

Figure 5.2 Agricultural Conversion Ratios and Township Lot Size Zoning



T-Test Results

1975-87	T	p
Strata 1&2	1.05	0.30
Strata 1&3	1.95	0.05
Strata 2&3	0.97	0.34
1988-95		
Strata 1&2	1.28	0.20
Strata 1&3	3.11	0.002
Strata 2&3	1.16	0.26
1975-95		
Strata 1&2	1.64	0.10
Strata 1&3	2.81	0.01
Strata 2&3	1.33	0.18

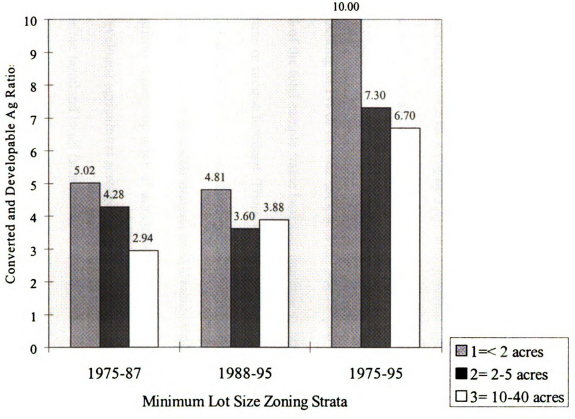
55%. In other words, according to their interpretation of land use change, approximately 7.6% of all Ottawa County land in 1992 consisted of land taken out of agricultural use. This includes agricultural land that is not zoned for agricultural use, where the conversion rate could be expected to be greater.

Converted and Developable Agricultural Acreage Ratios

Considering that portion of quarter sections in agricultural use that was either converted or determined by the researcher as intended for future residential conversion, the range of converted and developable agricultural land use ratio or percentage is from 1.1% to 18.2% for individual townships. The percentage ranges between 4-10% for the zoning strata, once again the highest ratio being found in the group of townships with the smallest minimum lot size restrictions. The mean ratio for all sample is 8.2%. As a proportion of the mean ratio for all agriculture land cover on residential parcels (9.5), approximately 86% of the farmland on residential parcels can be considered as or likely to be developed.

Figure 5.3 gives the comparative ratios for farmland that was either converted or considered as converted for future residential use. There was no significant difference in the mean ratios for any stratification of the zoning factor studied. However, the alternative hypothesis $H_1 > H_3$ is significant at the 95% confidence level ($\rho = 0.045$) for the earlier period. The largest percentage difference between ratios for converted agricultural land as compared to converted or developable agricultural land is for the stratum representing townships with the largest lot size minimums. The difference,

Figure 5.3 Converted and Developable Agricultural Ratios and Township Lot Size Zoning



T-Test Results

1975-87	T	p
Strata 1&2	0.60	0.55
Strata 1&3	1.71	0.09
Strata 2&3	1.00	0.16
1988-95		
Strata 1&2	0.68	0.50
Strata 1&3	0.66	0.51
Strata 2&3	-.20	0.84
1975-95		
Strata 1&2	1.21	0.22
Strata 1&3	1.51	0.13
Strata 2&3	0.24	0.81

2.2% for actual farmland conversion to 7% for actual and eventual conversion, is thought to reflect a larger proportion of parcels with no built-up residential development in townships with large lot zoning, and the method of ascribing developable agricultural acres to these parcels.

Converted and Developable Agricultural Acreage Ratios: Prime and Unique

The final column of Table 5.3 lists the township and strata ratios of *developable prime ag acres*. This is the percentage of the sample that is prime or unique farmland (NRCS) in the first photo. The western half of Ottawa County, especially the tier of four townships extending to Lake Michigan, has very little prime farmland and therefore ratios are small for samples in this area. (Figure 3.1) Two townships had as much as 11% of the sample area considered as developable prime farmland. One township with a significant percentage of its land comprised of prime farmland had prime farmland conversion amounting to 1% of its total sample area. The overall mean ratio indicates that about 3.8% of the total sample frame land area has been or will likely be comprised of converted prime or unique farmland. There was no significant difference in the mean ratios of prime or unique converted and developable farmland for any minimum lot size zoning stratification. A more thorough analysis of converted prime and unique farmland involves comparison of the proportion of developable prime and unique agricultural acreage to all developed agricultural acreage and how this measure compares with the proportion of prime farmland to all farmland in the study area.

Agricultural Land Use and Conversion as Proportions of Parcel Measures

If there is little residential parcellation the extent of residential parcellation on agricul-tural land will necessarily be minor, and likewise the conversion of land from agricultural to residential use. Examining the proportions of one measured variable to another is a more common and perhaps more useful appraisal of trends in residential land use. For this study the measures include: the proportion of total parcel acreage consisting of agricultural land use to the total parcel acreage measure for a sample; the proportion of converted agricultural land to total parcel acreage in agricultural use; the proportion of agricultural land converted or likely to be converted to total agricultural land located within residential parcels; and the proportion of farmland converted or likely to be converted that is prime and unique to total developed or developable agricultural land. Depending on the proportion analyzed, calculation of these measures necessitates deletion from the data sets of all quarter section samples with no residential parcellation, samples with parcellation but which do not include agricultural land use, and samples with no converted agricultural acreage or agricultural acreage estimated as developable. Findings will be reported for the entire twenty-year period as well as for the periods 1975-87 and 1988 to 1995.

Proportion of Agricultural Land Cover to Total Parcel Acreage

Table 5.4 provides a summary of the agricultural land use portion of all zoning strata parcellation ratios. This table allows for comparison between zoning strata and any changes in the tendency for residential parcels to locate on farmland. The importance

Table 5.4 Proportions of Agricultural Land Cover to Total Parcel Acreage

Zoning Strata	1975-95	1975-87	1988-95
< 2 acres	.50	.49	.54
2-2.5 acres	.46	.52	.29
5 acres	.40	.35	.42
10 acres	.32	.29	.38
20-40 acres	.41	.36	.49
< 2 acres	.50	.49	.54
2-5 acres	.43	.45	.36
10-40 acres	.37	.33	.42
Total	.45 n= 162	.44 n= 142	.46 n= 114

of this measure is related to the notion that in areas of predominant agricultural use it may be easier for farmers to split and sell one or two acre parcels from their stock of non-productive acreage. By contrast, if that farmer is bound by township zoning to sell a minimum of ten or twenty acres it may be more difficult to arrange land divisions which do not affect productive agricultural acreage (Kartez, 1980).

The average proportion of agricultural acreage to all parcel land seen here shows that for all 213 quarter section samples there was little change between the earlier and later period in the mean proportion of agricultural acreage to total parcel acreage. The mean ratio for all township groups only deviates by one percent for parcels created later in the study period to those from the early part of the study. It is interesting to note that in analyzing parcels for agricultural land use 51 quarter section samples, or 24% of all samples, had no residential parcellation for the duration of the study. For the period 1988-95 only 54% of the quarter sections had any residential parcellation.

For no period is there a significant difference (ANOVA) in the means of proportions of agricultural to total parcel land use across zoning strata at the 95% level of confidence. For the latter period, 1988-95, the proportion of total parcellation formerly or presently in agricultural use is significantly greater in the less than two-acre minimum lot size townships to render the overall difference significant at the 90% confidence level (p= .09, ANOVA).

Proportion of Converted Agricultural Land to Total Agricultural Land

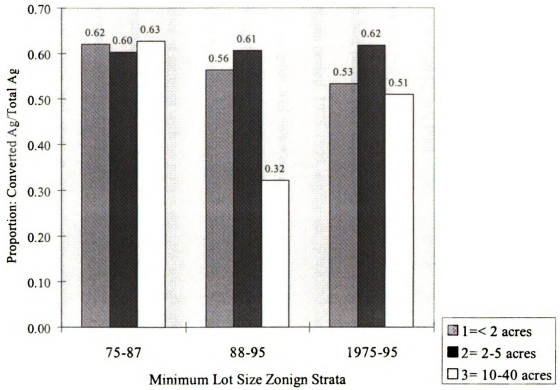
In the conversion of rural land to residential use agricultural acreage is permanently removed from productive use, as when buildings, impervious services or yards become a part of the parcel, or semi-permanently, when formerly cropped portions of the parcel are idled through transfer of ownership. If residential parcellation, and the extent to which agricultural land is affected, is relatively equal across townships, the tendency in parcel size, represented here by the variation in lot size restrictions, may be an important factor in the idling of agricultural acreage in the presence of residential development. There may be an associated concern in townships with large lot zoning to limit residential development to non-productive parcels, and hence the actual conversion of agricultural land located on parcels with a principal non-farm use may be higher than in townships with less restrictions (ie: lower minimum lot sizes) for parcellation of agricultural land. From Table 5.3, converted or idled agricultural land ranged from a township mean of 0.4% to as high as 15.1% of the total sample quarter section land. Since some land zoned for agricultural use is in forest, water, open field or other urban use, it is assumed that the proportion of converted farmland to all parcel acreage

consisting of farmland would be slightly to considerably higher than that ratio of the total land area as reported in the previous section.

In addition to the samples with no residential parcellation there were many samples with parcellation which did not include agricultural land cover. This further reduced the number of quarter section observations, necessitating grouping of zoning strata for statistical analysis. The proportions of mean agricultural conversion ratios to all agricultural land cover on residential parcels are shown in the graph in Figure 5.4 together with the t-test results.

Considering only those samples where residential parcellation and agricultural associated land uses coincided during the study period, conversion ratios do not seem to vary greatly by the zoning lot size factor nor between the earlier and later periods, except for the large minimum lot size category. Here the ratio is approximately one half that of the other zoning categories for the later eight years and one half of the conversion ratio of the large lot samples for the earlier time period. Since many parcels with no evidence of built-up residential use were still actively farmed by 1995, conversion ratios of land use were correspondingly low for samples with a high percentage of such parcels. Given some time lapse between parcellation and residential activity on the parcel, one might expect a higher proportion of more recent parcels (1988-95) showing no built-up use. If residential parcel sizes in townships with large lot zoning reflect the lot sizes specified by the ordinances, and if the tendency for residential parcellation to anticipate actual residential use by many years is biased for larger parcels, a significantly lower conversion ratio in large lot zoned townships, as seen in Figure 5.4 (1988-95), might be explained.

Figure 5.4 Mean Proportions of Converted Agricultural Land to Total Agricultural Land



T-Test Results

1975-87	T	p
Strata 1&2	0.26	0.80
Strata 1&3	-0.03	0.97
Strata 2&3	-0.23	0.82
1988-95		
Strata 1&2	-0.35	0.73
Strata 1&3	2.10	0.04
Strata 2&3	1.99	0.05
1975-95		
Strata 1&2	-1.06	0.29
Strata 1&3	0.26	0.80
Strata 2&3	1.08	0.29

Furthermore, the practice of large lot zoning may be more prevalent in agriculturally predominant townships with lower population densities, areas where expectations for gain on sales of rural residential parceled land may outpace the actual demand for building lots.

In ANOVA tests the only significant difference in mean proportions of farmland conversion to parceled farmland between zoning strata was for 1988-95, where the level of significance indicated by the probability of random chance error was $\rho = .02$ (F ratio=3.96). The difference was significant (ρ=0.03) when a two independent sample t-test was employed to check the relative strength of significant difference in the large lot zoned conversion ratios from other lot size zoning. The level of significance was 0.015 in a one-tail t-test for the alternative hypothesis that agricultural conversion in the large lot size stratum was significantly less than in the other strata. The less than two acre and 2-5 acre strata had significantly greater proportions of farmland in parcellation that was converted during the later period (See Figure 5.4).

For the aggregate period, 1975-1995, eighty-six of the 213 sampled quarter sections, or 40% of all samples, had either no residential parcellation or no parcellation which encroached on land in agricultural use in 1973. After subtracting those samples with no parcellation, 78 % of the remaining samples had some residential parcellation on farmland. The number of samples with no rural residential parcellation or no parcellation which encroached on land in agricultural use increased to 133 for the years 1988 to 1995. This represents 62% of all samples for this period.

Of the total agricultural land cover in residential parcellation approximately 55% was idled or converted to yards, driveways, houses or other residential land cover. The

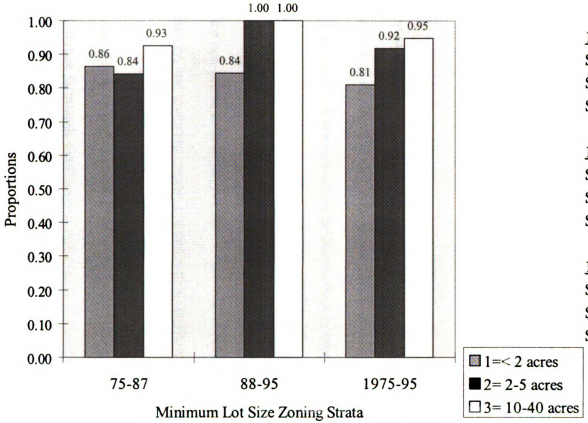
overall percentage conversion decreased from 62% for those parcels created before 1988 to 51% for those parcels split in following years. It should be reiterated that conversion proportions include parcels considered likely to convert to residential use but with no apparent built-up use. Many of these parcels are indistinguishable from many larger farm tracts except for their size.

Proportion of Converted or Developable Agricultural Land to Total Agricultural Land

Broadening the definition of converted agricultural land to include acreage currently in agricultural use but not considered by the researcher to be a long-term sustainable land use increased the total mean proportion of agricultural conversion from 55% to 87%. (Figure 5.5) This is the mean of all sample proportions as expressed by the 127 samples which contained any residential parcel acreage in agricultural use at the beginning of the study.

Townships with smaller minimum lot size ordinances as a group have a lower proportion of developable agriculture to total residential parcel agriculture than other township groups. For the entire study period, as well as for the later period, the proportion of developable agricultural acreage in the less than two acre zoning strata was significantly lower than in the other strata. In an ANOVA test the difference in proportions of converted and developable agricultural land is significant at $\rho = 0.019$ for all parcels and at $\rho = 0.01$ for parcels activated since 1987. From Figure 5.5 t-test results show a significantly greater proportion of converted and developable farmland in Strata 2 and 3 than in Stratum 1. This difference was not noted in the analysis of the proportion of parcel agricultural acreage which had already been idled or converted. The researcher

Figure 5.5 Mean Proportions of Converted and Developable Agricultural Land to Total Agricultural Land



T-Test Results

1975-87	T	p
Strata 1&2	0.44	0.66
Strata 1&3	-0.96	0.34
Strata 2&3	-1.19	0.24
1988-95		
Strata 1&2	-3.46	0.001
Strata 1&3	-2.35	0.02
Strata 2&3	1.24	0.22
1988-95		
Strata 1&2	-2.05	0.04
Strata 1&3	-2.73	0.01
Strata 2&3	-0.50	0.62

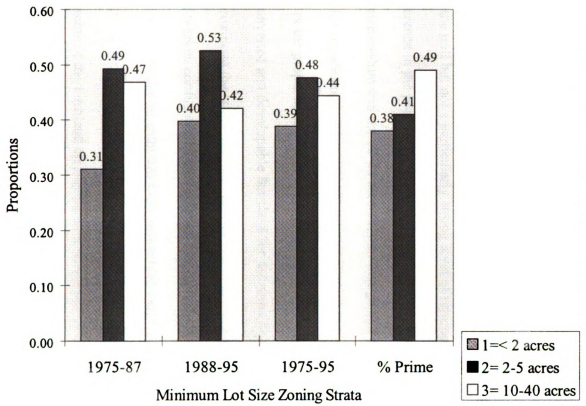
suspects that any difference is related to the greater lag time between parcellation and actual change in land use in areas with less accelerated population growth. Ottawa County has several fast growth townships with small lot zoning and a greater number of slow or moderate growth townships with large lot zoning: minimum lot sizes of at least 10 acres. The researcher suspects that many more 1988-95 parcels were not yet developed or still on the market by the time of the last photo than were parcels created before 1988, and, therefore, all of the agricultural acreage on these parcels would necessarily be considered converted. The disadvantage of using this measure, apart from the obvious possibility of misjudging the future land use of some parcels, is that either all or none of the agricultural acreage of a parcel is deemed to be converted to residential use.

Proportions of Converted Farmland: Prime and Unique

The most restrictive agricultural zoning may be warranted for lands with the best endowment of high quality soils. A few townships in Ottawa County have drawn zoning district boundaries most restrictive to non-farm use to coincide with the location of prime farmlands mapped by the NRCS. Whether parcellation and agricultural land use conversion is biased for non-prime soils depends either on the will of farmers, individually or collectively, and township zoning and planning commission members to protect production on the best farmland soils.

Figure 5.6 on the following page summarizes the proportions of agricultural acreage on prime and unique farmlands developed or considered as developed to total agricultural acreage developed or considered as developed. For comparative purposes,

Figure 5.6 Mean Proportions Prime and Unique Converted/Developable Agricultural Land to Total Agricultural Land



T-Test Results

1975-87	T	p
Strata 1&2	-1.94	0.05
Strata 1&3	-1.44	0.16
Strata 2&3	0.21	0.83
1988-95		
Strata 1&2	-0.97	0.34
Strata 1&3	-0.19	0.85
Strata 2&3	0.69	0.50
1975-95		
Strata 1&2	-0.97	0.34
Strata 1&3	-0.61	0.54
Strata 2&3	0.32	0.75

the average proportion of prime farmland in 1978 for the townships represented by each zoning stratum are also given. This information was taken from digitized soil and land cover data (MIRIS) and is the mean of the proportions of prime farmland to all farmland for each zoning group.

Residential parcellation occurring in agriculturally zoned districts with large lot zoning does not appear to be biased against the use of prime farmland any more than in less restrictively zoned areas. The only statistically supported difference in mean zoning strata proportions of converted and developable prime or unique farmland to total converted or developable farmland is between the less than two acre zoning group and the 2-5 acre minimum lot size strata for the period 1975-87. The calculated *t* value of -1.94 ($p=0.05$) for the two tail test of the null hypothesis of no significant difference in means is sufficient to reject the null but not a particularly strong level of rejection. There is also a corresponding difference in the proportion of prime farmlands between the less than 2 acre minimum lot size stratum and the 10-40 acre stratum though this difference was not statistically tested for significance.

The means of the proportions of prime and unique converted and developable farmland to total converted and developable farmland for the townships grouped by zoning closely approximate the strata means of percentage of prime and unique farmland. This would tend to weaken confidence in the results of the previous t-test.

One conclusion to be drawn from this table is that residential parcellation occurs on prime and non-prime farmland proportionate to the distribution of these lands in the study area. Since some of the farmland on parcels with no residential built-up use will continue in long-term agricultural use after residential conversion, the actual acreage of

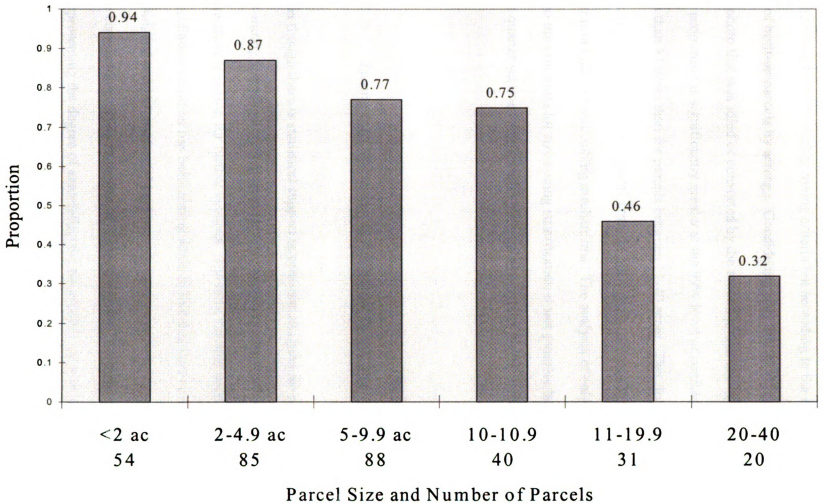
converted prime and unique farmland, represented by the ratios in Table 5.3, is probably an overestimation. Given, however, the high proportions of converted and developable farmland and the assumption that prime and unique farmland will convert to other uses in equal proportion to other farmland (Vesterby et al., 1994), the proportions in this analysis should be valid representations of the phenomenon. The comparison of prime and unique farmland conversion for this study is mainly intended to explore any differences occurring due to a zoning factor.

Conclusions on Agricultural Conversion

The significantly greater ratios of agricultural land conversion for township samples with smaller lot size zoning (less than two acres) correspond to the higher proportions of parceled land that was farmland in 1973 for these same quarter sections. The results from Figure 5.2 show a significant larger parcellation ratio of converted farmland in townships with less than two acre minimum lot size zoning than in townships with ten acres or greater zoning. From this analysis the third hypothesis regarding proportions of converted farmland and the zoning technique examined in this study can be rejected. While there is a significant difference in proportions of converted farmland to total farmland in samples taken from large lot (10-40 acres) zoned townships than from other townships (1988-95), the author has attributed some of this difference to a greater proportion of parcels in large lot zoned areas that have not yet been converted for residential use but which have been split into smaller parcels which are unlikely to be in long term productive use.

Figure 5.7 summarizes the proportions of converted farmland for only those

Figure 5.7 Proportion of Farmland That Was Converted on Built-up Parcels, By Parcel Size: 1975-95



parcels which had evidence of built-up use during the period. The results are not stratified according to the township zoning criteria but according to the distribution (arbitrary) of built-up parcels by acreage. Considering only that land in agricultural use in the first photo that was idled or converted by the second photo, the difference in the conversion proportion is significantly greater at the 99% level of confidence for all parcels less than 11 acres than for parcels between 11-40 acres. This does not directly address the third hypothesis since parcel sizes do not directly correspond to townships with similar minimum lot size zoning mechanisms. The analysis of only built-up parcels according to the minimum lot size zoning stratification is not possible because there are insufficient quarter section samples with built-up use parcels for the larger lot size zoned areas.

Zoning as a Determinant in Residential Parcellation

Even though there is statistical support in previous analyses for parcellation differences among townships with diverse lot size regulations for residential development in rural areas there is reason for further analysis. The only variable used previously to explain parcellation variation has been zoning when in fact there are many determinants to the location and level of residential land use.

The correlation coefficient matrix of Table 5.5 provides a numeric value between -1 and 1, representing the degree of association for all possible pairs of variables. There are formulas for determining the critical level of correlation (r) though none were

Table 5.5 Correlation Coefficient Matrix of the Dependent Variable SPACRE and the Independent Variables

	SPACRE	DISTCITY	DISTG	TOTDIST	AG%	PA116	FARMACRE	SOLIMIT	POPDEN	LMHI	ZONING	MPLAN	UGROWTH	AGDCLN	PRIMSOIL
SPACRE	1.000	-.197	.028	-.083	-.340	-.339	-.338	-.090	.116	.028	-.103	.176	.234	.180	-.187
DISTCITY		1.000	-.106	.454	.001	.271	.063	-.167	-.519	-.103	.051	-.166	-.142	-.454	-.100
DISTG			1.000	.838	-.302	-.240	-.276	-.238	.187	.043	-.088	-.012	.381	-.020	-.342
TOTDIST				1.000	-.269	-.066	-.213	-.304	-.117	-.018	-.051	-.102	.263	-.267	-.361
AG%					1.000	.361	.898	.299	-.110	-.038	-.062	-.116	-.251	-.156	.541
PA116						1.000	.356	.179	-.181	-.019	.029	-.111	-.216	-.142	.211
FARMACRE							1.000	.251	-.150	-.102	-.095	-.166	-.257	-.209	.495
SOLIMIT								1.000	-.100	.049	.288	-.067	-.300	.056	.593
POPDEN									1.000	.011	-.079	.248	.302	.458	-.121
LMHI										1.000	.180	.075	.127	-.165	.146
ZONING											1.000	-.112	-.363	.003	.139
MPLAN												1.000	.216	.126	-.110
UGROWTH													1.000	.154	-.287
AGDECLN														1.000	-.075
PRIMSOIL															1.000

applied in this test. The regression analysis was performed with all samples as well as with a data set which excluded 18 samples that were outliers. Correlation coefficients for the data set with outliers removed are given in italics.

The relationship between parcellation and several independent variables was relatively weak, including zoning (-.103, *-.180*). The most significant, and nearly equal in importance were, *farmacre*, the portion of land in large farmed parcels; *pa116,* land enrolled in Michigan's Farmland and Open Space Preservation program; and, *ag%,* all land in agricultural use. The correlation coefficients for *farmacre*, *pa116* and *ag%* are -.338, -.339, and -.340, (*-.444, -.425, -.455*) respectively. It was expected that the amount of land in large farm parcels would have a more significant effect on parcellation than the variable for all agricultural acreage though this was not the case. The correlation between these variables is quite high, .90, so it is assumed that a large proportion of 1973 agricultural acreage was in parcels of 40 acres or greater. Limiting the *farmacre* variable to parcels of 60 or 80 acres may have increased the explanatory power of this variable with respect to the dependent variable or even with respect to zoning.

Other independent variables moderately correlated with parcellation were, *ugrowth* (.234, *.376*), and *distcity* (-.197, *-.211*). Other significant, though weakly correlated, independent variables paired with *parcacre* included *mplan*, the number of acres in the quarter section designated in the master plan as residential use (r= .176, *.208*) and *primsoil*, the percentage of the sample consisting of prime farmland (r= -.187, -*.280*). The researcher believes that a variable measure for non-prime farmland would have a higher coefficient than *primsoil* and that the value here does not indicate any bias for residential parcellation on prime farmland.

The variables most highly correlated with *zoning* were *solimit* (.288, *.284*), and *ugrowth* (-.363, *-.367*). A strong negative r value between zoning and urban growth rate suggests the tendency of fast growing townships to legislate lower minimum lot size ordinances to allow higher residential densities.

The correlation coefficients of the four independent variables selected by the step-wise regression, *ag%, pa116, totdist*, and *ugrowth*, in order, were significant at the 99% level of confidence ($\rho \leq .001$). The variable *farmacre* was not selected as it was highly correlated with *ag%*. With *ag%* variable selected, the partial correlation coefficient for *farmacre* no longer met the criteria for entry.

The r^2 statistic, the coefficient of multiple determination, is the ratio of the dependent variable variation explained by the independent variables to the total variation in the dependent variable. There is no standard for determining the relative strength of the statistic, though the closer the value is to one the better the model explains the phenomenon examined. Some branches of study (eg: biological or social science) attribute greater or lesser importance to a given r^2 value. This analysis attempts to understand the motives underlying peoples choices in purchasing residential land. In regression models including variables of human behavior, r square values of .3 are generally thought to account for a significant level of the variation in the response variable. [1] The coefficient of multiple determination in this equation is .2264. In other words, the variables chosen by the researcher to explain differences in residential parcellation in agriculturally zoned areas only accounted for 22.6% of the variation in parcellation. After deleting 18 quarter section sample observations determined to be

[1] The discussion on regression analysis was aided by consultation with Dr. Yousceek Jeong, Calvin College.

outliers the r^2 increased to .384 with a highly significant F ratio statistic of 29.62. Since zoning was not selected as a significant explanatory variable in the equation, the null hypothesis regarding the impact of zoning on parcellation cannot be rejected.

Even though there are insufficient significant factors by which to explain the variation in parcel splits across the county agricultural districts the correlation of *ag%* and *pa116* with the parcellation variable are in themselves significant factors. Of interest is their negative signs and the implication that perhaps land wholly in agricultural use is not being converted into smaller parcels to the extent of agricultural land consisting of non-tillable portions in forest or other cover. The mean proportion of parcel acreage with agricultural use to all parcel acreage for all of the samples is .45 (Table 5.4). The proportion of land with agricultural use to all land (1978 MIRIS) for only those Ottawa townships characterized as rural (< 150 person/sq.mi., 1990), is approximately 70%. This figure may underestimate the actual percentage of agricultural zoned land in agricultural use but may serve as a proxy for comparison with the former proportion of parcellation on farmland (.45) and support an interpretation of the data that residential parcellation is biased towards less productive land or parcels less conducive to efficient production practices.

The lack of difference in correlation coefficients for *pa116* and *ag%* does not aide the present discussion; one would expect land under long term conservation agreement to show a lower incidence of parcellation as indicated by a correlation coefficient closer to -1. It is possible that farms under contract with Michigan's Farmland and Open Space Preservation Program (PA116) may be parceled for eventual sale so long as change in ownership or use does not occur. If a prospective buyer with an

attractive offer can induce a farmer to sell, he or she may still come out ahead after foregoing any benefits and assuming any penalties incurred by early termination.

Analysis of Variance for Standardized Residuals

Having excluded approximately 38% of the effects from other variables influencing parcellation which may have confounded the effects of zoning in the previous difference of means tests, it is possible to repeat an analysis of the mean parcellation ratios with respect to zoning, this time utilizing standardized residuals from the regression equation. ANOVA tests were carried out for various zoning strata configurations using the regression residuals after outliers had been removed. The results are shown in Table 5.6. The last row in the table is the ρ value from the ANOVA tests.

Table 5.6 Results of Zoning and Parcellation ANOVA Using Standardized Residuals

Strata	Mean	Strata	Mean	Strata	Mean	Strata	Mean
<2 ac.	0.09	*≤ 1 ac.*	-0.075	*≤ 1 ac.*	-0.075	*< 2 ac.*	0.09
2-2.5 ac.	0.169	*1.5-2.5*	0.249	*1.5-2 ac.*	0.207	*2-5 ac.*	0.122
5 ac.	0.088	*5-10 ac.*	-0.048	*2.5-5 ac.*	0.173	*10-40 ac.*	-0.293
10 ac	-0.284	*20-40 ac.*	-0.373	*10-40 ac.*	-0.293		
20-40 ac.	-0.299						
ρ *Value*	**0.185**		**0.033**		**0.038**		**0.047**

Depending on the manner in which township minimum lot sizes are grouped, a null hypothesis of no significant difference in means can result in rejection or failure to reject. In the former case the value of the ρ statistic is not especially strong and observation of the strata means fails to indicate any systematic correlation between lot size and residual means. The apparent reason for the significant ρ statistics (0.033 and 0.038) is the comparatively large difference in means between the 1.5-2.5 acre stratum and the large lot stratum. If the regression analysis had only included townships in these strata the importance of zoning may have increased along with the explanatory power (r^2) of the independent variables.

Results of t-tests between the three zoning strata examined throughout this chapter show that the standardized residuals of parcellation for the large lot (10-40) acre zoning samples are significantly less than for the other strata. The results are shown in the following table.

Table 5.7 T-test Results for the Standardized Residuals of Parcellation Ratios, 1975-95

Strata	T	ρ
< 2 acres and 2-5 acres	-0.31	0.75
< 2 acres and 10-40 acres	2.20	0.03
2-5 acres and 10-40 acres	2.23	0.03

The results from this table support the rejection of the first hypothesis, that there is no difference in parcellation ratios among township with varying sizes of minimum allowable residential use lots.

Analysis of Parcel Size

The previous analysis gives rise to questions regarding the absence of a more significant and linear relationship between large lot zoning and residential parcellation of rural land. The past analyses also may not indicate how parcel size, rather than zoning, affects the longevity of agricultural activity on large rural land parcels split into smaller lots.

The summary of data thus far does not provide any information on the average size of parcels created in townships with varying lot size restrictions during the study period. One could assume with rural land division that individual parcel acreage should be correlated with the township lot size regulating land division. Although high parcellation ratios should suggest a high incidence of new parcels, a small number of parcels in a township with a ten or twenty acre lot size ordinance could result in a parcellation ratio equal to that of a township with a one or two acre lot size ordinance where a greater number of smaller parcels were created. Conversely, a minimum lot size restriction does not limit the amount of land a seller and buyer exchange other than that they abide by the required minimum.

The land market, influenced by many economic, natural resource and institutional factors, including land prices, mortgage interests rates, availability of land, and land division regulations such as Michigan's Subdivision Control Act, may establish a trend in lot size that varies considerably from a legislated minimum lot size. Because the parcels included in this study are purchased by individuals for the purpose of home construction and, for the most part, not by developers, the factors influencing parcel size

should include some of the aforementioned factors as well as the wish to maximize rural amenities by building on parcels larger than available in the typical suburban or rural subdivision. Residential lot sizes in areas zoned for agricultural use could also be expected to be larger on average than lots in residential zoned areas since land prices per acre should be lower (Vesterby et al., 1994). Similarly, with more rapidly growing populations and increased demand for rural residential land it could be hypothesized that rural residential lot sizes will decrease towards the legislated minimum compared with lots in more slowly growing rural areas.

Parcel Size Distribution

To what extent average parcel sizes reflect local minimum lot codes can first be addressed by examining the distribution of all parcels in the study by some arbitrarily chosen categories. Table 5.8 provides percentages of total parcels for each of the parcel size increments, according to small (less than 5 acres) and large (5 acres or greater) lot size zoning, as well as the total. The 10-10.9 acre category is an indicator of those parcels created in order to avoid platting costs as determined by the former Subdivision Control Act (SCA). The percentages refer to the frequency of parcels for each category and not the parcellation acreage as in previous cases. Perhaps the most interesting observation to be made from this table is the high proportion (40%) of parcel splits under five acres in townships with lot size zoning of at least five acres. Fifty-three percent of all parcels are at least five acres and 28% are ten acres or greater. Nearly 12% of all parcels were between 10 and 10.9 acres. This echoes the propensity of lots just greater than ten

acres throughout Michigan due to the SCA, as reported by Arthur (1981) and Norgaard (1994).

Table 5.8 Parcel Distribution by General Lot Size Zoning Categories

Parcel Size	Small Lot Zoning	Large Lot Zoning	All Parcels
< 2 acres	22%	18%	21%
2-4.9 acres	27	22	26
5-9.9 acres	26	24	25
10-10.9 acres	10	15	11.5
11-19.9 acres	10	12	10.5
20-40 acres	5	9	6

Mean and Median Parcel Size

Table 5.9 indicates mean and median acreage by township for all parcels included as residential land use during the study period. The number of parcels recorded for each time period is also given. Computing the median parcel size is useful in analyzing parcel size distribution since it represents that parcel which falls in the middle of the distribution of all parcel sizes and, unlike the mean, is not effected by extreme low or high values. Mean and median residential parcel acreage for the seventeen townships across the study area are not closely correlated with the acreage set forth in the mandated minimum lot sizes.

No township with a lot size ordinance greater than ten acres has a mean or median parcel size equal to or greater than its mandated lot size, while all of the townships with

Table 5.9 Parcel Size Characteristics By Township

		1975-87	1988-95	1975-95	Population Growth Rate 1970-1990
	< 2 Acre Lot Size				
Allendale	Mean	5.54	5.28	5.40	
	Median	5.00	3.41	4.42	125.7%
	Parcels	67	78	145	
Blendon	Mean	8.94	8.00	8.56	
	Median	9.15	7.50	8.25	61.9%
	Parcels	60	40	100	
Georgetown	Mean	5.08	6.51	5.76	
	Median	2.90	2.90	3.10	85.5%
	Parcels	38	34	72	
Jamestown	Mean	8.72	5.50	7.55	
	Median	9.50	4.30	6.88	38.7%
	Parcels	14	8	22	
Polkton	Mean	10.53	1.40	8.57	
	Median	3.60	1.00	2.50	16.4%
	Parcels	11	3	14	
Robinson	Mean	5.41	5.67	5.56	
	Median	5.00	4.70	5.00	90.8%
	Parcels	31	41	72	
Spring Lake[1]	Mean	8.27	6.86	7.30	
	Median	4.50	4.85	4.50	65%
	Parcels	11	241	35	
Zeeland[2]	Mean	7.72	4.07	5.84	
	Median	6.00	2.45	3.10	52.4%
	Parcels	33	36	69	
2-2.5 Acre Lot Size					
Chester	Mean	8.13	6.73	7.64	
	Median	3.50	7.70	6.80	18.7%
	Parcels	11	6	17	
Olive[3]	Mean	6.83	8.20	7.17	
	Median	5.00	10.00	5.00	38.3%
	Parcels	27	9	36	
Port Sheldon	Mean	4.88	4.99	4.91	
	Median	2.95	3.60	3.00	171.4%
	Parcels	60	19	79	
Spring Lake[1]	Mean	8.27	6.86	7.30	
	Median	4.50	4.85	4.50	65%
	Parcels	11	24	35	
Zeeland[2]	Mean	7.72	4.07	5.84	
	Median	6.00	2.45	3.10	52.4%
	Parcels	33	36	69	

[1] 1 acre minimum before 1988, 2 acre minimum 1988-95
[2] 2.5 acre minimum before 1986, 1 acre minimum 1986-95
[3] 2 acre minimum before 1988, 10 acre minimum 1988-95

Table 5.9 con't. Parcel Size Characteristics By Township

		1975-87	1988-95	1975-95	Population Growth Rate 1970-1990
5 Acre Lot Size					
Grand Haven	Mean	10.66	10.99	10.84	
	Median	4.45	10.30	10.00	76.9%
	Parcels	18	22	40	
Holland	Mean	6.30	8.86	7.43	
	Median	5.00	5.85	5.10	61.5%
	Parcels	38	30	68	
10 Acre Lot Size					
Crockery	Mean	8.65	6.54	8.13	
	Median	10.00	4.75	7.20	25.8%
	Parcels	31	10	41	
Olive[3]	Mean	6.83	8.20	7.17	
	Median	5.00	10.00	5.00	38.3%
	Parcels	27	9	36	
Park	Mean	7.29	3.06	6.08	
	Median	5.50	2.80	4.95	104%
	Parcels	20	8	28	
Tallmadge	Mean	8.73	12.42	10.76	
	Median	6.80	10.00	9.95	28.9%
	Parcels	9	11	20	
20-40 Acre Lot Size					
Crockery	Mean	9.24	11.65	10.56	
	Median	5.05	8.90	5.90	25.8%
	Parcels	14	17	31	
Park[4]	Mean	7.29	3.06	6.08	
	Median	5.50	2.80	4.95	104%
	Parcels	20	8	28	
Wright	Mean	4.96	9.44	7.26	
	Median	2.00	7.50	4.90	10.1%
	Parcels	16	17	33	

[3] 2 acre minimum before 1988, 10 acre minimum 1988-95

[4] 20 acre minimum before 1988, 10 acre minimum 1988-95

smaller than ten acre requirements have mean and median parcel sizes greater than the required minimum. Two of the four townships in the ten acre zoning stratum have a median or mean parcel size of at least ten acres for the period 1988-95. The township mean and median parcel data is aggregated into the respective zoning lot size strata for the two time periods and for the combined period, 1975-1995, and appear in Table 5.10.

Table 5.10 Parcel Size Characteristics by Zoning Strata

	< 2 Acres	2-2.5 Acres	5 Acres	10 Acres	20-40 Acres	Total
			1975-87			
Mean Acres	6.88	6.27	7.70	8.63	7.09	6.98
Median Acres	5.00	5.00	5.00	9.00	4.00	5.00
# Of Parcels	232	131	56	40	50	509
Average Parcels per Sample	2.83	2.85	1.93	1.90	1.43	2.39
			1988-95			
Mean Acres	5.75	6.12	9.76	7.90	10.54	6.89
Median Acres	4.10	4.00	8.20	5.95	6.10	5.00
# Of Parcels	240	49	52	38	34	413
Average Parcels per Sample	2.73	1.63	1.79	.93	1.36	2.07
			1975-95			
Mean Acres	6.31	6.23	8.69	8.29	8.49	6.94
Median Acres	5.00	4.85	6.70	7.00	5.35	5.00
# Of Parcels	472	180	108	78	84	922
Average Parcels per Sample	5.60	5.00	3.72	2.69	2.71	4.33

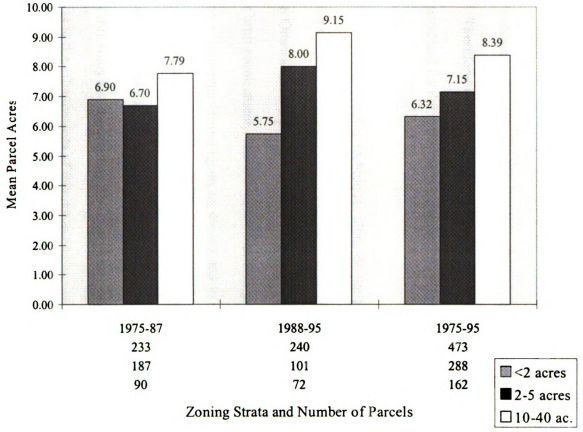
The deviation of mean and median parcel sizes from the minimum required acreage seen in Table 5.9 is replicated when the data is stratified by lot size ordinance. In all but one case the medians are smaller than the means. When the sample size is small this may indicate the presence of outliers significantly larger than the mean parcel size. When the difference between medians and means remains, albeit a large data set, the

probability of skewness is greater: the presence of a significant number of values smaller or larger than the mean. This is the case in the less than two acre zoning stratum where a mean larger than the median indicates many parcels significantly larger than the average. The last row in the table for each time period is the average number of residential parcels per township quarter section for that stratum.

Whether parcellation is comprised of more large parcels in townships with large lot zoning restrictions can be tested by comparing the difference in means of all parcel sizes by zoning strata. ANOVA tests were employed for the five zoning strata for both 1988-95 and 1975-95 time periods. At the 95% confidence level there was a significant difference ($\rho < 0.01$) in parcel sizes among the five strata for both time periods. Since the means appear less dissimilar for those townships with large lot zoning, five, ten, and twenty to forty acre minimums, an ANOVA was also computed for these strata for the same time periods. There was no significant difference ($\rho = .69$) in mean parcel size for the nine township agricultural zones comprising these strata for the entire study period, but for the same strata in the latter period of the study, 1988-95, the null hypothesis of equal means was rejected ($\rho = 0.00$). This may be due to the small parcel sizes in Park Township, which are considerably lower than the mean for the ten acre stratum for this period, 3.06 acres for Park compared to the mean parcel size for the ten acre stratum, including Park, of 7.90 acres. Crockery Township, which may be allowing significant parcel splits less than the minimum, per the clause in the ordinance permitting smaller lots for family members, also had lower parcel sizes (6.54 acres) than the stratum mean.

Among townships with larger lot size ordinances, residential lots should be smaller when mandated lot sizes are comparatively smaller than in other large lot

Figure 5.8 Mean Parcel Acreage and Minimum Lot Size Zoning



T-Test Results

1975-87	T	p
Strata 1&2	0.31	0.76
Strata 1&3	-1.05	0.30
Strata 2&3	-1.21	0.23
1988-95		
Strata 1&2	-2.71	0.01
Strata 1&3	-2.94	0.004
Strata 2&3	-0.88	0.38
1975-95		
Strata 1&2	-1.67	0.10
Strata 1&3	-2.98	0.003
Strata 2&3	-1.63	0.10

townships. A one-tail t-test of the five acre and 10-40 acre strata for the years 1988 to 1995 found that the mean parcel sizes were not significantly different (ρ=.86/2).

Figure 5.8 shows the parcel size mean by the three zoning strata analyzed in previous sections. It is interesting to note that for no period is there a statistically supported difference (at the 95% confidence level) in mean parcel size between samples from townships employing 10-40 acre minimum lot sizes and those with 2-5 acre minimums. For the overall period, however, the three mean parcel sizes are significantly different from each other at the 90% confidence level and at the 95% confidence level when the one-tailed alternative hypotheses are tested, that larger regulated minimum lot size areas are characterized by larger parcel sizes than areas with smaller lot size regulations. Therefore, the last hypothesis from Chapter 4 can be accepted for the aggregate period and for the differences between Strata 1and 2 and Strata 1 and 3 for the period 1988-95.

Minimum lot size zoning techniques alone do not guaranty that parcellation will conform to the standard minimum acreage of the ordinance. Most rural residential land purchasers in Ottawa County prefer a lot size of at least three acres or greater, regardless of any lower limit requirement, and few desire lot sizes greater than 7-10 acres. The latter preference, however, is contingent on the manner in which zoning is carried out in townships with large lot requirements. Determining why areas with large lot zoning do not yield samples of residential parcels reflecting the acreage restriction cannot be fully explained by this study but the answers to this question would provide more important information as to the effectiveness of this zoning technique in controlling undesirable conversion of rural land. Clearly, there would be more lots greater than ten acres if the

ordinances requiring large lots were enforced as simply stated, or residential development in rural areas so zoned would diminish in favor of areas with smaller parcel restrictions.

The exceptions or clauses relative to the large lot size restrictions from Table 3.1 contribute to the low mean and median parcel acreage. For Wright and Tallmadge townships, where parcels split from parent parcels smaller than the specified acreage at the time of the ordinance are exempt, care was taken to include only non-exempt parcels. The great majority of the residential parcel splits in these townships were from conforming parcels, not by way of the exceptions. The researcher was not aware at the time of the data collection phase of the clause in the Park Township agricultural district ordinance and the "ma and pa" allowance of the Crockery Township AG-1 district (40 acre minimum). Time constraints did not allow for exclusion of these parcels from the analysis. In the case of townships with ordinances worded so as to permit lawful non-conforming parcels for children, establishing the relationship between original buyer and seller would be difficult. In conversations with township officials, it was also clear that such clauses were loosely regulated and the splitting of lawful non-conforming parcels was often extended to persons beyond the intent of the ordinance. Furthermore, it was not the intent of the study to exclude any and all parcels created without regard to the ordinance since an important criteria of the effectiveness of the zoning measure is the extent to which it is enforced, evidenced by the number of undersized lots.

At the beginning of the study the researcher reviewed township zoning board of appeals and township board minutes to record variances or rezoning in the agricultural zoning districts but this proved to be too arduous a task. The regression analysis included a variable, *mplan*, which intended to capture any effects of future township land use plans

on residential parcellation, presumably as a result of rezoning or lot splits in proximity to available services.

Trends in Rural Residential Lot Size

In discussions of trends in population growth and land use much emphasis is placed on the contribution of decreasing housing densities to the increased rates of urbanized land use (MSPO, 1995). As residential lot sizes increase, assuming a steady demand for low density housing, the total and per unit residential land use increases and the pool of available land for future housing needs decreases by a larger factor than would occur if densities remained static. From a nationwide sample of urbanized land in fast growth counties, 1960-80, Vesterby et al. (1994) associated the trend in larger residential lots (lower densities) to the growing proportion of residential parcellation in rural areas and the difference in residential land conversion rates per household in rural areas, 0.95 acres, versus urban areas, 0.45 acres. The rate was even greater in counties in earlier, more rapid stages of population growth.

In the sample of residential lot sizes of Figure 5.8 the trend in lot size appears unchanged between the periods 1975-87 and 1988-95. The mean parcel size for all parcels varies slightly, from 6.89 acres for parcels recorded with the register of deeds between 1975 and 1987, and 6.94 mean acres thereafter. The median for all parcels (5.00 acres) is unchanged for the two time periods. Approximately half of the townships, nine of seventeen, had increases in the mean parcel size during the two periods and most of the increases occurred in townships with five acre or greater lot size ordinances. The small

number of parcels in these townships accounts for the insignificant change in the overall mean. For the five acre and twenty to forty acre strata the mean parcel size increases by more than two and three acres, respectively. The decreases in the means in the other strata are much less significant except for the nearly one acre decrease in the parcel size of the less than two acre stratum. This stratum has a higher incidence of townships with high population density and this trend in decreasing parcel size may indicate that in areas with greater population and land division pressure land prices have increased to the point that people are purchasing smaller lots as a cost saving measure and that sellers of rural land are splitting parcels into smaller acreage units, in expectation of added profits from increased per unit prices.

Built-up Parcels

Testing the significance of any decrease in residential lot size during the study period was carried out first on those parcels recorded in the study that showed built-up residential use in viewing the aerial photography. Parcels with no evidence of built-up residential use may be further divided before homes are built and, therefore, may inflate the estimated parcel size of home sites and confuse comparisons over time and between strata.

The data in Figure 5.9 and Table 5.11 for all parcels and for residential built-up parcels only show little difference in the mean and median parcel size for all parcels for the period 1975-87. For the later period, however, there is a substantially smaller average parcel size for built-up parcels, 4.86 acres (median, 3.00 acres) compared to all parcels for the same period, 6.89 acres (median, 5.00 acres). The decrease in built-up parcel size

Figure 5.9 Trend in Mean Parcel Size by Minimum Lot Size Zoning: 1975-87 and 1988-95

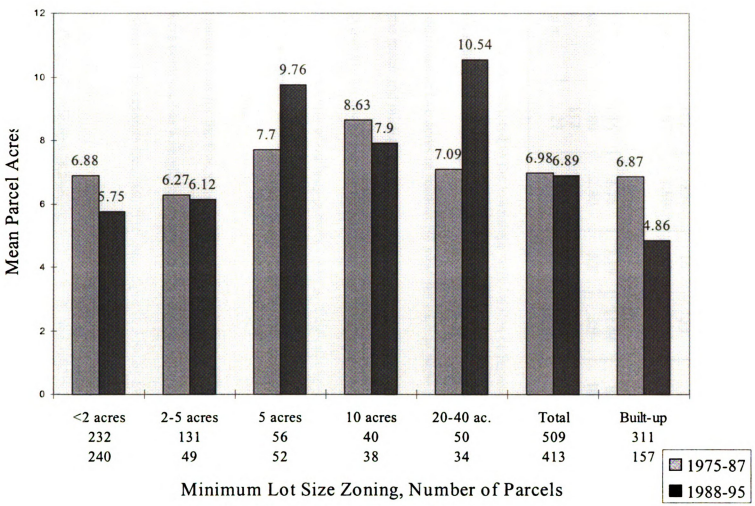


Table 5.11 Mean Acreage of Built-up Parcels

	< 2 Acres	2-2.5 Acres	5 Acres	10 Acres	20-40 Acres	Total
	1975-87					
Mean Acres	6.80	5.90	8.38	9.96	6.93	6.87
Median Acres	5.00	4.00	7.10	10.00	5.30	5.00
# Of Parcels	162	83	16	23	27	311
Av. Parcels per Sample	1.97	1.80	.55	1.10	.83	1.47
	1988-95					
Mean Acres	4.16	3.76	7.19	11.86	8.94	4.86
Median Acres	2.80	2.40	5.2	2.9	10.00	3.00
# Of Parcels	112	21	11	8	5	157
Av. Parcels per Sample	1.27	.70	.38	.20	.20	.74

over the study period is limited to the townships with lot size ordinances of five acres or less. There is a decrease in mean parcel size of at least one and as many as two and a half acres and a decrease of two acres in median lot sizes for each of these groups. The increase in the mean and median lot size for the large lot strata are based on only thirteen new built-up parcels for the 65 sample quarter sections in these six townships between 1988-95. Given the scarcity of built-up parcels in most of the zoning groups for 1988-95 an analysis of the trend in the mean built-up lot size over time could not be done with out further grouping of the data.

The parcel sizes for the five, ten and twenty to forty acre minimum lot zoned townships were computed as a single strata and the two acre and less than two acre townships remained as separate data sets. The results can be seen in the chart in Figure 5.10.

Since the graph indicates decreasing built-up rural residential lot sizes for all parcels, an alternative hypothesis (two sample t-test) for decreasing mean lot size over time for the less than two acre, 2-2.5 acre minimum lot size strata and for total built-up

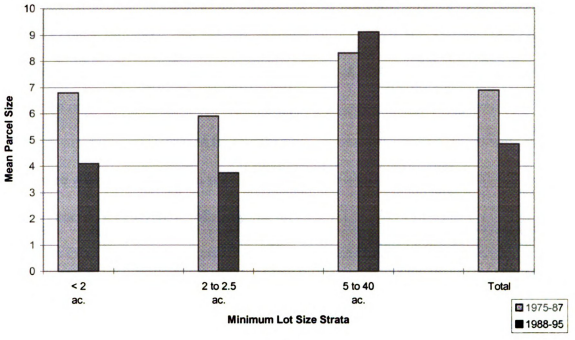


Figure 5.10 Built-up Residential Parcel Size Trend, 1975-87 and 1988-95

residential parcels was accepted at the 95% confidence level (ρ = 0.000, 0.015, and 0.0001 respectively). A null hypothesis of no significant difference between parcel size means over the study period for the townships with 5-40 acre lot zoning could not be rejected at the 95% confidence level. The negligible change in mean parcel acreage between 1975-88 and 1988-95 for all parcels counted in the study could not be expected to support a hypothesis that residential densities are increasing over this period of time.

From the analysis of only those parcels with residential built-up use it is clear that for the minimum lot size zoning strata of fewer than five acres the trend is for decreasing residential lot sizes. The same is not true for housing lots in townships with at least ten acre minimum lot size zoning. The samples from these townships comprise

approximately 25% of the study's samples but only 13.5% of the built-up parcels were observed in these samples.

The increasing parcel sizes in the large lot zoning strata could be due to imprecise information correlating the enactment date of the ordinance with the earlier years of the study or, if lot sizes were imposed by this time, population growth and residential land use pressure was not yet having a significant impact in rural areas of Ottawa County and thus less concern was given to enforcing the lot size restrictions.

The trend for increasing residential parcel size in these townships may be increasing when all parcels are considered. (Table 5.10) The mean for all parcels for the 5-40 acre lot size townships increases from 7.75 acres to 9.40 acres from the period 1975-87 to 1988-95. For the first time period there were a total of 146 parcels created of which 66, or 45%, showed evidence of residential development. For the latter years of the study only 24 parcels out of a total of 124 (19%) had homes built since the parcel was activated. This difference, however, is to be expected since the period of time between parcel creation and possible residential construction, as seen in the 1995 aerial photos, for the first time period is much longer than for the period 1988-95. An aerial image taken in the year 2000 will show that many of the 1988-95 developable parcels have been built on, including some that have been split into smaller parcels.

Any discrepancy between the increases in the average size of all parcels for 5-40 acre minimum lot size townships in Table 5.10 and the lack of a significant enough increase for built-up parcels in the latter period to reject the null hypothesis of equal means is probably do to the high number of undeveloped parcels in these townships as projections for population growth spur increasing parcellation in rural areas. Many of

these parcels of ten or more acres will undergo further division before residential development.

Undeveloped Residential Parcels

Data from only undeveloped parcels, those parcels created between 1975 and 1995 that were considered as likely sites for residential development but with no obvious change toward residential land use during the study period, can be seen in Table 5.12.

Table 5.12 Mean Acreage of Undeveloped Residential Parcels

	< 2 Acres	2-2.5 Acres	5 Acres	10 Acres	20-40 Acres	Total
	1975-87					
Mean Acres	6.93	7.70	8.22	7.31	7.10	7.39
Median Acres	5.00	5.00	5.00	5.00	3.26	5
# Of Parcels	49	36	28	13	21	147
Average Parcels per Sample	.60	.78	.97	.62	.63	.69
	1988-95					
Mean Acres	7.48	7.70	11.31	7.12	10.49	8.38
Median Acres	5.20	7.45	10.00	7.20	6.10	6.84
# Of Parcels	102	26	31	27	25	211
Average Parcels per Sample	1.16	.87	1.07	.66	1.00	.99

For the period 1975-87 the mean and median parcel size for all built-up parcels are 6.87 acres and 5.00 acres while for undeveloped parcels the mean is one half acre greater (7.39) and the median is the same. For the later period the difference in means and medians is nearly double: built-up parcels' mean and median are 4.86 and 3.00 acres and undeveloped parcels' mean and median are 8.38 and 6.84 acres. This difference is largely accounted for by the differences in built-up and undeveloped parcel sizes in the

five acre and smaller lot size strata. It was conjectured earlier in this chapter that perhaps parcels remained undeveloped for a shorter period of time in townships with smaller lot size minimums, which in this survey includes several townships with higher population density. Without this parcel data disaggregated for each township it is difficult to theorize why the data on undeveloped parcels does not support this earlier statement.

There is an increase from 7.39 to 8.38 acres in the mean and from 5.00 to 6.84 acres in the median size of undeveloped parcels over time, though based on the assumption that a certain proportion of undeveloped parcels undergo further splits before residential development, any trend for increasing built-up lot sizes would necessitate a significant increase from one period to another (1975-87 to 1988-95) in the size of undeveloped parcels. The increased mean undeveloped parcel size over the study period was not tested for significance using a t-test since it was believed by the researcher that the difference may be explained by a number of un-developed parcels during the first part of the study that were split into smaller, yet to be developed parcels. Similarly, parcels created in the latter part of the study would be subsequently split for sale to other purchasers of residential building lots. In order for this assumption to be true there would have to be some evidence that the proportion of parcels created during 1975-87 and then split into yet smaller parcels was greater than such parcellation during 1988-95. In other words, many parent parcels that are split into lots of ten acres are subsequently subdivided when residential development in the area, or at least on the parcel, is imminent. Other undeveloped parcels remain vacant for many years as is evidenced by the 147 parcels created before 1988 that continued to be undeveloped by 1995.

Parcel Density

Table 5.13, Parcel Densities By Zoning Lot Size Strata, is the number of total parcels in the strata divided by the number of quarter section sample units in the strata. The last entries of 2.39 and 2.07 in the totals columns of Table 5.10 indicate that, on average across all townships, 2.39 and 2.07 residential parcels were created for each 160 acre sample of rural land during the periods 1975-87 and 1988-95, respectively. Over the twenty year period there were an average of 4.3 residential parcels created in each sample quarter section. This average, however, is not indicative of actual parcellation in each township quarter section of land since many samples had no parcellation and many others obviously had much greater parcel density.

Table 5.13 Summary of Parcel Densities By Zoning Lot Size Strata

	< 2 Acres	2-2.5 Acres	5 Acres	10 Acres	20-40 Acres	Total
	Built-up Residential Parcels					
1975-87	1.97	1.80	.55	1.10	.83	1.47
1988-95	1.27	.70	.38	.20	.20	.74
	Undeveloped Residential Parcels					
1975-87	.60	.78	.97	.62	.63	.69
1988-95	1.16	.87	1.07	.66	1.00	.99
	All Residential Parcels					
1975-87	2.83	2.85	1.93	1.90	1.43	2.39
1988-95	2.73	1.63	1.79	.93	1.36	2.07
1975-95	5.60	5.00	3.72	2.69	2.71	4.33

With respect to built-up parcels, the average number of parcels per quarter section sample in Table 5.13 show that in townships with smaller lot zoning, less than five acres, there is double the built-up parcellation density than in townships with larger lot size ordinances. This tendency is absent for undeveloped parcels. Parcels recorded for the earlier period included twice as many built-up as undeveloped parcels while for the later period there were approximately 30% more undeveloped parcels than there were parcels with new homes. This substantiates the time period that exists between parcellation and residential development and/or the expectation of increasing demand for rural residential land.

Parcellation Density and Population

One final analysis of parcellation can help clarify where differences in parcellation, as determined by parcel density, occur. From the regression analysis the rate of population growth is one of the most significant factors affecting the level of parcellation acreage in the study. Assuming the importance of this variable in affecting the number of parcels created over time, Table 5.13 is disaggregated by township population growth and appears below. Tables 5.14a and 5.14b stratify 1970-1990 township population growth rate into high, 50% or greater, and low, below 50%. Townships are grouped by either low or high minimum lot sizes in order to increase the relative value of the statistic.

Nearly 77% of all the parcels recorded in the study were located in townships with population growth rates of greater than 50% between 1970 and 1990. Michigan's population during this period grew by only 4.7%. By this standard these townships were

Table 5.14a Residential Parcels in Seven Low Population Growth Townships: 1975-1995

	< 5 acre lot size	≥ 5 acre lot size	All townships
Parcels	80	134	214
Parcels per sample	2.00	2.68	2.38
Mean acres	7.51	8.88	8.36
Median acres	5.00	6.60	5.90

Table 5.14b Residential Parcels in Ten High Population Growth Townships: 1975-1995

	< 5 acre lot size	≥ 5 acre lot size	All townships
Parcels	573	136	709
Parcels per sample	6.82	3.48	5.76
Mean acres	6.12	8.15	6.51
Median acres	4.60	5.70	5.00

undergoing fast growth during the period. Weighting the number of parcels by the proportion of samples in each group to the total number of samples lowers the percentage of parcels created in the fast growth townships to 71%, and 29% in townships with less than a 50% population growth rate. Calculating the same weighted percentages for the less than five acres and greater than five acres zoning groups, 77% of parcels in townships with minimum lot size zoning of less than five acres were created in fast growth townships compared to 23% of total parcels in this category for slow growth townships. The analysis of parcels created under zoning restrictions of five acres or greater reveals that 57% of the parcels were located in fast growth townships while the remaining 43% were in slow growth townships.

Table 5.14b shows that the parcel density for fast growth townships is nearly double for samples with less than 5 acre lot size zoning than for samples with 5 acre or greater minimums. Perhaps this points toward some effectiveness of large lot zoning in limiting rural residential parcellation in areas with greater growth pressure that does not occur in less populated areas. From Table 5.14a it appears that this bias for parcel creation in samples with small lot zoning does not hold for the low population growth townships. Fifty seven percent of the parcels created during the study in low population growth townships were in large lot zoning townships.

Parcellation in any township, however, may more closely reflect characteristics of land division in that township than they reflect similarities in zoning with other townships. Given the small number of townships in either population group, any differences in institutional and physical factors that may discourage residential parcellation may better explain the variations in parcel density. As an example, Polkton and Chester townships, two of the four townships comprising the smaller acreage lot size group with less than 50% population growth, constitute 65% of the samples in this group and had significantly fewer parcels created in the study period samples than other low growth, largely agricultural townships with large lot zoning. Polkton and Chester have the lowest population densities of all the townships and are among those townships with the highest proportion of land in agricultural use, 73% and 74 % in 1992, respectively (Koches and Toering, 1995). Chester Township is the most remote of any Ottawa township from any significant population or business center and, combined with the high level of agricultural land use in the area, make this an undesirable, or unfeasible, residential location for most. Polkton Township's zoning ordinance regarding non-farm

land uses in areas zoned for agricultural use is augmented by township officials' commitment to disallow any residential development on productive agricultural land.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The use of rural land, and especially farmland, for urban purposes is a phenomenon of growing concern in areas of rapidly growing populations. This study examined a specific method of zoning employed by township governments to regulate land division in rural areas. The minimum lot size requirement contained in all local ordinances in Ottawa County stipulates the minimum parcel acreage on which permitted land uses can occur. The author proposed this study based on his understanding that such a zoning technique was utilized for, and might be effective in, limiting the sheer acreage of parcel formation for residential purposes, thereby reducing unnecessary urban use of rural land, especially land in agricultural use.

The following paragraphs summarize the results of the hypotheses carried out on the parcel data collected.

Hypothesis One:

The mean of sample residential parcellation ratios for townships employing large lot zoning is not significantly different from the mean of sample ratios in townships with small lot size zoning.

When the parcellation ratios from the quarter section samples were stratified by township minimum lot sizes of less than two acres, 2-5 acres and 10-40 acres, t-tests showed mean parcellation ratios in townships with 10-40 acre minimum lot sizes to be significantly less than the mean ratios in townships with less than two acre minimum lot sizes. Similar results were obtained for the aggregate data set when t-tests were computed for the standardized residuals from the step-wise regression analysis. Standardized residuals of the parcellation ratios from large lot zoning samples were significantly less than both the ratios from the other two strata. Given these results, the first hypothesis was rejected.

Hypothesis Two:

Among many explanatory factors related to levels of parcellation of rural land for residential use, minimum lot size zoning is not a significant contributing factor.

The regression analysis used for this hypothesis did not show zoning lot size regulations to have a linear relationship with the percentage of quarter section samples divided into parcels of residential size. Other significant predictors of parcellation were able to explain approximately 23% of the variability in parcellation. With removal of outliers the explanatory power increased to 37%. By isolating the variables which may confound the relationship between parcellation and lot size zoning, the standardized

residuals did show parcellation ratios to differ significantly by zoning strata and random effects. Therefore, the second hypothesis was rejected.

Hypothesis Three

The proportions of converted farmland to sample agricultural acreage do not vary to a significant degree according to lot size zoning: samples from townships with large lot zoning do not preserve a greater proportion of agricultural land than samples from townships without this zoning technique.

For all parcels in the sample clusters activated during the study period, approximately 45% of the acreage included land in agricultural use in 1973. The proportion of total county land in agricultural use was approximately 55% in 1978. This would seem to indicate that in agricultural zoning districts, where the proportion of land use in agricultural production could be assumed to be greater, residential parcels incorporate less agricultural land. On average, 55% of farmland acreage on residential parcels was idled or converted to residential related use by 1995 and an additional 32% (87% total) of the total farmland acreage in residential parcels was considered by the researcher to be developable.

There were statistically greater agricultural conversion ratios for all periods for townships with less than two acre minimum lot size zoning than for townships with large lot zoning. The proportion of agricultural land cover on parcels was also greater for samples from townships with less than two acre zoning. From this analysis, hypothesis three was rejected. A hypothesis regarding agricultural land cover that was converted and that which was determined as likely to be converted and a hypothesis concerning the

significant difference in proportions of converted farmland to total farmland on parcels could not be rejected. The researcher attributed the significantly smaller proportion of farmland conversion in the 10-40 minimum lot size stratum for the period 1988-95 to the larger proportion of parcels with no built-up use for the larger lot size strata for this period. The occurrence of a smaller proportion of built-up parcels in the large minimum lot size zoning samples was supported in an analysis of parcel density.

Of all converted and considered as converted farmland approximately 43% was comprised of prime or unique farmland. This nearly matched the proportion of total agricultural land use in 1978 that was comprised of prime farmland, by far the greatest component of these important farmlands. The null hypothesis concerning the difference in the conversion of prime and unique farmland and minimum lot size zoning could not be rejected.

Hypothesis Four

The average residential lot size in townships with small lot size zoning is significantly less than the average lot size for townships with large lot size zoning.

The researcher found the most surprising results from this hypothesis. He assumed that actual parcel sizes would more closely conform to the specified minimums, but average parcel sizes for both built-up and undeveloped parcels fell in the range of 6 to 10 acres for the entire study period. The mean was somewhat lower in the less than five-acre zoning strata for the analysis of built-up parcels, 1988-95. For those parcels active since before 1988 there was no significant difference in the mean parcel size between minimum lot size strata. For the period 1975-95 the hypothesis was accepted for all

minimum lot size strata as well as for the less than two acres and 10-40 acres strata for the period 1988-95.

Other Findings

- Forty-seven percent of the total of built-up parcel acreage consisted of agricultural cover and of this, 82% was converted, idled or considered as likely to be converted.
- Some townships seem to be more effective in limiting parcellation on farmland. They tend to employ rural residential as well as agricultural zoning districts and may be more restrictive in permit reviews for parcel splits and residential developments involving farmland.
- Parcellation density in township samples with less than five acre minimum lot size ordinances was notably higher. Townships with less than five acre minimum lot size ordinances created approximately two residential parcels for every one parcel created in townships with five acre or greater minimum lot size ordinances. Considering only parcels with evidence of built-up use this ratio was greater than 2.5 to 1.
- The number of non-conforming parcel sizes in the large lot zoning townships appeared to be significant. Large parcels, greater than ten acres, made up less than 40% of the built-up parcels in township samples with large lot zoning. This decreased the average parcel size for those townships. One possible explanation for such a large percentage of parcels less than the required minimum acreage is that variances are granted when parcels affect marginal agricultural land, smaller farm fields that have little commercial agriculture value. If this is not the case and the trend in lot size in rural areas observed in Ottawa County is not dissimilar to other areas, lot

size provisions in ordinances may make little difference in the actual lots created for residential use. If smaller parcels are allowed to be created from non-productive farm parcels the zoning may serve to preserve active farmland, though with increased parcellation the risk may increase that once begun, residential parcellation may grow, evolving into the effects described earlier in the paper as the impermanence syndrome of parcellation. If this research had addressed the question of rural residential pressures on farming and rural land from additional rural residents instead of the impacts from the effect of total residential parcel acres the results may have been different.

Recommendations for Further Research

One of the limitations of choosing the data source used in this study was the difficulty in managing the viewing of the large township section aerial photos. In order to optimize the information obtained in the photos and to ensure that there were observations of residential parcel activity in as many samples as possible the researcher chose to include the numerous parcels created with development intentions but which remain undeveloped. This proved to have some drawbacks in the data collection as well as the analysis stage. Determination of expected future use was time consuming and estimating agricultural conversion acreage and that agricultural acreage expected to convert was only possible on parcels with actual residential development. If this study were to be replicated for other townships or counties it would be possible to significantly increase the number of townships in the study, and increase the ability to generalize the findings, by computing acreage only on parcels already converted to residential use.

Some counties are beginning to store and update parcel information utilizing GIS technology. This would further ease analysis of a larger study area.

The author had some concerns that limiting the study area to a single county would preclude any possible conclusions for lot size zoning outside of the study area. Extending the research questions to include a broader sampling of agricultural zoning districts and counties with diverse population and parcellation characteristics could be facilitated by delineating zoning boundaries on county plat book maps and counting all parcels and acreage within the desired parcel size range (Arthur 1981, Norgaard 1994), though this method precludes analysis of data on agricultural land use.

Literature on farmland protection zoning is replete with strategies, such as sliding scale and quarter-quarter zoning, which utilize area based allocation methods. In this type of zoning, the size of a parent parcel determines the number of allowable residential lot splits from the parent parcel. To the extent that such methods are being used in Michigan, it is important to test whether they are more effective in reducing rural residential parcellation, especially as it affects sensitive agricultural lands. Ottawa County includes one township with an agricultural zoning district employing quarter-quarter zoning as well as a 1.5 acre minimum lot size district. A cursory analysis of parcellation ratios in this township did not reveal a noticeable difference between the two techniques in the extent of residential parcellation acreage.

Policy Recommendations

Alternatives for addressing the problem posed in this paper include:

- Mapping of zoning districts so that only that farmland deemed most worthy of protection is zoned as agricultural use. This entails significant restrictions on residential development and the commitment to enforce the restrictions in these zones, while allowing residential development at current or higher densities on less valued farm parcels. Grand Haven Township has taken similar steps by inventorying every parcel in its agricultural district as to the appropriateness of future rezonings to non-farm use. Curbing the over zoning of districts marked for open space or agricultural use can also serve to increase the likelihood of concentrating development in suitable areas.
- Consider setting maximum as well as minimum lot size standards. This technique could serve to increase density in targeted areas. Since the author is not aware of such regulatory techniques, other than what occurs by force of the market, such a tactic may not be upheld by the courts.
- Allow for sufficient rural residential parcels by redrawing agricultural and rural residential district boundaries where most appropriate. Rural residential districts can allow for the preservation of rural character through large lots while ensuring to allow such developments in non-productive areas or in areas with little prime or unique farmland.

- Draft zoning ordinances that incorporate building envelopes or a maximum disturbance area for residential structures on farmed parcels. This can aide in avoiding prime farmland or simply any tillable farmland.
- Employ lot size standards using area based allocation methods. These methods stipulate a maximum split based on the acreage of the parent parcel. The Land Division Act may provide greater incentive for using this technique.
- Increase the involvement of community members in the land use planning process.

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