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RESIDENTIAL DEVELOPMENT PATTERNS IN FLATHEAD COUNTY, MONTANA

By

Louis Anthony Jarvis

B.A. Geography, University of Montana, Missoula, 2002
B.A. Economics, University of Montana, Missoula, 2002

Thesis

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Approved by:

Dr. David A Strobel, Dean
Graduate School

Dr. Christiane von Reichert, Chair
Geography

Dr. Paul Wilson
Geography

Dr. Douglas Dalenberg
Economics

Abstract

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Residential Development Patterns in Flathead County, Montana

Chairperson: Dr. Christiane von Reichert

Population growth in the Non-Metropolitan West has increased over the last two decades. Many researchers have argued that natural amenity concerns, the quality and diversity of the environment, and the rural nature of the non-metropolitan West are the chief factors influencing individuals' decisions to settle. This research examines a single high-amenity county in Western Montana, Flathead County, and analyzes the factors affecting land values and the probability of residential development at the parcel level.

This research develops spatial variables thought to affect land values in an ArcGIS 9.2 environment and develops a regression model that estimates land values based on those spatial variables in SPSS 15.0. These variables include distance to lakes, roads, and streams, the density of homes and roads, and adjacency to open space. The regression model included 24,671 residential parcels and returned an R-squared of .522. In a similar manner, a binary logistic regression model was developed using the same variables in order to estimate the probability of parcel development. In this operation, 38,379 parcels were included, and the model estimated whether the parcel was developed or not correctly 73.1% of the time. The findings of this research shows that the spatial location of natural and man-made features have a real and measurable effect on land values and the probability of parcel development in Flathead County, Montana.

Key Words: amenity migration, residential development, exurban development

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INTRODUCTION

The Western United States as a region has experienced profound economic and demographic change in recent decades. In many parts the of the West, the traditional economic base of agriculture and resource extraction through logging and mining has been eroding and is being replaced by an increasingly diverse service economy that is based on natural amenity preservation and the tourism, migration, and entrepreneurship that the region's natural amenities attract (Rasker and Hansen 2000, Shumway and Otterstrom 2001). Retirement, second homes and construction, recreation, tourism, and the services concomitant with these activities form the foundation of the economies of many counties in the West—particularly the most amenity rich counties (Beyers and Nelson 1998). In many parts of the West, the "Old West" of resource extraction and grazing is being ushered out and the "New West" of rapidly growing communities and service-based economies is taking its place. This change is occurring in all corners of the West, including Montana (Lorah 2000).

Arguments forwarded by Power and Barrett (2001) and Rasker and Hansen (2000) explain the structure of the New West Economy: the future of the West lies not with harvesting the resources of the region, but with preserving and promoting the *place* of the region. It is the recreational opportunities, abundant natural beauty, quality of the communities, and rural feel of the region that are the driving forces attracting the new mix of entrepreneurs, retirees, skilled workers, and tourists to the amenity-rich West, and these individuals together place a greater demand on service industries. A decrease in the friction of distance for employment has been realized primarily through the growth of regional airlines and the increasing efficiency of the Internet, and this has allowed migrants to the New West greater freedom in where they reside (Lorah 2000).

The greater freedom exercised by new migrants is often manifested in a decided preference for a rural lifestyle. There has been considerable population growth in nearly all of the most desirable and amenity-rich counties of the West, and, while some of this growth has occurred in the region's urban areas, the preponderance of this growth has been realized in the unincorporated portions of the region (Cromartie and Wardell 1999, Beyers and Nelson 1998). For instance, in the three decades between the years 1970 and 2000, the population of the unincorporated portion of Flathead County, a high-amenity county in the Mountain West, grew by 125% while the incorporated portion grew by less than 40% (Montana Census and Economic Information Center 2006). The same pattern is evident in many other counties across the West.

The dramatic population growth experienced in many parts of the West has resulted in a landscape increasingly marked by the preferences of new migrants, who are often wealthy professionals or retirees desiring large, rural homes on large lots (Riebsame et al. 1996, Walker and Fortmann 2003). In many counties, there are few or weak planning regulations to limit the choices made by developers or migrants building a home, so the newcomer's preference for the wide-open and bucolic is materialized in very land-consumptive development patterns (Walker and Fortmann 2003, Heimlich and Anderson 2001). The dispersed pattern of settlement exhibited by new migrants to the West, commonly called "exurban" (Spectrosky 1955, Davis et al. 1994), is becoming so common in many counties in the West that low-density residential development is the primary cause of landscape change (Hansen et al. 2002).

Researchers have studied many of the consequences of exurban development from areas across the county. The effects of this dispersed style of development include numerous ecological, fiscal, and socio-cultural consequences. The ecological effects include species imperilment, loss of habitat, water quality degradation, and the alteration of natural fire regimes (Brown and Laband 2006, Fraterrigo and Wiens 2005, Hansen et al. 2002, Hansen et al. 2004, Maestas 2003, Odell and Knight 2001, Theobald 2003, Barnes et al. 2002, Nassauer et al. 2004). Included in the fiscal effects are dramatic increases in government spending on municipal services (Coupal and Seidel 2003, Crump 2002, Davis et al. 1994, Nelson and Deuker 1990), the increased exposure of people and structures to wildfire (Cova et al. 2004, Platt 2005), and the rapid conversion of agricultural land and open space to residential land (Cadieux 2007, Heimlich and Anderson 2001, Merenlender et al. 2005). Dispersed exurban development also has the socio-cultural effect of eroding the rural quality or feel of the region through increasing population densities, commercial development, and increasing traffic congestion (Crump 2003, Walker and Fortmann 2003). The effects of dispersed, low-density development are complex and interrelated, and the cumulative effect of these consequences may diminish an area's overall attractiveness. Analyzing the pattern of residential growth is an important component of successful local and regional planning. Flathead County is an attractive and growing place, and the social, environmental, and economic consequences of exurban development are real. For these reasons it is important to study residential development in this area.

Flathead County, Montana typifies the "New West" amenity economy in many ways. Northwest Montana was long a stronghold of logging and mining, but these industries have been in a steady decline, even while population and employment in the county have been steadily rising. The landscape of the county is remarkable; the two standout features of Flathead County are Glacier National Park and Flathead Lake. Additionally, Flathead County contains Whitefish Lake, many other smaller lakes and streams, the Whitefish Mountain Resort ski area, hundreds of thousands of acres of wilderness and National Forest land straddling several mountain ranges, and abundant open space and agricultural fields. Attractive, small communities are dispersed throughout the county and provide a unique rural Montana charm. It is these natural features and charming communities that are responsible for the recent rapid population growth and subsequent restructuring of the local economy (Swanson et al. 2003), and why Flathead County epitomizes the "New West."

Many studies have been conducted that analyze the attractive force of natural amenities in the West (Beyers and Nelson 2000, Brown et al. 2005, Cromartie and Wardell 1999, Hansen et al. 2002, Lorah 2000, McGranahan 1999, Rasker and Hansen 2000, Rudzitis 1999, Shumway and Otterstrom 2001), but these studies were conducted at scales that typically included many counties or the entire U.S, by using county, and therefore macro-level data. A few studies concerned with the pattern of regional or local population growth have focused on conducting analysis at a finer scale. For instance, the work of Cho and Newman (2005) is based on individual parcel data in Macon County, North Carolina, and Irwin et al. (2003), uses parcel level data from a seven-county area of Maryland near Washington, D.C. Hernandez (2004) is based on parcel data from twenty-two counties around Yellowstone National Park in Montana, Wyoming, and Idaho and is aggregated at the Public Land Survey System Section level

(One square mile). For Flathead County, little empirical analysis has been conducted that explores the spatial characteristics of land developed for residential use.

By focusing on a fast growing amenity county in the West, this study examines the residential patterns of development from three perspectives. First, parcel level data are used to examine the transformation of the spatial landscape of Flathead County over time and to determine if homes in the study area are being located at different distances from cities and natural features, and at different densities, over time. Second, this study uses a hedonic regression model to estimate the influence numerous spatial variables have over residential land values thought to be strongly related to current as well as future residential development. Third, a binary logistic regression model is employed to identify which amenity and locational attributes exert the greatest influence over parcel development.

By identifying the features that are most influential in effecting residential development in high amenity, non-metro counties in the West, the findings of this study will help local planners and legislators in Flathead County evaluate the effectiveness and need of various zoning ordinances and provide valuable insight into which areas of Flathead County are most likely to be developed, and hence most in need of planning ordinances.

BACKGROUND

This chapter provides the background for this study by describing the study area, by synthesizing the relevant literature on amenity migration, by discussing research on spatial patterns of residential development, and by considering the consequences of the transformation of the rural landscape. Beginning in the 1970's, amenity-seeking migrants began settling in the non-metro West in increasing numbers, and these population increases are not without consequences. In the section that follows, literature is reviewed that investigates the causes of amenity migration in the non-metro West at both the macro- and micro-levels, the spatial pattern of the residential development associated with amenity migration is discussed, and the consequences of this development are reviewed.

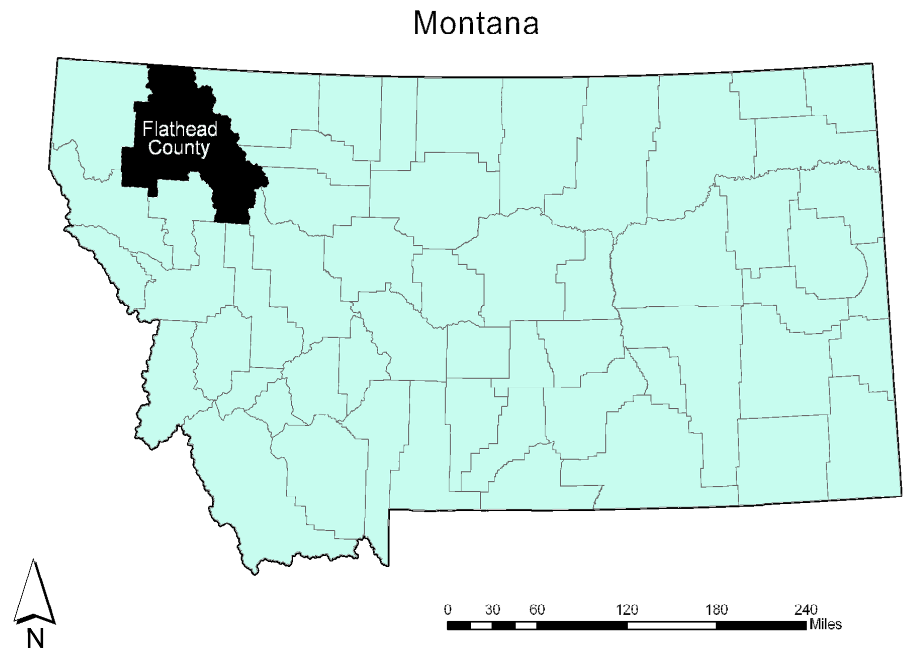
Study Area

Flathead County, the area studied, is characterized by a remarkable physical geography and by and interesting and changing economic and demographic structure. These two aspects of the study area are described in the sections that follow.

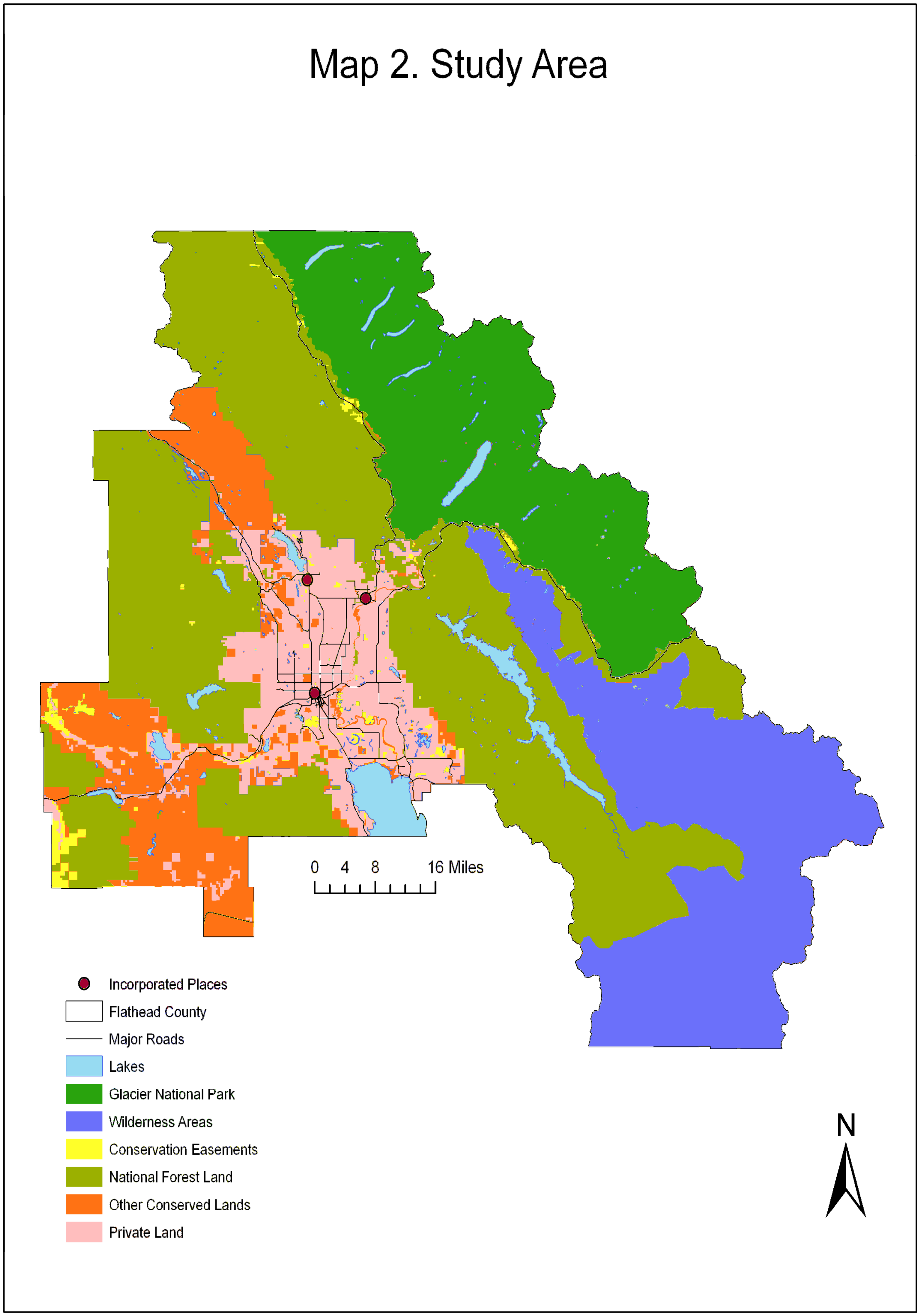
Geography of Flathead County

Flathead County is a large (5,252 square miles) and topographically diverse county located in northwestern Montana. Maps One and Two show the location of

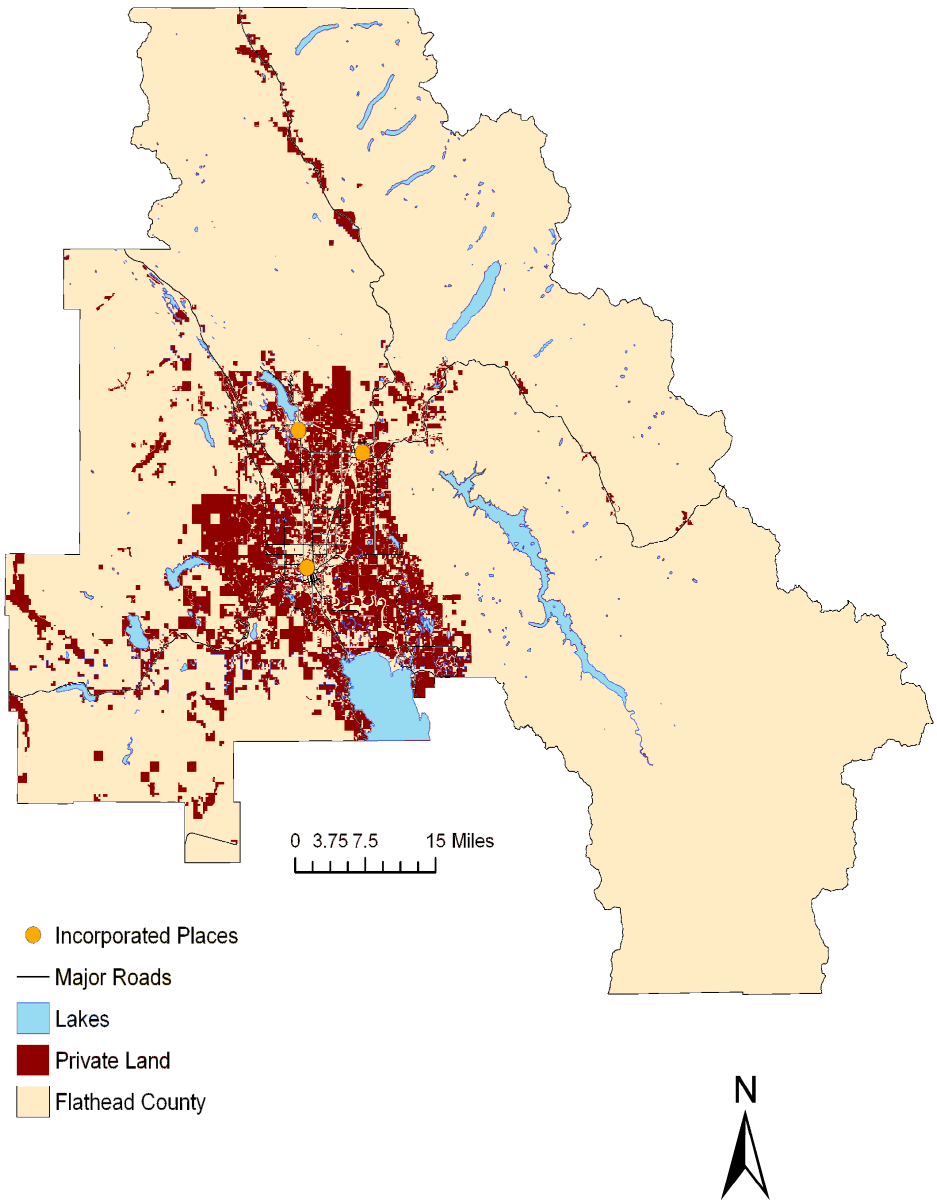
Map 1. Location of Study Area



Flathead County in Montana and the land ownership in the study area. The very center of the county is a large, flat valley that is north of Flathead Lake. Mountains ring Flathead Valley, and these mountains largely curtail development outside of the central valley. The core of the developable land in Flathead County measures roughly fourteen miles across, from the foothills of the Salish Mountains in the West to the abrupt rise of the Swan Range in the east, and twenty-three miles from the south at Flathead Lake to the north at the base of the Whitefish Range. The total developable area of this principle valley is about 400 square miles. Other significant developed portions of Flathead County follow the larger river and stream drainages, and total about an


Map 2. Study Area
0 4 8 16 Miles
Incorporated Places
Flathead County
Major Roads
Lakes
Glacier National Park
Wilderness Areas
Conservation Easements
National Forest Land
Other Conserved Lands
Private Land
N

Map 3. Private Land



additional 100 square miles. The total amount of privately held land is close to 920 square miles, not all of which is developable (Flathead Land Trust 2007). Map Three shows the distribution of privately owned land in Flathead County.

The overwhelming bulk of land in Flathead County is held by the public and protected by virtue of being Forest Service land, federally designated Wilderness, National Park Service land, Bureau of Land Management land, or Montana State Forest land. A sizeable portion of Flathead County is further protected by public and private land trusts and conservation easements. The total amount of land protected in Flathead County approaches 4300 square miles, or just over 80% of the total. Most of this land would not be developable due to the rough topography even if not protected, but many desirable and developable locations in Flathead County are also protected, primarily through state trust lands and along riparian corridors. Even though Flathead County is large, the amount of land open to development is relatively limited.

Flathead County is attracting many new residents largely due to the high quality of its natural environment, scenery, and recreational opportunities; in many ways, Flathead County epitomizes the qualities of the New West (Swanson 2003). The most notable natural features are Flathead Lake, the largest natural freshwater body in the Western United States and one of the cleanest in the world, and the many mountain ranges of the northern Rockies, none more notable than the Livingston and Lewis ranges in Glacier National Park. There are lakes and mountains nearly everywhere, and the scenery and recreation that these natural features provide are the principal forces drawing new residents to the area (Swanson 2003). Adding to the attraction, much of the mountainous areas are either federally protected wilderness area or forest service land managed as such by being designated as roadless by the Forest Service (Lorah 2000).

The three incorporated towns in Flathead County, Kalispell, Columbia Falls, and Whitefish, all have different charms and different qualities. Kalispell, with a Census 2000 population of 14,223, the largest population center in the County, is the center of employment, economic activity, and medical services. Columbia Falls (Census 2000 population of 3,642) is decidedly blue-collar and serves as the gateway to Glacier National Park. Whitefish (Census 2000 population of 5,032) is somewhat of a resort community located on sizeable Whitefish Lake and near the base of the Whitefish Mountain Ski resort. Whitefish has seen considerable upscale development in recent years. The other communities in Flathead County are all unincorporated and quite small, and dot the landscape at odd intervals around Flathead Lake and along the main river corridors. Both the unspoiled and beautiful natural environment and the small-town, rural feel of Flathead County augment its attraction to migrants looking for a high quality of life.

Demographic and Economic Structure of Flathead County

Flathead County has experienced robust population growth recently. During the 1980s, the population of Flathead County increased just fourteen percent, from 51,996 to 59,218, but during the decade of the 1990s, that rate of growth increased to 26%, and total population grew from just less than 60,000 to 74,461 (U.S. Bureau of the Census 2000). The estimated population of Flathead County on July first, 2007 was 86,844, an increase of over fourteen percent in six years (Montana Census and Economic

Information Center 2007). The population is expected to continue to grow between one and one-half and three percent annually (Flathead Growth Policy 2007). Flathead County is the sixth-fastest growing county in Montana, behind the other rapidly growing areas of the Bitterroot valley and the Bozeman area, and third in total population, behind only Missoula and Yellowstone Counties (Montana Census and Economic Information Center 2007).

More important than the rate of growth, perhaps, is the nature of the growth. In the decade of the 1980s, net migration into Flathead County totaled only 2,800 people, but in the decade of the 1990s, net migration into Flathead County was in excess of 12,000 people and responsible for over 80% of the population growth (Swanson 2002). The brisk influx of new residents has, and will continue, to change the age composition and economic structure of Flathead County.

In the 1990s, the segments of the Flathead population that increased the most were those between 40 and 50 years of age, and those in their youth and early teens (Swanson 2002). This would suggest that a rising number of professional families choose to reside in Flathead County. The birth rate also dropped considerably during the 1990s, from eighteen births per one thousand residents to twelve births per one thousand residents (Swanson 2002). The median age has risen considerably—from 30 years old in 1980, to 35.3 years old in 1990, to 39 years old in 2000 (Census). While a portion of the rise in the median age is certainly due to the natural increase from aging, some is also certainly from the in-migration of older residents.

The migration to Flathead County has resulted in a dramatic change in the area's income and economic structure. Income from non-labor sources has increased markedly; in 1980, labor accounted for about 70% of income in Flathead County, but in 2000 labor income accounted for just 60% of total income (Swanson 2002). Since 1980, income from investments and transfer payments grew at a much faster rate than labor income, and this trend is expected to continue. Labor income is expected to fall to about half of total income by 2010 (Swanson 2002). These changes mirror changes in income in other high-amenity counties in the West.

The structure of the economy is changing quickly in Flathead County. Extractive industries have long been declining in significance. Arriving are new residents, with greater portions of investment income, and tourists, and these groups have been increasing demand for services. Table 1 shows total employment levels for each industry in Flathead County. Even though mining, agricultural services, farming, and forestry all showed increases in employment between the years 1990 and 2000, they still account for a small percentage of total employment. Service industries and retail trade account for the largest percentages of total employment by far, followed by manufacturing and construction. Many high-amenity counties in the West experience similar increases in importance of these industries, particularly service industries, due to amenity-led population growth (Deller et al. 2001, Vias 1999, Shumway and Otterstrom 2001).

"Service industries" is a broad category, and includes both high and low paying jobs. Swanson (2002) analyzes changes in income at the sub-sector level and reports that among services, the three fastest growing sub-sectors were health services (doubling in size between 1987 and 2000 and accounting for 38% of all service sector growth), business services (nearly quadrupling in size between 1987 and 2000), and eating and drinking places (nearly doubling in size during the time period.) These findings are in line with other high amenity areas in the West, and suggest that many professionals are migrating to Flathead County and are demanding and consuming an increasing level of services.

Table 1. Employment by Sector, Flathead County, 1990 and 2000

	Persons Employed, 1990		Persons Employed, 2000	
	Total	Percentage	Total	Percentage
Total full-time and part-time employment	33258	100%	49278	100%
Farm employment	994	2.99	1124	2.28
Agricultural services, forestry, fishing	501	1.51	1223	2.48
Mining	95	0.29	227	0.46
Construction	1925	5.79	4183	8.49
Manufacturing	4127	12.41	5106	10.37
Transportation and public utilities	1803	5.42	2205	4.47
Wholesale trade	971	2.92	1198	2.43
Retail trade	6443	19.37	9873	20.03
Finance, insurance, and real estate	2428	7.30	3850	7.81
Services	9832	29.57	15600	31.66
Federal, civilian	865	2.60	851	1.73
Military	459	1.38	389	0.79
State government	495	1.49	551	1.12
Local government	2320	6.98	2898	5.89

Construction employment doubled in size between 1990 and 2000 (Montana CEIC, 2000), suggesting that many migrants prefer to build their home in the country, as most new residences are outside of city limits. Between the years 1989 and 2000, there was an average of 716 new residences built annually in Flathead County, a large number for a rural county with relatively (in comparison to a major metro county) few people (Flathead County Report 2001). The trend of rapid home building is not ebbing; in 2004, over 1,100 new homes were built, making Flathead County the largest residential construction market in the State of Montana for the second year in a row (Spence

2005). The magnitude of the growth, though, is not as important as the pattern and location.

Flathead County is also the leader in the number of subdivisions approved in the state on an annual basis (Jamison 2000, Spence 2005). In 1999, there were 252 residential subdivisions that created 464 new lots—more than twice the rate of any other county in Montana (Jamison 2000). During the two years from 2003 to 2004, just over 2000 new lots were created in Flathead County (Spence 2005). The part of concern is that there is little to no plan guiding these new residential developments, just a landowner selling an acre or two here and there, so the result is very haphazard, unplanned, and inefficient development (Jamison 2000). Former County Commissioner Howard Gipe says that development in Flathead County is the most disorganized in the State, and the primary reason for the disorganization is that minor subdivisions (fewer than five lots) have very little review, and the county is nearly powerless to stop them (Jamison 2000).

The above description of Flathead County highlights the demographic and economic trends that display the Counties' amenity-led development profile. Strong population growth and an aging population are typical of amenity-led growth (Lorah 2000), as are the economic restructuring and construction boom (Swanson 2002, Beyers and Nelson 2000). These trends, coupled with the consequences of rapid and dispersed, amenity-led development, are reasons why residential development needs to be studied in Flathead County.

Amenity Migration in the Non-Metro West: Why People Move

The following two sections address the literature concerned with the patterns of amenity migration in the West, the motivations that drive individuals to seek out a residence in the high-amenity West, and the methods used in studying these aspects of amenity migration. The first section below reviews studies conducted at regional or macro-level, and the second section reviews studies conducted at sub-county or micro-level.

Macro-level Studies

Beginning in the nineteen-seventies and continuing through the present, the non-metro West has experienced the highest rate of net in-migration of any region in the United States, attracting migrants principally through the draw of the region's amenities and rural lifestyle (Cromartie and Wardell 1999). Between the years 1990 and 1996, the non-metro West added nearly 700,000 residents through migration, which is nearly triple the rate of in-migration to the metro West or any other broad region of the United States (Cromartie and Wardell 1999). Many studies have investigated the reasons for the increased migration to the non-metro West. The majority of this research lends credence to the notion that individuals tend to prefer, and increasingly are actively seeking out, rural locations that have low population densities and a high degree of natural amenities and recreation opportunities.

Johnson and Beale (1994) and Brown et al. (1997) argue that the majority of people prefer their current residence types. Those who do not prefer their current residence type prefer smaller and less dense locations. Survey research concerning location preference from the 1970s indicate that over 70% of movers prefer to move to smaller and less dense locations (Fuguitt and Zuiches 1975, Dejong 1977), and the time span between these studies indicates that the preference for more rural locations is quite stable over time. This is one reason why growth in the non-metro West, including Flathead County, has increased greatly since the 1970s. Brown et al. (1997), Brown et al. (2005), Crump (2003), and Lorah (2000) further argue that the changing structure of our world economy, increasing efficiency in communications, and faster and better transportation, has allowed individuals greater freedom in acting out their preferences, and these preferences are being realized in the impressive rates of growth in the non-metro counties of the West.

Some scholars link the robust migration rates of the non-metro West to a uniquely American philosophical value. A fulfillment of a latent passion for (at least some portion of) the "Jeffersonian Ideal," the notion that the greatest and most noble expression of humanity is that of the life of the gentleman-farmer, is at least tacitly implied by Spectrosky (1955) and openly expressed by Nelson and Deuker (1990), Nelson and Sanchez (1997), Esparza and Carruthers (2000), and Cadieux (2007). It is certain that at least a portion of migrants to the West indeed become hobby-farmers, and it seems that the "Jeffersonian Ideal" and a simple preference for the less dense, less hectic, smaller, and more pastoral are at least indirectly linked in the human psyche, and it seems rational to assume that there is something innate in many humans that leads them to prefer lower population densities and rural settings, if given the choice.

Two recent studies (Rudzitis 1999, Crump 2003) have surveyed individuals to determine the most significant specific reasons for moving to high-amenity areas. In a survey of 1,800 people who migrated to Western counties, the four most important pull factors in their decision to move were scenery (cited by 72%), environmental quality (65%), pace of life (62%), and outdoor recreation (59%). Employment opportunity was cited by only 30% of the respondents (Rudzitis 1999). Most of the respondents (67%) were satisfied with their employment opportunities before they migrated to the non-metro West. The findings of this study are important because they demonstrate that non-economic factors are the principal reasons people migrate to the non-metro West.

Crump (2003) conducted a telephone survey of 100 residents of rural Sonoma County, California, to ascertain their reasons for their choice of residence. The findings were similar to Rudzitis (1999). Just over two-thirds of respondents reported that an attractive natural environment was either very important or the most important reason for their choice of residential location. Sixty-five percent said that a rural environment was either most important or very important, and 63% said that nearby open space was most important or very important. Recreational opportunities were cited as most or very important by 35% of those who responded, and job opportunities were cited as most or very important by only about one-quarter of respondents. The findings of these two surveys support the notion that natural amenity considerations are the chief motivators for people migrating to the non-metro West.

Other studies have used other techniques to investigate the attraction of amenities to migrants. McGranahan (1999) employs regression analysis on county-level data to explain the effects that specific natural amenities have on population growth in every county in the United States from the year 1970 to 1996. McGranahan ranked each county on a variety of amenity-related criteria. The ranked values of specific amenities included in this analysis were warm winter, winter sun, temperate summer, low summer humidity, water area, and topographic variation. These values were used to provide a numeric score of amenity levels for every county. The study concludes by asserting that natural amenities are highly correlated with population growth.

Another study, conducted at a more regional level than McGranahan (1999), investigates "how important amenities (are) in people's decision to move to rural areas, and moreover, which amenities are important" (Rasker and Hansen 2000, pg. 30). The study area for their research is the twenty-county region of the Greater Yellowstone Ecosystem (GYE), which is a hotspot for studies of rural population growth and development. Rasker and Hansen (2000) used the county as the unit of analysis in this study. The amenity variables developed to test the correlation between population growth and amenity levels are quite different from McGranahan (1999) and attempt to more closely capture specific natural features that affect population growth. The variables incorporated were percent forest cover, total length of streams, percent lake cover, standard deviation of mean elevation, minimum, maximum, and mean precipitation, mean annual temperature, and percent nature reserves (wilderness, National Park, wildlife refuge). These variables are used to assess which natural features have the most draw to migrants (Rasker and Hansen 2000). The final model included other social and economic variables pertinent to population growth at this scale such as percent of the adult population with a college degree, a variable capturing the rate of serious crimes, percent of total employment in various sectors of the economy, and percent of total income in various sectors of the economy.

The study concluded that there is significant correlation between population growth and ecological and amenity variables, enough correlation to say that "any model of population growth in the West should include variables that account for the differences of these (amenity) characteristics" (Rasker and Hansen 2000, 36). The two most significant amenity variables included in their model were percent of land in nature reserves (coefficient of .585) and percent forest cover (.612). These findings are consistent with other research; there has been considerable attention paid to the role federally designated wilderness plays in attracting migrants. Rudzitis (1993) notes that, when compared to other non-metro counties, counties containing designated wilderness have experienced accelerated rates of population growth since the 1960s. For example, in the 1960s wilderness-containing non-metro counties grew at triple the rate of other non-metro counties, double the rate in the nineteen-seventies, and six times the rate in the nineteen-eighties (Rudzitis 1993). To summarize the findings of Rasker and Hansen (2000), the portion of population growth among counties in the Greater Yellowstone Ecosystem (GYE) is most associated with counties containing significant mountainous terrain, high percentages of forest cover, high percentages of protected land, and (relatively) high mean annual precipitation. At the scale of this study, these are the natural features that explain the greatest portion of population growth.

Another study relating population growth and amenities in the GYE is one conducted by Hernandez (2004). This study is unique in that it contains a large study are, the twenty-county GYE, and utilizes a sub-county unit of analysis, the Public Land Survey System section–a unit with an area of one square mile. The finer resolution of this study provides further insight into the natural amenities that attract migrants to the non-metro West. The database used by the study includes every home in the GYE and the years they were built, from the year 1857 to 1999, and the results are summarized per one square mile section.

The amenity variables included in this research, not all of which were used in the final regression models, are quite exhaustive, and include distances to numerous natural and man-made features, density variables (for roads, houses), proportion variables (proportion of public land within a ten-mile radius, for example), climate variables, and a variable capturing topographic variation. The conclusions of Hernandez (2004) are similar to Rasker and Hansen (2000); the amenity variables that explain the greatest variation in housing growth were proximity to protected natural areas, proximity to lakes, and climactic variables, and this is consistent with other related studies. A surprising finding was that the proportion of public land in a given radius was inversely related to housing growth. This seems contrary to theory because past work has shown that the presence of wilderness areas and national parks is positively correlated with population growth, and it seems logical that distance to- and proportion of public land would have the same effect. The author offered an explanation by noting that most home development is on flat valley bottoms, away from most public land, and that the variable did not distinguish between more desirable public land (parks and wilderness) and less desirable, more actively managed public land (Bureau of Land Management land). Furthermore, Hernandez utilized a sub-county unit of analysis, which is unique, as most studies are conducted at the county level or greater.

A study conducted by Booth (1999) seeks to establish the spatial determinants of population density in part of the non-metro West. Booth builds a regression model to estimate variation in population density among 86 rural counties in California, Colorado, and Montana against the spatial determinants of distance to nearest metropolitan area, the number of interstates, the presence of ski areas, the presence of colleges or universities, and the proportion of land in National Parks or designated wilderness. This study provides perhaps the best analysis of why some high-amenity counties in the West grow faster than others. Significant variation in population density is explained by the distance to metropolitan areas and the number of interstates-both variables had strong positive correlations with population density; the author argues that "even though rural residents may be sufficiently footloose to choose their residential or business location in order to have immediate access to rural amenities, they may not want, nor be able, to entirely sever their urban ties" (Booth 1999, 388). The presence of a college or university was estimated to increase population density by 79% in the year 1985 and by 75 % in the year 1994, which suggests that institutions of higher learning have a powerful positive effect on population density.

Two findings were contrary to the findings of other research. For the years 1985 and 1994, an increase in the amount of land in wilderness actually resulted in a decrease in population density, and the number of skier visits did not have a statistically significant effect (Booth 1999).

The macro-level studies considered have contributed much to the impetus for, and basis of, the current research. The common tool of regression modeling is very useful at a greater scale in determining the influence of amenity variables on changes in population growth, population density, and housing growth, and will be employed at the parcel level scale to estimate the influence various hedonic variables have on land values. Many of the same amenity variables used in the past macro-level models will be incorporated into the current model. The survey research reviewed above shows that migrants to the non-metro West have a distinct preference for smaller, less dense and more rural locations, a set of preferences that is satisfied with the study area of Flathead County. The survey research also reveals a strong preference for pleasing natural scenery, a rural quality of life, and recreational opportunities—three other qualities the study area provides in abundance. Macro level studies are useful in grasping the forces behind change—in this case, the drivers of amenity migration and the most influential amenities—and useful in developing macro-level policies. Much research has contributed to the broad notion that the best way to foster population growth and economic prosperity lies in protecting and promoting the areas natural splendor, as this will attract the mix of individuals who will settle and start businesses, demand services, and build houses—the twenty-first century amenity and recreation homesteader. The macro-level studies reviewed above provide strong support for the notion that natural amenities play an important role in attracting people to specific regions.

Micro-level Studies

While macro-level studies are important in understanding the forces affecting residential location choice at the regional level, micro-level studies are concerned with the forces affecting where people chose to reside at the sub-county level. Micro-level studies also use regression analysis and amenity variables to model population and economic dynamics. Cho and Newman (2005) examine parcel-level residential development in rural Macon County, North Carolina, a rapidly growing county in the

Blue Ridge Mountains, using amenity variables. The data used for Cho and Newman was provided by the Macon County Tax Administration Department and included information on parcel size, the number of structures, and the assessed land value. The authors use the assessed land value as an approximation for real-world land price. The variables used in this study are the log of land value, a dummy variable capturing if adjacent land is developed or undeveloped, road density, housing density, stream density, median elevation, ratio of flat to steeply inclined land, and distance to city center, distance to nearest stream, and distance to nearest road. Cho and Newman seek to estimate which hedonic variables have the most influence on new residence location (using land values as a proxy for returns on development) within a high-amenity county. Further, they employ a probit model to estimate which parcels are developed, and additionally, they model residential development density.

All of the variables included in the model were statistically significant, and results reveal that land value increases as adjacent parcels are developed, as distance to a city center decreases, and as parcel size decreases, which is consistent with theory. Also, land values increase with decreasing distance to roads, but decrease with increasing road density—suggesting that people value access, but dislike crowding. Being close to streams and rivers also increased land values, as did higher median elevations and higher flat land ratios. These findings suggest that people value the natural environment and scenery. Cho and Newman provide a strong framework for analyzing residential development at the parcel level.

An important assumption by Cho and Newman, that assessed land values serve as an accurate proxy for land price and expected returns on development, and hence likelihood of development, has its root in Bockstael (1996). Bockstael provides a valuable overview of spatially explicit land use conversion modeling theory and techniques, and applies her methodology to part of a seven-county area, the Patuxent watershed in the Baltimore, Maryland--Washington, D.C. area. The study is pertinent to the current study for its building of development rules of parcels between undeveloped and developed states using assessed land values and it description of using hedonic variables in regression modeling.

Similar to the work of Cho and Newman (2005) and based on the same underlying theory regarding parcel conversion is the research by Irwin et al. (2003). Irwin et al. model land use conversion in Calvert County, Maryland at the parcel level with a probabilistic duration model, and the study is pertinent for its theory, technique, and variables.

All of the literature reviewed contributed in forming the methods used in this study and the selection of Flathead County as the study area. The macro-level studies reviewed highlight many reasons why Flathead County is an appropriate study area, and provide a basis for the methods used in evaluating residential development. The micro-level modeling techniques of Cho and Newman (2005) are borrowed from heavily, as is the theoretical framework provided by Bockstael (1996). The literature reviewed has provided insight into why migrants are choosing non-metro locations in the West, the specific amenities that influence residential location, and the methods used in analyzing development.

Amenity Migration in the Non-Metro West: Spatial Pattern of Development and Consequences

The pattern of residential development in the non-metro West has been variously described as “low-density,” “dispersed,” and “exurban” (Merenlender et al. 2005, Hansen et al. 2005, Gude et al. 2007, Riebsame et al. 1996, Johnson and Beale 1994). Exurban residential development, typically defined as residential development at densities of one home per one acre to one home per forty acres (Gude et al., 2007), is the fastest growing type of land-use in the United States and is estimated to cover roughly 25% of the lower 48 states (Brown et al., 2005). To highlight the rapidity of this process in the high-amenity areas of the West, Gude et al. (2007) note that between the years 1970 and 1999, the population of the Greater Yellowstone Ecosystem (GYE) increased 58%, but the area of land settled at exurban densities increased over 350%.

The general argument for the manifestation of this preference for low density rural life since the 1970s in parts of the rural West is summarized by gleaning sections of the work of Lorah (2000), Power and Barrett (2001), Shumway and Otterstrom (2001), Beyers and Nelson (1998), Brown et al. (2005), and Nelson and Sanchez (1999): In general, many individuals prefer less densely settled and more rural locations, partly due to dissatisfaction for bustling city life and partly due to engrained American philosophy. Increasing wealth, more efficient communication, and expanding regional transportation services have allowed individuals unprecedented freedom in the expression of residential choice, and increasingly, individuals are choosing to settle in the high-amenity, non-metro West at low densities.

A quote from an article in Sunset magazine captures the sentiment held by many concerning their place in the West. In answer to a question by the author of the article concerning the location of her new home on one acre in the Paradise Valley (to the south of Livingston, Montana): "it's close enough to town to duck in for a latte, but I wake to coyotes and deer rambling through my yard and an environment that really gets my creative juices flowing" (Matlack 2007). The purpose of this quote is not to deride an individual choice, but to emphasize the desires that many migrants hold about their choice of place in the landscape: low-density and rural with easy access to an urban center. For Flathead County, much of the evidence concerning exurban development is similarly anecdotal, and this study seeks to gather empirical evidence to evaluate the extent and pattern of amenity-led exurban development in the study area.

In short, the pattern of residential development associated with amenity migration is one of dispersion (or relatively low density), and proximity to urban areas, natural features, and outdoor recreation areas. This study investigates whether residential development patterns in Flathead County are changing in response to increasing amenity migration, and is important because dispersed residential development patterns are associated with many ecological, fiscal, and socio-cultural consequences.

Dispersed residential patterns can affect an area in many significant ways. There are ecological consequences, fiscal consequences, and socio-cultural consequences resulting from dispersed residential development, and the following section reviews each of these broad categories of consequences.

Ecological Consequences

The amenity-driven population growth in the West, and the considerably dispersed residential development that accompanies it, comes with many economic, social, and ecological consequences. A great deal of research has been conducted evaluating these effects, the ecological effects in particular, which, given the intense speed and wide dispersion, easily rival the deleterious environmental consequences of the extractive industries in total impact (Compass 2007, Power and Barrett 2001). While it is argued that the high quality of the natural environment is what attracts migrants, and therefore fuels economic growth, there is growing evidence that people's residential choices are altering ecosystems processes, destroying habitat, and threatening biodiversity (Theobald 2003).

For Flathead County the threats to the ecosystem are particularly troubling as the County has a diverse range of unique habitats and rare species. The North Fork of the Flathead River, on Glacier National Park's western edge, is thought to be one the last remaining areas of the lower 48 states to still contain virtually all of the species present at the time of European settlement (Flathead Coalition, no date). Glacier National Park is a treasure trove of insects, plants and animals. Flathead Lake is one of cleanest lakes in the world (Flathead Lake Biological Station, no date). Large forested areas contain significant populations of large mammals, most notably the Grizzly. The many lakes and streams form large riparian areas that are rich in biodiversity. Unplanned rapid residential development threatens Flathead County's rich biodiversity and clean environment.

There are many ways in which exurban residential development can negatively affect an area's ecology. Most visible is the direct conversion of land from one use, say undeveloped forest, prairie, or agricultural field, to residential use. Given that land-consumptive exurban development is the fastest growing land use in the country

(Heimlich and Anderson 2001), this is a serious concern. Also, the placement of exurban residential lots is not random across the landscape; research shows that people seek out scenic natural features like streams and lakes, national parks and preserved areas, and choice private land—which is also typically the most critical land for wildlife (Maestas 2007). In addition to new residences, increased infrastructure associated with development also adds to the impact of exurban development.

All exurban development takes place on private land. In the Western United States, private lands occupy the most productive soils, have a high percentage of riparian areas, and are typically at lower elevation. This makes private land disproportionably important to many species at different points in their life cycle (Maestas 2007, Odell and Knight 2001). The habitat conversion caused by exurban development also fragments large mammal habitat and can block important migration corridors (Hansen et al. 2002). The replacement of valuable roaming and grazing land favored by large mammals with low-density residences can hurt large mammal populations and affect an area's ecological balance by altering ratios of predator to prey (Hansen 2004). In the Glacier National Park-Bob Marshall Wilderness Complex in Flathead County, biologists report that over sixty-percent of all grizzly bear-human conflicts occur on private land, even though private land represents only seventeen percent of the area (Hansen 2004).

Significant research has been conducted on the relationship between exurban development and bird populations. Odell and Knight (2001) found that exurban development decreased bird species richness and population in Pitkin County, Colorado and contributed to the conversion of natural wildlife communities by favoring humanadapted species (robins and magpies) at the expense of other species (gnatcatchers and flycatchers). Fraterrigo and Wiens (2005) similarly found that, along the Front Range of Colorado, exurban development reduced bird populations and diminished species richness by favoring populations of generalist species at the expense of specialist species.

Low-density residential development can also affect an area's ecology in other ways. The construction of homes in heavily forested areas limits government ability to allow wildfires to take their natural course. By limiting or eliminating fires natural role in the landscape, exotic species can proliferate, some plants fail to regenerate, and the ecological balance of an area can be severely altered (Radeloff et al. 2005). In a heavily forested location like Flathead County, where fire's essential role in ecology is well studied and understood, far-flung low-density residences can have a serious negative impact on plant and animal abundance and diversity. A single person or family makes most residential development decisions, but their collective impact on the ecological health of an area can be great.

Exurban development in the West brings with it a multitude of water resource issues. In the drier areas of the West, residential development competes for water with agriculture, electrical power generation, and endangered species and fish recovery efforts (Reibsame et al. 1997). So in many areas, the chief concern about water is scarcity. This applies to Flathead County less in terms of overall quantity of water, but to a greater degree in confusing water-rights issues, as the senior water rights holder of a particular water supply can effectively limit the usage of those below them in rights-seniority (Witkowsky 1995). Another concern for the Flathead is conversion of agricultural land to housing and the associated loss of water filtering (Heimlich and Anderson 2001). As houses and impervious surfaces spring up, more potentially toxic runoff is created, and less undeveloped ground is available for filtering. This poses a threat to water quality of aquifers, streams, and lakes (Defries et al. 2004).

There is a disagreement over what may represent the greatest threat to water quality in Flathead Lake. A newspaper article in the *Missoulian* quotes a Department of Environmental Quality specialist who argues that the meteoric rate of minor subdivisions experienced in Flathead County is causing an unsafe number and density of septic systems to be installed, and that this poses the greatest threat to water quality (Jamison 2000). Conversely, a newspaper article in *The Daily Inter Lake* quotes Jack Stanford, director of the Flathead Lake Biological Station, who claims that modern septic systems are safe and not a major cause of concern, but that sewer systems are the biggest danger to water quality to both Flathead Lake and ground water. Dr. Stanford argues that sewer systems abet dramatic increases in population density and impervious surface, and that runoff affords the most ill consequences to water quality (Mann 2006). Regardless, increasing exurban development will cause increasing water quality concerns in Flathead County.

Fiscal Impacts

Aside from the array of ecological consequences born by low-density residential development, there are many effects on local government and the provision of services. Exurban development largely occurs outside of city limits in relatively sparsely populated counties, yet exurban migrants still demand Emergency Medical Services, public infrastructure like roads, police protection, and public schools (Davis et al. 2004). Also, one-time rural locations may see their densities increase and eventually may be annexed by a city, and the city may require that the area be connected to the sewer system. When this occurs, the connection of the sewer system is a considerable financial burden to the local residents. Studies show that exurban residential development typically does not pay for itself (Heimlich and Naderson 2001).

Coupal and Seidl (2003) show that 62 of 63 Colorado counties show a negative fiscal impact from dispersed residential development: on average, dispersed residential development in Colorado consumes $1.65 in services and education for every dollar generated in tax revenue. There was considerable variation in their findings; Elbert County, a largely agricultural county, received only $.53 in services for every dollar in tax revenue generated and Rio Blanco County received just $1.05 back for each dollar in taxes, though Jefferson and La Plata Counties received over five dollars back for each dollar generated. This is not to imply that agriculture is the most fiscally appropriate land use, but that through planning more efficient development can occur.

Other studies report similar findings concerning low-density development and public expenditure. In a synthesis of a number of studies, Heimlich and Anderson (2001) report that low-density, exurban style development costs roughly $1.24 for every dollar generated in local taxes while farmland consumes only $.38 for every dollar generated in taxes. The study goes on to make the point that the denser the population, the more efficient the use of public goods and services. Citizens for a Better Flathead provides nearly identical numbers from a study in Flathead County: analyzing numbers from the 1987 budget, the group claims "sprawl" consumes $1.23 for every dollar in tax collected, while timber and farms use only $.38 (2000). The group also notes that between the years 1992 and 1997, population in Flathead County increased by just over twenty-two percent, while homeowner's property taxes increased 65%, and this clearly adds credence to the notion that low-density development is expensive.

Increasing penetration of low-density, dispersed residential development into wildfire prone areas, commonly called the "wildland-urban" interface, also has economic repercussions (Gude et al. 2007). People building homes across the non-metro West tend to seek out scenic, high-amenity, often forested areas on the urban periphery—in areas prone to wildfires (Cova et al. 2004). Throughout history, fire has played an important role in the ecology of the West, and humans have drastically altered the natural fire regime in the last hundred years, and this has created a numerous repercussions (Pyne 2001). What is certain is that either nature or human activity will cause seasonal fires on nearly every patch of the forested Western landscape at some point, and that human life and structures are increasingly at risk of destruction (Radeloff et al. 2005, Theobald 2001). Not much can be done to curb the development of private land at risk of wildfire. The mitigation tools recommended curb the risk of fires to structures include creating a "defensible space" around structures (Pyne 2001), but given the enormity of some conflagrations, even with a defensible space, many homes, and perhaps lives, would be lost (Winter et al. 2002). Thinning the forest around the wildland-urban interface is another common policy recommendation, but can become prohibitively expensive as the scale of thinning project increases (Winter et al. 2002, Cova et al. 2004).

People will continue to exercise their preference for the country life and build homes in areas prone to wildfire. Gude et al. (2007, forthcoming) report that in Western states, 50% of all new homes are built in areas classified as severe fire zones. The financial burden of protecting structures in the wildland-urban interface is great. Between the years 2002 and 2006, over 6.3 billion federal dollars were spent fighting wildfires (an estimated 50 to 95% was spent fighting large fires threatening private homes), 92 people died, and nearly 11,000 homes were lost (Gude et al. 2007, forthcoming). Gude et al. (2007, forthcoming) report that only fourteen percent of the wildland-urban interface is developed in the West, and in the near future if trends don't change, annual firefighting cost could exceed four billion dollars.

To lessen the financial strain and reduce the loss of structures and lives, considerable multi-level planning will have to occur. One mitigation method is to make landowners in the wildland-urban interface pay a risk assessment fee. This occurs throughout Montana, but the fee is minimal--$30 for every parcel less than twenty acres, plus and additional $.20 for each additional acre (Testa 2007). This fee covers only a minute portion of the State costs of fighting fires and highlights the difficulty in exacting a fair fee for the impact of development in fire prone areas. Flathead County has the greatest number of homes in the wildland-urban interface in Montana (7,846), and the wildland-urban interface is less than a quarter developed (Gude et al. 2007). Continued dispersed development along the wildland-urban interface will only increase these costs.

Socio-Cultural Impacts

Unplanned, dispersed residential development has many ecological and economic consequences, but there are important socio-cultural effects, too. New migrants bring with them different ideas and values, and their growing numbers ensure that their values are increasingly the norm (Beyers and Nelson 2000, Lorah 2000). Many people are attracted by an area's scenic beauty and rural charm, and soon after arrival, may voice and exercise desire to preserve these qualities of the area. New migrants may often support or propose land-use regulations seen as unfavorable by long-time locals, and this disagreement on land use policy may cause tension. (Walker and Fortmann 2003). For example, during a community meeting in Nevada County, California, when discussing a proposed county-wide development regulation, a long-time local resident opined with the following sentiment:

> We didn't use to have committees to tell us what to do [with our land] . . . Now we have all these people telling us just how great we're going to make it for you. 'We're [county government] going to do this for you, we're going to do that for you.' And when it comes time to sell, well, 'We'll buy it from you [as a park or open space].' But now there's a little catch. 'We'll give you market value and maybe you paid $65,000 and you're selling it for $400,000; well, we'll give you the $65,000, but we'd like you to donate the balance to the wonderful Earth Charter.' By the way, [former Soviet leader Mikhail] Gorbachev runs that. All this crap's coming out of there ...(Walker and Fortmann 2003, pg 470).

This and other acrimonious diatribes are common in the West when groups have opposing land-use visions. New migrants bring with them different expectations concerning agricultural sights and smells, land-use planning and property rights, the provision of services, traffic, and many other cultural components (Paulson 2004, Stewart 2000), and these differences all add up to severe cultural friction.

New migrants are attracted by the amenities and want a piece of rural America, but long-time residents argue that they want to superimpose urban life on a rural landscape (Paulson 2004). Since jobs are not the primary reasons that many people are moving to the non-metro West, many migrants bring with them other income sources, and this can change the structure of the local economy (Deller et al. 2001, Vias 1999).

Many high-amenity areas that attract new migrants were once strongholds of primary resource extraction have seen these industries decline dramatically in importance over time, yet have added to total employment during this time and seen considerable diversification (Power and Barrett 2001). Many researchers have found that the economies of high-amenity areas of the non-metro West have been bolstered by large employment gains in professional and household service industries (Shumway and Otterstom 2001, Vias 1999, Power and Barrett 2001, Deller et al. 2001, Beyers and Nelson 2000). The increased importance of service industries has resulted in changes felt throughout high-growth areas.

Proponents of amenity-led growth point out the increases in total employment levels, decreased unemployment, and diversification of the economy (which considerably lessens the boom-and-bust pattern of prosperity associated with primary resource extraction) that amenity-led growth brings (Swanson 2002, Vias 1999, Green 2001). A detractor will argue that most service jobs pay very little, wages in service based economies are flat, and increased commercialization brings box stores and strip development, which detracts from the rural appeal (Vias 1999, Green 2001, Delhomme 2005). Not much is known about how the economic restructuring brought on by amenity-led development plays out in the long run. What is for certain is that many high-amenity areas in the West, Flathead County included, are seeing their economies become ever more service based, and that this trend is not likely to change in the near future.

The above review of literature highlights reasons why people chose to settle in the high amenity West, what specific amenities attract people and at differing scales, different methods used to study and evaluate amenity-led population growth and the significant ecological, social, and economic consequences of unplanned and haphazard residential growth. Flathead County, for many reasons, is the amenity economy incarnate: it is surrounded on all sides by diverse amenities, has a unique and largely pristine ecology that needs protection, is largely rural, has experienced persistent population growth in recent decades, and has undergone a dramatic economic restructuring. It is important to study amenity-led residential development in Flathead County because Flathead County continues to grow with vigor, has weak countywide planning and subdivision regulations, and is largely unstudied. This research examines amenity-led residential development in Flathead County in three ways: by analyzing how patterns of residential development have changed over time, by building a regression model which estimates which spatial features affect land values (and by theory, the likelihood of development) the most in the county, and by employing a binary logistic regression model to identify the specific parcels with the highest estimated probability of development in the future. The results of this study would benefit county planners and others making land use decisions in Flathead County.

METHODOLOGY

This study analyzes residential development, and the factors that influence residential development, in Flathead County. Three methods are used to this end. The first method describes patterns of development, and how these patterns have changed over time. The second part analyzes the locational and situational variables that effect land values. The third part of this study provides estimates of the probability of parcel development for each parcel in Flathead County based on variables developed in the second part. Two principal sources of data are used for this study: the Montana Natural Resource Information System (NRIS) and the Montana Computer Assisted Mass Appraisal (CAMA) database. The following is a more detailed discussion of the data and methods used in this study.

Data

The two most important sources for the data used in this study were the Montana Natural Resource Information System (NRIS) and the Montana Computer Assisted Mass Appraisal (CAMA) database. All digital information was compiled in an ArcGIS environment. Additional variables, particularly distance and density variables, were derived from existing data with ArcGIS.

NRIS is a very useful source for all types of data concerned with Montana. NRIS functions somewhat as a digital warehouse for geographic information for the State of Montana, which is stored and compiled by the Montana State Library. The data for roads, physical features, and political and jurisdictional boundaries was found there.

Data from NRIS are available as shapefiles, and as such, are readily incorporated into an ArcGIS environment.

The Montana CAMA database is a unique data source, and was essential to this study. The purpose of the CAMA database is to provide a statewide resource for the storage and research of parcel information, including taxable value data, in a standardized, digital format. The most important data to this study included in the CAMA database are the parcel boundaries for every parcel in Flathead County and the assessed taxable value of those parcels. In addition to the parcel boundary and taxable value data, the CAMA database provides strikingly detailed information about those parcels and structures located on them, from the owner's name and address to the roof material of the house, for every parcel in the state. The amount of data freely available in the CAMA database allows for unlimited research possibilities, but for this study, the parcel boundaries, taxable value of the land, and parcel type (residential, agricultural, or commercial) were the most salient.

The CAMA database is available for download by county. The parcel boundaries are stored as shapefiles, which is convenient for ArcGIS users, and the attribute data associated with each parcel is available in separate MS Access files, which must be joined to the parcel shapefiles for analysis in ArcGIS. Each parcel and its associated attribute data share a geocode, and the parcel data must be joined with its attribute data via this geocode. Ideally, geocodes would be 100% unique, but during the compilation of this database, some errors were undoubtedly introduced. The metadata says:

> "…all taxable and exempt parcels should have a geocode. Some rights of way or water bodies do not have a geocode. Geocodes are 99 % unique. There are instances where there are multiple geocodes for a parcel for percentage ownership or multiple parcels for the same geocode if a road were

> to split a taxable parcel. These occurrences are not frequent and are being cleaned up when possible" (CAMA Metadata)."

For Flathead County, it was found that only two-thirds of the geocodes were unique, and many geocodes were repeated multiple times. It is not unusual for one individual's property to consist of multiple lots. Reasons for an individual's property consisting of multiple lots include instances where two or more parcels were merged to form a larger parcel, instances where property lines are resurveyed, or when an individual's property is surrounded by another's property. The reasons for the replicated geocodes are numerous. Performing the correct operations in ArcGIS to eliminate the replicated geocodes and merge the related parcel polygons is simple.

To put the data in the proper form, one must simply dissolve the parcel boundaries based on the geocode, the replicated geocodes will disappear, and the multiple parcels associated with the identical geocodes merge into one polygon. As many of the parcel polygons increased in size after merging the polygons with identical geocodes, new values for area were calculated. Other important attribute data, such as the owner name and parcel type, remain correct. For all of the polygons sharing identical geocodes, the assessed land values were the same for each polygon that shared a replicated geocode.

For example, consider this typical situation encountered in the data: there are three distinct and adjacent polygons all sharing the same geocode. One polygon is exactly an acre, and the other two polygons are each 1/100th of an acre. All of the attribute data for each of the three polygons is the same from the owner's name to the assessed land values. This indicates that, even though there were three polygons in the data, each unique geocode references one distinct parcel of land. It would be quite rare that a parcel 1/100th of an acre in size would have the same assessed land value as an adjacent parcel of one acre. No additional calculations were necessary to determine the assessed values of parcels whose boundaries were manipulated.

The attribute data most important to this study is the current assessed land value of every parcel, as parcel land value is the dependent variable in the regression model. It is important to note that only assessed land values are used in this study, as the value of the structures that are present are not taken into consideration. Also, the CAMA data lists the year each structure was built. This important component of the data allows for analysis across time and for grouping the data into subsets for different time periods.

Other variables included in this research describe the spatial location and situation of the parcels. These variables pertain to distance, density, elevation, and adjacency to open space, and were derived using ArcGIS functions and the base data layers from NRIS. All distance values were calculated from the parcel centroid and represent straight-line distance. Travel distance along a road network is more accurate, but Euclidean distance is often used as an accurate proxy for accessibility (Cho and Newman 2005). The distance variables considered in this study are distance from parcel centroid to the nearest town, to the nearest road (any), to the nearest major road (state highway), to the nearest lake, to the nearest major lake (over two square kilometers in surface area), and to the nearest stream. These variables were chosen for their expected effect on the pattern of residential development and their use in similar studies.

Two density variables were calculated in this study, which were the density of homes and the density of roads. In the first analytical part of this study, development patterns across time are analyzed in five-year intervals, including changes in the density of new homes. To account for housing density changes over time, separate home density values were calculated for each five-year interval that is compared. The five-year density values used in the first part of this study is assumed to represent an accurate enough temporal resolution for comparing changes in density across time. For the regression model, the homes density variable represents the current density of homes per square mile in a circular neighborhood around each parcel centroid. The current home density value is used, as that is what affects the current land value, not the density of homes that existed when the home was built. The road density variable was calculated in a similar manner in ArcGIS, and represents the miles of road per square mile.

The other two variables derived for use in the regression model are elevation in feet and adjacency to open space. Elevation was extracted from 30-meter digital elevation models to each parcel. Adjacency to open space is an important variable common in regression modeling of land values (Irwin 2002) and represents the best effort and accuracy available with the data. As no "open space" layer is available, one was derived in ArcGIS. Adjacency in this model means adjacent to agricultural land, vacant land, public land, or undeveloped residential land. This is the best information available and is assumed to adequately capture the effect of open space on land values for the purpose of this study.

An attribute in the CAMA data important to this study is the property type. This variable allows the data to be analyzed in subsets of agricultural land, exempt public land, vacant land, farmsteads, rural and urban industrial land, rural and urban residential land, rural and urban commercial land, urban and rural condominiums, and urban and rural town homes. The attribute of property type is used in this study to create different subsets of the Flathead County parcel data that are appropriate to incorporate into the hedonic regression model and binary logistic regression model.

Methods

The following three sections discuss the specific methods used in this study. First discussed are the methods used in analyzing the residential development patterns in Flathead County. The second section describes the methods used in modeling residential land values, and the third section outlines the methods used in modeling the probability of parcel development.

Patterns of Residential Development

The literature on the changing nature of residential development supports the notion that amenity-led development tends to be further from town, displays a tendency toward larger lots, and occurs at low to very low densities (Riebsame et al. 1996, Walker and Fortmann 2003, Heimlich and Anderson 2001, Nelson and Sanchez 1999), and the analysis in this part of this study seeks to determine if development in Flathead County displays these tendencies over time. The research efforts are perhaps confounded to some degree by the knowledge that residential development patterns in Flathead County are mostly rural to begin with, and have historically occurred on large lots and at low densities. The analysis is important, though, and if statistically significant changes are detected, then the results will further show just how fervent the desire for the exurban life is in Flathead County.

In order to evaluate changes in selected residential development patterns over time in Flathead County, residential data was divided into five intervals, with each interval being five years. The first interval contains data for the years 1981 through 1985, and the intervals continue until 2005. For each interval, the value for the average lot size, average distance to town and average density of new homes is calculated, and then a two-sample difference in means test is used to determine if statistically significant changes in these values occur between each five year interval. The data for this analysis was assembled and analyzed in ESRI ArcGIS 9.2

Determinants of Land Value

The second part of this study is the estimation of a hedonic regression model of residential land values at the parcel level for Flathead County. To assess the effect of variables influencing land values, this research follows the model of Cho and Newman (2005). The model assesses how the locational and situational features of a parcel affect the land value of that parcel by taking attributes of the built and of the natural environment into account. Specifically, it examines the effect of the density at which homes are built, access to towns and infrastructure, and distance and adjacency to amenities. The equation of the model tested is as follows:

$$land\ value = \beta_0 + \beta_i\ density + \beta_j\ access\ to\ towns\ \&\ \text{infrastructure}\ + \beta_k\ natural\ amenities$$

where :

land value	=	log of land value (in dollars per acre)
density	=	density of homes (homes per square mile)
access to towns and infrastructure includes:		
towns	=	*distance to towns (in miles)*
major roads	=	*distance to major roads (in miles)*
roads	=	*distance to roads (in yards)*

road density	=	*miles of road per square mile*
natural amenities include:		
major lake	=	*distance to major lake (in miles, over two sq km)*
lake	=	*distance to lake (in miles)*
stream	=	*distance to stream (in miles)*
elevation	=	*elevation of parcel (in feet)*
open space	=	*adjacent or not adjacent to open space (1,0 dummy)*

Land values had to be log transformed to make the distribution of this variable more normal. Stepwise Ordinary Least Squares Regression is used in order to identify those variables that exert a significant influence on land values.

Only residential land uses are included in the model. Among residential land uses, condominiums and town homes are often quite small, very expensive (per unit area), and typically have little or no land associated with them, so they are excluded from the analysis. Urban and rural residential lands less than a tenth of an acre are also excluded to reduce the number of parcels included in the analysis that are actually part of a larger parcel, but have their own geocode.

Included in the regression model estimating residential land values are 24,671 residential parcels a tenth of an acre or larger. The total number of parcels in Flathead County, after correcting for replicated geocodes, is 48,462. There are 13,938 currently undeveloped, but developable, parcels that will be used for out-of-sample residential land-value prediction. The criteria used to determine if a parcel is "developable" is that the parcel be coded agricultural, farmstead, or vacant, be privately owned, and not be placed in any sort of conservation easement or other form of protection.

Bockstael (1996) argues that land values serve as a proxy for likelihood of development. The argument, in its very simplest form, is that an individual landowner may be induced to sell, subdivide, or otherwise convert their land from its current non-residential use to a residential use when the return on the conversion decision exceeds the return on its current state (Bockstael 1996). In other words, individuals will sell or develop their land when it becomes financially too attractive not to do so. This argument is implicit in this research, as land values serve as a bridge between the locational and situational variables of each parcel and the likelihood of development for that parcel.

Output from the regression is used in several ways. Regression coefficients allow for assessing the strength of the relationship between the dependent and independent variables as well as for calculating values predicted by the model for each parcel. Predicted values further allow for calculating residuals, which are the differences between observed values and values predicted by the model. Residual analysis is useful for identifying which parcels are currently lower valued, but have potential for higher land values based on their locational attributes.

To evaluate the accuracy of the model, the percentage difference between the observed and predicted value of the dependent variable is calculated. Further, the coefficients of the regression model are used to estimate the residential land values of currently undeveloped (but developable parcels, such as those currently in a vacant or agricultural state) parcels, and this would indicate which parcels are most likely to be converted from an undeveloped state to a developed state (Irwin et al. 2003). The output of this second stage is a map of the estimated parcel land values for those developable, but not currently developed parcels. This will add to the collective understanding of what features effect residential land values at the parcel level and show what parcels are most likely to be developed in the future. The data for this analysis was assembled in ArcGIS 9.2 and the regression analysis was performed in SPSS 15.0.

Probability of Parcel Development-Binary Logistic Regression

The third part of this study involves testing for factors that affect residential development. The parcel data included in the model are those parcels that are currently developed for residential use, or may become developed for such use, and amount to 38,379 parcels. Out of this total, 24,441 parcels were already developed, leaving 13,938 currently undeveloped, but developable parcels in the model. The parcels considered undeveloped, but developable were all the parcels in Flathead County coded residential, agricultural, farmstead, or vacant and over a tenth of an acre. As the dependent variable is binary —a parcel is developed (y=1) or not developed (y=0)—the procedure of choice is binary logistic regression of the following general form (Agresti 1990):

$$prob(y=1) = \frac{e^{\beta_0 + \beta_i X_i}}{1 + e^{\beta_0 + \beta_i X_i}}$$

The independent variables included are the same as those included in the hedonic regression model of land values. The form of the model is as follows:

$$prob\,(developed) = \frac{e^{\beta_0 + \beta_1\, density + \beta_2\, road + \beta_3\, major\ lake + \beta_4\, lake + \beta_5\, stream + \beta_6\, open\ space}}{1 + e^{\beta_0 + \beta_1\, density + \beta_2\, road + \beta_3\, major\ lake + \beta_4\, lake + \beta_5\, stream + \beta_6\, open\ space}}$$

where:

prob(developed)	=	probability for a parcel to be developed
density	=	density of homes (homes per square mile)
road	=	distance to a road (in yards)
major lake	=	distance to a major lake (in miles)
lake	=	distance to any lake (in miles)
stream	=	distance to a stream (in miles)
open space	=	adjacent or not adjacent to open space (dummy 1,0)

The goal of this stage of the study is to estimate the probability of development for each parcel and assign that probability value to each parcel. As the binary logistic regression model is very similar to the hedonic regression model from the previous section, the results are expected to be similar. In both model forms, the same independent variables are used, but the dependent variable is measured in different ways. In the hedonic regression model, land values were estimated. With logistic regression, parcel data are used to estimate the probability of parcel development. Different criteria were used in selecting the parcels included in the model. In the hedonic regression model, only residential parcels larger than one-tenth of an acre were included in the estimation of the model, and then the model was used for out of sample prediction. In the binary logistic regression model, all parcels determined to be developable (38,379 parcels) were included in the model, and a probability of development value was calculated for each parcel.

The advantage of this additional stage, and the reason why it was conducted, is because the output (the probability value computed for each parcel of becoming developed) is more easily interpreted, compared, and mapped. The output can be graphically represented to show which parcels have estimated probabilities of becoming developed within specific value ranges (greater than or less than fifty-percent, for example, or quartiles), and representing the data in this manner may present a clearer map image of the patterns of residential development in Flathead County. The data for this analysis was assembled in ArcGIS 9.2 and the binary logistic regression analysis was performed in SPSS 15.0.

RESULTS

This chapter provides answers to the questions posed in the previous sections concerning the changing nature of residential development in Flathead County. The questions that this chapter seeks to help in answering are: 1) What are the spatial characteristics of residential development in Flathead County? Are these characteristics taking on traits of exurbanism? Has there been a change in these characteristics over time? 2) What are the determinants of residential land values? 3) What factors determine whether land is put into residential or non-residential use? The first section below provides a simple analysis of how the spatial characteristics of residential development in Flathead County have changed over time. The second and third sections below report and discuss the results of the hedonic and binary logistic regression models.

Characteristics of Residential Development in Flathead County

The first section of analysis focuses on three residential characteristics suggested by the literature to be typical of residential development that is driven by the preference of amenity-seeking migrants—lot size, the distance from town, and the density at which the homes are constructed. Research suggests that as amenity-migrants are thought to be seeking their portion of rural bliss, development tends to more frequently occur on larger lots, further from town, and at lower densities (Riebsame et al. 1996, Walker and Fortmann 2003, Heimlich and Anderson 2001, Nelson and Sanchez 1999). In this section, data on these three spatial characteristics of development are compared across five intervals each containing five years. This analysis is offered to provide a feel of general development patterns and to determine if any obvious irregularities are identifiable. Table 2 summarizes the general residential characteristics of Flathead County in five-year intervals beginning with 1981 to 1985.

Table 2. Flathead County--Selected Residential Characteristics

Years	1981 -1985	1986-1990	1991-1995	1996-2000	2001-2005
Developed Residential Parcels	1,771	1,398	2,747	2,188	3,293
Mean New Lot Size, Acres	3.25	3.98	3.30	3.91	3.19
Standard Deviation of lot size	6.13	6.76	6.72	7.85	6.34
Mean Distance of Residential Parcels to Town, Miles	6.68	7.16	6.54	6.40	6.03
Standard Deviation of Distance to Town	6.33	6.41	5.94	6.02	5.74
Mean Density at which New Homes are Constructed, Homes per Square Mile	127.21	87.58	143.94	144.22	158.15
Standard Deviation of New Home Construction Density	115.60	87.79	126.05	127.23	131.95

The data reveal some interesting trends in the development of Flathead County. While the somewhat coarse scale of this analysis ignores the historical residential development of Flathead County, patterns do emerge from the data. A complete historical analysis is beyond the scope of this study. The important trend that emerges from the data is that the number of new developed residential parcels has been increasing markedly since 1981, and that with so much land still developable, will likely continue to increase.

Another significant trend revealed by the data is that average lot size has remained fairly stable. Average lot size has remained well above three acres, and for two different intervals was nearly four acres. This trend indicates the amenity migrant's preference for rural-style living and large lots. The high standard deviations associated with these values highlight the significant variation in parcel size in Flathead County.

Mean distance has decreased moderately since the first interval. Six miles is a significant distance to be located from town, especially considering the rather modest size of the three incorporated towns in this study. It is worthy to note that while six miles is far enough away from town to be "out of town," it is not great enough a distance to discourage people from traveling to town on a whim. Amenity migrants and exurban development typically seek a convenient distance from town, and six miles could easily be classified as a convenient distance. There is significant variation around this mean, which serves to underscore the tremendous variability of residential development in Flathead County.

The density at which new homes are constructed drops considerably after the first interval, and then increases for each interval. The post-1985 decrease perhaps highlights the Flathead resident's preference for low-density living, while the increase in density highlights the increasing scarcity of choice land and the increasing number of homes. It is worth noting that average density values for new home development are still very much in-line with exurban densities (158 homes per square mile equals one home per 4.05 acres). As with the other statistics, there is significant variability. The data reviewed here support the notion that new residential development in Flathead County tends to display exurban characteristics.

To determine if there has been a greater and consistent shift towards exurban traits since 1985, a two-sample t-test was conducted to compare the means of lot size, distance, and density between adjacent time intervals. While a t-test requires that the data be normally distributed, lot size and distance to town do not follow this distributional requirement—they are heavily right-skewed instead. To change the distribution towards greater normality, a log-transformation was employed. Table 3 reports the results of the difference in means test. In order to make the table more easily readable, some explanation is warranted. The row titled "T-statistic between means of adjacent intervals" refers to the T-statistic computed for the interval of years in the same column as the T-statistic is found and the interval of years adjacent to the right. For instance, the first T-statistic reported is computed for the means of the log (lot size) between the intervals 1981-1985 and 1986-1990, and the reported value is -4.91.

The large number of observations for each statistic ensures that the results of the t-test are significant. There are some interesting patterns revealed by the analysis. The difference in the log of new residential lot size is significant statistically, but as the mean lot size has both increased and decreased between intervals, no clear trend is evident. The log of mean distance to town is significant in every year-interval comparison expect between the intervals of 1991 to 1995 and 1996 and 2000, where the difference is quite small. The data reflect a trend towards development being located slightly closer to town, which goes against what is suggested in the literature. The mean density at which homes are constructed is significantly different between each interval, except between the intervals of 1991 to 1995 and 1996 and 2000, and this reflects a trend towards homes being developed at increasingly higher densities, which also is reverse of what is commonly thought in the literature, although the effects of human choice and the constraints resulting from an ever-increasing number of homes is difficult to separate.

Table 3. Statistical Comparison of Residential Characteristics

Years	1981-1985		1986-1990		1991-1995		1996-2000		2001-2005
Residential Lots	1,771		1,398		2,747		2,188		3,293
Mean of Log(lot size)	.24		0.48		0.13		0.25		0.03
Standard Deviation of Log(lot size)	1.32		1.37		1.44		1.51		1.50
T-statistic between means of adjacent intervals		-4.91		7.58		-2.83		5.42	
P-value		<0.001		<0.001		<0.001		<0.001	
Mean of Log (distance to town)	1.45		1.59		1.45		1.42		1.35
Standard Deviation of Log (distance to town)	.98		0.92		0.98		0.96		0.97
T-statistic between means of adjacent intervals		-4.10		4.46		0.86		2.59	
P-value		<0.001		<0.001		0.193		<0.001	
Mean Density of New Homes, Homes per Square Mile	127.21		87.58		143.94		144.22		158.15
Standard Deviation of New Home Construction Density	115.60		87.79		126.05		127.23		131.95
T-statistic between means of adjacent intervals		10.62		-17.00		-0.08		-3.90	
P-value		<0.001		<0.001		0.471		<0.001	

Note: when reading the T-statistics and P-Values, the interval 1981-1985 is compared to the interval 1986-1990, and then the interval 1986-1990 is compared to the interval 1991-1995,and so on.

One interesting pattern found in the analysis is that exurban characteristics appear to be more pronounced during intervals of lower residential growth. The 1986 to 1990 and 1996 to 2000 intervals realized slower rates of growth relative to the other intervals. For both of these intervals, mean lot size increased significantly. Also, mean distance to town was easily the greatest in the 1986 to 1990 interval, and, although the 1996 to 2000 interval was less than the preceding interval, it did serve to flatten out the general trend towards development being closer to town. This same pattern is also apparent in the data on home density. The general trend between 1986 and 2005 is that homes are being constructed at higher densities. The average new home density for the interval of 2001 to 2005 was nearly twice the density for the interval of 1986 to 1990. The 1996 to 2000 interval realized significantly slower growth in home density, and stands out in the data because flattening of the general trend.

A possible reason why exurban tendencies are more pronounced during intervals of lower growth could be that larger, planned developments and significant subdivisions tend to be located closer to town. If several larger subdivisions or developments were undertaken during an interval this would serve to increase the total number of parcels developed while increasing the average density of development, decreasing the average distance from town of development, and decreasing average lot size. If planned developments and large subdivisions are typically more dense, closer to town, and have smaller lots, then they could cause the observed patterns in the data.

This section of the analysis was intended to provide a general overview of patterns in Flathead County, and it is worth noting that it appears homes are being constructed closer to the three towns in the study area and at higher densities over time, which is somewhat contrary to what was expected. It is significant that these data definitely fall into the commonly accepted range for what is considered exurban. The considerable variation in each statistic reveals the difficulty in determining what "average" or "normal" is in terms of residential development in Flathead County. Perhaps a finer temporal resolution should have been employed to more thoroughly analyze the residential characteristics of Flathead County. Separating the study area into those parcels located within town boundaries and those in the urban fringe and beyond may also provide further insight into the characteristics of residential development in Flathead County.

Determinants of Residential Land Values

To better understand the nature of residential development, one needs to examine the factors that influence land values. Cho and Newman (2005) and Bockstael (1996) argue that land values are an approximation for the probability of development and, in effect, a precursor of development. This analysis investigates the amenities that are expected to have an effect on land values, as well as the effect that access to towns and infrastructure have on land values. The model can also be used to estimate the land values of parcels not currently in residential use.

The dependent variable included in this model is the value of residential parcels over a tenth of an acre in Flathead County, represented in dollars per acre. This value was log transformed to remove skewness and improve the normality distribution required for OLS. The explanatory variables related to amenities considered in the model are the distance to the nearest lake (measured in miles), the distance to the nearest major lake (over two square kilometers, measured in miles), distance to the nearest stream (measured in miles), elevation of each parcel (measured in feet), the density of homes (expressed as homes per square mile), and a dummy variable representing whether a parcel is adjacent to open space or not. The variables related to infrastructure and access to town include the distance to the nearest town (measured in miles), distance to the nearest road (measured in yards), the distance to the nearest major road (state highways, measured in miles), and the density of roads (expressed as miles of road per square mile).

SPSS was used to run a stepwise OLS regression model. With this stepwise procedure six of the ten variables entered the model, as they were significant in relation to land values. These variables contributing to the model were housing density, distance to roads, distance to major lake, distance to streams, adjacency to open space, and distance to lakes. Table 4 reports descriptive statistics for the independent variables and table 5 provides the regression model summary.

Table 4. Selected Independent Variable Statistics--Determinants of Residential Land Values

	Homes Per Sq. Mile	Distance to Road	Distance to Major Lake	Distance to Lake	Distance to Stream	Adjacency to Open Space (Dummy)
Min	0.09	0.00	0.00	0.00	0.00	0.00
Max	515.16	1.46	15.48	10.69	6.95	1.00
Mean	177.62	0.40	5.78	1.08	0.73	0.48
Std. Dev.	150.09	0.50	3.67	0.84	0.76	0.49
n=24,671						

The R-square value of .522 shows that just over half of the variation in the log of dollars per acre is explained by variation in the independent variables. An R-square value near .5 is fairly common for regression models using observational data. Certainly, this model fails to capture all the variables that effect land value. One factor believed to have contributed to the moderate power of the model is the nature of the data. The tax assessors use a standardized method of assessing land value, and in effect, this regression model is an attempt to provide a mathematical formula that expresses that assessment process; any attempt to replicate that assessment process will be met with difficulty. In light of this, it is not surprising that Cho and Newman

(2005), who use tax-assessed land values very similar to the CAMA data, report an R-squared of .533 in their initial regression model of land values using hedonic variables in Macon County, North Carolina.

Despite the moderate model fit, the accuracy of the model is fairly good. Over 50% of the predicted values for the dependent variable fall within five percent of the actual value, while 78% are within 10% and over 95% are with 20%. The model fit and accuracy was deemed strong enough to use the regression coefficients for out-of-sample prediction.

Table 5. Hedonic Regression Model Summary

R	R Square	Adjusted R Square	Std. Error of the Estimate
0.723	0.522	0.522	0.958

Coefficients

Independent Variables	Unstandardized Coefficients		Standardized Coefficients		Sig.
	B	Std. Error	Beta	t	
(Constant)	11.566	0.018		651.63	.001
Housing Density (houses/mile^2)	0.004	0.007	0.385	64.49	.001
Distance to Roads (yards)	-0.005	0.003	-0.332	-71.04	.001
Distance to Major Lake (miles)	-0.074	0.002	-0.198	-32.14	.001
Distance to Stream (miles)	-0.335	0.009	-0.186	-39.09	.001
Adjacent to Open Space, 1=adjacent to open space	-0.475	0.013	-0.171	-35.23	.001
Distance To Lake (miles)	-0.154	0.009	-0.094	-17.95	.001

N=24,671

The first variable included in the model was housing density. As housing density rises, so does the value of the independent variable, but by quite a small number—each additional home per square mile increases the log of dollars per acre by only .0004. The most appealing residential locations tend to be more densely settled, like properties close to lakes or just outside of towns, and these locations have higher assessed land values. The four distance variables included in the final model—distance to roads, lakes, major lakes, and streams, are all consistent with theory. People value being closer to all of these features, and as one gets closer to each of them, assessed land value increases. The standardized coefficients show that major lakes influence land value more than minor lakes, which is also logical.

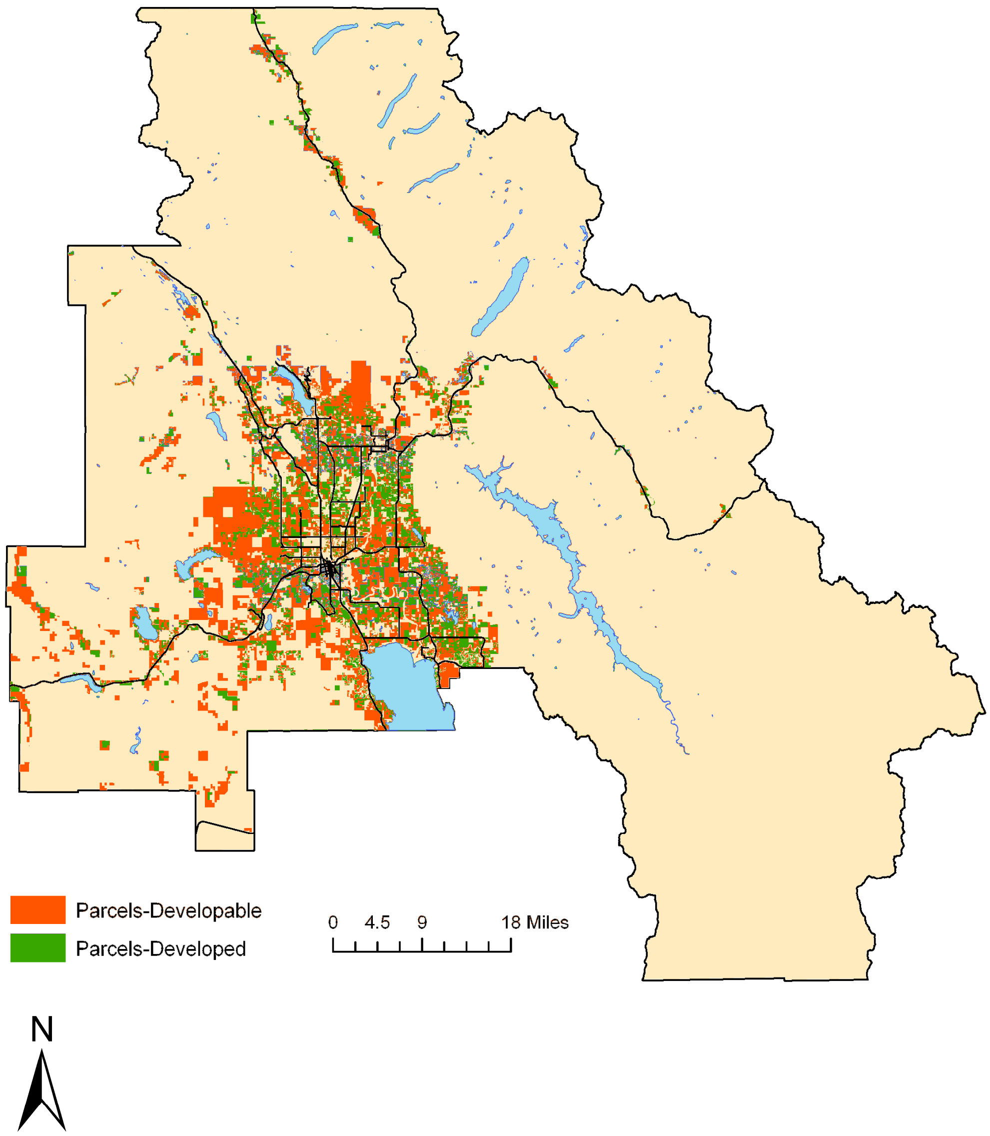
The sign on the coefficient of the adjacency to open space variable indicates that parcels next to open space have lower land values, and this is contrary to the expectation that adjacency to open space has a positive influence on land values (Irwin 2002). Several factors could affect this. First, the data used as representing open space could be flawed. Second, there could be proportionally less open space nearer the more desirable locations, like lakes, and this could cause the reversal of the sign of the coefficient for this variable.

It is surprising to note that the variable distance to town was not influential enough to be included in the model. Logic would seem to argue that locations closer to town are more valuable, but in this model, using this data, the variable distance to town did not enter the model by the stepwise procedure. This is likely due to issues of multicollinearity, which is difficult to avoid at this scale of analysis using spatial variables. Also found not to be influential were distance to major roads or road density. Being closer to major roads may typically also mean being closer to commercial development, which may have lowered land values for properties very close to major roads. Road density would be correlated with distance to town, as streets become much more numerous as one gets closer to urban areas--neither was significantly influential. It is logical that elevation had little influence, as there is very little variation in elevation among the locations where homes are present.

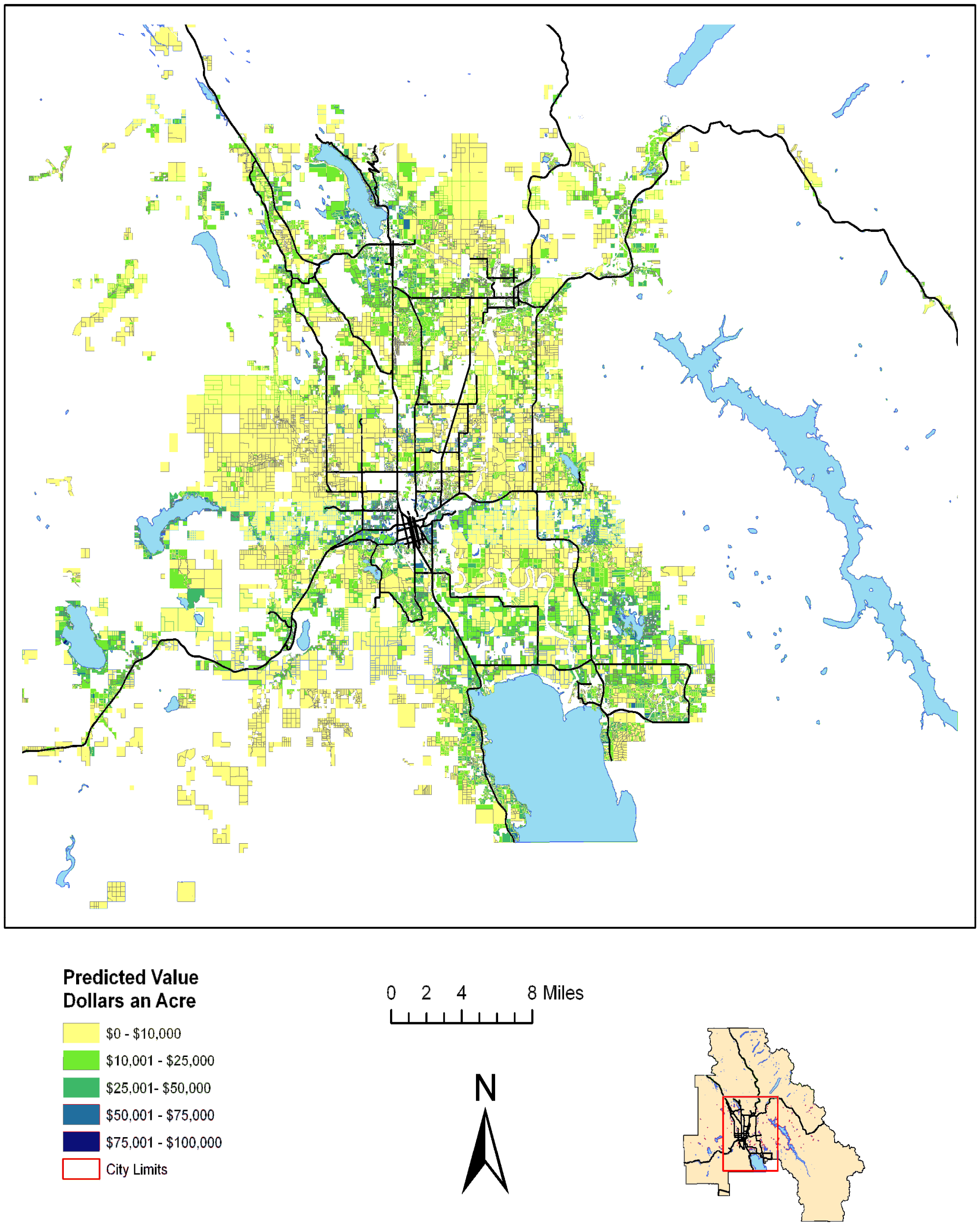
There were two goals for this second stage: to build the hedonic regression model estimating the influence certain hedonic variables have on land values and to use the coefficients of the regression model to predict land values for parcels currently not in residential use. Map 4 provides a view of all the parcels in Flathead County that are developed or may become developed. The data used suggest that there are currently 291,339 acres of developable land in Flathead County, or 450 square miles. The data also suggest that just 74,090 acres, or 115 square miles, are currently in residential use. These statistics bolster the need for planning.

Most of the land available for development is in larger agricultural tracts, and a significant portion is in the remote and ecologically sensitive North Fork of the Flathead River valley, adjacent to the western edge of Glacier National Park. Maps 5, 6, 7, and 8 focus on those parcels that are developable but undeveloped in four regions of Flathead County: the core of Flathead County, the Whitefish area, the Kalispell area, and the Bigfork area. For undeveloped parcels in those regions, the maps show the predicted land value of each parcel. The predicted land values are calculated from the estimated coefficients of the regression model. The chief pattern that the maps reveal is that estimated land values are higher closer to lakes and higher as the density of development increases.

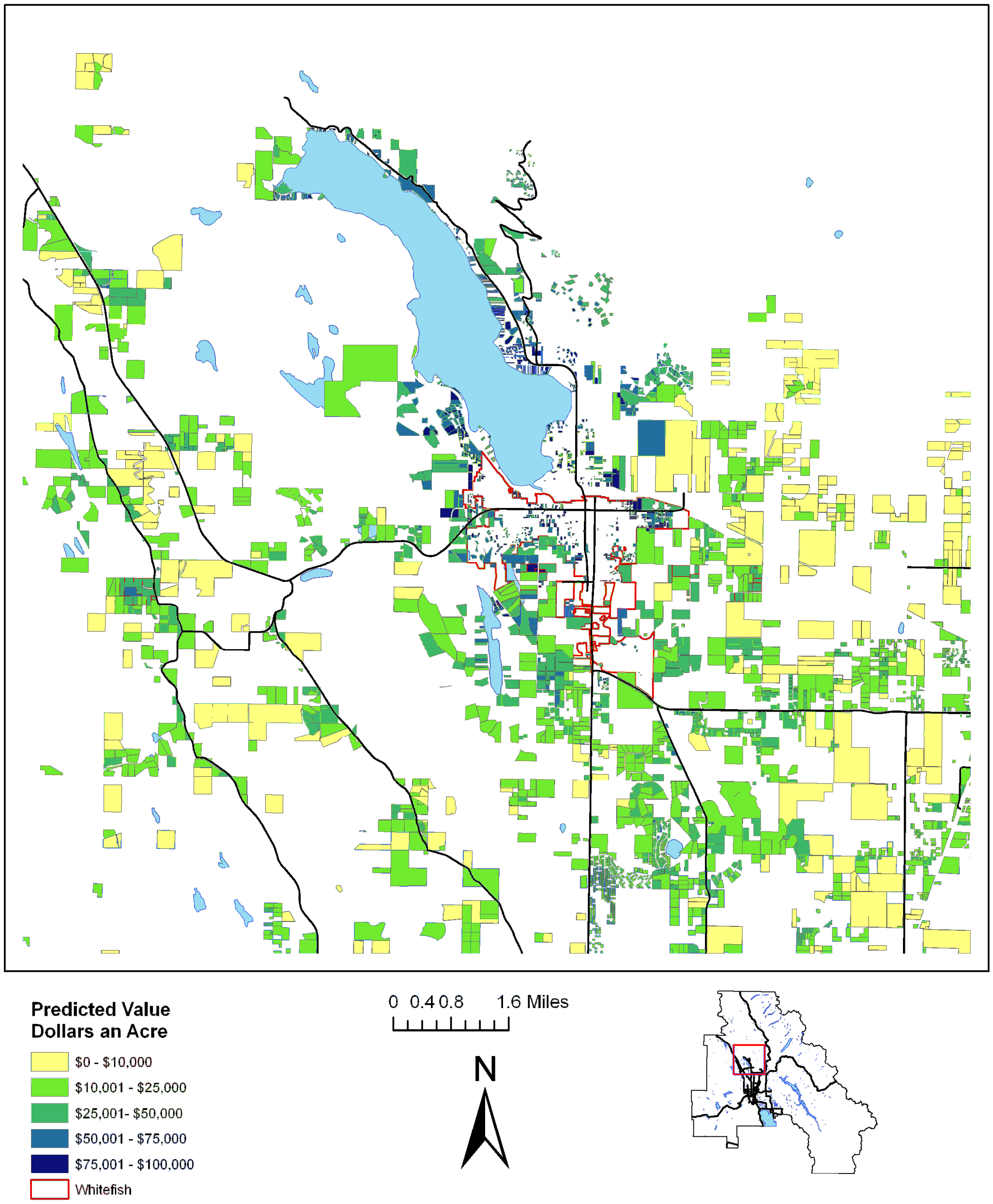
Map 4. Developed and Developable Parcels
Flathead County



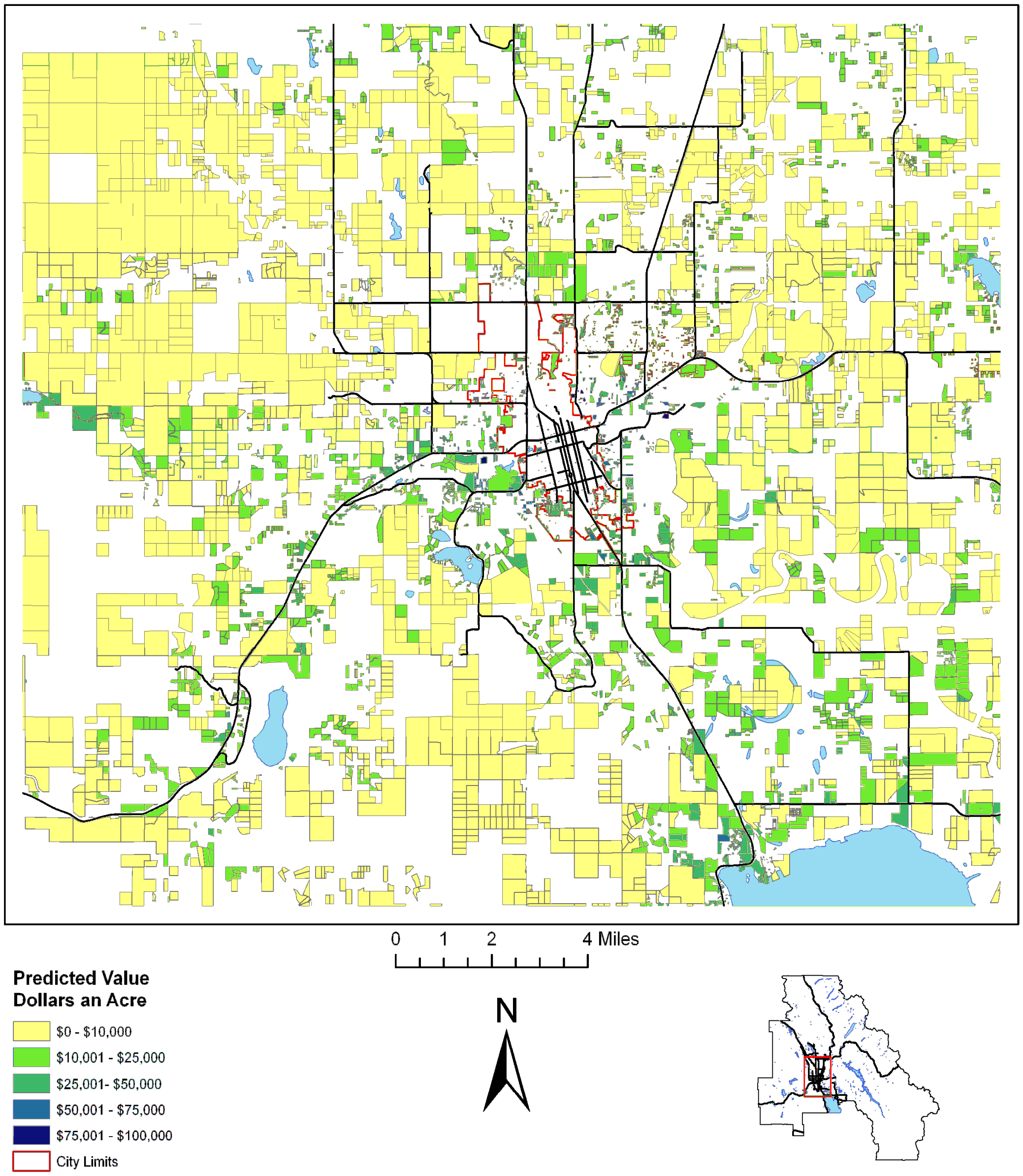
Map 5. Predicted Value of Developable Parcels
Core of Flathead County



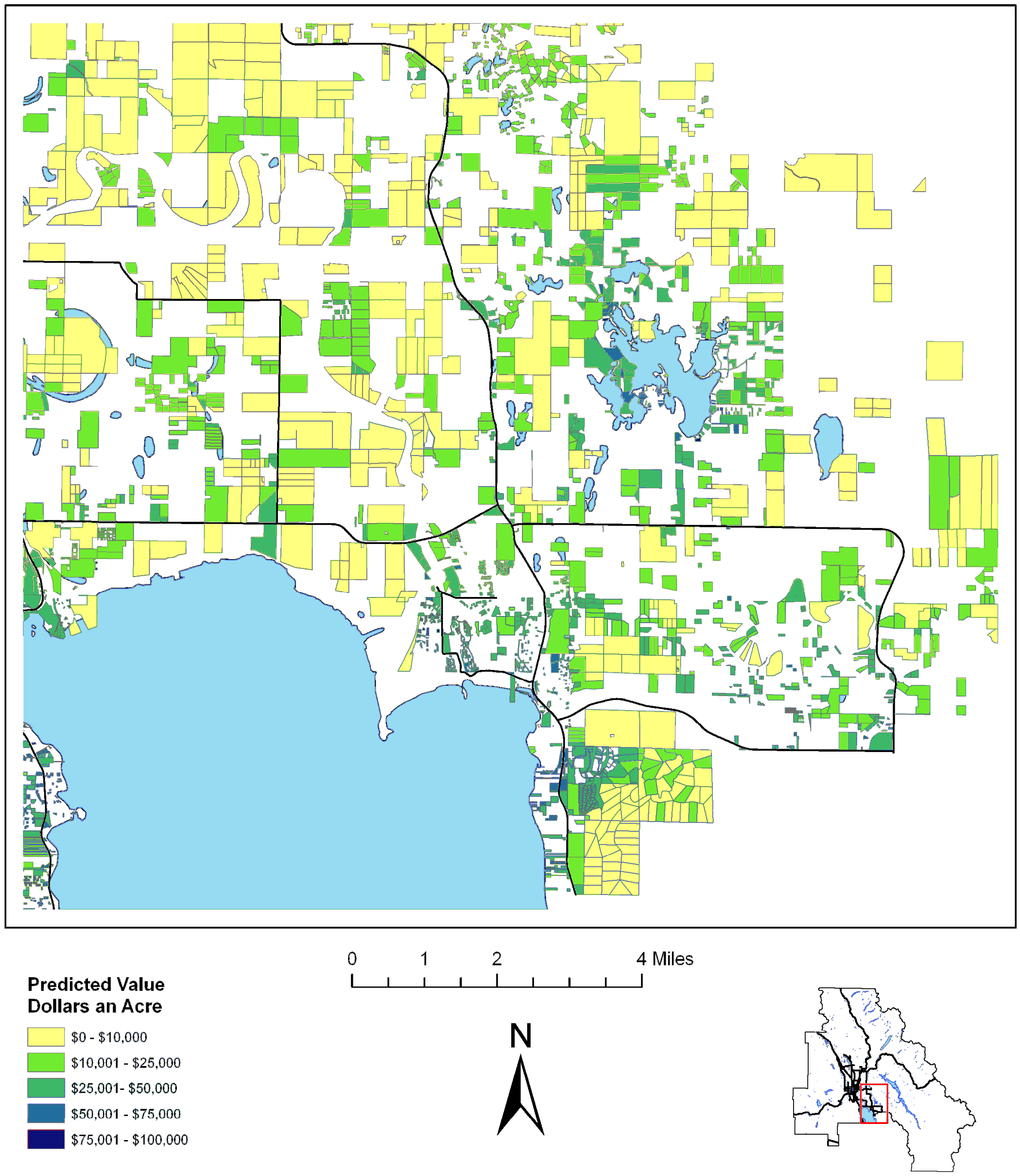
Map 6. Predicted Value of Developable Parcels
Whitefish and Vicinity



Map 7. Predicted Value of Developable Parcels
Kalispell and Vicinity



Map 8. Predicted Value of Developable Parcels
Northeast Flathead Lake/Bigfork and Vicinity



Determinants of Residential Development

The third part of this study is the estimation of a binary logistic regression model that estimates the probability that currently undeveloped parcels in Flathead County are developed based on the same criteria used in the hedonic regression model from stage two. The output of this is interpreted to show which of the parcels that are currently undeveloped have the greatest probability of becoming developed in the future.

There were 38,379 parcels included in the model—these are all the parcels in Flathead County coded residential, agricultural, farmstead, or vacant and over a tenth of an acre—all the parcels either developed or developable by the criteria used. Out of these, 24,441 parcels were already developed, leaving 13,938 currently undeveloped, but developable parcels. Based on the model, 4,563 of these developable parcels were estimated to have a greater than 50% chance of being developed. Table 6 reports the descriptive statistics for the independent variables and table 7 displays the parcel classification resulting from the model.

Table 6. Selected Independent Variable Statistics--Probability of Parcel Development

	Homes Per Sq. Mile	Distance to Road	Distance to Major Lake	Distance to Lake	Distance to Stream	Adjacency to Open Space
Min	0.01	0.00	0.00	0.00	0.00	0.00
Max	511.37	2.37	15.57	9.81	8.93	1.00
Mean	113.80	0.06	5.37	1.13	0.84	0.66
Std. Dev.	114.23	0.10	3.58	0.90	0.89	0.47

n=38,379

The model correctly predicted 73.1% of parcels overall. Within the subset of the data that was developed the model correctly predicted 76.5% of parcels, and within the subset of the data that was not developed correct prediction was 67.3%. The overall accuracy of the model is fairly high.

Table 7. Binary Logistic Regression Classification Table

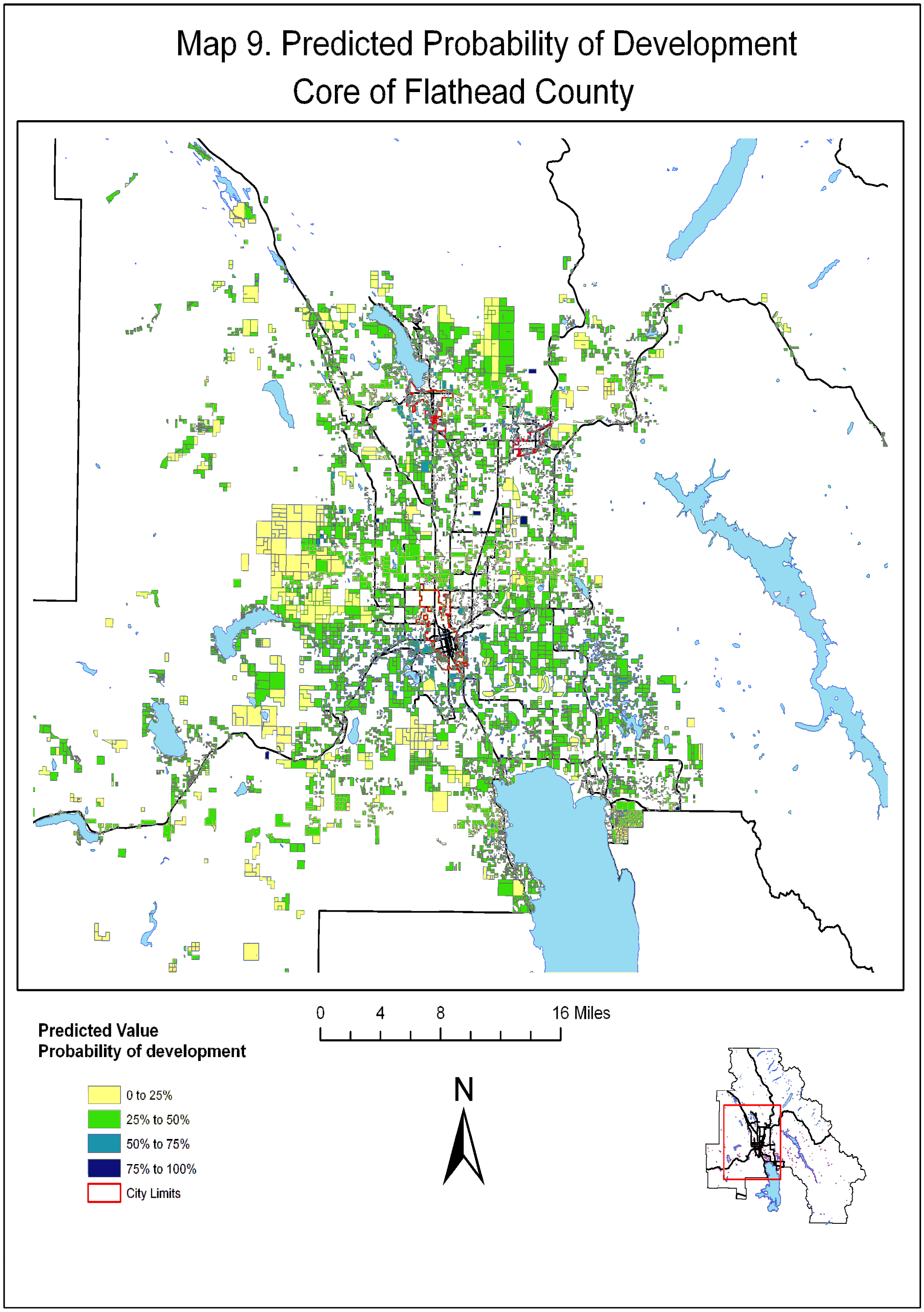
			Predicted		Percent Correct
Developed=1 Undeveloped=0			0	1	
		0	9375	4563	67.30%
n=38,379	Observed	1	5743	18698	76.50%
Overall Percentage					73.10%
The cut value is .5					

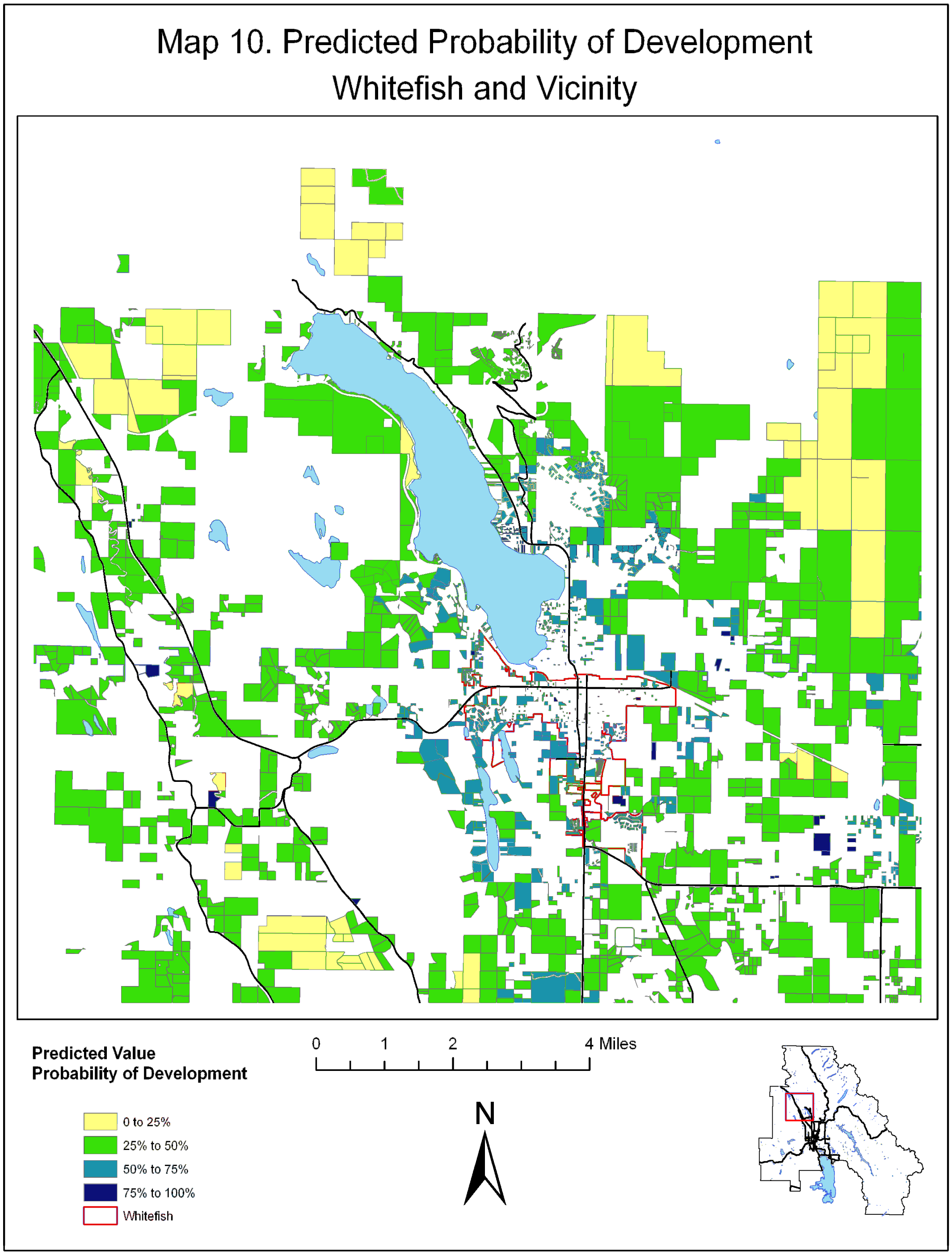
Table 8 below displays the estimated parameters of the model. It is surprising to note that the coefficients on the variables distance to major lake and distance to lake are different from each other. One would expect both to be negative. Perhaps the coefficient of distance to lake in this model is negative because the land around major lakes is typically more intensely developed than the land around minor lakes. The condition of being adjacent to open space is estimated to have a large negative effect on the probability of development. One might think that land adjacent to open space would be more desirable, and hence have a higher estimated probability of development.

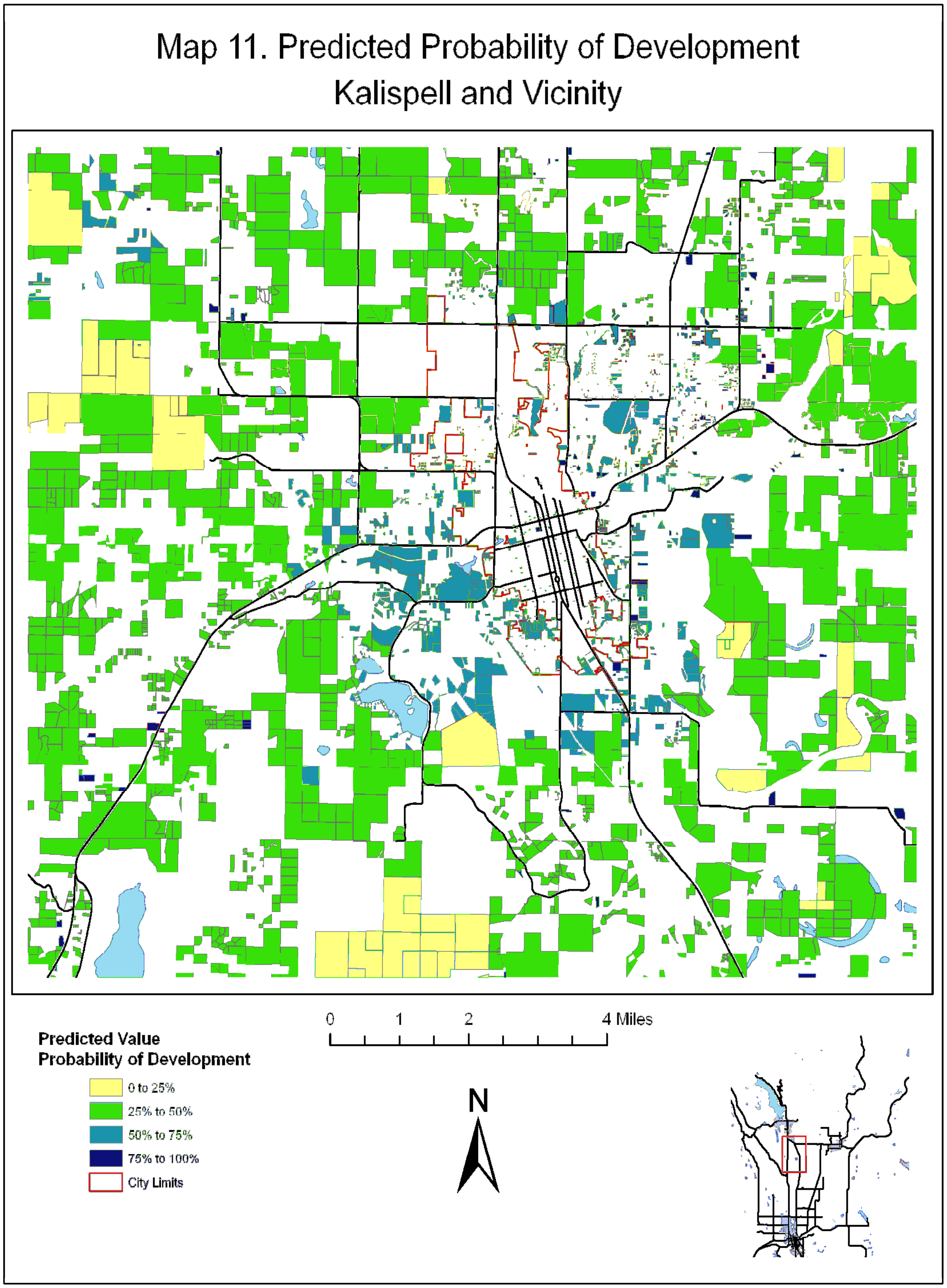
Inspecting the graphical output of the binary logistic regression reveals some surprises. Maps 9, 10, 11, and 12, which follow the text starting on page 68, are views identical to the map series showing predicted land values. The maps provide a different view of parcel development in Flathead County than the maps estimating land values. The predicted probability of development is shown in four categories—those undeveloped parcels with a predicted probability of development less than 25%, between 25% and 50%, between 50% and 75%, and greater than 75%. The influence of lakes seems to diminish in this view, as the overwhelming majority of lakefront property has an estimated probability of development less than 50%. The spatial pattern of parcels with estimated probabilities greater than 50% favors locations that are close to roads and locations with relatively higher densities of parcels. This indicates that housing density has a strong influence over the model, and is consistent with the estimations of the hedonic regression model.

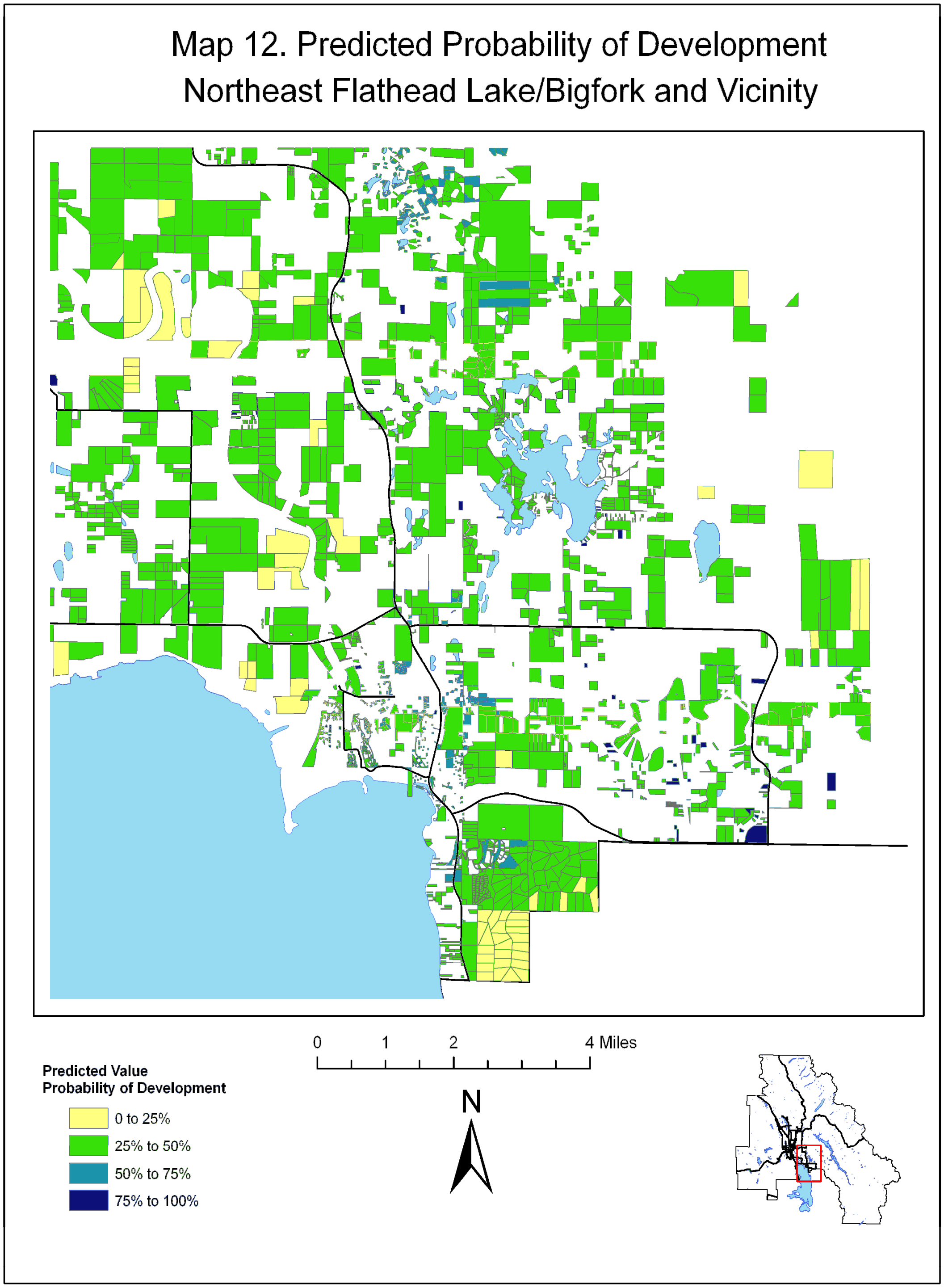
Table 8. Binary Logistic Regression Model Parameter Estimates

Variables in the Equation	B	S.E.	Wald	df
Distance to Major Lake	0.025	0.005	30.271	1
Distance to Lake	-0.094	0.016	34.003	1
Distance to Stream	-0.006	0.015	0.136	1
Housing Density	0.003	0.009	356.917	1
Distance to Road	-0.004	0.006	848.659	1
Adjacent to Open Space	-4.170	0.087	2287.875	1
Constant	4.181	0.091	2094.298	1


Map 9. Predicted Probability of Development
Core of Flathead County
0
4
8
16 Miles
Predicted Value
Probability of development
0 to 25%
25% to 50%
50% to 75%
75% to 100%
City Limits
N


Map 10. Predicted Probability of Development
Whitefish and Vicinity
Predicted Value
Probability of Development
0 to 25%
25% to 50%
50% to 75%
75% to 100%
Whitefish
0
1
2
4 Miles
N


Map 11. Predicted Probability of Development
Kalispell and Vicinity
0
1
2
4 Miles
Predicted Value
Probability of Development
0 to 25%
25% to 50%
50% to 75%
75% to 100%
City Limits
N



Map 12. Predicted Probability of Development
Northeast Flathead Lake/Bigfork and Vicinity
0
1
2
4 Miles
Predicted Value
Probability of Development
0 to 25%
25% to 50%
50% to 75%
75% to 100%
N

DISCUSSION

The following section summarizes the findings of the analysis, offers thoughts on the limitations of the data and methods, points to possible further research, and draws conclusions from the study.

Summary

The results of this study reveal some interesting and important aspects about residential development patterns in Flathead County, and these results have implications for high-amenity areas throughout the American West. The comparison of the general residential characteristics in five-year intervals is noteworthy in that it implies that development is occurring closer to incorporated towns on average, over time. This suggests that locations closest to town are more favorable for development. The significant variability in the statistic makes drawing firm conclusions risky business. Average lot size fluctuates between 3.25 and 3.98 acres, though remains quite within the bounds of "exurban".

The average density of development has increased markedly over time. This trend runs contrary to what the literature says about typical exurban development. As mentioned before, with an ever increasing number of houses, housing density will naturally rise, so it is difficult to separate a resident's preferred housing density with what is available in one particular area. The general trend is that development will occur nearer to town and at higher densities, and this trend begs a more strict interpretation. The average density of new home development between the years 2001 and 2005 was 158 homes per square mile; that is just over four acres per home, which is square in the middle of the definition of "exurban." This suggests that amenity-led development in Flathead County is quite similar to development experienced in other high-amenity regions of the non-metro West. The standard deviation around this mean was over 130 homes per square mile, though, so there is undoubtedly development occurring that is much denser and much less dense.

The average distance from town for each time period is between six and seven miles, which is not close to town at all, given the size of these towns and the size of the Flathead Valley. Despite the general trend towards greater density and increased nearness to town, on average, recent development in Flathead County is neither dense nor close to town; it is quite dispersed, and on average, decidedly exurban.

The hedonic regression model provides valuable, if not remarkable, insight into the features affecting land value in Flathead County. The overall model fit is moderate, but typical for this type of data. Housing density is positively correlated with land values. This is logical, given that more desirable locations are often more densely settled. However, this correlation certainly does not imply causation, as the most valuable locations in Flathead County are not the most valuable because they are dense, they are dense because they are generally closer to attractive natural features. The distance variables demonstrated that higher land values are associated with closeness to lakes, streams, and roads. This again makes sense, given that reason and the literature acknowledge that people generally value being close to water and easy transportation access.

It is surprising that distance to town appeared to not influence land values, especially since housing density was the most influential variable. However, the distance variable may have been excluded due to multicollinearity. The two variables are certainly related, for housing density typically decreases with increasing distance from the town. Given the output of the model, and supported by the graphical output, the areas of Flathead County with the highest estimated land values, and therefore estimated to be the most likely to experience development, are the areas immediately around lakes, between Whitefish and Kalispell, along Highway 93 North leaving Whitefish, and along the North Fork of the Flathead. The least valuable lands, and therefore estimated to be the least likely to become developed, are the agricultural fields on the far western and eastern sides of the valley, and the remote, privately owned parcels scattered at the farther ends of the county. There is still a tremendous amount of land in Flathead County to be developed, even in those areas with the higher estimated land values, and this study highlights the areas predicted to experience the most development.

The spatial patterns observed for estimated probability of development are very similar to the patterns observed for estimated residential land value. This is to be expected, as the model inputs were very similar. The parcels estimated to have the highest probability of being developed are near lakes and outside and between the three incorporated cities. Locations with greater density are also favored for development. This comes with little surprise, as housing density and distance to lakes were the most influential factors in both models.

Limitations and Further Research

It is important to note that this research, and the maps produced estimating land values and the probability of development, does not take into account planning regulations or other institutional controls. While these controls are currently weak, the situation on the ground in Flathead County could easily change, as each year there is a call for stricter regulations.

Second, the nature of the data has underlying inaccuracies. Use of tax assessor data is appealing, mainly because it is readily available to anyone and has detailed information on every parcel. However, tax assessor data is likely not the most accurate reflection of real estate market conditions or value. As noted before, the criteria that are applied to parcels to determine their value in the CAMA Database (or any tax assessor database) may partially confound an attempt to model parcel land values; the values in any tax assessor database are likely created, or at least updated, with the application of a formula or model. So in essence, an attempt to model parcel land value using tax assessor data may be an attempt to model some other model. If this were the case, this would undoubtedly diminish the explanatory power of the model in the real world.

Perhaps the use of real estate transaction data would increase the accuracy and power of the model in estimating land values by incorporating values that better reflect actual market value. This approach undoubtedly has appeal for this reason, and is also commonly used in a wide range of modeling applications, but comes with some problems as well. A sufficient number of recent transactions would need to be available for use in the model. In order to properly reflect the many varied locations in Flathead County (or any location of interest), the data would have to have significant spatial variation—data from areas around all the different lakes, the different communities, and the more remote and sparsely populated areas would have to be found in sufficient number. The more densely settled locations would likely have more data available, and their inclusion in greater proportion in the model may skew the results. The time in which these data were collected may also affect the results. A hot real estate market for a few years may cool, and transaction values for similar pieces of property could drop significantly. These transaction data would also need to be for parcels without houses on them or employ a method for separating the value of the house and the value of the land.

A third concern is that of scale. This study examined a single county and ten variables. A study at the county level may not include such relevant variables common in this type of research at larger scales of analysis like climactic variability, access to major transportation corridors and airports and economic and employment data because there is not sufficient variation in the data at the county level. Perhaps a multi-county study using parcel data would be better suited to capturing some of the effects these variables would have.

Another scale related concern for this study is the fact that nearly all of Flathead County could be described as high in amenities. The high level of amenities throughout the county reduces the variation that can be captured in the model. One is nearly always pretty close to a lake or stream. Other variables that were considered in the development of this study included distance to wilderness areas or trailheads, but these too lacked significant variability to warrant inclusion.

The R-square of .522 shows that more than half of the variability is explained, though there is still significant unexplained variation. One amenity variable that is known to affect land values, and perhaps may have the single largest effect in some cases, but is not included, is the view from the property. It is possible to determine viewsheds in ArcGIS, but properly assessing the "quality" of a view would present many difficulties.

Another possible avenue for increasing the explanatory power of the model would be the inclusion of various data that are expressed in a qualitative way. Variables like neighborhood quality, expressed on a scale from one to five, are available in the CAMA database, and certainly other similar data could be developed. There would be significant problems encountered in the inclusion of these variables, as to include them would mean the inclusion of some level of human subjectivity.

Finally, it should be noted that development patterns can change rapidly. The general development pattern in Flathead County has been the proliferation of small, haphazard, and totally unplanned subdivisions. This is not the case in other counties in the non-metro West, where large, master planned subdivisions complete with sidewalks, sewers, parks, and open space and even whole communities are planned. If Flathead County starts to experience more large-scale developments, then the large agricultural tracts which are currently estimated to be the least likely to be developed, may in fact become the most likely to be developed.

Conclusions

While there are limitations to this study, the results of this study still provide valuable insights. This research contributes to the understanding of the factors that affect residential development at the parcel level in the high-amenity, non-metropolitan West. While other factors are certainly significant in influencing development, any attempt to model development would need to consider the natural features incorporated in this research.

This study demonstrated the usefulness of parcel-level modeling with tax assessor data, and provides options for extending the analysis. This study successfully modeled the relationship between several locational attributes of a parcel and parcel land value, and further explained a significant portion of variation in land value. In a similar manner, maps of estimated probability of development were produced, and this data is useful for planners and those who manage Flathead County lands. This analysis could also be applied to other areas of the West experiencing amenity-led growth.

Specifically, this study showed that nearness to roads and increasing home density were both significant predictors of residential development. Natural amenity predictors like lakes and stream were also significant in estimating residential development. The importance of other locational attributes was also investigated, and possible directions for further related research were also provided. The findings of this research will be useful to those involved in the management of Flathead County lands by providing a guide to those locations most likely to be developed. By using this research as a guide, the planning efforts in Flathead County may well be bolstered in their endeavor to keep

Flathead County the attractive area it is, and the strong community and economic development seen in recent times may continue.

The findings of this study contributes to the collective knowledge of modeling techniques, the use of tax assessor data in regression modeling, and the residential development patterns and factor affecting residential development in Flathead County.

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