# The Impact of the Little Miami Scenic Trail on Single Family Residential Property Values

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**Duygu Karadeniz**

Bachelor of City Planning, Izmir Institute of Technology, 2003

Committee Chair: Rainer vom Hofe, Ph.D.
Faculty Member: Kiril Stanilov, Ph.D.
Reader: Don Burrell, AICP, Bicycle/Pedestrian Coordinator, OKI

**ABSTRACT**

Across the United States, many conversions of abandoned railroad rights-of-ways into trails have faced opposition from surrounding property owners. Much of the opposition derives from the fear that developing trails would cause a decrease in property values because of loss of privacy, increase in noise, traffic, litter and crime.

The objective of this study is to assess the impact of the Little Miami Scenic Trail on property values. To accomplish this task, the hedonic pricing technique was employed to measure the impact of the trail on single-family residential property values in southwest Ohio. Several of the variables used in this model were measured using Geographic Information Systems (GIS) software.

The analysis suggests that, each foot increase in distance to the trail decreases the sale price of a sample property by $7.05. In other words, being closer to the Little Miami Scenic Trail adds value to the single family residential properties.

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# CHAPTER I

# INTRODUCTION

Trails have the ability to improve many aspects of our lives, including recreation health, and fitness. People who walk, jog, skate or cycle on trails reap health/fitness benefits such as a lower risk of heart disease (Lindsey 2004). Moreover, by improving their health through exercise, trail users may enjoy another benefit - lower medical bills.

Trails may also provide transportation, environmental and visual/aesthetic benefits. If carefully planned, trails increase the number of people biking or walking to work and other destinations, decreasing traffic and air pollution (Lindsey 2004). Furthermore, the vegetation that grows along trails can serve as a wildlife corridor, facilitating the movement of animals (Hellmund and Smith 2006). This vegetation may also help to filter out pollutants coming from adjacent roadways, and provides visual/aesthetic benefits to nearby properties.

In some cases, trails may help to preserve local history and promote community pride. For example, *rail-trails*, or trails that are built within the right-of-way of an existing or former railroad, often provide access to historic features such as buildings, factories and bridges (Hellmund and Smith 2006). In this way, rail-trails help to protect the historic roots of communities. Trails may also serve as a social meeting place for local residents. On a regional level, trails offer connectivity between neighborhoods, thus promoting social interaction.

Last but not least, trails may provide economic benefits. Trail development may spur tourism, creating opportunities for economic development (bike rental shops, restaurants, etc.) along the trail (Lindsey 2004). This development may also encourage people to relocate to the community. Eventually, property values may rise as demand increases for real estate with access to the trail.

Although their benefits are widely recognized, trails are sometimes regarded as an inefficient use of public funds because of development and maintenance costs (Crompton 2001). Thus, to justify future investments into trails, it is necessary to quantify their economic benefits. Positive valuation of trails may encourage local governments to develop and maintain new trails. For example, Frederick Law Olmsted justified Central Park in New York City with the future increases in property values and property tax revenues he claimed would occur after the park was developed (Crompton 2001).

Another perceived drawback to trails is that they decrease property values due to a loss of privacy, and an increase in crime, traffic and noise. For example, the Little Miami Scenic Trail in southwest Ohio was opposed by property owners from The Village of Terrace Park on the grounds that it would lower property values (Edwards 1999).

## Research Objective and Questions

The objective of this study is to assess the influence of the Little Miami Scenic Trail on property values in southwest Ohio. To accomplish this task, the hedonic price technique will be employed to measure the impact of the trail on single-family residential property values in Hamilton County and Clermont County. The study seeks to answer the following related questions:

1. Does proximity to the Little Miami Scenic Trail affect the sale price of single-family properties in Hamilton County and Clermont County?
2. If yes, what is the estimated impact (in dollars) of the trail on these properties?

3. How does the dollar-value impact of the Little Miami Scenic Trail compare to that determined for other trails?

To answer these questions, a hedonic price model will be developed using the sale prices of single-family residential properties sold in Hamilton County or Clermont County from 2003-05 and located within one mile of a Little Miami Scenic Trail entrance. The one mile distance was selected based on findings from previous hedonic trail and open spaces studies. Structural, neighborhood and environmental characteristics to use in the model were determined after reviewing these studies and discussing their relevance to the present study.

## Significance of the Study

Although much research has been done to measure the impact of open spaces on the property values using hedonic price technique, little work has been undertaken on the impact of trails to surrounding property values. A comprehensive review of the literature revealed just 17 studies concerning effects of trails on property values. Further, only five of these studies used the hedonic price technique to measure the impact of the trails. The impacts of land uses, however, were not addressed in these studies. Consequently, local land use is incorporated into the analysis conducted for this study.

Another notable feature of the present study is that it uses network distance to trail, which provides a more accurate measurement of distance from a property to the trail (Hammer, Coughlin, and Horn 1974). Only two of the trail hedonic studies used network distance. In addition, there have been no comparisons of the findings on the impact of trails on property values. Therefore, a conscious effort will be made to compare the findings of this research with those of similar studies.

## Little Miami Scenic Trail

Little Miami Scenic Trail is the longest multi-purpose trail in Ohio (OKI 1999). It was converted from an old railroad right-of-way. The trail extends more than 70 miles from Springfield, Clark County to the Little Miami Golf Center in Hamilton County (Ohio Department of Natural Resources 2006). The construction of the trail between Milford and Little Miami Golf Center was started in March 2006 and completed in June 2006. Additional plans to connect the trail to the Ohio River are underway.

The Little Miami Scenic Trail is very popular, with over 150,000 users per year (OKI 1999; Henderson 2006). On a weekend day, users include over 400 bicyclists and almost 200 pedestrians (OKI 2006). Trail users spend an average of $13.54 per visit on food and auto expenses and $277 per year on related clothing and equipment (OKI 1999). An unpublished study (PKG 1999) used an opinion survey to measure the impact of the trail on property values. Among the 61 local property owners who were surveyed, 51% felt the trail increased residential property values. To date, however, no analysis of property values near the Little Miami Scenic Trail has used the hedonic price technique.

## Study Area

The area of focus for this study is the stretch of the Little Miami Scenic Trail between the cities of Loveland and Milford, Ohio. This section of the trail, which was constructed in 1991, passes through Hamilton County and Clermont County extending 9.5 miles. The section was chosen for this study because it was built long enough before, so property values may have adjusted to internalize the impact of the trail (Correll, Lillydahl, Singell 1978).


**Figure 1. A trail entrance in Loveland.**

**Figure 2. A part of the trail.**

**Figure 3. Trail users resting in Loveland.**


**Figure 4. A parcel for sale adjacent to the trail.**

## Organization of the Thesis

Chapter II provides an overview of the theories and concepts that are relevant to the present study. First, housing characteristics are explained. Second, the hedonic price technique and regression analysis are described. Lastly, a brief discussion of Geographic Information Systems (GIS) is provided.

Chapter III reviews the literature related to the present study. First, studies that used survey techniques to measure the impact of trails are summarized and critiqued. Then, studies that used the hedonic price technique to measure the impact of trails on property values are reviewed. Third, studies that used the hedonic price technique to measure the impact of open spaces are analyzed. The variables and methods which those previous studies used guided the variables and methods used in this study.

The fourth chapter of this study explains the methods used to obtain information about Hamilton County and Clermont County properties. This chapter includes a description of the approach used to identify the study area and sample properties. The chapter concludes with descriptions of and justifications for the variables to be used in the analysis.

Chapter V describes the hedonic price model developed. First, descriptive statistics and correlation matrix of the variables are discussed. After the development of the hedonic model is discussed, multicollinearity diagnostics are reported. Finally, the impact of each explanatory variable on property sale prices is evaluated.

Chapter VI describes how findings of this study relate to those of similar hedonic price studies. The thesis concludes with a discussion of the study limitations, along with recommendations for future research.

# CHAPTER II

# BACKGROUND

Several ideas that are relevant to the present study are explained in this chapter. First, housing characteristics, as well as the concepts of amenities, disamenities, open spaces and greenways are introduced. Then, the hedonic price technique and regression analysis are described in greater detail. These methods will be used to determine whether the Little Miami River Trail impacts property values in Hamilton County and Clermont County. Lastly, a brief discussion of Geographic Information Systems (GIS) is provided.

## Housing Characteristics

Housing is a composite and heterogeneous good that represents a bundle of characteristics offered by the land, location and structure (Cheshire and Shepard 1995). Housing characteristics may be classified as *amenities* or *disamenities*. Amenities are desirable features, such as parks, that contribute to an increase in property values. Disamenities, on the other hand, are unwanted features like noise and air quality that detract from property values.

Housing characteristics may be further classified into three categories: structural, neighborhood, and environmental (Lutzenhiser 2001, Irwin 2002). *Structural characteristics* are the physical features of the house and its lot. Examples of structural characteristics include: lot size, building condition, and number of rooms. *Neighborhood characteristics* refer to the social and physical features of the house surroundings. Distance to highway interchange, median income, and racial composition represent neighborhood characteristics. Lastly, *environmental characteristics* consist of environmental quality and natural or recreational features in the space surrounding the house. Distance to park, distance to river and air quality are all examples of environmental characteristics.

## ***Environmental Features***

### **Open Spaces**

*Open spaces* are lands without development. Open spaces vary widely by ownership and use. Agricultural lands, vacant lands, forests, recreational parks, and natural conservation areas represent different types of open spaces.

### **Greenways**

*Greenways* are protected open spaces that follow natural or manmade linear features (Hellmund and Smith 2006). Also known as “greenbelts”, “wildlife corridors” and “trail corridors”, greenways vary widely in function and location. Greenways mentioned in this study are described below.

### **Rail-to-Trails**

*Rail-to-trails* are abandoned railroad right-of-ways that have been converted into a recreational corridor (Hellmund and Smith 2006). Often, railroad right-of-ways are located near developed areas. Therefore, they have great potential for redevelopment as a rail-to-trail. In the Unites States, 13,150 miles of abandoned railroad right-of-ways have been converted to rail-to-trails, serving about 100 million users per year (Harnik n.d.).

### **Greenbelts**

*Greenbelts* are protected agricultural or natural lands established to restrict or direct the urban development (Hellmund and Smith 2006). These facilities may or may not feature trails.

**Conservation Corridors**

*Conservation corridors* are stretches of land that are preserved to create wildlife habitat, protect water quality, or control flooding (Hellmund and Smith 2006). As a rule, conservation corridors usually do not feature trails.

## Impact of Amenities (Disamenities) on Property Values

Certain housing characteristics such as proximity to a trail are neither bought nor sold; thus, they have no direct market value. If these characteristics affect human well-being, however, then they may increase property values (Lindsey et al. 2004). Therefore, the value of a property reflects the amenities and disamenities that it offers to buyers and sellers in the market.

Economists have developed two broad approaches to estimate the dollar impacts of amenities and disamenities on property values. The *survey technique* relies on surveys that ask people to answer hypothetical questions such as their willingness to pay for a certain service. The second approach, called the *hedonic price technique*, analyzes data coming from observed behaviors, including actual market transactions (Mitchell and Carson 1989, 74-87).

### *Hedonic Pricing Technique*

The hedonic pricing technique isolates the prices of amenities and disamenities by controlling for other variables that affect property values. This relationship is expressed mathematically through the *hedonic price function* as: $P_i = f(H_i, N_i, E_i)$, where $P_i$ is the sale price of an house i; $H_i$ is a set of structural characteristics (such as size, number of rooms, condition, etc.) for that house; $N_i$ is a set of neighborhood characteristics (such as the quality of local schools, median income, etc.) for the house; and, $E_i$ is a set of environmental characteristics (such as accessibility to parks, rivers, lakes, etc.) for the house (Irwin 2002, Lutzenhiser 2001).

There are two assumptions at the core of the hedonic price technique. First, the housing market is assumed to be in *equilibrium*, meaning that "all the individuals have made their utility-maximizing residential choices given the prices of alternative housing locations" (Freeman 1993, 371). Moreover, it is assumed that there is only one market for housing services; that is, buyers have information about their housing choices and are free to choose a house anywhere in the market.

### ***Regression Analysis***

Regression analysis is a method for "investigating functional relationships among variables" (Chatterjee, Hadi, and Price 2000). The outcome of a regression analysis is an equation expressed in the following form:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_p X_p + \varepsilon,$$

The variable on the left hand side of the equation (Y) is called the *dependent variable*, while the variables on the right hand side of the equation ($X_1$, $X_2$,…, Xp) are called *explanatory variables*. If a regression equation contains one explanatory variable, it is called a *simple linear regression*. A regression equation with more than one explanatory variable are called a *multiple linear regression*. Under the hedonic pricing technique, price is the dependent variable, and the structural, neighborhood, and environmental housing characteristics are explanatory variables. In this case, the regression equation is referred to as the *hedonic price model*.

The "betas" ($\beta_0, \beta_1, \beta_2, \ldots, \beta_p$) listed in a hedonic price model are called *regression coefficients*. Those values of the coefficients are estimated from the observed housing characteristics. A regression coefficient can be interpreted as “the change in the dependent variable when the corresponding explanatory variable is increased by one unit and all the other explanatory variables are held constant” (Chatterjee, Hadi, and Price 2000, 225). Lastly, the “ε” term shown in the hedonic price model represents random error in the model. In other words, ε accounts for “the failure of the model to fit the data exactly” (Chatterjee, Hadi, and Price 2000, 1).

*Hedonic prices* can be defined as the implicit prices that are revealed from the characteristics of products such as houses (Rosen 1974). *Implicit prices* are the regression coefficients ($\beta_0, \beta_1, \beta_2, \ldots, \beta_p$) in the hedonic price model and are estimated by regression analysis.

**Variable Types**

In generally, there are two types of variables in a regression equation: *quantitative variables* and *categorical variables*. Quantitative variables have specific values such as the square feet of a house. The value of a quantitative variable may be factored directly into the regression analysis. Categorical variables, on the other hand, must be assigned an arbitrary value to be included into the regression. Commonly, *dummy variables* are used to assign values to categorical variables. In this study, dummy variables take on one of two values: 0 or 1. A value of “0” indicates that a characteristic is non-existent; while a value of “1” specifies that this same characteristic is existent. For example, a fireplace dummy variable takes on a value of “1” when a house has a fireplace and “0” when it does not.

**Property Value**

The value of a property can be expressed as: *assessed value* and *sale price*. Assessed value is calculated by a real estate appraiser using various methods such as comparisons. Sale price, on the other hand, is the dollar amount for which a property is exchanged. Sale price reflects the amount of money that a buyer is willing to pay for the bundle of goods that come with a property.

**Goodness-of-Fit Indices**

Several statistics are available for measuring the ability of a model to predict sale price. One of those statistics is *R-squared* ($R^2$), also known as the goodness-of-fit index (Chatterjee, Hadi, and Price 2000). This statistic, which varies from 0-1, represents the proportion of the total variability in the dependent variable Y that is accounted for by the set of explanatory variables $X_1, X_2, \dots X_p$. In the context of the present study, a large R-squared value would indicate that the variables selected for the hedonic price model do a good job of predicting property sale prices.

**Statistical Significance**

Statistical significances are investigated in order to make sure that there is a relationship between explanatory and dependent variables and that the relationship is significantly different from zero. There are two statistical significance measurements used in this study: statistical significance of each of the estimators ($X_1, X_2, \dots X_p$) and overall significance of the model. The statistical significances of estimators are investigated using *t-tests.* The overall significance of the hedonic price model is measured using the *F-test*.

**Collinearity**

Explanatory variables used in hedonic studies are often not independent of one another. For example, housing with more bedrooms may also have more bathrooms, causing these variables to be interrelated. In statistical terminology, this situation is referred to as *collinearity* (*multicollinearity* for three or more variables). If strong collinearity exists among the variables, the parameters estimated in the hedonic price function may be questionably large or even have the wrong sign, making it difficult to evaluate the impact of the variables on sale prices (Chatterjee, Hadi, and Price 2000, 225). Thus, it is important to test whether collinearity is strong among the explanatory variables.

*Correlation analysis* is commonly employed to measure pairwise relationships between explanatory variables. Under this method, a correlation matrix is generated for the variables. This matrix contains correlation coefficients for all possible pairings of the variables. These coefficients vary from -1 to 1, with values larger than 0.8 or smaller than -0.8 suggesting a strong relationship between a pair of variables. It is important to note, however, that correlation analysis does not assess any multicollinearity that may exist among more than two of the variables.

Multicollinearity may be examined using the *variance inflation factor* (VIF) approach. This method considers the degree to which each variable is explained by the others. First, each explanatory variable is separately regressed on all other explanatory variables. The results of these regressions are then used to calculate variance inflation factors for each explanatory variable as $VIF_i = 1/(1 - R^2_i)$, where $R^2_i$ is the percent of variation in the ith explanatory variable that is due to the other explanatory variables.

Models with collinearity problems typically exhibit VIF values that are larger than 10 (Chatterjee, Hadi, and Price 2000, 240).

Multicollinearity can also be detected through the use of *condition indices*. The values of a condition index can range from 1 to infinity. When there is no multicollinearity, condition indices are equal to 1. Values greater than 30, on the other hand, indicate serious multicollinearity (Chatterjee, Hadi, and Price 2000, 240). For this study, condition indices and variance inflation factors will be calculated after the initial hedonic price model is developed.

# CHAPTER III

# LITERATURE REVIEW

In this chapter, first, studies that use surveys to investigate the perceived impacts of trails on property values are discussed. Second, studies that use the hedonic price technique to measure the implicit price of trails are reviewed. The chapter concludes with a discussion of literature on the impact of open spaces on property values using the hedonic price technique.

## Trail Studies that Use Opinion Surveys

Many researchers have used surveying techniques to determine whether trails affect property values. Their studies aim to evaluate how residents living close to the trails and/or realtors think the trails and greenways affect the property values. The surveys used in these studies commonly include estimates of general trends such as changes in value and salability of the properties. Summary of studies that investigated perceived impact of the trails on property values are given in Table 1.

One of the earliest such studies investigated the impact of the Burke-Gilman Trail in Seattle on property values (Seattle Office of Planning 1987). Investigators differentiated between the proximity of the residents surveyed: those living adjacent to the trail, and those living within two blocks of trail. Among the surveyed property owners that moved to the area after trail was built, approximately 48% of residents living adjacent to the trail believed that the trail increased selling price. Seventy-five percent believed that the trail increased the salability of their property, while 7.1% believed it decreased the salability. In general, residents who moved adjacent to the trail after the

**Table 1. Summary of Trail Studies That Use Opinion Surveys**

| Author | Study Area | Survey Respondents | Relationship to Trail | Impact of the Trail on Property Values | | |
|---|---|---|---|---|---|---|
| | | | | Increased | No change | Decreased |
| Office of Planning in Seattle (1987) | Burke-Gilman Trail | Residents | Adjacent | 48% | 28% | 4% |
| | | | Near | 37% | 46% | 2% |
| | | Realtors | Adjacent | 32% | 43% | 25% |
| | | | Near | 43% | 57% | 0% |
| Mazour (1988) | Luce Line Trail | Residents | Adjacent | 62% | 31% | 7% |
| Murphy (1992) | Brush Creek Trail | Residents | Adjacent | 23% | 69% | 8% |
| Moore, Graefe, Gitelson and Porter (1992) | Heritage Trail | Residents | Adjacent | 14% | 73% | 14% |
| | | | Near | 8% | 90% | 2% |
| | | Realtors | Adjacent | 12% | 82% | 6% |
| | | | Near | 12% | 88% | 0% |
| | St. Marks Trail | Residents | Adjacent | 16% | 74% | 11% |
| | | | Near | 21% | 77% | 2% |
| | | Realtors | Adjacent | 20% | 80% | 0% |
| | | | Near | 20% | 80% | 0% |
| | Lafayette/ Moraga Trail | Residents | Adjacent | 53% | 44% | 3% |
| | | | Near | 47% | 52% | 1% |
| | | Realtors | Adjacent | 24% | 52% | 24% |
| | | | Near | 48% | 52% | 0% |
| | Combined | Residents | Adjacent | 35% | 58% | 7% |
| | | | Near | 31% | 67% | 2% |
| | | Realtors | Adjacent | 19% | 70% | 10% |
| | | | Near | 28% | 72% | 0% |
| Alexander (1995) | Highline Canal Trail | Residents | Adjacent | 14% | 72% | 0% |
| | Weir Gulch Trail | Residents | Adjacent | 40% | 20% | 20% |
| | Willow Creek Trail | Residents | Adjacent | 100% | 0% | 0% |
| | Combined | Residents | Adjacent and Near | 29% | 43% | 7% |
| | | Realtors | Adjacent | 55% | 36% | 0% |
| | | | Near | 9% | 91% | 0% |

*Note:* In some cases, survey respondents "had no idea" whether the trail impacts property values. As a result, not all of the percentages shown add up to 100 percent.

**Table 1. *Continued.***

| Author | Study Area | Survey Respondents | Relationship to Trail | Impact of the Trail on Property Values | | |
|---|---|---|---|---|---|---|
| | | | | Increased | No change | Decreased |
| Schenectady County Department of Planning (1997) | Mohawk-Hudson Trail | Residents | Adjacent and Near | 7% | 54% | 7% |
| Greer (2000) | Trails in Omaha, Nebraska | Residents | Near (within one block) | 42% | 36% | 2% |
| Indiana University (2001) | Fort Wayne River Greenway Trail | Residents | Adjacent | 92% | | |
| | Maple City Greenway Trail | Residents | Adjacent | 92% | | |
| | Pennsy Rail Trail | Residents | Adjacent | 90% | | |
| | Monon Rail Trail | Residents | Adjacent | 95% | | |
| | Cardinal Greenway Trail | Residents | Adjacent | 86% | | |
| | Prairie Duneland Trail | Residents | Adjacent | 89% | | |
| Vogt, Van der Woud, Lynch, Nelson (2002) | Pere Marquette Rail-Trail | Residents | Adjacent | 18% | 77% | 5% |

*Note:* In some cases, survey respondents "had no idea" whether the trail impacts property values. As a result, not all of the percentages shown add up to 100 percent.

trail was built appreciate the trail more. Among residents living within one block of the trail surveyed, 37% stated the trail increased their property's value, and 62% believed it increased the salability of their properties.

Among local realtors surveyed in the Seattle survey, 32% thought that adjacent property's values are positively affected by the trail, while 25% thought that they were negatively affected. Moreover, 43% of the surveyed realtors believed that the trail increased the values of nearby properties within two blocks of the trail. Notably, none of them believed that the value of these properties was decreased by the trail. The vast majority (93%) of the surveyed realtors used the trail in their advertisements; that is, they advertised close proximity to the trail as an amenity.

Mazour (1988) analyzed the impact of two trails in Minnesota on property values. Through a survey, the author found out that majority of residents living adjacent to one of the trails (62%) believed that the trail had increased their property values. Asked about the salability of the properties, 33% believed that it was improved, while 17% believed it was decreased due to proximity to trail.

Murphy (1992) conducted a survey of residents who live adjacent to the Bush Creek Trail in Santa Rosa, California. According to the study, 23% of the residents believed that being adjacent to the trail increased their property's value, while 69% believed it did not have an impact. Thirty-three percent believed that the trail improved the salability of their property, while 49% believed that it did not have an impact. Sixty-one percent of the local realtors used the trail in their advertisements.

Moore, Grafe, Gitelson, and Porter (1992) studied the impact of three different rail-trails in Dubuque, Iowa, in Tallahassee, Florida, and in San Francisco. They surveyed residents living adjacent to or near the trails (within a quarter mile in Tallahassee and San Francisco; within a half mile in Iowa). The majority of residents surveyed believed that the trail increased the sale price and salability of their properties. Most residents (73%

and 74%, respectively) living adjacent to the trails surveyed in Dubuque (Heritage Trail) and Tallahassee believed that the trails did not have any impact on their property values, and 50% (St. Marks Trail) thought that the trail had no impact on the salability of the properties. Among residents who live adjacent to the trail in San Francisco (Lafayette/ Moraga Trail), 53% thought that the trail increased property values, while 44% thought that there was no impact. Seventy-four percent of them thought that the trail improved the salability of their properties. The majority of realtors surveyed noted that the trail did not have any impact on salability and price of properties adjacent to or near the trails. The authors also noted that the residents who move near trail after the trail was built had more positive attitudes towards trails.

Alexander (1995) studied three trails in Denver, Colorado: Highline Canal, Willow Creek and Weir Gulch. Seventy-two percent of the residents adjacent to the Highline Canal Trail felt that the trail had neutral impact on the selling price of their home. Fifty-seven percent believed that the trail improved the salability of their property, while 36% said it had no effect. All of the surveyed residents of single family homes adjacent to the Willow Creek Trail felt that the trail increased the property values, and 50% believed that the salability of their property was increased. Adjacent to the Weir Gulch Trail, 40% of surveyed residents believed property values increased, while 20% believed it declined. Sixty percent thought that salability was improved, while 20% believed it was reduced. When surveyed, realtors revealed that 55% believed that adjacency to trails increased property values, 73% thought it would be easier to sell a house adjacent to the trail and 82% used trails in their advertisements.

The Schenectady County (New York) Department of Planning (1997) investigated the impact of Mohawk-Hudson Trail on adjoining property values. According to their survey, the majority of residents (about 54%) believed that the trail did not have any impact on the property values. Seven percent felt that the trail increased the property values, while 32% had no opinion about it. In terms of salability, 18.5% of those surveyed said the trail made it easier to sell their property, while 65% said it had no effect.

Greer (2000) investigated residents' attitudes towards the trails in Omaha, Nebraska. According to the study, 65% of the residents felt that the trail made the properties easier to sell, while 15% thought it did not have any impact. Forty-two percent believed that the trail increased the price, while 36% said that the values of the properties were not affected by the trail.

In a study completed by the Indiana University, property owners living adjacent to trails in six Indiana cities were surveyed. The authors found that 86% to 95% of the property owners surveyed stated that the trail had either positive or no effect on the value of their property. Most (81% to 93%) of the surveyed property owners indicated that the trail had no impact on salability of their property or had no negative effect (Lindsey et al. 2001).

Vogt et al. (2002) studied adjacent residents and nearby businesses' views about the Pere Marquette Rail-Trail through mailed surveys. The majority of survey respondents felt that the trail had no impact on property values and the salability of their properties. Twenty-eight percent of residents surveyed thought that the trail would reduce the selling time of their property.

Table 1 summarizes the literature on studies that investigate the impact of trails on property values using opinion surveys. Most studies suggest that residents who live adjacent to or near a trail believe that the trail has either a positive or neutral effect on the value of their property. Conversely, there is insufficient evidence to suggest that proximity to a trail negatively impacts property values and salability. In general, there is not much difference between opinions of residents that live adjacent to and residents that live nearby to trails; that is, the literature by and large negates the idea that trails bring negative externalities such as noise, loss of privacy, littering, etc. to adjacent properties. Finally, the opinion survey studies suggest that, like residents, realtors perceive trails to have a positive or neutral effect on property values.

Although opinion survey studies give some insight into the impact of trails on property values, they have two major shortcomings. First, it is uncertain that survey respondents provide accurate answers because opinion survey questions are hypothetical (Brookshire et al. 1982). Second, the opinion survey approach does not provide the exact dollar amount of the impact of trails because they rely on perceptions rather than actual transactions that occur on the housing market. Historically, those increments of enhanced value attributable to amenities were used to fund construction of other similar amenities (Crompton 2005). Therefore, sometimes it is essential to estimate the actual values of those amenities using hedonic price technique proven to be useful in increasing our knowledge (Freeman 1979).

## Trail Studies That Use Hedonic Pricing Technique

In the literature, there are relatively few studies that apply the hedonic price technique to study the impact of trails on property values (Crompton 2001). One of the earliest such studies was conducted by Correll, Lillydahl and Singell (1978). The authors examined the effect of three different greenbelts with trails on property values in Boulder, Colorado. They found that each greenbelt had a different effect on property values. Property values dropped by $10.20 for every foot increase in distance from the first greenbelt, which was built four to seven years before neighboring residential areas. At the second greenbelt, property values again decreased (this time by $3.00 per foot) with distance from the greenbelt. Conversely, property values increased by $3.40 for every foot increase in distance from the third greenbelt, which ran parallel to a major road. The authors concluded that greenbelts increase property values when they are incorporated into the design of residential areas, as was the case for the first two green belts that were studied.

Lindsey, Payton and Dickson (2004) likewise used the hedonic price technique to measure the impact of greenways on property values. They classified greenways in Indianapolis, Indiana into three categories: greenways with trails; conservation corridors; and the Monon Trail, a popular rail-to-trail. The authors separately analyzed each category of greenway. They identified property transactions within half-mile straight-line distance from the trail while studying the greenways with trails and the Monon Trail, and half-mile straight line distance from the river while studying the conservation corridors. The authors found that the Monon Trail and conservation corridors had positive impact on properties. Fourteen percent ($13,056) of the predicted sales price was attributable to the popular Monon Trail, while 2.4% ($2,239) of the predicted sales price was attributable to the conservation corridors that exist in the area. However, they did not find enough evidence to suggest that the other greenways with trails affect the property values.

Nicholls and Crompton (2005) investigated the impact of a greenway with trail in Austin, Texas on surrounding property values. They examined three neighborhoods through which the greenway passed. While they could not find statistically significant impact of distance to greenbelt entrance (trail entrance) in two of the neighborhoods, they found impact in one of the neighborhoods. In this neighborhood, prices declined $3.97 per foot going away from the greenbelt entrance.

Krizek (2006) used the hedonic price technique to measure how bicycle facilities affect the property values in Minneapolis-St. Paul. When developing the model, the author differentiated between bicycle facilities in cities versus those in suburbs, hypothesizing that open spaces were valued differently in cities than in suburbs. The author also differentiated between types of facilities. He found that three different types of bicycle facilities (on street lane, roadside trail and non-roadside trails) had different effects, and that the facilities had different impacts in the city then they did in the suburbs. Properties located within 400 meters away from a roadside bicycle facility sold for $2,272 more in the city, $1,059 more in the suburbs. Properties located 400 meters away from an off-street bicycle facility were worth $510 less in the city, while such properties were worth $240 more in the suburbs.

Using the hedonic price technique, Campbell and Munroe (2007) estimated the land value impact of a planned trail in Mecklenburg County, North Carolina. For areas with existing trails, they found that property prices increased 0.03% for every 1% decrease in distance to a trail. Although the highest increases occurred within 1,000 ft of these trails, properties within 5,000 ft (about one mile) of the existing trails were worth $3,200 more than similar properties located further away.

In summary, studies using the hedonic price technique suggest that property prices are positively affected by trails (Table 2). Beyond one mile, though, the effect of the trail/greenway on property values may be insignificant. The most important difference between previous hedonic studies is the way they incorporated the trails into their studies. Two of them used network distance from each property to the trail entrances while two other studies used straight-line distance to the trail from each property. One of them used dummy for properties that are within half-mile of a trail.

**Table 2. Summary of Results of Studies Investigating Impact of Trails on Property Values using Hedonic Pricing Technique**

| Study | Years | Sample Size | Study Area | Greenway-Trail Proximity Measure | Greenway-Trail Proximity Effect |
|---|---|---|---|---|---|
| Correll, Lillydahl, Singell (1978) | 1975 | 36<br>31<br>18 | Within 3200 feet of three greenbelts in Boulder, Colorado | Network distance to greenbelt entrance (trail entrance) | Property prices declined $4.20 in all areas combined, declined $10.20 in area one, increased $3.4 in area two, declined $3.0 in area three for every foot increase in distance to greenbelts. |
| Lindsey et al. (2004) | 1999 | 9,348 | Marion County, Indiana | Dummy for properties within a half mile from the trail | 14 percent ($13,056) of the predicted sales price is attributable to the Monon Trail within a half-mile distance to the trail. No significant effect of other greenways with trails. |
| Nicholls and Crompton (2005) | 1997-2001 | 224<br>240<br>236 | Analysis in three different neighborhoods in Austin, Texas | Network distance to greenbelt entrance (trail entrance) | Property prices declined $3.97 per foot going away from the trail in one neighborhood. In the other neighborhoods the impact of trail was not significant. |
| Krizek (2006) | 2001 | 35,002 | Minneapolis, St. Paul, Minnesota | Straight-line distance | Getting 400 meter further away from an off-street bicycle facility decreases the property's price by $510 in the city, while it increases by $240 in the suburbs. |
| Campbell and Munroe (2007) | 2002-2003 | 33,562 | Within 5000 ft of trails in Mecklenburg County, North Carolina | Straight-line distance | 0.03% increase in the price for every 1% decrease in distance from the trail |

## Open Space Studies That Use Hedonic Pricing Technique

Fortunately, there are many studies from which to learn about the hedonic pricing method as it relates to open spaces. Early research generally suggested that the closer a house is to an open space, the higher its price, other factors held constant (Herrick 1940; Kitchen and Hendon 1967; Weicher and Zerbst 1973; Hammer, Coughlin, and Horn 1974; Peiser and Schwann 1993).

Still, more recent studies suggest that the relationship between open spaces and property values may be more complex. For example, proximity to open space may increase accessibility to recreation and provide pleasant views, enhancing property values. On the other hand, properties located close to an open space may also experience negative externalities such as noise and loss of privacy, decreasing the price of a home. The remainder of this chapter reviews hedonic studies of open space, focusing on their approach to measuring open space, measuring distance, and selecting variables.

### *Open Space Measures*

Hedonic studies of open spaces vary in terms of how they incorporate open space variables. While some studies (e.g., Acharya and Bennett 2001) used a single open space variable to represent all land without development, other studies (Bolitzer and Netusil 2000; Lutzenhiser and Netusil 2001; Anderson and West 2006) differentiated between parks, golf courses, cemeteries and other open spaces. In most cases, studies that made this distinction found houses in close proximity to parks have higher property values, all other factors held constant. Cemeteries did not have a significant impact on property values (Bolitzer and Netusil 2000; Lutzenhiser and Netusil 2001; Anderson and West 2006). Some studies (Do and Grudniski 1995 and 1997; Asabere and Huffman 1996;

Lutzenhiser and Netusil, 2001) showed that golf courses impact the value of adjacent properties. However, this impact quickly became insignificant as the distance from a property to a golf course increased. In fact, Anderson and West (2006) found insignificant evidence that accessibility to a golf course affects property values.

To investigate how future changes in land use might impact property values, several studies (Li and Brown 1980; Bockstael 1996; Irwin and Bockstael 2001; Irwin 2002; Geoghegan 2002; Geoghegan, Lynch, and Bucholtz 2003) distinguished between the effects of *permanent open space* and *developable open space*. Permanent open space may be defined as open spaces where the land uses are less likely to be converted such as public parks. Developable open space may be defined as open spaces where land uses may change in the future such as agriculture. In general, these studies found that proximity to permanent open space increased property values, while developable open space had less, negative or insignificant impact on home value.

### ***Measuring Distance***

Hedonic studies of open spaces used various forms of distance measurement. Several authors (Mahan, Polaski, and Adams 2000; Bolitzer and Netusil 2000; Lutzenhiser and Netusil 2001; Anderson and West 2006) investigated whether the value of a property is affected by its distance to the nearest open space. With the exception of Mahan et al., these researchers found that being in close proximity to open spaces increases property values.

Numerous studies (Cheshire and Sheppard 1995; Geoghegan, Waigner, and Bockstael 1997; Acharya and Bennett 2001; Irwin 2002; Geoghegan 2002; Geoghegan, Lynch, and Bucholtz 2003) examined whether the percentage of open space within a certain straight-line distance of a property affects its value. Some authors (e.g., Irwin 2002; Acharya and Bennett 2001) selected a quarter-mile distance to capture open space located in the immediate, visible vicinity of a property. In some studies (Acharya and Bennett 2001; Geoghegan 2002; Geoghegan, Lynch, and Bucholtz 2003), a one-mile buffer was selected to capture open space located within a 20-minute walking distance from a property. Overall, these studies found that property values increased as the amount of open space within a quarter-mile or one-mile from a property is increased.

### ***Variables***

Of those studies reviewed, most did not explain why certain variables were selected. Structural variables (area, number of bedrooms, etc.) were common to most of these studies (see Table 3). Out of 14 studies, the most popular structural variables were square footage of floor space (13 studies), lot size (12), age of building (to reflect condition) (12), number of bathrooms (11), fireplace (7), number of bedrooms/rooms (6), garage (5), and stories (4).

The use of neighborhood variables differed widely among the studies (Table 3). This may be because each study is unique in terms of the scale and location. Certain neighborhood variables, such as distance to CBD, may not inform the analysis when the study area is small or homogenous. At a larger scale, however, these variables may become more important. Among neighborhood variables, distance to CBD was the most frequently used (8 studies), followed by race (7), income (6), transportation (6), land use (5), school district (4), and population density (4). These variables are discussed in greater detail in subsequent sections of this chapter.

Distance to Central Business District

Distance to central business district (CBD) is the most commonly used neighborhood variable, perhaps owing to the traditional popularity of the *location rent model* (Cheshire and Sheppard 1995). This model was one of the first attempts by economists to explain property values using a theoretical framework. According to the model, property values decrease as the distance from a city's central business district (CBD) increases (Kaplan, Wheeler, and Holloway 2004). However, this model has been criticized for placing so much importance on the CBD (Cheshire and Sheppard 1995). Since the 1960s, economic activity in CBDs has generally declined with the rise of suburbs (Kaplan, Wheeler, and Holloway 2004). Consequently, this variable was excluded from several of the hedonic studies that were reviewed. In one study (Nicholls and Crompton 2005), the authors excluded distance to CBD from their analysis because their study area was small, making distances to CBD similar between samples. Other researchers (Harrison and MacDonald 1974) observed multiple commercial centers in their study area and chose to analyze distance to highway rather than distance to CBD.

**Table 3. Explanatory Variables Used in the Open Space and Trail Studies that Use Hedonic Pricing Technique**

| EXPLANATORY VARIABLES | Acharya and Bennett 2001 | Anderson and West 2006 | Cheshire and Sheppard 1995 | Correll Lillydahl and Singell 1978 | Bolitzer and Netusil 2000 | Campbell and Munroe 2007 | Geoghegan 1997 | Geoghegan 2002 |
|---|---|---|---|---|---|---|---|---|
| **Structural Variables** | | | | | | | | |
| House Size | X | X | X | X | X | X | | X |
| Lot Size | X | X | | X | X | | X | X |
| Age (Condition) | X | X | X | X | | X | X | X |
| Bathrooms | X | X | X | | X | X | | |
| Fireplace | X | X | | | X | | | |
| Rooms | | | X | X | | X | | |
| Garage | X | | X | | | | | |
| Stories | | | X | | | | | X |
| **Neighborhood Variables** | | | | | | | | |
| Distance to CBD | | X | X | | X | X | X | X |
| Race | X | | X | | | X | X | |
| Income | | X | | | | X | X | X |
| Transportation | X | | X | | X | | X | |
| Land Use | X | | X | | | | X | |
| Population Density | X | X | | | | | | X |
| School District | | | X | | | X | | |

*Note:* This table only consists of structural and neighborhood variables that are used more than two studies. It does not include environmental explanatory variables.

**Table 3. *Continued*.**

| EXPLANATORY VARIABLES | Irwin 2002 | Krizek 2006 | Lindsey et al. 2004 | Lutzenhiser and Netusil 2001 | Mahan, Polasky and Adams 2000 | Nicholls and Crompton 2005 | # of Studies Used |
|---|---|---|---|---|---|---|---|
| **Structural Variables** | | | | | | | |
| House Size | X | X | X | X | X | X | **13** |
| Lot Size | X | X | X | X | X | X | **12** |
| Age (Condition) | X | X | X | X | | X | **12** |
| Bathrooms | X | X | X | X | X | X | **11** |
| Fireplace | | X | | X | X | X | **7** |
| Rooms | | X | X | | | X | **6** |
| Garage | | X | X | | | X | **5** |
| Stories | | | X | | | X | **4** |
| **Neighborhood Variables** | | | | | | | |
| Distance to CBD | X | X | | | | | **8** |
| Race | X | X | X | | | | **7** |
| Income | X | | X | | | | **6** |
| Transportation | | X | | | X | | **6** |
| Land Use | X | | | | X | | **5** |
| Population Density | X | | | | | | **4** |
| School District | | X | X | | | | **4** |

*Note:* This table only consists of structural and neighborhood variables that are used more than two studies. It does not include environmental explanatory variables.

Race

Seven of the studies reviewed here considered how the percentage of African-Americans or Caucasians within census block groups affects property values. The authors of these studies found that, holding all other factors constant, census block groups with a higher percentage of African-Americans had lower property values. This outcome might be due to the tendency for African-Americans to prefer diverse neighborhoods, where ethnicities of residents vary (Kaplan, Wheeler, and Holloway 2004, 246). On the other hand, Caucasians often prefer all-Caucasians neighborhoods and may be willing to pay a premium to live in these areas.

Median Household Income

In six of the studies, the impact of median household incomes on property values was considered. Consider two houses that have exactly the same attributes (structural, neighborhood and environmental), except that one is located in a wealthy census block group, the other one is in a poor census block group. In the wealthier census block group, the surrounding houses would likely be more expensive and better-kept than those of the poor census block group. In this case, the house in the wealthier census block group itself would tend to be more expensive than the house in the poorer census block group. Yet, it is important to recognize that the median income of a census block may be correlated with other characteristics of a property, such as location relative to commercial and industrial areas, proximity to parks, etc. (Li and Brown 1980).

Transportation

A few studies included variables that capture the disamenity or amenity effect of transportation systems. For example, Cheshire and Sheppard (1995) used dummy variables to study the impact of different types of roads on property values. The authors concluded that transportation networks have a strong negative impact on property values. Transportation variables used in other studies included: distance to nearest highway (Li and Brown 1980, Bockstael 1996; Acharya and Bennett 2001; Krizek 2006), traffic (Bolitzer and Netusil 2000; Mahan, Polaski and Adams 2000; Krizek 2006) and distance to nearest major road (Geoghegan, Wainger, and Bockstael 1997). Palmquist (1992) and Gamble, Owen, and Langley (1974) found that properties abutting the freeway have lower values than similar properties located elsewhere. Still, a recent literature review of freeway studies (Ryan 1999) indicated that accessibility to a freeway increases property values. In fact, Li and Brown (1980) found that property values increase as the distance to an expressway interchange decreases, all other factors held constant. The authors also determined that property values are negatively impacted within 950 feet of a major road. Poon (1978) found that the negative externality of railroads extended up to 850 feet, while Strand and Vagnes (2001) found it to be 350 feet.

Land Use

A few studies have suggested that the land use pattern surrounding a house affects its price. A number of studies measured the percentage of area of various land uses or land use indices within a specified buffer or buffers (Cheshire and Sheppard 1995; Geoghegan, Wainger, and Bockstael 1997; Acharya and Bennett 2001; Irwin 2002), while other studies used distance to nearest industrial and commercial areas (Mahan, Polaski and Adams 2000; Li and Brown 1980). Mahan, Polaski and Adams (2000) found that as the distance from industrial and commercial zones increase, property values increase. The studies which used the percentage of industrial and commercial uses found that as that percentage increases, property values decrease (Irwin, 2002; Cheshire and Sheppard, 1995).

School District

Properties located near good schools may be worth more than similar properties at other locations. There are various measures of school quality, including expenditures by pupil, reading achievement scores, or statewide proficiency test results. Two of the open space studies (Lindsey et al., 2004; Krizek, 2006) examined whether property values are affected by standardized test scores by school districts. These studies found that properties in school districts with higher test scores are more expensive, holding all else equal. Two of the studies (Cheshire and Sheppard, 1995; Campbell and Munroe, 2007) differentiated between school districts, however the results were mixed.

Population Density

Population density was considered in a few of the studies. Generally, it was found that denser census block groups have lower property values. This outcome might be due to the preference that many Americans have for large homes, big yards and more rural settings (Davis, Nelson, and Dueker 1994).

Rivers

Rivers were also thought as an influence on sale price and were included in some analyses in different forms. Some studies used distance to river variable (Li and Brown 1980; Asabere, Huffman, and Mehdian 1994; Gartner, Chappelle, and Girard 1996; Mahan, Polasky, and Adams 2000; Anderson and West 2006). Among those, only Li and Brown (1980) and Anderson and West (2006) found that as distances from the river increase, the prices decrease, controlling for the other variables. Besides the distance to river variable, Gartner, Chappelle, and Girard (1996) studied being on the river variable, but they did not find significant impact. Clark and Herrin investigated being within a quarter-mile of lake, river or stream but did not find a significant impact.

Overall, open space studies that used hedonic price technique varied widely from each other since they cover different sizes of study areas, different time periods, different variables, and different empirical techniques. Therefore, it is difficult to summarize the results. Nonetheless, the hypothesis that property values are affected by open spaces is generally supported by the literature (Table 4).

The literature in general supported that a trail's effect may extend up to one mile. Including percentages of certain land uses around each property into hedonic price model also seemed to be effective in explaining the property values. The land use percentages within quarter mile of properties are especially helpful in capturing the negative and positive effects of the immediate surroundings of each property.

**Table 4. Summary of Open Space Studies That Use Hedonic Pricing Technique**

| Author | Study Area | Time | Sample Size | Type of Open Space | Change in Property Values |
|---|---|---|---|---|---|
| Cheshire and Sheppard (1995) | Reading and Darlington UK | 1984 | 350 490 | "Open land" and "closed land." | Pounds per percentage increases: Open land: 50 pounds in Reading, 83 pounds in Darlington. Closed land: 101 pounds in Reading, 0 pounds in Darlington. |
| Geoghegan, Waigner and Bockstael (1997) | Seven counties in Patuxent Watershed MD | 1990 | | Percent forest and agricultural land within 0.1km and 1km. | Within 0.1 km buffer, open space increased sale prices by 1.89%. Within 1km buffer open space decreased sale price by 3.4% |
| Bolitzer and Netusil (2000) | Portland, OR | 1990-1992 | 16472 | Public parks, private parks, cemeteries and golf courses. | Being within 1500 feet of an open space added $2105 in linear model. Open space size was affecting positively, while private parks and cemeteries did not have any impact. |
| Mahan, Polasky and Adams (2000) | Multnomah County, Portland, Oregon | 1992-1994 | 14485 | 4 different wetland types, parks, lakes, streams, rivers. | Increasing the size of the nearest wetland by one acre increases home's value by $24. Reducing the distance by 1000 feet increases property value by $436. Wetland type was not effective. |
| Lutzenhiser and Netusil (2001) | City of Portland, Multnomah County | 1990-1992 | 16636 | Urban park, natural area, specialty park/ facility. | All open space types except cemeteries had significantly positive impact. Being within 1500 feet of natural areas added $10,648, specialty parks $5,657 and urban parks $1,214. |
| Acharya and Bennett (2001) | New Haven County, CT | 1995-1997 | 4000 | Any land without development within 1 mile and 1/4 mile distance. | A percentage increase in the open space within 1/4mile of a house increases the price by $75. It is not significantly different within 1 mile. |

**Table 4.** ***Continued.***

| Author | Study Area | Time | Sample Size | Type of Open Space | Change in Property Values |
|---|---|---|---|---|---|
| Geoghegan (2002) | Howard County, Washington, DC | 1993-1996 | 5599 | Percent of land within 1600m buffer in developable open space and permanent open space. | The permanent open space increases the near-by land uses three times more than the developable open space. |
| Irwin (2002) | Three Counties in MD | 1995-1999 | 55799 | Cropland, pasture, forest, private conservation, military land and other public land. | Privately owned land in conservation and publicly owned and non-military land create significant positive benefits rather than developable open space. Also a change from pastureland to forest creates a negative significant effect on property values. |
| Anderson and West (2006) | Minneapolis-St. Paul metropolitan area | 1997 | 24862 | Neighborhood park, special park, golf course, lake, river. | Halving the distance to the nearest park increases the value by $246, to the special park increases by $1790.Distance to rivers, lakes, cemeteries and golf courses also increases property value. |

## CHAPTER IV

## METHODOLOGY

This chapter begins with an explanation of the methods used to obtain information about Hamilton County and Clermont County properties. After that, discussion turns to the approach used to identify the study area and sample properties. The chapter concludes with descriptions of and justifications for the variables to be used in the analysis.

### Data Collection

The first step to assessing the impact of the Little Miami Scenic Trail on property values was to build a GIS database from existing Hamilton County and Clermont County data sources. Each county maintains a separate GIS with streets, railroad and parcel feature classes for their jurisdiction. To facilitate management of this data, ArcGIS was used to merge Hamilton County feature classes (streets, railroad, and parcels) with those of Clermont County. The merged feature classes were named "hc_cc_streets", "hc_cc_railroad" and "hc_cc_parcels" to represent streets, railroads and parcels, respectively, in the two counties.

A few adjustments were made to the merged feature classes to improve their accuracy. In a map of the "hc_cc_streets" feature class, several east-west streets were shown as not connecting. To resolve this matter, the endpoints of these streets were connected to one another using the ArcGIS Editor tool.

Several new feature classes were created also. First, a feature class called "trail" was produced to represent the stretch of the Little Miami Scenic Trail that runs by Clermont County and Hamilton County. Clermont County trail features, coded as "Bike

Trail" in "hc_cc_streets", were exported into "trail" using ArcCatalog. The Hamilton County portion of the trail was not available as a feature class. Instead, these features were digitized from local aerial photos and appended to "trail", this time with the help of the ArcGIS Editor tool.

A second feature class ("trail_entrance") was created to represent points of entrance to the Little Miami Scenic Trail, as identified by the author on 10/27/2007. This field survey revealed that access occurs where streets intersect the trail. No *informal access*, or public access across private property, was found along the trail.

As we will see, many of the variables selected for this study are calculated as the distance from a property to some geographic feature (e.g., a trail access point). To make these calculations and other calculations such as finding buffers possible, the single family property transactions contained in "hc_cc_parcels" have to be represented in GIS as point features rather than polygons. Accordingly, the ArcGIS Feature to Point tool was used to create a new point feature class ("hc_cc_par_pnt") containing the centroids of the parcel features found in "hc_cc_parcels."

Several steps were required to acquire the structural attributes, sale prices and sale dates of single family properties in Hamilton County and Clermont County. First, this data was downloaded from the Hamilton County and Clermont County auditors' websites and saved as a single, ArcGIS-compatible .dbf file called "auditors_data". Using the Join function in ArcGIS, property identification numbers from "auditors_data" were then matched with those from the feature class ("hc_cc_par_pnt") with parcel centroids to create a new feature class called "property_data." Thus, "property_data" contains the structural attributes, sale prices and sale dates of all single family properties in Hamilton County and Clermont County for which previous GIS data existed.

The last step to the data collection was to select a year or range of years in which to study property transactions. Basing the analysis on a single year of transaction data might not yield statistically meaningful results. On the other hand, using too many years of data increases the likelihood that housing market conditions will be inconsistent across those years. For this study, only single family property transactions that occurred in 2003, 2004 and 2005 were used in the analysis. This is the most recent data available, as 2006 property transaction data was incomplete. It is assumed that the housing market conditions in Hamilton County and Clermont County were relatively similar for these three years.

Using the Select by Attributes function in ArcGIS, features in "property data" with sale date "2003", "2004" or "2005" and land use class number "510" (single family residential) were selected and then exported to a new feature class called "sf_all." To ensure that they are comparable between years, sales prices were converted into 2005 dollars using inflation rates reported by US Department of Labor, Bureau of Labor Statistics. Hence, "sf_all" contains the structural attributes, sale prices and sale dates of all single family properties in Hamilton County and Clermont County *sold in 2003, 2004 or 2005* for which previous GIS data existed.

## Study Area and Sample Properties

As discussed in the Literature Review, there may be a threshold distance beyond which the value of a property is not impacted by its proximity to a trail. After reviewing the literature, it was concluded that properties located within one mile of a trail or open space may have higher values than similar properties found elsewhere.

To find the impact of Little Miami Scenic Trail within one mile, the properties within this distance should be analyzed. Determining which properties are located within one mile of the trail requires selecting from two different distance measures: straight-line distance or network distance. As its name implies, *straight-line distance* is the length of the straight line that joins two points of interest (for example, the trail entrance and a given property). *Network distance*, on the other hand, is the distance that must be traveled along the street network to reach a property from the trail. Because it inherently considers rivers, steep topography and other factors that may inhibit trail accessibility and are present near the Little Miami Scenic Trail in Hamilton County and Clermont County, network distance was used in this study.

ArcGIS Network Analyst was used to identify the study area, or one-mile service area, and to calculate the network distance from each property in the study area to the trail. Network Analyst is an extension of ArcGIS that provides street network-based spatial analysis including closest facility and service area analysis (ESRI n.d.). *Service area analysis* is used to create a polygon (service area) representing the specified distance that can be reached from each facility (trail access point) using a street network (Chandrasekhar 2005). *Closest facility analysis* is used to find the shortest path from each incident (sample property) to the nearest facility, and the length of that path. Closest facility analysis was used to find the distance to trail, distance to highway and distance to park variables described in more detail later.

Network Analyst was used to calculate the study area, which consists of all properties in Hamilton County or Clermont County from which the trail can be reached via the street network in one mile or less. Then, features in "sf_all" within the one-mile service area were captured using the ArcGIS Select by Location tool and exported into a new feature class called "sf_sample." These features consists of properties in the study area that were sold between 2003 and 2005, i.e. the study sample (see Figure 5).

## Variables Used

### *Dependent Variable*

Recall that most of the literature reviewed in Chapter II used sale price to represent the "value" of a single family property. Unlike assessed value, sale price reflects the value that a homebuyer assigns to the bundle of services that is provided by a property among the range of competing choices. For this reason, sale price (adjusted for inflation), rather than assessed value, was selected as the dependent variable for this study.

To ensure that the sale prices of sample properties are as accurate as possible, the "sf_all" feature class was examined for errors. Fifty-six properties with sale prices of zero were removed from the feature class. These may indicate recording errors. Moreover, 17 properties were extracted from "sf_all" due to their being sold several times during a year or two. In these cases, properties had probably been sold for lower prices than their actual market value and thus were not appropriate for the analysis. After these measures had been taken, 376 properties remained in the sample. This sample is large enough for statistical analysis.

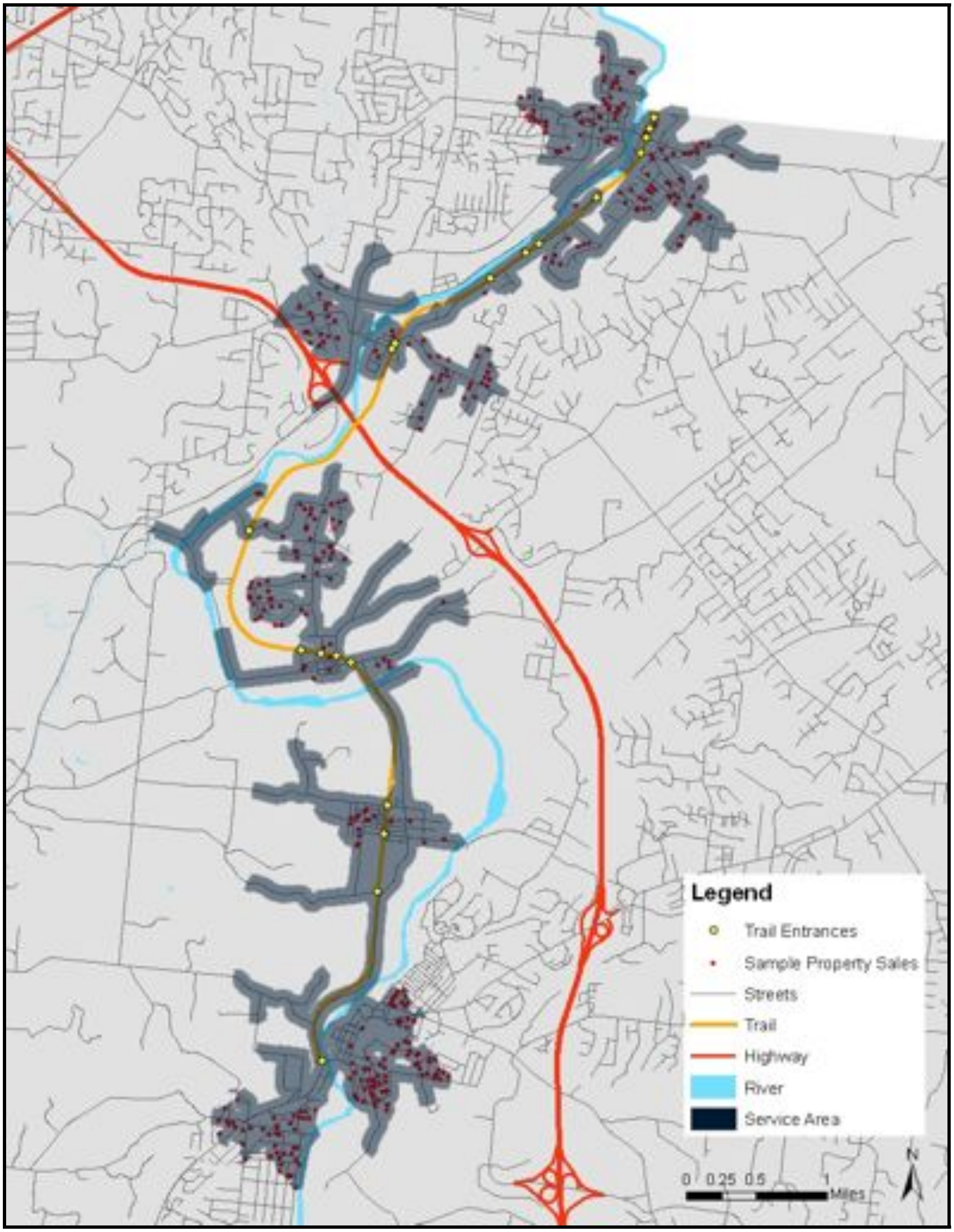


**Figure 5. One-mile service area of the Little Miami Scenic Trail.**

***Source:*** **CAGIS 2007, Clermont County GIS 2007**

### *Explanatory Variables*

**Structural Variables**

Nine structural variables were selected for this study (see Table 5): house size, building condition, lot size, number of rooms, number of half bathrooms, number of full bathrooms, a dummy variable for fireplace, number of car bays in a garage, and number of stories. In addition to their being readily available, these variables were chosen because they were used in two or more of the previously reviewed studies showing their significant influence on the sale price of a property (see Table 3 in Chapter III).

The "sf_sample" feature class contains all of the structural variables except number of car bays. To obtain this information, the square footage of garage space for each sample property was first looked up on the Clermont County/Hamilton County auditor's website. Then, the number of car bays was approximated by the square footage of garage space.[1]

**Neighborhood Variables**

Like structural variables, neighborhood variables were chosen as suggested by the relevant literature (see Table 3 in Chapter III). In addition, distance to river, and dummy variables for Terrace Park and railroad were selected for the analysis to account for characteristics specific to the study area; namely, the presence of the Little Miami River, Marietta and Cincinnati Railroad and the affluent Terrace Park neighborhood. Neighborhood and environmental variables are explained in greater detail below:

[1] The area of one car garage is 225 sqft minimum, each additional car bays adds 175 sqft minimum (Rumbarger and Vitullo 2003).

**Table 5. Explanatory Variables with Anticipated Effects**

| CODES | EXPLANATORY VARIABLES | UNITS/NOTES | EXPECTED EFFECT |
|---|---|---|---|
| **Structural Variables** | | | |
| HOUSE_SIZE | Area of finished floor space of the building | Square feet | Positive |
| LOT_SIZE | Lot Size | Acres | Positive |
| CONDITION | Condition of the building | 6=excellent, 5=good, 4=average, 3=fair, 2=poor, 1=very poor | Positive |
| N_ROOMS | Number of rooms in the house | | Positive |
| N_HALFBATHS | Number of half bathrooms in the house | | Positive |
| N_FULLBATHS | Number of full bathrooms in the house | | Positive |
| D_FIREPLACE | Dummy for fireplace in the house | Value=1 if there is a fireplace, 0 if otherwise | Positive |
| N_GARAGE | Number of car bays in a garage | | Positive |
| **Neighborhood Variables** | | | |
| D_TERRACEPARK | Dummy for location in Terrace Park | Value=1 if in Terrace park, 0 if not | Positive |
| INCOME | Median household income | Dollars by census block group | Positive |
| DIST_HGHWY | Distance to the nearest highway interchange | Network distance measured in feet | Negative |
| D_MAJORROAD | Dummy for location of the house relative to major roads | Value=1 if the house is located within 950 feet of a major road, 0 if otherwise | Negative |
| D_RAIL | Dummy for location of the house relative to the rail-line | Value=1 if the house is located within 850 feet of the rail-line, 0 if otherwise | Negative |
| PCT_COMMERCIAL | Amount of commercial land around the house | Area percentage within the 1/4 mile buffer around house | Negative |
| PCT_INDUSTRIAL | Amount of industrial land around the house | Area percentage within the 1/4 mile buffer around house | Negative |
| PCT_PARK | Amount of neighborhood, community and/or regional park land around the house | Area percentage within the 1/4 mile buffer around house | Positive |
| PCT_OTHER_PUBLIC | Amount of other federal/ state/ county/ township/ municipality owned land without development around the house | Area percentage within the 1/4 mile buffer around house | Positive |
| PCT_AGRICULTURE | Amount of agricultural land around the house | Area percentage within the 1/4 mile buffer around house | Positive |

**Table 5. *Continued*.**

| Environmental Variables | | | |
|---|---|---|---|
| DIST_TRAIL | Distance to the nearest trail entrance | Network distance measured in feet | Negative |
| DIST_RIVER | Distance to the river | Straight line distance measured in feet | Negative |
| DIST_PARK | Distance to the nearest public park entrance | Network distance measured in feet | Negative |

Median Income

The median income of each census block group in the study area was obtained from the 2000 dataset available on the US Census Bureau website (US Census Bureau). Census block groups were used because they provide more localized information than census tracts and can be linked to a feature class called "cenbgr2k", which contains census block group boundaries for Hamilton County and Clermont County. Using the Join function in ArcGIS, the dataset was linked to "cenbgr2k" by census block group ID number. Census block group ID numbers that did not match were corrected by comparing the boundary maps on the US Census Bureau website with those of "cenbgr2k" produced in ArcGIS (Figure 6). Finally, the ArcGIS Spatial Join tool was used to assign median incomes to the sample properties in "sf_sample" according to their census block group.

Distance to Highway

The distance from each sample property to the nearest highway interchange was calculated using closest facility analysis in ArcGIS Network Analyst. First, ArcCatalog was used to create a new point feature class called "interchange_entrance" that contains entrance points to highways in Hamilton County and Clermont County. Using the closest facility command in Network Analyst, "interchange_entrance" was then uploaded as facilities and "sf_sample" as incidents. Lastly, the solve command was executed to draw

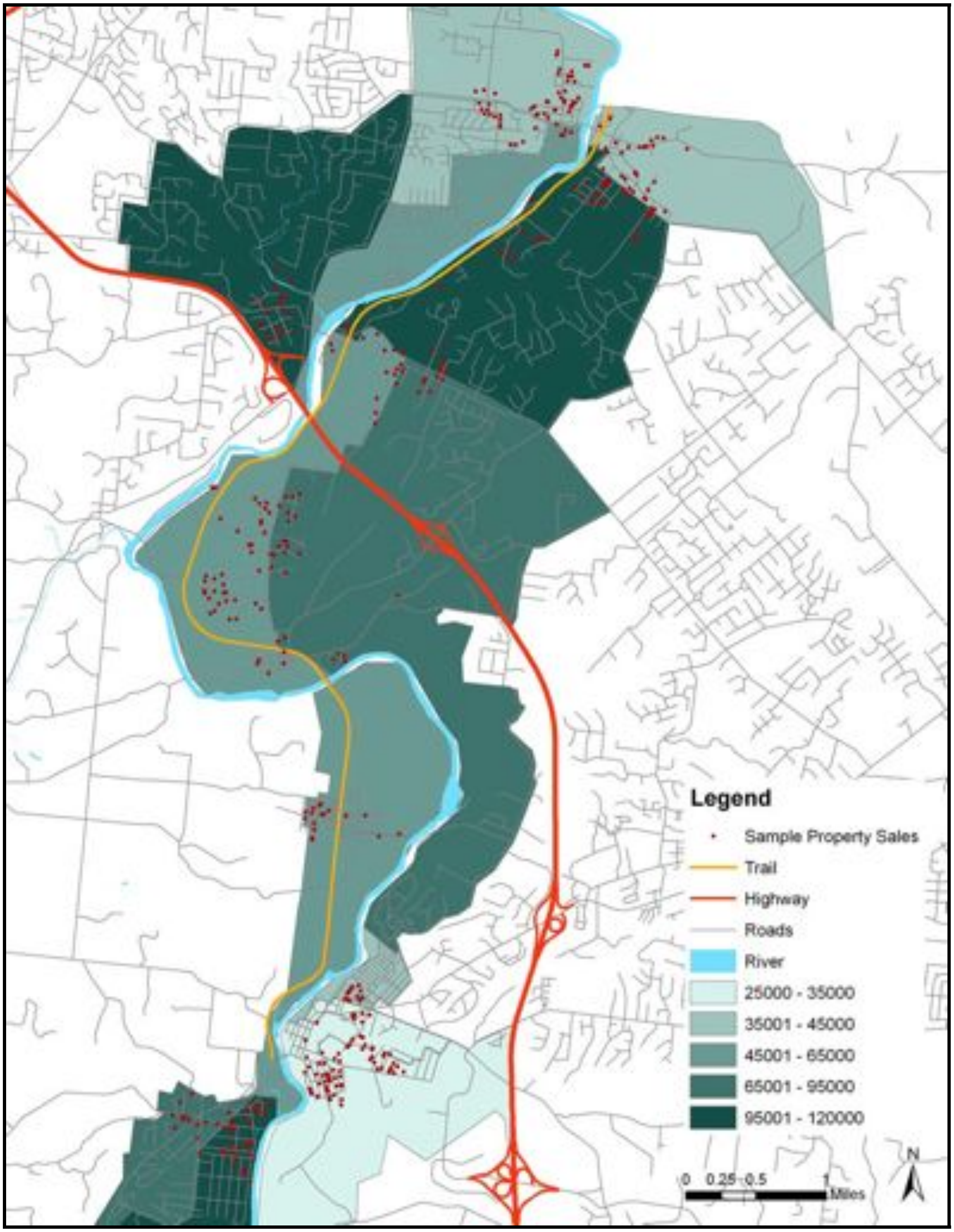


**Figure 6. Median income by census block groups.**

***Source:*** **CAGIS 2007, US Census Bureau 2000**

the shortest routes and calculate the distances from each sample property to the nearest highway interchange (Figure 7).

Major Street Dummy Variable

As discussed in the Literature Review, properties located within 950 feet of a major street may be worth less than similar properties found elsewhere. Therefore, a dummy variable was included in the analysis to indicate whether a sample property is located within 950 feet of a major street. Major streets were identified from the "hc_cc_streets" feature class, which contains an attribute called "class" that rates roads from 1-6, in order of decreasing capacity and volume. Features in "hc_cc_streets" with class values 1-4 are arterials and collectors with larger capacities and volumes than local streets. Accordingly, ArcGIS was used to select and export these features to a new feature class called "major_roads."

After determining the major roads, the ArcGIS Buffer tool was used to draw a 950-foot buffer along the features found in "major_roads." In creating the buffer, straight-line distance was used because noise and other potentially negative effects of major roads do not follow the street network. Finally, a new attribute called D_MAJORROAD was created in "sf_sample" to indicate whether each sample property is located within the 950-foot buffer. Using the Select by Location tool in ArcGIS, property features in "sf_sample" that are located within the buffer were assigned a value of "1" to D_MAJORROAD. Conversely, features located outside of the 950-foot buffer were assigned a value of "0."

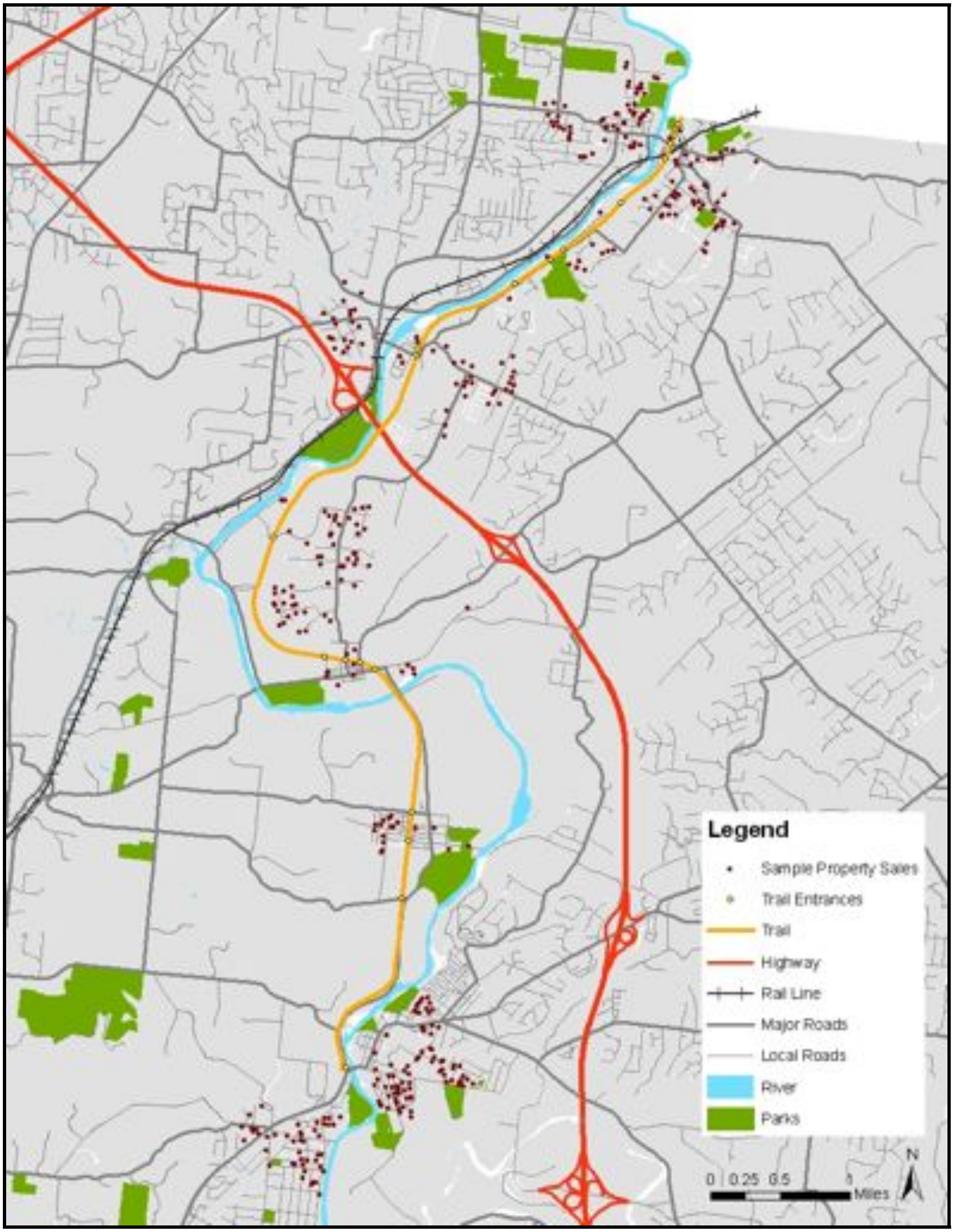


**Figure 7. Transportation and parks in and around the study area.**

***Source:*** **CAGIS 2007, Clermont County GIS 2007**

Railroad Dummy Variable

Railroads, like major roads, may have a negative impact on sale prices. The literature suggests that properties located within 850 feet of a railroad may be worth less than similar properties found elsewhere. Therefore, a dummy variable was included in the analysis to indicate whether a sample property is located within 850 feet of a railroad.

As before, the ArcGIS Buffer tool was used to draw a buffer – this time 850 wide on both sides of the railroad features found in "hc_cc_railroad". After that, a new attribute called D_RAIL was created in "sf_sample" to indicate whether each sample property is located within 850 feet of a railroad. Lastly, the Select by Location tool was used to assign features in "sf_sample" that are located within the 850-foot buffer a value of "1" to D_RAIL. Once again, features located outside of the buffer were assigned a value of "0."

Terrace Park Dummy Variable

Another dummy variable called D_TERRACEPARK was added to the "sf_sample" feature class to control the impact that Terrace Park has on the analysis. Terrace Park is a highly affluent community with a mean property sale price that is more than two times that of the other neighborhoods in the study area (see Figure 8). To control for this effect, the Select by Location tool was used to assign features in "sf_sample" that are located in Terrace Park a value of "1" to D_TERRACEPARK. All other features were assigned a value of "0".

Land Use Percentages

The literature suggests that land use percentages within a quarter mile of properties capture the immediate surroundings that are visible from the property. The

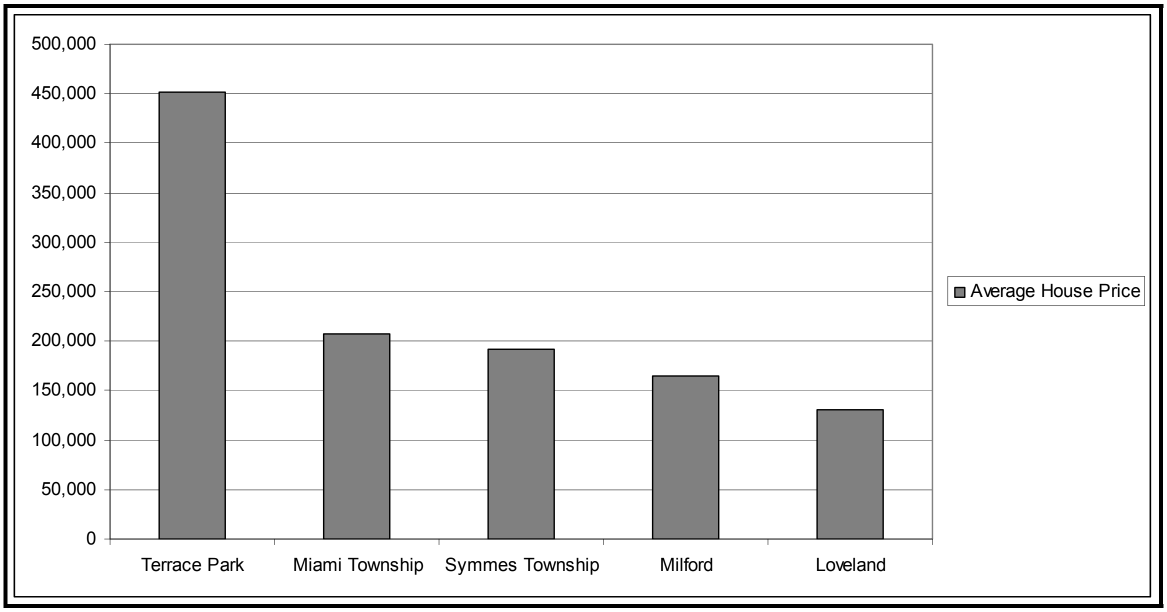


**Figure 8. Average sale prices of properties sold from 2003-2004, by neighborhood.**

land uses most used in the reviewed studies were commercial, industrial and various categories of open space. In this study, the percentages of commercial, industrial, agricultural, recreational park and other public land[2] uses within a quarter-mile around sample properties were considered.

To start, using the ArcGIS Buffer tool, quarter-mile buffers were drawn around the property features contained in "sf_sample" and saved into a new feature class called "sf_sample_buf." Straight-line distance was used to create the buffer because potentially negative impacts of land uses behind the property may occur regardless of accessibility from the street network. Next, using the Intersect tool, land use data in the "hc_cc_parcels" feature class was intersected with "sf_sample_buf" to create a new feature class called "hc_cc_parcels_buf". This feature class contains the areas (in square

[2] Other public lands consist of Federal, State, County, Township or Municipality owned lands without development.

feet) of commercial, industrial, agricultural and other land uses located within a quarter-mile of each sample property.

To calculate the *percentage* of each land use in the sample property buffers, new attributes called PERC_COM, PERC_IND, PERC_AG, PERC_PARK and PERC_OTHP were added to the attribute table of "hc_cc_parcels_buf". Using the ArcGIS field calculator, each "PERC" attribute was assigned a value equal to the area of each land use divided by the area of the buffer (5,471,136 square feet), multiplied by 100. For example, the percentage of commercial land use (PERC_COM) was calculated as the area of commercial land use divided by the total area of the buffer and multiplied by 100. After organizing in Microsoft Access, the table of "hc_cc_parcels_buf" was saved as a .dbf file. The ArcGIS Join tool was used to add the "PERC" attributes in "hc_cc_parcels_buf" to "sf_sample". Hence, "sf_sample" contains the percentages of commercial, industrial, agricultural, recreational park and other public land uses located within a quarter-mile of each sample property (Figure 9).

**Environmental Variables**

<u>Distance to Trail</u>

Because of the rivers, steep topography and other factors that may reduce accessibility to the Little Miami Scenic Trail, network distance was used to measure the distance from each sample property to the nearest trail access point using ArcGIS Network Analyst. First, the closest facility command was used to upload trail access points ("trail_entrance") as facilities and sample properties ("sf_sample") as incidents. Then, the solve command was executed to draw the shortest routes and calculate the distances from each sample property to the nearest trail access point. Twelve properties in

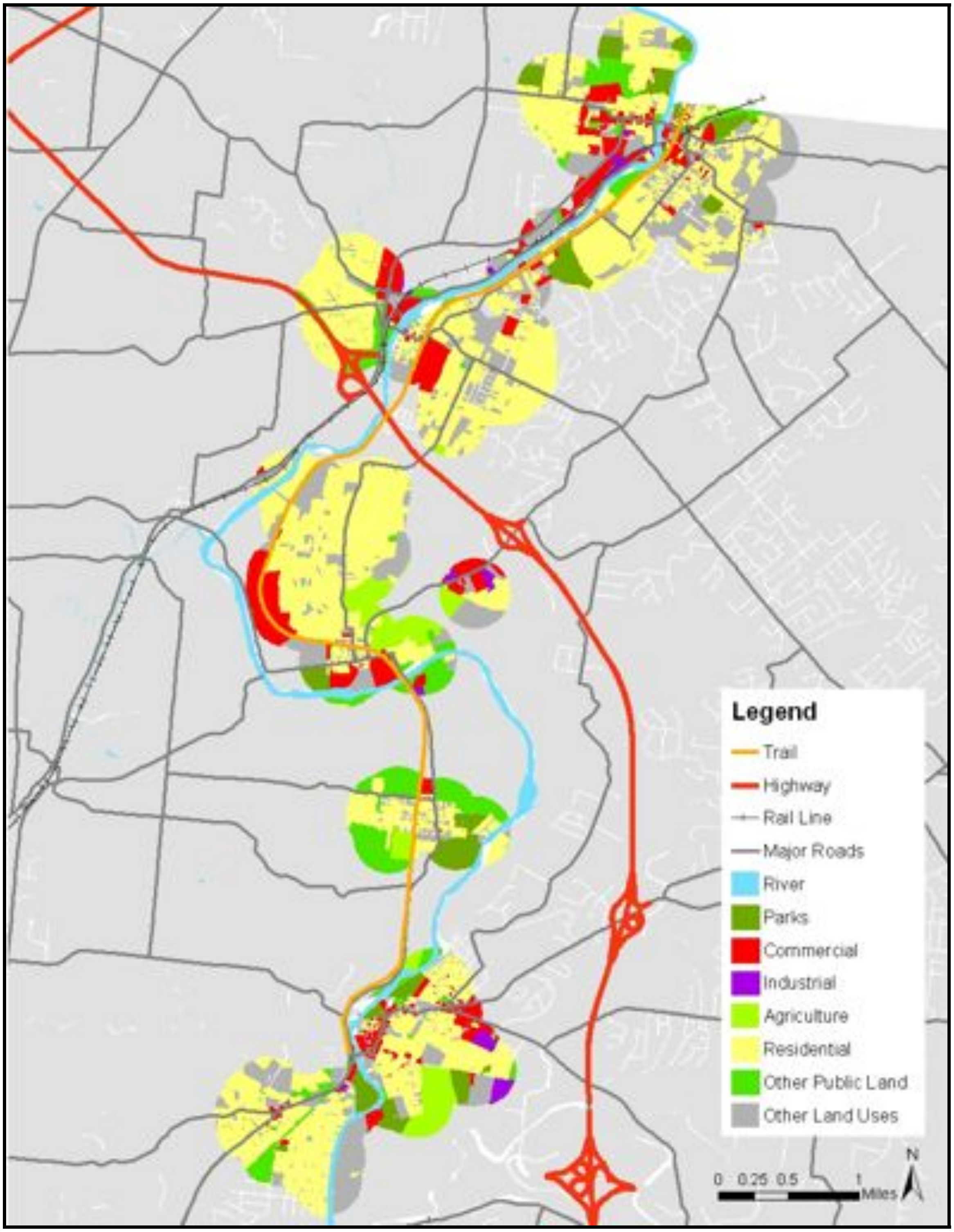


**Figure 9. Land uses in the buffers of sample properties.**
***Source:*** **CAGIS 2007, Clermont County GIS 2007**

the study area abut the trail. The literature, however, suggests that properties abutting the trail do not experience a loss in their property values. Therefore, it was not necessary to differentiate between properties located along the trail versus those that are found elsewhere in the study area.

<u>Distance to River</u>

During different stretches of the Little Miami Scenic Trail, the trail follows, crosses over, or breaks from the river (Figure 9). There is nothing to suggest, however, that distance to the river and distance to the trail are correlated: properties that are close to the trail may or may not be near the river. Therefore, this study will apprehend to separate the effect of the river and trail on the sale prices of sample properties. To capture the effect of the "feeling" of the river, or open space view associated with the river, the straight-line distance from each sample property to the river was calculated using the ArcGIS Near tool.

<u>Distance to Nearest Park</u>

The literature suggests that parks may have a positive effect on property sale prices. Consequently, network distance was used to calculate the distance from each sample property to the nearest park entrance. First, ArcCatalog and Editor tool was used to create a new point feature class called "park_access" that contains entrance points to parks in Hamilton County and Clermont County. Using the closest facility command in Network Analyst, "park_access" was then uploaded as facilities and "sf_sample" as incidents. Lastly, the solve command was executed to draw the shortest routes and calculate the distances from each sample property to the nearest park entrance.

## Variables Not Used

Several of the variables that were used in previous studies were not included here. For instance, distance to CBD was not used because it does not vary much among the sample properties, all of which are located in the northeast suburbs of Cincinnati. In addition, the distance to highway variable that was incorporated into the analysis may reflect accessibility to commercial/business centers in the study area. Thus, distance to CBD was left out of the analysis.

The percentage of African-Americans was also excluded from the study for the similar reasons. As can be seen from Figure 10, this percentage hardly varies between census block groups found in the study area. In fact, there is only one census block group for which African-Americans comprised more than 5 percent of the population. As a result, this variable is most likely not relevant to sale prices in the study area.

Another variable that was left out of the analysis is school district. The study area consists of four school districts: Loveland City School District, Sycamore Community City School District, Indian Hill Exempt City School District, and Milford Exempt Village School District. The Ohio Department of Education maintains report cards that measure each school district's designation. All of the school districts in the study area were designated as "excellent" during 2006-2007. Therefore, differences between property sale prices in the study area are probably not attributable to school district. Finally, population density was not incorporated into the analysis, because census block groups are too large to reflect actual density. As can be seen from Figure 11, low-density census block groups may include denser settlements in the study area, such as downtown Loveland or Milford.

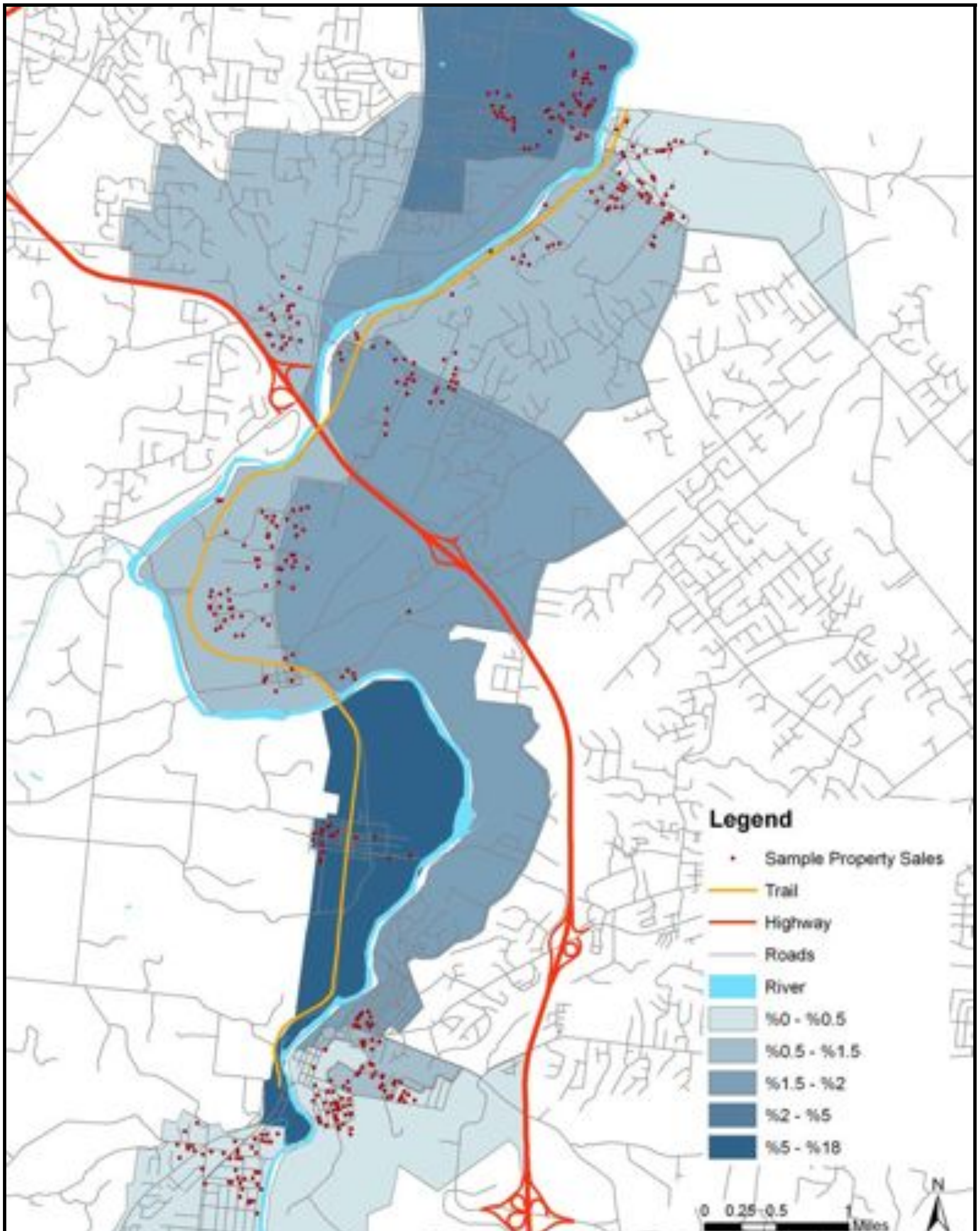


**Figure 10. Percentage of African-Americans by census block groups.**
***Source:* CAGIS 2007, US Census Bureau 2000**

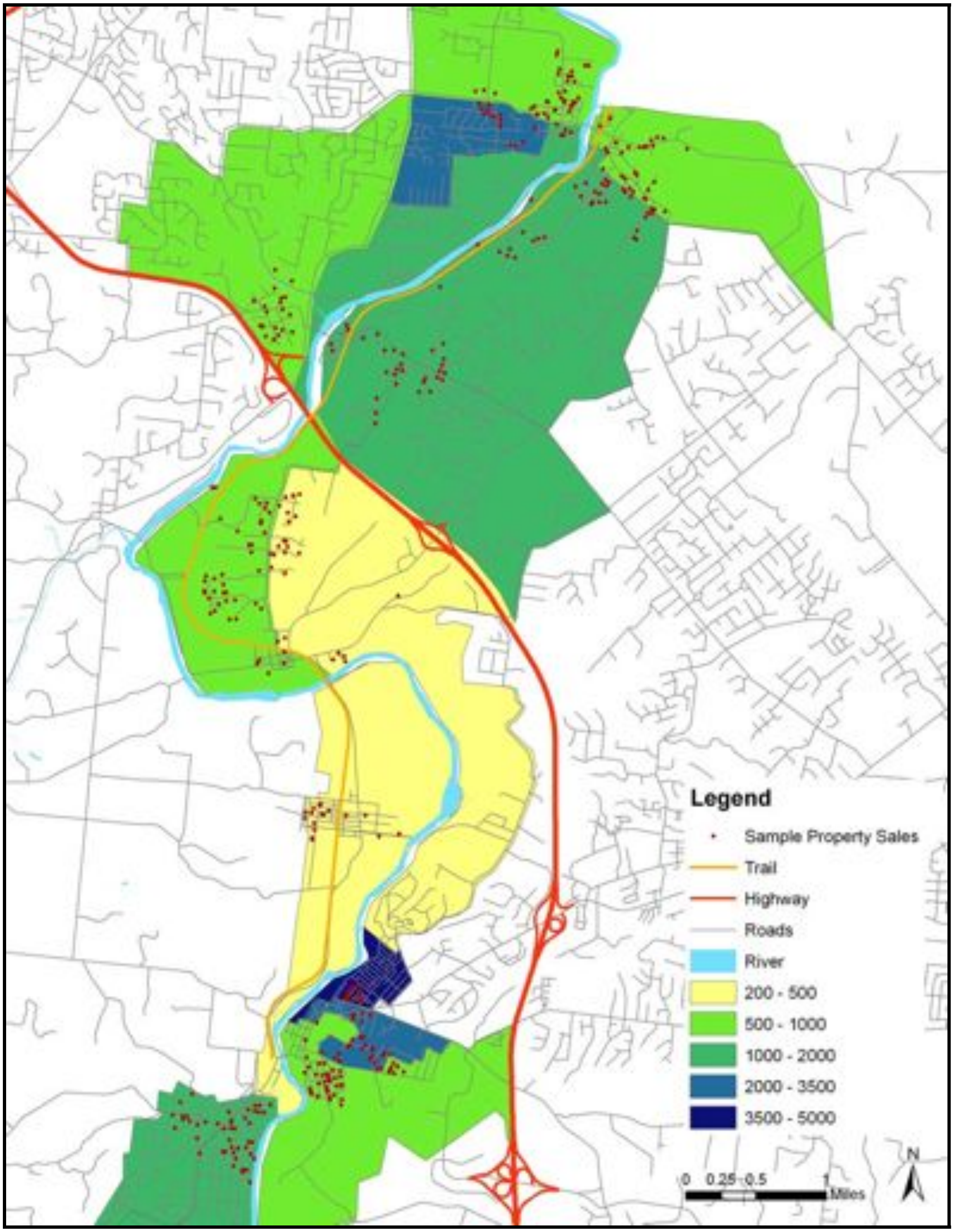


**Figure 11. Persons per square-mile by census block groups.**
***Source:*** **CAGIS 2007, US Census Bureau 2000**

# CHAPTER V

# MODEL RESULTS

This chapter describes the hedonic price model developed to measure the impact of the Little Miami Scenic Trail on property sale prices in Hamilton County and Clermont County. First, descriptive statistics are provided for all of the variables considered for the hedonic price model. Correlation coefficients are used to test for collinearity between pairs of the explanatory variables. Discussion then turns to the development of the hedonic price model. The explanatory variables used in this model are assessed for multicollinearity. Finally, the impact of each explanatory variable on property sale prices is evaluated.

## Descriptive Statistics

The minimum, maximum, mean and standard deviation of each variable considered for the hedonic price model is shown in Table 6. The dependent variable, sale price (PRICE), ranged in value from $31,800 to $982,500, with a mean value of $203,596. As noted in Chapter III, Terrace Park is a highly affluent neighborhood, with a mean sale price of $451,958 versus $169,835 for the other neighborhoods (see Appendix B). Other variables considered for the model did not differ much between Terrace Park and the other neighborhoods.

**Table 6. Variables Considered for the Hedonic Price Model.**

| | Minimum | Maximum | Mean | Std. Deviation | Units |
|---|---|---|---|---|---|
| PRICE | 31,800 | 982,500 | 203,596 | 146,849 | $ |
| HOUSE_SIZE | 640 | 5,280 | 1,783 | 842 | sqft |
| LOT_SIZE | 0.045 | 6.950 | 0.469 | 0.543 | acre |
| N_ROOMS | 3 | 12 | 6.402 | 1.610 | |
| N_HALF_BATH | 0 | 2 | 0.420 | 0.526 | |
| N_FULL_BATH | 1 | 4 | 1.559 | 0.642 | |
| N_GARAGE | 0 | 4 | 1.301 | 1.003 | |
| N_STORIES | 1 | 2 | 1.521 | 0.500 | |
| INCOME | 27,670 | 119,297 | 61,593 | 29,901 | $ |
| DIST_TRAIL | 100 | 5,280 | 3,390 | 1,380 | Feet |
| DIST_RIVER | 48 | 4,128 | 1,796 | 1,004 | Feet |
| DIST_PARK | 12 | 10,771 | 4,545 | 4,947 | Feet |
| DIST_HIGHWAY | 2,623 | 19,811 | 12,385 | 4,076 | Feet |

House sizes ranged between 640-5,280 square feet, with a mean value of 1,783 square feet. Lot sizes ranged between 0.045-6.950 acres, with a mean value of 0.469 acres, which is larger than a typical 0.25-acre suburban plot. The median income by census block group ranged between $27,670 and $119,297, with a mean value of $61,593. Thus, household incomes in the study area are high relative to those of Greater Cincinnati (44,485). Network distances from the sample properties to a trail access point ranged between 100-5,280 feet, with a mean value of 3,390 feet.

## Correlation Analysis

To assess for collinearity among pairs of the explanatory variables, a correlation matrix was generated using SPSS (see Appendix C). Although there is moderate correlation between some of the structural variables, none of the correlation coefficients are larger than 0.8 or smaller than -0.8, suggesting that pairwise collinearity is not a serious issue. The largest correlation coefficient (0.78) is between house size (HOUSE_SIZE) and number of rooms (N_ROOMS). This rather strong correlation is expected as one would assume that large houses have more rooms. However, it can be argued that both variables have a significant impact on sale prices. For example, large families pressed to decide between two houses of the same size but different number of rooms may choose the house with more rooms. Consequently, all of the explanatory variables, including house size and number of rooms, were retained for further analysis.

## Model Development

In developing a hedonic price model for the sample properties, it is desirable for the final model to be effective with as few explanatory variables as possible. This rule of thumb is known as the *principle of parsimony* in statistical circles (Chatterjee, Hadi, and Price 2000). The principle of parsimony provides two advantages: 1) it allows one to identify explanatory variables with the most statistically significant impact on the dependent variable (in this case, sale price); and, 2) it results in a hedonic price model that is easier to understand and interpret than more complex models. In addition, the main focus of this research is the influence of the proximity to the trail, rather than the influence of other explanatory variables.

Some of the explanatory variables chosen for this study may not be helpful in explaining the sale prices of the sample properties. To ensure that only statistically significant variables are considered, *backward elimination* was used to develop the hedonic price model. This procedure was selected because it handles multicollinearity that may be present among the explanatory variables better than other variable selection methods (Chatterjee, Hadi and Price 2000).

The backward elimination procedure starts by putting all of the explanatory variables into a multiple linear regression model. The predictive ability of each explanatory variable is evaluated through its t-statistic value. The explanatory variable which has the lowest significance in the first run of the model is dropped for a second run of the regression model. The process continues, with additional variables being eliminated one-by-one until all of the t-statistics in the regression model are significant. This final model, the hedonic price model, is used to evaluate the impact of the Little Miami Scenic Trail on the sale prices of the sample properties within one-mile.

The backward elimination procedure was carried out using SPSS. Table 7 shows the final model after 13 explanatory variables were eliminated. These variables are: lot size (LOT_SIZE), number of half baths (N_HALFBATHS), number of full baths (N_FULLBATHS), fireplace dummy variable (D_FIREPLACE), number of cars in garage (N_CGARAGE), number of stories (N_STORIES), median household income (INCOME), distance to river (DIST_RIVER), railroad dummy variable (D_RAIL), percent industrial land (PCT_INDUSTRIAL), percent park land (PCT_PARK), percent other public land (PCT_OTHER_PUBLIC) and percent agricultural land (PCT_AGRICULTURAL).

The hedonic price model for this study can be written as: PRICE = - 49,631 + 62.50 • (HOUSE_SIZE) + 22,215 • (CONDITION) + 18,581 • (N_ROOMS) + 194,787 • (D_TERRACEPARK) - 7.05 • (DIST_TRAIL) - 1.62 • (DIST_PARK) - 3.63 • (DIST_HIGHWAY) - 26,351 • (D_MAJOR_ROAD) - 1,676 • (PCT_COMMERCIAL).

**Table 7. Hedonic Price Model Resulting from Backward Elimination Method**

| | B | Significance | Variance Inflation Factor (VIF) |
|---|---|---|---|
| (Constant) | -49,631.32 | 0.11 | |
| HOUSE_SIZE | 62.50 | 0.00 | 3.367 |
| CONDITION | 22,214.60 | 0.00 | 2.203 |
| N_ROOMS | 18,581.46 | 0.00 | 2.635 |
| D_TERRACEPARK | 194,786.59 | 0.00 | 1.394 |
| DIST_TRAIL | -7.05 | 0.02 | 1.300 |
| DIST_PARK | -1.62 | 0.07 | 1.477 |
| DIST_HIGHWAY | -3.63 | 0.00 | 1.447 |
| D_MAJORRD | -26,351.13 | 0.00 | 1.152 |
| PCT_COMMERCIAL | -1,676.96 | 0.00 | 1.192 |
| **R Square** | 0.777 | | |
| **Adjusted R Square** | 0.771 | | |
| **F** | 141.330 (0.00) | | |

### *Multicollinearity Diagnostics*

Statistical diagnostics (see Appendix D) suggest that moderate multicollinearity may be present among the explanatory variables. However, the condition index estimated for the hedonic price model is less than 30, and no variance inflation factor is greater than 10 (Table 7). Therefore, multicollinearity appears not to be a serious problem and no additional steps were taken.

## Model Interpretation

The hedonic price model has an R-square value of 0.777, which suggests that it fits the data quite well: 77.7 percent of the variation in sale prices can be explained by the variables included in the model. The high significance of F-statistic with more than 99.9% confidence indicates that the model as a whole is statistically significant. The distance to the trail (DIST_TRAIL) and distance to the nearest park (DIST_PARK) variables were significant at the 0.05 and 0.10 levels, respectively. All other explanatory variables were found to be significant at the 0.01 level of significance.

All of the model coefficients (i.e., the B-values listed in Table 8) have the expected signs. Those coefficients suggest that, all other factors held constant, sale prices increase with the size and condition of a property. For example, the coefficient for house size (HOUSE_SIZE), at 62.50, indicates that each square-foot increase in house size adds $62.50 to the property sale price. Similarly, each unit increase in the condition of a building adds $22,215 to the sale price. Finally, each additional room increases sale price by $18,581.

The negative sign of the DIST_TRAIL model coefficient implies that as the network distance to the trail increases, property values decrease. In other words, being closer to the Little Miami Scenic Trail adds value to the properties. All other factors held constant, each foot decrease in distance to the trail increases the sale price of a sample property by $7.05. Likewise, sale prices increase by $1.62 and $3.63, respectively, for every foot closer a property is located to a park or highway interchange. Thus, proximity to the trail contributes more to property values than proximity to the park or the highway.

Properties located within 950 feet of a major road sell for $26,351 less than similar properties found elsewhere. The property sale price decreases by $1,677 for each percentage increase in commercial land within a quarter mile of a property. This means that a property that has 20 percent commercial land use within a quarter mile buffer around it, sells for 20 x $1,677 = $33,540 less than a property that does not have any commercial land use within a quarter mile. Finally, Terrace Park properties sold for $194,787 more than those located in other neighborhoods. This result is expected since the average sale price of properties in Terrace Park was about $200,000 more than the highest average property price among other neighborhoods.

# CHAPTER VI

# DISCUSSION AND CONCLUSION

The aim of this study was to determine whether the Little Miami Scenic Trail impacts property values in Hamilton County and Clermont County. It was found that the trail positively impacts single-family residential property values, with sale prices increasing by $7.05 for every foot closer a property is located to the trail. This final chapter describes how these findings relate to those of similar hedonic price studies. In addition, study findings are compared with the expected results, particularly for those variables found to have no significant impact on property sale prices. The thesis concludes with a discussion of the study limitations, along with recommendations for future research.

## Comparison with Similar Studies

Five of the hedonic studies reviewed for this thesis examined the impact of greenways/trails on property values. Of these five studies, however, only two used the same methods (linear regression and network distance analysis) as those applied here. An important finding from the first study (Correll, Lillydahl, and Singell 1978) was that property values increased by $10.20 for every foot decrease in distance to a greenway entrance. In the second study (Nicholls and Crompton 2005), however, the authors found that the premium for living one foot closer to an access point of a different greenway was only $3.97. The premium ($7.05) determined for the present study is roughly equal to the mean of the premiums from these two studies.

The low premium that Nicholls and Crompton (2005) observed may be due to the large geographic size of their study area. Among properties sampled by the authors, the mean distance to a greenway entrance was 5,244 feet. This suggests that many of the sampled properties may be located more than one mile (5,280 feet) from the trail. As noted in the Literature Review, the impact of a greenway/trail on property values may become insignificant beyond one mile from an access point. It follows that many property values in the Nicholls and Crompton (2005) study may not be affected by proximity to the greenway. If that is the case, then the premium for living one foot closer to a greenway entrance will be low.

Compared to the Nicholls and Crompton (2005) study, properties selected for the present study were typically located closer to a greenway entrance. In fact, the mean distance from a sample property to a Little Miami Scenic Trail access point was 3,390 feet – or about 0.64 mile. With a maximum distance of 3,200 feet, the properties sampled by Correll, Lillydahl, and Singell (1978) were located closer to a greenway entrance. This helps to explain why the premiums observed in these two studies are larger than that reported by Nicholls and Crompton (2005).

## Non-Significant Variables

In the Analysis section, some of the variables considered for the hedonic price model were found to be non-significant; that is, there was insufficient evidence to suggest that these variables affect the sale prices of single-family residential properties in Hamilton County and Clermont County that are located within one mile network distance of the Little Miami Scenic Trail. These non-significant variables include: lot size (LOT_SIZE), number of half bathrooms (N_HALFBATHS), number of full bathrooms

(N_FULLBATHS), fireplace dummy (D_FIREPLACE), number of car bays in garage (N_GARAGE), number of stories (N_STORIES), median household income (INCOME), railroad dummy (D_RAIL), percent industrial land (PCT_INDUSTRIAL), percent park land (PCT_PARK), percent other public land (PCT_OTHER_PUBLIC), and percent agricultural land (PCT_AGRICULTURAL).

There are a number of possible explanations for the non-significance of an explanatory variable. First, the variable may be deemed non-significant when there is insufficient variation in the sample (Janssen 2003). Consider the railroad dummy variable (D_RAIL), for example: only 21 of the 376 sampled properties are located within 850 feet of a railroad. Likewise, only two properties in the sample were located within a quarter mile of more than 10 percent industrial land (PCT_INDUSTRIAL > 10). Without greater variation among the sample properties, the railroad dummy and percent industrial land variables are not likely to be significant.

In a hedonic study, personal preferences may also influence the significance of an explanatory variable (Janssen 2003). For example, a person may be willing to pay a premium for a house with a fireplace. Another person who views fireplaces as old-fashioned or unnecessary may prefer to purchase a house without a fireplace. If less than 50% of homebuyers in the study area favor owning a home with fireplaces, then it is likely that the fireplace dummy variable will be non-significant in the hedonic price model; that is, property sale prices will not be affected by the presence (or absence) of a fireplace.

## **Policy and Planning Implications**

Trails are sometimes regarded as an inefficient use of public funds (Crompton 2004). Opponents cite that trails are costly to maintain and that the land acquired for trails could be used to generate tax revenues. Further, some state that trails might decrease the values of nearby properties. Evidence from the present study, however, suggests that the Little Miami Scenic Trail provides financial benefits in terms of increased property values. All other factors held constant, Hamilton County and Clermont County sale prices increase by $7.05 for every foot closer a property is located to trail. This finding can be used by planners and policymakers to justify making future investments into the trail.

The notion that trails improve nearby property values is rooted in the so-called *proximate principle* (Crompton 2004). This concept suggests that the costs of developing and maintaining trails are eventually recovered by way of increased property tax revenues. Thus, increases in property tax revenues due to trail development can be retained to pay for future trail acquisition and development or to pay off the debt incurred from the initial investment into the trail.

## **Study Limitations and Future Research**

The hedonic price model developed for this study is based on data from single-family residential properties. For this reason, the study results cannot be generalized to multi-family residences and commercial properties. These property types were excluded from the analysis because most properties in the study area are primarily single-family residential. However, future research into the effect of trails on the values of multi-family residences and commercial properties would be informative.

Of the 22 variables considered for the hedonic price model, nine were found to be significant. Together, these nine variables explain 78% of the variation in sale prices among the sample properties. The remaining 22% of the variation not explained was attributable to factors not included in the model or to random influences (i.e., model error). It is possible that the hedonic price model would be improved with the inclusion of additional variables such as view of the river. Yet, the sample contains only 7 properties that feature a view of the river. Consequently, the sample size is not large enough to consider additional variables for the model.

Of course, the sample size could be boosted by using additional years of property sales data. In doing so, however, one must assume that the same market conditions prevail for all of the years sampled. Over a large number of years, it is more likely, for example, that conditions will shift from a "buyer's market" (where there are relatively few homebuyers compared to sellers) to a "seller's market" (where the reverse is true). If this is the case, then an additional explanatory variable must be incorporated into the hedonic price model to account for the effect of time on sale prices.

A second approach to increasing the sample size might be to increase the study area boundary, to include properties located further northeast in Butler County and Warren County. Enlarging the study area, however, may introduce additional factors that must be considered for the hedonic price model. For example, landfills may be more common in the rural areas of Butler County and Warren County. In this situation, a landfill variable would need to be added to the model.

An important assumption of this study is that the GIS data from which the hedonic price model was developed is accurate and complete. While every attempt was made to ensure that this is the case, it should be recognized that the data comes from two different sources, and thus may be subject to error. In addition, land use information might have changed during the three years upon which the analysis is based. Park locations were verified during surveys of the Little Miami Scenic Trail; however, it was not possible to check that land uses across the entire study area were correctly coded.

Two additional assumptions made for this study are related to *spatial autocorrelation* and *heterogeneity*. Spatial autocorrelation refers to a condition where the sale price of a given property is influenced by neighboring sale prices. Heterogeneity exists when property characteristics such as house size vary from location to location. In other words, house with similar characteristics are likely to be located next to one another. If present in the data, spatial autocorrelation and heterogeneity may lead to incorrect results. Future studies should investigate and remedy any spatial autocorrelation and heterogeneity that might be found in the data.

## Conclusion

This study examined how the Little Miami Scenic Trail affects the sale prices of single-family residential properties in Hamilton County and Clermont County, Ohio. Using structural, neighborhood and environmental variables, a hedonic price model was developed for 376 properties located within one mile of the trail. This model demonstrated that proximity to the trail positively impacts property values. Specifically, the model results suggested that for every foot closer to the Little Miami Scenic Trail a single-family residential property is located, its sale price increases by $7.05. This finding is notable because rail-trails such as the Little Miami Scenic Trail are often criticized for having a negative impact on property values. This study suggests, to the contrary, that rail-trails can have a positive effect on the economic well-being of the surrounding community.

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# APPENDICES

**APPENDIX A. Data Dictionary**

| Data File | Description | Data Type | Feature Type | How Collected |
|---|---|---|---|---|
| pin | Parcels in Clermont County (CC) | feature class | polygon | Clermont County Geographic Information Systems (Clermont County GIS) |
| parcpoly | Parcels in Hamilton County (HC) | feature class | polygon | Cincinnati Area Geographic Information Systems (CAGIS) |
| streetcl | Streets in HC | feature class | polyline | Clermont County GIS |
| centerline | Streets in CC | feature class | polyline | CAGIS |
| railroad | Railroad in HC | feature class | polyline | CAGIS |
| hc_cc_streets | Streets in HC and CC | feature class | polyline | Merging "streetcl" with "centerline" |
| hc_cc_parcels | Parcels in HC and CC | feature class | polygon | Merging "pin" with "parcpoly" |
| hc_cc_railroad | Railroad in HC and CC | feature class | polyline | Merging "railroad" with railroad in CC |
| trail | Trail in CC and HC | feature class | polyline | Exporting features coded as “Bike Trail” in “hc_cc_streets”, and digitizing from local aerial photos |
| trail_entrance | Trail entrances in CC and HC | feature class | point | Digitizing trail entrances recorded in a field survey |
| hc_cc_par_pnt | Centroids of parcels in HC and CC | feature class | point | Using Feature to Point tool on "hc_cc_parcels" |
| auditors_data | Data related to the properties in HC and CC | .dbf | | Combining and organizing the data gathered from HC and CC Auditors |
| property_data | All properties in HC and CC containing all available data | feature class | point | Joining "auditors_data" with "hc_cc_par_pnt" using parcel identification numbers |
| sf_all | Single family properties within service area of the trail that were sold in 2003-2005 containing all data | feature class | point | Exporting features in "property_data" with sale date “2003”, “2004” or “2005” and land use class number “510” |

## APPENDIX B. Descriptive Statistics for Terrace Park versus Other Neighborhoods

| | OTHER NEIGHBORHOODS (n=331) | | | | TERRACE PARK (n=45) | | | |
|---|---|---|---|---|---|---|---|---|
| | Minimum | Maximum | Average | Standard Deviation | Minimum | Maximum | Average | Standard Deviation |
| PRICE | 31,800 | 596,250 | 169,835 | 88,150.788 | 79,500 | 982,500 | 451,928 | 232,088.928 |
| HOUSE_SIZE | 640 | 5,280 | 1,680 | 778.862 | 854 | 4,449 | 2,538 | 907.631 |
| LOT_SIZE | 0.045 | 6.950 | 0.474 | 0.572 | 0.170 | 1.815 | 0.434 | 0.246 |
| N_ROOMS | 3 | 12 | 6.257 | 1.503 | 4 | 12 | 7.467 | 1.961 |
| N_HALF_BATHS | 0 | 2 | 0.405 | 0.522 | 0 | 2 | 0.533 | 0.548 |
| N_FULL_BATHS | 1 | 3 | 1.480 | 0.568 | 1 | 4 | 2.133 | 0.842 |
| N_GARAGE | 0 | 4 | 1.224 | 1.002 | 0 | 4 | 1.867 | 0.815 |
| N_STORIES | 1 | 2 | 1.502 | 0.501 | 1 | 2 | 1.667 | 0.477 |
| INCOME | 27,670 | 119,297 | 56,859 | 28,757.850 | 91,963 | 98,415 | 96,408 | 3,020.693 |
| DIST_TRAIL | 100 | 5,267 | 3,295 | 1,402.890 | 2,143 | 5,280 | 4,084 | 954.199 |
| DIST_RIVER | 100 | 4,128 | 1,864 | 986.948 | 48 | 3,430 | 1,297 | 1,001.989 |
| DIST_PARK | 12 | 16,771 | 4,934 | 5,146.125 | 26 | 2,576 | 1,681 | 622.680 |
| DIST_HIGHWAY | 2,623 | 19,811 | 11,907 | 4,104.386 | 13,960 | 17,104 | 15,902 | 954.199 |

**APPENDIX C. Correlation Matrix**

| | PRICE | HOUSE_ SIZE | LOT_SIZE | CONDITION | N_ ROOMS | N_ HALF_BATH | N_ FULL_BATH | D_ FIREPLACE | N_ GARAGE | N_ STORIES | D_ TERRACEPARK |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PRICE | 1.00 | | | | | | | | | | |
| HOUSE_SIZE | 0.76 | 1.00 | | | | | | | | | |
| LOT_SIZE | 0.16 | 0.24 | 1.00 | | | | | | | | |
| CONDITION | 0.61 | 0.69 | 0.19 | 1.00 | | | | | | | |
| N_ROOMS | 0.67 | 0.78 | 0.25 | 0.59 | 1.00 | | | | | | |
| N_HALF_BATH | 0.44 | 0.56 | 0.08 | 0.50 | 0.57 | 1.00 | | | | | |
| N_FULL_BATH | 0.65 | 0.76 | 0.20 | 0.60 | 0.67 | 0.36 | 1.00 | | | | |
| D_FIREPLACE | 0.42 | 0.43 | 0.22 | 0.47 | 0.40 | 0.33 | 0.45 | 1.00 | | | |
| N_GARAGE | 0.45 | 0.54 | 0.19 | 0.51 | 0.44 | 0.37 | 0.50 | 0.41 | 1.00 | | |
| N_STORIES | 0.46 | 0.57 | 0.09 | 0.50 | 0.60 | 0.50 | 0.48 | 0.28 | 0.36 | 1.00 | |
| D_TERRACEPARK | 0.62 | 0.33 | -0.02 | 0.21 | 0.24 | 0.08 | 0.33 | 0.25 | 0.21 | 0.11 | 1.00 |
| INCOME | 0.45 | 0.42 | 0.17 | 0.24 | 0.33 | 0.32 | 0.44 | 0.30 | 0.32 | 0.20 | 0.43 |
| DIST_TRAIL | 0.23 | 0.23 | -0.03 | 0.30 | 0.21 | 0.16 | 0.24 | 0.28 | 0.20 | 0.02 | 0.19 |
| DIST_RIVER | -0.12 | 0.01 | 0.07 | 0.00 | -0.03 | 0.00 | 0.01 | -0.10 | 0.10 | -0.16 | -0.18 |
| DIST_PARK | 0.04 | 0.24 | 0.25 | 0.34 | 0.21 | 0.30 | 0.21 | 0.30 | 0.28 | 0.15 | -0.21 |
| DIST_HIGHWAY | 0.06 | -0.03 | -0.19 | -0.13 | -0.05 | -0.12 | -0.10 | -0.15 | -0.10 | -0.04 | 0.32 |
| D_MAJORRD | -0.17 | -0.08 | 0.05 | -0.16 | -0.05 | 0.02 | -0.07 | -0.03 | -0.02 | 0.00 | -0.09 |
| D_RAIL | -0.13 | -0.06 | 0.00 | -0.15 | -0.05 | -0.06 | -0.09 | -0.15 | -0.13 | 0.02 | -0.09 |
| PCT_COMMERCIAL | -0.19 | -0.09 | 0.06 | -0.10 | 0.00 | 0.02 | -0.10 | -0.09 | -0.09 | 0.09 | -0.21 |
| PCT_INDUSTRIAL | -0.12 | -0.14 | 0.03 | -0.17 | -0.08 | -0.11 | -0.15 | -0.13 | -0.19 | -0.19 | -0.07 |
| PCT_PARK | -0.14 | -0.19 | -0.13 | -0.16 | -0.12 | -0.12 | -0.17 | -0.07 | -0.20 | -0.06 | -0.14 |
| PCT_OTHER_ PUBLIC | -0.18 | -0.22 | -0.08 | -0.23 | -0.23 | -0.14 | -0.18 | -0.16 | -0.11 | -0.17 | -0.06 |
| PCT_ AGRICULTURAL | -0.12 | -0.20 | -0.07 | -0.05 | -0.17 | -0.19 | -0.17 | -0.06 | -0.19 | -0.14 | -0.16 |

**APPENDIX C.** ***Continued.***

| | INCOME | DIST_ TRAIL | DIST_ RIVER | DIST_ PARK | DIST_ HIGHWAY | D_ MAJORRD | D_ RAIL | PCT_ COMMERCIAL | PCT_ INDUSTRIAL | PCT_ PARK | PCT_ OTHER_ PUBLIC | PCT_ AGRICULTURAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| INCOME | 1.00 | | | | | | | | | | | |
| DIST_TRAIL | 0.11 | 1.00 | | | | | | | | | | |
| DIST_RIVER | -0.01 | 0.34 | 1.00 | | | | | | | | | |
| DIST_PARK | 0.28 | 0.15 | 0.27 | 1.00 | | | | | | | | |
| DIST_HIGHWAY | -0.14 | -0.17 | -0.07 | -0.43 | 1.00 | | | | | | | |
| D_MAJORRD | 0.26 | -0.24 | 0.11 | 0.12 | -0.10 | 1.00 | | | | | | |
| D_RAIL | -0.02 | -0.35 | -0.26 | -0.05 | 0.05 | 0.17 | 1.00 | | | | | |
| PCT_COMMERCIAL | -0.14 | -0.18 | -0.25 | 0.15 | -0.26 | -0.01 | 0.30 | 1.00 | | | | |
| PCT_INDUSTRIAL | -0.19 | 0.16 | 0.21 | -0.15 | -0.07 | -0.19 | 0.03 | 0.09 | 1.00 | | | |
| PCT_PARK | -0.38 | -0.03 | -0.16 | -0.47 | 0.20 | -0.27 | -0.04 | -0.12 | 0.40 | 1.00 | | |
| PCT_OTHER_ PUBLIC | -0.16 | -0.38 | 0.01 | -0.24 | 0.32 | 0.02 | 0.00 | -0.10 | -0.09 | 0.09 | 1.00 | |
| PCT_ AGRICULTURAL | -0.32 | -0.10 | 0.01 | -0.08 | -0.12 | -0.37 | -0.11 | -0.11 | 0.12 | 0.11 | 0.05 | 1.00 |

**APPENDIX D. Collinearity Diagnostics**

| Dimension | Eigenvalue | Condition Index | Variance Proportions | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | (Constant) | HOUSE_SIZE | CONDITION | N_ ROOMS | D_ TERRACEPARK | DIST_ TRAIL | DIST_ PARK | DIST_ HIGHWAY | D_ MAJORRD | PCT_ COMMERCIAL |
| 1 | 7.312 | 1.000 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2 | 1.060 | 2.626 | 0.00 | 0.00 | 0.00 | 0.00 | 0.39 | 0.00 | 0.04 | 0.00 | 0.00 | 0.10 |
| 3 | 0.556 | 3.628 | 0.00 | 0.00 | 0.00 | 0.00 | 0.12 | 0.00 | 0.06 | 0.00 | 0.01 | 0.72 |
| 4 | 0.439 | 4.079 | 0.00 | 0.00 | 0.00 | 0.00 | 0.16 | 0.00 | 0.48 | 0.02 | 0.10 | 0.01 |
| 5 | 0.332 | 4.695 | 0.00 | 0.00 | 0.00 | 0.00 | 0.16 | 0.03 | 0.05 | 0.00 | 0.58 | 0.00 |
| 6 | 0.131 | 7.476 | 0.00 | 0.20 | 0.00 | 0.01 | 0.05 | 0.29 | 0.06 | 0.02 | 0.00 | 0.00 |
| 7 | 0.110 | 8.139 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.33 | 0.25 | 0.29 | 0.12 | 0.01 |
| 8 | 0.031 | 15.393 | 0.07 | 0.32 | 0.25 | 0.03 | 0.07 | 0.27 | 0.04 | 0.40 | 0.05 | 0.07 |
| 9 | 0.019 | 19.651 | 0.00 | 0.15 | 0.33 | 0.77 | 0.01 | 0.00 | 0.02 | 0.01 | 0.02 | 0.03 |
| 10 | 0.010 | 27.522 | 0.93 | 0.30 | 0.42 | 0.18 | 0.03 | 0.07 | 0.00 | 0.26 | 0.11 | 0.06 |