WHAT ARE GREENWAYS WORTH?
THE IMPACT OF THE BUCKEYE TRAIL GREENWAY ON HOME SALE PRICE IN RALEIGH, NORTH CAROLINA

By

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Abstract

The monetary impact of greenways on proximate residential property values remains somewhat of a mystery. Many of the existing claims about the positive and negative impacts of greenways on property values are not substantiated by quantitative analysis. This study uses the hedonic pricing method in an attempt to examine and quantify the impacts of a greenway in Raleigh, North Carolina, on surrounding single family homes. The results demonstrate that the greenway examined may not have significant positive impacts on proximate home sale prices. Also, adjacency to the greenway produced slightly negative and insignificant impacts on property values. I speculate that the unexpected findings may be explainable by data and model limitations that preclude analysis of all influential variables.

Introduction

Whether living in rural, suburban or urban communities, more Americans are demanding that green places be protected as a way to maintain their quality of life. Trails and greenways are a means by which municipalities can shape their communities by preserving natural open spaces. A greenway is defined as "a linear open space established along a natural corridor such as a riverfront or stream valley, an abandoned railroad right-of-way, a canal, a scenic road or some other linear route" (Little, 1990, p.1). Greenways have been described as "fingers of green that reach out from and around and through communities all across America" (President's Commission on Americans Outdoors, 1987, p. 142). They are valued for their ability to connect people with places and enhance the beauty of the built environment. Famous greenways such as Washington, D.C.'s Rock Creek Park are prominent examples of planned greenways that improve cities and the quality of life for their residents (Economic Benefits of Trails and Greenways, 2000)

The development of greenway networks in America has been somewhat controversial, and disagreement as to their potential impacts on the value of nearby properties is a prominent element in the debate. Proponents of greenways argue that the presence of such facilities offer a host of benefits to surrounding communities. These benefits may include preservation of critical open space that provides natural buffer zones protecting streams, rivers, lakes, and wildlife from pollution run-off, while simultaneously improving water quality and mitigating flood damage, and dually serving as a public place for outdoor recreation. In addition to the environmental, social, aesthetic,

recreational, and health advantages offered by generic types of public open space, the linear nature of greenways enables them to offer routes for alternate modes of transportation, which is an especially useful asset in congested urban areas. As a result of these benefits, supporters argue, greenways are likely to increase nearby property values and consequently augment property tax revenues (Economic Benefits of Trails and Greenways, 2000; Crompton, 2002; Nichols, 2005).

However, opponents of greenways feel that the potential benefits of greenways are overshadowed by the perceived association of negative externalities. Opposition to greenway development stems from fears that they are conducive to invasion of privacy of those residents whose properties directly adjoin greenways, that they increase traffic from 'unwanteds' and strangers, and fears of increased noise, littering, trespass, vandalism, and other crime and anti-social behavior. As a result, opponents claim that greenways will cause property values to decline and may adversely affect the greater property tax base (Crompton, 2002; Nichols, 2005).

Although the perceived advantages and disadvantages of greenways are easy to state rhetorically, they are often difficult to quantify. A lot of the evidence both supporting and rejecting the provision of greenways remains anecdotal, and a need exists to substantiate verbal claims with hard quantitative evidence (Doherty, 1998; Cinoman, 2000). Though urban open spaces traditionally have been publicly provided amenities for which no price has been established in the market, they are increasingly being evaluated in terms of their dollar contributions to communities (Correll et al., 1978; Crompton, 2001). When a greenway or open space is provided at a cost to taxpayers, the ability to demonstrate that an economic return will be realized, and that such amenities can be viewed as investments, not sunk costs, is extremely important for planning agencies. Unless the benefits of greenways and open space, both tangible and intangible, can be quantified, it is unlikely that such amenities will be perceived as the "highest and best" use of any developable land. Therefore, it has become necessary for local governments to investigate and reevaluate ways of monetizing the value of greenways as well as other types of public open space.

The purpose of this paper is to attempt to determine and quantify the impact greenway proximity on single family home sale prices. This study examines a portion of the Capital Area Greenway, located in Raleigh, North Carolina, and its effects on home sale prices in the surrounding neighborhood. The findings will add to the growing body of knowledge from which local governments and citizens can utilize to assess the quantitative benefits of greenways throughout the country. This study is similar to existing ones that make use of hedonic modeling and various geographic information systems (GIS) techniques, but it differs by focusing on a unique geographic area and can hopefully be replicated in other greenway-proximate neighborhoods. Due to time and data limitations, this study will only examine general correlations between home sale price and greenway accessibility, and will not investigate causality.

The following section includes a review of the existing literature on the relationship between greenways and open space, and property values. Following that is a section on this study's data, methods, results, limitations, discussion, and recommendations for future research.

Literature Review

Although there is a growing amount of work focusing on the impact of public parks and generic open space on property values, literature relating to the proximate impacts solely of greenways is sparse. However, because greenways are a special type of open space, and share some of the perceived benefits and criticisms of generic open space, I have decided to review literature on both greenways and broader forms of open space. First reviewed is the pertinent literature specific to greenways which is then followed by a review of related studies on broader forms of open space.

Studies on the effect of greenways on property values

One of the first studies to analyze the influence of greenways on property values is also one of the only few to calculate their actual dollar impacts on sales prices using the

hedonic method. Correll, Lillydahl, and Singell's (1978) examination of property values within 3,200 feet of three greenbelts (containing trails) in Boulder, Colorado, discovered that, on average, property values fell $4.20 with for every foot of distance away from a greenbelt. Distance was measured in terms of walking distance, "using the most direct public access", estimated by examining city maps. The average price of a property adjacent to a greenbelt was $54,379, while the average at a distance of 3,200 feet from such an amenity was only $41,206. Unfortunately, these aggregated figures obscured substantial differences in results among the three trails. While the decline in value with each foot from the amenity was a significant $10.20 in one case, in the second the $3.00 decline per foot was insignificant, while in the third a significant increase of $3.40 per foot from the trail was found. These differences were somewhat explained by the timing and planning of the greenbelt purchases in relation to residential construction around them. In the first case (the $10.20 decline), the greenbelt had been established for four to seven years at the time of the analysis, and had preceded residential development. Moreover, development was planned to take maximum advantage of the greenbelt in terms of neighborhood design and the position of houses relative to the greenway corridor. However, in the third case (the $3.40 increase), the greenbelt was relatively new and separated from nearby residences by a major access road. This road, though not specifically incorporated into the regression analysis, may have been considered a significant nuisance by nearby residents. Therefore, the positive relationship between distance from the greenbelt and property value may well have reflected the negative impact of proximity to the road rather than any negative impact of the greenbelt. Nevertheless, the research ended up concluding that the total value of the first greenway adjacent neighborhood observed was $5.4 million more than if there had not been a greenbelt present. In this case the authors extrapolated that additional annual property tax revenue generated as a result of the greenbelt amounted to $500,000- enough to repay the cost of the greenbelt purchase over the course of a few years. Policy recommendations at the end of the study indicate that a key future issue will be determining how jurisdictions divvy up greenbelt costs and benefits as greenbelt effects spread regionally.

A more recent study on the effects of greenway proximity on property values comes from Nicholls and Crompton (2005) who examined home sale prices throughout three neighborhoods, Barton, Lost Creek, and Travis, in Austin, Texas in 2002. All three neighborhoods were sited in relative proximity to the Barton Creek Greenbelt and Wilderness Park, which is a 1,771-acre natural area containing 7.5 miles of trails, parking, and bathroom facilities, and is close to downtown Austin. The authors conducted their analysis using the hedonic method, operationalized through multiple regression. Sales price adjusted to constant 1999 dollars was used as the dependent variable, while distance to the greenbelt, along with several other factors that may influence home sale price, were included as independent variables. The value of the greenbelt was measured in two ways- 'view of greenbelt' and 'adjacency to greenbelt', were dummy variables used to capture aesthetic value, and 'distance to greenbelt entrance' was a continuous variable used to capture the recreation and transportation value to nearby residents. The authors felt that aesthetic value and physical proximity value were essentially measuring two sides of the same amenity, and therefore the variables were analyzed in separate regressions. All distances were measured using the existing street network. The study's results were mixed. In the Barton neighborhood, a property's location directly adjacent to the greenbelt was associated with a whopping $44,332 rise in property value that was statistically significant. The variable representing the view of the greenbelt was not statistically significant, and distance to the nearest greenbelt entrance had no significant impact on property prices. The results from the Lost Creek neighborhood produced opposite results. Adjacency to the greenbelt had no significant impact on sales value, but as expected, prices fell a significant $3.97 per each foot further away a home was to the nearest greenbelt entrance. Also, in this neighborhood, view of the greenbelt was an insignificant factor. In the Travis neighborhood, direct adjacency to the greenbelt had a significant positive impact of $14,777 on home sale prices. The view variable was not applicable in this neighborhood because the topography disallowed any real vistas from non-adjacent properties. Also, in this neighborhood, distance to nearest greenbelt entrance was found to be insignificant. An additional analysis was conducted using quarter-mile buffers from the greenbelt entrance out to a radius of 1 mile, essentially creating bands for which homes located within could be attributed a dummy distance

variable. In the Barton and Travis neighborhoods, none of the distance bands were statistically significantly. However, in the Lost Creek neighborhood, location within the first quarter mile band closest to the greenbelt entrance was associated with a statistically significant increase in home sale price of $46,086; and properties located between three quarters and one mile away experienced a significant increase of $28,715, but properties in the one-quarter to one-half mile band were associated with statistically significant declines of $45,384 in value. Much speculation is given to the unexpected and seemingly bizarre results of the analysis. The authors posit that in the case of the Lost Creek neighborhood, steep slopes and thick vegetation could be responsible for the lack of a positive impact of greenbelt adjacency. They believe that this would make sense because in the other two neighborhoods, where greenbelt adjacency has a positive impact, topography is less steep and vegetation is thinner allowing easier access to trails via informal entrance paths. In the Barton neighborhood, the lack of a significant distance-to-greenbelt entrance impact could be attributable to the neighborhood's proximity to downtown and other various green spaces scattered throughout the neighborhood. The authors did find a significant impact from distance to a pedestrian bridge to downtown and therefore think that benefit provided by the bridge along with separate green spaces have diluted the value of greenbelt proximity. Results of the Travis neighborhood were explained due to fact that distance to the greenbelt entrance was really a negligible measure since the greenbelt could easily be accessed from virtually any area along the greenbelt- more so than in the other neighborhoods where entrance points were truly limited due to physical obstacles. Total monetary benefits from the greenway's impact on homes in the Barton and Travis neighborhood were calculated to be $13.64 million.

In 2002, the city of Surrey Parks, Recreation, and Culture department undertook a study to determine whether or not single family homes adjacent to greenways are financially benefiting from their location (Hobden et. al, 2002). A matched pair study was used to analyze the value effects of greenway adjacency in 3 different neighborhoods in British Columbia, Canada. The study examined data from 1980 to 2001 to see the change in home sale prices for homes sited next to a greenway and similar homes that were not adjacent to a greenway. 32,595 non-subject property sales and 1,792 subject property

sales were collected; the non-subject sales represented roughly $6.4 billion of sales volume and the subject sales comprised roughly $363 million in sales volume. The authors attempted to investigate crime data to determine if a correlation existed with the greenways in question, but crime time data did not match temporally with the study's time frame. The authors do note that they did conduct a superficial analysis of crime information and there appeared to be no direct correlation with subject properties. Greenways present in each of the study neighborhoods varied within and throughout, and were assigned labels according to their characteristics. For the study neighborhoods in aggregate, the authors found a significant increase in the value of homes bordering GREENWAY A (label for a "pure park" greenway that has no trail, no easements, and no overhead power lines) and GREENWAY BP (label for a greenway containing only a pathway). However, a significant decrease in value was found for homes bordering greenway type GREENWAY AE (label for greenways similar to type A except they contain small easements). Other types of greenway borders were found to exhibit no significant effect on the value of adjacent single-family properties. The authors note that about nine individual properties bordered the greenway labeled as GREENWAY AE, which was largely overgrown and portions made not passable, at the time of observation. They speculate that the negative impact upon value may be attributable to deferred maintenance of the greenway as opposed to the small existing easements. Analyzing the value of a greenway border during different time periods revealed that the value of a greenway border had increased over the past 21 years (accounting for inflation), though not as fast as the average value of single-family property.

Writing in her Masters Project, Love (2005) investigated whether or not the presence of a greenway affects the occurrence of crime to properties adjacent to it. She conducted a matched pair study examining three greenways in Chapel Hill, North Carolina and analyzed crime data for times both before and after the construction of each greenway; the time frame for the data analysis ranged from the mid-1990s to early 2000s. The matching of control areas to study areas was completed solely based on median household income data from the U.S. Census at the block group level. Crime data was gathered from the local police department and geocoded for all of the years investigated;

the total number of reported crime incidents amounted to 35,230. Using a kernel estimation method, the author was able to create a smooth estimate of crime intensity over time over specific areas. Comparing changes over time between the control and study areas, the study's results showed that two of the three greenways (Booker Trail and Dry Creek Trail) appeared to have no influence on the rate or location of crime, but in one case (Bolin Creek Trail phase II), the density of crime in the vicinity of the greenway increased by 12 percent after the opening of the trail. Interestingly enough, in the Bolin Creek phase II trail control area, crime incidents per square kilometer increased even more dramatically. Love speculates that the reason for this could be that the socioeconomic improvement in the Bolin Creek phase II study area counteracted part of the greenway's negative effect. Although, the author reveals that in this case there was a higher proportion of crime occurring on greenway-adjacent parcels after the greenway was completed, but the evidence supported a general correlation, not a causal one. The main limitations of Love's study included: the use of only reported crimes (a data limitation), examination of only three cases which do not make assertions of causality, and the size of the study and control areas were much too large for all parcels to be affected by the greenway (this was another data limitation since relevant data was not available at the Census Block level). All in all, the results ultimately provided reassuring information for concerned residents as the majority of greenways studied showed no adverse impact on crime levels.

Other relevant studies on the effect of open space on property values

John Crompton (2005) published an extensive literature review summarizing all of the modern day findings on the impact of parks, including some greenways, on property values. Crompton believed that a new literature review was needed because within the past couple of decades, new innovations in data collection and analysis have emerged that more accurately describe and measure property characteristics than past methods. These three innovations include: increased sophistication of the hedonic method and associated statistical tools, the rise of electronic Multiple Listing Services in the 1980s, and the advent of geographic information systems (GIS). The empirical evidence from 20 of the 25 studies reviewed supported the premise that parks and open space contributed to

increasing proximate property values. In four of the five studies that did not support the proximate principle, it was suggested that the ambivalent findings might be attributable to methodological limitations. The support extended beyond urban areas, to include properties that were proximate to large state parks, forests and open space in rural areas. Also, the conventional wisdom that creating large state or federal park or forest areas results in a net reduction in the value of an area's tax base was not supported. Parks embracing primary active use recreation areas showed much smaller proximate increases than those accommodating only passive use. Crompton suggests to decision-makers that a generalizable estimate to measure potential benefits of a park on property values is a 20 percent positive impact on fronting or abutting properties. Based on the literature, the estimated distance over which the proximate impact of a park or open space reaches is substantial up to 600 feet away. Though in the case of large community-sized parks the estimated effect is extended to 1,500 to 2,000 feet, but after 600 feet the premium tends to be smaller. Some of the common limitations shared by the studies are that the analyses fail to capture the greater public benefits beyond those that arise from home proximity including: water supply protection, reduction in soil erosion, wildlife habitat preservation, attracting visitors and businesses to a community, etc., and another limitation is that existing studies have not address impacts of open space on non-single family homes. Regardless of study limitations, their results are still useful for informing park advocates and decision makers about the monetary value of parks.

Smith et al. (2002) examined a 30 year history of home sales data in northern Raleigh, North Carolina, and used the hedonic method to analyze the affects of fixed versus adjustable open spaces on home sale price. By comparing the changes in estimates of the effects of proximity to different types of land uses on property values over time, the authors hoped to be able to evaluate whether the distinctions between fixed and adjustable land uses help in measuring the incremental value of open space amenities. Fixed use open space was categorized into three parts: public open space (including greenways), private golf courses, and the right-of-way corridor for Interstate Highway 540. Adjustable land uses were defined as land designated as agricultural and forestry, as well as undeveloped or vacant land. Their study sample included 19,637 residential

properties sold between 1980 and 1998 [filtering out "land sales; transactions likely to be other than 'arms-length' sales identified as below the 1st percentile and above the 99th percentile in price; transactions where the square footage of the house is below the second percentile or where the age of the home is unknown", (Smith, 2002 p. 115)]. In the study area 76% of the parcels were residential uses, but covered only 19% of the study area, while public open space represented roughly 2% of the parcels but covered 23% of the study area; and the majority of the private open space, 8% of parcels and 27% of coverage, was vacant land. Ordinary Least Squares and Box-Cox models were used to adjust for change in prices over time and a hedonic model was used to determine the effects of five structural variables including: square feet of living space, number of bathrooms, lot size in acres, age of home; and the effects of several spatial relativity variables including: distance to forest, distance to agricultural land, distance to closest vacant land in the year of the home sale, distance to closest public land, distance to closest golf course, and distance to I-540 on the sale price of homes. All distances were measured based on a straight line assumption. The authors hypothesized that proximity to fixed types of open space would have different effects on property values over time than proximity to adjustable types of open space due to the inherent perception of land use expectations. Results of the empirical analysis showed that the proximate effects of golf courses and other types of private open space proved to generally have a negative correlation with sale price, as expected. Over time, as open space became developed and scarcer, the effect of private open space on prices went from being insignificant to statistically significant; except in the last time period (1996-1998) when estimated marginal values were actually lower than in earlier periods despite increased scarcity of open space. The authors suggest that this phenomenon may reflect the potential for conversions and reductions in amenities provided by private open space. Surprisingly, over time, the effect of distance to public open space provided consistent significant negative impacts to property values; this effect was also present across sub-periods. The authors explain that this finding, contrary to popular belief and prior research, could be due to two potential factors. They believe that their distance measure (straight line distance to closest open space) may not adequately reflect the relative benefit of proximate open space perceived by home owners. They suggest that measuring the

percent of undeveloped land surrounding each home may be a better method of assessing value, however it would be difficult to determine what parcels to include, and the technique would not account for fixed versus adjustable status. Disamenities near open spaces could be the other reason responsible for the result, as negative land use sources could overpower the positive benefits potentially realized by public open space. The authors checked this possibility and found no explanatory land uses. In the I-540 case, results were as expected. In the early period, when the loop corridor was vacant, distance had a significant negative effect on property values. In later periods, as the highway begins to be constructed, distance reflected a significant positive effect; the I-540 corridor became a disamenity. The qualitative variable for being adjacent to the corridor displayed an insignificant effect for all of the sub-periods. Results for adjustable land uses also revealed a change of property value effects over time. In the early time period, undeveloped land had no effect on sales prices. Beginning in 1990, the effect of distance became negative and statistically significant, and the effect of adjacency to vacant land was positive and statistically significant in most sub-periods. The value benefit fluctuated though. Proximity to undeveloped land increased the real sales price of a home by approximately $2.30 per foot for the 1996-1998 sub-period, was half that value in the 1990-1995 period, and about the same amount in the 1985-1989 period, despite increased scarcity. The fluctuation was expected, as the authors believed that it reflects both the importance of open space and the changed expectations about the likely future uses of vacant lands. The study concludes that the results support the contention exploring fixed and adjustable open spaces, but future research should strive to develop a better index for interpreting how home-buyers perceive open space.

Methods

Research Design

In choosing an analytic method for this study it is important to note that the value sought in this case, in economic terms, is a shadow price. A shadow price is a price imputed to a good, service, or resource that is not priced by the marketplace or that is incorrectly priced by the market. The home market does not price "property in proximity to a greenway" because it only comes bundled with all the other characteristics of single-family dwellings. "Proximity to greenway" is not and cannot be sold as a separate entity because it is an immobile feature of land use. (Hobden, 2001).

In the past, economist have developed and adapted various statistical methods to study and measure shadow prices for the purposes of policy analysis. One common method is referred to as 'hedonic pricing' (Griliches, 1972). Another common method is referred to as 'matched pairs.' These two methods offer different ways of controlling for non-greenway differences in the sample of property sales. By doing so, the effect of proximity to greenway on properties is isolated. This research only makes use of the former technique.

The hedonic model is conducted through the use of classical multiple regression techniques in which prices of a good (single family homes in this case) are regressed on measures of its attributes. Regression coefficients can be interpreted as implicit marginal prices of, or willingness to pay for, these attributes. According to the hedonic approach, the factors that influence property prices can be divvyed up into six broad groups of characteristics that include: 1) Physical or structural features of the individual property, which include features such as number of bedrooms, square footage of home, lot size, age of house, existence of a garage, etc.; 2) Neighborhood conditions, which include things such as socio-economic characteristics of neighboring residents, quality of neighboring structures, neighborhood demographics, and ownership/rental rate; 3) Community conditions, which include school district and tax district; 4) Spatial location factors, which include factors such as proximity and accessibility to various amenities including

highways, schools, shopping centers, churches, airports, parks, public transit, etc.; 5) Environmental factors, which include pollution levels, location within a floodplain, noise levels, vistas, etc.; and 6) Macroeconomic market conditions at the time of sale, which includes month and year of sale, and number of days on the market (Nicholls, 2005). The price of a property at any point in space and time is a result of interactions between multiple individual attributes within each of the six broad groups of influences. The regression model used to empirically estimate attribute prices is:

$$P = \beta_1 + \beta_S X_S + \beta_N X_N + \beta_C X_C + \beta_L X_L + \beta_E X_E + \beta_T X_T + \mu$$

Where: ***P*** represents the dependent variable, observed home sale prices; $\mathbf{X_S}$ is the vector of structural attributes; $\mathbf{X_N}$ is the vector of neighborhood attributes; $\mathbf{X_C}$ is the vector of community attributes; $\mathbf{X_L}$ is the vector of spatial location attributes; $\mathbf{X_E}$ is the vector of environmental attributes; $\mathbf{X_T}$ is the vector of time attributes; $\boldsymbol{\mu}$ represents the stochastic disturbance term; $\boldsymbol{\beta_1}$ represents the constant term; and $\boldsymbol{\beta_x}$ represent estimates of relevant attributes' implicit marginal prices after differentiation. The specific attributes selected in this model are addressed later on when study area variables are discussed.

Study Area

The study area for this research is the Buckeye Trail, a 3-mile long greenway located in the southeast quadrant of the city of Raleigh, North Carolina. Raleigh, the capital of North Carolina, is growing and urbanizing at a rapid rate, has a well established greenway plan in place, and is regionally accessible which makes it an ideal candidate study location. Buckeye Trail is actually only a small segment of the city's larger, and growing, greenway network known as the Capital Area Greenway. The Capital Area Greenway plan and commission began in 1974 in response to new concerns over rapid growth and

urbanization; the greenway system is currently 54 miles long and covers roughly 3,000 acres of land (City of Raleigh Parks and Greenway Planning and Development, 2008). Buckeye Trail, completed in 1980, measures roughly 2.5 miles and meanders alongside Crabtree Creek, located just north of the trail. Crabtree Creek is a major body of water in the county; it flows through multiple municipalities, acts as a primary tributary to the Neuse River, and is home to some of Raleigh's most exotic wildlife (City of Raleigh Parks and Greenway Planning and Development, 2008). The neighborhood bordered by the greenway, from which home sale prices are analyzed, does not have an official name, but it is a relatively compact and uniform area that has clear physical boundaries, and is further defined by the Census as Census Track 519. According to the 2000 Census data, Tract 519, in the year 2000, contained a total of 1,426 single-unit detached homes, most of which were built between 1940 and 1970; and the majority of year 2000 residents moved into their homes between 1995 and 1998. The majority of homes have only one vehicle available. The population was composed primarily of middle-lower income homeowners- the mode price for owner-occupied units was in the range of $50,000- $99,999, the median annual household income was $37,098, and 13.2 percent of families lived below the poverty level. Track 519 is delineated by two arterial roads- New Bern Avenue and N. Raleigh Boulevard, to the east and to the west, respectively, which eventually converge towards the southern portion of the study area. Roughly 12 feet wide, the paved trail itself is buffered by several feet of thick foliage and at times steep topography making it very

difficult to access the trail in places other than the designated entrance points. There are three designated entrance points: one located on N. Raleigh Blvd., one located in the middle of the study area neighborhood along Culpepper Road, and a third located close to New Bern Ave., alongside Milburine Road. There are no formally designated, or informal, automobile parking facilities located near either the N. Raleigh Blvd. entrance or the Milburnie Rd. entrance. At the Culpepper Rd. entrance (the middle entrance) there is the potential for on-street parking, but no formally designated parking spots exist for the greenway. North of the trail flows Crabtree Creek, and north of the creek there is an access road flanked by light commercial and light industrial development. Running parallel north of the industrial service road is Interstate Highway 440, which is part of the beltline bypassing downtown. Based on a site visit, I observed that the greenway appears to be well maintained; the trail is clear of debris, and the paved pathway is smooth and even throughout. However, I did notice occasional spots of litter visible in the surrounding foliage and around edges of the creek comprising mainly plastic grocery bags and rags, but there was also an abandoned moped partially buried under some brush. There are also large manholes protruding from some portions of land bordering the trail, which I assume to be part of a water/sewer easement. At the Culpepper Rd. entrance there exist a small open field to the side of the paved path that could be used for picnicking or other light recreation, but it was too small to use for any organized sport. Aside from this, there were few other user amenities- there only a couple of benches, no useful way-finding signage surrounding the greenway, no water fountains, and no emergency call boxes. Figure 1 depicts an aerial view of the study area and Figure 2 displays a GIS map of the study area.

Buckeye Trail Study Area

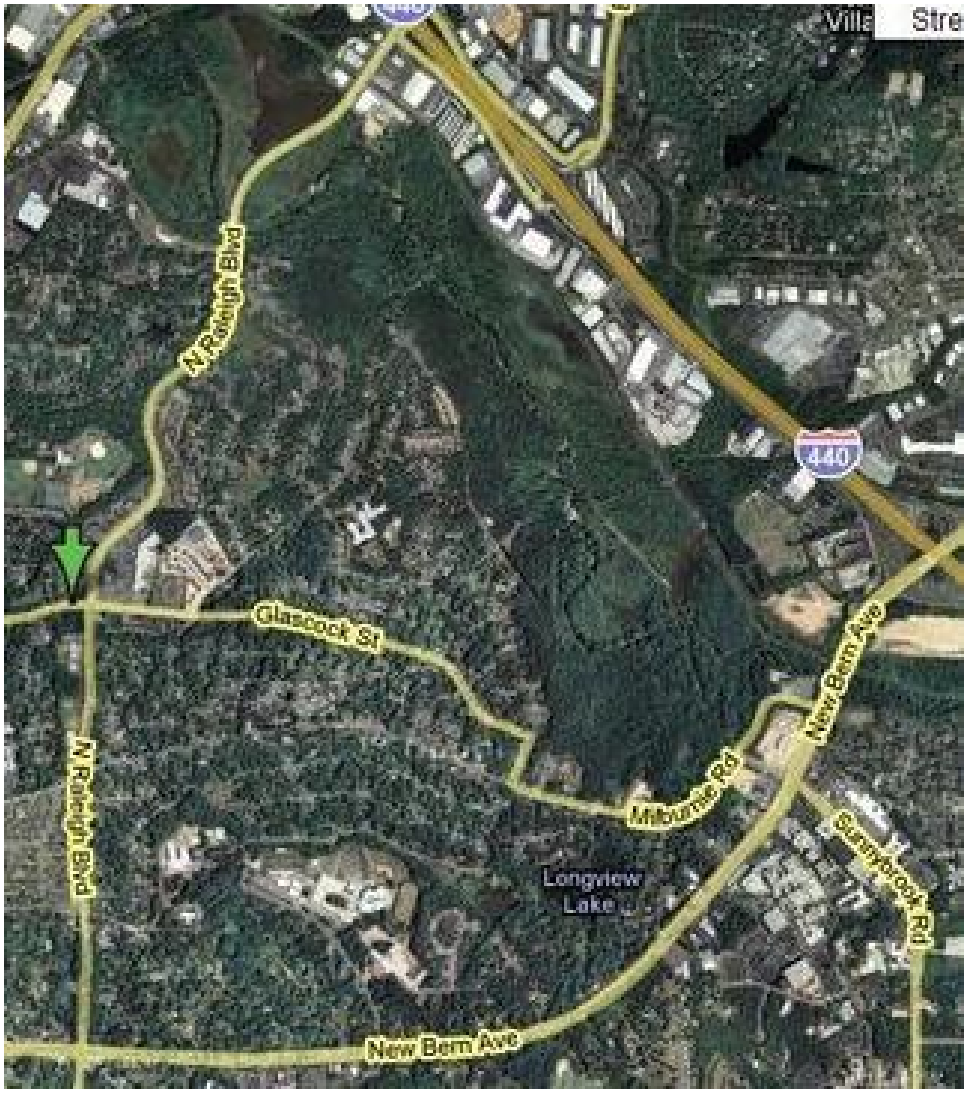

Figure 1: Aerial image of the Buckeye Trail study area. (Source: Google 2008)

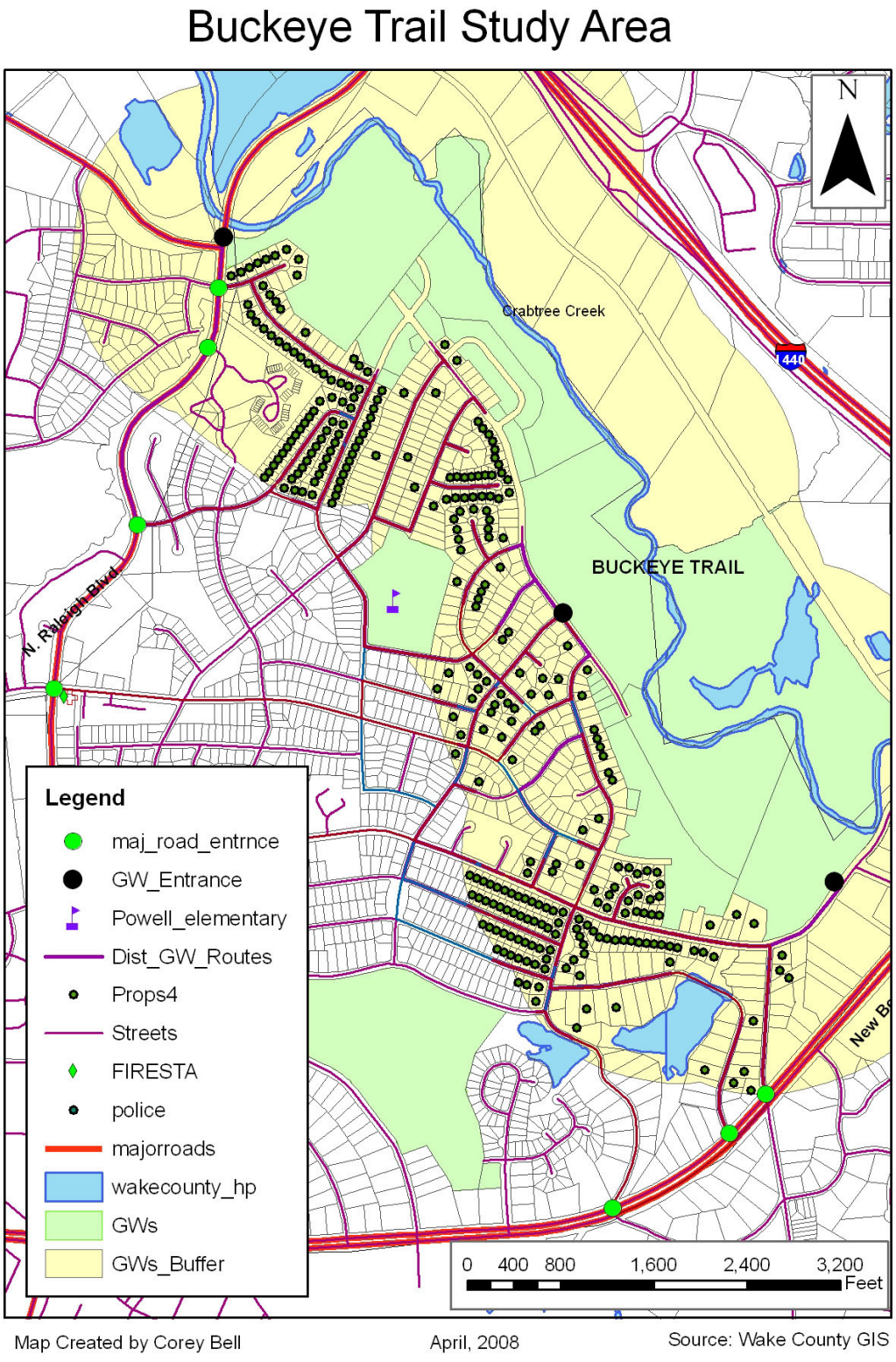

Figure 2: Buckeye Trail study area. 'Props 4' are the homes analyzed. The paved trail runs roughly parallel to Crabtree Creek.

Variables

Dwelling units were filtered in order to obtain as homogenous of a sample as possible. I filtered parcels such that every home analyzed met a degree of uniformity. All homes share the same design style (conventional), the same land class (residential), the same type/use (one family), the same APA activity code (household), the same APA function code, indicating the economic use of the land (private household), and all homes analyzed have sale data post 1980, the year when the Buckeye Trail was completed. Also, because of the depth of Census Tract 519, I decided to narrow the study area down by creating a quarter-mile buffer around the greenway, as I feel that this is the maximum distance for which potential homes could be located away from the greenway and still legitimately benefit from its presence. In other words, because this study is chiefly an examination of greenway benefits that relate to proximity, which implies that those specific benefits can only be achieved by accessing the greenway (e.g. in order to enjoy its natural surroundings, use it for exercise, and or travel on it) then I posit that only residents within walking distance (considered here to be approximately a straight line quarter-mile) to the greenway have the potential to enjoy those accessibility benefits. I believe that there are other benefits to homes outside of a quarter-mile, as supported by other studies, but measuring these non-accessibility based benefits is outside the scope of this work. Home sale price, adjusted to constant 2007 dollars, is used as the dependent variable. Independent variables fall into the categories of structural, spatial, and environmental factors. Although many structural variables exist in reality, for this study, only structural variables available from the data provider, Wake County government, were used. Environmental and spatial variables primarily pertain to the greenway, but other local amenities and disamenities were also included. Table 1 provides a summary of all of the variables used in the study and their predicted coefficient sign.

Table 1: Description of Dependent and Independent Variables

Variable Name	Variable Description	Expected Sign on Coefficient	Type of Variable
Constant_s~s	Home sale price in constant 2007 dollars	N/A	Continuous
Deed_acres	Property lot size in acres	+	Continuous
Heatedarea	Heated area of the house in square feet	+	Continuous
Utilities	Utility level of home (either 'All' or 'WSE-Water, Sewer, Electricity')	+	Discrete
Year_built	Year in which the home was constructed	+	Continuous
Totunits	Total number of units on the property	+	Continuous
Distance_t~w	Distance to greenway entrance by way of the street network (in feet)	-	Continuous
Dist_to_sc~l	Distance to Powell Elementary School by way of street network (in feet)	-	Continuous
Dist_to_ma~d	Distance to the intersection of a major road via the street network (in feet) (i.e. N. Raleigh Blvd. or New Bern Ave.)	+[1]	Continuous
Culdesac	Homes located in a cul-de-sac	+	Discrete
Corner_lot	Homes located on a street corner lot	-	Discrete
Adj_to_gw	Homes located abutting Buckeye Trail or forestry surrounding greenway	+	Discrete
Adj_to_majrd	Homes located adjacent to a major road (i.e. N. Raleigh Blvd. or New Bern Ave.)	-	Discrete

[1] The sign for this coefficient could potentially be (-) if people perceive accessibility to a major road more valuable than not. It is possible that a person would want to locate close to a major road for accessibility, but at the same time not want to live adjacent to it.

Hypothesis

My null hypothesis (H_0) is that proximity to the nearest Buckeye Trail entrance via the street network (continuously) or direct adjacency to any part of the tail (discretely) has no effect on home sale price, and my alternative hypothesis (H_A) is that proximity to Buckeye Trail does have a significant impact on home sale price.

Descriptive Statistics

Summary statistics are provided in the following table. The ranges for sale price (constant_s~s) may appear a little extreme but the values are in fact accurate. Also, it is interesting to see that the range for distance to greenway entrance (distance_t~w) is from roughly 550 feet at the minimum to almost 1 mile at the maximum- even though all of the properties examined were within a quarter-mile straight line buffer from the edge of the greenway.

Table 2. Summary Statistics for all Variables.

Variable	n	Mean	Standard Dev.	Min.	Max
Sale Price	222	110305.5	35138.8	10956.2	341272.6
Deed Acres	222	.298153	.1715901	.16	1.6
Heated Area	222	1241.32	377.72	816	3136
Utilities	222	.9819	.133317	0	1
Year Built	222	1968.35	17.6241	1920	2006
Total Units	222	1.00045	.0671156	1	2
Distance to GW Entrance	222	2630.995	1167.386	552.99	5149.86
Distance to School	222	3170.443	1323.37	1024	7076
Distance to Major Road	222	2960.122	1237.59	60.29	5159.75
Cul-de-sac	222	.108108	.3112186	0	1
Corner Lot	222	.103603	.3054343	0	1
Adjacent to GW	222	.13063	.3377575	0	1
Adjacent to Major Road	222	.009009	.0947008	0	1

Regression Analysis

Standard multiple regression procedures were used with the aid of STATA to carry out the hedonic method. Matrices used to check for collinearity between independent variables can be found in the Appendix. Table 3 displays the regression results from the model using the continuous distance variable to measure proximity to the nearest greenway entrance. Table 4 displays results from the model using the discrete variable of greenway distance to measure greenway proximity. The independent variables were regressed against the log of the home sale price in order to assess change in the dependent variable in terms of percentage change per unit change in independent variable.

Table 3. Regression Results: Distance to GW measured as continuous variable

Source	SS	df	MS
Model	1.96828966	11	.178935424
Residual	3.20410383	210	.015257637
Total	5.1723935	221	.023404495

Number of obs =	222
F(11, 210) =	11.73
Prob > F =	0.0000
R-squared =	0.3805
Adj R-squared =	0.3481
Root MSE =	.12352

log_sale_p~e	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
deed_acres	.1136412	.0597339	1.90	0.058	-.0041136	.2313961
heatedarea	.0001548	.0000273	5.68	0.000	.0001011	.0002086
utilities	-.0300733	.0677333	-0.44	0.658	-.1635976	.1034511
year_built	.0032387	.000601	5.39	0.000	.0020538	.0044236
totunits	-.0382096	.1274882	-0.30	0.765	-.2895303	.2131111
distance_t~w	2.45e-06	8.07e-06	0.30	0.762	-.0000135	.0000184
dist_to_sc~l	1.38e-06	6.97e-06	0.20	0.843	-.0000124	.0000151
dist_to_ma~d	-2.70e-06	7.55e-06	-0.36	0.721	-.0000176	.0000122
culdesac	.0006792	.0312288	0.02	0.983	-.0608828	.0622412
corner_lot	.0204685	.0288035	0.71	0.478	-.0363127	.0772496
adj_to_majrd	.0938537	.0964226	0.97	0.331	-.0962265	.2839339
_cons	-1.519643	1.187014	-1.28	0.202	-3.859634	.8203474

Table 4. Regression Results: Distance to GW measured as a discrete variable

Source	SS	df	MS	Number of obs =	222
				F(11, 210) =	11.72
Model	1.96753612	11	.17886692	Prob > F =	0.0000
Residual	3.20485738	210	.015261226	R-squared =	0.3804
				Adj R-squared =	0.3479
Total	5.1723935	221	.023404495	Root MSE =	.12354

log_sale_p~e	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
deed_acres	.1137374	.0602233	1.89	0.060	-.0049822	.232457
heatedarea	.0001543	.0000272	5.67	0.000	.0001006	.0002079
utilities	-.0339481	.0662673	-0.51	0.609	-.1645825	.0966862
year_built	.0033127	.0005735	5.78	0.000	.0021822	.0044432
totunits	-.037387	.1274548	-0.29	0.770	-.2886418	.2138677
dist_to_sc~l	1.44e-06	6.96e-06	0.21	0.836	-.0000123	.0000152
dist_to_ma~d	-2.74e-06	7.61e-06	-0.36	0.719	-.0000178	.0000123
culdesac	-.0000168	.0311963	-0.00	1.000	-.0615148	.0614812
corner_lot	.0207331	.0287914	0.72	0.472	-.0360241	.0774902
adj_to_gw	-.0054883	.0265308	-0.21	0.836	-.0577891	.0468125
adj_to_majrd	.0930098	.0963871	0.96	0.336	-.0970004	.28302
_cons	-1.654477	1.14203	-1.45	0.149	-3.905789	.596835

Based on the calculated coefficients, the regression model for estimating home sale price, when greenway proximity is factored as a continuous variable, will take the form of:

Log (Home Price, 10) = -1.5196 + 0.11364(property acreage) + 0.00015(heated area of home) -.03007(utility setup) + 0.00323(year built) – 0.0382(total number of units on property) – 0.00067(cul-de-sac situated) + 0.0288 (corner lot situated) + 0.00000245 (distance from greenway entrance) + 0.00000138(distance from Powell School) - 0.0000027 (distance to major road) + 0.938(if adjacent to major road)

Surprisingly, this means that, holding all other independent variables constant, a home's sale price decreases by 0.00245 percent for every foot closer it is to its closest Buckeye Trail entrance point, measured along the street network. The same is true for the other coefficients- holding all other independent variables constant, for every additional acre a property has, its sale price increases by 11.3 percent and for every year younger a house is, its sale price increases by 0.323 percent, and for every additional square foot of heated area in a home, it its sale price sees an increase of 0.015 percent. However, two of the three structural variables just mentioned, 'heated area of home' and 'year built', are the only variables that were found to be statistically significant under a 95 percent confidence level. The same variables are also the only ones that hold statistical significance in the second model, where proximity is characterized by a discrete variable. The coefficient for 'distance to greenway entrance', along with the other variables not mentioned, is not

statistically significant because its p-value. The p-value for the 'distance to greenway entrance' variable is 0.762, meaning that there is roughly a 76 percent chance that its derived coefficient and t-statistic would have come up in a random distribution. Because of this, I cannot reject my null hypothesis that proximity to Buckeye Trail has no affect on home sale price. However, the p-value for the equation as a whole is 0.00000 meaning that the entire equation itself is statistically valid. Although this is beneficial for verification that the model's combined coefficients are correlated with home sale price, it does not necessarily indicate that the model is good for prediction. For indication of usefulness for prediction we look at the R-squared value. The R-squared value in this case is 0.3805, which means that the independent variables account for only roughly 38 percent of the variation in home sale prices. Because R-squared is so low, this lets us know that the model should not be used for prediction purposes. The adjusted R-squared value, which is close to the regular R-squared, indicates that about 35 percent of the variation in home sale prices are explained by the model, even after taking into account the number of predictor variables used. Figure 3 and Figure 4 display a scatter plot and best fit line for relationship between the sale price and distance from trail entrance, and the log of home sale price. The best fit line is very horizontal confirming the weak positive correlation calculated in the regression.

Figure 3: Scatter plot with best fit line for distance measured as a continuous variable The Y-axis indicates home sale price in constant 2007 dollars.

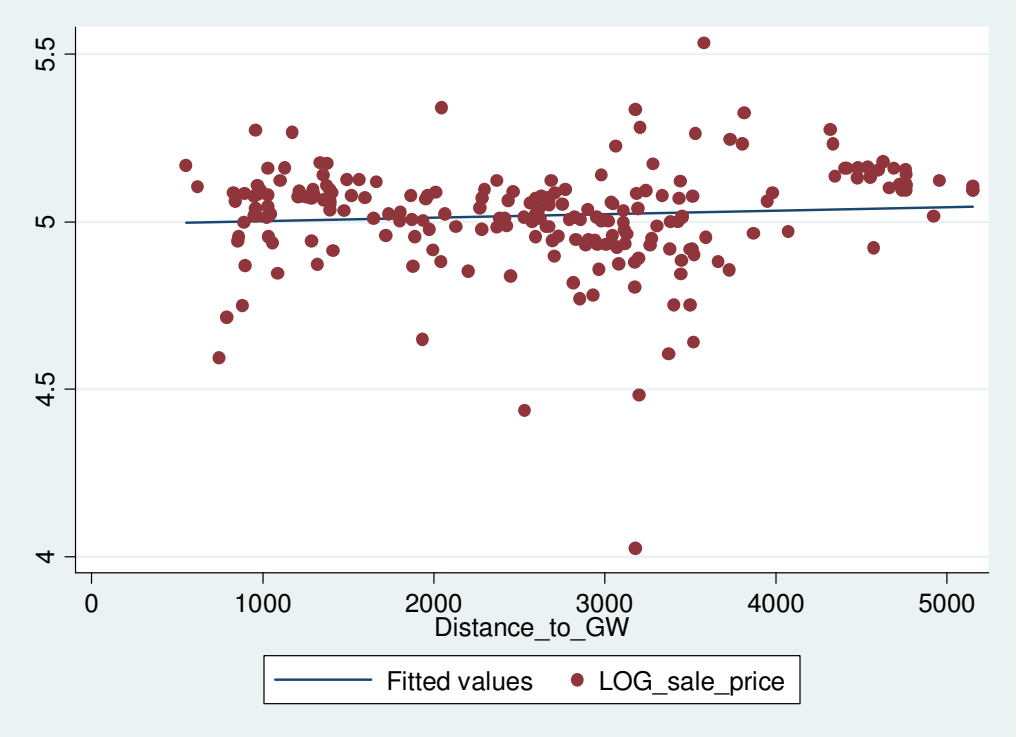

Figure 4: Scatter plot with best fit line for distance measured as a continuous variable The Y-axis indicates the log of home sale price.

Discussion

The regression results raise numerous questions about their occurrence. Firstly, surprisingly, several of the coefficients calculated ended up having the opposite sign than expected. This is especially curious for the primary exploratory variable in question-distance to greenway entrance. There are several reasons why proximity to the closest Buckeye Trail entrance may have resulted in a positive coefficient, meaning that the closer a home is to the trail entrance, the lower its sale price. My initial reaction to this was to blame the location of the greenway entrances. If you recall from the previous maps, there are only 3 designated entrances from which people can access the greenway, two of which essentially coincide with the potential disamenity of a major road; that disamenity stemming from traffic noise, speed, congestion, and loss of natural scenery. In fact, for residents closest to the westernmost entrance to access the greenway quickest, they would have to actually walk along N. Raleigh Blvd, a high speed and highly trafficked arterial, to enter the trail. Although there is a sidewalk present, it is certainly not an inviting street, and could potentially be viewed as a barrier to entry. The easternmost entrance is also very pedestrian-unfriendly. Though not as bad as N. Raleigh Blvd., the eastern entrance is located on Milburnie Ave., a wide neighborhood street lacking a continuous sidewalk connecting it to the inner parts of the neighborhood, and at the time of visitation, showed signs of maintenance neglect. Furthermore, the easternmost entrance is a dead-end entrance. During the time of the study, the Capital Area Greenway did not continue, or at least directly connect to, the easternmost entrance of the Buckeye Trail. But not only was there no greenway continuation, there were virtually no nearby activity centers accessible by foot or bicycle; the only nearby destination is a CVS drugstore. So, upon arrival at the easternmost entrance, a person would have to make a u-turn because there is essentially nowhere else to go. Furthermore, because of the easternmost entrance's location, some of the homes measured to be closest to that entrance would have to travel away from the middle entrance to get there; this is an important point because once a neighborhood resident has made his or her way to the easternmost entrance, they would essentially be backtracking when traveling along the trail since the only direction to go is west. Therefore, for destination-based travel, it would make more sense to enter the trail at the middle or westernmost entrance. I argue

that the only proximate benefits of the easternmost entrance are recreational, since beginning a destination-based trip from that entrance would not logically be efficient. Because of this, I wonder if people actually perceive the eastern entrance as less of asset than the other entrances. Perhaps that, coupled with the fact that N. Raleigh Blvd. could have nullified some of the proximate benefits of the westernmost entrance could provide clues as to why the regression finds a slightly positive correlation between sale price and proximity to closest greenway entrance. This speculation is also supported by the fact that the coefficient for 'distance to major road' was negative. The second unexpected result was the negative impact, however so slightly, on home sale price for homes that are located adjacent to the greenway. Though there appeared to be only minor benefits from being adjacent to the greenway (e.g. privacy, preserved natural surrounding, etc.) based on the site visit, there appeared to be no associated disamenities. Perhaps limitations in the data or methodology would account for the unexpected results.

Limitations

There are several limitations present in the data and methodology used in this study that may preclude discovery of the most accurate results. First, there are arguably many characteristics of Buckeye Trail that could be beneficial or detrimental to a home's sale price, and in this study all but one of the characteristics are being ignored- value gained by having accessibility to the actual facility. I think that the Buckeye Trail is first and foremost a natural open space which provides homes protection against potential flood damage from Crabtree Creek, and buffers noise and visual pollution emanating from I-440. This study does not examine the monetary impacts on home sale price of the current scenario against a scenario where the greenway was absent and replaced by a road or more residential development. The flipside of this is that there are probably several potentially detrimental characteristics of the greenway area that could negatively affect home values and have also not been considered. Two examples of this are crime and greenway perception. Perception is important because if a home seller does not perceive any advantage for being close to a greenway then they will not impute that into the price tag of their home; or if they perceive being close to the closest Buckeye Trail entrance as a disamenity then they will consequently lower the price of their home. Many factors can

influence a person's perception of a greenway's value, not only the inherent positive factors, but also negative ones such as crime. Time and data limitations prevent crime from being incorporated into the model. Factoring in crime would be insightful but also laborious as crime location would have to be geocoded for each time period for every home sold (e.g. two new variables could be included in the model representing number of 'nearby crimes at the time of sale' and 'distance to nearby crime at the time of sale'). Further determination of what types of crimes to include as well as the extent of a crime's temporal impact on sale price (e.g. does a nearby robbery affect a home's sale price for one, two, five, or X years?) would require an in depth analysis.

Another limitation of the model is that it does not account for the relative benefit of the greenway's presence. Viewing public open space as a good, I imagine that the value of Buckeye Trail would also be related to the ratio of supply and demand of greenways and other proximate public open space. Supply and demand would also be influenced by Buckeye Trail's level of maintenance, maturation level, and degree of use. Like other goods, the premium that people are prepared to pay to be proximate to a park or open space is influenced by the available supply. In the case of Raleigh, the greenway system covers 3,000 acres, which is only 2.5 percent of the jurisdiction's total land area. The relative abundance of greenways and open space may diminish premiums as supply continues to increase, and or if demand decreases. Similarly, if houses in an area have relatively large private lawns and gardens, then it is likely that premiums will be lower than in areas with relatively little private space because privately owned space may act as a partial substitute for public greenway space since they both offer access to places of natural environmental solace. Level of greenway maintenance relates to its quality. A well-landscaped and well-groomed greenway is likely to increase the value of a home, whereas if it is overgrown with weeds and littered with trash then the property value is likely to be diminished. Adverse impacts also may emanate from nuisances such as trail congestion, litter, vandalism, noise, or other anti-social behaviors. Again, level of maintenance is something that could vary with time and therefore change the value of the greenway during different seasons or years. Unfortunately there is no data available that would suggest the maintenance level of Buckeye Trail for years past. Maturation level

recognizes that it may take 30 to 40 years for a new or renovated greenway to mature- as its ultimate transportation value will not be realized until all portions of the greenway have become interconnected. Thus the premium in later years is likely to be greater than in earlier years as more destinations become accessible. The influence of maturation could greatly conflate the results. For example, if Home A is very close to its closest trail entrance and Home B is far from its closest trail entrance, but Home A is sold when the greenway system is young (i.e. there are no other trails connecting to the Buckeye Trail, and thus no other accessible destinations) and Home B is sold when the greenway system is its most mature, then the marginal benefits of the greenway will be different for both homes. The Buckeye Trail will be a greater amenity at the time of sale for Home B than at the time of sale for Home A- it has essentially become two different amenities, and the model does not control for this.

Lastly, the model could potentially be improved though the examination of other variable categories that were assumed to be controlled for. These include neighborhood characteristics, environmental characteristics, and market characteristics during the time of sale. While the study area was relatively compact and contained within the same Census Tract, it does not necessarily mean that neighborhood, and environmental characteristics are uniform throughout. Pockets of self-segregated populations may exist (ethnic and or socio-economic) and some lots in the area may be designated as being in located in a flood plain or may lie adjacent to unstable soil. Also, housing market conditions would play a role in determining home sale price. For instance, in the event of a mortgage lending crisis, some people sell their homes at an extremely reduced price out of necessity. These variables should be explored in order to improve the model's validity.

Conclusion

Calculating the financial impacts of greenways on home sale price should put an end to the debate of whether or not home values benefit from proximity to greenways. Unfortunately, this is easier said than done. Although the hedonic model is currently one of the most sophisticated statistical methods available to test the influence of shadow prices such as proximity to a greenway's entrance on home sale prices, its usefulness is

predicated on an abundance of data that is not readily available. In this study, the use of the hedonic model determined that there is a weak positive and statistically insignificant correlation between proximity to the nearest Buckeye Trail entrance and proximate home sale price. The finding is unexpected but does not necessarily contradict some of the existing literature (Hobden, 2002; Nicholls, 2005) and the results may be explainable by a number of confounding factors. Some of these factors include location of two of the three entrances near major roads, variability of sale date with respect to different stages of greenway maturation, lack of crime data and data on other neighborhood, community, and environmental variables, supply and demand analysis, and perception of greenway by residents. A greenway's existence in and of itself does not necessarily make it beneficial. It needs to provide good access to destinations, must be safe, appealing, and accessible. These characteristics, along with others, may change the perceived value of a greenway and should be examined in follow up research. Future research on the Capital Area Greenway should examine trails other than the Buckeye Trail and should also gather data on more structural attributes, analyze different home design styles, include crime data analysis, examine supply of other public open space, survey residents' perceptions of the greenway, and conduct analyses based on different buffer sizes and types (straight line vs. network based). No policy recommendations can be made at this time because of the ambiguity of the results and the study's limitations. Although it may in fact be impossible to quantify all of the impacts from greenways, thus making their true value immeasurable, further study into the Capital Area Greenway will be insightful for those on both sides of the greenway debate.

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Appendix

Figure 5: Correlation matrices for all variables:

```
. pwcorr deed_acres heatedarea utilities year_built totunits distance_to_gw dist_to_sc~l dist_to_ma~d culdesac corner_lot ad
> j_to_majrd, sig
```

	deed_a~s	heated~a	utilit~s	year_b~t	totunits	distan~w	dist_t~l
deed_acres	1.0000						
heatedarea	0.5108 0.0000	1.0000					
utilities	0.0460 0.4952	0.0111 0.8696	1.0000				
year_built	-0.0730 0.2785	0.0701 0.2981	-0.2592 0.0001	1.0000			
totunits	0.0754 0.2634	0.1832 0.0062	0.0091 0.8926	-0.0434 0.5198	1.0000		
distance_t~w	-0.1849 0.0057	-0.0925 0.1698	-0.2411 0.0003	0.3481 0.0000	0.0031 0.9631	1.0000	
dist_to_sc~l	0.3559 0.0000	0.2856 0.0000	0.0917 0.1736	-0.0149 0.8256	-0.0588 0.3832	-0.0766 0.2555	1.0000
dist_to_ma~d	-0.1770 0.0082	-0.0254 0.7066	-0.1040 0.1224	0.3695 0.0000	-0.0505 0.4540	0.2264 0.0007	-0.1157 0.0854
culdesac	-0.0174 0.7962	-0.0344 0.6106	-0.2800 0.0000	0.4245 0.0000	-0.0234 0.7286	0.0045 0.9466	0.0817 0.2253
corner_lot	0.0123 0.8554	-0.0392 0.5613	0.0461 0.4948	-0.1497 0.0257	-0.0229 0.7347	-0.0442 0.5122	0.0556 0.4097
adj_to_majrd	0.0985 0.1435	0.1950 0.0035	0.0129 0.8482	-0.0371 0.5819	-0.0064 0.9243	-0.1089 0.1056	0.1524 0.0232

	dist_t~d	culdesac	corner~t	adj_to~d
dist_to_ma~d	1.0000			
culdesac	0.1555 0.0204	1.0000		
corner_lot	-0.1222 0.0693	-0.0708 0.2939	1.0000	
adj_to_majrd	-0.2213 0.0009	-0.0332 0.6228	0.2805 0.0000	1.0000

Distributions of variables examined

Figure 6: Deed_acres

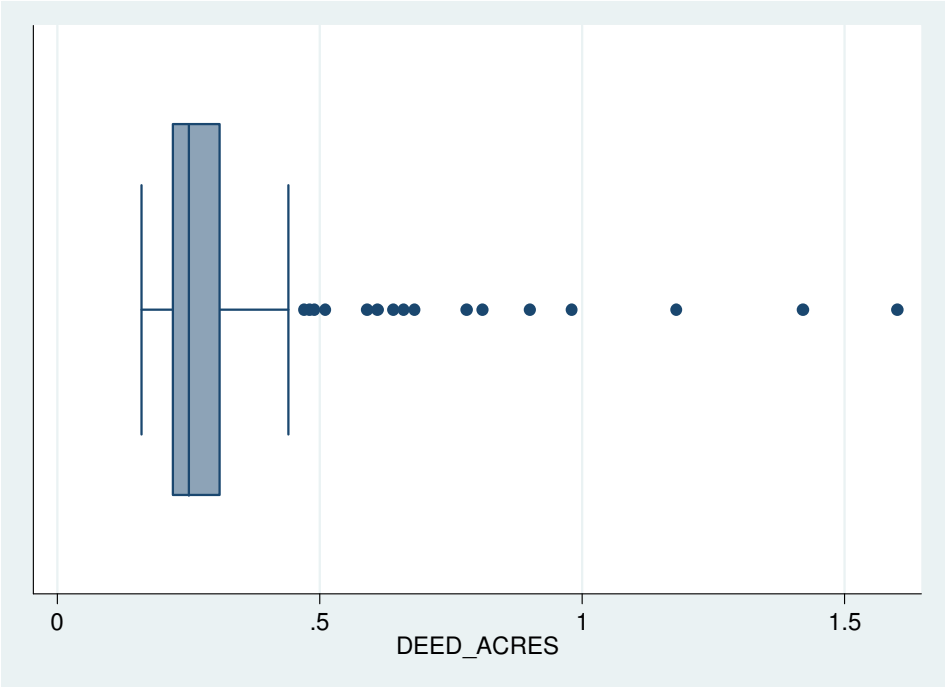

Figure 7: Heated area (square feet)

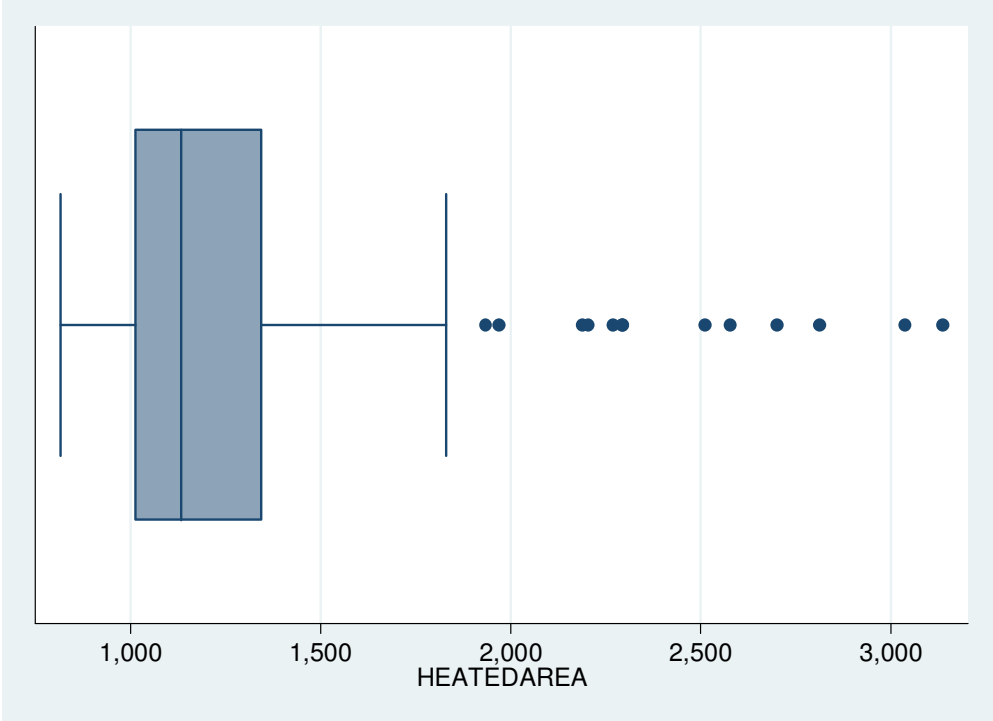

Figure 8: Year_built

Figure 9: Distance to greenway entrance (feet)

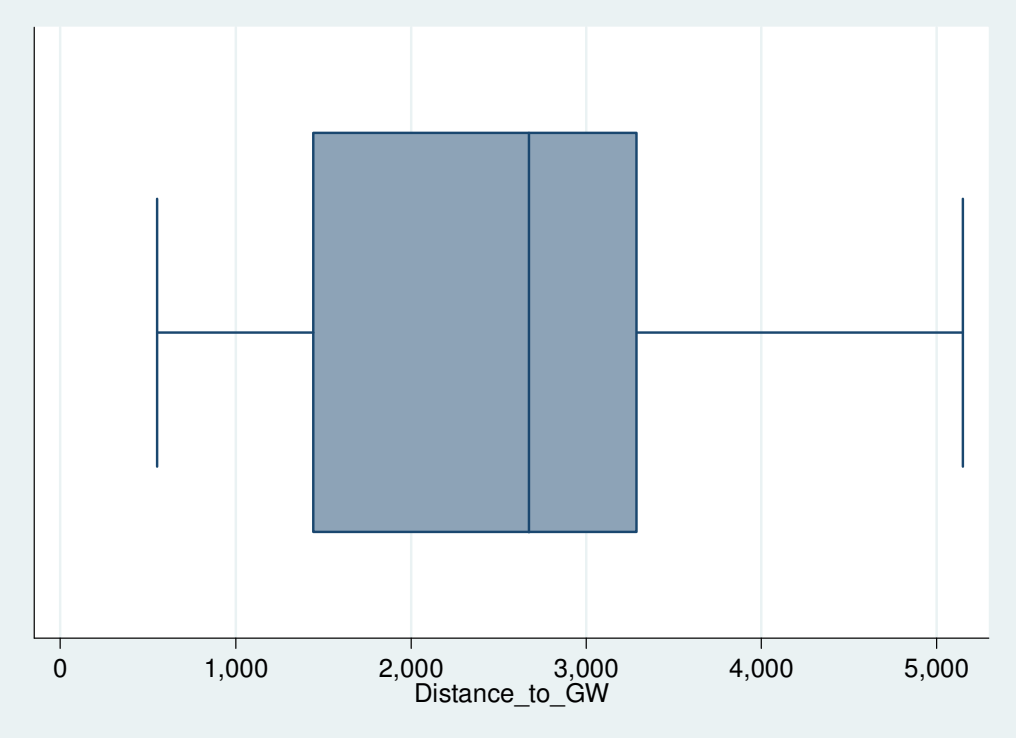

Figure 10: Distance to school (feet)

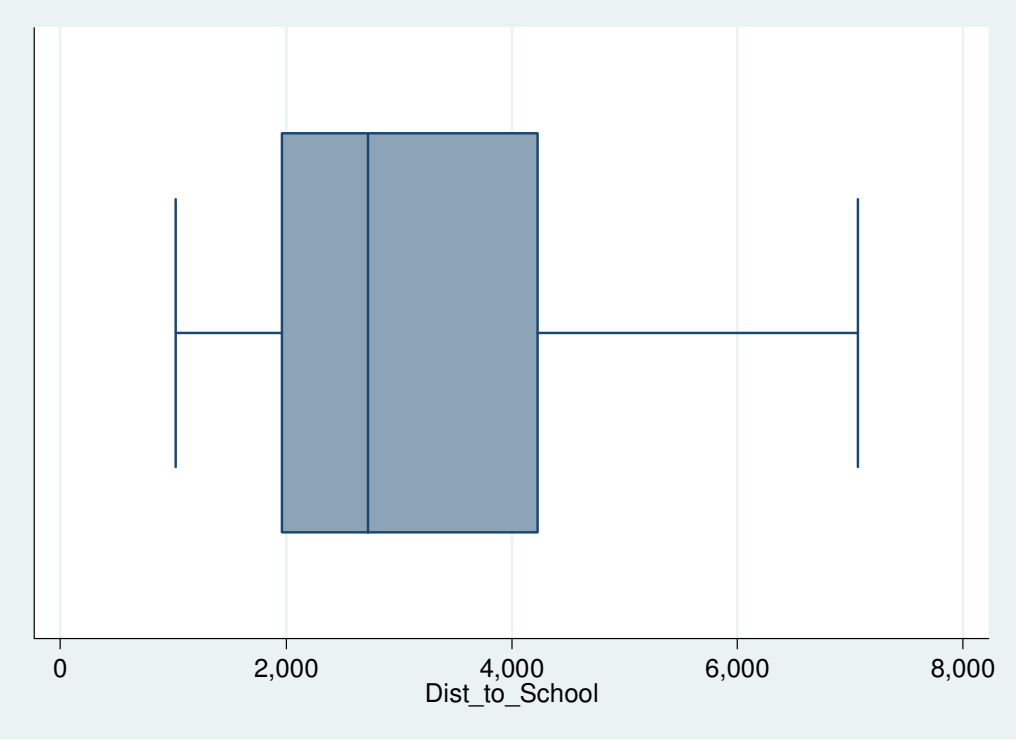

Figure 11: Distance to major road (feet)