Measuring the Impact of Greenway Infrastructure: Evidence on Heterogeneous Demand for Environmental Amenities

Lee Parton

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1 Introduction

As municipalities such as Raleigh, NC continue to experience population growth, access to environmental and recreation amenities are becoming central home-buying decisions. Environmental and recreation amenities include parks, open space, trails and greenways.

A greenway is defined as a linear open space established along a natural corridor such as a stream, river, valley, scenic road, abandoned railroad corridor or other natural or man made route (Shafer et al., 2000). Greenways are seen as an environmental amenity with many benefits including conservation and health implications (Oja et al., 1998; Krizek et al., 2009; Dill and Carr, 2003; Krizec, 2007). As budgets for parks, greenways and open space increase it is becoming increasingly important to understand the impacts of these taxpayer-funded public projects.

The goal of this research is to expand our understanding of willingness to pay (WTP) for greenways across previously unexplored margins. The majority of existing research measures greenway values in a revealed preference framework, often using hedonic methods and a single cross section of data to evaluate marginal WTP (Asabere and Huffman, 2009; Campbell and Munroe, 2007; Dill and Carr, 2003; Gotschi, 2011; Crompton et al., 2001). Despite a large and growing literature on environmental valuation, little work has been done on measuring how the size and type of a greenway system influences property values.[1] In addition, distributional effects of greenway infrastructure has gone largely unexplored.

The purpose of this analysis is to understand the effects of greenways on property values, more specifically, how different segments of the population value greenways differently. An obvious benefit of greenways are related to health and recreation, giving residents the opportunity to walk, run or bike on an off-street trail. Among many other benefits, greenways are thought to offer a low cost form of alternative transportation and the possibility for increased pedestrian and biking commuter mode share (Moore and Ross, 1998), raising the question: do individuals in lower income areas receive a greater benefit from a greenway system that is extensive and connects to areas with employment opportunities? If greenways offer an alternative form of transportation for those who cannot afford cars there may be heterogeneous effects across residents who value a greenway for recreation versus transportation. In particular, resident values may differ between greenways that connect with parks, schools and cultural centers and those that connect with shopping centers and commercial areas. Homeowners in high income areas may value greenways for recreation where as low income homeowners may value the transportation aspect. To understand willingness to pay, property values will be evaluated to measure the effects of greenway infrastructure across heterogeneous populations in Wake County. In addition, tests will determine if greenways in low income areas are valued as forms of access to commercial areas or as recreational amenities. If greenways do increase job accessibility,

[1] Greenway "type" is measured by how well a greenway system connects users to commercial areas and areas of interest within the community such as parks, schools and museums.

properties in close proximity to "commuting" greenways may have a higher WTP for trails than similar properties near "recreation" greenways.

I find evidence that the construction of a greenway increases property values by as much as 10 percent in low income areas. Additionally, greenways in low income areas connect directly do downtown Raleigh, NC, which may be driving increased values. This differs form results for greenways in high income areas where willingness to pay measures are largely insignificant. This offers insights for urban planners and policy makers who are considering the costs and benefits of greenway construction and where to locate these amenities.

The remainder of this paper proceeds as follows. Section 2 reviews the existing literature on greenway and open-space valuation, Section 3 discusses the Capital Area Greenway System in Raleigh, NC and Section 4 discusses the data. Empirical methods are proposed in Section 5 with preliminary results, Section 6 proposes extensions to the empirical approach and Section 7 briefly concludes.

2 Previous Research

Limited evidence has been found that well-maintained multi-use greenways improve community health, increase property values, attract tourists, increase access to jobs and promote habitat conservation and biodiversity (Oja et al., 1998; Krizek et al., 2009). Perceptions of neighborhood quality, trail quality, safety and ease of access to recreational amenities has been shown to have a significant positive impact on exercise habits and the decision to bike for both commuting and exercise (Boslaugh et al., 2004; Akar and Clifton, 2009). Shafizaden and Niemeier (1997) utilize an intercept survey to untangle the effects of trail perceptions on commuting decisions, their research indicates that bike commuters are willing to travel further to utilize off-street trails similar to those that make up the Capital Area Greenway System.

Research has shown that proper planning and maintenance of greenways can reduce crime incidents and increase trail use amongst residents (Racca and Dhanju, 2006). Proper greenway design and maintenance can also encourage exercise and increase pedestrian and bike commuter mode share. Cities with a large and well-maintained greenway infrastructure experience higher rates of recreational use and commuting by bike (Dill and Carr, 2003). A study of the Burke-Gilman Trail in Seattle, Washington examined effects on property values and crime. The study found that increased crime and decreased property values were not a valid concern, and in fact the opposite is true. Research to the contrary has indicated that multi-use trails help sell homes, increase property value, and are perceived as an amenity (Lagerwey and Puncochar, 1988).

The perceived value of nearby amenities often influences the purchasing decisions of home buyers (Dill and Carr, 2003). Alexander (1995) found that 29 percent of single-family home buyers viewed access to recreational trails as an amenity, while 42 percent of town-home and condominium residents, adjacent to the trail, believed that the trail would increase their home's selling price and 17 percent of residents in the study were influenced by the trail to move to the area. The City of Raleigh, along with Wake County, continues to designate and develop multi-use greenways in hopes of realizing the aforementioned benefits.

Given the magnitude of the aforementioned perceptions, it is important to test if gains are realized. Residential and commercial investment planners may attempt to expand amenities in order to attract residents. Given that large public projects, such as greenways, require significant taxpayer support, plans are often presented with anecdotal evidence of potential benefits. Campbell and Munroe discovered that in Charlotte, North Carolina, there is a .03 percent premium for every 1 percent decrease in the distance from a planned greenway (Campbell and Munroe, 2007). After testing linear, exponential, and threshold spatial relationships, their model suggested a distance decay effect up to 5000 feet, after which the distance from the greenway becomes insignificant. It is important to consider that Campbell and Munroe were studying a greenway in the nascent planning stages.

Several studies have shown a significant spatial relationship between property values and proximity to a greenway, with impacts becoming insignificant at varying distances, with varying price impacts, suggesting heterogeneous effects across different cities and neighborhoods (Racca and Dhanju, 2006; Lindsey et al., 2004; Nicholls et al., 2005).

In a comparison of stated and revealed preference techniques, Krizek (2006) attempted to quantify varying effects by bicycling infrastructure type comparing on-street, off-street and protected on-street facilities. Using an adaptive stated-preference survey and a hedonic price model, it was found that cycling facilities had a negative impact on home values in suburban areas as opposed to the opposite in urban areas (Krizek, 2006). An Indianapolis, Indiana study used hedonic methods to determine that a significant inverse relationship exists between proximity to greenways and property values. In the case of Indiana's Monon trail a 14 percent increase in sale price could be expected for properties near the trail (Lindsey et al., 2004). It is important to note that the same study found a negative, but insignificant, relationship for homes located within 1/2 mile of other trails highlighting the potential for localized effects on property values.

While some studies have shown that trails can increase property values, there has been research to the contrary. A study of trails in Portland, Oregon found that a property located within 200 feet of a trail would, on average, sell for 6.8 percent less than a comparable property, the decrease was attributed to the trails in question being located in and around industrial and high crime areas, demonstrating an important econometric issue associated with hedonic price analysis, omitted variable bias (Netusil et al., 2003). When estimating the hedonic price surface it may be the case that unobserved characteristics of the properties or neighborhoods influence property values, specifically unobserved neighborhood quality as in the Portland study.

Hedonic techniques are useful for recovering the value of public goods that are thought to impact property values and have been widely used to estimate the value of open space and greenways (Lindsey et al., 2004; Campbell and Munroe, 2007; Krizec, 2007; Racca and Dhanju, 2006). However, these studies have concentrated largely on localized effects ignoring the quantity and type of greenways that properties are located near.

3 The Capital Area Greenway System

The Capital Area Greenway System Master Plan was adopted in March 1974 to preserve open space in response to growth and urbanization in the Raleigh, NC area. The current version of the plan was adopted in 1989 and is gradually being implemented. Since fiscal year 2010 Raleigh has added 65 miles of greenway trails and the Capital Area Greenway system currently has over 100 miles of trails comprised of 28 individual trails. The system connects parks, commercial areas, schools, museums and other areas of interest (City of Raleigh Parks and Resources, 2014). In November 2014 voters approved a parks bond referendum, which included $15.4 million for greenway expansion and improvement and $10 million for land acquisition for parks and greenways (City of Raleigh Parks and Resources, 2014). For the 2015 fiscal year, the City of Raleigh has earmarked $1.8 million for greenway improvements and maintenance (City of Raleigh, 2014).

The expansion of the Capital Area Greenway System from 2010 to 2015 offers an opportunity to apply hedonic techniques in an attempt to understand the effects of an expanding system across several dimensions. Figure 1 shows all Wake County greenways and outlines the area of interest for this proposed study. The five greenways in the study area, shown in Figure 2, account for over 40 of the 65 miles of trail added since 2010. The House Creek, Neuse River, Crabtree Cree, Walnut Creek and Mingo Creek greenways, part of the Neuse River system, have expanded significantly since 2010.

The northernmost 6.5 miles of the Neuse River greenway was completed in November 2011, with the final one mile stretch being completed in early 2015 connecting the southern 20 miles to the northern 6.5 miles. The most recent large greenway to be completed, Walnut Creek, was finished in February, 2015 and connects areas of southeast Raleigh to downtown. Among the greenways completed since 2010, there is significant variation in the areas that they connect and heterogeneity among the populations located near the trails.

To give a sense of land use in the area covered by greenways, Figure 3 illustrates the spatial distribution of employment by Census block group (BG) throughout Wake County, measured as jobs per person in a given BG, i.e., the total number of employees divided by total population in the BG.[2] Upon visual inspection it appears that the Neuse River Greenway serves primarily as a recreation trail, given that it connects areas with fewer jobs per person, i.e., lightly shaded BGs, to areas with similarly low employment opportunities. Other trails, such as the Crabtree and Walnut Creek Greenways, connect areas with low employment per person to those with higher employment opportunities. The Walnut Creek Greenway, upon completion in February 2015, has established a pedestrian connection from Southeast Wake County to downtown Raleigh, serving as a connection between areas that differ greatly in employment opportunities as shown in Figure 3.

The prolific expansion of greenways over the past five years is chronicled in Figure 5. The variation across greenway types, i.e., greenways that connect to downtown or other commercial areas versus those that do not, offers the opportunity to understand

[2]Block groups are U.S. Census Bureau geographies drawn to closely resemble neighborhoods and consist of 600 to 3,000 residents

how heterogeneous pedestrian facilities are valued.

4 Data

Data for this study have been gathered from three primary sources: the City of Raleigh, Wake County Assessor's Office, and the U.S. Census Bureau (The City of Raleigh is located within Wake County). Property sales data from January 1st, 2006 to June 1st, 2015 have been obtained from the Wake County Assessor's Office. These data include sale price and assessed value, along with structural and property characteristics. An example of the available property characteristics is presented in Table 1 and summary stats for all residential properties sold during the sample are shown in Table 2.

GIS data on greenways and residential parcels were downloaded as ArcGIS shape files, which describe the length, location and type of greenway along with locational property characteristics. The greenway designation can have many different interpretations. However, for this study, a greenway must have a trail that can be used for recreation. Trails may be paved, hard pack gravel, or dirt. Wake County defines trails and greenways as follows;

> *"Trails can be categorized as either park trails or connector trails. Park trails are generally contained within one park area. Connector trails serve a different purpose; they run between parks and other recreation facilities, thus connecting them and creating a system that is accessible from many different points."*
>
> *"Similar to trails in that they connect parks, greenways normally exist parallel to other resources in the environment, such as rivers and boulevards."*

In keeping with this definition analysis will be performed on greenways and trails as defined above.

Data on construction time nine of the 28 trails in the Capital Area Greenway System are have been compiled and include observations on proposal date, approval date, construction start date and completion date for several greenway segments. This information, provided by the City of Raleigh, will serve as the foundation for understanding the timing of capitalization effects.

GIS data procured from Wake County also include the location of parks, museums, schools and commercial areas i.e., shopping centers, malls and downtown areas.

Demographic information at the Census block group level was obtain through the U.S. Census Bureau and through data aggregated by ESRI for use with ArcGIS. Demographic variables include, but are not limited to, median household income, race, employment and educational attainment.

The top panel of Table 3 contains summary statistics for properties sold in the first half of 2015 that are located within 5,000 feet of a greenway, followed by summary statistics for four representative trails. It should be noted that properties near Trail 7 sell for significantly less than properties near other greenways in the sample. Figure 4 demonstrates heterogeneity among households located near trails through an American Community Survey (ACS) index score. The ACS index score is calculated by ranking the 455 Census BGs in Wake County across five dimensions. Each BG was ranked from 1 to 455 across unemployment, poverty, no high school diploma, non-working age population and housing vacancies. The rankings across all five categories are then summed to construct the ACS Score, i.e., the best possible score is $(5 * 1)$ and the worst possible score is $(5 * 455)$. Block groups are then ranked from 1-455 based on this index. The BG index serves as a measure of "distress" for city planners with a rank of one being the least distressed and a rank of 455 being the most distressed. As represented in Figure 4 darker BGs represent more distressed areas while the blue shaded areas represent properties that lie with 5000 feet of one of the greenways in the study. It is important to note that the ACS index applies equal weight to all five measures.

The combination of demographic, spatial, property and greenway timeline data allows for the analysis of greenway construction and expansion on property values across different socioeconomic strata and geographic areas. Additional spatial data may be incorporated as needed.

5 Methods

To develop an initial understanding of the relationship between property values and greenways, a hedonic analysis was undertaken. Consider the following model,

$$p_{it} = \alpha + \beta X_{it} + \sum_{j=1}^{16} \delta_j D_{ijt} + \sum_{j=1}^{16} \zeta D_{ijt} E_{jt} + \sum_{m=2}^{455} \phi_m BG_{it}^{m} + \epsilon_{it} \tag{1}$$

where,

$$E_{jt}^{\tau} = \begin{cases} 1 & if\ t = \tau \\ 0 & otherwise. \end{cases} \tag{2}$$

X_i is a vector of structural characteristics for the i^{th} sale in year t, D_{ijt} is a measure of distance from each of the 16 greenways, existing or to be constructed during the sample period, E_{jt}^{τ} indicates the existence greenway j at time t and BG_{it}^{m} indicates the Census Block Group m in which the i^{th} sale in year t is located. This specification serves as a starting point for analyzing a single cross section of sales in a give time period (set $t = T$ in equation 1).

Being that greenways are often constructed along streams and rivers, or parks and existing green space, it is necessary to thoughtfully disentangle the effect of a greenway separate from the effects of existing amenities. The existence indicator serves to untangle the value of the trail from previous capitalized amenities while controlling for block group is intended to reduce the omitted variable bias that is inherent in the hedonic framework.

The effect of distance to trails can be specified in one of two ways. First, D_{ijt} can enter linearly as in equation (1). Alternatively, the distance effect can be measured as a set of incremental binary variables such as $\sum_{k=1}^{K-1} \sum_{j=1}^{16} \theta_k d_{ijt}^k$, where k denotes a given distance range. Consider,

$$p_{it} = \alpha + \beta X_{it} + \sum_{k=1}^{K-1} \sum_{j=1}^{16} \theta_{kj} d_{ijt}^k + \sum_{m=2}^{455} \phi_m BG_{it}^m + \epsilon_{it} \tag{3}$$

where,

$$d_{ijt}^1 = \begin{cases} 1 & if \ D_{ijt} \in [0, 500) \\ 0 & otherwise \end{cases}$$

$$d_{ijt}^2 = \begin{cases} 1 & if \ D_{ijt} \in [500, 1000) \\ 0 & otherwise \end{cases}$$

$$\vdots$$

$$d_{ijt}^K = \begin{cases} 1 & if \ D_{ijt} \in [5000, \infty) \\ 0 & otherwise \end{cases}$$

where the excluded category, for this analysis, are properties beyond 5000 ft.

This specification allows for non-linearities in distance from a greenway and the ability to test several distance specifications. Previous research has found that the effect of greenways and open space on property values becomes unmeasurable beyond a distance of 5,000 ft (Lindsey et al., 2004), therefore this distance will serve as the cutoff for categorical distance measures.

To accommodate multiple years of sales, I introduce year fixed effects, again controlling for greenway existence;

$$p_{it} = \alpha + \beta X_{it} + \sum_{\tau=2006}^{2015} \psi_\tau Y_{it}^\tau + \sum_{k=1}^{K-1} \sum_{j=1}^{16} \theta_{kj} d_{ijt}^k + \sum_{m=2}^{455} \phi_m BG_{it}^m + \sum_{k=1}^{K-1} \sum_{j=1}^{16} \xi_{jk} d_{ijt}^k E_{jt} + \epsilon_{it} \quad (4)$$

where,

$$Y_{it}^\tau = \begin{cases} 1 & if\ t = \tau \\ 0 & otherwise. \end{cases} \quad (5)$$

This specification allows for the interaction of temporal variables with neighborhood and property characteristics, in hopes of uncovering the heterogeneous effects of greenways on housing prices. The interaction between the distance and existence variables is the primary vehicle through which we hope to draw inferences about the greenway effect.

5.1 Non-Linear Specification

When choosing a non-linear specification for the distance dummies I allow the data to guide distance category width. To test categorical distance specifications I estimate the following equation using only distance to the nearest trail as the greenway effect measure.

$$p_{it} = \alpha + \beta X_{it} + \sum_{\tau=2006}^{2015} \psi_\tau Y_{it}^\tau + \sum_{k=2}^{K} \theta_k d_{it}^k + \sum_{m=2}^{455} \phi_m BG_{it}^m + \epsilon_{it} \quad (6)$$

Two separate models were estimated, the first model using 500 ft increments for the non-linear distance specifications and the second using a more aggregated specification for distance. The results from the OLS estimation of both models specified by Equation 6 are presented in Table 4. An F-test was then used to detect differences in the location parameter across distance indicators in each of the models, where 500 indicates a $sale_i < 500ft$ from a greenway, 1000 indicates $sale_i \in [500ft, 1000ft)$

from a greenway, etc. Results from significance tests between categories are presented in Table 5. As per these results distance categories are constructed as follows: 0-500ft, 500-1000ft, 1000-2000ft, 2000-3000ft, 3000-4000ft and 4000-5000ft. While Model 2 does raise questions regarding evidence of no apparent difference between the $[3000ft, 4000ft)$ and $[4000ft, 5000ft)$ categories are constructed as stated above for simplicity.

5.2 Results

Summary statistics by year for Sale Price, Heated Area, Grade and Bathrooms are presented in Table 2. While sale price is reported in Table 2, Log(Sale Price) is used as the dependent variable in subsequent analysis as this most closely fits a normal distribution. Log(Sale Price) allows regression coefficients to be interpreted as a percent change in price resulting from one unit change in a given variable. It is important to note that this interpretation does not hold for categorical variables such as distance. Categorical variable coefficients should be interpreted as the percent change in sale price as the result of moving a given property from beyond 5000 ft to within the given category.

Table 6 contains coefficients for categorical distance variables as well as distance-existence interactions estimated using Equation 4. Other variables used in the estimation are listed in Table 1 however coefficients are excluded for brevity. Estimation of Equation 4 offers significant explanatory power with an adjusted R-squared of 0.842 and several interesting effects are observed in the model.

Significant amenity and disamenity values are associated with areas where certain trails are located. Results show that areas where trails 1, 2, 6 and 7 are located, irrespective of greenway existence, are associated with disamenity values as indicated by statistically significant negative coefficients for the "Distance Indicator" variables. For instance, a home relocated from beyond 5000 feet of the area where Trail 2 was constructed, to within 500 feet of that trail would see a decrease in transaction price of 8.65%, representing a significant loss. The Distance Indicator variable does not capture the effect of trail construction, this is included in the Distance-Interaction variable where trail existence is interacted with the distance indicators.

Outcomes for Trail 1 offer interesting insights into how greenways capitalize into property values. Trail 1, part of the Crabtree Creek Trail, traverses through lower-income neighborhoods, as indicated by the ACS ranking in Figure 6, where darker shades represent the most distressed BGs. This trail was recently completed, connecting many of Raleigh's urban greenways to a large, 28 mile long, recreational greenway that runs along the Neuse River. The Distance coefficients indicate a non-linear disamenity. No effect is measured for properties very close to the trail while moving further from the trail results in a quadratic disamenity as compared to properties located beyond 5000 ft. This makes intuitive sense as some of the areas around this trail are considered distressed by the City of Raleigh as per the constructed ACS Score. When accounting for the completion of Trail 1 significant amenity values are measured. This effect holds across all distance categories, as is evidenced by the "Existence Interaction" coefficients for Trail 1. Not only are amenity values realized with the construction of a trail, in this instance they dominate the previously associated disamenity affect.

Trail 1 is an interesting case being that the same positive existence effect is not consistently detected when examining results for the other eight trails. This result holds for areas with both positive and negative distance values in the pre-construction period. We do see evidence of other positive amenity values after trail construction, namely in the 1000 ft and 2000 ft categories, which most consistently reap the capitalized benefits of a trail. This is the case for trails 2, 4, 5, 6, 7 and 8, all of which, with the exception of 8, had an associated negative value in the aforementioned categories prior to trail construction.

In only one case do we see statistically significant negative value associated with the construction of a trail. This is in the case of Trail 3, where previously significant amenity values associated with the area where diminished with the construction of a trail. While the existence effect does not dominate the distance effect alone, it does represent a loss to homeowners located near that particular trail.

6 Future Research

To further this research I intend estimate the average treatment effect and the average treatment on the treated in a difference in differences framework. The challenge with estimating a diff-in-diff model lies with the structure of the housing data. When I consider repeat sales of individual housing units the number of observations shrink substantially, making analysis around individual trails difficult with panel methods. However, it is possible to construct a housing index, differencing out housing characteristics, similar to the Case-Schiller housing index, at the census block group or block level. This would allow me to construct valid treatment and control groups using proximity as the treatment or by utilizing matching methods to construct a counter-factual controls.

6.1 Incorporating Crime

While not explored in this proposal it is possible that there is a spillover effect taking place with the construction of a greenway. If a trail is constructed in a low income are, on previously unusable land such as along a river or stream, it may alter undesirable characteristics of the area which, in turn, is capitalized into housing values. Gathering crime statistics from Wake County over time and testing for the effect of greenways on ambient crime will help answer this question.

7 Conclusion

Given the significant expenditures earmarked for greenway construction, including \$24.6 million from the 2014 Raleigh Parks and Greenway Bond (City of Raleigh Parks and Resources, 2014), it is important to understand the distributional effects of proposed greenways. In addition to monies allocated from Parks Bonds, the City of Raleigh budgets approximately \$2.0 million per year for greenway maintenance and improvements. This does not include funds allocated by Wake County, and other municipalities within Wake County, for the construction and maintenance of greenways. Several municipalities, such as Zebulon, Garner, Knightdale, Wake Forest and Cary, all located within Wake County, are working to develop systems of their own that connect to existing greenways in Raleigh and the surrounding area (Moody, 2015). When planning greenway expansion and integration, expected capitalized values may serve as a guide when evaluating alternative greenway proposals. This research demonstrates that these values are not distributed evenly across all populations within the county or city.

I find evidence that greenway values differ spatially and across demographic groups. Property values demonstrate a sensitivity to the amenity or disamenity values associated with an area before greenway construction and evidence shows that greenways have the potential to increase property values where a disamenity was previously associated with proximity to a given area. The aforementioned results point to heterogeneous values associated with greenways which may help decision makers develop greenway facilities where residents place the highest values.

Future research should consider a more in depth analysis of individual household adjustment through the implementation of sorting methods. Developing structural models would help to gain a better understanding of household preferences over greenway facilities. In addition, the average treatment effect should be estimated for the greenway expansion. For a more robust analysis intercept surveys could be administered to greenway users in an attempt to uncover use values for individuals that may not live near a greenway.

Given that the greenway system is utilized not only by individuals that reside near a greenway the hedonic approach may result in lower bound value estimates. Property values do have a direct effect on tax revenues which is of concern to officials however full willingness to pay may not be measured by hedonic methods, especially in the context of a non-marginal change in an amenity, which has been the case with the Wake County greenway expansion. In order to reveal willingness to pay for the entire system methods must be employed that capture the values of all users.

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Table 1: Description of Variables

Variable Name	Variable Description	Type of Variable*
PRICE	Sale Price	C
LNPRICE	Log(Sale Price)	C
AREA	Heated area	C
ACRE	Deeded acreage	C
CONV	Conversion style home	D
DUPL	Duplex style home	D
TWNH	Townhouse style home	D
CONDO	Condo style home	D
RANCH	Ranch style home	D
SPLEVL	Split level style home	D
SPFOY	Split foyer style home	D
CONTMP	Contemporary style home	D
LOG	Log style home	D
MODLR	Modular home	D
BSFUL	Full basement	D
BSPRT	Partial basement	D
BRICK	Brick exterior	D
CBLK	Concrete block exterior	D
BRFRM	Brick & frame exterior	D
STCC	Stucco exterior	D
STCCMS	Stucco & masonry exterior	D
STN	Stone exterior	D
STNFR	Stone & frame exterior	D
STNBR	Stone & brick exterior	D
SGFRS	Vinyl siding exterior	D
ALVSID	Alum vinyl siding exterior	D
BATH	Number of bathrooms	C
STORY	Number of stories	C
AGE	Age of home (original build date)	C
GRADE	Assessor property grade	C
BATH	Number of bathrooms	C
BLOCK GROUP	Census Block Group	D
YEAR	Year sold	D
DISTANCE	Distance indicators for all greenways	D
NEAREST TRAIL	Distance from nearest greenway	C

*C denotes continuous variable, D denotes discrete variable

Table 2: Residential Property Sales

Descriptive Statistics: Sales by Year

Year	**Statistic**	**Sale Price**	**Heated Area**	**Grade**	**Bathrooms**
2005	mean	227,054	2,077	1.43	2.47
	sd	123,598	832	8.35	0.58
	max	760,000	17,787	388.00	7.50
	min	58,500	100	0.30	0.00
2006	mean	239,612	2,088	1.37	2.49
	sd	130,008	846	7.07	0.62
	max	763,000	7,684	388.00	7.00
	min	58,500	446	0.30	0.00
2007	mean	249,182	2,101	1.63	2.51
	sd	134,106	850	12.36	0.63
	max	763,000	7,347	388.00	6.50
	min	58,500	480	0.30	0.00
2008	mean	251,442	2,105	1.52	2.51
	sd	135,487	872	10.21	0.65
	max	762,500	14,292	388.00	6.00
	min	58,500	480	0.47	0.00
2009	mean	236,201	2,089	1.50	2.52
	sd	124,055	854	9.93	0.64
	max	762,500	9,324	388.00	7.50
	min	58,500	542	0.59	1.00
2010	mean	245,285	2,188	1.55	2.57
	sd	128,835	897	10.43	0.68
	max	760,000	10,606	388.00	7.50
	min	58,500	540	0.62	0.00
2011	mean	243,789	2,218	1.45	2.61
	sd	126,501	882	8.06	0.69
	max	760,000	7,456	388.00	6.50
	min	58,500	500	0.59	0.00
2012	mean	248,236	2,253	1.65	2.62
	sd	127,664	897	11.86	0.68
	max	762,000	8,658	388.00	6.50
	min	58,500	566	0.59	0.00
2013	mean	255,288	2,245	1.50	2.62
	sd	131,828	898	9.47	0.69
	max	761,500	9,187	388.00	7.50
	min	58,500	500	0.53	0.00
2014	mean	261,708	2,221	1.58	2.62
	sd	134,749	879	10.98	0.70
	max	762,500	7,103	388.00	7.50
	min	59,000	433	0.59	0.00
2015	mean	254,951	2,118	1.60	2.52
	sd	135,196	887	11.64	0.69
	max	755,000	8,678	388.00	6.50
	min	59,000	445	0.30	0.00

Table 3: Summary Statistics 01 JAN 2015 - 10 JUN 2015

Residential Property Sales Within 5000 ft of Study Greenways 01 JAN 2015 - 10 JUN 2015						
Variable	N	Median	Mean	Min	Max	Std Dev
Sale Price	6,335	225,000	261,920	500	3,400,000	17,102
Assessed Value		153,571	163,038	44,658	592,715	22,688
Heated Area		1,960	2,164	381	12,469	950
Deeded Acreage		0.23	0.39	0	6.77	1.14
Age		16	21.35	1	175	18.57
Baths		2.5	2.55	0	7.4	0.68
Residential Property Sales Within 5000 ft of Trail 1						
Sale Price	209	252,000	322,525	31,000	2,150,000	253,660
Assessed Value		129,413	143,214	66,883	592,715	58,955
Heated Area		1,609	1,875	600	12,469	1,135
Deeded Acreage		0.23	0.26	0	1.11	0.17
Age		52.00	45.28	1.00	100.00	25.08
Baths		2.0.	2.15	1	5.4	0.84
Residential Property Sales Within 5000 ft of Trail 2						
Sale Price	42	317,000	359,024	100,000	1,015,000	190,839
Assessed Value		154,851	166,338	101,582	323,511	52,185
Heated Area		2,051	2,225	1,196	5,223	903
Deeded Acreage		0.31	0.28	0.03	0.65	0.19
Age		39.00	37.45	2.00	73.00	16.41
Baths		2.50	2.66	1.00	3.80	0.71
Residential Property Sales Within 5000 ft of Trail 4						
Sale Price	335	228,000	244,076	3,000	805,000	116,254
Assessed Value		155,627	163,770	72,908	379,035	50,497
Heated Area		2,052	222	942	7,397	889
Deeded Acreage		0.17	0.24	0.02	3.33	0.29
Age		14.00	16.17	1.00	114.00	10.51
Baths		2.50	2.62	1.00	6.60	0.57
Residential Property Sales Within 5000 ft of Trail 7						
Sale Price	49	116,500	116,093	2,500	165,000	31,670
Assessed Value		122,243	122,705	70,866	165,065	21,734
Heated Area		1,420	1,493	946.00	2,290.00	330
Deeded Acreage		0.15	0.20	0.02	0.7	0.15
Age		14.00	16.96	5.00	67.00	10.63
Baths		2.50	2.37	1.50	3.80	.038

Table 4: OLS using distance to nearest trail for categorical variables

	Model 1	Model 2
	500 ft increments	1000 ft increments (excl. 0-500ft)
Variable	Log(Sale Price)	Log(Sale Price)
Heated Area	0.000309***	0.000309***
	(0.00000322)	(0.00000322)
Deeded Acreage	0.0268***	0.0268***
	(0.00629)	(0.00629)
Bathrooms	0.104***	0.104***
	(0.00294)	(0.00294)
Age	-0.000730***	-0.000730***
	(0.000122)	(0.000122)
0 ft - 500 ft	0.0370***	
	(0.00614)	
500 ft - 1000 ft	0.0307***	
	(0.00607)	
1000 ft - 1500 ft	0.0341***	
	(0.00609)	
1500 ft - 2000 ft	0.0107*	
	(0.00587)	
2000 ft - 2500 ft	-0.000218	
	(0.00583)	
2500 ft - 3000 ft	0.00449	
	(0.00594)	
3000 ft - 3500 ft	0.0114*	
	(0.00603)	
3500 ft - 4500 ft	0.0180***	
	(0.00571)	
4000 ft - 4500 ft	0.0140**	
	(0.00576)	
4500 ft - 5000 ft	0.0156***	
	(0.00570)	
0 ft - 500 ft		0.0345***
		(0.00602)
500 ft - 1000 ft		0.0284***
		(0.00595)
1000 ft - 2000 ft		0.0227***
		(0.00555)
2000 ft - 3000 ft		0.00197
		(0.00515)
3000 ft - 4000 ft		0.0150***
		(0.00497)
4000 ft - 5000 ft		0.0150***
		(0.00473)

N=153069, adj R2=0.841 (both models)
Standard errors in parentheses: *p<0.10 **p<0.05 ***p<0.01

Table 5: F-test for non linear specification of distance dummies

Model 1		Model 2	
Regression with 500 ft distance intervals (table 6)		Regression with 1000 ft distance intervals (excl first category)(table 4)	
H0:	F-stat	H0:	F-stat
500-1000=0	4.07**	500-1000=0	3.75*
1000-1500=0	0.91	1000-2000=0	3.22*
1500-2000=0	32.31***	2000-3000=0	29.26***
2000-2500=0	5.47***	3000-4000=0	8.63***
2500-3000=0	0.69	4000-5000=0	0
3000-3500=0	1.29	5000-5001=0	10.00***
3500-4000=0	1.16		
4000-4500=0	0.42		
4500-5000=0	0.06		
5000-5500=0	7.47		

Table 6: Log price regression for all sales in all years

	Trail 1		**Trail 2**		**Trail 3**		**Trail 4**		**Trail 5**	
	Distance Indicator	Existence Interaction	Distance Indicator	Existence Interaction	Distance Indicator	Existence Interaction	Distance Indicator	Existence Interaction	Distance Indicator	Existence Interaction
500 ft	0.000384	0.0419**	-0.0865***	-0.0174	0.130***	-0.0334	-0.0199	-0.00590	-0.147***	0.0181
	(0.0112)	(0.0182)	(0.0280)	(0.0284)	(0.0240)	(0.0246)	(0.0237)	(0.0177)	(0.0342)	(0.0628)
1000 ft	-0.0211*	0.0454*	-0.0847***	0.0446**	0.0886***	0.00413	0.00483	0.00600	-0.132***	-0.00268
	(0.0113)	(0.0234)	(0.0246)	(0.0208)	(0.0295)	(0.0307)	(0.0235)	(0.0204)	(0.0306)	(0.0492)
2000 ft	-0.0486***	0.106***	-0.0248	0.0448**	0.0631***	-0.0610**	-0.0306	0.00368	-0.00324	0.109**
	(0.00909)	(0.0214)	(0.0243)	(0.0228)	(0.0216)	(0.0250)	(0.0217)	(0.0141)	(0.0200)	(0.0466)
3000 ft	-0.0691***	-0.00796	-0.0745***	0.0311	0.0227*	-0.0173	-0.0517**	0.0446***	-0.00615	-0.0112
	(0.00918)	(0.0287)	(0.0184)	(0.0248)	(0.0137)	(0.0164)	(0.0206)	(0.0149)	(0.0164)	(0.0495)
4000 ft	-0.0716***	0.0901*	0.00663	0.0278	0.0589***	-0.0340*	-0.0175	0.0261	0.00735	0.0104
	(0.0107)	(0.0473)	(0.0137)	(0.0184)	(0.0138)	(0.0184)	(0.0173)	(0.0242)	(0.0150)	(0.0408)
5000 ft	-0.0279***	0.101***	0.0188	0.0346**	0.0437***	-0.00687	0.00140	0.0282	0.00914	0.0868**
	(0.00720)	(0.0263)	(0.0134)	(0.0151)	(0.0137)	(0.0196)	(0.0170)	(0.0218)	(0.0109)	(0.0440)
	Trail 6		**Trail 7**		**Trail 8**		**Trail 9**			
500 ft	-0.0363**	0.00750	-0.0840***	0.0513*	0.183***	-0.0573	0.0134	-0.0678		
	(0.0165)	(0.0184)	(0.0274)	(0.0284)	(0.0392)	(0.0705)	(0.0264)	(0.0719)		
1000 ft	-0.0561***	0.0146	-0.0737***	0.0807**	0.0248	0.0874**	0.0810***	-0.0138		
	(0.0158)	(0.0152)	(0.0285)	(0.0333)	(0.0276)	(0.0380)	(0.0311)	(0.0303)		
2000 ft	-0.0630***	0.0319***	-0.0889***	0.00233	-0.118***	0.0184	0.0490***	-0.00613		
	(0.0143)	(0.0116)	(0.0188)	(0.0260)	(0.0203)	(0.0300)	(0.0184)	(0.0210)		
3000 ft	-0.0237**	0.000570	-0.0683***	0.0122	-0.0703***	0.0132	0.0379***	0.0250*		
	(0.0118)	(0.0127)	(0.0152)	(0.0204)	(0.0145)	(0.0240)	(0.0142)	(0.0151)		
4000 ft	0.0106	0.00851	-0.0718***	-0.0136	-0.0157	0.0252	0.0157	0.0700***		
	(0.0103)	(0.0152)	(0.0138)	(0.0194)	(0.0151)	(0.0188)	(0.0101)	(0.0117)		
5000 ft	0.0148*	0.0207	-0.0220**	-0.0109	-0.0369***	-0.00396	-0.00116	0.0862***		
	(0.00817)	(0.0130)	(0.00985)	(0.0163)	(0.0119)	(0.0270)	(0.00775)	(0.00908)		

standard errors reported in parentheses: *p<0.1, ** p<0.05, ***p<0.01
N = 153069, adjusted R-squared = 0.842

Figure 1: Wake County Greenways

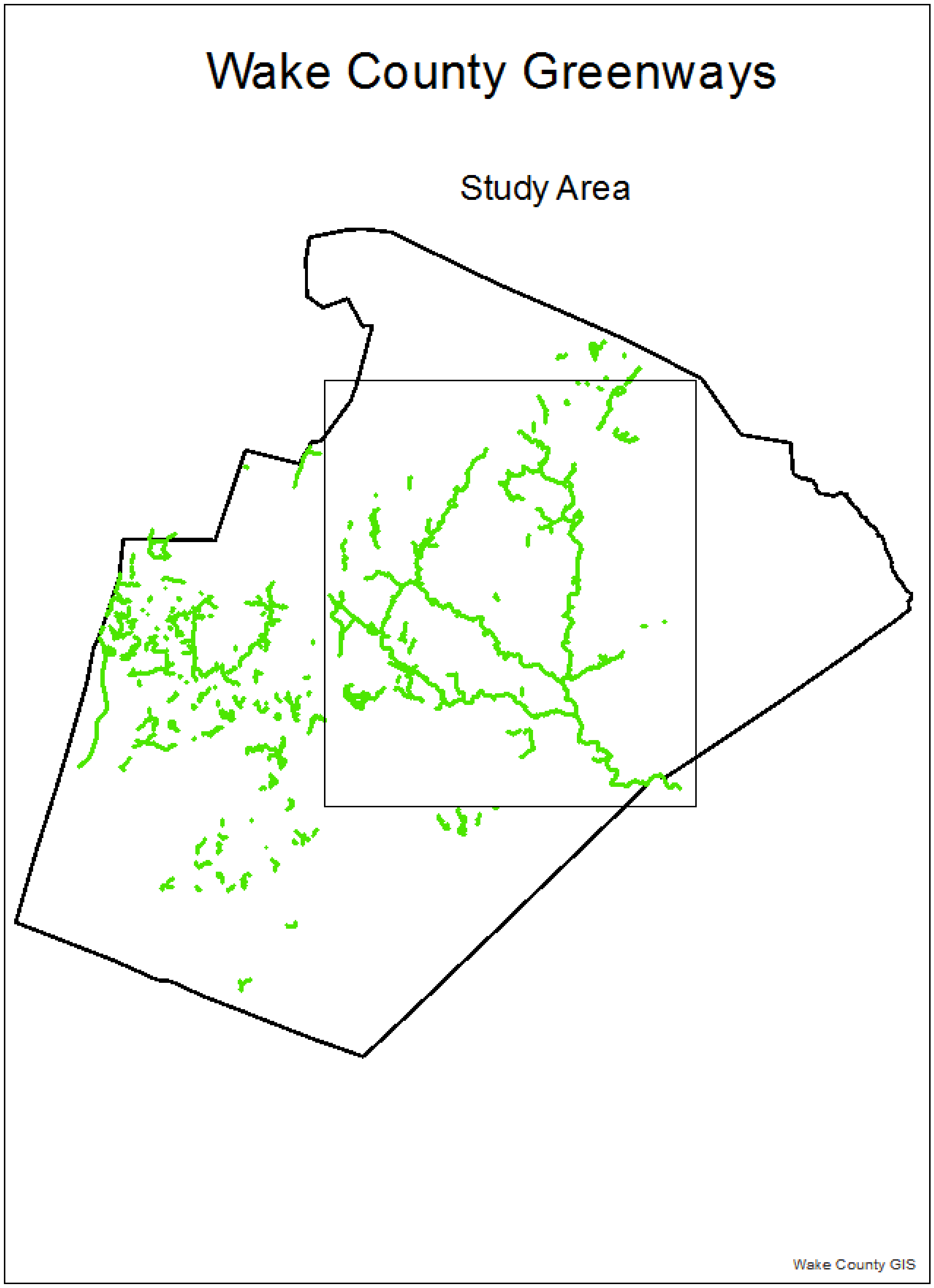

Figure 2: Recently Constructed Greenways

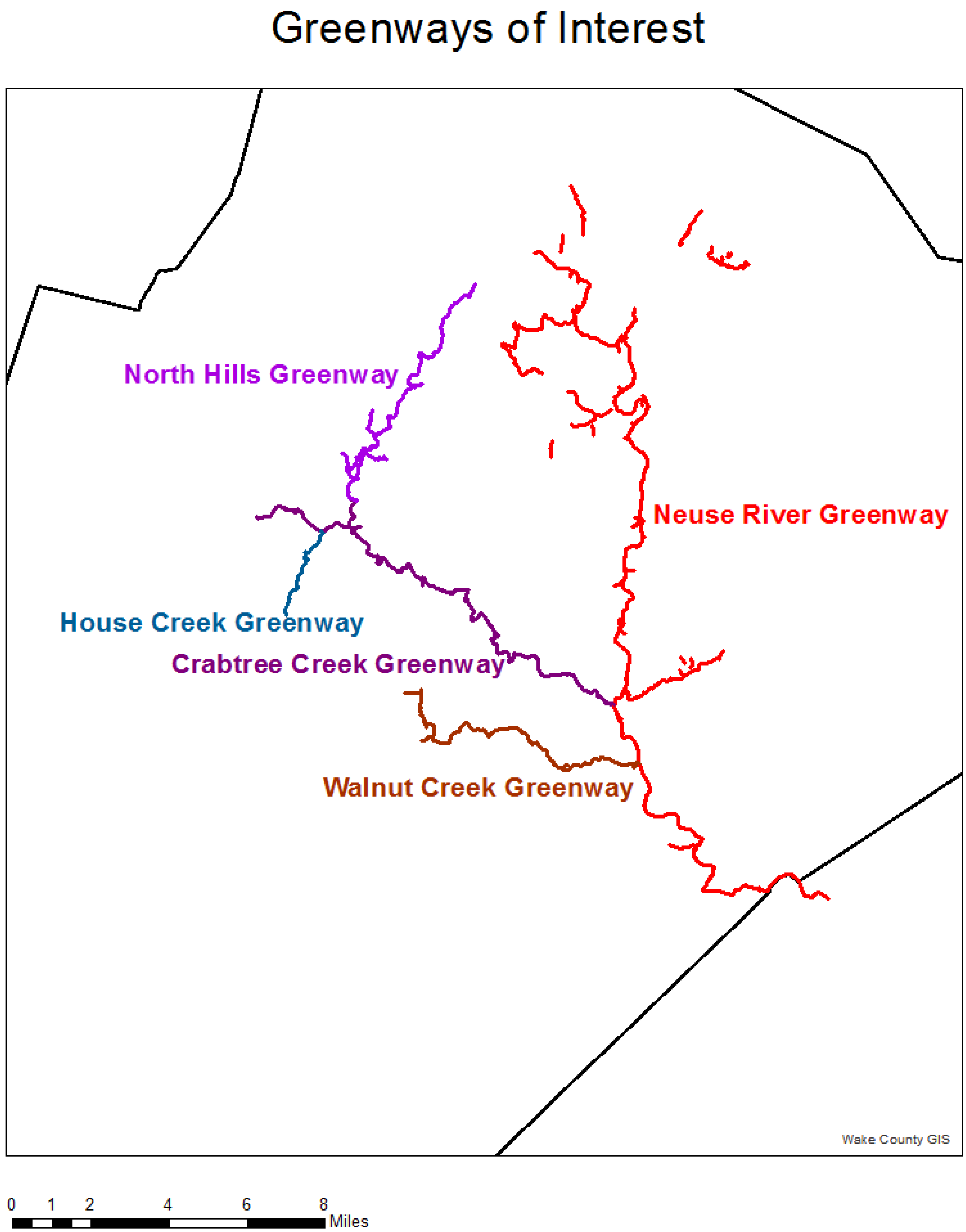

Figure 3: Jobs Per Person by Census Block Group

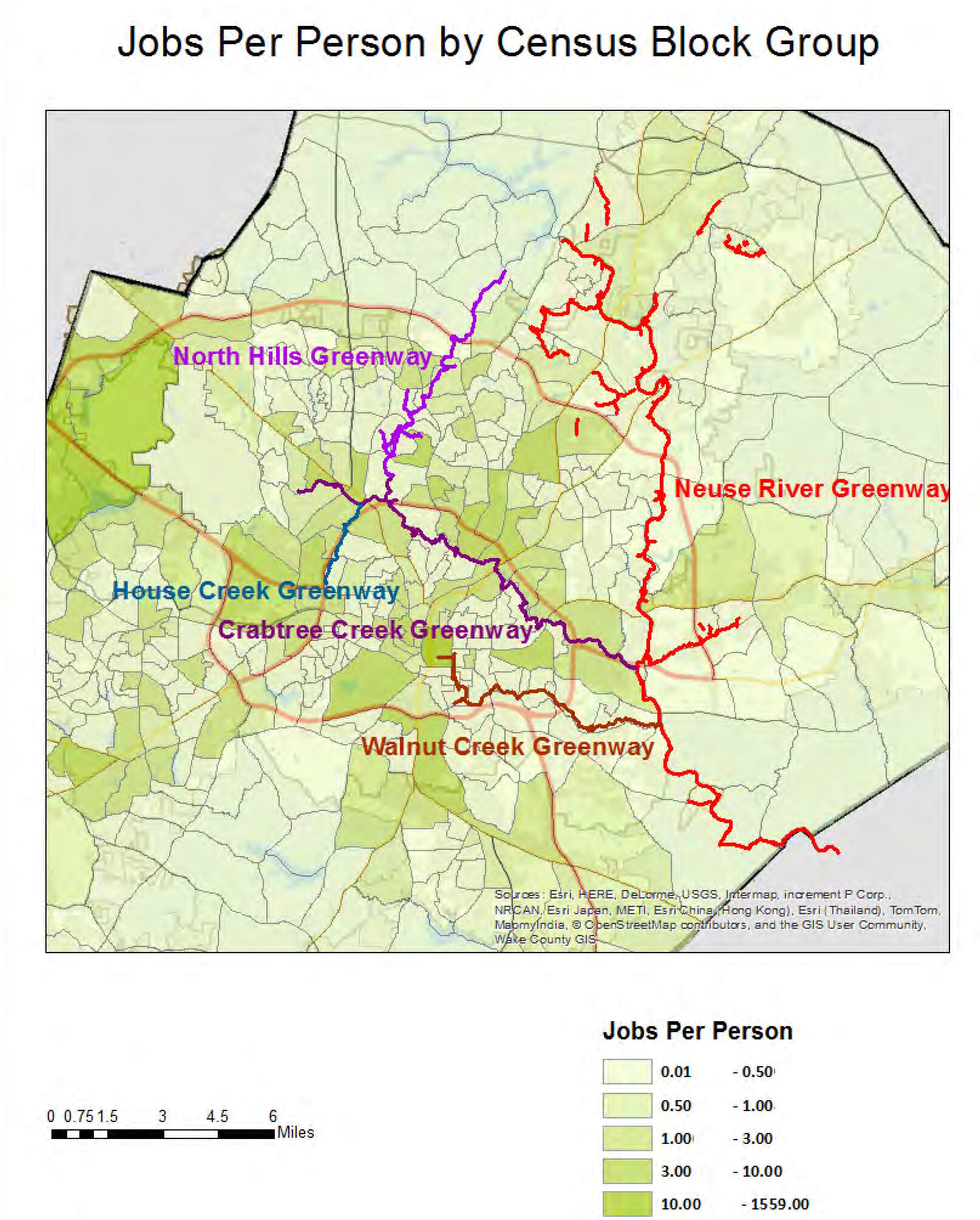

Figure 4: ACS Index Score by Census Block Group

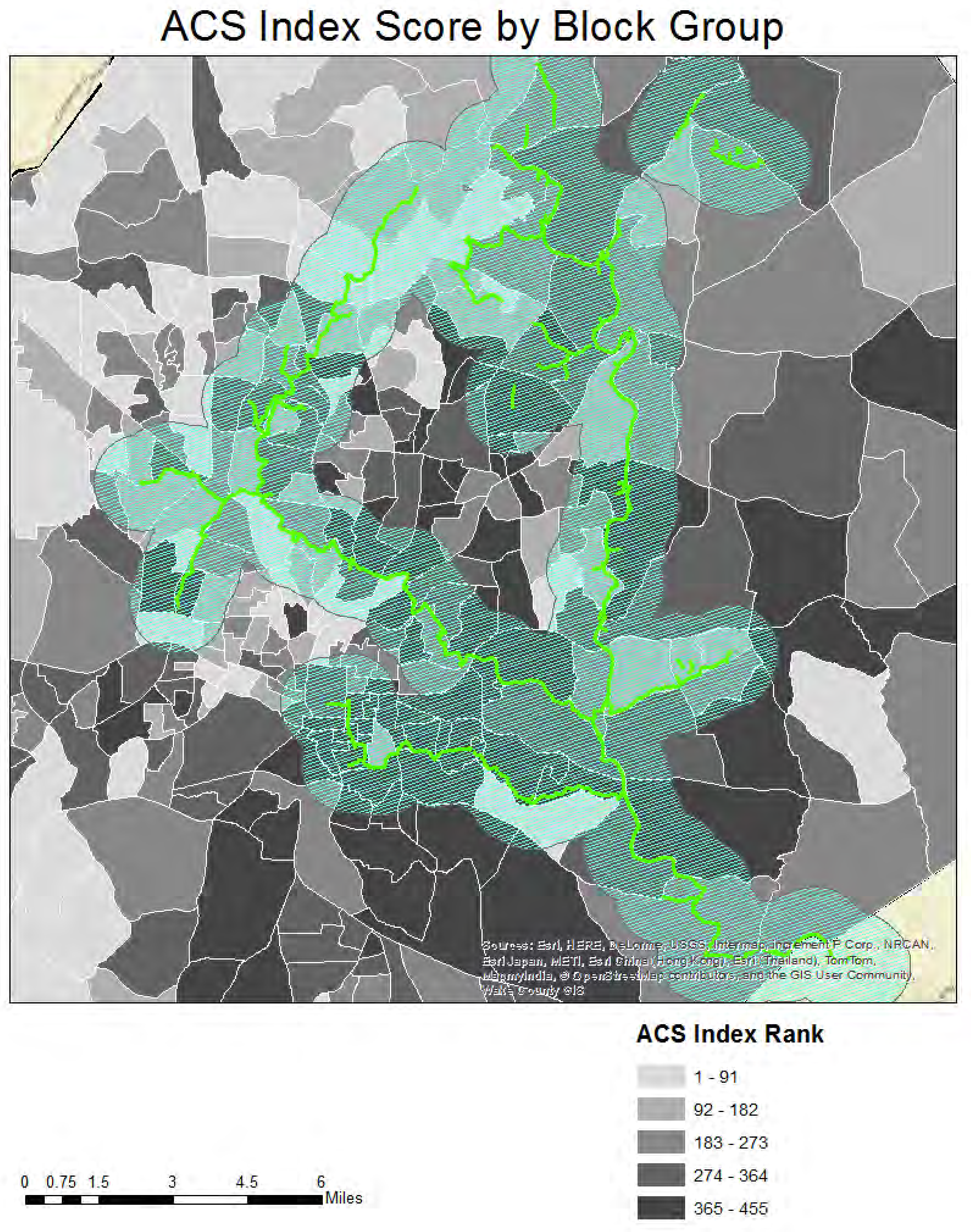

Figure 5: Greenway Evolution in Wake County

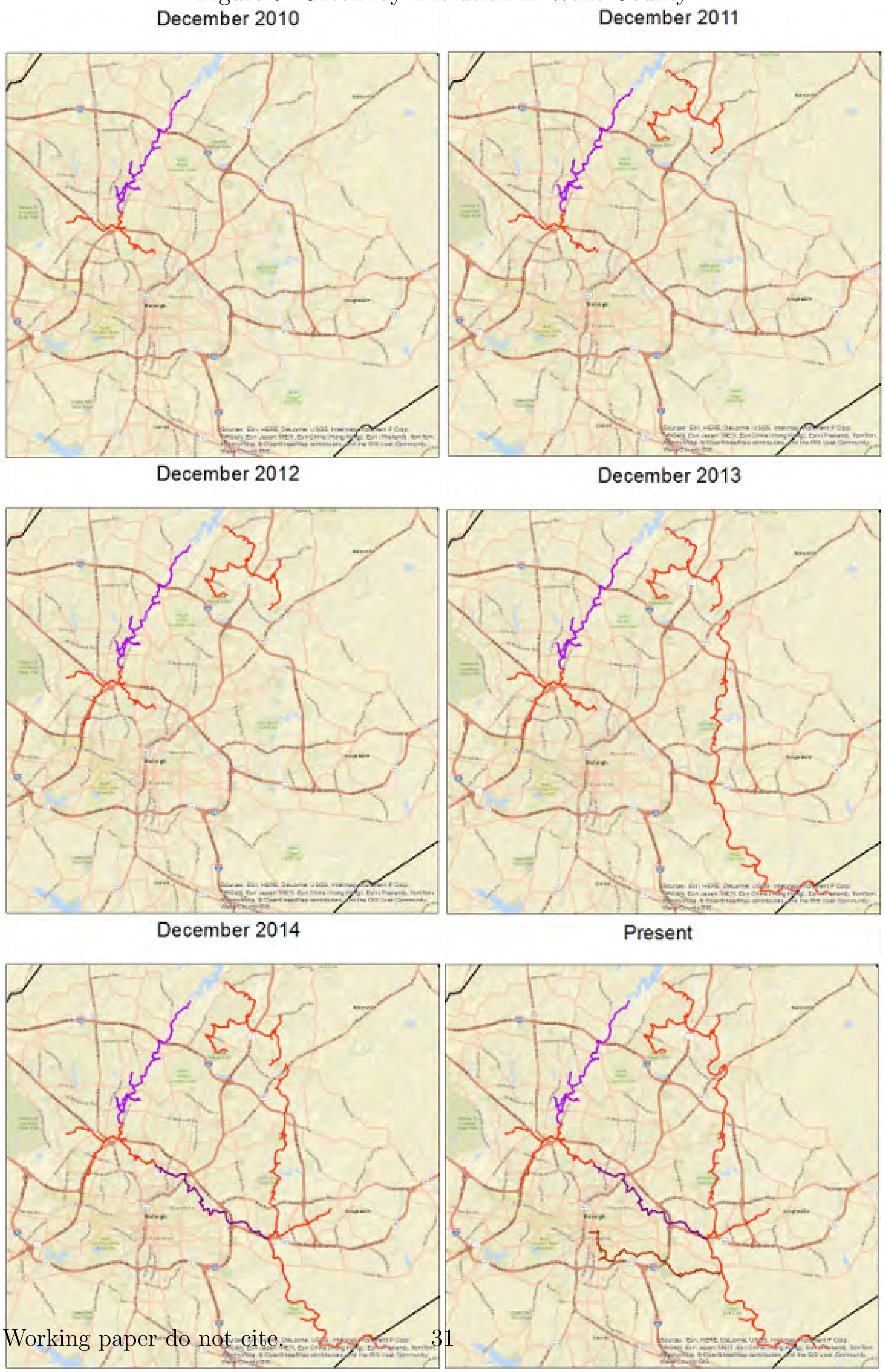

Figure 6: East Crabtree Creek Trail