THE IMPACT OF BICYCLE FACILITIES ON SINGLE FAMILY RESIDENTIAL PROPERTY VALUES: EVIDENCE FROM ALACHUA COUNTY, FLORIDA

By

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A THESIS PRESENTED TO THE GRADUATE SCHOOL
OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF ARTS IN URBAN AND REGIONAL PLANNING

UNIVERSITY OF FLORIDA

2014

To my cats, Wheezy and Mr. Jigglesworth, for supporting my academic endeavors and only accidentally turning off my computer once

ACKNOWLEDGMENTS

I would like to thank my Chair, Ilir Bejleri, and my Co-Chair, Abhinav Alakshendra, for their guidance and support. I learned a considerable amount as a result of their assistance. I would also like to thank my teachers who have supported me and given me advice; I never would have made it without their help. Additionally, I would like to thank my classmates, especially Sarah Benton, for reminding me of due dates. Lastly, I would like to thank my amazing girlfriend, Katie Skorpinski, for putting up with my endless shenanigans.

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LIST OF ABBREVIATIONS

CAMA	Computer Assisted Mass Appraisal
FGDL	Florida Geographic Data Library
GIS	Geographic Information Systems
GWR	Geographically Weighted Regression
OLS	Ordinary Least Squares
SW	Southwest
UF	University of Florida

Abstract of Thesis Presented to the Graduate School
of the University of Florida in Partial Fulfillment of the
Requirements for the Degree of Master of Arts in Urban and Regional Planning

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May 2014

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Major: Urban and Regional Planning

Bicycle lanes and trails are an important part of the transportation infrastructure of a city. They provide recreational and health benefits, as well as an alternate means of transportation for commuters. In some cities in the United States, where bicycle culture is growing, the value of properties with close proximity to these amenities has increased. The objective of this study was to assess the impact that bicycle lanes and trails provide to single family residential property values. This was accomplished by using ordinary least squares regression to create a hedonic pricing method, followed by a locational study using geographically weighted regression. The study was performed in Alachua County, Florida, using geographic information systems (GIS).

The analysis showed that the impact of bicycle lanes and trails varies by location. The use of ordinary least squares does not take location into account, therefore geographically weighted regression was employed to consider spatial variation. It was found that in some locations, proximity to a bicycle facility decreased the value of homes, possibly stemming from issues regarding decreased privacy or increased crime.

In other locations, property values were increased at homes located near bicycle facilities, as a result of commuting ease or recreational benefit.

CHAPTER 1
INTRODUCTION

Problem

The city of Gainesville, Florida, touts a ranking of 37th on the list of bike-friendly cities in the United States (UF Office of Sustainability, 2013). Gainesville also ranks seventh for metro areas in which commuters bike to work. In 2009, 3.3% of workers aged 16 or older used their bicycle as their primary source of transportation to work (McKenzie & Rapino, September 2011).

Academic research supports that bicycle paths, trails, and greenways can provide increased recreation, more flexible transportation, lower crime, and – as the key point of this research – increased property value. How are residential property values and local economy affected by the presence of bicycle facilities? This thesis seeks to examine residential properties and their values near bicycle lanes and trails to determine whether there is a positive impact, negative impact, or no impact for access to this amenity.

Research Questions and Objectives

The purpose of the research is to determine whether or not the presence of a bicycle lane or trail has an impact on the just (market) value of a home. The research is based on the following questions:

1. Does a home’s proximity to a bicycle lane (marked lanes) or a bicycle trail (an off-street facility, such as the Gainesville-Hawthorne Trail) have an impact on its just (market) value?

2. If so, what is the estimated impact of the facility on the just value of said properties? Is it positive or negative?

3. How far from a bicycle lane or trail is the impact significant? (For example, in some studies (Campbell & Munroe, 2007; Racca & Dhanju, 2006), a property’s

value will increase by a certain dollar amount for every foot closer to the amenity, but is insignificant past a certain distance.)

To study the impacts, I used geographic information systems (GIS) in combination with ordinary least squares regression to create a hedonic pricing method and geographically weighted regression, using Alachua County as a case study. The hedonic pricing model is a method which isolates characteristics of housing which internally impact its price (such as number of bedrooms, number of bathroom, square footage, etc.) or externally (such as accessibility to parks, schools, etc.) (Lindsey, Man, Payton, & Dickson, 2004). Hedonic pricing models can be used to infer a premium that a homebuyer would be willing to pay to purchase a home near an amenity – in this case, a bicycle lane or trail – or away from a disamenity (Racca & Dhanju, 2006) such as pollution or an industrial park.

The hedonic pricing method will reveal how the dependent variable, just value, is related to the independent variables, such as the number of bedrooms, square footage, or distance from bicycle facility). Independent variables which are found to be statistically relevant will then be used to determine the impact on housing prices. Geographically weighted regression will be used to determine locations at which the impact is significant.

Method

The value of a home can be attributed to many different factors. The use of a hedonic pricing method will allow one to estimate how different factors contribute to the overall value of the property. The analysis was performed using ordinary least squares (OLS) at various specified distances from the bicycle lanes and trails in Alachua County. The relationship between the independent variable (just value) and several independent locational, structural, and neighborhood variables was estimated. Geographically weighted regression (GWR) analysis was then used, making use of only the variables from OLS which were determined to be statistically significant. The GWR analysis seeks to improve upon the results by taking into account spatially varying relationship. Utilizing GWR allows for analysis at specific locations, as the impacts may vary between locations.

CHAPTER 2
LITERATURE REVIEW

Bicycle Lane and Trail Impacts

Besides being a source of transportation, bicycle lanes and trails can have a positive impact on different aspects of one's life. They can be a source of recreation for both children and adults, and help to influence good health and improved fitness by way of exercise. This can, in turn, also lead to lower medical bills (Karadeniz, 2008). In addition to health benefits, bicycle facilities may provide environmental benefits by decreasing the number of trips made by car. Trails also can provide aesthetic benefits as they may be incorporated into a larger greenspace, such as a park (Lindsey, Wilson, Yang, & Alexa, 2008). The Gainesville-Hawthorne Trail, sometimes referred to as simply the Hawthorne Trail, is one such example.

Rail-trails in particular may also help to preserve a historical sense. Rail-trails are multiuse trails built upon the former rights-of-way of railroad lines. As some railroad lines became unprofitable to operate throughout the 1970s, railroad companies sought to abandon the lines in order to reduce costs. This was enabled in 1983 with National Trails System Act. This act allowed railroad companies to donate, sell, or lease the right-of-way for use as a trail to various qualified public or private entities, such as the Rails-to-Trails Conservancy. (Rails-to-Trails Conservancy, 2005) The Hawthorne Trail is an example of a rail-trail, converted from the former corridor of the Seaboard Coast Railroad (Florida Division of Recreation and Parks, n.d.).

Gainesville historically was a central meeting point of many railroads; rail-trails have been constructed along some of these now abandoned rail lines. These routes may also provide access to historic buildings, such as the Gainesville Depot (which will be incorporated into Depot Park), and to bridges, such as the 13th Street pedestrian overpass bridge, a former railroad bridge which is now part of the Depot Avenue Rail Trail. (Gainesville Community Redevelopment Agency, 2013) This bridge provides easy access to Shands Hospital from homes located across SW 13th Street.

Bicycle lanes and trails may also be a source of economic benefits to a community. The Gainesville-Hawthorne State Trail, a 16 mile paved rail-trail which connects Gainesville to Hawthorne to the east, passes through the Paynes Prairie Preserve State Park (Florida Division of Recreation and Parks, n.d.). Paynes Prairie attracted 176,134 visitors in 2011-2012 to Alachua County (Florida Department of Environmental Protection, 2012). While the park itself does not charge admission, the influx of visitor to the county has economic potential.

Despite the positive ramifications, the expansion of bicycle networks is not without opponents. Opposition is typically brought by property owners who are adjacent to bicycle facilities. Some property owners believe that off-street bicycle trails in particular can decrease property value by increasing the potential for crime and reducing their privacy (Hawthorne, Krygier, & Kwan, 2008). Others believe that the addition of bicycle lanes within a city is a luxury, leaving transportation planners to justify their construction (Krizek, 2007). The construction of trails in Gainesville has been subject to opposition from residents. In September of 2012, the Alachua County Commission decided in a 3-2 vote that the Archer Braid Trail, a multi-use trail, would not extend through the Haile Plantation development located west of Gainesville (McClenny, 2012). The 2.2 mile section of the trail was to traverse SW 91st Street and SW 46th Boulevard as part of the Archer Braid Trail. The trail, when completed, would have linked the Kanapaha Park near Haile Plantation to the city of Archer in southwest part of Alachua County (Florida Department of Transportation, 2012). For now, the Archer Braid Trail runs along the south side of Archer Road, but terminates to the east at SW 91st Street, where it connects with an existing off-street facility that merges onto an on-street bike lane near Tower Road.

Bicycle Facilities in Alachua County

There is a total of 1,185 miles of roadways and trails in Alachua County. The on-road portion of the network is 823 miles, while 229 miles of the road portion includes paved shoulders or striped bike lanes. Of the entire 1,185-mile network, 362 miles are trails, however only 58 miles are existing. (Sprinkle Consulting, Inc., 2001)

There are several classifications of bicycle facilities in Alachua County. They are as follows:

- Alternate street-oriented route
- Dedicated street-oriented route with bike lane
- Dedicated street-oriented route with paved shoulder
- Future off-road trail
- No street facility without sidewalk
- No street facility with sidewalk
- Off-street facility
- Shared street-oriented route

These types of facilities differ based on their relative location in the right-of-way or how the facilities are marked on the ground. (City of Gainesville, 2011)

The least accessible facilities are those which include no lane or division from the road. Both types of lanes indicated with no street facility fit this description. There is no curb lane, no bicycle lane, and may or may not have a sidewalk. This is the least desirable type of facility. (City of Gainesville, 2011)

Moderately accessible facilities are those which are located on roads that are not busy or have lower speed limits, such as through residential neighborhoods. These facilities may have a wide parking lane that may or may not be in use. Alternate street-oriented routes and shared street-oriented routes are of this type. (City of Gainesville, 2011)

The most desirable routes are those which include facilities specifically intended for use by cyclists. Off-street facilities are paved routes that are separated from the road, such as rail-trails. Dedicated street-oriented routes are those which include a lane adjacent to the road which is marked for use by cyclists with pavements markings or signage. (City of Gainesville, 2011)

Valuing Residential Properties

In order to quantify the impact of an independent variable has on the value of residential properties, one must understand how the variables can impact the housing values. The value of residential properties is a function of several variables, and can be estimated using regression models such as the hedonic pricing model.

Variables

Estimation of the impact of bicycle lanes and trails on property values first requires an understanding of the variables which impact sale values. There are many different variables which contribute to the sale price of residential properties. The variables used by studies vary, but there are many concepts that apply to all of them.

According to Freeman (2003), the independent variables fall into three different categories: environmental, structural, and neighborhood. Environmental variables include those which are specific to a location, such as air quality or water quality. Structural variables include those which define certain physical aspects of the house (such as number of bedrooms or number of bathrooms), characteristics of the lot (such as acreage), presence of a particular amenity (such as a fireplace or garage), and miscellaneous property characteristics (such as the age of the home or the property's assessed value). Neighborhood variables include items such as quality of nearby schools, racial makeup of the neighborhood, or the household incomes of the neighborhood.

Nicholls & Compton (2005) expand the above categories into a six-category model. In addition to environmental, structural, and neighborhood variables, the property value is said to be impacted by community variables (such as school district) and separates these attributes from Freeman's definition of neighborhood variables. The property value is also said to be impacted by locational variables. Locational variables are those whose proximity and accessibility may or may not be desirable, and can include such disamenities (such as landfills or power lines) or amenities such as churches or parks. Lastly, the property value can be impacts by time-related variables, and typically involve attributes such as available interest rates or the number of days a property is on the housing market.

The estimated impact of a bicycle lane or trail on the resale price of a house can be determined by using proximity to the amenity as an explanatory variable. Explanatory variables, or independent variables, are those which contribute to the value of the dependent variable. In a simple linear regression, the regression equation contains just one explanatory variable. In a multiple linear regression, there are multiple explanatory variables. Using the hedonic pricing method, the dependent variable is the value of the home, and the structural, neighborhood, and environmental characteristics make up the explanatory variables. (Karadeniz, 2008)

Hedonic Pricing Model

The hedonic pricing model, as represented by Freeman (2003), can be represented using the following equation:

$$Rh_j = Rh\ (S_j, N_j, Q_j) \quad (2\text{-}1)$$

Where:

- Rh_j = the price of the jth residential location
- S_j = structural characteristics
- N_j = neighborhood characteristics
- Q_j = environmental characteristics.

Nicholls and Crompton (2005) provide a linearized model which includes the expanded six categories:

$$P = \beta_1 + \beta_S X_S + \beta_N X_N + \beta_C X_C + \beta_L X_L + \beta_E X_E + \beta_T X_T + \mu \quad (2\text{-}2)$$

Where:

- P = observed property prices
- X_S = structural attributes
- X_N = neighborhood attributes
- X_C = community attributes
- X_L = locational attributes
- X_E = environmental attributes
- X_T = time attributes
- β_1= constant term
- β_x = estimates of relevant attributes' implicit marginal prices after differentiation
- μ = stochastic disturbance term.

In both cases, the sale value of the residential property is represented by the dependent variable on the left side of the equation and the explanatory variables, represented by various attributes, is on the right side of the equation.

Geographically Weighted Regression

Geographically weighted regression is a form of linear regression which is used to model relationships which may differ spatially. This tool creates a separate regression model for each individual record in the provided dataset. The principle idea of GWR is that there is variation across a given spatial area which ordinarily least squares does not take into account. The availability of coefficients for individual records addresses the issue that the average coefficient over a large geographic area may not be representative of the sample dataset due to said variation across the landscape. (Legg & Bowe, 2009)

Study Limitations

These models are not without some limitations. One common problem among regression models is that the explanatory variables may not be independent of one another. For example, a home which has more bedrooms may also have more square footage. This phenomenon, called collinearity, or multicollinearity for three or more variables (Freeman, 2003), can cause the parameters of the hedonic pricing model to be exceptionally large or to have the incorrect sign, which may cause difficulty in determining which variables impact sale prices (Karadeniz, 2008).

Some variables may not be statistically significant to the study. To determine which variables are statistically significant, a backwards elimination technique can be used. This method handles issues stemming from multicollinearity. The backwards elimination technique begins by placing all of the independent variables into a multiple linear regression. The t-statistic value can then be used to determine the relative strength of prediction of each of the independent variables. The independent variable with the lowest significance is removed, and the process is repeated with additional variables being removed, one at a time, until all the t-statistics of the model are significant. The remaining variables can then be incorporated into the hedonic price model. (Karadeniz, 2008)

Case Studies

A number of studies have been completed for various municipalities to study the impact of bicycle lanes and bicycle trails on property values. Some have concluded that there is a positive impact, which others have concluded that there is a negative impact or no significant impact at all. Several studies have used opinion surveys to determine if homeowners perceive their proximity to a trail to increase their property's value, however there are some which have studied the impact using the hedonic pricing technique.

The first subsection discusses perceptions that homeowners and homebuyers have regarding their proximity to trails. These opinion-based studies largely use surveys or questionnaires to determine if property owners felt that living near a bicycle lane or bicycle trail has positive impacts, such as increased aesthetics or increased property values, or negative impacts, such as increased crime or decreased privacy. The second subsection discusses studies which use the hedonic pricing method to determine which attributes contribute to the resale value of a home. These attributes are largely the independent variables, which are discussed in the third subsection.

Opinion-Based Studies

A study by Greer (2000) of recreational trails and their effect on property values and public safety was conducted in Omaha, Nebraska. This study surveyed 149 households along three separate trail segments from the Omaha trail network. Questions related to the economic impact of the trails found the following statistics: 81%

of the respondents surveyed felt that the nearby trail's presence would have a positive effect or no effect on the ease of sale of their homes. The clear majority of residents (63.8%) who bought their homes after the construction of the trails reported that the trail had positively influenced their purchase decision, and residents living along the trails appear to perceive there to be a positive relationship between the trails and quality of life (75%).

Another study of home sales near two rail trails in Massachusetts found data related to the average time it took to sell homes in the area surrounding the trails. While the average sale price of the homes was similar whether or not they were located near a trail, the difference of the average time on the market was significant. Specifically, homes near rail trails sold in an average of 29.3 days as compared to 50.4 days for homes not near rail trails. (Penna, 2006) While this does not reflect on the value of the homes, it does suggest that properties located near rail trails may be more desirable than those that are not.

Hedonic Pricing Technique Studies

A study was performed by the University of Delaware in 2006 for the Delaware Center for Transportation and the State of Delaware Department of Transportation. In the paper, researchers sought to find how proximity to bicycle lanes and trails impacted residential property values in New Castle County, Delaware. GIS data was used in combination with a hedonic pricing model to calculate these values. In this study, a positive significance of approximately $8,800 was found for properties located within 50 meters of a trail. The study concludes that the effect of the nearby bike paths, while small, is positive. There is approximately a 4 percent increase in the value of homes located near trails. (Racca & Dhanju, 2006)

Nicholls and Crompton (2005) used the hedonic pricing method to study the impact of greenways in three different neighborhoods near the Barton Creek Greenbelt and Wilderness Park in Austin, Texas. The results were found to be insignificant in one neighborhood, Lost Creek, however the impact was substantial in the other two. In the Barton neighborhood, it was found that 12.20% ($44,332) of the resale value of a home was attributed to being adjacent to the greenway. In the Travis neighborhood, it was found that 5.70% ($14,774) of the resale value was attributed to greenway proximity. In all cases, only properties which were directly adjacent to the greenbelt showed a significant impact; those which had a view but were not adjacent had no significant positive impact on the sales price. (Nicholls & Crompton, 2005)

Lindsey, Man, Payton, and Dickson (2004) also used the hedonic method to study the Monon Trail, a rail trail which extends north out of Indianapolis. Results were positive and significant; homes within one-half mile of the trail were found to have 14% ($13,056) of their sale price attributed to proximity to this flagship trail. (Lindsey, Man, Payton, & Dickson, 2004)

A study completed by Campbell and Munroe (2007) showed similar results, but included results for multifamily and commercial properties in addition to single family homes located in Raleigh, North Carolina. In all cases, the value of the property increased as one moved closer to the trail. In single family homes, property values decreased 0.0312% for every 1% increase in distance from the greenway. In multifamily homes, the impact was just 0.0013%, and in commercial properties, the impact was 0.0172%. The study found that the highest increases in single family values were within 1,000 feet of the trail, however the impact was significant enough that homes within

5,000 feet (approximately one mile) had a higher value of $3,245 as compared to similar homes located farther away. For multifamily homes, the increased value was found to be $231. For commercial properties, the increased value was found to be $4,472. (Campbell & Munroe, 2007)

The impact of bicycle trails may not always be a positive one. The creation of bicycle trails in the United States has been controversial. Hawthorne, Krygier, & Kwan (2008) and Krizek (2007) discuss that trail opponents often believe trails will decrease their property values due to increased crime and negative effects on their privacy. This same literature also suggests that these concerns may be based on mistaken perceptions, which are the real reason behind the hostility and conflict surrounding the development of trails (Hawthorne, Krygier, & Kwan, 2008). Some consider spending money on bicycle facilities to be a luxury (Krizek, 2007) given that such a low percentage of people actually use them. Just 0.8% of trips in North America are completed by bicycle (Krizek, 2006).

In Krizek's study (2006), the author uses the hedonic pricing method to study homes in the Minneapolis-St. Paul "Twin Cities" region in Minnesota. The author in this instance used a different regression to compare the inner city versus the suburbs. In his research, the author hypothesized that greenways in suburbs were valued differently than those in the city because suburbanites were less likely to use bicycles as a source of transportation. The study confirmed this: properties within the inner city which are located within 400 meters of bicycle lane or within 400 meters of an off-street trail sold for $2,272 more and $510 less, respectively, suggesting that urban homeowners highly value access to bicycle lanes, but not access to trails. In the suburbs, homes within 400 meters of a bicycle lane sold for $1,059 more, indicating that suburbanites do place value on bicycle lanes, but less so than their urban counterparts. However, the study also found the suburban homes with 400 meters of an off-street trail sold for $240 more, suggesting that suburban homeowners value bicycle trails slightly. (Krizek, 2006)

A study by Netusil (2005) was performed in Portland, Oregon – largely regarded as a bicycle friendly community – which used the hedonic pricing method to examine the impact of environmental zoning on single-family housing prices. The study found that a trail within 200 feet of a single-family home would decrease its sale price by approximately 5.54%. The study suggests that this impact may be caused by noise and congestion stemming from proximity to a trail. The study goes on to state that the impact of the trail itself may not necessarily be the cause, as the negative impact may be caused by the proximity to industrial areas located near railroad rights-of-way which were later converted to trails.

Another study performed by Correll, Lillydahl, and Singell (1978) makes use of a similar model. This study involved three different neighborhoods within the city of Boulder, Colorado. Two of the three neighborhoods were found to have decreasing resale values in homes as one moves away from the trail. The third was found to have increasing values, indicating the living near the trail decrease property values. The article makes an interesting note that increased property values generate more tax income for the local government; as such, one can infer that a higher number of such public amenities can have large results on supporting one’s local government. (Correll, Lillydahl, & Singell, 1978)

Variables Used

The hedonic studies did not explain why the variables used were chosen. Of the hedonic studies reviewed, the most used variables were the acreage or lot size, the square footage of the home, and the age of the home at the most recent sale. The lot size was used in six studies, and found to be significant in each of them. The square footage was also used in six studies, although Campbell & Munroe (2007) used this variable only in evaluating commercial properties, not on single family or multifamily homes. The age of the sale was used in six studies as well. In the seven studies, the structural variables used to study single family properties are as follows: acreage/lot size (6), house size/square footage (6), age at sale (6), number of bathrooms (5), numbers of bedrooms (4), number of garage bays (4), number of stories (3), number of fireplaces (3), number of rooms (2), building value (2), years since last sale (1), air conditioning (1), porch (1), and land value (1).

The neighborhood variables used also vary by study. Each study used proximity to a trail, however some used an increasing distance to study the impact (Campbell & Munroe, 2007; Correll, Lillydahl, & Singell, 1978; Krizek, 2006; Netusil, 2005) in order to determine the change as distance increases from the trail. The other three studies used direct adjacency to the trail as a dummy variable (Lindsey, Man, Payton, & Dickson, 2004; Nicholls & Crompton, 2005; Racca & Dhanju, 2006). The other neighborhood variables used are as follows: racial makeup of neighborhood (3), school quality (2), and household incomes (2).

CHAPTER 3
METHODOLOGY

The goal of this case study is to determine whether or not there is an increased value of a residential property within a reasonable distance of a bicycle facility. The hypothesis is that there will be a small negative correlation between the property value and the distance to a bicycle facility; that is, as the distance increases from a bicycle facility, the just value of a home will decrease. In other words, properties nearest the facilities will be valued more due to their proximity. The relationship will be impacted by other structural and neighborhood variables, as previously discussed.

Two popular methods for valuing this premium include the use of opinion-based studies and hedonic pricing studies. While there are many studies that use respondents' opinions to assess value, these studies only show perception. They are useful for indicating qualities of a neighborhood which may impact value, and thus suggestions for variables in analysis, however the results are qualitative in nature. The goal of the study is to quantify the value by studying market values as determined by the property appraiser; as such, the hedonic pricing method is used for the purpose of this analysis.

The backwards elimination technique was first used to examine the significance of the available variables. Ordinary least squares was then used to determine the impact of each individual variable.

Case Study

Alachua County is located in North-Central Florida. It has an area of 969.12 square miles. As of the 2010 Census, the population was 247,336, with 255.22 persons per square mile. There were 96,544 households and 113,194 housing units. (U. S. Census Bureau, 2014) Gainesville is home to the University of Florida, the largest university in the state of Florida, as well as Santa Fe College. These two academic institutions both have a large student population. The University of Florida had 50,086 students (UF Office of Institutional Planning and Research, 2013) and Santa Fe College had 6,659 students (Santa Fe Office of Planning and Institutional Effectiveness, 2013) in 2013. The University of Florida also employs more than 41,000 people (University of Florida, 2013), and Shands Hospital (located on the university's campus) employs more than 12,000 (University of Florida, 2014). The University of Florida generated a substantial amount of concentrated bicycle traffic. Approximately 12% of the students, faculty, and staff commute to the university campus by way of bicycle. This number exceeds all other universities in the State University System in Florida combined. (Sprinkle Consulting, Inc., 2001)

Figure 3-1 shows the study area and bicycle facilities for study.

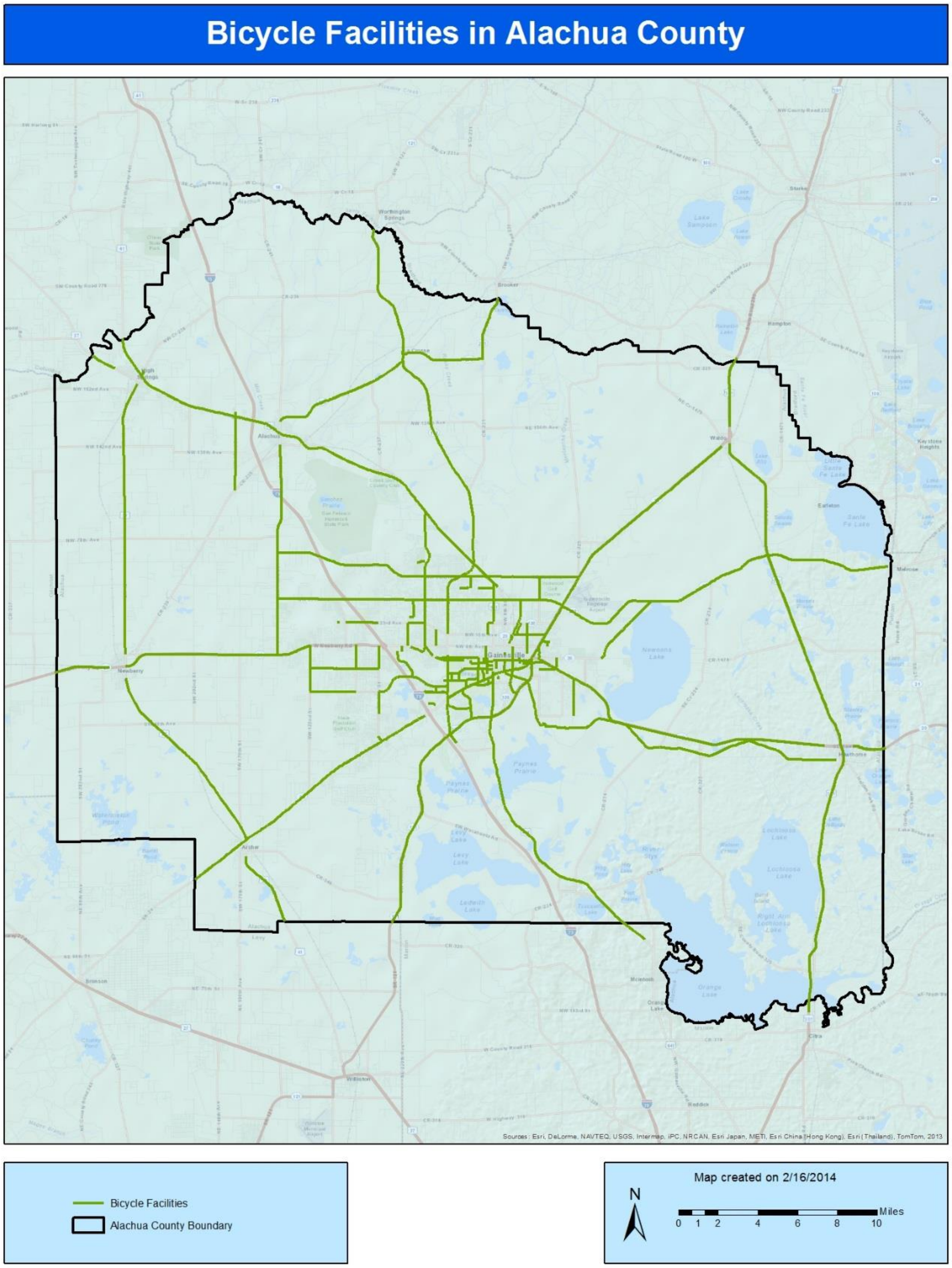

Figure 3-1. Map of study area and bicycle facilities.

Data Collection

There are a few important datasets needed for this study: a list of all of the single family residential parcels in Alachua County, and a list of all of the bicycle facilities within the county, as well as data pertaining to neighborhood attributes. Parcel data was obtained from the Florida Geographic Data Library (FGDL). Property data was obtained from the Alachua County Property Appraiser's GIS Service Center. This data, a master computer-assisted mass appraisal (CAMA) database, included several attributes pertaining the buildings and parcels located within the county. The bicycle facilities data was obtained from the City of Gainesville Public Works Department. This data included a list of every bicycle facility in the county, both existing and proposed. Data pertaining to neighborhood attributes was obtained from the 2010 United States Census. In order to simplify the regression, all datasets would require editing.

Parcels

The parcels data, provided by the Florida Department of Revenue and obtained from FGDL, was used for ease in determining which properties were zoned for single family residential use. This dataset, PARCELS_10, included the land use of each parcel located in the county. Because the study is focused only on single family property values, only those with the description "single family residential" were used. All other land uses were removed. Additionally, only parcels which were greater than 0.10 acres were used.

CAMA Tables

The CAMA dataset included an excess of information. Much of it was unnecessary for this study. From the CAMA dataset, only the GISbldgpub (building information) and GISsale (sale information) tables were used. These two tables include all of the variables used in the previously mentioned hedonic studies, such as those found in Lindsey, Man, Payton, & Dickson's study of the Monon Trail (2004) or Krizek's study of Minneapolis-St. Paul, Minnesota (2006). Data pertaining to the structure and land – acreage, square footage, age of home at most recent sale, number of bedrooms, number of bathrooms, and number of stores – were extracted from the GISbldgpub table. Data pertaining to the just value was extracted from the GISsale table. Only properties which included one or more bedroom, one or more bathroom, one or more story, and a properly formatted year built were used.

Bicycle Facilities

The bicycle facilities data is necessary to determine which properties lie within a reasonable distance of an appropriate facility. While the table includes data on every bicycle lane or trail in Alachua County, some of this data could not be used. Future off-road trails are not feasible for study as they have not yet been constructed and the study is intended to assess value based on existing trails. Additionally, routes with the attributes of "no street facility", "alternate street-oriented route", or "shared street-oriented route" are not feasible for study as these routes do not have facilities intended only for use by cyclists. Only off-street facilities (trails) and dedicated street-oriented routes were used (those with paved curb lanes or marked bicycle lanes); all other types were removed.

Census Data

Data from 2010 United States Census was obtained for neighborhood variables. The Census provides information about the population, race, and income on a census block, census block group, census tract, city, county, and state level. Percent minority and population density are available at a census block level, however the smallest denomination that income data is available at is the block group level. This data was joined using ArcMap to estimate the population density and percent minority in neighborhoods.

Combined Dataset

The edited parcel dataset and CAMA tables were combined using ArcMap using the parcel number to identify unique records. The Near analysis tool of ArcMap was then used to determine the distance from each parcel to its nearest off-street or dedicated street-oriented facility. The combined dataset contains 50,309 single family properties.

Table 3-1 lists the attributes available for use in the regression analysis.

Table 3-1. Attributes available in final dataset.

Attribute	Description
ParcelID	Parcel number as assigned by Alachua County Property Appraiser
Acres	Area of parcel in acres
LndSqFoot	Area of parcel in square feet
Amount	Amount of most recent sale
YearSale	Year of most recent sale
Beds	Number of bedrooms
Baths	Number of bathrooms
ActYr	Year structure was constructed
AC_code	Presence (1) or absence (0) of air conditioning
Heat_code	Presence (1) or absence (0) of heating
Stories	Number of stories in structure
TotArea	Total floor area of structure
Near_Dist	Distance to nearest applicable bicycle facility in meters
FtFromBL	Distance to nearest applicable bicycle facility in feet

Data Limitations

Upon review of the final dataset, it was determined that using a property's sale price as the dependent variable would present significant challenges due to questionable data quality, such as home sales with incorrectly formatted dates, or very large or very small sale prices. Additionally, housing prices may fluctuate greatly over time because of economic externalities. For these reasons, the just (market) value of the property was used. The just value is calculated by the Alachua County Property Appraiser using a computer-assisted mass appraisal (CAMA) method. The CAMA method determines the market value by analysis of similar properties' sales, the cost of reproducing property, and the ability of the property to earn income (Alachua County Property Appraiser, n.d.).

Regression Analysis

To answer the research questions, two different types of regression analyses were utilized: ordinary least squares (OLS) and geographically weighted regression (GWR). The first, OLS, was utilized using the methods set forth in the literature. The basis for analysis is derived from the following model:

$$V_i = f\,(L_i, S_i, N_i) \qquad (3\text{-}1)$$

Where:

- V_i = the just value of the ith residential location
- L_i = locational variables
- S_i = structural variables
- N_i = neighborhood variables.

The dependent variable in this model is the just value of the property. The locational, structural, and neighborhood variables are all independent variables. The model can be expanded into the following equation:

$$V_i = X_i + ActYrBlt_i + Acres_i + Beds_i + Baths_i + Stories_i + TotArea_i + AC\_code_i + FtFromBL_i + DenPop2010_i + Pct\_Mnrty_i \qquad (3\text{-}2)$$

Where:

- V_i = the just value of the ith residential location
- $ActyrBlt_i$ = Actual year built
- $Acres_i$ = Acreage of parcel

- $Beds_i$ = Number of bedrooms in property
- $Baths_i$ = Number of bathrooms in property
- $Stories_i$ = Number of stories in property
- $TotArea_i$ = Total covered area of property
- AC_code_i = Presence or absence of air conditioning
- $FtFromBL_i$ = Free to nearest bicycle facility
- $DenPop2010_i$ = Population density (persons/acre)
- Pct_Mnrty_i =Just (market) value.

The locational variable in the model is the distance of a property from the bicycle facility (FtFromBL). After running ordinary least squares, the expected coefficient of this attribute is negative, indicating decreasing property value as a property's distance from a bicycle facility increases. The distance was calculated using the Near function in ArcMap, which calculates the distance from each parcel to the nearest feature (in this case, bicycle facilities).

The structural variables in the model are the parcel size, total area, number of stories, number of bedrooms, number of bathrooms, and presence of air conditioning. The expected value of the parcel size, total area, number of bedrooms, and number of bathrooms is positive, indicating an increased property value as the number of each increases. The expected value of the presence of air conditioning and the presence of heating system is also positive, indicating an increased property value for each of these systems being present in the property. The expected value of the number of stories is negative, indicating a decreased property value as the height of the structure increases.

The neighborhood variables in the model are the percent minority and population density. The expected value of percent minority is negative, indicating a decreased property value as the percent minority increases. The expected value of population density is positive, indicating an increased property value as population density increases. This stems from the desire to be closer to the city where the population density is higher. The average population density of the city of Gainesville is 1993.17 persons per square mile, as compared to 255.22 persons per square mile for the whole of Alachua County.

Table 3-2 shows the variables to be used in the regression analysis and their expected values.

Table 3-2. Variables used in regression analysis.

Variable Name	Description	Type	Expected Value
ActYrBlt	Actual year built	Independent	+
Acres	Acreage of parcel	Independent	+
Beds	Number of bedrooms in property	Independent	+
Baths	Number of bathrooms in property	Independent	+
Stories	Number of stories in property	Independent	+
TotArea	Total covered area of property	Independent	+
AC_code	Presence or absence of air conditioning	Independent	+
FtFromBL	Feet to nearest bicycle facility	Independent	-
DenPop2010	Population density (persons/acre)	Independent	+
Pct_Mnrty	Percent minority	Independent	-
JV	Just (market) value	Dependent	n/a

The study seeks to address changing value as distance increases from bicycle facilities. Properties were chosen at different distances from the facilities in Alachua County: 500 feet, 1000 feet, 2000 feet, ¼ mile, and ½ mile. Additionally, all properties within the county were used to determine overall value.

Using ordinary least squares to study spatial relationships can create an issue because of spatial heterogeneity. OLS assigns a coefficient for each variable; the coefficient is, in essence, an average of the coefficients for each record in the data. Geographically weighted regression was used to account for this problem. GWR calculates a coefficient for each record in the data, and allows for the study to be analyzed at specific locations. In other words, the value of a property may be impacted in one part of the county different than in another part of the county.

Several different locations were chosen for additional analysis: parcels near the Hawthorne Trail, parcels near Millhopper Road, and parcels near the University of Florida, parcels near the intersection of SW Archer Road and SW 91st Street. Since they are both heavily travelled for recreational use, the expected value for parcels near the Hawthorne Trail and near Millhopper Road is negative, indicating decreasing value as one moves away from these facilities. The expected value for parcels near the University of Florida is negative, indicating decreasing value as one moves away from the university. The value is expected to be negative because of the concentration of bicycle lanes near the university, facilitating ease in commuting by bicycle for students. The expected value for parcels near the intersection of SW Archer Road and SW 91st Street is positive, indicating an increasing value as one moves away from bicycle facilities. This value is expected to be positive due to strong opposition for extension and expansion of the bicycle trails in this area.

CHAPTER 4
FINDINGS AND RESULTS

Ordinary Least Squares (OLS)

Ordinary least squares was employed first, utilizing just value as the dependent variable, and ten explanatory variables. Regressions were run for the entire county, and at distances of a 500 feet, 1,000 feet, 2,000 feet, ¼ mile, and ½ mile away from a bicycle facility. Table 4-1 shows the results for each regression.

Table 4-1. Results of ordinary least squares.

Variable Name	Model 1 Alachua County Coefficient (T-Statistic)		Model 2 500 feet Coefficient (T-Statistic)		Model 3 1,000 feet Coefficient (T-Statistic)		Model 4 2,000 feet Coefficient (T-Statistic)		Model 5 1/4 mile Coefficient (T-Statistic)		Model 6 1/2 mile Coefficient (T-Statistic)	
ActYrBlt	401.19	*	333.99	*	357.01	*	353.14	*	355.58	*	361.82	*
	(-41.39)		(14.50)		(23.10)		(30.48)		(26.10)		(33.09)	
Acres	2400.77	*	2965.07	*	2857.54	*	2903.44	*	2940.26	*	2799.54	*
	(39.14)		(15.74)		(18.19)		(24.01)		(19.89)		(24.41)	
Beds	-3682.95	*	964.51		-1990.16	*	-3534.26	*	-2825.55	*	-3756.01	*
	(-10.00)		(1.11)		(-3.32)		(-7.97)		(-5.36)		(-9.10)	
Baths	17672.42	*	17150.00	*	764.39	*	14932.34	*	14259.55	*	15513.82	*
	(472.56)		(15.55)		(18.06)		(26.28)		(21.21)		(29.46)	
Stories	565.91		4057.42	*	3200.62	*	4031.34	*	3677.31	*	2084.95	*
	(483.01)		(3.18)		(3.67)		(6.48)		(4.90)		(3.66)	
TotArea	65.82	*	53.80	*	61.40	*	62.48	*	61.91	*	64.25	*
	(219.34)		(73.49)		119.62		(164.51)		(136.84)		(183.86)	
AC_code	-5666.05	*	-239.80		-1034.10		-2568.30	*	-2496.98	*	-3777.14	*
	(-6.59)		(-0.14)		(-0.84)		(-2.70)		(-2.25)		(-4.17)	
FtFromBL	0.15	*	4.45		4.20	*	1.62	*	3.66	*	1.30	*
	(2.15)		(1.30)		(3.58)		(3.56)		(4.65)		(3.93)	
DenPop2010	1293.41	*	1921.87	*	1653.47	*	1535.49	*	1586.09	*	1310.00	*
	(21.74)		(15.51)		(18.71)		(22.56)		(20.29)		(21.46)	
Pct_Mnrty	-154.41	*	-198.11	*	-167.39	*	-185.23	*	-179.96	*	-168.54	*
	(-18.78)		(-11.33)		(-13.75)		(-20.25)		(-16.66)		(-19.68)	
R-Squared	0.80		0.72		0.76		0.78		0.76		0.79	
n	50,309		8,905		17,354		31,061		22,698		36,729	

*An asterisk next to a number indicates a statistically significant p-value ($p < 0.05$).

Alachua County

Using all of Alachua County, excluding the properties which lack proper attributes (regarding the number of stories, number of bedrooms, and number of bathrooms), resulted in a dataset containing 50,309 properties. The average just value for these properties was $147,277.34, and the average distance from a bicycle facility was 2,105.14 feet.

After running ordinary least squares, a multiple R-squared value of 0.80 was returned, indicating that 80% of the just value of the included properties could be explained by the variables used. All variables, with the exception of the number of stories, were found to be statistically significant at the 0.05 probability level. Based on the output, value of properties increases by $0.15 per foot as one moves away from a bicycle facility. The presence of air conditioning yielded a negative coefficient, indicating a lower value for properties with air conditioning, a value which is contrary to the expected value.

500 feet

Next, regressions were run at various distances. Selecting only properties within 500 feet of a bicycle facility resulted in a dataset with 8,905 properties. These properties had an average just value of $124,920.48, with an average distance from a bicycle facility of 204.94 feet.

The OLS results for the 500 foot data set yielded a multiple R-squared value of 0.72, indicating that 72% of the just value of the included properties could be explained by the variables used. The number of bedrooms, presence of air conditioning, and feet away from a bike lane were all found to not be statistically significant below the 0.05

level. The t-statistic for total area, a value of 73.49, indicates that this variable has the greatest influence.

1,000 feet

A distance of 1,000 feet was selected next to include additional nearby properties which may impacted by their location relative to a bicycle facility. In the 1,000 foot dataset, there were a total of 17,534 properties. These properties had an average just value of $128,238.63. The average distance to the nearest bicycle facility was 424.89 feet.

After running ordinary least squares on the 1,000 foot dataset, all variables were found to be statistically significant at the 0.05 level, with the exception of the presence of air conditioning. The multiple R-squared value for this dataset was 0.76, indicating that 76% of the just value could be attributed to these variables. Furthermore, it was found that the coefficient for the number of bedrooms was -1990.16, indicating that was the number of bedrooms increases, the just value of the home decreases. This is contrary to the expected value, suggesting that there may be an issue with this model. A t-statistic of 119.62 was found for the total area, once again indicating that this was the more influential variable. The coefficient for distance from bike lane was found to be positive and significant; the value of a property increases by $4.20 for every foot one moves away from the facility.

2,000 feet

A dataset for properties within 2,000 feet of a bicycle facility was selected next. Within this dataset, there was 31,061 single family properties, more than half of those within the entire county. The average just value for these properties was $132,905.48, with an average distance of 787.40 feet to the nearest bicycle facility.

Once again, the results of ordinary least squares were questionable. All variables were found to be statistically significant, and the R-squared value was found to be 0.78, signifying that 78% of the just value could be explained by these variables. However, despite being statistically significant, the coefficient for the number of bedrooms was negative – a value of -3,534.26 – suggesting that the just value of homes within this dataset decreases as the number of bedrooms increases. Additionally, the coefficient for the presence of air conditioning was negative, suggesting that homes with air conditioning are valued less than those without. Both of these statistics do not conform to expected values. The coefficient for distance from bike lane was found to be positive and significant; the value of a property increases by $1.62 for every foot one moves away from the facility. Once again, the t-statistic for the total area indicated that this was the most influential variable.

¼ mile

A distance of ¼ mile was selected next, to attempt to explain the difference between the results of the 1,000 foot and 2,000 foot datasets. Within ¼ mile of a bicycle facility, 22,698 properties are located. These properties have an average just value of $130,149.09, and are located an average distance of 556.52 feet from a bike lane.

The ordinary least squares results for the ¼ mile dataset were found to be similar to those of the 2,000 foot dataset. A multiple R-squared value of 0.76 was found, indicating that 76% of the just value could be explained by these variables. All ten variables were found to be statistically significant. The large negative coefficient for the number of bedrooms raised concern once again, as did the large negative coefficient for the presence of a bicycle facility. OLS yielded a coefficient of 3.66 for the distance from bike lane variable; this indicated that properties increase in value by $3.66 for every foot one moves away from the bicycle lane.

½ mile

Lastly, a distance of ½ mile was used. This value was chosen because it was the furthest distance at which other studies were able to produce consistent results with negative coefficient for the distance from bike lane variable. Within the ½ mile dataset are 36,729 single family properties. These properties have an average just value of $136,191.68. The average distance from a bicycle facility for these properties is 974.24 feet.

The OLS results for the ½ mile dataset were similar to the ¼ mile and 2,000 foot datasets, as well as the whole Alachua County dataset. As before, all variables were found to be statistically significant. The variable with the most influence was the total area once again, with a t-statistic of 183.36 and a coefficient of 64.25. This result is similar to the result found in the dataset for the whole county. The coefficient of 1.30 for the distance from bike lane suggests once again that the value of properties increases as one moves away from the facility. In this case, that value is $1.30 per foot.

Outcome of OLS

The results of these datasets may not be reliable for a variety of reasons. The expected value of the coefficient for some variable is contrary to what one would rationally expect. For example, in Florida, the presence of an air conditioning system would be expected increase property value rather than decrease it. The same could be said for the number of bedrooms. There is additional concern regarding the number of bedrooms, as its value is related to the total area; that is, properties with more bedrooms tend to have larger square footage. Given that no model provided by the literature indicated a negative relationship, the reliability of these models is questionable.

While the coefficient for distance from bike lane was positive and significant in most results, the reliability of these results is questionable as well. It is hypothesized that the value may vary, depending upon the location in the county. For example, the value of a property near the University of Florida may be found to be influenced greatly by its proximity to a bicycle facility. Given that there is insufficient parking on and around the campus, the use of alternative transportation such as bicycles can be expected for commuters.

Another example where location may factor in is the residential areas around the Hawthorne Trail. The 16-mile trail allows for recreational bicycling; it is possible that properties located adjacent or near the trail will be influenced by their proximity.

Complete descriptive statistics for ordinary least squares regressions can be found in Appendix A.

Geographically Weighted Regression (GWR)

Since the ordinary least squares results include properties throughout all of Alachua County, geographically weighted regression was employed to address spatial differences. While ordinary least squares disregards the possibility of spatial variants, geographically weighted regression, a function found in the ArcMap GIS software, creates a regression for each individual feature (in this case, each parcel) located in the dataset.

After the GWR was executed, 14,015 of the 50,309 parcels (27.9%) returned coefficients of $-1.797698 \times 10^{308}$. According to the manufacturer of the ArcMap software, ESRI, features (parcels) which return this value should not be trusted due to local multicollinearity (ESRI, 2013); thus, these records were removed, leaving 36,294 parcels to evaluate. Descriptive statistics for these remaining parcels as used for geographically weighted regression can be found in Appendix B.

When using properties within the whole county, all coefficients showed their expected sign, with the exception of the distance from bike lane variable. This suggests that over all, the value of homes is not positively impacted by bicycle lanes, and is supported by the results of the ordinarily least squares analysis. However, the location at which a home is located may produce different results. For the 36,294 properties in the county, 15,318 (about 42%) showed a negative coefficient for the distance to bike lane variable. This means that the just value for about 42% of the properties in the GWR dataset is increased by their proximity to a bicycle facility. Figure 4-1 shows the locations of the negatively and positively correlated properties within the whole county.

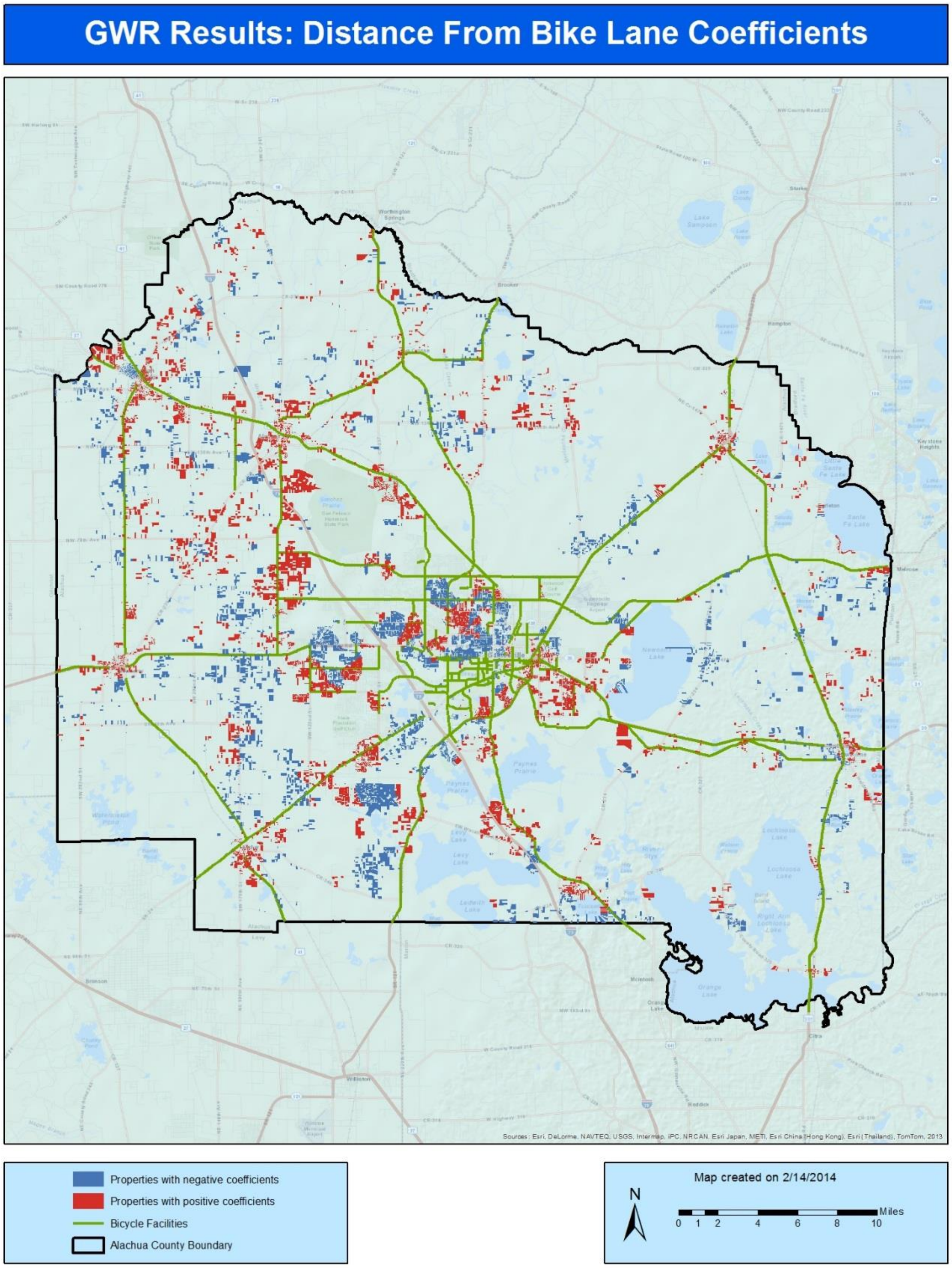

Figure 4-1. Coefficients for distance from bike lane variable for all properties in GWR dataset.

The mean just value for the GWR dataset is $138,383.99. The mean just value for the properties with a negative correlation coefficient for the feet from bike variable is $141,693.93; in other words, the average value added by bicycle lanes can be estimated at $3,309.94 (a 2.9% increase) in locations where there is an added value in Alachua County. The averages for the entire county may not necessarily be reliable, therefore specific locations would need to be chosen for additional analysis.

Four locations were selected within the county for additional analysis. The first location includes single family homes around the University of Florida. This location was chosen because of the homes' proximity to the university campus, facilitating ease in commuting by bicycle, and shown in the data supporting bicycle ridership. It is hypothesized that this area will exhibit a negative correlation as one moves away from the university campus; that is, properties located further from the university will be valued less than those located near it. The second and third locations include single family properties near the Hawthorne Trail and single family properties near Millhopper Road. The locations were chosen because of their popularity among recreational cyclists. The Hawthorne Trail is an off-street facility, while Millhopper Road has a striped bicycle lane with signage. It is hypothesized that these two areas will exhibit a negative correlation to increasing distance as well. Lastly, single family homes near the intersection of SW Archer Road and SW 91st Street (near Haile Plantation) were selected for the fourth location. This area was chosen because of recent strong opposition by residents to expand bicycle facilities through this area. It is therefore expected that there will be a positive correlation at this location, indicating that properties further away from the trail will be valued more than those properties which are closest to it.

For each of these locations, single family homes were evaluated within one mile of the facility, or in the case of the university campus, within one mile of the border. This distance was chosen because it was the furthest distance in the literature at which all variables were statistically significant, regardless of their sign.

University of Florida

There are 3,212 single family properties in the GWR dataset which are within one mile of the University of Florida boundary. Of these, 2,492 (about 78%) exhibited a negative coefficient for the feet from bike lane variable. The mean coefficient for this location is -2.92, suggesting that, on average, the just value of homes within one mile of the University of Florida increase by $2.92 for every foot one moves closer to the university. The average distance from a bicycle facility for this location is 1102.40 feet (a little less than ¼ of a mile). The values in this area conform to the expected value.

Figure 4-2 shows the homes within one mile of the University of Florida and whether they are positive or negatively impacted.

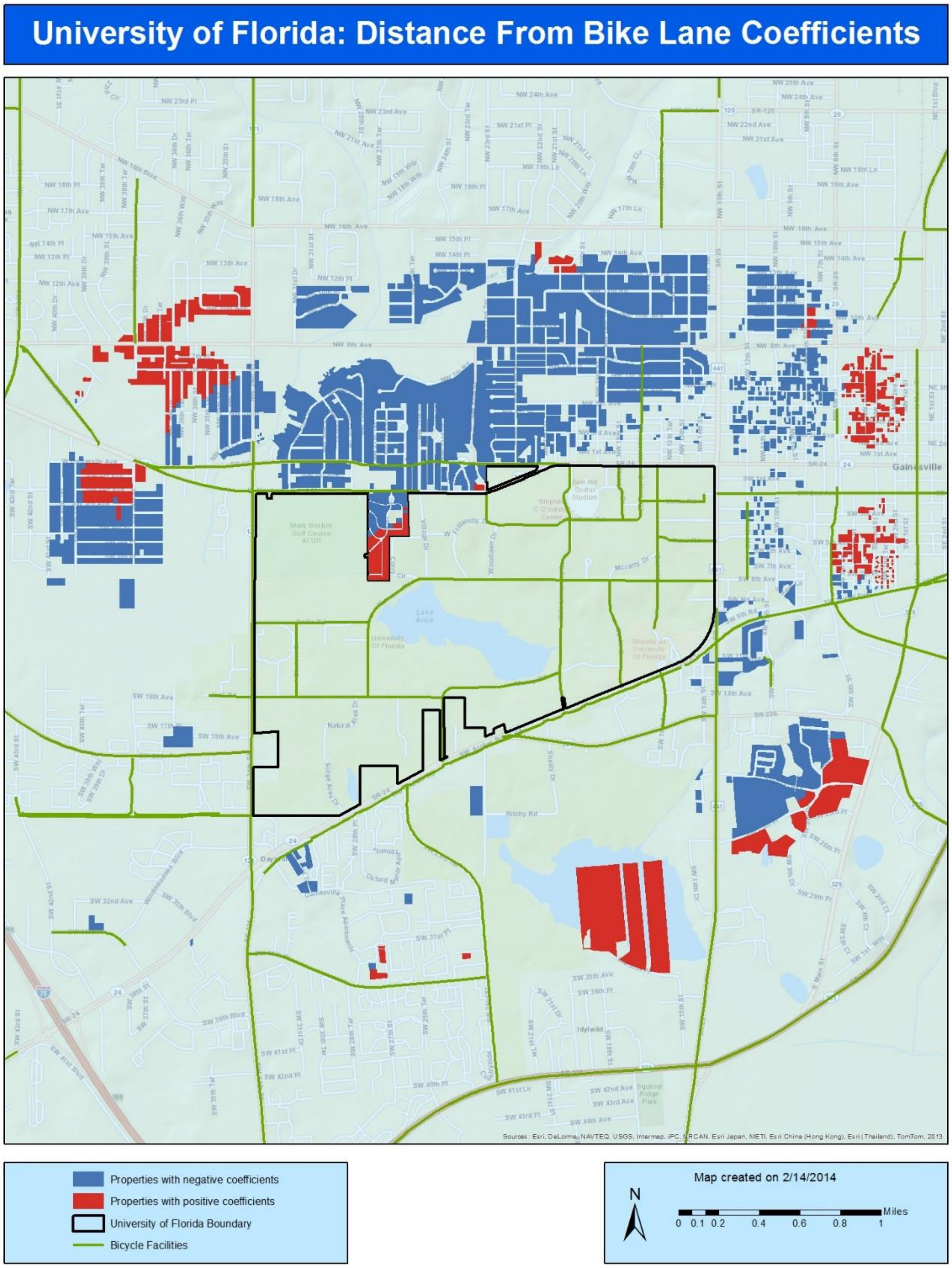

Figure 4-2. Coefficients for distance from bike lane variable for all properties within one mile of the University of Florida.

Hawthorne Trail

There are 895 single family properties in the GWR dataset within one mile of the Hawthorne Trail. Of these, only 283 produced a negative coefficient for the feet from bike lane variable. The mean coefficient for these homes is 2.36, suggesting that the average just value increases by $2.36 per foot as one moves away from the trail. The average distance from the trail is 1027.16 feet. The values in this area do not conform to the expected value.

Figure 4-3 shows the homes within one mile of the Hawthorne Trail and how their just value is impacted by proximity.

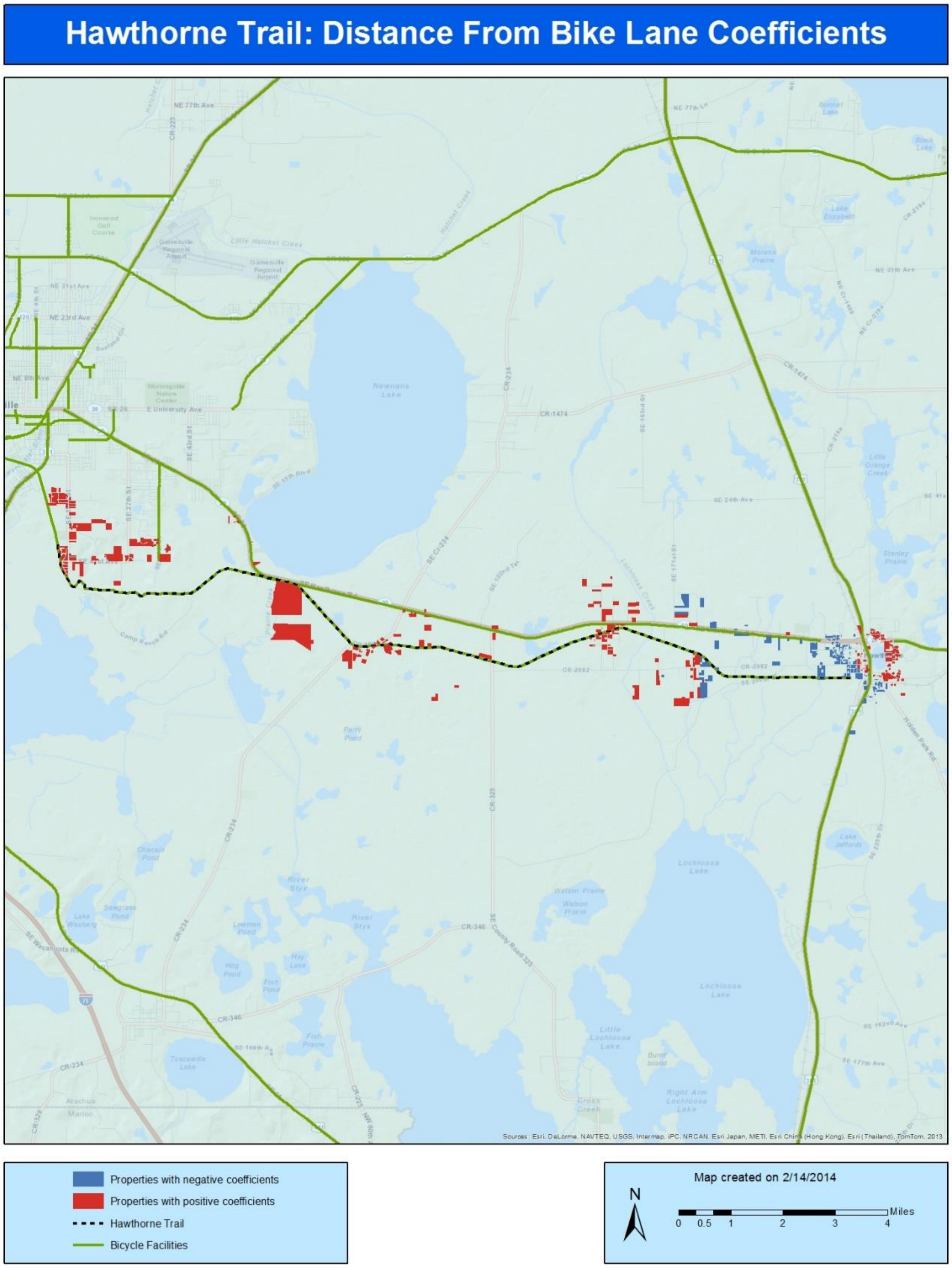

Figure 4-3. Coefficients for distance from bike lane variable for all properties within one mile of the Hawthorne Trail.

Millhopper Road

Within one mile of Hawthorne Road, there are 313 single family parcels in the GWR dataset. Of those, just 53 (about 17%) produced a negative coefficient for the feet from bike line variable. The mean coefficient for these properties is 4.67, indicating that the average just value increases by $4.67 for each foot further from the trail. The average distance to Millhopper Road is 900.03 feet. The values in this area do not conform to the expected value.

Figure 4-4 shows the properties within one mile of Millhopper Road and whether they are positively or negatively impacted.

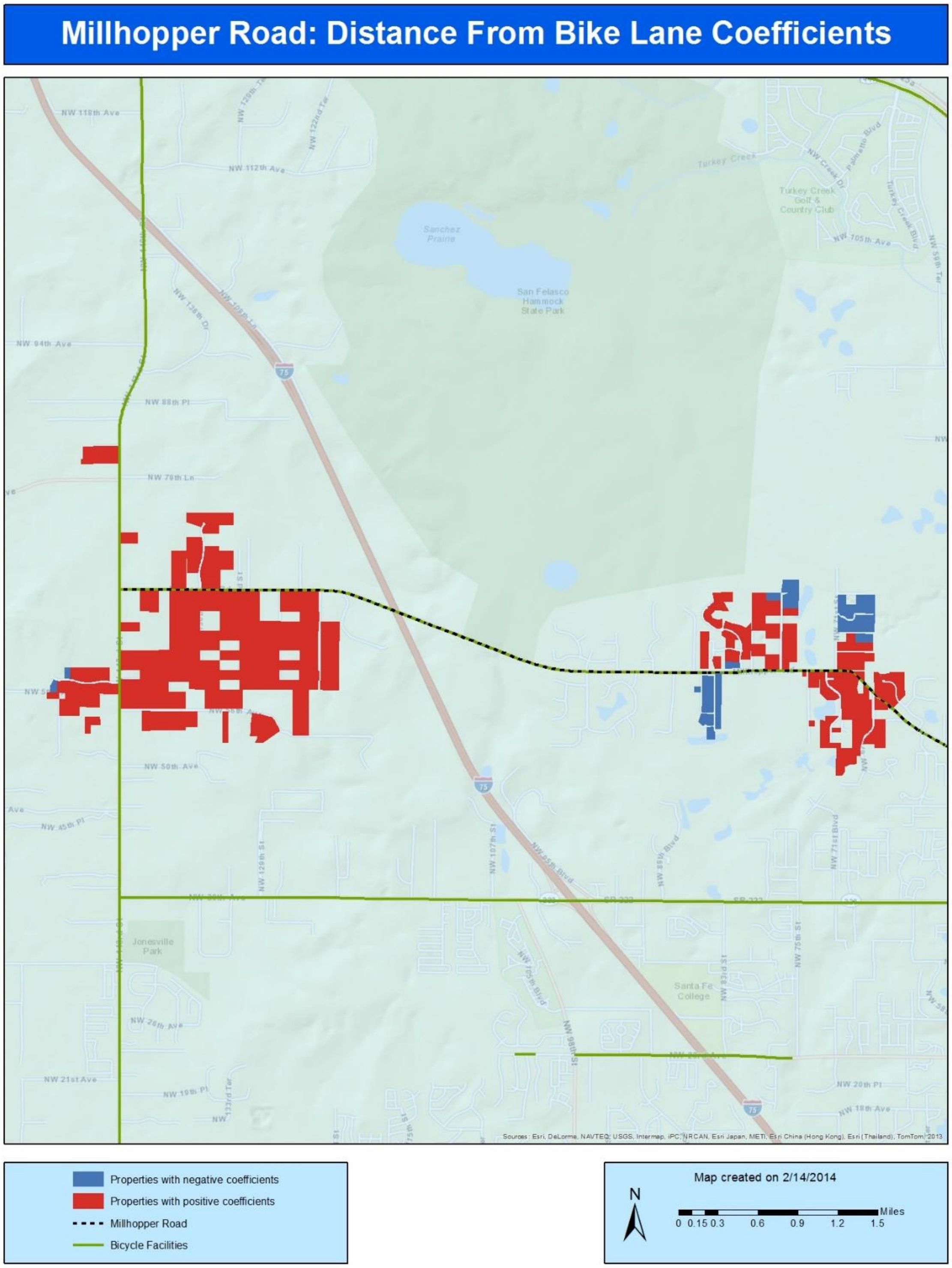

Figure 4-4. Coefficients for distance from bike lane variable for all properties within one mile of Millhopper Road.

SW Archer Road & SW 91st Street

There are 1,135 single family properties within one mile of the intersection of SW Archer Road and SW 91st Street in the GWR dataset. Within this area, not a single property showed produced a negative correlation for the feet from bike lane variable. The mean coefficient for this location was 5.95, indicating an increase of $5.95 for each foot one moves away from a bicycle facility. This conforms to the expected value.

Figure 4-5 shows the properties within one mile of the intersection of SW Archer Road and SW 91st Street and how their proximity is impacted.

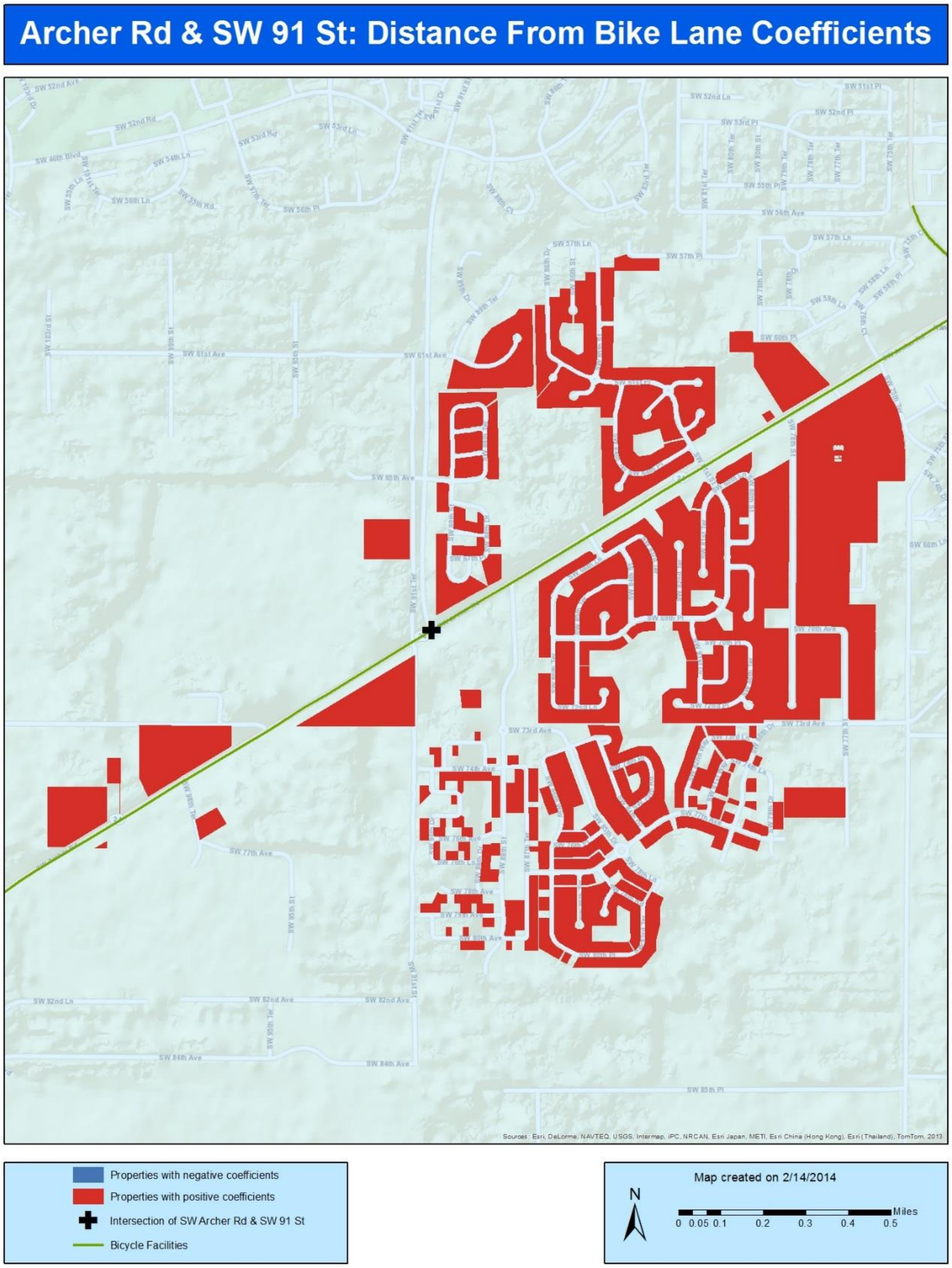

Figure 4-5. Coefficients for distance from bike lane variable for all properties within one mile of the intersection of SW Archer Road and SW 91st Street.

CHAPTER 5
DISCUSSION AND CONCLUSION

Discussion

As discussed in the literature, the value of a home can be attributed to many factors. The value differs depending upon the attributes of the property, the location, as well as the distance from an available facility. Environmental factors may also play a role in determining a home's value. It has been shown that the structural attributes of a single family properly produce the most impact on a home's value. This is reflected in the t-statistic of the total area of the property repeatedly producing a high value in different ordinary least squares regressions. The total value is further contributed to by the locational and neighborhood characteristics, albeit to a lesser extent.

When reviewing the locational variable, feet from bike lane (FtFromBL), the distance was found to be important, however accessibility is important to consider as well. For example, properties along the Hawthorne Trail were mostly found to not benefit from their proximity to this amenity. This does not fit the expected outcome; however the values of properties closest to the east trailhead near the city of Hawthorne did show an increased just value. The properties along the trail may not have direct access because of other neighboring properties, fences, or terrain. Trail users may need to travel a distance more than the studied distance in order to access the trail.

The issue of accessibility can also be applied to homes in neighborhoods. While a property may lie within a linear distance of a facility, it may not be directly accessible within that distance because of the design of the neighborhood. Depending upon that design, a user of a particular facility may be required to travel a distance further than the studied distances. To study the issue of accessibility, further analysis utilizing the Network Analyst feature of ArcMap would be informative.

The type of facility may also have an impact. Casual cyclists may see less value in striped bicycle lanes because of perceived safety, particularly of those along major or busy roads. They may only see recreational value in off-street facilities such as the Hawthorne Trail. However, the impact of off-street facilities may also produce a negative impact. This stems from homeowners' perceptions regarding how a trail impacts their properties. While positive impacts are present, such as recreational benefits, some residents view the nearby trails as a potential source of crime. Others view the trails as negatively impacting privacy. These perceptions can lead to decreased value, as seen in the neighborhoods near the intersection of SW Archer Road and SW 91st Street, an area in which the expansion of a bicycle trail was contested, and eventually blocked.

Limitations

The study was developed to analyze single family properties, therefore the results cannot be applied to multi-family properties or commercial properties. These types of properties may be impacted in a similar manner as nearby single family properties. Further research into the effect of bicycle facilities on the values of mutli-family residences and commercial properties would be useful.

The use of ordinary least squares produced a best case R-squared value of 0.80 indicating that the ten variables used explained 80% of the variation in just values among the single family properties studied. The other 20% (or greater, at some distances) of the variation may be explained by variables which were not included in the model. For example, the value of properties may be impacted by a waterfront view or proximity to a park. There are many possibilities to consider, all of which cannot simply be covered in this study.

The just value of a home may also not be a truly accurate representation of value to an individual. The property appraiser determines this value, however the actual price of the property when sold may be determined by other factors, such as the amount time on the market or structural characteristics that are not available from the property appraiser, such as a home being fenced in or having been remodeled or upgraded. In regards to the distance from a bicycle lane, a homebuyer may search for a home and value it more because of its proximity and accessibility if the homebuyer is choosing the property explicitly for those reasons. A study of the actual sale prices of homes would be useful, however inconsistent data from the property appraiser and lack of data pertaining to sales which appear to not be arm's length transactions complicate this concept. Quantifying this value is difficult, however with quality data, the use of regression can help to estimate this value.

Conclusion

This study examined how bicycle lanes in Alachua County impact property values of single family homes. Locational, structural, and neighborhood values were employed using ordinary least squares regression to create a hedonic pricing method. Geographically weighted regression was then used to improve upon the results by studying specific locations. Results showed that the impact varies greatly depending upon location. Further examination of specific bicycle facilities in Alachua County confirmed that the impact can be positive or negative, and varies based on that location. One may draw the conclusion that when studying locational variables, a case by case approach should be taken given the impact of location on the relationship.

APPENDIX A
RESULTS OF ORDINARY LEAST SQUARES

Table A-1. Descriptive statistics for all single family properties within Alachua County.

Variable Name	Minimum	Maximum	Mean	Standard Deviation
ActYrBlt	1853	2011	1978.18	21.19
Acres	0.10	159.55	1.01	2.48
Beds	1	5	3.11	0.67
Baths	1	10	2.00	0.68
Stories	1	5	1.14	0.42
TotArea	180	22685	2375.78	1082.24
AC_code	0	1	0.94	0.24
FtFromBL	0	34324.10	2105.14	2895.89
DenPop2010	0	146.63	3.77	3.50
Pct_Mnrty	0	100	29.86	25.17

n = 8,905

Table A-2. Descriptive statistics for all single family properties within 500 feet of a bicycle facility in Alachua County.

Variable Name	Minimum	Maximum	Mean	Standard Deviation
ActYrBlt	1853	2011	1971.82	23.41
Acres	0.10	159.55	0.85	2.46
Beds	1	5	3.00	0.65
Baths	1	8	1.88	0.64
Stories	1	3	1.10	0.37
TotArea	252	22685	2127.00	963.99
AC_code	0	1	0.91	0.28
FtFromBL	0	434.02	204.95	131.38
DenPop2010	0	57.39	4.10	3.78
Pct_Mnrty	0	100	32.95	26.93

n = 8,905

Table A-3. Descriptive statistics for all single family properties within 1,000 feet of a bicycle facility in Alachua County.

Variable Name	Minimum	Maximum	Mean	Standard Deviation
ActYrBlt	1853	2011	1973.42	22.43
Acres	0.10	159.55	0.71	2.00
Beds	1	5	3.03	0.65
Baths	1	8	1.90	0.64
Stories	1	4	1.11	0.37
TotArea	252	22685	2160.86	961.95
AC_code	0	1	0.92	0.27
FtFromBL	0	868.30	424.89	257.47
DenPop2010	0	70.61	4.26	3.60
Pct_Mnrty	0	100	32.41	26.54

n = 17,534

Table A-4. Descriptive statistics for all single family properties within 2,000 feet of a bicycle facility in Alachua County.

Variable Name	Minimum	Maximum	Mean	Standard Deviation
ActYrBlt	1853	2011	1974.71	21.91
Acres	0.10	159.55	0.69	1.90
Beds	1	5	3.07	0.65
Baths	1	8	1.93	0.64
Stories	1	4	1.11	0.38
TotArea	252	22685	2214.40	981.98
AC_code	0	1	0.93	0.25
FtFromBL	0	1735.78	787.40	483.86
DenPop2010	0	70.60	4.25	3.46
Pct_Mnrty	0	100	32.08	26.19

n = 31,061

Table A-5. Descriptive statistics for all single family properties within ¼ mile of a bicycle facility in Alachua County.

Variable Name	Minimum	Maximum	Mean	Standard Deviation
ActYrBlt	1853	2011	1974.06	22.17
Acres	0.10	159.55	0.69	1.86
Beds	1	5	3.04	0.64
Baths	1	8	1.91	0.63
Stories	1	4	1.11	0.37
TotArea	252	22685	2178.89	962.14
AC_code	0	1	0.93	0.26
FtFromBL	0	1146.52	556.52	333.90
DenPop2010	0	70.61	4.27	3.56
Pct_Mnrty	0	100	31.90	26.15

n = 22,698

Table A-6. Descriptive statistics for all single family properties within ½ mile of a bicycle facility in Alachua County.

Variable Name	Minimum	Maximum	Mean	Standard Deviation
ActYrBlt	1853	2011	1975.49	21.69
Acres	0.10	159.55	0.70	1.87
Beds	1	5	3.08	0.66
Baths	1	8	1.95	0.66
Stories	1	4	1.12	0.39
TotArea	180	22685	2253.95	1016.17
AC_code	0	1	0.93	0.25
FtFromBL	0	2292.51	974.24	627.08
DenPop2010	0	146.63	4.24	3.61
Pct_Mnrty	0	100	32.13	26.27

n = 36,729

Summary of OLS Results

Variable	Coefficient [a]	StdError	t-Statistic	Probability [b]	Robust_SE	Robust_t	Robust_Pr [b]	VIF [c]
Intercept	-825092.666261	19936.160673	-41.386738	0.000000*	42712.177343	-19.317504	0.000000*	--------
ACTYRBLT	401.193457	10.249573	39.142456	0.000000*	21.941645	18.284566	0.000000*	1.364472
ACRES	2400.766428	82.241733	29.191584	0.000000*	321.358134	7.470688	0.000000*	1.201355
BEDS	-3682.948841	368.326458	-9.999143	0.000000*	650.153702	-5.664736	0.000000*	1.775606
BATHS	17672.416522	472.561964	37.397035	0.000000*	1048.248164	16.859001	0.000000*	3.010816
STORIES	565.907800	483.014126	1.171617	0.241355	855.712344	0.661329	0.508402	1.163848
TOTAREA	65.818793	0.300074	219.341934	0.000000*	1.276233	51.572708	0.000000*	3.048192
AC_CODE	-5666.049321	859.204568	-6.594529	0.000000*	1008.412327	-5.618782	0.000000*	1.200961
FTFROMBL	0.149378	0.069437	2.151284	0.031443*	0.114387	1.305908	0.191599	1.168645
DENPOP2010	1293.405697	59.489206	21.741855	0.000000*	104.380753	12.391228	0.000000*	1.252915
PCT_MNRTY	-154.405979	8.220666	-18.782662	0.000000*	10.108473	-15.274907	0.000000*	1.237445

OLS Diagnostics

Input Features:	parcels_cenblk selection	Dependent Variable:	JV
Number of Observations:	50309	Akaike's Information Criterion (AICc) [d]:	1213234.224096
Multiple R-Squared [d]:	0.803203	Adjusted R-Squared [d]:	0.803164
Joint F-Statistic [e]:	20528.570854	Prob(>F), (10,50298) degrees of freedom:	0.000000*
Joint Wald Statistic [e]:	69554.265208	Prob(>chi-squared), (10) degrees of freedom:	0.000000*
Koenker (BP) Statistic [f]:	4764.793410	Prob(>chi-squared), (10) degrees of freedom:	0.000000*
Jarque-Bera Statistic [g]:	5003943.390375	Prob(>chi-squared), (2) degrees of freedom:	0.000000*

Notes on Interpretation

* An asterisk next to a number indicates a statistically significant p-value ($p < 0.05$).

[a] Coefficient: Represents the strength and type of relationship between each explanatory variable and the dependent variable.

[b] Probability and Robust Probability (Robust_Pr): Asterisk (*) indicates a coefficient is statistically significant ($p < 0.05$); if the Koenker (BP) Statistic [f] is statistically significant, use the Robust Probability column (Robust_Pr) to determine coefficient significance.

[c] Variance Inflation Factor (VIF): Large Variance Inflation Factor (VIF) values (> 7.5) indicate redundancy among explanatory variables.

[d] R-Squared and Akaike's Information Criterion (AICc): Measures of model fit/performance.

[e] Joint F and Wald Statistics: Asterisk (*) indicates overall model significance ($p < 0.05$); if the Koenker (BP) Statistic [f] is statistically significant, use the Wald Statistic to determine overall model significance.

[f] Koenker (BP) Statistic: When this test is statistically significant ($p < 0.05$), the relationships modeled are not consistent (either due to non-stationarity or heteroskedasticity). You should rely on the Robust Probabilities (Robust_Pr) to determine coefficient significance and on the Wald Statistic to determine overall model significance.

[g] Jarque-Bera Statistic: When this test is statistically significant ($p < 0.05$) model predictions are biased (the residuals are not normally distributed).

Figure A-1. Ordinary least squares results for all single family properties in Alachua County.

Summary of OLS Results

Variable	Coefficient [a]	StdError	t-Statistic	Probability [b]	Robust_SE	Robust_t	Robust_Pr [b]	VIF [c]
Intercept	-692227.472639	41805.686843	-16.558213	0.000000*	136211.721696	-5.081996	0.000001*	--------
ACTYRBLT	333.993113	21.550574	15.498107	0.000000*	69.994601	4.771698	0.000003*	1.329521
ACRES	2965.069290	188.338502	15.743299	0.000000*	1540.996390	1.924125	0.054367	1.120833
BEDS	964.512601	871.875753	1.106250	0.268642	1992.964253	0.483959	0.628441	1.676592
BATHS	17149.995816	1103.080716	15.547363	0.000000*	3017.458301	5.683590	0.000000*	2.587325
STORIES	4057.418087	1275.156804	3.181897	0.001484*	2711.695894	1.496266	0.134635	1.139502
TOTAREA	53.801973	0.732108	73.489107	0.000000*	4.901507	10.976618	0.000000*	2.602307
AC_CODE	-239.804328	1707.044705	-0.140479	0.888271	2315.872506	-0.103548	0.917513	1.236527
FTFROMBL	4.445818	3.420198	1.299871	0.193687	4.898033	0.907674	0.364060	1.054925
DENPOP2010	1921.874116	123.878063	15.514241	0.000000*	244.582265	7.857782	0.000000*	1.148474
PCT_MNRTY	-198.106547	17.475835	-11.336028	0.000000*	25.304433	-7.828926	0.000000*	1.157448

OLS Diagnostics

Input Features:	parcels_cenblk selection	Dependent Variable:	JV
Number of Observations:	8905	Akaike's Information Criterion (AICc) [d]:	214572.772025
Multiple R-Squared [d]:	0.721382	Adjusted R-Squared [d]:	0.721068
Joint F-Statistic [e]:	2302.779670	Prob(>F), (10,8894) degrees of freedom:	0.000000*
Joint Wald Statistic [e]:	8531.008138	Prob(>chi-squared), (10) degrees of freedom:	0.000000*
Koenker (BP) Statistic [f]:	1075.690584	Prob(>chi-squared), (10) degrees of freedom:	0.000000*
Jarque-Bera Statistic [g]:	3563844.992535	Prob(>chi-squared), (2) degrees of freedom:	0.000000*

Notes on Interpretation

* An asterisk next to a number indicates a statistically significant p-value (p < 0.05).

[a] Coefficient: Represents the strength and type of relationship between each explanatory variable and the dependent variable.

[b] Probability and Robust Probability (Robust_Pr): Asterisk (*) indicates a coefficient is statistically significant (p < 0.05); if the Koenker (BP) Statistic [f] is statistically significant, use the Robust Probability column (Robust_Pr) to determine coefficient significance.

[c] Variance Inflation Factor (VIF): Large Variance Inflation Factor (VIF) values (> 7.5) indicate redundancy among explanatory variables.

[d] R-Squared and Akaike's Information Criterion (AICc): Measures of model fit/performance.

[e] Joint F and Wald Statistics: Asterisk (*) indicates overall model significance (p < 0.05); if the Koenker (BP) Statistic [f] is statistically significant, use the Wald Statistic to determine overall model significance.

[f] Koenker (BP) Statistic: When this test is statistically significant (p < 0.05), the relationships modeled are not consistent (either due to non-stationarity or heteroskedasticity). You should rely on the Robust Probabilities (Robust_Pr) to determine coefficient significance and on the Wald Statistic to determine overall model significance.

[g] Jarque-Bera Statistic: When this test is statistically significant (p < 0.05) model predictions are biased (the residuals are not normally distributed).

Figure A-2. Ordinary least squares results for all single family properties within 500 feet of a bicycle facility.

Summary of OLS Results

Variable	Coefficient [a]	StdError	t-Statistic	Probability [b]	Robust_SE	Robust_t	Robust_Pr [b]	VIF [c]
Intercept	-737209.202046	30007.196588	-24.567747	0.000000*	85809.554274	-8.591225	0.000000*	--------
ACTYRBLT	357.005953	15.457308	23.096256	0.000000*	44.026724	8.108847	0.000000*	1.353680
ACRES	2857.538655	157.130129	18.185810	0.000000*	1194.599031	2.392048	0.016750*	1.115560
BEDS	-1990.159200	599.901243	-3.317478	0.000927*	1370.121517	-1.452542	0.146384	1.695107
BATHS	13803.877445	764.392869	18.058616	0.000000*	2262.662925	6.100722	0.000000*	2.674572
STORIES	3200.622898	871.316837	3.673317	0.000254*	1860.351072	1.720440	0.085379	1.159448
TOTAREA	61.402966	0.513316	119.620157	0.000000*	3.434897	17.876216	0.000000*	2.746381
AC_CODE	-1034.102619	1234.423643	-0.837721	0.402184	1564.339572	-0.661047	0.508588	1.229671
FTFROMBL	4.201904	1.173394	3.580982	0.000358*	1.369714	3.067723	0.002174*	1.028052
DENPOP2010	1653.467527	88.381188	18.708365	0.000000*	177.616113	9.309220	0.000000*	1.140943
PCT_MNRTY	-167.386063	12.176072	-13.747132	0.000000*	18.539146	-9.028790	0.000000*	1.176681

OLS Diagnostics

Input Features:	parcels_cenblk selection	Dependent Variable:	JV
Number of Observations:	17534	Akaike's Information Criterion (AICc) [d]:	420893.854389
Multiple R-Squared [d]:	0.759914	Adjusted R-Squared [d]:	0.759777
Joint F-Statistic [e]:	5546.345081	Prob(>F), (10,17523) degrees of freedom:	0.000000*
Joint Wald Statistic [e]:	18997.367774	Prob(>chi-squared), (10) degrees of freedom:	0.000000*
Koenker (BP) Statistic [f]:	2209.275039	Prob(>chi-squared), (10) degrees of freedom:	0.000000*
Jarque-Bera Statistic [g]:	5506516.458077	Prob(>chi-squared), (2) degrees of freedom:	0.000000*

Notes on Interpretation
* An asterisk next to a number indicates a statistically significant p-value (p < 0.05).
[a] Coefficient: Represents the strength and type of relationship between each explanatory variable and the dependent variable.
[b] Probability and Robust Probability (Robust_Pr): Asterisk (*) indicates a coefficient is statistically significant (p < 0.05); if the Koenker (BP) Statistic [f] is statistically significant, use the Robust Probability column (Robust_Pr) to determine coefficient significance.
[c] Variance Inflation Factor (VIF): Large Variance Inflation Factor (VIF) values (> 7.5) indicate redundancy among explanatory variables.
[d] R-Squared and Akaike's Information Criterion (AICc): Measures of model fit/performance.
[e] Joint F and Wald Statistics: Asterisk (*) indicates overall model significance (p < 0.05); if the Koenker (BP) Statistic [f] is statistically significant, use the Wald Statistic to determine overall model significance.
[f] Koenker (BP) Statistic: When this test is statistically significant (p < 0.05), the relationships modeled are not consistent (either due to non-stationarity or heteroskedasticity). You should rely on the Robust Probabilities (Robust_Pr) to determine coefficient significance and on the Wald Statistic to determine overall model significance.
[g] Jarque-Bera Statistic: When this test is statistically significant (p < 0.05) model predictions are biased (the residuals are not normally distributed).

Figure A-3. Ordinary least squares results for all single family properties within 1,000 feet of a bicycle facility.

Summary of OLS Results

Variable	Coefficient [a]	StdError	t-Statistic	Probability [b]	Robust_SE	Robust_t	Robust_Pr [b]	VIF [c]
Intercept	-726722.076784	22494.823256	-32.306192	0.000000*	52322.351928	-13.889324	0.000000*	--------
ACTYRBLT	353.140048	11.584539	30.483738	0.000000*	26.866098	13.144449	0.000000*	1.347168
ACRES	2903.441687	120.905928	24.014056	0.000000*	793.508133	3.658994	0.000267*	1.104221
BEDS	-3534.262373	443.391380	-7.970977	0.000000*	883.489189	-4.000346	0.000071*	1.732348
BATHS	14932.337859	568.290990	26.275866	0.000000*	1454.598836	10.265606	0.000000*	2.805360
STORIES	4031.341156	622.436304	6.476713	0.000000*	1194.393155	3.375221	0.000755*	1.166939
TOTAREA	62.475126	0.379762	164.511104	0.000000*	2.054507	30.408819	0.000000*	2.907164
AC_CODE	-2568.296430	951.344868	-2.699648	0.006943*	1190.207552	-2.157856	0.030931*	1.216333
FTFROMBL	1.623458	0.455543	3.563788	0.000381*	0.482100	3.367473	0.000776*	1.015645
DENPOP2010	1535.485394	68.057133	22.561712	0.000000*	120.841585	12.706598	0.000000*	1.161320
PCT_MNRTY	-185.233784	9.146331	-20.252251	0.000000*	12.816947	-14.452254	0.000000*	1.199628

OLS Diagnostics

Input Features:	parcels_cenblk selection	Dependent Variable:	JV
Number of Observations:	31061	Akaike's Information Criterion (AICc) [d]:	744145.316709
Multiple R-Squared [d]:	0.780590	Adjusted R-Squared [d]:	0.780520
Joint F-Statistic [e]:	11046.611904	Prob(>F), (10,31050) degrees of freedom:	0.000000*
Joint Wald Statistic [e]:	39908.691940	Prob(>chi-squared), (10) degrees of freedom:	0.000000*
Koenker (BP) Statistic [f]:	2886.727813	Prob(>chi-squared), (10) degrees of freedom:	0.000000*
Jarque-Bera Statistic [g]:	6552842.090103	Prob(>chi-squared), (2) degrees of freedom:	0.000000*

Notes on Interpretation
* An asterisk next to a number indicates a statistically significant p-value (p < 0.05).
[a] Coefficient: Represents the strength and type of relationship between each explanatory variable and the dependent variable.
[b] Probability and Robust Probability (Robust_Pr): Asterisk (*) indicates a coefficient is statistically significant (p < 0.05); if the Koenker (BP) Statistic [f] is statistically significant, use the Robust Probability column (Robust_Pr) to determine coefficient significance.
[c] Variance Inflation Factor (VIF): Large Variance Inflation Factor (VIF) values (> 7.5) indicate redundancy among explanatory variables.
[d] R-Squared and Akaike's Information Criterion (AICc): Measures of model fit/performance.
[e] Joint F and Wald Statistics: Asterisk (*) indicates overall model significance (p < 0.05); if the Koenker (BP) Statistic [f] is statistically significant, use the Wald Statistic to determine overall model significance.
[f] Koenker (BP) Statistic: When this test is statistically significant (p < 0.05), the relationships modeled are not consistent (either due to non-stationarity or heteroskedasticity). You should rely on the Robust Probabilities (Robust_Pr) to determine coefficient significance and on the Wald Statistic to determine overall model significance.
[g] Jarque-Bera Statistic: When this test is statistically significant (p < 0.05) model predictions are biased (the residuals are not normally distributed).

Figure A-4. Ordinary least squares results for all single family properties within 2,000 feet of a bicycle facility.

Summary of OLS Results

Variable	Coefficient [a]	StdError	t-Statistic	Probability [b]	Robust_SE	Robust_t	Robust_Pr [b]	VIF [c]
Intercept	-732214.994177	26437.782820	-27.695779	0.000000*	68545.958486	-10.682103	0.000000*	--------
ACTYRBLT	355.578341	13.621424	26.104343	0.000000*	35.173606	10.109238	0.000000*	1.348893
ACRES	2940.262461	147.857712	19.885757	0.000000*	1108.126085	2.653365	0.007971*	1.117228
BEDS	-2825.548081	527.221299	-5.359321	0.000000*	1139.579674	-2.479465	0.013153*	1.709991
BATHS	14259.550272	672.207660	21.213014	0.000000*	1856.749127	7.679848	0.000000*	2.703354
STORIES	3677.309450	752.126634	4.889216	0.000002*	1530.231960	2.403106	0.016250*	1.164824
TOTAREA	61.905561	0.452363	136.849387	0.000000*	2.758660	22.440444	0.000000*	2.802020
AC_CODE	-2496.983291	1111.651021	-2.246193	0.024685*	1482.355888	-1.684470	0.092115	1.222535
FTFROMBL	3.663705	0.787686	4.651228	0.000005*	0.866736	4.227014	0.000029*	1.023163
DENPOP2010	1586.085157	78.184170	20.286525	0.000000*	153.588119	10.326874	0.000000*	1.143996
PCT_MNRTY	-179.960061	10.799405	-16.663887	0.000000*	15.598781	-11.536803	0.000000*	1.179338

OLS Diagnostics

Input Features:	parcels_cenblk selection	Dependent Variable:	JV
Number of Observations:	22698	Akaike's Information Criterion (AICc) [d]:	544523.428123
Multiple R-Squared [d]:	0.764668	Adjusted R-Squared [d]:	0.764564
Joint F-Statistic [e]:	7371.719821	Prob(>F), (10,22687) degrees of freedom:	0.000000*
Joint Wald Statistic [e]:	25037.759938	Prob(>chi-squared), (10) degrees of freedom:	0.000000*
Koenker (BP) Statistic [f]:	2279.485527	Prob(>chi-squared), (10) degrees of freedom:	0.000000*
Jarque-Bera Statistic [g]:	7001271.228275	Prob(>chi-squared), (2) degrees of freedom:	0.000000*

Notes on Interpretation

* An asterisk next to a number indicates a statistically significant p-value (p < 0.05).

[a] Coefficient: Represents the strength and type of relationship between each explanatory variable and the dependent variable.

[b] Probability and Robust Probability (Robust_Pr): Asterisk (*) indicates a coefficient is statistically significant (p < 0.05); if the Koenker (BP) Statistic [f] is statistically significant, use the Robust Probability column (Robust_Pr) to determine coefficient significance.

[c] Variance Inflation Factor (VIF): Large Variance Inflation Factor (VIF) values (> 7.5) indicate redundancy among explanatory variables.

[d] R-Squared and Akaike's Information Criterion (AICc): Measures of model fit/performance.

[e] Joint F and Wald Statistics: Asterisk (*) indicates overall model significance (p < 0.05); if the Koenker (BP) Statistic [f] is statistically significant, use the Wald Statistic to determine overall model significance.

[f] Koenker (BP) Statistic: When this test is statistically significant (p < 0.05), the relationships modeled are not consistent (either due to non-stationarity or heteroskedasticity). You should rely on the Robust Probabilities (Robust_Pr) to determine coefficient significance and on the Wald Statistic to determine overall model significance.

[g] Jarque-Bera Statistic: When this test is statistically significant (p < 0.05) model predictions are biased (the residuals are not normally distributed).

Figure A-5. Ordinary least squares results for all single family properties within ¼ mile of a bicycle facility.

Summary of OLS Results

Variable	Coefficient [a]	StdError	t-Statistic	Probability [b]	Robust_SE	Robust_t	Robust_Pr [b]	VIF [c]
Intercept	-744256.063872	21237.109408	-35.045074	0.000000*	47760.289315	-15.583157	0.000000*	--------
ACTYRBLT	361.822148	10.934041	33.091347	0.000000*	24.517173	14.757906	0.000000*	1.345240
ACRES	2799.538381	114.669296	24.414019	0.000000*	680.504031	4.113919	0.000045*	1.104025
BEDS	-3756.014910	412.543135	-9.104539	0.000000*	810.066763	-4.636673	0.000005*	1.755857
BATHS	15513.818908	526.598411	29.460436	0.000000*	1343.536770	11.547000	0.000000*	2.898790
STORIES	2084.948812	569.669755	3.659925	0.000266*	1032.409974	2.019497	0.043433*	1.171959
TOTAREA	64.250460	0.349446	183.864013	0.000000*	1.781755	36.060212	0.000000*	3.017082
AC_CODE	-3777.142121	905.649048	-4.170647	0.000036*	1100.004546	-3.433751	0.000612*	1.207880
FTFROMBL	1.298350	0.330027	3.934073	0.000093*	0.364906	3.558042	0.000389*	1.024812
DENPOP2010	1310.004792	61.033984	21.463531	0.000000*	129.433435	10.121069	0.000000*	1.159739
PCT_MNRTY	-168.540735	8.561696	-19.685437	0.000000*	12.102759	-13.925811	0.000000*	1.210867

OLS Diagnostics

Input Features:	parcels_cenblk selection	Dependent Variable:	JV
Number of Observations:	36729	Akaike's Information Criterion (AICc) [d]:	881129.879076
Multiple R-Squared [d]:	0.793866	Adjusted R-Squared [d]:	0.793810
Joint F-Statistic [e]:	14140.926541	Prob(>F), (10,36718) degrees of freedom:	0.000000*
Joint Wald Statistic [e]:	48092.731479	Prob(>chi-squared), (10) degrees of freedom:	0.000000*
Koenker (BP) Statistic [f]:	3491.913300	Prob(>chi-squared), (10) degrees of freedom:	0.000000*
Jarque-Bera Statistic [g]:	6768457.801059	Prob(>chi-squared), (2) degrees of freedom:	0.000000*

Notes on Interpretation
 * An asterisk next to a number indicates a statistically significant p-value (p < 0.05).
[a] Coefficient: Represents the strength and type of relationship between each explanatory variable and the dependent variable.
[b] Probability and Robust Probability (Robust_Pr): Asterisk (*) indicates a coefficient is statistically significant (p < 0.05); if the Koenker (BP) Statistic [f] is statistically significant, use the Robust Probability column (Robust_Pr) to determine coefficient significance.
[c] Variance Inflation Factor (VIF): Large Variance Inflation Factor (VIF) values (> 7.5) indicate redundancy among explanatory variables.
[d] R-Squared and Akaike's Information Criterion (AICc): Measures of model fit/performance.
[e] Joint F and Wald Statistics: Asterisk (*) indicates overall model significance (p < 0.05); if the Koenker (BP) Statistic [f] is statistically significant, use the Wald Statistic to determine overall model significance.
[f] Koenker (BP) Statistic: When this test is statistically significant (p < 0.05), the relationships modeled are not consistent (either due to non-stationarity or heteroskedasticity). You should rely on the Robust Probabilities (Robust_Pr) to determine coefficient significance and on the Wald Statistic to determine overall model significance.
[g] Jarque-Bera Statistic: When this test is statistically significant (p < 0.05) model predictions are biased (the residuals are not normally distributed).

Figure A-6. Ordinary least squares results for all single family properties within ½ mile of a bicycle facility.

APPENDIX B
RESULTS OF GEOGRAPHICALLY WEIGHTED REGRESSION

Table B-1. Descriptive statistics for all single family properties in Alachua County used in geographically weighted regression.

Variable Name	Minimum	Maximum	Mean	Standard Deviation
ActYrBlt	1853	2011	1975.29	23.37
Acres	0.10	159.55	1.24	2.83
Beds	1	5	3.06	0.68
Baths	1	8	1.93	0.70
Stories	1	4	1.14	0.42
TotArea	180	22685	2306.64	1097.55
AC_code	0	1	0.92	0.28
FtFromBL	0	34324.10	2211.44	3188.35
DenPop2010	0	146.63	3.40	3.65
Pct_Mnrty	0	100	31.07	27.62

n = 36,294

OID	VARNAME	VARIABLE	DEFINITION
0	Bandwidth	1192.622727	
1	ResidualSquares	651680946319	
2	EffectiveNumber	61.008955	
3	Sigma	73695.860544	
4	AICc	4639.488311	
5	R2	0.813389	
6	R2Adjusted	0.720062	
7	Dependent Field	0	JV
8	Explanatory Field	1	ACTYRBLT
9	Explanatory Field	2	ACRES
10	Explanatory Field	3	beds
11	Explanatory Field	4	baths
12	Explanatory Field	5	stories
13	Explanatory Field	6	totarea
14	Explanatory Field	7	ac_code
15	Explanatory Field	8	FtFromBL
16	Explanatory Field	9	DENPOP2010
17	Explanatory Field	10	PCT_MNRTY

Figure B-1. Properties of geographically weighted regression variables.

APPENDIX C
LIST OF BICYCLE FACILITIES IN ALACHUA COUNTY, FL

Table C-1. List of bicycle facilities in Alachua County, Florida.

Name	Type
2300 NW 53rd Ave to NW 45th Ave	OSF
6th Street Rail-Trail	OSF
Bledsoe Dr	DSORBL
Buckman Dr	DSORBL
Center Dr	DSORBL
Depot Ave Rail-Trail	OSF
Downtown Connector Trail	OSF
Fletcher Dr	DSORBL
Fraternity Row	DSORBL
Gainesville-Hawthorne Trail	OSF
Gale Lemerand Dr	DSORBL
Hull Rd	DSORBL
Inner Rd	DSORBL
Kermit Sigmon/SR 24 Trail	OSF
Millhopper Rd	DSORBL
Mowry Dr	DSORBL
Museum Rd	DSORBL
N Main St	DSORBL
N SR 121	DSORPV
N State Road 121	DSORPV
N US HWY 441	DSORPV
NE 12th Ave	DSORBL
NE 15th St	DSORBL
NE 16th Ave	DSORBL
NE 16th Ave	DSORPV
NE 19th Ter	DSORBL
NE 2nd St	DSORBL
NE 39th Ave	DSORPV
NE 39th Ave	DSORBL
NE 53rd Ave	DSORPV
NE 55th Blvd	DSORPV
NE 55th Blvd	DSORBL
NE 9th St	DSORBL
NE SR 26	DSORPV
NE US HWY 301	DSORPV
NE Waldo Rd	DSORPV
Newell Dr	DSORBL
Newell Dr	OSF

Name	Type
NW 13th St	DSORBL
NW 13th St	DSORPV
NW 143rd St	DSORBL
NW 143rd St	DSORPV
NW 14th Ave	DSORBL
NW 16th Ter	DSORBL
NW 173rd St	DSORPV
NW 17th St	DSORBL
NW 22nd St	DSORBL
NW 23rd Ave	DSORBL
NW 23rd Ave	DSORPV
NW 27th Ave	DSORPV
NW 31st Blvd	DSORPV
NW 34th St	DSORBL
NW 38th St	DSORBL
NW 39 Ave	DSORBL
NW 39th Ave	DSORBL
NW 39th Rd	DSORBL
NW 39th Rd	OSF
NW 43rd St	DSORBL
NW 45th Ave	DSORBL
NW 45th Ave	DSORPV
NW 45th Ave	OSF
NW 51st St	DSORBL
NW 53rd Ave	DSORBL
NW 53rd Ave	OSF
NW 53rd Ave	DSORPV
NW 55th St	DSORBL
NW 64th Blvd	OSF
NW 6th St	DSORPV
NW 75th St	DSORPV
NW 75th St	OSF
NW 91st St	OSF
NW US HWY 441	DSORPV
Old Archer Road Trail	OSF
Radio Rd	DSORBL
S Main St	DSORBL
S US HIGHWAY 441	DSORBL
S US HWY 441	DSORBL
SE 11th St	DSORBL
SE 16th Ave	DSORPV
SE 24th St	DSORBL

Name	Type
SE 2nd Ave	DSORBL
SE 2nd Ave	OSF
SE 35th St	DSORPV
SE 3rd Ave	DSORBL
SE 4th Ave	DSORBL
SE 7th Ave	DSORBL
SE 8th Ave	DSORBL
SE Blvd	OSF
SE Depot Ave	DSORBL
SE Hawthorne Rd	DSORBL
SE Hawthorne Rd	DSORPV
SE US HWY 301	DSORBL
SE US HWY 301	DSORPV
SE Williston Rd	DSORBL
SR 235	DSORPV
SR 24	DSORPV
SR 45	DSORPV
Stadium Rd	DSORBL
SW 10th Ter	OSF
SW 122nd St	DSORPV
SW 12th St	DSORBL
SW 13 ST US 441	DSORBL
SW 13th St	DSORBL
SW 16th Ave	DSORBL
SW 16th St	DSORBL
SW 20th Ave	DSORBL
SW 23rd Dr	DSORBL
SW 23rd St	DSORBL
SW 23rd Ter Trail	OSF
SW 24th Ave	DSORBL
SW 24th Ave	OSF
SW 2nd Ave	DSORBL
SW 2nd Ave SR 26A	OSF
SW 33rd Pl	DSORPV
SW 34th St	DSORBL
SW 35th Pl	DSORBL
SW 37th Blvd	DSORPV
SW 38th Ter	OSF
SW 43rd St	DSORBL
SW 62nd Blvd Sidewalk	OSF
SW 62nd St Sidewalk	OSF
SW 75th St	DSORBL

Name	Type
SW 75th St	DSORPV
SW 8th Ave	DSORPV
SW 91st St	OSF
SW Archer Rd	DSORBL
SW Archer Rd	DSORPV
SW Archer Rd	OSF
SW SR 45	DSORPV
SW Williston Rd	DSORBL
SW Williston Rd	OSF
Terwilliger Path	OSF
Union Dr	DSORBL
US Hwy 441	DSORPV
W Newberry Rd	DSORBL
W Newberry Rd	DSORPV
W University Ave	DSORBL
W US HWY 27	DSORPV
Waldo Rd	OSF
Waldo Rd	DSORBL
Waldo Rd	DSORPV
Waldo Rd Greenway Trail	OSF
Waldo Rd Greenway-Depot Ave Rail-Trail	OSF

OSF = Off-street facility
DSORBL = Dedicated street-oriented route with bike lane
DSORPB = Dedicated street-oriented route with paved shoulder

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BIOGRAPHICAL SKETCH

Kevin Szatmary was born in Fort Lauderdale, Florida, and has lived in Florida for his entire life. After graduating from high school in 2001, he attended community college before attending the University of Florida in Gainesville, Florida, to pursue a Bachelor of Science in Geomatics. He has served as an intern for the Army Corps of Engineers and the National Park Service as a land surveying technician and a GIS technician. He graduated in 2009, and decided to remain at the University of Florida to pursue a Master of Arts in Urban and Regional Planning. Kevin enjoys college athletics, old maps, and riding bicycles.