

Hedonic Valuation of Forested Riparian Buffers Along Rivers in Northwestern North Carolina

Mallory Vannoy

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APPROVED:

Kevin Boyle

Michael Sorice

Kurt Stephenson

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ABSTRACT

This revealed preference study estimates the implicit value associated with owning a home along a river and tree coverage of riparian areas along rivers. The setting of this study is Ashe and Watauga Counties in Northwestern North Carolina and the two rivers that flow through those counties: New River and Watauga River. House sales form the basis of the hedonic models used to value these environmental characteristics. Homes that border a river sell for at least \$28,000 more than otherwise similar homes that do not border a river. Riparian area tree coverage positively impacts river-bordering house prices, but only to a certain point. The results of this study are important for environmental organizations in this region working to safeguard the New and Watauga Rivers through riparian buffer installation and protection.

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GENERAL AUDIENCE ABSTRACT

This study describes homeowner values of owning a home near a river, along with values associated with tree coverage of riparian areas along rivers. The setting of this study is Ashe and Watauga Counties in Northwestern North Carolina and the two rivers that flow through those counties: New River and Watauga River. Using data on home sales between 2005 and 2020, models estimate the value of two environmental characteristics home properties. This research found that homes bordering a river sell for at least \$28,000 more than otherwise similar homes that do not border a river. Having any amount of tree coverage up to 90% tree coverage in a riparian area increases home sale prices, therefore homeowners positively value tree coverage in riparian areas to a point. Tree coverage in riparian areas is beneficial for the protection of rivers and river-dependent wildlife. The results of this study are important for environmental organizations in this region working to safeguard the New and Watauga Rivers through riparian buffer installation and protection.

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1 Introduction

The attention of scientific research to interactions between the built world and environmental world has increased in recent years. Brought on by wider recognition of climate change, researchers are exploring how and why humans impact the environment. Environmental economics bridges the gap between environmental science and sociological science by estimating human values of environmental features. This study delves into the connections between riparian buffers along rivers and their corresponding values to residential landowners. A revealed preference study is performed to estimate the value of riverfront land and riparian buffers along the New and Watauga Rivers of Ashe and Watauga Counties, North Carolina.

Riparian buffers are strips of land beside a waterbody with naturally occurring, deep-rooted vegetation. These buffers are a waterbody's natural defense system against pollutants, provide protection against erosion, and support wildlife by offering habitats for all types of water-dependent creatures (Osmond & Burchell, 2017). The roots of trees and large shrubs in riparian buffers hold the ground in place, preventing loss of land that can occur with flooding from large storms. Effective widths of riparian buffers vary depending on factors such as slope of the land to the river, types of soils on land bordering the river, the presence of wetlands and which resource is being protected (Hawes & Smith, 2005).

Ashe and Watauga Counties are considered southern Appalachia and part of the Blue Ridge Mountain range. Historically, the land use in this area has been largely agricultural. Early 1900's saw deforestation for the sake of timber and crop production, especially along rivers where land is relatively flat and accessible for tractor use in an otherwise hilly region. A study by the New River Conservancy, a local environmental advocate organization, used historical land cover data to find a correlation between decreasing forestation and increasing river widths. They

discovered that the level of vegetative land cover around the South Fork New River in Ashe County was at a minimal during the 1940's and 1950's, rising in the 1960's through 1980's, and has since began to decrease again (New River Conservancy, 2020). As forested river buffers decrease, rivers widen and become shallower which negatively effects native wildlife habitats.

Recent population growth and an increase in second home development in northwestern North Carolina threatens riparian buffer systems along the New and Watauga Rivers. The population of Ashe County has increased by around 140% and Watauga County has increased by over 240% in the last forty years. In 2011, nearly 70% of Ashe and Watauga's vacant housing stock was dedicated to seasonal, recreational, or occasional uses (Mountain Resources Commission, 2011). Ashe and Watauga Counties' tourism expenditures have seen annual growth between 2-14% since 2010 (Economic Development Partnership of North Carolina, 2020). River properties are especially appealing in these counties because of their scenic views and water access for recreational activities. As development expands along the New and Watauga Rivers, there is a heightened need to protect current riparian buffers and reestablish riparian buffers where they previously existed.

Efforts to protect the New and Watauga Rivers are led by local organizations like the New River Conservancy, Watauga River Keepers and regional Soil and Water Conservation Districts. River cleanups and transitioning private lands to publicly maintained lands are two major methods used by these organizations to protect the rivers. Another key tool is offering riparian buffer restoration programs for landowners at reduced costs with cost-share programs. For example, the New River Conservancy's River Builders program has restored over 36 miles of riparian buffer in the New River watershed in the last decade (New River Conservancy, 2020). Other regions of North Carolina have recently enforced requirements to protect riparian areas,

like the Riparian Buffer Protection Rules for the Neuse and Tar-Pamlico Rivers in eastern NC. Endeavors to protect, install, and repair riparian buffers along rivers are widespread in North Carolina.

As the majority of land bordering rivers in this region is privately owned, investigating landowner incentives to installing and keeping riparian buffers is important for policy decision makers. Many studies have estimated community willingness to pay for river restoration projects but enticing landowners to participate in those projects is the key to success. There is no economic literature estimating landowner values for riparian buffers with similar socioeconomic and geographic characteristics as this study. The research presented in this thesis fills a gap in environmental economic literature by estimating both the implicit value of owning a home bordering a river and riparian area tree coverage along those rivers in a new, rural setting. Adding to the uniqueness of this study, riparian areas are defined using a model including land characteristics to produce a variable-width riparian buffer area along the rivers.

This paper describes a revealed preference study using Ashe and Watauga Counties housing market data in hedonic models. The first objective of this research is to estimate the implicit value of riverfront homes as a proxy for the value of the rivers as natural amenities. The second objective is to explore the effects of riparian area vegetation coverage on prices of homes with river frontage. Combining home sale and geospatial information, the landowner valuation of riparian areas in this thesis is useful to assist in decision-making by organizations interested in improving riparian buffers along the New and Watauga Rivers through landowner programs. The remaining sections of this thesis reviews riparian buffer and similar nonmarket valuation studies, then describes the methods, materials, and results of this revealed preference research. Final sections discuss policy implications and study conclusions.

2 Literature Review

The following section reviews the environmental significance of riparian buffers around waterbodies. Then, previous stated and revealed preference economic literature focusing on riparian buffer valuation is summarized. The significance of this research among broader environmental economic literature is finally described.

2.1 Importance of Riparian Buffers

Riparian buffers offer an array of benefits to communities and wildlife that depend on healthy rivers. These areas of vegetation along riverbanks provide protection against erosion and filter nonpoint pollutants from lawns, agricultural lands, and other sources. Buffers include trees and similar deep-rooted vegetation that stabilize shorelines. Buffers can include a combination of vegetation including grasses, shrubbery, and trees. Each type of vegetation offers unique benefits to rivers and surrounding lands; however, tree coverage is particularly effective at reducing streambank erosion and provides habitat for water-dependent wildlife. The vegetation overstory keeps the water temperature at optimal levels for native wildlife by shading and cooling rivers (Hawes & Smith, 2005; New River Conservancy, 2020). Thus, forested riparian buffer protection and restoration are popular land management tools for environmental organizations interested in safeguarding the health of rivers.

The width of riparian buffer impacts the amount of environmental protection to waterbodies. Generally, as the width of the riparian buffer increases, the level of environmental protection increases as well. Effective riparian buffer widths are determined by the needs of the land and waterbody: how steep the land is, the types of soils, occurrences of major flooding events, and so on (Hawes & Smith, 2005). Fixed-width buffers are easier than variable-width to administer in

broad-reaching situations like policies for mandatory installation and protection. Policymakers often promote fixed-width riparian buffers for ease of definition and regulation. However, local organizations can visit and investigate land needs, therefore suggesting appropriate buffer widths based on the specific area.

Riparian areas along headwaters of rivers, like the sections of the New River and Watauga River in northwestern North Carolina, are especially important to protect because the water quality in those areas plays a significant role in determining water quality for the entire downstream watershed (Dodds & Oakes, 2008).

2.2 Riparian Buffer Economic Valuation

Economists conduct stated preference and revealed preference studies to estimate the value of nonmarket goods. Nonmarket goods are goods that are not directly bought and sold in normal market situations, like clean air, clean water, and other environmental qualities of an area. Although riparian buffers are part of the land, the buffers themselves and the protection that they give to waterbodies have no discernible price, making them a nonmarket good. Stated preference studies are survey-based, relying on individuals to state their willingness to pay for a good with nonmarket characteristics. Revealed preference research commonly uses housing market data to relate nonmarket goods to property values. Previous research using both types of nonmarket valuation methods suggest that individuals and homeowners positively value riparian buffers.

A stated preference study conducted in an eastern Canadian watershed found residents were willing to pay \$6.80 to \$42.85 annually per household for various programs to restore, preserve, or enhance riparian buffer systems along the Canaan River (Trenholm, Lantz, Martinez-Espineria, & Little, 2013). Bergstrom and Loomis (2017) reviewed nonmarket valuation studies

of 38 river restorations in the US and Europe. The studies cover of all types of river restoration actions, including installing and protecting riparian buffers, and found annual household values ranging from \$0.25 to \$12 per mile of river restored. These stated preference studies provide evidence that owners of waterfront properties and those who live within river catchments value activities to improve and protect waterways.

Holmes, Bergstrom, et al. (2004) produced a stated preference study around 100 miles southeast of the setting for this research. Like northwest North Carolina, the setting for the Holmes, Bergstrom, et al. paper is in southern Appalachia, is historically agricultural and has seen a recent rise in second home ownership and tourism. They found that Macon County residents were willing to pay a tax increase of \$4.54 per mile to install riparian buffers along the Little Tennessee River. The research presented in this paper adds to the Little Tennessee River study by exploring landowner values for riparian buffers, as landowner participation is essential for riparian programs to be effective.

There is evidence of positive values associated with riverfront land and riparian buffers from revealed preference literature as well, although none in similar settings as this research. A revealed preference study by Qui, et al. (2006) in St. Louis, Missouri found that home prices fell by \$16 per meter as home locations moved further away from nearby streams. Similarly, Bin, et al. (2008) estimated price premiums of 26% for homes on land parcels adjacent to the Neuse River with riparian buffers compared to otherwise equivalent homes. Studies in the Tuscan, Arizona area have found 3-6% property premiums for homes located within half a mile of riparian areas and that higher quality riparian habitats add value to nearby homes compared to riparian buffers with lower quality vegetation (Bark, Osgood, Colby, Katz, Stromberg, 2009; Colby, Wishart, 2002). The width of riparian buffer can impact the value placed on the buffer

itself. Mooney & Eisgruber (2001) discovered a price premium for stream frontage in the Mohawk River watershed in Oregon, yet property values show an inverted “U”-shape with respect to the width of buffer along the stream.

Although nonmarket valuation studies generally conclude positive values of riparian buffers among neighboring communities and landowners, the majority of revealed preference studies have been conducted in urban, suburban, and arid settings. In revealed preference studies considering relative location to waterbodies, rural areas tend to see different or lesser effects compared to urban settings (White & Leefers, 2007). The research discussed in this paper identifies connections between riparian buffers along rivers and property values in a new setting: rural southern Appalachia. Other revealed preference studies have used either binary variables to represent the presence of riparian buffers or continuous variables as the distance away from riparian buffers. Studies that utilize “distance to” variables could overestimate the value of riparian buffers due to the correlation between distance to riparian buffers and distance to the rivers themselves, which are natural amenities. This study adds to the literature by defining the riparian buffer variable of interest as the ratio of tree coverage in a riparian area. This allows for variation in the values associated with riparian buffers as the vegetation coverage fluctuates. We also estimate the implicit value of bordering rivers separately from the implicit value of riparian areas in two distinct models.

3 Methods and Materials

The economic framework and design of this revealed preference study are explained in the following sections. The economic theory of hedonic models and spatial econometrics used to estimate the value of nonmarket goods are defined in the context of this study. The area of study

is further illustrated in the following section. Housing market data, used as the basis of the hedonic models in this study, are described next. As spatial data form the objectives of this research, the final section details the procurement and summary statistics of those data.

3.1 Economic Theory

Revealed preference research has a theoretical foundation in the economic concept of utility. Utility is the pleasure or satisfaction one receives from consuming a good or service. People are utility maximizers, so they will make economic choices that gives them the highest level of happiness while taking their budget constraints into consideration.

Lancaster coined the theory of hedonic utility in 1966, forming the basis of hedonic models used in revealed preference research. Lancaster maintains that it is the characteristics of a good that create utility, not simply the good itself. For example, the utility associated with owning a cellphone comes more from the features of the cellphone than the phone itself. The camera quality, video chat features, internet speeds, storage capabilities and so on each bring utility to the cellphone consumer. Rosen (1974) expands on Lancaster's idea of hedonic utility by forming a theory of hedonic pricing. The theory of hedonic pricing states that the total price of an item is equal to the sum of prices of its utility-generating characteristics. This theory implies that it is possible to regress the price of a good against the characteristics of that good to find the price of each characteristic, foreshadowing the hedonic models used in this paper.

3.2 Hedonic Models

The models in this study estimate the value of residential property characteristics using housing market data. Applying housing market data to hedonic models is a popular way that

economists estimate the value of nonmarket, environmental goods. It is broadly accepted that homeowners have preferences for where they live based on the natural environment around them, therefore the environmental characteristics are part of the bundle of characteristics making up the full price of a property.

There are two types of hedonic models used in this research: linear and semi-log. The linear hedonic models regress the value of the good against the characteristics of the good. In this case, the price of homes will be regressed against the characteristics of those homes,

$$\text{Value} = f(S, T, L, E)$$

where

S represents the structural characteristics of a property (square footage, house age)

T represents sale transaction characteristics (year sold, season sold)

L represents location characteristics of a property (county, distance to grocery store, etc.)

E represents environmental characteristics of a property (bordering a river, riparian buffer, etc.)

$$\text{VALUE} = X\beta + \varepsilon$$

The expected price of a home is the matrix of characteristics (*X*) times a vector of marginal prices (β) plus an error term (ε).

The second type of hedonic model implemented here is the semi-log model. In this case,

$$\text{VALUE} = e^{X\beta\varepsilon}$$

therefore

$$\ln(\text{VALUE}) = X\beta + \varepsilon$$

The log of the expected price of a home is the matrix of characteristics (X) times a vector of marginal prices (β) plus an error term (ε). Semi-log models allow for nonlinearity in prices. In semi-log models, the value of characteristics may vary proportionately with the value of other characteristics.

Two different hedonic models are discussed in this paper to achieve the objectives of estimating the implicit price paid to own a home bordering a river in northwestern NC compared to a similar home not on a river and the implicit price of riparian area tree coverage for homes bordering rivers in the same area. The first model uses home sales data for all homes sold in Ashe and Watauga Counties to estimate the implicit price of bordering a river,

Riverfront Valuation Model:

$$\begin{aligned} \text{sale_price} = & \beta_0 + \beta_1(\text{recession_cat}) + \beta_2(\text{sale_season}) + \beta_3(\text{ashe}) + \beta_4(\text{disttogroc}) + \beta_5(\text{houseage}) \\ & + \beta_6(\text{sq_ft}) + \beta_7(\text{acres}) + \beta_8(\text{disttopubcacc}) + \beta_9(\text{bordersriver}) + \varepsilon \end{aligned}$$

where

sale_price is the price of home sold

recession_cat is a categorical dummy variable for homes sold before and after the Great Recession, compared to the years during the Great Recession (2008-2009),
sale_season is a categorical dummy variable for season home was sold, compared to spring,
ashe is a dummy variable, 1=Ashe County and 0=Watauga County,
disttogroc is a continuous variable, the distance to the nearest grocery store in meters,
houseage is a continuous variable, the age of the home in years,
sq_ft is a continuous variable, the size of the home in square feet,
acres is a continuous variable, the size of the land parcel that the home sits on in acres,
disttopubacc is a continuous variable, the distance to public access points on the rivers in meters,
and
bordersriver is a dummy variable, 1=home borders a river and 0=home does not border a river.

In the Riverfront Valuation Model, *bordersriver* is the variable that satisfies the first research objective: valuing homes bordering a river compared to otherwise similar homes not bordering a river. The remaining variables in this model control for other structural, transactional, and locational characteristics.

The second model in this study uses home sales data where the homes border a river in Ashe or Watauga County. The objective here is to estimate the implicit price of riparian area tree coverage. Like the Riverfront Valuation Model, the Riparian Tree Coverage Model is a linear hedonic model.

Riparian Tree Coverage Model:

$$\begin{aligned} \text{sale_price} = & \beta_0 + \beta_1(\text{recession_cat}) + \beta_2(\text{sale_season}) + \beta_3(\text{ashe}) + \beta_4(\text{disttogroc}) + \beta_5(\text{houseage}) \\ & + \beta_6(\text{sq_ft}) + \beta_7(\text{acres}) + \beta_8(\text{riverfrontfeet}) + \beta_9(\text{slopedegree}) + \beta_{10}(\text{ratorip}) + \beta_{11}(\text{ratorip}^2) + \varepsilon \end{aligned}$$

where

sale_price, *recession_cat*, *sale_season*, *ashe*, *disttogroc*, *houseage*, *sq_ft* and *acres* are specified as in the Riverfront Valuation Model,

riverfrontfeet is a continuous variable, the feet of river frontage of the land parcel,

slopedegree is a continuous variable, the slope from the home to the river in degrees,

ratorip is a continuous variable, the ratio of the riparian area covered in trees, and

*ratorip*² is a continuous variable, the squared ratio of the riparian area covered in trees.

In the Riparian Tree Coverage Model, control variables are similar to the Riverfront Valuation Model with the addition of *riverfrontfeet* and *slopedegree*. The objective variables of interest in this model are *ratorip* and *ratorip*². It was decided to square the ratio of riparian area covered in trees after models separating *ratorip* into categories (0-0.20, 0.20-0.40, 0.60-0.80 and 0.80-1) indicated a pattern consistent with squaring the term.

3.3 Spatial Econometrics

When dealing with spatial data like the home sales in this study, the price of homes sold are often not only dependent on the characteristics described in the models above. Spatial econometrics assumes that the price of a home sold can also depend on the characteristics of

homes sold near that home of interest. To define these relationships, we use spatial weight matrices in spatial lag and spatial error models.

The spatial weight matrix provides the structure of the spatial relationships among home sales observations. Spatial weight matrices contain information on which observations are neighbors. Neighbors can be defined several different ways. When defining neighbors based on contiguity, an observation's neighbors are considered those that border that observation. Neighbors based on contiguity make sense for spatial data in the form of polygons, like census tracts, counties, or European countries. Other ways to categorize neighbors are based on distance from the location.

Three distance-based neighbor methods are inverse-distance, distance bands, and k-nearest. Inverse-distance computes a weight that is inversely proportional to the distance between each observation. Building weight matrices based on inverse-distance becomes computationally difficult with large datasets like home sales data in this study. Distance bands assume a spatial buffer around each observation and any observation falling inside that buffer is considered a neighbor. The distance band method is appropriate for data that is spatially consistent in density of observations. As some neighborhoods in this dataset contain many houses and some houses are alone on hundreds of acres of land, the distance band method is not ideal and would result in some observations with hundreds of neighbors while others having very few neighbors, if any.

This study utilizes the k-nearest distance neighbors methodology. In this method, the researcher defines "k," which is the number of neighbors that each observation will have. Each observation in this study will have 8 neighbors, so $k=8$. The 8 homes closest to each observation is considered a neighbor, coded as "1" in the matrix, while every other non-neighbor observation

is coded as “0”. The diagonal elements of the spatial weights matrix are always “0”, meaning each observation is not considered a neighbor of itself. Finally, the spatial weight matrices are row standardized so that the elements in each row sum to “1”.

Below is an example of a small spatial weight matrix. In this case W is the spatial weight matrix defining the relationships between three observations: A, B and C. The first matrix explains that A is only a neighbor to B, B is a neighbor to A and C, and C is only a neighbor to B. The second matrix reveals that spatial matrix row standardized, by dividing each element by the sum of its corresponding row.

$$W = \begin{matrix} & \begin{matrix} A & B & C \end{matrix} \\ \begin{matrix} A \\ B \\ C \end{matrix} & \begin{pmatrix} 0 & 1 & 0 \\ 1 & 0 & 1 \\ 0 & 1 & 0 \end{pmatrix} \end{matrix}$$

Then row summarized,

$$W = \begin{matrix} & \begin{matrix} A & B & C \end{matrix} \\ \begin{matrix} A \\ B \\ C \end{matrix} & \begin{pmatrix} 0 & 1 & 0 \\ .5 & 0 & .5 \\ 0 & 1 & 0 \end{pmatrix} \end{matrix}$$

The spatial weight matrix is used in two types of regressions: spatial lag and spatial error regressions. The spatial lag regression assumes that the spatial relationship between observations is captured in the dependent variable. The spatial lag regression is defined as:

$$Y = \rho WY + \beta X + \varepsilon$$

where Y is the vector of dependent observations, ρ is the coefficient on the spatial weight matrix (also known as the estimated spatial dependence parameter), W is the spatial weight matrix, β is the vector of independent variable coefficients, X is the matrix of independent variables, and ε is the error term. The independent variables in this model explain the variation in the dependent variable that is not explained by the neighbors' values.

The spatial error model is appropriate when correcting for spatial autocorrelation assuming spatially correlated errors due to unobservable features or omitted variables associated with location. In this case, the spatial relationship is captured in the error term, ε . The spatial error regression is defined as:

$$Y = \beta X + \varepsilon$$

where

$$\varepsilon = \lambda W\varepsilon + u \quad \text{or} \quad (I - \lambda W)\varepsilon = u$$

reducing to

$$(I - \lambda W)Y = (I - \lambda W)\beta X + u$$

where the multipliers in front of the dependent and independent variables are the variation unexplained by the neighbors' values. The λ value is the estimated spatial dependence parameter in the spatial error regression. A spatial weight matrix was defined for the entire dataset for the Riverfront Valuation Model and the dataset including only river-bordering observations for the Riparian Tree Coverage Model. Spatial lag and error models were considered for both hedonic models using those spatial weight matrices.

3.4 Study Area

The New River and Watauga River in Ashe and Watauga Counties are the two waterbodies of interest in this study. The headwaters of the New River begin as two forks,¹ North Fork New River and South Fork New River, in Watauga County. The majority of the North and South Forks, however, are located in Ashe County, joining at the confluence just south of the Virginia state line. The Watauga River begins south of Watauga County in Avery County, flows through southern Watauga County and across to Tennessee before entering a manmade lake.

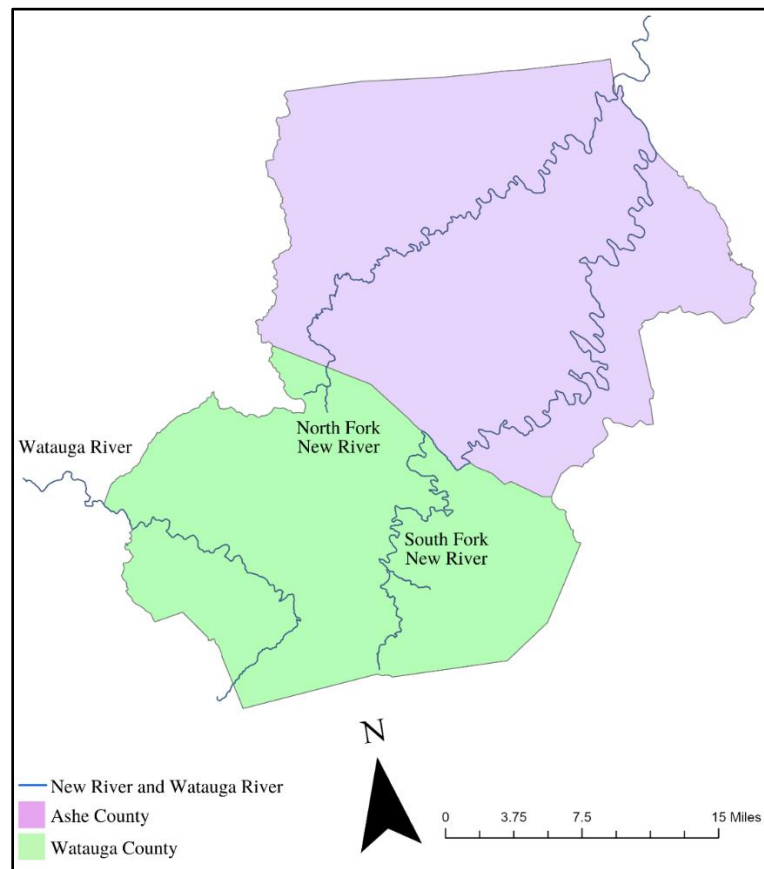


Figure 1. North Fork New River, South Fork New River and Watauga River in Ashe and Watauga Counties.

¹ For the purposes of this study, the South Fork New River begins where its two forks meet in central Watauga County. The two forks of the South Fork New River are very small, so nearby homeowners would likely not consider those sections a full “river.”

This northwestern region of North Carolina is part of the Appalachian and Blue Ridge Mountain range. Although the scenic mountain views throughout both counties are highly attractive to homeowners, the rivers add yet another natural amenity. The New and Watauga Rivers are frequently used recreationally for activities such as kayaking, tubing, and fly fishing. The rivers are valuable assets to these counties as they entice second homeownership and tourism in the area. Notably, Watauga County is home to Appalachian State University, a public university with around 19,000 students. The town of Boone, where Appalachian State University is located, doubles in population when school is in session at the university. The population of Watauga County is 56,000 while Ashe County is home to only 27,000 people. A combination of the university and several tourist-centric towns in Watauga County compared to a smaller city center and largely agricultural regions in Ashe County can be attributed to the stark difference in population.

3.5 Housing Market Data

The foundation of the hedonic models used in this study is housing market data provided by Estanted, a company specializing in property sales data. The data includes information on house sale transactions as well as property characteristics. Home sales begin in January 2005 and end in October 2020, just before the data was acquired. Some homes were sold multiple times in that 15-year time range and each sale is presented as a separate observation. Only single-family homes are considered, and observations were analyzed and cleaned for errors. Observations with any type of inaccuracy compared to county tax records that would affect these models were dropped from the dataset. After cleaning, 19,074 observations remain.

Sale price is the dependent variable for the hedonic models. The mean price of homes sold is \$239,460 in this dataset, slightly higher than the \$231,166 average home value for all of North Carolina (Zillow.com). Although the most expensive home was sold for more than \$16 million, the distribution of sale prices is skewed to the right and over 90% of the homes sold were sold for less than \$500,000. The average price of home sold in Ashe County is over \$10,000 less than the average home sold in Watauga County. The year and season in which homes were sold are other sale transaction characteristics included in the model as controls.

Property characteristics included as control variables are county, house age, square footage, and acres. 61% of observations are in Watauga County, the remaining 39% are in Ashe County. The average house is 33 years old, and they range from brand new (0 years old) to 220 years old. Ashe County (2,403 square feet) has an average square footage that is slightly higher than Watauga County (2,136 square feet). The counties have a combined average of 2,240 square feet. Both house age and square footage values are skewed to the right across the dataset. Acreage is defined as the acres of land contained by the land parcel that the house sits on. Homeowners might own multiple parcels surrounding their home, but this study only considers the parcel that contains the homesite. Acreages range from less than a quarter of an acre to over 300 acres, also skewed to the right. The average parcel is 2.6 acres.

Table 1. House Sales Summary Statistics

County	Observation Count				
Watauga	11,631				
Ashe	7,443				
Total	19,074				

Variable		Mean	Std. Dev.	Min	Max
Sale Price		\$239,460	\$248,967	\$1,000	\$16,500,000
	Ashe	\$172,851	\$157,495	\$1,000	\$2,020,000
	Watauga	\$282,085	\$284,824	\$1,000	\$16,500,000
House Age		33 years	24 years	0 years	220 years
	Ashe	35 years	28 years	1 years	213 years
	Watauga	32 years	22 years	0 years	220 years
Square Footage		2,241 sqft	1,135 sqft	156 sqft	13,577 sqft
	Ashe	2,403 sqft	1,211 sqft	156 sqft	13,577 sqft
	Watauga	2,136 sqft	1,070 sqft	304 sqft	10,845 sqft
Acres		2.6 acres	8.1 acres	0.02 acre	301.1 acres
	Ashe	4 acres	10.9 acres	0.04 acre	258.9 acres
	Watauga	1.8 acres	5.4 acres	0.02 acre	301.1 acres

3.6 Spatial Data

Spatial data form the objective variables used in both hedonic models. In the Riverfront Valuation Model with all sales data, *bordersriv* is the variable of interest. This variable was created by overlaying the tax parcel feature layer onto a river feature layer in ArcGIS. Any parcel that shared a border with the river feature layer was coded as “1” and all other parcels coded as “0”. After merging the spatial dataset from ArcGIS with the sales data by parcel number, 463 observations border a river and 18,611 observations do not. Of those 463, 80 border

the Watauga River, 215 border the South Fork New River, and 168 border the North Fork New River.

Table 2. Observations Bordering Rivers

Does Home Border a River?	Observation Count
No	18,611
Yes	463
<i>Watauga River</i>	80
<i>South Fork New River</i>	215
<i>North Fork New River</i>	168
Total	19,074

Along with *bordersriv*, the distance to grocery store (*disttogroc*) and distance to public access points along the rivers (*disttopubacc*) control variables were computed in ArcGIS. The grocery store locations were added using addresses of the eight Watauga County and three Ashe County grocery stores. All the grocery stores in Watauga County are located in the town of Boone except one in Blowing Rock, the second largest town in the county. Ashe County grocery stores are located within three miles of each other in the towns of Jefferson and West Jefferson. Public river access points for the New River were shared by the New River Conservancy and Watauga River access points were gleaned from local kayaking and fishing websites. Notably, the only public river access points on the New River are on the South Fork.

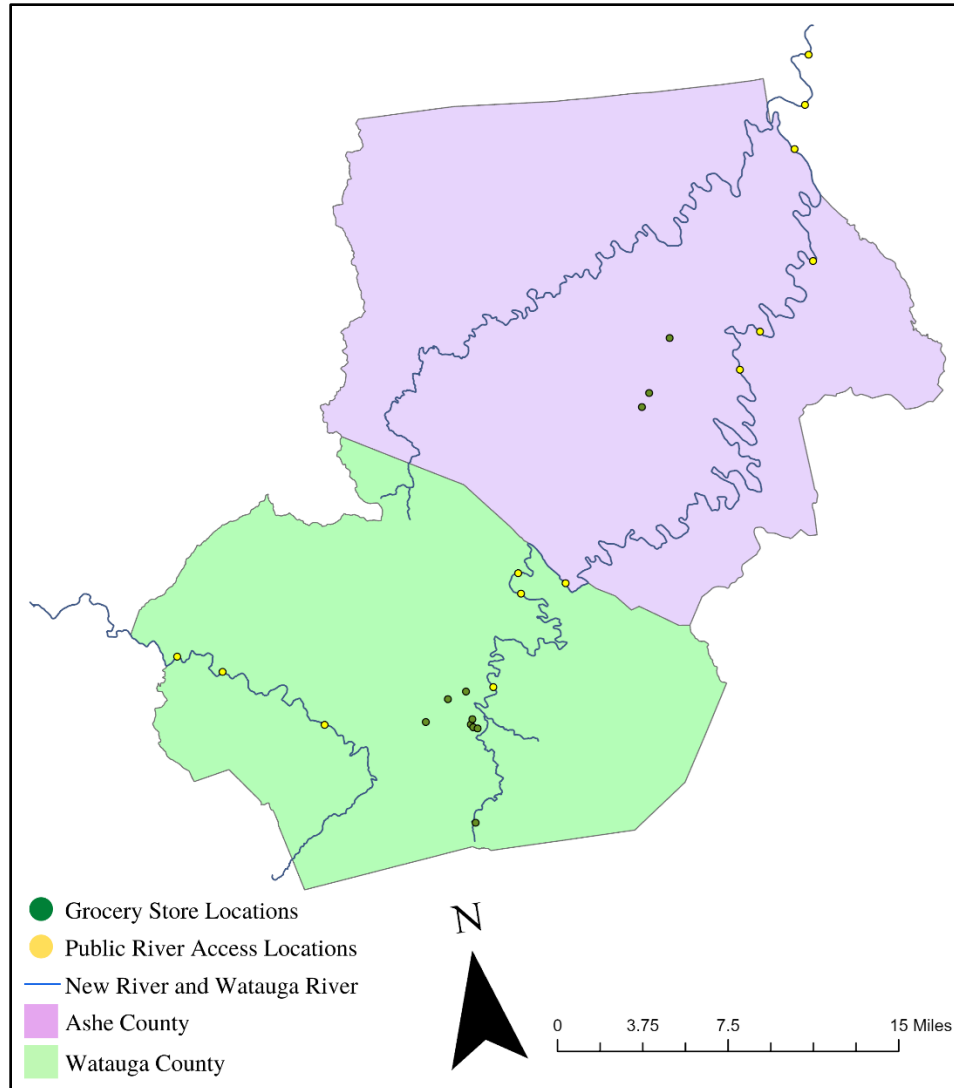


Figure 2. Grocery Store and Public River Access Points.

Distances to nearest grocery stores and public access points are Euclidean distances, so driving distances could be considerably longer bearing in mind the winding, mountainous roads in the two counties. The average distance to the nearest grocery store is 7,474 meters (4.6 miles) and the farthest house from a grocery store is 37,834 meters (23.5 miles) away. Homes are generally closer to public river access points than they are to grocery stores in Ashe and Watauga Counties. The mean distance to the nearest public river access point is 6,759 meters (4.2 miles).

Table 3. Distance to Grocery Stores and Public River Access Points Summary Statistics

Variable	Mean	Std. Dev.	Min	Max
<i>All Observations</i>				
disttogroc	7,474 meters	5,157 meters	30 meters	37,834 meters
disttopubacc	6,759 meters	3,865 meters	25 meters	29,827 meters

The Riparian Tree Coverage Model only utilizes river-bordering home sales to estimate the value of a riparian area. The feet of river frontage of the river-bordering parcel (*riverfrontfeet*) and the slope from the home to the river (*slopedegree*) are included in the second model as control variables. To compute the slope variable, the river layer was converted from a line to many points in ArcGIS. The elevation at the river points closest to each homesite, the elevation at the homesite, and the distance from the river to the homesite were used to define slope. The average river frontage is 424 feet, ranging from 5 feet (minimal access) to 15,505 feet (nearly 3 miles of river access). The angle from homes to the river range from 0.24 degrees to 58.1 degrees, averaging 12.5 degrees.

Table 4. River-Bordering Observations Summary Statistics

Variable	Mean	Std. Dev.	Min	Max
<i>Observations Bordering a River</i>				
Feet of River Frontage	424 feet	1,107 feet	5 feet	15,505 feet
Slope from Home to River	12.5°	10.3°	0.24°	58.1°
Ratio of Treed Riparian Area	0.38	0.31	0	1

The ratio of riparian area covered in trees (*ratiotrip*) is the variable of interest in the Riparian Tree Coverage Model. The ratio of riparian area covered in trees would be 1 if the

riparian area is completely covered in trees and 0 if there is no forested buffer, or no trees in the riparian area. The average ratio of treed to total riparian area in this dataset is 0.38. Although constant-width riparian buffers are easier to enforce at large scales, locally focused organizations are able to suggest riparian widths based on the needs of specific areas. For example, although a cost-share program might recommend a 15-foot wide minimum buffer, they will work with landowners to install riparian buffers with widths that are most beneficial to the river, often wider than the 15-foot minimum. Buffer systems that vary in width depending on different land and river characteristics are more efficient at protecting water quality and providing habitats than buffer systems that are a constant width through the entirety of the river. Considering the practice of basing buffer widths off land and river needs, riparian areas in this study were regarded as variable-width.

An ArcGIS toolbox created by the USDA Forest Service's Watershed, Fish, Wildlife, Air, & Rare Plants program in coordination with Michigan Technological University's College of Forest Resources and Environmental Science was utilized in this research to create a variable-width riparian area layer. The riparian buffer delineation model, RBDM v5.x, is "an ArcGIS Desktop\Pro toolbox designed to accurately and efficiently map variable-width riparian areas utilizing open-source geospatial data." Incorporating data from the National Hydrology Dataset, wetlands data from National Wetlands Inventory, SSURGO soils data from National Resources Conservation Service, elevation DEM data, landcover data, and 50-year flood height data, the riparian buffer toolbox modeled the riparian area around the New and Watauga Rivers (Abood, Maclean & Mason, 2012; Abood & Maclean, 2012).

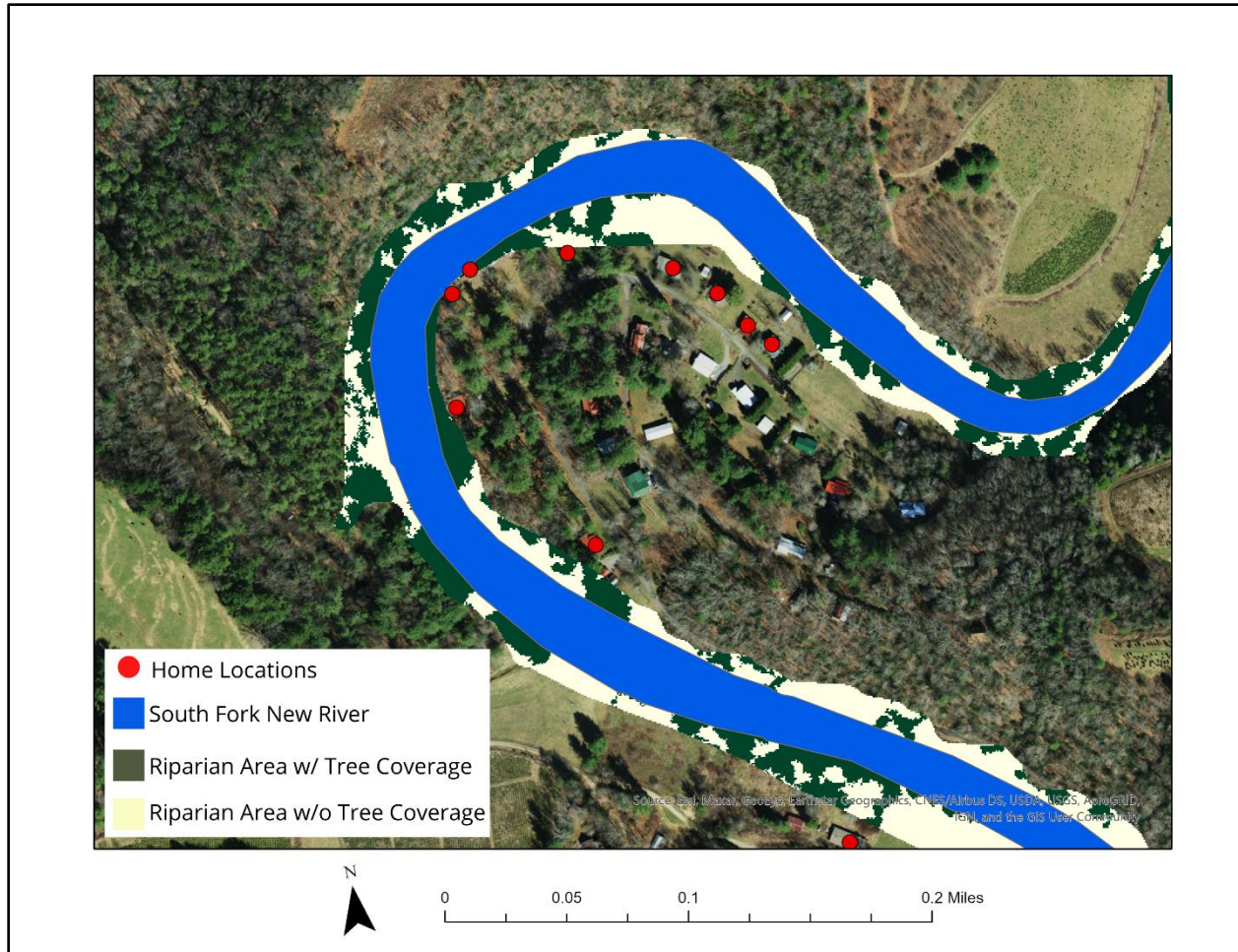


Figure 3. Section of Riparian Area Tree Coverage.

Considering trees are highly effective at protecting against erosion, providing wildlife habitat, and shading river waters compared to grasses and other vegetation with smaller root systems, a tree coverage layer was examined as the primary landcover of interest for riparian buffers in this study. Figure 5 shows a section of the South Fork New River (blue) surrounded by the riparian area with tree coverage (dark green) and riparian area without tree coverage (beige). For context, home locations along the river are red points. This figure represents how the riparian area produced by the USDA's ArcGIS toolbox varies in width along different points of the river. This figure also visualizes the patterns, or lack of patterns, of tree coverage in this dataset. Tree

coverage is sporadic. Two properties that have a ratio of .5 tree coverage to total riparian area could show very different tree coverage patterns. One property could have trees only along the river while another could have clusters of trees and non-treed land throughout the entire buffer, both riparian areas considered 50% treed. Tree coverage in this study is not necessarily contiguous.

As described above, this study estimates the value of riverfront property in Ashe and Watauga Counties and the value of riparian tree coverage on those riverfront properties. The results using the sales and spatial data detailed above are explained in the remaining sections of this study.

4 Results

This section of the paper details the results of the two main models described in the previous sections, as well as the spatial lag and spatial error adaptations of those models. The first model uses housing market data from Ashe and Watauga Counties to estimate the implicit price associated with a home bordering either the Watauga River or New River versus a similar home that does not border a river. The second model analyzes the prices of homes bordering a river in those two counties as they relate to the amount of riparian area tree coverage.

4.1 Model Results

Table 5 describes the results of the Riverfront Valuation Model in its initial linear form and then controlled for spatial lag and spatial error effects. Year effects are categorically defined as the years before the Great Recession (2005-2007) and years after (2010-2020) compared to

years during the Great Recession (2008-2009)². In all versions of the Riverfront Valuation Model, the years before the recession show significantly lower house prices than recession years. Home prices for years after the recession are slightly higher than recession years, but that value is only significant in the spatial lag model. Seasonality in home sales was also controlled for in all models, with each season category compared to spring. Homes sold in summer and fall had significantly higher prices than homes sold in spring, however homes sold in winter had insignificant negative effects. Depending on spatial specifications of the model, Ashe County homes sold for between \$106,000 to \$152,000 less than homes in Watauga County. The county variable is highly significant in all three versions of the Riverfront Valuation Model. These negative coefficients were expected considering the amenities associated with Appalachian State University and frequently traveled tourist locations in Watauga County compared to abundant agricultural lands in Ashe County. Homes farther away from grocery stores see sale prices significantly decrease by \$4 to \$6 per meter, or \$6,440 to \$9,660 per mile. As homes increase in age, housing prices decrease significantly in each version of the Riverfront Valuation Model. Square footage of homes (\$73 - \$88) and parcel acreage (\$8,000 - \$8,500) both positively and significantly affect house prices. As the distance to public river access points increase, the prices of homes also increase at a significant rate. This indicates that homeowners prefer to be farther away from public access points to the rivers, possibly because those are high traffic areas and can disturb privacy.

² Models were ran including binary variables for all years instead of recession categories. This year specification made no difference in linear and spatial error coefficient estimates, but spatial lag did not work because collinearity. The other variables were qualitatively unchanged when using recession categories compared to year binary variables.

Rho and lambda values indicate that the spatial lag and spatial error terms significantly contribute to this model, so the prices of homes sold in this model are dependent on the prices of homes sold in the same spatial region. Finally, homes bordering rivers sell for significantly higher prices than similar homes not bordering river in all three model specifications. The highest river price effect, \$40,600, is in the linear model. Both regressions including spatial effects indicate bordering a river increases home sales prices by \$27,200-\$28,400. Considering the significant rho and lambda coefficients, along with lower AIC values for spatial lag and spatial error regressions, the price associated with living on a river is likely closer to \$28,000. When not correcting for spatial autocorrelation in the “Linear Model” column, the value associated with bordering a river is overstated but observationally equivalent to the models that do correct for spatial autocorrelation.

Table 5. Riverfront Valuation Model Results

Variable	Linear Model		Spatial Lag Model		Spatial Error Model	
	Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error
<i>Recession Years Omitted</i>						
Years Before Recession (=1)	-13472.80**	5666.59	-14704.77***	3912.16	-16097.55***	5443.70
Years After Recession (=1)	1810.46	5097.01	979.04***	197.83	1290.23	4900.46
<i>Homes Sold in Spring Omitted</i>						
Sold in Summer (=1)	13651.84***	4204.22	13160.68***	3532.71	12871.30***	4019.47
Sold in Fall (=1)	20346.94***	4281.21	18612.35***	3765.05	15750.99***	4107.40
Sold in Winter (=1)	-1654.92	4587.62	-1352.19	923.09	-1960.52	4395.15
Ashe County (=1)	-151814.88***	3358.72	-106252.36***	3690.17	-150767.55***	5311.60
Distance to Grocery Store	-5.48***	0.32	-3.77***	0.34	-5.91***	0.51
House Age	-342.17***	66.05	-222.72**	99.15	-288.91***	70.87
House Square Footage	87.58***	1.42	72.86***	1.49	77.67***	1.52
Parcel Acres	7951.42***	196.31	8026.31***	190.10	8537.77***	196.47
Distance to Public Access	3.48***	0.44	1.72**	0.70	3.35***	0.70
Borders River (=1)	40632.41***	12266.69	28436.41***	12463.24	27175.35**	13442.42
Constant	102522.02***	7545.72	30095.10***	6566.14	127645.56***	8700.80
Rho			0.36***			
Lambda					0.40***	
Adjusted R ²	0.29					
AIC	513,490		512,520		512,560	

***p<0.01 , **p<0.05 , *p<0.1

The Riparian Tree Coverage Model results for linear, linear with spatial lag, and linear with spatial error specifications can be found in Table 6. All year and season effects³ become insignificant in this model compared to the previous model. County effects remain significant, suggesting that homes along the rivers in Ashe County sell for \$98,000 to \$141,000 lower than similar homes in Watauga County. As before, the differences in county prices can be attributed to the presence of a public university in Watauga County. Distance to the nearest grocery store has significantly negative impacts on housing prices. Like the Riverfront Valuation Model, houses farther from grocery stores have lower prices than those closer to grocery stores. The few grocery stores in Ashe and Watauga Counties are located in and around the city centers. Therefore, as homes become more rural and are located farther away from city centers, the sale prices decline. The effects of house age are insignificant with a sample of homes that border a river. Square footage and acreage remain significant in all versions of this model. The price per square foot and price per acre drops by around \$30 and \$4000 respectively compared to the Riverfront Valuation Model. There is less useable land on riverfront properties due to flooding, so it is unsurprising that the coefficient on riverfront land acreage is smaller than the model containing homes not bordering a river as well. River frontage and slope from the home to the river also serve as controls in this model. Feet of river frontage is positive and significant, so increasing river frontage increases home sale prices. The slope from the house to the river is defined as the arctangent of the difference in the river and home elevation divided by the

³ There are missing values in the spatial lag model for the fall season standard error and p-value due to correlation between season categories and the spatial matrix specification. Each model was run with only a summer season binary (1=sold in summer, 0=sold in another month) and without season variables at all. Only having the summer binary still has missing standard error and p-value for that variable and the model works properly when removing seasons altogether. Seasonality variable specifications does not quantitatively change the remaining variable coefficients.

distance from the home to the river. This slope variable is only significant in the initial linear model, not in the spatial lag and spatial error models. However, this variable is negative in all three versions of the model, suggesting that as slopes from homes to the neighboring rivers become steeper, house prices decrease.

The spatial dependence parameters, rho and lambda, are also significant in the Riparian Tree Coverage Model. The AIC values for the linear, spatial lag, and spatial error models suggest that the spatial lag model most accurately describes the variation in this dataset. Both the ratio of riparian area that is treed and that ratio squared are significant in all three versions of this model. The effects of the ratio of riparian area that is covered in trees on housing prices for river-bordering homes follows an inverted “U”-shape. Consider the spatial lag model estimates. House prices are positive and increasing as the ratio of treed riparian area goes from 0 to 0.46, remain positive and begin to decrease until a ratio of 0.92. When the ratio of treed riparian area to total riparian area is 0.92 or higher, house prices decrease. The linear and spatial error versions of the model follow a similar pattern, revealing maximum ratios of treed riparian areas of 0.45 and 0.43 and decreasing house prices starting at 0.90 and 0.87 respectively. Controlling for spatial autocorrelation changes implicit values slightly, but all three versions of the model are observationally equivalent.

Table 6. Riparian Tree Coverage Model Results

Variable	Linear Model		Spatial Lag Model		Spatial Error Model	
	Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error
<i>Recession Years Omitted</i>						
Years Before Recession (=1)	27205.83	40577.63	18978.58	36234.56	15535.89	38336.86
Years After Recession (=1)	32528.93	36473.78	24933.23	32744.59	22193.17	34474.29
<i>Homes Sold in Spring Omitted</i>						
Sold in Summer (=1)	10554.87	30961.24	5602.84	22258.51	9637.60	29300.42
Sold in Fall (=1)	10477.23	30645.99	446.89	NA	-4737.06	29363.89
Sold in Winter (=1)	-6468.70	36973.08	-11426.01	30850.94	-9597.63	34704.40
Ashe County (=1)	-140619.92***	28871.38	-98323.08***	30074.70	-112723.50***	38303.46
Distance to Grocery Store	-10.03**	4.10	-8.08**	3.94	-11.81**	5.30
House Age	-206.65	454.06	-367.75	431.51	-301.17	441.42
House Square Footage	53.58***	8.51	47.39***	8.28	49.76***	8.54
Parcel Acres	3922.15***	1236.97	4158.49***	1176.70	4092.56***	1174.65
Feet of River Frontage	48.23**	18.24	42.94**	17.38	45.20**	17.37
Slope from River to House	-2073.98*	1148.51	-1572.97	1105.44	-1292.24	1143.88
Ratio Riparian Area Treed	312152.08**	136093.77	254467.35*	131442.94	260279.52*	131548.56
Ratio Riparian Area Treed ²	-347138.01**	141962.48	-276595.39**	137508.09	-299621.74**	137709.31
Constant	257303.72***	65933.94	167423.03**	65879.81	277863.25***	73244.19
Rho			0.26***			
Lambda					0.32***	
Adjusted R ²	0.45					
AIC	8,194.9		8,185.9		8,186.6	

***p<0.01 , **p<0.05 , *p<0.1

Semi-log versions of the Riverfront Valuation and Riparian Tree Coverage Models can be found in the appendix. Linear versions are used in the main section of this paper considering the adjusted R² value is higher for the linear models than semi-log models. In the semi-log version of these models, the dependent variable, house sale price, is logged. Signs and significance levels of control variables in A1 and A2 are consistent with those in the linear

models. Rho and Lambda are significant in A1, indicating spatial dependence in the semi-log version of the Riverfront Valuation Model. Homes that border a river have significantly higher prices than those not bordering a river in A1 as well. Inserting the median sale price of \$195,000 into the derivative of the semi-log spatial lag equation reveal that sale prices increase by over \$46,000 for a home bordering a river. This value is quantitatively almost double the value from linear models controlled for spatial autocorrelation.

Neither rho nor lambda are significant with the logged sale price specification in A2 and the AIC is lowest for semi-log alone, so the simple semi-log version without spatial dependence gives the most accurate results for A2. The optimal riparian tree coverage ratio and ratio where sale prices become negative are quantitatively consistent with the linear versions of this model.

4.2 Discussion of Results

Both models were adjusted for spatial autocorrelation along with basic models with no spatial adjustments. Controlling for spatial autocorrelation with the spatial lag models are the best fit of the three model specifications for both the Riverfront Valuation and Riparian Tree Coverage Models. However, proximity to river and riparian area tree coverage variables are stable across all three model specifications. The following discussion describes results from the spatial lag model specifications.

The first model in this paper reveals that the marginal implicit price of owning a home bordering a river is significant and positive. The positive valuation associated with owning a home near a natural amenity is supported by previous revealed preference literature. Holding all other transactional, structural, and locational characteristics constant, homes bordering a river in

Ashe and Watauga Counties sell for around \$28,436 more than similar homes that do not border a river.

Table 7. Implicit Prices of Riverfront Homes and Riparian Area Tree Coverage

Variable	Implicit Price
Home Borders River (=1)	\$28,436
Ratio Riparian Area Treed (=0.05)	\$12,032
Ratio Riparian Area Treed (=0.46)	\$58,527
Ratio Riparian Area Treed (=0.75)	\$35,266
Ratio Riparian Area Treed (=0.92)	-\$0.38
Ratio Riparian Area Treed (=1)	-\$22,128

The second model estimates a positive marginal implicit price associated with treed riparian areas. This maximizes value at around 46% riparian area tree coverage and becomes negative at around 92% tree coverage. Table 7 shows the positive impacts of riparian area tree coverage to home sale prices, maximized at around \$58,500. Even 5% tree coverage increases home prices by around \$12,000. As riparian area tree coverage reaches 92%, the value added to riverfront homes becomes close to zero. Any riparian tree coverage over 92% has negative effects on home sale prices. A complete riparian buffer with 100% riparian area tree coverage can decrease home prices by around \$22,000. The declining values after the optimal tree coverage percentage and negative values associated with riparian areas with over 92% tree coverage are likely due to the loss of river visibility with added trees and vegetation.

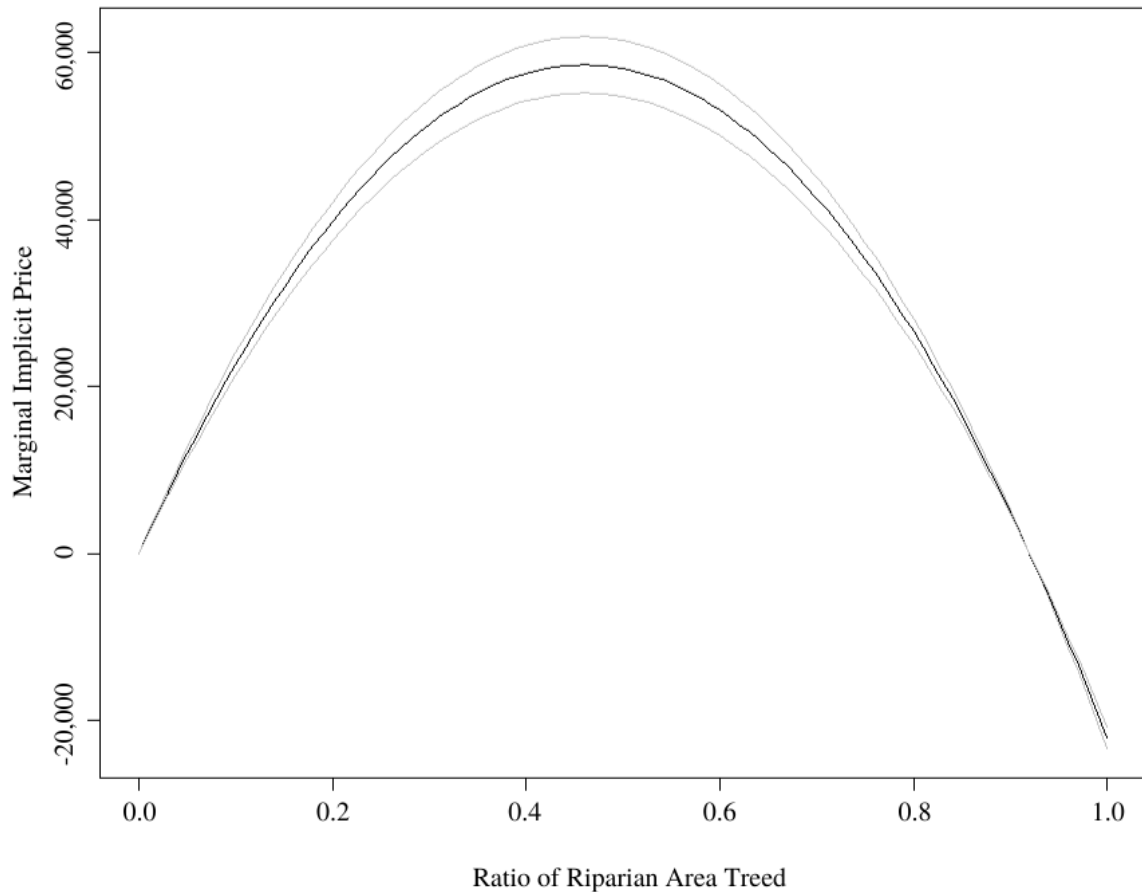


Figure 4. Ratio of Riparian Area Treed Marginal Implicit Price Plot (Black)
with 95% Confidence Intervals (Gray).

The coefficients on Ratio of Riparian Area Treed constant and squared terms describe marginal impacts to home sales prices for the average observation in this dataset. People have individual preferences, so some people will have higher or lower values of tree coverage. Figure 4 visualizes how marginal impacts adjust as the ratio of riparian area covered in trees increases from 0.0 to 1.0, or zero tree coverage to complete tree coverage. There is a 95% confidence interval, gray lines, around the curve to show how individual values can vary from the average

implicit price impacts. Importantly, for most people any amount of tree coverage up to around 90% coverage increases home values.

4.3 Policy and Research Relevance

The results of this study can be used to influence local policy and structure riparian buffer installation and protection programs. Rivers can be considered both public and private goods. The public has access to the river itself, mainly for recreational purposes. Private riverfront landowners have other benefits that the public does not, like water and riparian land access and constant scenic views. The positive implicit price associated with owning a home that borders a river suggests that those who border a river will have higher property tax prices compared to similar homes not bordering a river. That difference in tax revenue could conceptually help fund efforts to protect rivers, along with publicly funded donations or tax increases as discussed in stated preference research.

Although it is in the best interest of environmental organizations to promote complete riparian buffers along rivers, the variation in riparian area tree coverage values suggest that a compromise of partial riparian buffers might be more attractive to landowners. The environmental and economic costs and benefits of some land completely buffered versus more land partially buffered would need to be analyzed. It is also possible to increase the optimal value ratio of riparian area tree coverage through educational programs about the environmental benefits of riparian areas.

4.4 Study Limitations

There are limitations to this research due to fluctuations in environmental and locational characteristics. The natural environment is endlessly evolving, yet the data used to construct riparian areas and tree coverage are constant in these models. Landowners can add or remove vegetation to their river-bordering lands at any point in time. This region of North Carolina is known for Christmas Tree farms, which are harvested every seven years or so. A Christmas Tree farm bordering a river could be defined as a riparian tree coverage under this study's assumptions for years, and then later removed for harvest. Also, the geospatial quality of this data lends itself to correlation issues. The robustness of these models was examined by varying model and variable specifications and found that the estimates are reasonably accurate.

This study only includes residential sales. Large amounts of property in this region are agricultural and those landowners would have different incentives to protect riparian buffers or use riparian areas for crop production. The reasons that riparian area tree coverage is valued cannot be distinguished in this study. It is unclear if landowners recognize the environmental impacts of riparian buffers, if they simply enjoy the shade and landscape appeal that riparian vegetation provides, or if they value tree coverage for other reasons. Further research is required to estimate valuation of riparian buffers on non-residential lands and the reasonings behind those values.

5 Conclusion

This nonmarket valuation study uses housing market data in revealed preference hedonic models to estimate the value of river-bordering homes and riparian buffers in two Northwestern North Carolina and southern Appalachian counties. The literature of riparian buffer valuation

through revealed preference is mainly set in cities and arid areas, however, is sparse in rural settings. Other studies assume the presence of a riparian buffer is binary: either the buffer exists, or it does not. This study adds to the literature by valuating riparian buffers through revealed preference in an understudied geographic area and defines the riparian buffer variable in a way that explains variability in values as the level of riparian vegetation fluctuates. The valuation of riverfront land and riparian vegetation can also be utilized by local environmental organizations that are seeking funding avenues for riparian restoration and cooperate with private landowners to install and protect riparian buffers along the New and Watauga Rivers.

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Appendix

A1: Riverfront Valuation Model Semi-Log Results

Variable	Semi-Log Model		Spatial Lag Model		Spatial Error Model	
	Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error
<i>Recession Years Omitted</i>						
Years Before Recession (=1)	-0.09293***	0.02438	-0.1003***	0.0238	-0.1060***	0.0238
Years After Recession (=1)	0.03664*	0.02193	0.0336	0.0214	0.0363*	0.0214
<i>Homes Sold in Spring Omitted</i>						
Sold in Summer (=1)	0.06677***	0.01809	0.0627***	0.0176	0.0605***	0.0175
Sold in Fall (=1)	0.07484***	0.01842	0.0693***	0.0180	0.0644***	0.0179
Sold in Winter (=1)	-0.03547*	0.01974	-0.0344*	0.0193	-0.0359*	0.0192
Ashe County (=1)	-0.68602***	0.01445	-0.4864***	0.0157	-0.6736***	0.0206
Distance to Grocery Store	-0.00002***	0.00000	0.0000***	0.0000	0.0000***	0.0000
House Age	-0.00083***	0.00028	-0.0003	0.0003	-0.0003	0.0003
House Square Footage	0.00031***	0.00001	0.0003***	0.0000	0.0003***	0.0000
Parcel Acres	0.00875***	0.00084	0.0096***	0.0008	0.0103***	0.0009
Distance to Public Access	0.00000	0.00000	0.0000	0.0000	0.0000	0.0000
Borders River (=1)	0.28883***	0.05277	0.2397***	0.0515	0.2689***	0.0573
Constant	11.68382***	0.03246	7.9294***	0.1391	11.7324***	0.0361
Rho			0.3102***			
Lambda					0.3227***	
Adjusted R ²	0.23					
AIC	49,338		48,626		48,696	

***p<0.01 , **p<0.05 , *p<0.1

A2: Riparian Tree Coverage Semi-Log Results

Variable	Semi-Log Model		Spatial Lag Model		Spatial Error Model	
	Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error
<i>Recession Years Omitted</i>						
Years Before Recession (=1)	0.00613	0.19223	0.00975	0.18736	0.00975	0.18736
Years After Recession (=1)	0.06031	0.17279	0.06459	0.16839	0.02661	0.18712
<i>Homes Sold in Spring Omitted</i>					0.07815	0.16806
Sold in Summer (=1)	-0.00742	0.14668	-0.00423	0.14310		
Sold in Fall (=1)	0.06543	0.14518	0.06917	0.14153	-0.00383	0.14278
Sold in Winter (=1)	-0.01661	0.17516	-0.01583	0.17075	0.07911	0.14045
Ashe County (=1)	-0.44337***	0.13678	-0.46748***	0.14169	-0.01861	0.17098
Distance to Grocery Store	-0.00004**	0.00002	-0.00004**	0.00002	-0.46523***	0.12028
House Age	-0.00078	0.00215	-0.00070	0.00210	-0.00004**	0.00002
House Square Footage	0.00016***	0.00004	0.00016***	0.00004	-0.00057	0.00207
Parcel Acres	0.00974	0.00586	0.00956*	0.00571	0.00016***	0.00004
Feet of River Frontage	0.00004	0.00009	0.00004	0.00008	0.00914	0.00570
Slope from River to House	-0.00839	0.00544	-0.00863	0.00532	0.00005	0.00008
Ratio Riparian Area Treed	1.52424**	0.64473	1.54454**	0.62908	-0.00927*	0.00516
Ratio Riparian Area Treed ²	-1.76293**	0.67253	-1.78677**	0.65730	1.58002**	0.62131
Constant	12.33495***	0.31235	12.87719***	1.49840	-1.79794**	0.64750
Rho			-0.04332			
Lambda					0.79733	
Adjusted R ²	0.17					
AIC	814.38		816.24		815.58	

***p<0.01 , **p<0.05 , *p<0.1