COLORADO MESA UNIVERSITY

The impact of natural amenities on home values in the greater Grand Junction area

By Nathan Perry, Tammy Parece, Cory Castaneda and Tim Casey

SUPPORTED BY

GRAND JUNCTION AREA REALTOR ASSOCIATION

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

THE IMPACT OF NATURAL AMENITIES ON HOME VALUES IN THE GREATER GRAND JUNCTION AREA

By Nathan Perry, Tammy Parece, Cory Castaneda, Tim Casey[1]

EXECUTIVE SUMMARY

- This study uses three distinct multiple regression models to determine the impact of various natural amenities on home values, controlling for all other characteristics of the home. It is important to understand that all of the subsequent results provided control for all other factors that may influence the value of the home that are in the statistical model.
- This report will illustrate the impact of various amenities measured at three different proximities; 250 meters, 500 meters, and 1000 meters.[2] The statistical model controls for characteristics of the home, spatial effects, time effects, and demographic effects in order to isolate the impact that natural amenities have on home values.
- The area studied is the Greater Grand Junction Area (GGJA) which includes the cities of Grand Junction, Palisade, and Fruita, Colorado. The data set contains 6,501 home sale transactions from the years 2013-2015.
- Homes located within 250 meters of a trail sell for 4.45% more, while homes located within 500 meters of a trail sell for 3.26% more. For the average home value of $208,602, this equates to $9,470 added value at a distance of 250 meters and $6,800 for homes within 500 meters of a trail. If the distance is expanded to 1000 meters the result becomes statistically insignificant.
- Homes located within 500 meters of BLM land sell for 9.07% more, or $18,920 for the average home. Homes within 1000 meters of BLM land sell for 4.85% more, or $10,117 for the average home.
- Homes located within 250 meters of a golf course sell for 12.70% more ($26,492), and homes located within 500 meters of a golf course sell for 8.45% more ($17,626). Homes within 1000 meters of a golf course sell for 7.67% more ($16,000).

---

[1] Authors: Nathan Perry is an Associate Professor of Economics at Colorado Mesa University, Tammy Parece is an Instructor of Geography at Colorado Mesa University, Cory Castaneda is a graduate student in economics at the University of Illinois, Urbana Champaign, and Tim Casey is a Professor of Political Science at Colorado Mesa University.

[2] This study is conducted in meters. As a guide, 250 meters=820 feet, 500 meters=1640 feet, and 1000 meters=3280 feet. 1000 meters is roughly equivalent to .62 of a mile.

- Homes located within 250 meters of the Colorado National Monument sell for 12.90% more ($26,909). Living within 500 meters of the Colorado National Monument increases home values by 9.93% ($20,714). Homes within 1000 meters of the Colorado National Monument sell for 13.80% more ($28,787).
- Homes located within 500 meters of public parks sell for 1.4% less, indicating that home buyers find close proximity to public parks as a negative characteristic.
- Homes within 500 meters of the Colorado and Gunnison Rivers sold for 5.90% less. Buyers may be taking into account the risk of flooding when purchasing these homes.
- Homes located within 250 meters of open space sell for 6.94% less. This may be for the same reason people do not want to live next to parks; these areas are noisy, and there may be traffic near the home. Homes within 500 meters of an open space is statistically insignificant, while living within 1000 meters is statistically significant and has an associated increase of 5.4% in home value.
- Home values increase by 3.2% for every additional 100 square feet of living space. For every increase of 1000 feet, home values increase 32%.
- Each additional bathroom adds 5.5% to the value of the home, equating to $11,473 per bathroom.
- Every acre of land adds 6.4% percent to the value of a home.
- Given the same characteristics of a single family residential home, a condo sells for 52.50% less than a single family home, while townhomes sell for 23.50% less.
- Homes in Palisade sell for 13.60% more than homes in Grand Junction, while homes in Fruita have a statistically insignificant difference compared to homes in Grand Junction.
- Quarter 3 is the top selling quarter, and homes sold in quarter 1 sold for 6% less than homes sold in quarter 3. Homes sold in quarter 2 and 4 are not statistically different than those sold in quarter 3.
- The value of a home decreases by -.40% each year, equating to approximately $834 less per year for the average home.
- Living in the Redlands increases home values by approximately 10%. Living in Palisade increases home values by approximately 12%. Adversely, homes in the area of Clifton sell for almost 20% less, while homes in Fruitvale sell for approximately 9% less. The Fruitvale zip code was broken into the areas of Fruitvale North and Fruitvale south, which are separated by the river. Fruitvale North homes sell for 6.2% less, while Fruitvale South homes sell for

16.2% less. Homes in Orchard Mesa sell for approximately 3% less, homes in North Grand Junction sell for approximately 5% more, and Fruita is statistically insignificant.

- Elementary schools were tested with a barrier of 500 meters. Results indicate that proximity to some schools adds significant value to the home (Chipeta, Wingate Lincoln, Mesa View, Thunder Mountain) and shows the opposite effect (with proximity hurting home values) for (Clifton, Nisley, Pear Park, Rim Rock, and Tope).
- Middle schools and high schools were also tested. Four out of eight middle schools have a statistically significant effect on home values. Being located with 500 meters of Bookcliff Middle School and Fruita Middle School has a positive impact on home value, while proximity to West Middle School or Orchard Mesa has a negative impact. Proximity to Grand Junction and Palisade High School improves home values, while proximity to Fruita High School is statistically insignificant.
- Other public amenities such as distance to a fire station, hospital, school, and police station were also tested. There was no statistical significance and a weak theoretical reason that home values may be higher with close proximity to these amenities, so they were removed from the model.

ACKNOWLEDGEMENTS

The research team at Colorado Mesa University wishes to thank the Bureau of Land Management and the Grand Junction Area Realtor Association for their generous support of this research. The views and conclusions contained in this document are those of the authors and should not be interpreted as representing the opinions or policies of the U.S. Government. Mention of trade names or commercial products does not constitute their endorsement by the U.S. Government. The research team would also like to thank the Office of Sponsored Programs and Academic Research at CMU and Steve Smith, GIS Specialist at the City of Grand Junction for their logistical support, and the administration of CMU for their on-going support of the research done at the Natural Resource Center.

Table of Contents

INTRODUCTION

This paper studies the relationship between natural amenities and home values using three different regression models. Specifically, the paper examines the implicit price that home buyers are willing to pay to be located near trails, Bureau of Land Management (BLM) land, the Colorado National Monument, golf courses, open space, parks, and rivers, controlling for other characteristics of the home.

Mesa County is an ideal location for this type of study due to its diversity of outdoor recreation (see Appendix A, Figures 1-3). The county encompasses a total of 3,309 square miles and 72% of this land is owned or managed by federal agencies including the National Park Service (NPS), U.S. Forest Service (USFS), and the Bureau of Land Management (BLM). There are also public lands managed by state and local agencies. The area draws mountain bikers from around the world who travel to Mesa County to enjoy the Kokopelli Trail, 18 Road Trails and Lunch Loops. The county is surrounded by recreational areas including the Colorado National Monument on the west side of Mesa County, the Bookcliff Mountains to the north, Uncompahgre Plateau to the south and the Grand Mesa to the East. The Colorado and Gunnison Rivers also run through the center of the Greater Grand Junction Area (GGJA).[3] Many outdoor enthusiasts and retirees are drawn to Mesa County for this abundance of outdoor recreation. The natural characteristics of the area and the proximity of these amenities to homes makes Mesa County an ideal location to study how these natural amenities influence home values.

LITERATURE REVIEW

Hedonic house price models are a common model used to determine the value of various amenities and dismenities affecting home values. Hedonic house models are one of the few ways to value a natural amenity. By controlling for all other amenities that contribute to a home's value, it allows the researcher to indirectly value the proximity to a natural amenity by inferring it from observable market transactions (Taylor, 2003).

Many studies have investigated various types of natural amenities including open space, natural views, trails and greenways, lakes, parks, golf courses, national parks, etc. However, it is rare to have a geographic location where several of these amenities can be tested in the same model.

Trails can add recreational value for people and actual value to homes if they are within reasonable proximity. Many studies have evaluated the impact of forest or greenway proximity, but fewer have specifically examined the impact of trails. Existing research illustrates that close

[3] See http://www.mesacounty.us/geography for more information about the geography of Mesa County.

proximity to trails almost always has a positive impact on home values. Asabere and Huffman (2009) find that trails, greenbelts, and a product variable which represents greenbelts with trails have a 2, 4, and 5% price premium in San Antonio, Texas. Racca and Dhanju (2006) examine home values in Delaware, and find that homes with a bike path in close proximity sell for approximately 4% more when controlling for other factors affecting the home.

The impact that national parks or national monuments have on home value can depend on the type of park. In the case of national parks and monuments, people may value the proximity to the amenity for recreation purposes, or they may value proximity to the amenity for the view. In the case of the Colorado National Monument, it is likely that people value both the proximity for recreation and the view. The Colorado National Monument is a beautiful mountainside of red rock that has been weathered by nature to have interesting rock formations and views. Grand Junction's southwest area (known as the Redlands) has pristine views and close proximity to the Colorado National Monument. This study examines how much value proximity to the Colorado National Monument adds to homes, controlling for all other factors. Pearson, Tisdell, and Lisle (2002) study the impact of the Noosa National Park (outside of Brisbane, Australia) on surrounding home values. They find that proximity to the park is associated with 6-7% increase in home values. Stetler (2009) finds that every kilometer closer to Glacier National Park in Montana improves home value.

Golf courses are desired due to their views, status, and proximity to golf recreation. Lutzenhiser and Netusil (2001) find that golf course increase home value by $8,849. Do and Grudnitski (1995) examine the Rancho Bernardo area in California, and find that proximity to golf courses increase home values by 7.6%. Nicholls and Crompton (2007) find that in College Station, Texas, lots adjacent to golf courses sell for 25.8% of the average sales price of the home. Stetler (2009) finds that homes in Western Montana adjacent to golf courses sell for a 19% premium.

The impact of parks varies widely in the home value literature, with some studies showing that parks bring positive value to surrounding homes, and some studies showing negative value. Crompton (2001) conducts a thorough literature review of studies that try to measure the impact of parks on surrounding home values. Twenty five of the thirty studies he covers illustrate a positive impact on home value, leading to Crompton's conclusion that proximity to parks improves home values by approximately 20%. He also concludes that more heavily used parks may not add as much value to the home, instead adding 10% within approximately 3 blocks. In a subsequent study that uses regression analysis, Nicholls and Crompton (2005) study the area of Bastrop County, Texas, and find that parks do not have a statistically significant impact on home values. The authors reason that because the study area was rural, the value of having open space is diminished because there is so

much of it. Cebula (2009) examines the housing market in Savannah, Georgia and finds among other things that locations adjacent to parks improve home values by 14%. The primary concern regarding proximity to parks is the potential for crime. Troy and Grove (2008) examine the interactive role of crime and public parks in Baltimore, Maryland. They find that park proximity improves home value when the crime rate is below a certain threshold. Parks in areas that surpass the crime threshold reduce surrounding home values, indicating that crime rates drive the value of parks.

Open space in this study is defined as space that has no plans for development by the city. This generally creates a space where people will walk their dogs or allow children to play. Acharya and Bennet (2001) find that open space generally improves home values, and Anderson and West (2006) find that neighborhoods parks increase home values by 0.173%. Anderson and West also find that proximity to golf courses is positively related to home value. Lutzenhiser and Netusil (2001) use data from Portland, Oregon, from 1990-1992, and find that natural area parks within 1,500 feet of a home increase home values by $10,648.

Bureau of Land Management (BLM) land is an interesting variable that is not common in the literature. It can be seen as both a National Park, as well as a form of open space. Since the BLM land is full of trails, it can also be seen as a trail proxy. As a trail proxy, it is different from trails that are adjacent to neighborhoods because there are very few BLM trails that are close to homes within the distance parameters of this study.

The goal of this study is to determine the value to home buyers of the following natural amenities: proximity to trails, BLM land, the Colorado National Monument, parks, open space, the Colorado and Gunnison Rivers, and golf courses.

DATA/METHODOLOGY

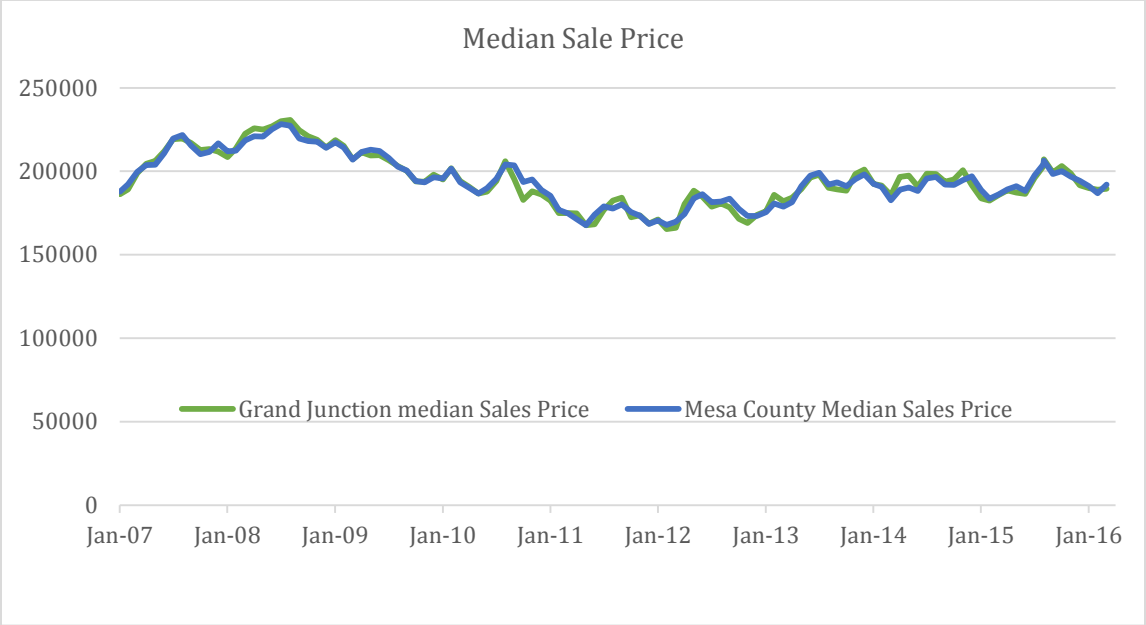
The area of study was narrowed from all of Mesa County to the greater Grand Junction area (GGJA). The GGJA consists of Grand Junction, Fruita, and Palisade, Colorado (Figure 2 in appendix A). Areas outside of the GGJA were omitted because they are significantly more rural, and the necessary GIS information on natural amenities, dismenities, and other variables do not exist outside of the GGJA.

Geographic Information Systems (GIS), specifically ESRI's ArcGIS, was used for determining distances to various amenities. The data were obtained in shapefile form from either the Grand

Junction GIS Department or downloaded from various government FTP GIS download sites.[4] Table 9 in Appendix D lists each shapefile by title and source, and provides a description where pertinent.

Homes sales from the years 2013-2015 were used because it was determined that Grand Junction home values had stabilized by this time following the housing bust of 2009. As figure 4 illustrates, 2013 to 2015 prices maintain stability and appear to be moving horizontally.[5] There are 6,501 single family homes in this dataset from the cities in the Greater Grand Junction Area.

Figure 4: Median Sale Price of Mesa County and Grand Junction Homes



In order to create consistent coherent variables, several shapefiles of similar nature were combined into one variable. For instance, there are several trail shapefiles, including BLM trails, National Park Service Trails, and 18 other types of trails (local bike, pedestrian, etc.) that were combined into one shapefile. This study defined trail as an outdoor space, one that was not paved, but one that had a natural landscape experience. Thus "trails" such as city biking paths were deleted from the larger shapefile in order to create the distinctive trail definition that is being tested in this study.

Parks in this study are defined as a public park recognized by the city as public spaces. This does not include school playgrounds or national parks (which have their own GIS coding). Open spaces are defined as non-agricultural land that is not currently developed or that has an easement from the city to not be developed. Agricultural land was not included in the definition of open space

[4] Special thanks go to Stephen M. Smith of the City of Grand Junction for his help collecting the shapefiles and his recommendations in various issues regarding the GIS work and data collection phase of this project.
[5] Regardless of when home values leveled out, in the fixed effects model time effects are controlled for.

because the agricultural land was generally on the outskirts of town and had very large lot sizes. Ultimately, open space as a non-developed piece of land that can be utilized for recreation or for view is very different from agricultural land, which is not used for recreation and is less likely to be used for view. Socioeconomic variables included in our analysis were obtained at the Block Group Level and ascribed to each home located within the block group.

The dependent variable is the sale price of single family homes adjusted for concessions by either the buyer or seller. Adjusting for concessions gives the true sale price for each home. Homes with unusual sale circumstances as determined by the assessor (and tracked by the Mesa County Assessor's Office), such as selling to family member, or sold at a significant discount due to being bank owned, or other different circumstances were omitted from the dataset.[6] Independent variables are listed and described in table 1 in appendix B.

The study employs three types of regression models; ordinary least squares (OLS), a fixed effects model (FE) that controls for time effects and spatial effects (zip code), and a spatial error model (SE). The generic model is as follows:

$$\ln P_i = \beta_0 + \beta_1 S_i + \beta_2 N_i + \beta_3 Q_i + \varepsilon_i$$

Where P_i is the natural log of the adjusted home price, S_i is a vector of house and property characteristics, N_i is a vector of neighborhood characteristics, and Q_i is vector of natural amenities, measured by distance dummy variables.

Model Specification

Many studies take the natural log of square feet of the home, because it is expected that as square footage increases the effect on price will decline. However, in a scatter plot and simple regression analysis, it is clear with this data that a linear trend line fit the relationship between square feet and home price better than the natural log form. The R-squared for the linear trend is .64 vs. the natural log trend of .56, hence the natural log of total square feet was not used. Appendix B lists all variables by variable type.[7]

[6] The authors would like to thank Matt Barber at the Mesa County Assessor's Office for help in determining which sales were qualified vs. unqualified.

[7] The authors also tested public amenities such as distance to a fire station, hospital, school, and police station. There was no statistical significance and a weak theoretical reason that home values may be higher with close proximity to these amenities, so they were removed from the model.

Model Selection and Spatial Autocorrelation

When conducting a hedonic house price model, it is important to test for spatial autocorrelation. Spatial autocorrelation is the concept that expensive homes are likely located near each other. This violates an important assumption in regression analysis, which is the idea that all data points are independent. Moran's I test was used on the OLS model to confirm spatial autocorrelation (table 2). A fixed effects model was conducted using both fixed effects for location (zip code) and time. After including the zip code fixed effects, Moran's I indicated no spatial autocorrelation. Although the fixed effects model specification was adequate to control for spatial effects, a spatial error model was conducted. The spatial error model did not eliminate spatial autocorrelation at 250 and 500 meters, however, it did indicate that at 1000 meters that spatial autocorrelation is less of a problem. Initially, the spatial model was conducted with zip codes, however, the results were statistically insignificant when zip codes were added to the spatial model. Because of this, zip codes were omitted from the spatial model.

Table 2 illustrates several other model specification tests. The Brusch Pagan (BP) test shows no signs of heteroscedasticity. The model was tested for spillovers, local spillovers, and global spillovers to determine what type of spatial regression is appropriate for the model. This model tries to capture the influence that the nearest neighbor has on housing price, with that influence declining as distance increases. A global spillover would model this accurately, and a spatial error model would theoretically be the optimal model for the regression. LM tests were used to help determine the appropriate spatial model. Initially a spatial lag model was conducted, however the LM test was insignificant, hence a spatial error model was chosen. The spatial error model incorporates spatial effects through the error term. The ε is the vector of error terms that are spatially weighted using the weight matrix W. The λ term is the spatial error coefficient. The ζ is the vector of uncorrelated error terms.

$$y = x\beta + \varepsilon \ \ with$$
$$\varepsilon = \lambda W\varepsilon + \zeta$$

In addition to these tests, a multicollinearity test was performed (VIF test) and shows no signs of multicollinearity. The results for the VIF test are in table 8 in appendix C.

Table 2: Model Specification Tests

	OLS – 250	**OLS - 500**	**OLS - 1000**	**OLS - FE 250**	**OLS - FE 500**	**OLS - FE 1000**	**Error - 250**	**Error - 500**	**Error - 1000**
Moran's I	0.0034	0.0031	0.0016	-0.00006	0.00001	-0.00005	0.0016	0.0013	0.0007
	(0.000)	(0.000)	(0.000)	(0.715)	(0.596)	(0.685)	(0.003)	(0.006)	(0.045)
BP	273.99	282.50	289.07	279.47	299.36	297.54	276.52	287.08	292.74
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
LogLik	-182.74	-157.59	-75.24	27.33	33.71	85.3	-168.99	-147.23	-71.03
AIC	423.47	373.19	208.48	19.35	6.59	-96.61	397.96	354.46	202.07
BIC	620.09	569.80	405.09	270.20	257.44	154.24	601.35	557.85	405.46
LMerr	56.76	36.49	10.14	0.01	0.00	0.01			
	(0.000)	(0.000)	(0.001)	(0.908)	(0.981)	(0.929)			
LMlag	1.72	0.75	0.04	0.04	0.01	0.06			
	(0.189)	(0.386)	(0.836)	(0.851)	(0.923)	(0.808)			
RLMerr	56.71	36.46	10.14	0.01	0	0.01			
	(0.000)	(0.000)	(0.001)	(0.908)	(0.981)	(0.929)			
RLMlag	1.67	0.72	0.04	0.04	0.01	0.06			
	(0.196)	(0.395)	(0.842)	(0.851)	(0.923)	(0.808)			

P-values are reported within parentheses

Spatial Weight Matrix

The standard method of selecting a weight matrix for a spatial regression is to decide between either using a k-nearest neighbor approach, a contiguity matrix, or a weight matrix based off of distance. The k-nearest neighbor approach takes into account the next closest number of neighbors that you select. The contiguity matrix either takes into account horizontal/vertical neighbors or diagonal neighbors depending on whether you use a Rook or Queen matrix. The distance matrix can use a measure such as km or miles, or it can use the great circle method and calculate Euclidian distance. Each one of these measures has merit for different forms of research, but a special weight matrix was used for the concept of capturing neighbor relationships between observations instead of modeling distance from the observation. An inverse-distance weight matrix with nonzero elements is used to proxy the peer effect relationship that is most likely occurring between residents (Mueller & Loomis, 2013). If the distance was within 50 miles of the house, the inverse distance was calculated from a distance matrix.

$$W_{ij} = \frac{1}{d^2} \; if \; d_{ij} < distance$$

Ultimately, the pre and post tests for the three models (OLS, FE, Spatial Error) indicate that the fixed effects model is the best model, and the results discussed in this paper are the results from the fixed effects model.

Results: Home Characteristics[8]

The results from the three models are generally consistent, and are listed in table 3. Because the FE model at 500 meters adequately meets all the criteria to be considered an accurate model with no spatial autocorrelation, the FE results will be emphasized in this results section. The square foot variable can be interpreted as follows: For every increase in 100 square feet, there is an increase in home value of 3%. For every increase of 1000 feet, there is an increase in home value of 30%. The number of bedrooms is generally not significant in any of the models. This could be an issue with minor multicollinearity, or it could be a specific feature of the Grand Junction area. On average,

[8] Note that the writing of the results section reports percentages, not coefficients, whereas table 3 reports just coefficients. Many people believe that the coefficient from a log-linear model is the percentage impact. However, the coefficient must be transformed with the equation 100(exp(x)-1) to get exact percentages from the log-linear model. For small coefficients, there is generally no difference. The larger the coefficient, the larger the difference between the coefficient and the percentage.

younger individuals with children have less income than those who are older and without children. Grand Junction is both a retirement community and a college town. Both retirees and college students have less need for additional rooms.

Each additional bathroom increase home values by approximately 5-6%. For an average home value of $208,602, this equates to approximately $12,500 per bathroom. Controlling for other factors, every acre of land increases home value by approximately 6%.

The results for the dummy variables condo and townhouse show that controlling for all other factors, condos sell for 35% less than their single family home counterparts, while townhouses sell for approximately 20% less.

Dummy variables were created to control for the selling season, with the top selling quarter (quarter 3) as the baseline. The dummies indicate that home sold in quarter 1 sell for approximately 5.5% less, equating to $11,500 less than in quarter 3. Quarter 2 and 4 were statistically insignificant from quarter 3.

Natural Amenity Variables

The natural amenity variables illustrate interesting and robust results. The coefficient results for natural amenities are listed with the rest of the coefficients in table 3. Table 4 below interprets these natural amenity coefficients as a percentage impact on home values for the three different distances. Table 4 illustrates that the closer the proximity to trails, the higher the impact on home values. Home values within 250 meters of a trail increase by 4.54%, which equates to $9,465 for the average home. This effect deceases to 3.26% at a distance of 500 meters and is statistically insignificant at 1000 meters.

Proximity to BLM land also shows a strong impact on home values. Proximity within 250 meters of BLM is statistically insignificant, however, this is not surprising since it is difficult to find home that are located so closely to BLM land. A distance of 500 meters is a more realistic proximity to which homes are actually built near BLM land. Home values increase by 9.07% within 500 meters of BLM land, equating to $18,920 for the average home. At 1000 meters, home values increase by 4.85%.

Living within 250 meters of a golf course increase home values by 12.7%, 8.45% at 500 meters, and 7.67% at 1000 meters. The results of the golf course amenity are similar to the results of other studies.

Public parks in all of the regressions have a negative coefficient. The literature on public parks shows that parks can have both a positive or negative effect on home values, so a negative sign is not surprising. At 250 meters, public parks are not statistically significant, but at 500 and 1000

Table 3: Results

	Log-Linear Model			**Fixed Effects Model**			**Spatial Error Model**		
Distance Variable	250 meters	500 meters	1000 meters	250 meters	500 meters	1000 meters	250 meters	500 meters	1000 meters
House Characteristics									
Square Footage	.0003***	.0003***	.0003***	0.0003***	0.0003***	0.0003***	.0003***	.0003***	.0003***
Bedroom	-.0003***	-.0023	-.0015	0.0003	0.0011	0.0027	-.0035	-.0024	.0012
Bathrooms	.0653***	.0638***	.0648***	0.0544***	0.0538***	0.0534***	.0608***	.0592***	.0602***
Acres	.0616***	.0616***	.0617***	0.0608***	0.0617***	0.0619***	.0629***	.0630***	.0625***
Condo	-.4060***	-.4067***	-.3987***	-0.4319***	-0.4283***	-0.4227***	-.4100***	-.4101***	-.4002***
Townhouse	-.1946***	-.1970***	-.1871***	-0.2186***	-0.2190***	-0.2111***	-.1935***	-.1960***	-.1867***
Q1 Dummy	-.0589***	-.0607***	-.0587***	-0.0556***	-0.0580***	-0.0571***	-.0582***	-.0601***	-.0579***
Q2 Dummy	-.0010***	-.0024	-.0007	-0.0023	-0.0036	-0.0018	-.0033	-.0048	-.0016
Q4 Dummy	.0042**	-.0202	-.0039	0.0053	0.0045	0.0047	-.0029	.0016	.0026
Palisade	.1128**	.1308***	.1283***				.1145***	.1334***	.1229***
Fruita	.0231***	.0359***	.0586***				.0276***	.0376***	.0575***
Home age	-.0034***	-.0035***	-.0037***	-0.0039***	-0.0040***	-0.0040***	-.0037***	-.0037***	-.0039***
Natural Amenity Variables									
Trails	.0607***	.0459***	-.0215***	0.0443***	0.0321***	0.0024	.0584***	.0447***	.0189***
BLM Land	-.0084	.0962***	.0570***	-0.0020	0.0912***	0.0474***	-.0178	.0968***	.0538***
Golf Course	.1305***	.0964***	.0767***	0.1196***	0.0801***	0.0739***	.1285***	.0944***	.0788***
Public Parks	-.0046	-.0200***	-.0754***	-0.0051	-0.0144*	-0.0568***	.0034	.-.0174**	-.0762***
Colorado/Gunnison River	-.0038	-.0457***	-.0572***	9.15E-05	-0.0646***	-0.0597***	-.0003	-.0498***	-.0570***

Colorado National Monument	.1590***	.1201***	.1520***	0.1213***	0.0928***	0.1293***	.1524***	.1163***	.1481***
Open Space	-.0262*	.0291**	.0766***	-0.0719***	-0.0018	0.0518***	-.0309**	.0273**	.0767***
Dismenities									
Within 250 meters of highway	.0299***	.0345*	-.0398***	-0.037***	-0.0408***	-0.0400***	-.0303***	-.0348***	-.0400***
Within 100 meters of major roads	.0079	.0090	.0038	0.0130*	0.0137*	0.0072	.0093	.0104	.0048
Demographic information (control variables)									
Percentage of population 65 years and older	.2445***	.2263***	.1859***	0.0391	0.0473	0.0476	.2412***	.2229***	.1820***
Percent of unemployed	-.6853***	-.6923***	-.7214***	-0.5676***	-0.5660***	-0.5527***	-.6993***	-.7050***	-.7285***
Percent of people with Bachelors Degrees	.6848***	.6439***	.5388***	0.4441***	0.4149***	0.3871***	.6597***	.6203***	.5269***
Median Household Income	6.31e-07**	5.31e-07**	6.05e-07**	2.50E-07	3.52E-07	2.61E-07	.0000***	.0000***	.0000***
Fixed Effects									

2014				0.045582***	0.0456***	0.0455***	.0438***	.0442***	.0443***
2015				0.121072***	0.1219***	0.1216***	.1200***	.1211***	.1218***

Zip Code FE									
81503				-0.04452***	-0.0353**	-0.0159***			
81504				-0.08666***	-0.0945***	-0.0462***			
81505				0.06208***	0.0529***	0.0889***			
81506				0.04085*	0.0276*	0.0548***			
81507				0.123545***	0.0960**	0.0950***			
81520				-0.19404***	-0.1951***	-0.1657***			
81521				-0.03399	-0.0010	-0.0087			
81526				.0976***	.1169***	.1383***			

Intercept				0.2503***	0.2254***	0.2167***			

*** Indicates significance at the 99% level
** Indicates significance at the 95% level
*Indicates significance at the 90% level

meters proximity to parks decreases home value by 1.51% and 5.5% respectively.

Proximity to the Colorado and Gunnison Rivers is not statistically significant at 250 meters. This is likely because no houses can be built that close to the river. At 500 and 1000 meters, proximity to the rivers decreases home values by 5.9% and 5.8% respectively.

Distance to the Colorado National Monument is statistically significant in all models at all distances. Living with 250 meters of the National Monument increases home values by 12.9%. Living within 500 and 1000 meters increases home values by 9.93% and 13.8% respectively.

The open space variable shows some variability across models and across distances. In the FE model at 500 meters opens space is statistically insignificant. However, at 250 and 500 meters the impact is approximately -7% and 5% respectively. The negative trend for the 250 meter distance for open space is consistent in all 3 models.

Table 4: Natural Amenity Distance Comparisons (percentages)[9]

Natural Amenity	250 meters	500 meters	1000 meters
Trail	4.54***	3.26***	0.24
BLM	-0.20	9.07***	4.85*
Golf course	12.70***	8.45***	7.67*
Public park	-0.51	-1.51*	-5.52***
River	0.00	-5.90***	-5.80***
Colorado National Monument	12.90***	9.93***	13.80***
Open space	-6.94***	-0.20	5.32***

*** Indicates significance at the 99% level
** Indicates significance at the 95% level
*Indicates significance at the 90% level

DISMENITIES

Living within 250 meters of a highway decreases home value by 3-4%, while living within 100 meters of a major road is mostly insignificant. Note that the dismenity distance does not change in each model, and always stays at 250 meters and 100 meters, respectively. Since the GGJA is not considered a large city, the major road result may be explained by the fact that even the major roads in the area are not congested, and not detrimental to the decision to buy a home. However, highway proximity does reduce home values, illustrating that when noise and congestion are dense enough, homebuyers react by being willing to pay less.

[9] Note these are percentages, not coefficients. The coefficients from the Fixed Effects model were used in the equation 100(exp(x)-1) to get exact percentages from the log-linear model.

Fixed Effects (Time and Location)

Both time and location are statistically significant. Specific zip codes for the greater Grand Junction area are listed in table 5. There are three years of data in this dataset (2013, 2014, 2015), with homes in 2014 being sold for approximately 4.5% more than 2013, while homes in 2015 were sold for approximately 12% more than homes in 2013.

Zip codes show that living in the Redlands, a generally higher income area nestled next to the Colorado National Monument, increases home values by approximately 10%. Living in Palisade increases home values by approximately 12%. On the opposite end, the area of Clifton sells for almost 20% less, while homes in Fruitvale sell for approximately 9% less. The Fruitvale zip code was broken into the areas Fruitvale North and Fruitvale south, separated by the river. Fruitvale north homes sell for 6.2% less, while Fruitvale south home sell for 16.2% less. Orchard Mesa sells for approximately 3% less, Northwest Grand Junction sells for approximately 5% more, and Fruita is statistically insignificant.

Table 5: Greater Grand Junction Area Zip Codes

Zip Code	
81503	Grand Junction (Orchard Mesa)
81504	Grand Junction (Fruitvale)
81505	Grand Junction (Northwest GJ)
81506	Grand Junction (Horizon Drive)
81507	Grand Junction (Redlands)
81520	Clifton
81521	Fruita
81526	Palisade

Elementary Schools

Table 6 illustrates the coefficient estimates for proximity (500 meters) to elementary schools. Elementary school dummy variables were added to the fixed effects model to estimate proximity to elementary school coefficients. Being close to an elementary school has benefits to home buyers because it allows their children to walk safely to school. However, if a school has a lot of activity or a large park area, it can also be seen the same as living next to a public park. The results for the GGJA

elementary schools are mixed. Proximity to some schools adds significant value to the home (Chipeta, Wingate Lincoln, Mesa View, Thunder Mountain) while proximity to others hurts home values (Clifton, Nisley, Pear Park, Rim Rock, and Tope). This does not necessarily mean that the presence of the school itself lowers home values, however it could be related to the adjacent playground, the walking paths to school, blocked views, or some other feature surrounding the school that is not controlled for in this study (such as Chipeta and the historical houses surrounding it). In general, controlling for all of the other factors present in the earlier fixed effects Unimodel, the results show that proximity to some schools adds value while proximity to other schools hurts value.

Table 6: Elementary Schools Coefficients

School	Coefficient	School	Coefficient	School	Coefficient
Appleton	.1500	Lincoln	.0948***	Rocky Mountain	.0491*
Broadway	-.0270	Mesa View	.0811**	Scenic	-.0679
Chatfield	.0438	Nisley	-.1953***	Shelledy	.0118
Chipeta	.3351***	Orchard Avenue	-.0402	Taylor	-.0037
Clifton	-.0895**	Pear Park	-.1576***	Thunder Mountain	.1377***
Dos Rios	.0698	Pomona	.0095	Tope	-.1285***
Fruitvale	.0594**	RimRock	-.0694***	Wingate	.0746*

MIDDLE SCHOOLS/HIGH SCHOOLS

Table 7 illustrates the coefficients for middle schools and high schools. Four out of eight middle schools have a statistically significant effect on home values. Being located with 500 meters of Bookcliff Middle School and Fruita Middle School has a positive impact on home value, while proximity to West Middle School and Orchard Mesa has a negative impact. Proximity to Grand Junction and Palisade High School improves home values, while proximity to Fruita High School is statistically insignificant.

Table 7: Middle School and High School Coefficients

Middle School	Coefficient
Mt. Garfield	.0893
Bookcliff	.096***
East	-.0187
West	-.1065***
Orchard Mesa	-.0603*
Redlands	-.0504
Fruita	.0658**
Grand Mesa	-.0108

High School	Coefficient
Grand Junction	.1056***
Fruita	-.0518
Palisade	.1686**

CONCLUSION

The results of this study illustrate several important points about the relationship between natural amenities and home values in the Greater Grand Junction area.

1) Natural amenities improve home values. Trails, National Monuments, BLM land, and golf courses all add significant value to a home. This has implications for the Mesa County area and its future community development, mainly that including amenities that can be built (such as trails and golf courses) has a significant impact on home prices. The fact that buyers are willing to pay more to be near these amenities indirectly shows the value of the amenities themselves. Homebuilders in particular should take note of how they incorporate natural features into their building plans to maximize value.

2) Some amenities may be desirable in general but are not desirable to live by. Although parks are highly desired by citizens, it is important to understand that park placement in relation to residential homes is important. A similar statement can be made about the rivers in the GGJA. Although they add value to the community, living within too close a proximity can deter homebuyers.

3) Where you live matters. In addition to controlling for spatial effects, zip codes illustrated that some areas of the GGJA are more desirable to live than others, and that homebuyers are willing to pay more for the same characteristics of a home just to live in a certain area.

4) Living next to a school can have a variable effect. Proximity to some schools increases home values, while proximity to others reduces home values. This can be explained by the parks that are adjacent to the school, the way the school is built into the community, or even features of homes directly around the school that are not controlled for in this model.

APPENDIX A: GIS FIGURES

Figure 1: Mesa County and the U.S.

Figure 2: Greater Grand Junction Area

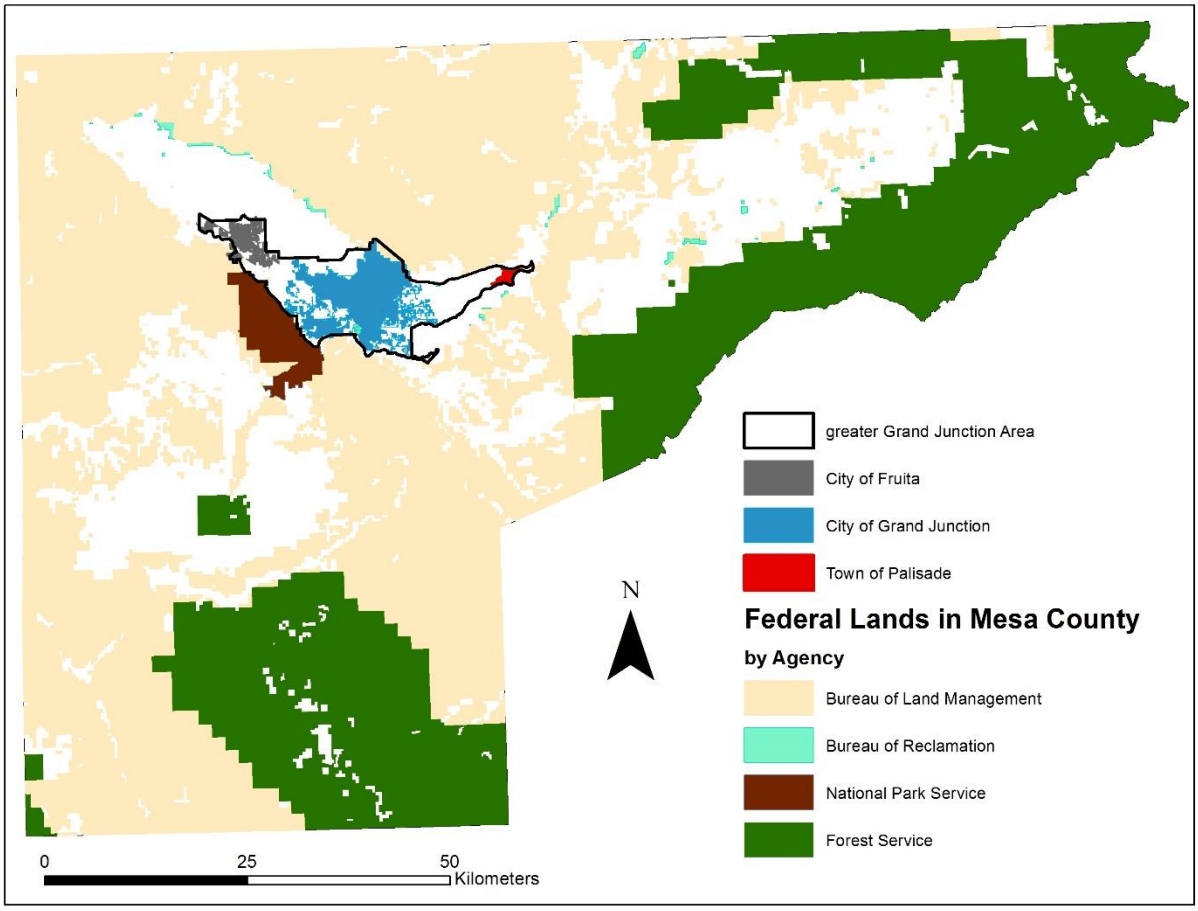
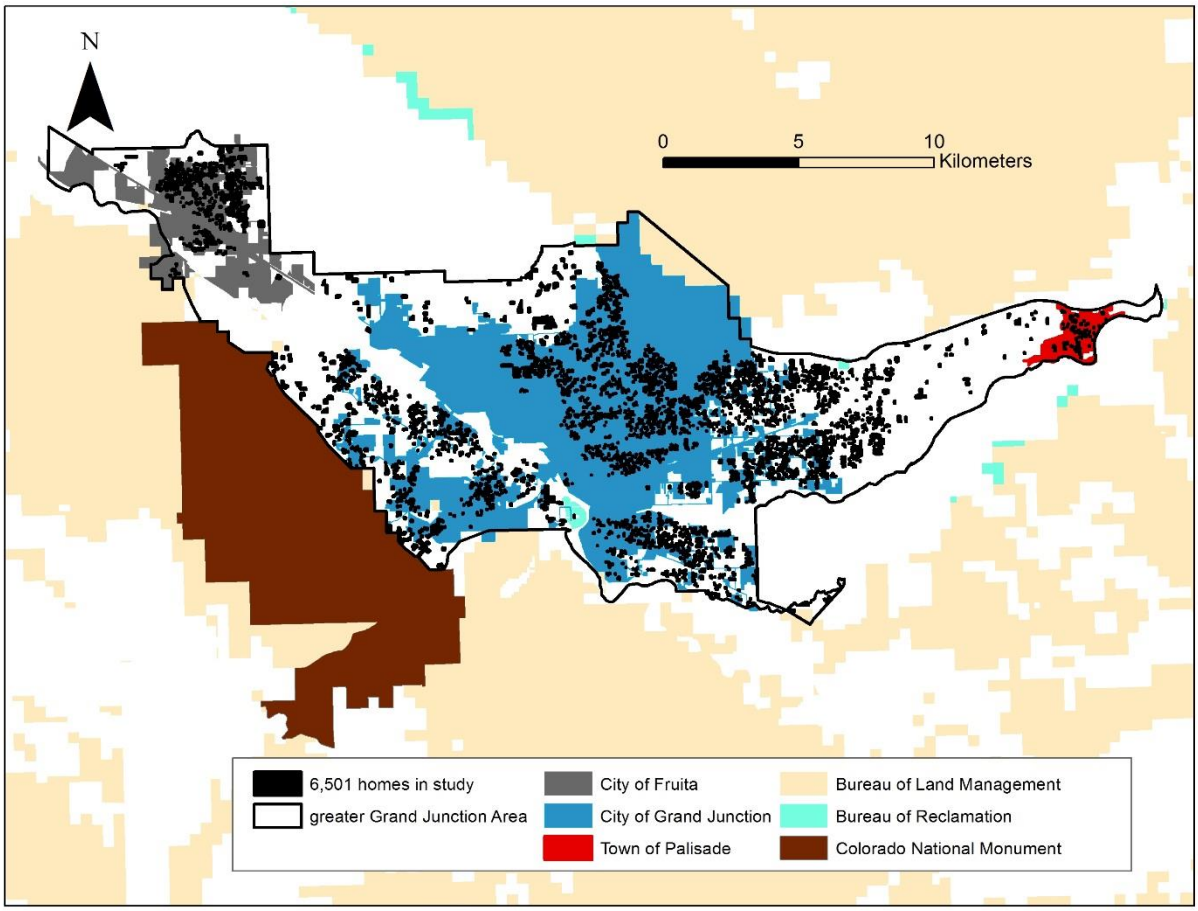


Figure 3: Federal Lands in the Greater Grand Junction Area



APPENDIX B: DATA SOURCES

Table 1: Variable List and Data Source

Variable	Description	Expected Sign	Data Source
House Characteristics			
Home value	Sale price minus adjustments		Mesa County Assessor's Office
Square footage	Total heated square feet	Positive	Mesa County Assessor's Office
Bedroom	Total number of bedrooms	Positive	Mesa County Assessor's Office
Bathrooms	Total number of bathrooms	Positive	Mesa County Assessor's Office
Acres	Total amount of acreage	Positive	Mesa County Assessor's Office
Condo	Dummy variable if home is a condo	Negative	Mesa County Assessor's Office
Townhouse	Dummy variable if home is a townhouse	Negative	Mesa County Assessor's Office
Quarterly sale dummy	Q1, Q2, and Q3 dummies	Positive	Mesa County Assessor's Office
Palisade	Dummy for Palisade location	Positive	Mesa County Assessor's Office
Fruita	Dummy for Fruita location	Positive	Mesa County Assessor's Office
Home age	Age of home at sale date	Negative	Mesa County Assessor's Office
Natural Amenities			
Within 250 meters of a trail		Positive	Calculated using GIS
Within 250 meters of BLM land		Positive	Calculated using GIS
Within 250 meters of golf course		Positive	Calculated using GIS
Within 250 meters of public parks		Unclear	Calculated using GIS
Within 250 meters of Colorado or Gunnison River.		Unclear	Calculated using GIS

Within 250 meters of open space		Positive	
Within 250 meters of Colorado National Monument		Positive	

Neighborhood Characteristics			
Percentage of population 65 years and		Positive	U.S. Census (2012)
Percent of unemployed		Negative	U.S. Census (2012)
Percent of people with Bachelor's Degrees		Positive	U.S. Census (2012)
Distance to highways		Negative	
Distance to major roads		Negative	

APPENDIX C: VIF TEST

Table 8: The VIF test for multicollinearity (FE Model)

Variable	**VIF**
Square footage	3.27
Bedroom	1.80
Bathrooms	2.88
Acres	1.22
Condo	1.23
Townhouse	1.19
Q1 dummy	1.32
Q2 dummy	1.40
Q4 dummy	1.38
Palisade	1.03
Fruita	1.61
Home age	1.84
Natural Amenity Variables	
Within 250 meters of a trail	1.18
Within 250 meters of BLM land	1.14
Within 250 meters of golf course	1.12
Within 250 meters of public parks	1.19
Within 250 meters of Colorado or Gunnison River.	1.12
Within 250 meters of Colorado National Monument	1.19
Within 250 meters of open space	1.25
Dismenities	
Within 250 meters of highway	1.07
Within 100 meters of major roads	1.12
Demographic Information (Control Variables)	
Percentage of population 65 years and older	1.33
Percent unemployed	1.64

Percent of people with Bachelor's Degrees	2.18
Average	1.50

Table 8 illustrates the Variance Inflation Factor test for multicollinearity. The average of 1.50 indicates that the model as a whole exhibits no multicollinearity. In hedonic house models, the relationship between square footage, bedrooms, and bathrooms is always troublesome because as square footage increases so do the number of bedrooms and bathrooms. This was clear in the initial correlation coefficients conducted by the authors. However, individual VIF tests are no cause for concern, as 3.29 is higher than the average but still within acceptable levels.

APPENDIX D: GIS SOURCES

Table 9: Shapefile name, data, and source

Shapefile name	Description of pertinent data	Source (Website if downloaded)
Parcels	Sale date, sale price, location, house size, lot size, room make-up	Stephen M. Smith, GISP GIS Analyst, City of Grand Junction
2011_ACS_5YR_BG_08_COLORADO	Socioeconomic Data: Educational attainment, age, employment status, median household income	U.S. Census Bureau, American Community Survey, (https://www.census.gov/programs-surveys/acs/data/data-via-ftp.html)
Trails (BLM, Local); Federal Land (BLM, USFS, NPS); Fruita Golf Courses; Grand Junction Golf Courses; Local Parks; Open Space; Rivers, Colorado and Gunnison; Highways; Major Roads, Zip Codes		Stephen M. Smith, GISP GIS Analyst, City of Grand Junction
Colorado National Monument Trails		National Park Service Data and Information Data Clearinghouse (https://www.nps.gov/gis/data_info/)
Colorado Parks		Colorado Parks and Wildlife (http://www.arcgis.com/home/search.html?q=Colorado%20Parks%20and%20Wildlife&t=groups)

BIBLIOGRAPHY

Acharya, G., and Bennet, L.L. (2001). Valuing open space and land use patterns in urban watersheds. Journal of real estate finance and economics. 22:2/3, 221-237.

Anderson, S.T., and West, S.E. (2006). Open space, residential property values, and spatial context. Regional Science and urban economics. 36, pp. 773-789.

Cebula, R.J. (2009). The hedonic pricing model applied to the housing market of the city of Savannah and its Savannah historic landmark district. The Review of Regional Studies. Vol. 39, No. 1, 9-22.

Crompton, J.L. (2001). The impact of parks on property values: A review of the empirical evidence. Journal of Leisure Research. Vol. 33, No. 1, pp. 1-31.

Do, A.Q., and Grudnitski, G. (1995). Golf courses and residential house prices: An empirical examination. Journal of real estate and finance economics, 10: pp. 261-270.

Lutzenhiser, M., and Netusil, N.R. (2001). The effect of open spaces on a home's sale price. Contemporary Economic Policy. Vol. 19, No. 3, July 2001, 291-298.

Mueller, J., Loomis, J. (2013). A Spatial Probit Modeling Approach to Account for Spatial Spillover Effects in Dichotomous Choice Contingent Valuation Surveys. *Journal of Agricultural and Applied Economics*, 53-63.

Nicholls, S. and Crompton, J.L. (2007). The impact of golf courses on residential property values. Journal of Sports Management. Vol. 21, 555-570.

Nicholls, S., and Crompton, J.L. (2005). Impacts of regional parks on property values in Texas. Journal of Park and Recreation Administration. Vol. 23, No. 2, 87-108.

Pearson, L.J., Tisdell, C., and Lisle, A.T. (2002). The impact of Noosa National park on surrounding property values: an application of the hedonic price method. Economic Analysis and Policy. Vol. 32, No.2. Special Issue, June.

Racca, D.P., and Dhanju, A. (2006). Property value/desirability effects of bike paths adjacent to residential areas. University of Delaware, Delaware Center for Transportation. Working Paper 188.

Stetler, K.M., Venn, T.J., and Calkin, D.E. (2010). The effects of wildfire and environmental amenities on property values in northwest Montana, USA. Ecological Economics. Vol. 69, pp. 223-243.

Taylor, L. O. (2003). The hedonic method. In P Champ, K Boyle, & T Brown (Eds.), A primer on nonmarket valuation (pp. 331-393). Norwell, MA: Kluwer.

Troy, A., and Grove, M.J. (2008). Property values, parks and crime: A hedonic analysis. Landscape and Urban Planning. 87, pp. 233-245.