Measuring the Value of Open Space: A Hedonic Study

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Abstract

Using hedonic analysis, this study measures the effect of proximity to open space on house values in Lynnfield, Massachusetts. The open space types are divided into conservation, recreation, historic, and water supply land. The expectation is that homes in close proximity to open space will be more expensive than homes at a distance, when all other housing attributes are equal. In order to account for the quality of the open space, a size specification is incorporated, which assumes that the larger the open space area, the greater the value of the home. The results highlight the preferences of homeowners in Lynnfield and provide insight to policymakers when considering open space purchase.

The coefficient on distance from conservation and historic land is negative and statistically significant, meaning that homes in close proximity to these open space types sell at higher prices than equivalent homes. The coefficient on recreation land is negative and less significant, while the coefficient on water is positive, indicating that homes decline in value as they get closer to water supply lands. Possible reasons for the discrepancy regarding water supply lands are the result of omitted variable bias, the small number of observations for homes near water, or the exclusion of water-front properties. On average, a house adjacent to open space is found to sell for $34,600 more than a house at the mean distance of 198 meters.

Introduction

> "*If future generations are to remember us with gratitude rather than contempt, we must leave them something more than the miracles of technology. We must leave them a glimpse of the world as it was in the beginning, not just after we got through with it.*"
>
> \- **President Lyndon B. Johnson**, on the signing of the Wilderness Act of 1964

Untouched earth is becoming a scarce commodity. As years pass and technology advances, the nest of natural resources is quickly being destroyed. Like President Johnson, many Americans appreciate the ideals of preservation and conservation and want to protect nature and the wilderness for the pleasure of future generations. No shopping center, highway, or sky-rise building compares to the scenic beauty and quiet solace of a forested backyard. The importance of land protection is often overlooked, but the time has come to uncover the care and concern of our nation's people and reclaim our natural world.

As the third most densely populated state in the nation, Massachusetts is just one of many areas that have lost much of their natural habitat due to the rapid rate of residential and commercial development. State agencies are working to locate and protect the most important open space areas, including water resources, core habitats, farms and forests, and outdoor recreation areas. However, in order to make efficient decisions regarding the provision of open space, policymakers need to account for citizen's preferences and preserve the land that citizens find most crucial to their lives.

Because many open spaces are public goods, it is difficult to quantify the value that people place on their existence. This paper uses hedonic analysis of home sales data in Lynnfield, Massachusetts, to estimate what homebuyers are willing to pay to live among open space amenities. The assumption is that open space is a beneficial parcel of land providing scenic beauty, wildlife habitat, privacy, and recreational opportunities for residents who live among it; therefore, they would be willing to pay a premium to live in close proximity to a quality open space area. Although people may not pay to preserve the open space areas specifically, they are paying more for their homes because they appreciate some aspect of the great outdoors.

The information provided will hopefully enlighten Massachusetts' residents, policymakers and state agencies and increase awareness regarding open space preservation. Despite the driving force for development, there is a body of people who find value in the amenities of nature, which will be appreciated by generations to come. Quick and complete decisions must be made to preserve and conserve our natural resources to accommodate people's needs today and in the future.

Previous Research

A number of studies have been conducted throughout the United States to estimate citizens' willingness-to-pay for open space amenities. The hedonic analysis approach to calculating environmental variables is becoming widespread with recent technological advances. Geographic Information Systems (GIS) is a computer program that spatially georeferences a given area with the capacity to incorporate a variety of different land attributes, such as soil or air quality, land use, demographics, or infrastructure, which can then be linked to a variety of other databases.

Geoghegan, Wainger, and Bockstael (1997) were among the first economists to use GIS to explain land and housing values in their research pertaining to the diversity and fragmentation of land uses around people's homes. In postulating that people will pay higher prices for desirable living space as it becomes scarce, they use GIS to measure the distance between homes and different land use types—agricultural crops, pasture, forest, wetlands, barren, high density residential, low and medium density residential, and industrial and commercial. They find that more open space in the immediate neighborhood of homes positively and significantly influences the price of homes.

In research pertaining to preserved open space relative to developable agricultural and forested lands, Irwin (2002) postulated that homeowners pay a premium to live near permanent open space. She hypothesized that open space is most valued for providing an absence of development, rather than for providing a particular bundle of open space amenities. Her findings reveal that the conversion of one acre of developable pastureland to privately owned conservation land within a neighborhood increases the value of the average property by $3,307 or 1.87% of the predicted residential value, and conversion to publicly owned, non-military land use also increases property values. However, values decrease with conversion to low density residential land use, to commercial/industrial land use, and to forested land. Irwin's results correlate with her hypothesis about the higher value of preserved open space.

In researching the value of wetland types, Doss and Taff (1996) found that certain wetland types increase home value at close distances, while other wetland types decrease home value. These discrepancies are due to the dissimilarity of wetlands—lake front properties will be more expensive than property in close proximity to a swamp. Doss and Taff found that a lake view is worth $46,000 and all wetland types positively influence house values. However, emergent-vegetation wetlands are positive only at a distance beyond 300 meters and are negative at any closer distance. Due to these discrepancies, the researchers conjecture that residents do not want to live too close to swamp-like wetlands.

Benson *et al.* (1998) focus on the impact of a view on property values, using dummy variables to separate ocean, lake and mountain views. In order to differentiate the quality of the ocean views, they used dummy variables designating homes with a full ocean view, superior/partial, good/partial and a poor/partial ocean view. Findings showed that the value of an ocean-front view varies inversely with distance from the water, meaning the closer a house is to the water, the higher the value of the home.

Burton and Hicks (2003) found that the presence of a park increases home values by roughly $2,600 in two large, suburban towns in West Virginia. The goal of their research was to estimate property value enhancements due to proximity to parks and indicate the subsequent increase in property tax revenues, which was approximately $980,000 during 2002. In theory, these taxes could be used to fund the construction of parks and recreational trails through the use of tax increment financing.

If land is bought as permanent open space or converted to any other land use, Riddel (2001) postulates that changes in environmental and neighborhood characteristics of a home that may occur over time could affect the value of a home. Her concern is that the full effect of these changes would not be incorporated into house prices for a significant period of time. For example, if an open space area is purchased, she concludes that it can take up to four years to adjust to the full impact, so that in a given year, house prices may not have fully adjusted to environmental or neighborhood changes in the area.

Anderson and West (no date) were among the first to test for open-space size in their hedonic analysis of the Minneapolis-St. Paul area, comparing the proximity, size, and proximity-size interactions of parks to households in urban and suburban areas. They found that parks have a positive effect on home values in the city, with the magnitude of this effect being larger for larger parks. Their logic was that proximity to an otherwise identical but larger amenity would have a *stronger* positive effect on home values. In the suburbs, however, the impact of park proximity and size on house values was insignificant. Suggesting reasons for these results, they assumed that residents value open space because of its limited availability, and homes in suburban towns have ample amounts of open space, so people are not inclined to pay more for homes in close proximity.

To calculate the value of open space outside of hedonic analysis, researchers will often use contingent valuation surveys. For example, Halstead (1984) used the iterative bidding technique, which asks residents what they would be willing to pay for an additional unit of some open space. The questioning continues until the resident has maximized his utility, meaning that paying for an additional unit of open space would decrease the resident's overall welfare. He concluded that increasing levels of development on agricultural land near the respondent's home provoked substantially increased bids, which revealed that residents value the agricultural land. However, these bids will never be paid by the respondents because it is simply a question and answer session.

The Great Marsh Coalition (2003) distributed a contingent valuation survey to residents of the Great Marsh in Massachusetts to determine how they value and what they would hypothetically pay to preserve the Great Marsh in the form of taxes and donations. The results showed that residents most highly regard the Great Marsh as "a place of scenic beauty", less as a tourist attraction, and in varying proportions for fishing/clamming, bird watching, boating, hiking and open space visits. They determined what people are willing to pay to preserve the Great Marsh, but only in a hypothetical context. Surveys offer interesting results, but are subject to bias because residents are responding to hypothetical situations without direct consequence.

Methodology

In this study, the market value of open space is examined by means of hedonic analysis. Specifically, it aims to determine how Lynnfield residents value open space and calculate what they actually do pay to live in close proximity to conservation, historic, recreation, and water supply land. Preferable to other open space valuation methods, hedonics uses true market transactions, rather than a hypothetical willingness-to-pay.

An ideal study would couple a contingent valuation survey (discussed above) with hedonic analysis to illustrate what people pay through market transactions and highlight which open space attributes they value. With more time and resources, a survey would have been distributed to the 210 homeowners that were used for the Lynnfield home sales sample to determine if residents enjoy the open space for the scenic beauty, as wildlife preservation land, or as a barrier between their home and commercialization. However, hedonic analysis should not be discredited because it accurately establishes the correlation between house price and proximity to a particular kind of open space.

On the other hand, as Irwin suggested, people may care little about what kind of open space buffers them from development, but are predominantly concerned that the open space is permanent. The conservation and historic land is expected to have the largest effect on sale price because it is deeded as permanent open space, whereas recreational open space can be bought and developed, which may be less desirable for residents. Also, people may enjoy the amenities of quiet backyards and surroundings more than recreational areas, which often surround schools and can carry traffic and noise. Following Irwin, the assumption here is that the permanence of open space is of critical importance for homebuyers.

Studies have yielded conflicting results on the impact of recreational facilities, specifically parks. Anderson and West (no date) found that proximity to parks had an insignificant effect in the suburban towns they sampled. On the contrary, Burton and Hicks (1996) found that parks have an upward pull on the sale price of homes. The discrepancy between the two studies could be a result of differences in population density or the percentage of open space. If a town has a small number of residents and a large amount of open space, the open space may not be as valuable, as compared to an overpopulated town with a large amount of open space. The expectation here, however, is that even in the presence of substantial open space, suburban residents are willing to pay a premium to live near permanent open space in the form of conservation and historic land and are less inclined to pay to live near developable recreation land.

In approaching the variation in open space types, it seemed appropriate to not only separate permanent and developable open space, but also to assess the quality of the open space area. Benson *et. al* (1984) separated the quality of ocean views into four categories, ranging from a superior view to a poor view using dummy variables where quality views were more highly sought. The question of how the quality of an open space area would affect resident's preferences seemed like a necessary component to this study.

Investigating the quality of every open space area in Lynnfield was not feasible, however. Instead, the proximity-size interaction postulated by Anderson and West (no date) is used because the size of the open space could impact how residents value the open space amenities, suggesting the larger the open space, the higher the value of the home.

Model and Data

Results were found using hedonic analysis, where the price of a home (P) is comprised of its structural attributes S and environmental amenities E:

$$P_h = P(S, E)^{1}.$$

Using regression analysis, the hedonic price function yields the marginal implicit price that can be attributed to each component. The hedonic model breaks up the value of a home into all its characteristics, where the explicit price of a single-family home in Lynnfield can be attributed to the implicit prices of its attributes.

Using Multiple Listings Services (MLS) in Massachusetts, data on all the homes sold in Lynnfield during 2002 were collected. A single year was used in order to avoid problems with time variant models, as discussed by Riddel (2001), but it left a fairly small sample. All transactions between $75,000 and $750,000 were collected, excluding waterfront properties and mobile homes leaving 226 properties. Doss and Taff (1996) found that the coefficient on water-front properties is disproportionately larger than other wetland types, so those properties were excluded so as not to skew the results. After omitting those with missing or unreasonable data, 210 observations remained to be cross-referenced with open space types in GIS. The available structural attributes of each home included number of bedrooms, bathrooms, and garage stalls, lot size, and age.

The environmental variable incorporated into the model is proximity to open space, which is divided into four open space types—conservation, recreation, historic and water supply. Land preserved as habitat protection through deed or law in the form of forests, farms, or wetlands is defined as conservation land; these parcels contain little to no recreational facilities, such as walking trails. Outdoor facilities such as town parks, playing fields, school fields, golf courses, bike paths, and cemeteries comprise the recreational land in Lynnfield. Little explanation is given to the composition of the historical lands and the water supply lands, but both areas are predominantly protected by deed. All areas may be privately or publicly owned, and only those that are deeded as protected open space will remain undeveloped. The division between open space types was made to highlight what homebuyers value and calculate how much they are willing to pay for a home adjacent to different open space areas.

The addresses of the homes from MLS and the open space areas in Lynnfield were incorporated into GIS. Incremental meter distances were calculated from these addresses to the edge of a particular open space—recreation, conservation, historic, and water supply—along with the acreage of the open space type. If homes were completely within an open space area, a distance of one meter was assigned, and in instances where homes were extremely close to two open space areas, the acreage was summed assuming the larger size would constitute a higher house value. All the homes in the sample were within 650 meters of some open space shown on the map in Graph 1.

The locational variables that various other studies incorporate into a hedonic model aim to designate neighborhood effects on home values and proximity to the nearest highway or downtown district. Lynnfield was chosen to remove these locational characteristics because it is a fairly homogenous town with fixed neighborhood effects, minimal commercialization, and easy access to Boston (it is approximately forty minutes north of Boston, housing middle-to-upper class families). Hedonic analysis runs a heavy risk of omitting pertinent variables leading to biased coefficients or unstable conclusions regarding open space amenities because the distance coefficient could pick up an effect external to the model. Including the distance to the nearest highway would have been superior, but due to time and access constraints, the highway variable had to be omitted.

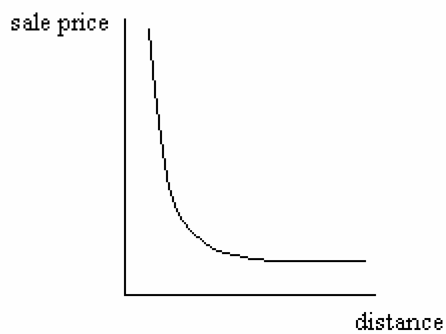
The econometric model regresses the sale price of homes on their structural variables and on their proximity to the nearest open space parcel. Four regressions were conducted to separate the impact of proximity to conservation, historic, recreation or water supply land, with the structural variables, a distance variable, and a quadratic variable, *distance-squared*, incorporated into each model. Using the quadratic variable assumes that the relationship between distance and sale price is non-linear; that is, there is no constant decrease in price with each meter increase in distance. Rather, the house values are expected to be highest in close proximity to open space, but beyond a certain point, there may be little variation in house price.

For each of the four categories, the initial model is specified by:

$$saleprice = B_1 + B_2 rooms + B_3 bedrooms + B_4 bath + B_5 age + B_6 lotsize + B_7 garage + B_8 distance + B_9 distance\^{}2 + e,$$

where B_2 through B_6 are the coefficients for the structural attributes and B_7 is the coefficient on the distance variable, which is expected to be negative, meaning the greater the distance, the lower the sale price of a home. If B_8, the coefficient on the quadratic variable is positive when the distance coefficient is negative, then there is a non-linear relationship between sale price and distance; thus, homes in closest proximity to open space have the greatest effect on sale price.

The expectation, as shown in the graph, is that there is a large drop in sale price as distance grows, but the drop tapers at a certain distance. The sale price of similar homes beyond this distance is generally the same.



In a second model, the interaction term, distance*size, is incorporated to determine if there is a stronger relationship for proximity to a larger open space area, allowing the effect of distance to vary with the size of the relevant open space. Assuming the coefficient on the distance term is negative, the interaction term is expected to have a negative coefficient, suggesting that larger open space areas increase the marginal effect of proximity.

In addition to the separate regressions for homes closest to conservation, historic, recreation or water supply lands, sale price was regressed on the structural and environmental variables for the pooled sample of 210 observations, which ignored the distinction between open space types, which is labeled the "all" category[2]. All regressions were tested for heteroskedasticity using White's test, and White's robust standard errors were used to calculate t-statistics when necessary[3].

In order to test for stability across the four subpopulations, an F-test was conducted with a null hypothesis that the beta values for each of the open space types are equal versus the alternative that at least one is not equal. The test could not reject the null hypothesis that they are equal; therefore, the coefficients among open space types are not significantly different from one another[4]. This may mean that the separation of open space into different types may be unnecessary, rendering the "all" category most useful. However, the separation revealed the discrepancy with the water supply lands, so it seems appropriate to continue to look at conservation, recreation, historic and water supply lands separately.

Table 1 lists and defines the variables used in the estimation. Table 2 shows the descriptive statistics of the structural characteristics and distance and includes the observations in each open space category, specified by *n.* The sale price was rescaled during regression analysis for easier explanation and readability, so note the appropriate transformations necessary in Table 3 and Table 4.

Results

Ordinary least squares is used to estimate the effects of structural and environmental characteristics on home values. Shown in Table 3, as expected, nearly all of the coefficients on the number of bedrooms, bathrooms, and garage stalls are positive and statistically significant, as is the coefficient on the lot size of the property. The sign on age is negative because as the house ages, its value declines. The constant is positive because homes have a base value regardless of additional features. As seen in the table, a few of the coefficients, though they have the appropriate sign, are not statistically significant, which could be the result of omission of an explanatory variable, such as the presence of a pool or nearness to a highway.

The coefficient on distance, which is the variable in question, is negative in regards to conservation, historic, and recreation land, meaning that as distance increases, the value of the sampled homes declines. As hypothesized, nearness to open space positively affects house value; therefore, residents of Lynnfield are willing to pay to live in close proximity to these open space types. In the regressions for conservation and historic land, the distance coefficients are statistically significant[5], which correlates with a second hypothesis that permanent open space is more highly regarded than developable recreation land. Nearness to recreation land does not significantly increase the value of a home.

Contrary to expectations, the coefficient on water is positive. The sign indicates that house prices decline as homes get closer to water supply lands, but it is not statistically significant[6] suggesting there is not a significant change in house price with respect to distance to water. One would intuitively expect proximity to water to increase the value of a home, but as found by Doss and Taff, certain wetland types can negatively impact house prices at close distances; in particular, emergent-vegetation wetlands negatively impacted house values at distances less than 300 meters. Another explanation for this result is the exclusion of all water-front properties, which may indicate that only homes in extreme proximity to water benefit from the amenity. Also, the model could suffer from omitted variable bias, where the distance coefficient is capturing an effect of an omitted variable on the homes closest to water supply lands.

Table 3 gives the coefficient, standard error, and t-statistic for the initial regressions of each of the open space types and the category that includes all observations. Because the stability test found that the coefficients for each open space type are not significantly different from one another, it is appropriate to look at the distance term for the "all" category. The distance coefficient is negative and statistically significant[7], and the distance-squared coefficient is positive and statistically significant[8] suggesting a non-linear relationship between sale price and distance. Therefore, homes are generally more expensive when they are very close to open space, but as distance increases there is a point beyond which price is relatively the same. The coefficient for distance-squared is most significant for conservation land, less so for historic land, becomes insignificant for recreation, and is entirely insignificant for water supply lands[9]. Again, the results for recreation and water supply lands do not strongly correlate with the hypothesis that proximity to open space increases the value of a home.

Despite the stability test, there are implications for using the "all" category, rather than looking at the unique distance coefficients for each subpopulation. The variation between distance coefficients implies that open space may be perceived and valued differently, depending on whether it is conservation, historic, recreation, or water supply land. The strongest significance exists among homes in proximity to conservation land. Historic land also has a significant distance coefficient, which suggests that there is a noticeable upward pull in the price of homes near preserved open space. Residents recognize the value of land protected as permanent open space, which reveals that land preservation is deemed important. Although there are a number of open space areas in Lynnfield, those that are protected as permanent open space are more valuable than those that can be developed.

Using the statistics for the “all” category for simplicity, the mean distance of 198 meters was incorporated into the hedonic equation revealing that at 198 meters the value of a home declines by $34,600. As suggested by the coefficients, people are willing to pay this price to live adjacent to an open space area versus 198 meters away. Understand, however, that this price is only an approximation. The hedonic equation does not include any locational variables, nor does it regress a large number of observations, so the results should be viewed as trends and not exact values. Also, beyond 264 meters, the value of homes begins to climb, suggesting that when a home is far enough away from open space proximity is no longer important. However, specific circumstances in Lynnfield could account for the upward shift in house value at large distances, such as desirable neighborhoods or the quaint charm of downtown, which would not be near open space.

The second phase of the regression analysis was the incorporation of the proximity-size interaction term with results shown in Table 4. Its effect on sale price, however, was not statistically different from zero[10], which unfortunately corresponds to the results generated by Anderson and West (no date). Perhaps they were correct in proposing that residents are only inclined to pay more for proximity to large open space areas in the absence of abundant open space. The large number of open space parcels in Lynnfield may discredit the value of the size of the open space, or on the other hand, residents may simply value having permanent open space in their backyard, regardless of size[11].

Conclusion

Using hedonic analysis, this study estimates the externality effect of open space on residential home values in Lynnfield, Massachusetts. The valuation method is meant to indicate how Lynnfield residents value open space and what they are willing to pay to preserve it. Each increase in sale price that can be attributed to proximity to open space generates tax revenues that could be used to preserve additional permanent open space.

Policymakers need to look at these open space areas and the results of this study when considering open space purchase. If money is being generated in the form of taxes because residents value certain open space areas, then it seems appropriate to use tax increment financing as a way to purchase and preserve open space. According to this study, during 2002 a home that is adjacent to open space generates $415 in additional taxes versus a home 198 meters away[12]. Though only an approximation, it should indicate a financial incentive to preserve open space. Both the government and developers need to weigh the benefits with the costs of building commercially or leaving the area as open land, but it may be profitable to respond to homebuyer's preferences.

Research has been done to generate the costs and benefits associated with open space purchase as compared to the costs and benefits of development. A Cost of Community Services study was done by the Southern New England Forest Consortium (1995) to analyze the revenues and expenditures of three land uses: residential, commercial/industrial, and open space, forest, and agriculture. The outcome revealed that it costs towns more to accommodate the increased need for public services with increased residential development than they collected in increased tax revenues. Therefore, it is of no fiscal benefit to the town to allow for increased residential development. The study goes on to reveal that there are benefits from commercial/industrial development, in that more revenue is generated than spent. However, due to hedonic studies, it seems possible that the value of a home will depreciate in close proximity to commercial development, which will decrease tax revenue in turn.

An appropriate element to add to a hedonic study is proximity to commercial/industrial development, but it was not deemed necessary in Lynnfield because of minimal development of this kind. Limitations of this study include the omission of other types of open areas, including specific recreational facilities (e.g. parks, schools, sports fields), and the omission of prevalent locational characteristics (e.g. proximity to the highway or downtown district). Also, by only considering the nearest open space, the analysis fails to account for important amenities that are close, but not the closest. Because open space is a public good, hedonic analysis provides results that are a lower bound estimate, which aid in valuing the benefits of open space in Lynnfield, but do not illustrate total willingness-to-pay. People from all over the town and from other towns in Massachusetts can appreciate the scenery of conservation land, recreational opportunities, and an escape from commercialized life.

With more time and resources, it would be interesting to survey the homes in the sample to see why they value living near open space. Are they most interested in having conservation land in their backyard, or do they simply like living in a peaceful town with a quiet backyard? Further research is necessary to adequately determine how Massachusetts' residents value open space. In an effort to inform the public, this study revealed that people in Lynnfield are willing to pay more for a home in close proximity to conservation land. With a variety of towns, a larger number of observations, and a great deal of time, a study could be conducted to accurately calculate the tax revenue that is generated from increased property value and determine an appropriate procedure to accommodate for the desire of Massachusetts' residents to preserve open space.

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Endnotes

[1]Among the first to use hedonic analysis was Rosen in his study titled “Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition”, which was published in 1974.

[2]For clarification, regressions were run on homes closest to one of the four open space types, designating “distance” as the distance to the closest open space parcel. The regression for homes closest to conservation land held 112 observations, historic 21 observations, recreation 49 observations, and water 27 observations. The “all” category regressed all observations on distance to the closest open space parcel regardless of type.

[3]Both regressions for recreation land were found to be heteroskedastic using White’s test with no cross terms because of the small number of observations, with Wstat=30.289 and p-value=0.01092 for the initial equation and Wstat=30.787 and p-value=0.0212 for the model with the interaction term.
Both regressions for the “all” category were found to be heteroskedastic using White’s test with cross terms, where Wstat=71.993 and p-value=0.00365 for the initial equation and Wstat=81.372 and p-value=0.00736 for the model with the interaction term.

[4]Using a traditional F-test, with restrictions=27 and df_U=174, the Fstat=.9695 and pvalue=0.513.

[5]The null hypothesis that the distance coefficient is equal to zero versus the alternative that the coefficient is less than zero is rejected for conservation at the 1.18% level and historic land at the 8.3% level using a t-test. The null can only be rejected at the 12.6% level for recreation land, so this coefficient is not statistically significant.

[6]The null hypothesis that the distance coefficient for water is equal to zero versus the alternative that the coefficient is greater than zero, contrary to expectations, can be rejected using a t-test at the 12.8% level, so this coefficient is not statistically significant.

[7]For the all category, the null hypothesis that the distance coefficient is equal to zero versus the alternative that the coefficient is less than zero is rejected at the 0.76% level.

[8]For the all category, the null hypothesis that the distance-squared coefficient is equal to zero versus the alternative that the coefficient is greater than zero is rejected at the 0.45% level.

[9]The null hypothesis that the distance-squared coefficient is equal to zero versus the alternative that the coefficient is greater than zero is rejected at the 2.15% level for conservation, 8.03% level for historic, 13.4% level for recreation, 77.8% level for water because the coefficient is negative.

[10]The null hypothesis that the interaction coefficient is equal to zero versus the alternative that it is less than zero cannot be rejected for any of the regressions at less than the 13% level, so this coefficient is not statistically significant.

[11]The accuracy of the interaction term proposed by Anderson and West (no date) is uncertain, but it proposed a valid question, so the model was incorporated into this study. Further research is needed to determine if their equation is an accurate way to determine if the size of an open space parcel affects the value of a home.

[12]In Lynnfield during 2002, the tax rate on residential property was $12.00 (per 1,000). Using the estimated house price of a home adjacent to open space, which is $504,666, the annual tax bill for 2002 was $6056. If $34,600 (6.68%) of that is attributed to proximity to open space, then, so too, is $415 of the tax bill.

Table 1: Variables and Definitions

Variable	Definition
Saleprice	Sale price of home in $
Rms	Number of rooms
Bed	Number of bedrooms
Bath	Number of bathrooms
Age	Age of home in 2003
Lotsize	Lot size in acres
Garage	Number of garage stalls
Distance	Distance to nearest open space in meters
*Distance*OSAcreage*	Interaction between distance and size of open space in acres

Table 2: Descriptive Statistics

	All		**Conservation**		**Historic**		**Recreation**		**Water**	
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev	Mean	Std. Dev.
Price of home	470066.1	117277.7	485897.2	123968.4	465259.8	114005.4	431710.2	104114.7	482598.1	101226.3
Rms	7.562	1.524	7.634	1.5007	7.190	1.209	7.306	1.432	8.037	1.911
Bed	3.448	0.853	3.464	0.848	3.380	0.590	3.306	0.796	3.704	1.103
Bath	1.904	0.704	1.933	0.719	1.762	0.645	1.735	0.576	2.194	0.830
Age	51.305	23.933	48.741	21.597	60.286	29.129	50.388	19.977	55.222	32.524
Lotsize	0.590	0.559	0.618	0.443	0.848	1.298	0.430	0.254	0.574	0.380
Garage	1.534	0.704	1.608	0.633	1.335	0.728	1.410	0.811	1.594	0.744
Distance	198.014	131.176	215.196	143.061	128.619	63.038	180.204	111.517	216.204	136.174

Table 3: Initial Regression

Variable		Conservation	Historic	Recreation	Water	All
Rooms	*Coefficient*	1.131	1.33	3.74	2.616	2.108
	(Std. Error)	(0.891)	(2.033)	(0.854)	(1.372)	(-0.512)
	(T-statistic)	(1.269)	(0.654)	(4.379)	(1.906)	(-4.117)
Bed		2.98	5.279	0.049	-2.197	1.165
		(1.467)	(4.518)	(1.337)	(2.496)	(0.997)
		(2.031)	(1.168)	(0.036)	(-0.88)	(1.168)
Bath		4.91	3.499	2.886	2.69	3.821
		(1.47)	(3.725)	(2.01)	(2.722)	(1.154)
		(3.339)	(0.939)	(1.436)	(0.988)	(3.312)
Age		-0.076	-0.096	-0.081	-0.136	-0.083
		(0.037)	(0.081)	(0.081)	(0.048)	(0.027)
		-2.031	-1.186	-1.008	-2.847	-3.067
Lotsize		2.628	1.403	2.902	2.408	3.693
		(1.951)	(1.807)	(6.406)	(4.689)	(1.071)
		(1.347)	(0.777)	(0.453)	(0.514)	(3.449)
Garage		4.113	2.767	3.823	4.428	4.078
		(1.398)	(3.032)	(1.296)	(1.994)	(0.853)
		(2.943)	(0.913)	(2.948)	(2.22)	(4.784)
Distance		-0.037	-0.216	-0.031	0.048	-0.028
		(0.016)	(0.146)	(0.026)	(0.041)	(0.012)
		(-2.298)	(-1.476)	(-1.162)	(1.174)	(-2.451)
Distance2		0.000061	0.000953	0.000074	-0.000067	0.000053
		(0.00003)	(0.000637)	(0.000066)	(0.000086)	(0.00002)
		(2.049)	(1.495)	(1.121)	(-0.782)	(2.638)
Constant		19.539	22.232	10.329	22.543	18.202
		(4.591)	(16.645)	(6.7)	(9.331)	(3.174)
		(4.256)	(1.336)	(1.542)	(2.416)	(5.735)
n		112	21	49	27	210
R^2		0.652768	0.718946	0.697058	0.699732	0.638606

Table 4: Regression with Interaction Term

Variable		Conservation	Historic	Recreation	Water	All
Rooms	*Coefficient*	1.126	1.247	3.654	2.543	2.110
	(Std. Error)	(0.893)	(2.057)	(0.999)	(1.382)	(0.545)
	(T-statistic)	(1.261)	(0.606)	(3.657)	(1.841)	(3.870)
Bed		3.040	5.377	0.388	-2.036	1.166
		(1.471)	(4.568)	(1.507)	(2.515)	(0.924)
		(2.066)	(1.177)	(0.258)	(-0.810)	(1.261)
Bath		4.790	2.844	3.072	1.935	3.818
		(1.481)	(3.840)	(2.355)	(2.860)	(1.007)
		(3.235)	(0.741)	(1.305)	(0.676)	(3.792)
Age		-0.079	-0.080	-0.076	-0.116	-0.083
		(0.038)	(0.084)	(0.054)	(0.053)	(0.023)
		(-2.091)	(-0.948)	(-1.417)	(-2.184)	(-3.681)
Lotsize		2.583	2.049	2.963	1.018	3.689
		(1.955)	(1.973)	(4.231)	(4.957)	(0.952)
		(1.321)	(1.039)	(0.700)	(0.205)	(3.875)
Garage		3.874	3.460	4.050	4.723	4.080
		(1.431)	(3.167)	(1.550)	(2.031)	(0.807)
		(2.707)	(1.092)	(2.612)	(2.326)	(5.058)
Distance		-0.032	-0.239	-0.020	0.069	-0.028
		(0.017)	(0.150)	(0.031)	(0.047)	(0.011)
		(-1.833)	(-1.592)	(-0.642)	(1.464)	(-2.476)
Distance2		0.000056	0.000747	0.000058	-0.000152	0.000053
		(0.000030)	(0.000687)	(0.000077)	(0.000128)	(0.000023)
		(1.859)	(1.089)	(0.759)	(-1.193)	(2.349)
*Dist*OS*		-0.0000417	0.0086720	-0.0000745	0.0000490	0.0000011
		(0.0000519)	(0.0100260)	(0.0000698)	(0.0000542)	(0.0000183)
		(-0.803)	(0.865)	(-1.066)	(0.905)	(0.060)
Constant		20.059	20.155	8.567	21.856	18.193
		(4.644)	(16.993)	(6.129)	(9.409)	(3.096)
		(4.319)	(1.186)	(1.398)	(2.323)	(5.877)
n		112	21	49	27	210
R^2		0.065	0.737	0.706	0.714	0.639

Graph 1: GIS Map of Lynnfield—open spaces and homes included.