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The Influence of Wetland Type and Wetland Proximity on Residential Property Values

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Using detailed residential housing and wetland location data, we determine relative preferences for proximity to four broad classes of wetlands, as expressed through housing values. Implicit prices for proximity to open-water and scrub-shrub wetlands are relatively higher than those for emergent-vegetation and forested wetlands.

Key words: hedonic pricing, housing, wetlands

Introduction

Research and policy debates on wetland values have primarily focused on the preservation of wetlands in rural and, especially, agricultural areas. Most analysts assume that wetlands are a public good, consequently research has focused on trying to assign economic value as part of the process of developing and evaluating preservation policies.[1] Almost no work has been done to evaluate the value of wetlands within urban areas. There is ample evidence that urban residents enjoy living near lakes and rivers, but there is little research examining their preferences for wetland proximity. This article is a step along that line of inquiry. We address two questions: Do people in urban areas prefer to live closer to or farther from wetlands? Are these preferences dependent upon the type of wetland?

Location-specific National Wetlands Inventory (NWI) data (U.S. Dept. of Interior 1993) permit a more detailed examination of wetlands valuation issues than has previously been possible. In this study, we combine this additional data from the NWI with data on housing value, structure, and location attributes to calculate the distance from each property to the nearest of each of four wetland types—forested, scrub-shrub, emergent vegetation, and open water. Using this data, the implicit economic value of proximity to each type of wetlands is estimated within a standard hedonic framework.

Natural resource economic theory asserts that many natural resources, such as wetlands, may have both public and private values. The public component of these values is presumably not fully captured in market prices. Wetlands provide habitat for animals and waterfowl and provide drainage to limit flooding. In addition, urban wetlands provide open spaces in urban areas (Reenstierna). Most studies have focused on the public value of wetlands, frequently using a contingent valuation approach (Whitehead and Blomquist; Whitehead and Thompson; Lant and Roberts; Benin; Stevens, Benin, and Larson).[2] In addition, some

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[1] Leitch and Ludwig, Leitch and Ekstrom, and McKinnon include numerous studies that estimate a value for wetlands in their annotated bibliographies.

[2] None of these studies examine the value of urban wetlands.

researchers have considered the value of wetlands for specific uses, such as recreation (Bergstrom and Stoll).

In this study, however, we are concerned with the private valuation of wetlands by people living near them. Although we know that houses near lakes are desirable (as expressed by property price premiums), we have no reason a priori to expect that urban homeowners similarly want to live near wetlands. Urban wetlands may provide amenities such as open space and opportunities to view wildlife and waterfowl, but they may also generate disamenities including nuisance animals, insects, or odors. Thus, although people may want wetlands to exist, we can find no evidence in the literature on whether people want them in their own backyards or even on their own blocks.

This study asks whether different types of wetlands in the neighborhood are associated with increases or decreases in housing prices. Are wetlands, like open spaces and parks, desirable in a neighborhood, or are they more like dumps or refineries, which everyone agrees are necessary but would prefer not to see? The results of this analysis can give policymakers some indication of whether policies to preserve urban wetlands will meet with favorable or unfavorable responses from the people who will be most directly affected.

We are interested in determining the portion of housing value that correlates with proximity to wetlands. Economic theory suggests that implicit prices for attributes that are not marketed independently, such as wetland proximity, can be recovered by carefully examining prices of the marketed good, such as housing. Using standard hedonic methods, we can estimate the hedonic price of proximity to different types of wetlands. As Rosen (p. 34) notes:

> Hedonic prices are defined as the implicit prices of attributes and are revealed to economic agents from observed prices of differentiated products and the specific amounts of characteristics associated with them. . . .Econometrically, implicit prices are estimated by the first-step regression analysis (product price regressed on characteristics) in the construction of hedonic price indexes.

Hedonic approaches have been used to determine implicit prices for numerous housing attributes, including location. Palmquist found that property values were reduced by noise from nearby highways. Kohlhase concluded that people would pay to live farther from toxic waste sites. Smith and Desvousges estimated the consumer surplus received by households for each additional mile that they lived from a hazardous waste dump. In contrast, parks are usually considered to be desirable features of a neighborhood. Vaughn found that house values were higher due to proximity to 16 out of 17 different parks in Chicago. More and Stevens found that houses located next to a park in Worcester, Massachusetts, sold for considerably more than comparable houses located 2,000 feet away.

In the only study that we are aware of that examined the value of urban wetlands, Lupi, Graham-Tomasi, and Taff measured the impact of nearby wetlands (specifically, the number of wetland acres in the survey section in which a house is located) on housing prices. Lupi, Graham-Tomasi, and Taff used 1987–89 sales and property characteristics data, as well as wetland data from the Minnesota Protected Waters Inventory. They found that willingness to pay for additional wetland acreage was positive at lower levels of existing wetland acres per section and negative at higher levels. However, this data did not include point location data and, thus, did not allow the researchers to estimate a relationship between distance to a wetland and property value. In addition, the data did not allow distinctions to be made between wetland types.

Wetland Characteristics

Four types of wetlands are important in Ramsey County, Minnesota, which is composed of the city of St. Paul and surrounding suburban areas. These types of wetlands are: forested, scrub-shrub, open water, and emergent vegetation.[3] All together they constitute 7.6% of the county's land area. These four types of wetlands differ with respect to visual appearance and support different wildlife. Thus, people might prefer one type over another.

Forested wetlands include both wooded swamps and bogs and tend to be located along rivers and streams. The soil is waterlogged to, at least, within a few inches of the surface and may support a spongy covering of mosses. These wetlands can support trees such as tamarack, black spruce, balsam, red maple, and black ash. They show the least open water of the four types of wetlands examined here.

Scrub-shrub wetlands have soil that is usually waterlogged during the growing season and is often covered with as much as six inches of water. These wetlands are somewhat more open than forested wetlands and they tend to have a wide variety of types of vegetation. The height of the vegetation varies, presenting a varied visual pattern. These wetlands also support trees such as alders, willows, buttonbush, dogwoods, and swamp privet.

Emergent-vegetation wetlands include seasonally flooded basins or flats, inland fresh meadows, and inland fresh marshes. These wetlands are fairly open, but most of the vegetation is about the same height. They vary from being well drained during much of the growing season to having up to three feet of water. The vegetation might include grasses, sedges, rushes, and other marsh plants such as cattails and wild rice.

Open-water wetlands include shallow ponds and reservoirs. The water is usually less than ten feet deep and is fringed by a border of emergent vegetation. They exhibit the most open water of the four types and may provide habitat for the most waterfowl.

Only wetlands within Ramsey County boundaries were analyzed. Table 1 shows their distribution. To the extent that property values located within the county are influenced by nearby wetlands outside the county, the results presented in this study may be biased. However, the structure of the data set does not allow us to exclude houses near the boundary. Since the number of houses that potentially are closer to wetlands in adjacent counties than to wetlands in Ramsey County is small and our present results are significant at a very high level, we would expect that the effects of such an exclusion—if it were possible—would be modest.

For distance calculations, we employed the Environmental Planning and Programming Language (EPPL7), a raster (cell-based) geographic information system developed by the state of Minnesota (Minnesota Land Management Information Center). Each property location (cell) was assigned a number which represents the closest distance to a cell containing a wetland of a given type.[4] That number becomes an independent variable in the hedonic equation. We measured up to 1,000 meters around each property. If there was not a wetland of each type within this range, the property was excluded from further analysis. Of the 106,049 single-family residential properties in the county, 32,417 remained.

Table 2 shows the extent to which distances were correlated and table 3 provides descriptive statistics on wetland proximity. (All reported distance measurements here are for 10-meter increments, so the range of observed distances is from 1 to 100.) Correlation

[3]These types are aggregations of Cowardin wetland system, subsystem, and class designators used by the Minnesota Department of Natural Resources (Cowardin et al.). The Cowardin system does not completely correspond to the older and more familiar USFWS "Circular 39" classification system (Shaw and Fredine) since the two classification systems were developed for different purposes. Detailed information on the classification scheme is available from the authors.

[4]For detailed information on the calculation of the distance measurements, see Doss and Taff.

coefficients range from 0.1661 (for open-water and forested wetlands) to 0.3461 (for open-water and emergent-vegetation wetlands). These coefficients indicate that, although all of the properties are within 1,000 meters of all four types of wetlands, variation still exists in terms of the distances from the properties to the different types of wetlands.

Housing Characteristics

The data set for this analysis includes all of the single-family houses in the county that lie within 1,000 meters of each of the four types of wetlands. This is approximately 31% of the single-family, currently occupied houses in the county. The complete set of attributes, the descriptive statistics for which are itemized in table 3, includes value, lot area, number of bathrooms, living area, age, and distance to the nearest lake. We used dummy variables for each of four suburban school districts and whether or not the property has a lake view. These structure and location attributes of the housing in our study were compiled by Lyons from 1990 Ramsey County property tax records.

This is a more parsimonious list of housing characteristics than in many hedonic housing studies we have seen. However, in estimating a more variable-laden model, we found that including a larger number of attributes did not appreciably affect any results shown here.

Price Data

The hedonic equation seeks to track the "true price"—that dollar value agreed upon by willing buyers and sellers, each with full information and no coercion. This price is never directly observable. Common proxies in the literature include census-tract average value, parcel-level assessor market value, and parcel-level reported transaction price. Even the latter, which is frequently assumed to equal the true price, necessarily contains some error: reported transaction prices are often not adjusted for time or terms, they are subject to recording error, and they may be intentionally misreported.

Consequently, any observed price—whether the transaction price or the assessor's estimate—is only a proxy for the unobservable true price. Which proxy is "best" is an empirical matter and proxy selection will be necessarily influenced by data availability. We suspect that reported transaction prices are closer to the true price than are assessed values. However, for the present study these simply were not available. We used assessor market values, which are estimated sales prices based on existing market and property characteristics. Minnesota law requires that all properties be assessed at their market value and Ramsey County has a competent professional staff to ensure that assessments are frequently updated to reflect changing market conditions. At a minimum, every property is physically examined every four years and most assessed values are revised annually. Using assessed value has the advantage of greatly increasing the number of properties in our analysis; it has the disadvantage of perhaps imparting a bias to our estimates greater than the bias that would have resulted from using reported transaction prices.

Because true price is not observable, we cannot directly evaluate which proxy is the closest. We can, however, determine the statistical relationship between reported transaction

Table 1. Distribution of Wetland Types in Ramsey County, MN

Wetland Type	Hectares	Acres	Percent of County
Forested	550	1,359	1.04
Scrub-shrub	639	1,578	1.21
Emergent vegetation	2,328	5,750	4.42
Open water	482	1,191	0.92

Table 2. Correlations among Distance to Types of Wetlands, Ramsey County, MN

Wetland Type	Scrub-Shrub	Emergent Vegetation	Open Water
Forested	0.2764	0.3111	0.1661
Scrub-shrub		0.3163	0.1777
Emergent vegetation			0.3461

prices and assessor market values using a data set that contains both sets of prices.[5] In an examination of 2,976 residential property sales in Ramsey County in 1992, we found a strong link between prior assessed market values (AV) and reported transaction prices (TP) adjusted for terms and time. (The ratio AV to TP is essentially the transaction's "sales ratio," a relationship frequently used in the analytical and legal evaluation of assessor practices.) A simple ordinary least squares model yields

(1) $$\underset{(708)}{TP = -4{,}7005} + \underset{(0.007)}{1.13}AV \qquad R^2 = 0.90.$$

Standard errors are in parentheses. We conclude that similar results would be obtained using either proxy, were that possible. Unless the differences in AV and TP are correlated with distances to different types of wetlands, our eventual ranking of homeowner preferences for different types of wetlands will not depend on which proxy is used.

[5]Unfortunately, this data set does not include the location identification codes necessary to match it with our data set which includes location variables. As a result, we cannot estimate our model using both value proxies and then compare the results.

Table 3. Property Characteristics of Houses Included in Wetland Proximity Study, Ramsey County, MN

Variable	Mean	Minimum	Maximum	Standard Deviation
Value ($)	104,956	4,000	1,914,400	46,484
Lot area (sq. ft.)	19,895	1,680	4,965,270	53,818
Bathrooms (#)	1.5	0.25	7.25	0.6
Living area (sq. ft.)	1,536	320	10,553	600
Age (years)	27.7	1	132	18.8
Distance to lake	90.94	1	255	63.0
Distance to forested wetlands	50.18	1	100	25.2
Distance to scrub-shrub wetland	50.20	1	100	26.1
Distance to emergent vegetation wetland	25.10	1	100	17.2
Distance to open water wetland	35.88	1	100	21.9

Note: Distance variables are in 10-meter increments. The sample size was 32,417.

Estimating Distance Effects

We assume that house values are based upon structural and location attributes, including distance from wetlands, and we use a standard hedonic framework to estimate the implicit price of proximity to the four wetlands types.[6] To determine the effect of distance from wetlands on house value, a number of equations were estimated. Results are presented from estimations using a quadratic fuctional form.

To deal with possible curvature in the hedonic equation, we estimated

$$(2)\quad value = \alpha + X'\gamma + \beta_1 D_1 + \beta_2 D_2 + \beta_3 D_3 + \beta_4 D_4 + \beta_5 D_1^2 + \beta_6 D_2^2 + \beta_7 D_3^2 + \beta_8 D_4^2 + e,$$

where *value* is the assessed price of the house, X is the vector of housing characteristics including distance to the nearest lake (described in table 3), D_1 is the distance to forested wetlands, D_2 is the distance to scrub-shrub wetlands, D_3 is the distance to emergent wetlands, and D_4 is the distance to open-water wetlands. The squared terms on distance variables

[6]See Rosen or Palmquist for the theoretical framework of hedonic models.

Table 4. Effects of Housing Characteristics and Distance to Wetlands on House Value

Variable	Parameter Estimate	Standard Error	*t*-Statistic
Intercept	41992**	1624.38	25.85
Lot area	0.05**	0.02	2.71
Bathrooms	4871.44**	564.60	8.63
Living area	48.95**	0.95	51.64
Age	−387.08**	10.77	−35.95
Lake view	45949**	1188.63	38.66
Dist. to lake	−187.92**	7.70	−24.41
Dist. to forested	47.93*	22.17	2.16
Dist. to scrub-shrub	−199.21**	23.67	−8.42
Dist. to emergent vegetation	−239.96**	28.83	−8.32
Dist. to open water	−117.13**	21.16	−5.53
Sqr. dist. to lake	0.64**	0.03	22.46
Sqr. dist. to forested	− 0.13	0.20	− 0.63
Sqr. dist. to scrub-shrub	1.07**	0.21	5.06
Sqr. dist. to emergent	4.14**	0.39	10.73
Sqr. dist. to open water	0.52*	0.22	2.35
School 1	110876**	433.93	25.06
School 2	4457.62**	476.32	9.36
School 3	7661.97**	405.03	18.92
School 4	4716.55**	489.04	9.64

Note: This R^2 is 0.7581. One asterisk denotes significance at the 0.025 level and two asterisks denote signficance at the 0.001 level. The sample size was 32,417.

permit us to capture the possibility that homeowners will have a stronger preference for moving ten meters closer to a wetland if that move resulted in their living immediately adjacent to the wetland instead of, say, 980 meters from it. Similarly, their preferences for living farther from wetlands could be stronger if the initial distance to the wetland was shorter.

The estimated parameters for (2) are shown in table 4. Testing for heteroskedasticity by comparing the matrix of consistent covariance of estimates with the OLS matrix shows that heteroskedasticity is present so the reported standard errors have been corrected (White). White's approach is consistent but is not asymptotically efficient. It is used here because it does not require an assumption about the form of the heteroskedasticity.

The coefficients on all of the nondistance variables are significantly different from zero at the 0.001 level and have the expected signs. Lot area, number of bathrooms, living area, and lake view all are positively related to property value. The sign on the estimated coefficient for age is negative, and the coefficient on lake view is significant and quite large. By these estimates, a lake view is worth $46,000, an amount similar to the result found by Lansford and Jones, in which a waterfront property on Lake Austin in Texas was worth $59,826. As expected, proximity to lakes is also positively valued. Proximity to lakes is valued slightly higher than proximity to the most preferred wetland type, scrub-shrub wetlands.

There is clearly a relationship between property value and distance to wetlands: all of the coefficients on the distance variables are significant at least at the 0.001 level except for the squared distance to forested wetlands. F-tests of the null hypothesis that the coefficients on the distance variables (distance and distance squared) were the same for any combination of two wetland types lead us to reject that hypotheses for all such pairings: all of the coefficients are significantly different from each other at the 0.01 significance level (table 5).

Rankings between three of the wetland types are clear. If one interprets the relative magnitude of the hedonic equations' distance components as a preference ordering, the more negative the value, the more proximity to that wetland type is valued. Scrub-shrub wetlands are preferred, followed by open-water, then forested wetlands. Because of the quadratic functional form, emergent-vegetation wetlands are not strictly dominated by any of the others, nor do they strictly dominate any. At a distance of up to 300 meters, the implicit price of proximity to emergent-vegetation wetlands is positive; after that point, it is negative.

Implicit Price of Proximity to Wetlands

The distance parameter estimates are with reference to a location 10 meters closer to the appropriate wetland. Under the quadratic model, the implicit price of living an additional ten meters closer to a forested wetland is –$145. (Each of these reported prices is calculated at the mean distance for that particular type of wetland using the estimated coefficients reported in table 4. For forested wetlands, we assume that the coefficient on the squared term is zero for the calculations since we cannot reject the null hypothesis that it is zero.) For the other three types of wetland types, the implicit price is positive at the mean distance: moving an additional ten meters towards an emergent-vegetation wetland increases house value by $136, towards open-water wetlands by $99, and towards scrub-shrub wetlands by $145.

Table 5. Tests of the Null Hypothesis of Equal Coefficients on Wetland Proximity (F-Statistics)

Wetland Type	Scrub-Shrub	Emergent Vegetation	Open Water
Forested	113.08	52.83	72.47
Scrub-shrub		129.94	7.45
Emergent vegetation			88.11

Note: If the F-statistic is greater than 6.63, we reject the null hypothesis that the coefficients are the same at the 0.01 level of signficance.

Thus, decreasing the distance from any wetland type by 200 meters, approximately one city block, yields an implicit price range of –$960 (for a forested wetland) to $2,900 (for a scrub-shrub wetland). The marginal prices of other housing characteristics can be read directly from the parameter estimates in table 4.

To test the robustness of the results, a number of other models were estimated but not reported here. Several of those models used all of the houses in Ramsey County, not just those within 1,000 meters of wetlands. Those results also indicate that scrub-shrub and open-water wetlands are preferred compared with forested and emergent-vegetation wetlands. (For details on these other models, see Doss and Taff.)

Conclusions

These price estimates provide a lower bound of the value of wetlands. To estimate the full value of wetlands, public values should also be considered. Preference orderings of homeowners may or may not correspond with the public value of different types of wetlands. However, these results provide information for policymakers who want to understand the private values. It suggests that neighborhood residents will respond positively to policies that preserve scrub-shrub and open-water wetlands. Residents may respond negatively to policies that preserve forested wetlands and may have little response to policies that preserve emergent-vegetation wetlands. Policy decisions about wetland preservation should consider the public value of the wetlands, but to implement these policies, it is important to have expectations about responses from neighborhood residents.

The estimated coefficients on distances to wetlands provide only a partial measure of the value of wetlands. They capture only the portion of house value that is due to the distance from particular wetland types. They do not directly measure the willingness to pay for wetlands by all people in the area, nor do they provide information on what the total public and private value of additional wetlands might be. As such, the magnitudes of the value effects estimated here do not translate smoothly into a policy debate. However, the relative valuations estimated here are useful, because they allow us to rank the types of wetlands based on homeowners' preferences. This research indicates that homeowners clearly place different valuations on living near different types of wetlands and that they may respond differently to policies that affect different types of wetlands in their neighborhoods.

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