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Evidence on the Amenity Value of Wetlands in a Rural Setting

Okmyung Bin and Stephen Polasky

This study uses a hedonic property price method to estimate how wetlands affect residential property values in a rural area. The study utilizes wetland inventory data coupled with extensive property sales records between January 2000 and September 2004 from Carteret County, NC. Our results indicate that i) a higher wetland percentage within a quarter mile of a property, ii) closer proximity to the nearest wetland, and iii) larger size of the nearest wetland are associated with lower residential property values. These results contrast with previous hedonic studies that use data from urban areas, which found positive associations between wetlands and property values. The amenity value of wetlands appears to depend at least as much on the characteristics of the area being considered as it does on the characteristics of the wetlands.

Key Words: hedonic prices, housing market, rural area, wetlands

JEL Classifications: D12, Q24, Q26, R21

Wetlands can provide valuable ecosystem services, such as habitat for fish and wildlife; flood protection; water quality improvement; opportunities for recreation, education, and research; and aesthetics. Many of these ecosystem services have characteristics of public goods whose benefits are shared by a large number of people. Though wetlands can provide valuable ecosystem services to society as a whole, it is not clear that wetlands provide

positive net benefits to nearby landowners. Some of the ecosystem services mentioned above might provide amenities for nearby residents (e.g., open space, aesthetics, flood protection, opportunities to watch wildlife). Conversely, wetlands can produce disamenities for nearby residents by providing breeding grounds for insects that might be vectors for disease (e.g., mosquitoes and West Nile Virus), limiting mobility across the terrain, or inhibiting economically productive activities like farming (Shultz and Taff). In general, whether wetlands generate positive or negative net benefits for nearby residents is an empirical question.

Estimating the value of wetland amenities and disamenities requires the use of nonmarket valuation techniques because virtually all of the amenities and disamenities provided by wetlands are not directly traded in markets. The hedonic property price method uses observations on property values to infer values for nontraded goods and services such as those

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The authors thank Tom Crawford for guidance on GIS analysis, Barry Blackburn for providing Carteret County property parcel data, Kelly Williams for providing wetland inventory data, and Greg Meyer for providing excellent research assistance. The authors also thank V. Kerry Smith; seminar participants at Camp Resources X, Louisiana State University, and North Carolina State University; and two anonymous referees for helpful comments.

generated by wetlands. Observing how property values change as the level of various attributes change, such as proximity to wetlands, provides a way of estimating the marginal value of these attributes to property owners.

In this paper, we use the hedonic property price method to estimate the amenity or disamenity value in a rural area of i) percentage of land area that is wetland within a quarter mile of a property, ii) distance to the nearest wetland, and iii) size of the nearest wetland. Virtually all prior hedonic studies have been done in urban areas. We use data from Carteret County, which is a rural county located on the Atlantic Coast in eastern North Carolina with numerous wetlands. Carteret County contains no city or town with a population over 8,000. Evidence from this study indicates that wetlands are negatively associated with property values. An increased percentage of wetlands within a quarter mile of a property is associated with lower property value. Increasing the percentage of wetland within a quarter mile of the property by 25% (from 10% to 12.5%) lowers estimated property value by \$1,420 for a property with an average property value of \$157,839. Closer proximity to wetlands is also associated with lower property values. Evaluated at the sample mean 233 meters (766 feet), decreasing the distance to the nearest wetland by 25% lowers estimated property value by \$945 for a house with the average property value. Increasing the size of the nearest wetland again reduces property values. Evaluated at the observed mean value 0.23 square kilometers (57 acres), increasing the nearest wetland size by 25% yields an estimate of \$217 in decreased property values. All wetland effects are statistically significant at the 5% level of significance.

These results contrast with results of previous hedonic studies on wetlands with data from urban areas. In urban areas, hedonic studies have generally shown that closer proximity and increased size of wetlands increases nearby property values. Lupi, Graham-Tomasi, and Taff, and Doss and Taff used data from the Twin Cities metropolitan area in Minnesota and found that proximity to wetlands increased nearby residential property values.

Lupi, Graham-Tomasi, and Taff found that wetlands were relatively more valuable in areas with relatively few wetlands. Doss and Taff assessed the value of different types of wetlands and found a preference for scrub shrub and open-water wetlands over forested and emergent-vegetation types of wetlands. Mahan, Polasky, and Adams used data from Portland, OR, and found that decreasing the distance to the nearest wetland and increasing the size of the nearest wetland increased property values. In their study, they did not find a clear preference for particular types of wetlands. Earnhart combined a hedonic analysis with conjoint analysis to study the value of wetlands in Fairfield, CT. This study found that restored wetlands generated large positive increases in nearby property values. Proximity to disturbed wetlands, on the other hand, generated decreases in property values. Woodward and Wui, and Boyer and Polasky provide recent reviews of empirical valuation studies of wetlands, including both hedonic and non-hedonic studies.

There has been little prior research applying the hedonic property price method to wetlands valuation outside of urban areas. Reynolds and Regalado found mixed results on the effect of wetlands on nearby residential property values; wooded and emergent vegetation wetlands had a negative effect on property values, whereas open-water and scrub shrub wetlands had a positive value. Shultz and Taff found negative values for wetlands on land in production agriculture, in which wetlands can restrict production and profitability. There is no such effect for residential properties. In our results for rural residential properties, we find that proximity to wetlands lowers property values regardless of wetland type. For Carteret County, NC, a rural area with numerous wetlands, it appears that wetlands on net generate negative amenities for residential property owners.

Study Area and Data

Carteret County is a rural county located on the coast of the Atlantic Ocean in eastern North Carolina. It has a total population of

59,383. The largest town in the county, Morehead City, has a population of 7,691. Historically, a large percentage of the county was wetlands. The North Carolina Division of Coastal Management (NCD CM 1999a) reports that Carteret County has about 180,000 wetland acres, which make up about 45% of the total land area. Originally, an even higher percentage of land was wetlands. NCD CM estimate that almost half of the original wetland acreage in eastern North Carolina has been converted to other uses. Agricultural conversion has been the largest contributor to wetland loss, but recent losses are largely due to draining and filling wetlands for development projects. The Coastal Area Management Act of 1974 offers stringent protection for coastal wetlands in North Carolina, whereas inland wetlands have not been specifically protected under North Carolina law (NCD CM 1999b).¹

¹ Coastal wetlands are designated Areas of Environmental Concern that typically require permits for development. Areas of Environmental Concern include the estuarine and ocean system, public water supplies, and natural and cultural resource areas.

Figure 1 is a map of Carteret County showing the property parcels and wetlands. As shown in Figure 1, wetlands are plentiful and located throughout the county.

This study uses multiple data sources: property parcel data from Carteret County Tax Office, wetland inventory data from NCD CM, county boundary with the coastline data from North Carolina Center for Geographic Information and Analysis, digital flood maps from North Carolina Flood Mapping Program supported by the Federal Emergency Management Agency (FEMA), and 2000 U.S census data. Data from these sources are combined so that the attributes of the nearest wetland are attached to each property sales record along with its structural and neighborhood attributes.

The Carteret County Tax Office maintains property parcel records on all properties in the county. We use a total of 2,379 single-family residential property sales records from January 2000 to September 2004 in this study. Part of the county is on coastal barrier islands that form the Outer Banks of North Carolina. The barrier islands are primarily a vacation and re-

Figure 1. Map of Carteret County, NC

Table 1. Distribution of Wetland Types in Carteret County, North Carolina

Wetland Type	Observations	Area (mi. ²)	% of County
Coastal wetlands			
Emergent vegetation	740	82.30	15.83%
Inlands wetlands			
Emergent vegetation	119	0.71	0.14%
Scrub shrub	1,653	92.37	17.76%
Forested	2,321	57.29	11.02%
Total	4,833	232.67	44.74%

Note: Percentage of County is based on the total land area of Carteret County (520 mi.²) from 2000 U.S. census data. Wetlands that are partially drained, disturbed, and cleared are not included in this study.

sort area, with many rental properties. The housing market on the barrier islands appears to be quite different from that of the mainland. Property sales data from the barrier islands are not included in this study.² Sales prices were adjusted to report figures in September 2004 dollars with the use of a Consumer Price Index for housing. The average sales price for properties in the data set was \$157,839. The property sales data also include a series of structural attributes, including the number of bathrooms, the age of the house, the square footage of the house, the lot size, and whether the property is sold within a year of being built.

The explanatory variables we are most interested in are related to wetlands. NCDCM maintains wetland inventory data for 20 coastal counties as one component of the Wetlands Conservation Plan implemented in 1992. Location, size, and vegetation type of wetlands are recorded in a Geographic Information System. The data include a total of 4,833 wetlands in Carteret County. Wetlands vary from primarily open-water wetlands to forests and grasslands that are wet only part of the year. Different types of wetlands can provide different amenities and disamenities and can be valued differently. In this study, we used four categories of wet-

lands on the basis of whether it is a coastal or inland wetland and dominant vegetation type: coastal emergent vegetation, inland emergent vegetation, inland scrub shrub, and inland forested wetlands. Coastal wetlands are occasionally flooded by tides. Such wetlands buffer storms, slow shoreline erosion, and provide food and habitat for clams, crabs, and juvenile fish, as well as offering shelter and nesting sites for several species of migratory waterfowl. All coastal wetlands in our study area fall into the category of emergent vegetation wetlands. Emergent vegetation wetlands are usually dominated by perennial plants that are present only during the growing season and include marsh, meadow, fen, and slough. Inland wetlands are common on floodplains along rivers and streams and in other low-lying areas. Inland wetlands can be differentiated by their dominant vegetation: emergent vegetation wetlands, scrub shrub wetlands, and forested wetlands. Scrub shrub wetlands are dominated by woody vegetation less than 6 meters (20 feet) tall. Forested wetlands are characterized by woody vegetation that is 6 meters (20 feet) tall or taller. A total of 740 wetlands are classified as coastal wetlands and 4,093 are inland wetlands. Among the inland wetlands, 119 wetlands are classified as emergent vegetation wetlands, 1,653 are scrub shrub wetlands, and 2,321 are forested wetlands. Table 1 shows the distribution of wetland types and the percentage of land area in the county. The percentage of wetlands within a circular neighborhood of 402

² The structural difference between the two housing markets is statistically significant. The wetland variables in the barrier island housing market are mostly insignificant, suggesting that the presence or absence of wetlands might be inconsequential for a vacation community centered on ocean and beach recreation.

meters ($\frac{1}{4}$ mile) of each house is calculated with an iterative Geographic Information System (GIS) program based on raster focalsum functions. The average percentage of wetlands within a quarter mile of each house is about 10%. Distance to the nearest wetland for each residential property is measured in feet from the centroid of the property to the edge of the nearest wetland. The average distance to the nearest wetland is 233 meters (766 feet). The average size of a wetland is 0.23 square kilometers (57 acres). About 17% of residential properties in the data set have coastal emergent vegetation wetlands as the nearest wetland type, 5% have inland emergent vegetation, 49% have scrub shrub, and 30% have forested wetlands as the nearest type.

The mainland part of the county is separated from the barrier islands by Pamlico Sound and other intracoastal waterways (hereafter referred to collectively as "the sound"). Close proximity to the sound is highly desirable. We measure the distance to the sound for each residential property using GIS information on the county coastline that delineates the boundary of the sound. The average distance to the sound for the properties is about 1.6 kilometers (5,197 feet). We also have information on whether a property is located within a floodplain or not. Digital flood maps created with the support from FEMA are used to identify the properties within the floodplains that would flood in a 100-year flood event (i.e., areas with a 1.0% chance of flooding in a year). One might expect properties within floodplains to sell at a discount, reflecting the additional risk. Bin and Polasky found a discount for floodplain location in a nearby county in eastern North Carolina. About 9% of houses in our data set are located in a floodplain.

In addition, we calculate the distance of each property to regional business centers (New Bern and Jacksonville, NC), nearest highway, railroad, regional airport, and park or preserve area (forest and game preserves). Distances to these features are measured as the Euclidean distance in feet from the centroid of the property to the nearest edge of a feature. We control for unobserved heterogeneity

across townships using a set of dummy variables representing the 15 townships in the county. We also control for whether the property is located within a municipality or not. Finally, we include the percentage of owner-occupied properties, population density per square mile, the percentage of nonwhite populations, and mean travel time to work in minutes by census block groups from the 2000 U.S. census data. Palmquist, Roka, and Vukina also used commute time by census tract in their hedonic study of the effects of hog operation on property values in eastern North Carolina.

Given the large number of explanatory variables employed in our model, there is some potential for multicollinearity. Pairwise correlation coefficients among the variables do not indicate high multicollinearity in our data, with the exception of distance to coastal emergent vegetation wetlands and distance to the sound (correlation coefficient of 0.8). In general, multicollinearity causes large standard errors, resulting in insignificant estimates. In our study, because of the large number of observations, we generate statistically significant results for variable of interest and so do not worry further about multicollinearity. Table 2 provides the definition and description of the variables used in this study. Summary statistics are presented in Table 3.

Methodology

This study uses the hedonic property price method to estimate the effects of wetlands on property values. Since Rosen, numerous studies have applied hedonic property price models to estimate the value of various environmental amenities or disamenities (see Palmquist for a summary).

Let S_i represent a vector of structural characteristics of the i th house, such as age, square footage, and number of bathrooms. Let N_i represent a vector of neighborhood characteristics of the i th house, such as distance to business center and commute time to work. Let W_i represent a vector of environmental characteristics for the i th house, such as the distance to

Table 2. Definition and Description of the Variables

Variable	Description
PRICE	House sales price adjusted to September 2004 dollars
TOWN1	Dummy variable for a township (1 if Atlantic, 0 otherwise)
TOWN2	Dummy variable for a township (1 if Cedar Island, 0 otherwise)
TOWN3	Dummy variable for a township (1 if Davis, 0 otherwise)
TOWN4	Dummy variable for a township (1 if Harkers Island, 0 otherwise)
TOWN5	Dummy variable for a township (1 if Harlowe, 0 otherwise)
TOWN6	Dummy variable for a township (1 if Marshallberg, 0 otherwise)
TOWN7	Dummy variable for a township (1 if Merrimon, 0 otherwise)
TOWN8	Dummy variable for a township (1 if Morehead, 0 otherwise)
TOWN9	Dummy variable for a township (1 if Newport, 0 otherwise)
TOWN10	Dummy variable for a township (1 if Sea Level, 0 otherwise)
TOWN11	Dummy variable for a township (1 if Smyrna, 0 otherwise)
TOWN12	Dummy variable for a township (1 if Stacy, 0 otherwise)
TOWN13	Dummy variable for a township (1 if Straits, 0 otherwise)
TOWN14	Dummy variable for a township (1 if White Oak, 0 otherwise)
TOWN15	Dummy variable for a township (1 if Beaufort [county seat], 0 otherwise)
MUNICIPAL	Dummy variable for municipality (1 if within a municipality, 0 otherwise)
NEWHOME	Dummy variable for new home (1 if sold within a year after built, 0 otherwise)
BATHRM	Number of bathrooms
AGE	Year house was built subtracted from 2004
SQFT	Total structure square footage
LOTSIZE	Total lot size measured in acres
CBD1	Distance in feet to a northbound business center (New Bern, NC)
CBD2	Distance in feet to a southbound business center (Jacksonville, NC)
HIGHWAY	Distance in feet to nearest highway
RAILRD	Distance in feet to nearest railroad
AIRPORT	Distance in feet to nearest airport
PARK	Distance in feet to nearest park, forest, or game land
OWNER	Percentage of owner-occupied homes by census block group
COMMUTE	Mean travel time to work in minutes by census block group
POPDENSITY	Population density per square mile of land area by census block group
NONWHITE	Percentage of nonwhite populations by census block group
FLOOD	Dummy variable for house within a floodplain (1 if floodplain, 0 otherwise)
SOUND	Distance in feet to sound or intracoastal waterways
WTLDPCT	Percentage of wetlands within a quarter mile of each house
WTLDDIST	Distance in feet to nearest wetland
WTLDSIZE	Acreage of nearest wetland
CSTEMG	Dummy variable for nearest wetland type (1 if coastal emergent, 0 otherwise)
INDEMG	Dummy variable for nearest wetland type (1 if inland emergent, 0 otherwise)
SCRSHB	Dummy variable for nearest wetland type (1 if scrub shrub, 0 otherwise)
FOREST	Dummy variable for nearest wetland type (1 if forested, 0 otherwise)

and size of the nearest wetland. The housing market is assumed to be in equilibrium, which requires that households optimize their residential choice on the basis of the prices of alternative locations. The hedonic price function can be written as

$$(1) \quad P_i = P_i(S_i, N_i, W_i).$$

We estimate the following hedonic price function,

$$(2) \quad \ln P = \alpha + \sum_i \beta_i S_i + \sum_j \gamma_j N_j + \sum_k \psi_k W_k + \varepsilon,$$

where $\ln P$ is the natural log of sales price and

Table 3. Summary Statistics of the Variables

Variable	Mean	SD	Minimum	Maximum
PRICE	157,839.42	104,419.90	15,000.00	1,100,000.00
TOWN1	0.01	0.10	0.00	1.00
TOWN2	3.78×10^{-3}	0.06	0.00	1.00
TOWN3	4.62×10^{-3}	0.07	0.00	1.00
TOWN4	0.01	0.12	0.00	1.00
TOWN5	0.02	0.14	0.00	1.00
TOWN6	0.01	0.08	0.00	1.00
TOWN7	0.01	0.07	0.00	1.00
TOWN8	0.43	0.50	0.00	1.00
TOWN9	0.15	0.36	0.00	1.00
TOWN10	2.52×10^{-3}	0.05	0.00	1.00
TOWN11	0.01	0.08	0.00	1.00
TOWN12	2.10×10^{-3}	0.05	0.00	1.00
TOWN13	0.03	0.17	0.00	1.00
TOWN14	0.20	0.40	0.00	1.00
TOWN15	0.11	0.31	0.00	1.00
MUNICIPAL	0.42	0.49	0.00	1.00
NEWHOME	0.18	0.38	0.00	1.00
BATHRM	2.02	0.59	1.00	6.00
AGE	20.48	20.88	0.00	103.00
SGFT	1,705.91	580.07	288.00	6,108.00
LOTSIZE	0.61	1.02	0.03	18.60
CBD1	155,515.92	22,374.02	111,845.48	227,417.46
CBD2	111,742.57	44,185.18	27,273.86	289,445.31
HIGHWAY	6,165.16	6,179.43	54.50	57,446.34
RAILRD	20,069.54	22,617.83	39.00	141,249.30
AIRPORT	45,976.24	26,126.89	2,298.90	106,592.69
PARK	9,984.89	7,552.02	4.02	41,835.47
OWNER	79.60	9.42	34.60	92.66
COMMUTE	22.27	3.86	18.90	61.80
POPDENSITY	624.91	540.26	8.00	2,858.70
NONWHITE	0.10	0.08	0.01	0.59
FLOOD	0.09	0.29	0.00	1.00
SOUND	5,196.58	7,842.94	2.11	36,762.16
WTLDPCT	10.11	11.90	0.00	72.21
WTLDDIST	766.15	647.54	0.14	3,945.44
WTLDSIZE	56.86	171.97	0.00	1,276.03
CSTEMG	0.17	0.37	0.00	1.00
INDEMG	0.05	0.21	0.00	1.00
SCRSHB	0.49	0.50	0.00	1.00
FOREST	0.30	0.46	0.00	1.00

Note: Number of observations is 2,379.

ε is an independent random error term. We use the natural logs of the distance-related variables and the size of nearest wetland to capture diminishing marginal effects. It seems reasonable to expect that the effect of distance on property value will decline with distance rather than being constant. Given our specifica-

tion, the coefficient estimates for log-transformed variables represent elasticities. We use quadratic specifications for nondichotomous structural variables such as total structure square footage and age of house. We experimented with several alternative specifications and found that the primary results are robust

to alternative functional forms. White's method is used to obtain a consistent estimator of the covariance matrix to get estimates of the standard error corrected for potential heteroskedasticity.

We estimate three hedonic price models in this study. First, we estimate the model using the percentage of wetlands within a quarter mile of each house. The percentage of wetlands is negatively correlated with distance to the nearest wetland and positively correlated with size of the nearest wetland. An anonymous referee suggested this approach given the abundance of wetlands in the study area and the close average distance to the nearest wetland. Second, we estimate the model using the proximity and size of the nearest wetland separately without distinguishing the type of the nearest wetland. It is implicitly assumed that what affects property values is the proximity and size of the nearest wetland regardless of its type. Third, we allow for heterogeneity across the wetland types through the slope-shifting dummy variables. Interaction terms of the wetland types with both the distance and the size of the nearest wetland are included in the regression. This model shows whether the effect of distance and size of the nearest wetland differs across wetland types.

In the following section, we report the estimation results and the marginal effects of the explanatory variables on property values. As suggested by Halvorsen and Palmquist, the marginal effect for the dummy variables is calculated by $P[\exp(c) - 1]$, where P is the sales price and c is the coefficient of a dummy variable. For distance-related variables, which are log transformed, the marginal effect is price times the distance coefficient divided by the distance. All marginal effects are evaluated at the observed mean values. In addition, the effects of discrete changes in the distance are reported by $\ln P_1 - \ln P_0 = \delta(\ln d_1 - \ln d_0)$, where δ is the coefficient for the distance-related variable, d is the distance-related variable, and the subscripts 0 and 1 represent the quantities before and after the change, respectively.

Estimation Results

We present estimation results in Tables 4–6. The estimation results for the model with the percentage of wetlands within a quarter mile are shown in Table 4. As shown in Table 4, the coefficients on most variables are statistically significant, with signs that are consistent with common findings in the hedonic price literature. The estimation results indicate that a higher percentage of wetlands within a quarter mile lowers property values. The coefficient on the wetland percentage variable is statistically significant at any conventional level of significance ($p < .0001$). The estimated marginal effect shows that increasing the wetland percentage from 10% to 12.5% within a quarter mile lowers the property value by \$1,420 for a house with an average property value.

Table 5 reports the results for the model with the proximity and size of the nearest wetland without distinguishing the type of the nearest wetland. The estimation results suggest that closer proximity to the nearest wetland lowers property value. Note that for distance-related variables, a positive (negative) relationship to the dependent variable means that closer proximity to the features decreases (increases) property value. Estimation results show that, evaluated at the mean value 233 meters (766 feet), decreasing distance to the nearest wetland by 25% 59 meters (192 feet) lowers the property value by \$945 for a house with an average property value. If the distance to the nearest wetland decreases by 10% to 50%, the estimated reduction in property values is from \$347 to \$2,267. The coefficient for the size of the nearest wetland is also statistically significant and has a negative sign. Evaluated at the mean value 0.23 square kilometers, increasing the nearest wetland size by 25% 0.06 square kilometer yields an estimate of \$217 in decreased property value. Again, if the size of the nearest wetland increases by 10% to 50%, the estimated reduction in property values would be from \$93 to \$394.

The specification used to generate the results in Table 6 is identical to the specification used to generate Table 5 with the exception of

Table 4. Estimation Results of the Hedonic Price Function—Percentage of Wetland

Variable	Coefficient	Standard Error	p-Value	Marginal Effect
INTERCEPT	13.948	2.478	0.0000	
TOWN1	-0.248	0.084	0.0033	-\$34,680.18
TOWN2	-0.180	0.174	0.2998	-\$26,041.72
TOWN3	-0.570	0.117	0.0000	-\$68,552.22
TOWN4	-0.176	0.080	0.0281	-\$25,459.21
TOWN5	-0.451	0.071	0.0000	-\$57,271.01
TOWN6	-0.349	0.113	0.0020	-\$46,451.58
TOWN7	-0.414	0.108	0.0001	-\$53,478.20
TOWN8	-0.318	0.055	0.0000	-\$42,996.17
TOWN9	-0.142	0.077	0.0662	-\$20,891.85
TOWN10	0.004	0.192	0.9835	\$629.45
TOWN11	-0.317	0.113	0.0050	-\$42,890.46
TOWN12	-0.051	0.176	0.7715	-\$7,847.99
TOWN13	-0.435	0.065	0.0000	-\$55,699.04
TOWN14	-0.416	0.073	0.0000	-\$53,749.18
MUNICIPAL	0.071	0.018	0.0001	\$11,549.64
NEWHOME	-0.047	0.019	0.0146	-\$7,264.89
BATHRM	0.174	0.046	0.0002	\$16,497.60
BATHRM ²	-0.017	0.009	0.0614	
AGE	-0.011	0.001	0.0000	-\$1,220.53
AGE ²	9.05×10^{-5}	1.17×10^{-5}	0.0000	
SQFT	0.001	4.56×10^{-5}	0.0000	\$89.63
SQFT ²	-8.78×10^{-8}	1.02×10^{-8}	0.0000	
LOTSIZE	0.099	0.014	0.0000	\$14,794.31
LOTSIZE ²	-0.004	0.001	0.0003	
ln(CBD1)	-0.102	0.186	0.5824	-\$0.10
ln(CBD2)	-0.132	0.061	0.0306	-\$0.19
ln(HIGHWAY)	0.025	0.007	0.0005	\$0.65
ln(RAILRD)	-0.026	0.009	0.0023	-\$0.21
ln(AIRPORT)	0.084	0.031	0.0060	\$0.29
ln(PARK)	-0.014	0.008	0.0692	-\$0.22
OWNER	0.003	0.001	0.0179	\$410.38
COMMUTE	-0.012	0.004	0.0041	-\$1,908.28
POPDENSITY	2.91×10^{-5}	1.99×10^{-5}	0.1441	\$4.60
NONWHITE	-0.397	0.126	0.0016	-\$62,678.03
FLOOD	0.020	0.028	0.4641	\$3,267.49
ln(SOUND)	-0.147	0.007	0.0000	-\$4.47
WTLPDCT	-0.004	0.001	0.0000	-\$561.91
Adjusted R ²	0.7373			
F-statistic	181.36			

Note: Number of observations is 2,379. Dependent variable is the log of sales price. Standard errors and *p*-values are based on the robust, heteroskedasticity-corrected covariance matrix. Marginal effects are evaluated at the sample means. Category omitted for township is Beaufort (county seat).

allowing for heterogeneity across wetland types through the slope-shifting dummy variables. All the slope-shifting dummy variables for the distance to the nearest wetland are not significantly different from that of the base category (coastal emergent vegetation wet-

lands). The estimation results indicate that proximity to the nearest wetland lowers property values but that the type of the nearest wetland does not affect property values. The slope-shifting dummy variables for the size of the nearest wetland are also not significantly

Table 5. Estimation Results of the Hedonic Price Function—Distance to and Size of Wetland

Variable	Coefficient	Standard Error	p-Value	Marginal Effect
INTERCEPT	14.362	2.490	0.0000	
TOWN1	-0.245	0.085	0.0039	-\$34,275.55
TOWN2	-0.105	0.175	0.5498	-\$15,688.66
TOWN3	-0.515	0.117	0.0000	-\$63,515.18
TOWN4	-0.143	0.081	0.0758	-\$21,046.51
TOWN5	-0.444	0.072	0.0000	-\$56,546.33
TOWN6	-0.286	0.113	0.0116	-\$39,298.50
TOWN7	-0.382	0.109	0.0004	-\$50,101.87
TOWN8	-0.320	0.055	0.0000	-\$43,168.30
TOWN9	-0.132	0.078	0.0892	-\$19,519.65
TOWN10	0.074	0.194	0.7044	\$12,073.86
TOWN11	-0.275	0.114	0.0156	-\$37,910.63
TOWN12	-0.065	0.177	0.7144	-\$9,885.90
TOWN13	-0.406	0.066	0.0000	-\$52,707.26
TOWN14	-0.418	0.073	0.0000	-\$53,947.81
MUNICIPAL	0.066	0.018	0.0003	\$10,760.44
NEWHOME	-0.047	0.019	0.0148	-\$7,287.47
BATHRM	0.175	0.047	0.0002	\$16,515.83
BATHRM ²	-0.017	0.009	0.0579	
AGE	-0.012	0.001	0.0000	-\$1,229.89
AGE ²	9.30×10^{-5}	1.18×10^{-5}	0.0000	
SQFT	0.001	4.58×10^{-5}	0.0000	\$90.48
SQFT ²	-8.97×10^{-8}	1.03×10^{-8}	0.0000	
LOTSIZE	0.097	0.014	0.0000	\$14,513.71
LOTSIZE ²	-0.004	0.001	0.0003	
ln(CBD1)	-0.112	0.187	0.5503	-\$0.11
ln(CBD2)	-0.164	0.061	0.0074	-\$0.23
ln(HIGHWAY)	0.024	0.007	0.0013	\$0.60
ln(RAILRD)	-0.027	0.009	0.0017	-\$0.21
ln(AIRPORT)	0.071	0.031	0.0202	\$0.24
ln(PARK)	-0.008	0.008	0.2797	-\$0.13
OWNER	0.003	0.001	0.0053	\$482.99
COMMUTE	-0.013	0.004	0.0016	-\$2,121.36
POPENSITY	3.98×10^{-5}	2.00×10^{-5}	0.0463	\$6.28
NONWHITE	-0.387	0.127	0.0024	-\$61,077.54
FLOOD	0.008	0.028	0.7821	\$1,226.42
ln(SOUND)	-0.148	0.007	0.0000	-\$4.49
ln(WTLDDIST)	0.021	0.005	0.0000	\$4.30
ln(WTLDSIZE)	-0.006	0.003	0.0435	-\$17.10
Adjusted R ²	0.7350			
F-statistic	174.60			

Note: Number of observations is 2,379. Dependent variable is the log of sales price. Standard errors and *p*-values are based on the robust, heteroskedasticity-corrected covariance matrix. Marginal effects are evaluated at the sample means. Category omitted for township is Beaufort (county seat).

different from that of the base category (coastal emergent vegetation wetlands) except for scrub shrub wetlands. It is interesting to note that increasing the size of the nearest scrub shrub wetland is viewed more positively than

for other wetland types. Previous studies have found a preference by homeowners for scrub shrub wetlands over forested and emergent vegetation wetland types (Doss and Taff; Reynolds and Regalado).

Table 6. Estimation Results of the Hedonic Price Function—Type of Wetland

Variable	Coefficient	Standard Error	p-Value	Marginal Effect
INTERCEPT	15.309	2.503	0.0000	
TOWN1	-0.227	0.086	0.0082	-\$31,999.81
TOWN2	-0.011	0.179	0.9529	-\$1,656.45
TOWN3	-0.479	0.117	0.0000	-\$60,100.66
TOWN4	-0.096	0.082	0.2386	-\$14,459.46
TOWN5	-0.423	0.072	0.0000	-\$54,441.15
TOWN6	-0.217	0.117	0.0634	-\$30,818.96
TOWN7	-0.365	0.109	0.0008	-\$48,255.77
TOWN8	-0.305	0.055	0.0000	-\$41,531.84
TOWN9	-0.126	0.078	0.1066	-\$18,664.97
TOWN10	0.149	0.198	0.4495	\$25,430.16
TOWN11	-0.213	0.115	0.0627	-\$30,343.01
TOWN12	-0.020	0.178	0.9126	-\$3,057.34
TOWN13	-0.365	0.067	0.0000	-\$48,311.64
TOWN14	-0.414	0.073	0.0000	-\$53,531.41
MUNICIPAL	0.064	0.019	0.0007	\$10,408.43
NEWHOME	-0.048	0.019	0.0142	-\$7,329.62
BATHRM	0.176	0.047	0.0002	\$16,781.14
BATHRM ²	-0.017	0.009	0.0615	
AGE	-0.012	0.001	0.0000	-\$1,247.60
AGE ²	9.32×10^{-5}	1.18×10^{-5}	0.0000	
SQFT	0.001	4.59×10^{-5}	0.0000	\$90.38
SQFT ²	-9.01×10^{-8}	1.03×10^{-8}	0.0000	
LOTSIZE	0.097	0.014	0.0000	\$14,600.86
LOTSIZE ²	-0.004	0.001	0.0003	
ln(CBD1)	-0.115	0.187	0.5372	-\$0.12
ln(CBD2)	-0.210	0.063	0.0008	-\$0.30
ln(HIGHWAY)	0.022	0.007	0.0031	\$0.56
ln(RAILRD)	-0.027	0.009	0.0022	-\$0.21
ln(AIRPORT)	0.043	0.032	0.1722	\$0.15
ln(PARK)	-0.009	0.008	0.2594	-\$0.14
OWNER	0.003	0.001	0.0089	\$453.00
COMMUTE	-0.015	0.004	0.0006	-\$2,392.85
POPDENSITY	3.70×10^{-5}	2.01×10^{-5}	0.0657	\$5.83
NONWHITE	-0.373	0.131	0.0045	-\$58,866.21
FLOOD	0.019	0.028	0.5099	\$2,953.64
ln(SOUND)	-0.150	0.007	0.0000	-\$4.55
ln(WTLDDIST)	0.021	0.007	0.0021	\$4.30
ln(WTLDDIST)*INDEMG	-0.006	0.008	0.4315	\$3.03
ln(WTLDDIST)*SCRSHB	-0.002	0.005	0.6443	\$3.83
ln(WTLDDIST)*FOREST	4.95×10^{-4}	0.005	0.9215	\$4.40
ln(WTLDSIZE)	-0.018	0.008	0.0311	-\$49.94
ln(WTLDSIZE)*INDEMG	-0.053	0.038	0.1632	-\$197.17
ln(WTLDSIZE)*SCRSHB	0.022	0.009	0.0201	\$9.97
ln(WTLDSIZE)*FOREST	0.006	0.010	0.5745	-\$34.56
Adjusted R ²	0.7362			
F-statistic	151.82			

Note: Number of observations is 2,379. Dependent variable is the log of sales price. Standard errors and p-values are based on the robust, heteroskedasticity-corrected covariance matrix. Marginal effects are evaluated at the sample means. Marginal effects for the wetland-type interaction terms represent the effects of coastal emergent, inland emergent, scrub shrub, and forested wetlands, respectively. Category omitted for township is Beaufort (county seat).

We find that there is a very large premium for proximity to the sound. Decreasing the distance to the sound or the intracoastal waterways by 25% 402 meters (0.25 mile) from the mean value (about 1.6 kilometers (1 mile)) raises a property's value nearly \$6,853, which represents about 4.3% of the average property value. Milon, Gressel, and Mulkey estimated a large positive value from being close to the shore. They found that property values declined 36% in moving 500 feet from the Gulf of Mexico. Other studies have also found positive though smaller values from being close to the ocean (Earnhart; Shabman and Bertelson).

A possible reason for the negative value of wetlands is that proximity to wetlands might be related to higher risk of flooding. Prior literature on flood hazards has found that a house located within a floodplain has a lower market value than an equivalent house located outside the floodplain.³ In a recent study of data from Pitt County, NC, Bin and Polasky found a statistically significant price discount for floodplain location, one that increased substantially after Hurricane Floyd in September 1999. In this study, we do not find a statistically significant effect of location within a floodplain on property values. A relatively small number of properties were located in floodplains (9%). Furthermore, whereas Pitt County suffered massive flooding during Hurricane Floyd, Carteret County did not. Bin and Polasky suggest that risk premiums for flood hazards are closely tied to recent experience of flooding. In our study, we find that controlling for flood risk by incorporating a variable about whether a property is located within a floodplain does not change the negative association between property values and wetlands.

The effects of structural variables on property values have consistent estimates across the three models. Most coefficients have the

expected signs and are statistically significant. Evaluated at the average house value, our results indicate that house price increases by about \$90 per additional square foot. An additional year of age of a house lowers the estimated sales price by \$1,230 evaluated at the observed mean values. Having an additional bathroom increases estimated sales price by \$16,516. A new house sold within a year after construction lowers estimated sales price by \$7,287 (excluding the effect of age of house). Many new homes in Carteret County are sold without landscaping. Houses that are 2 or 3 years old might bring a higher price because they are likely to have complete landscaping.

Most of the neighborhood characteristics have the expected sign. Location within a municipality substantially raises property value in the study area. The results indicate that proximity to the highways and regional airports lowers property value. Proximity to these features might expose the property to greater noise, congestion, and traffic. However, proximity to railroads increased property value. Reducing the distance to Jacksonville, NC, a regional business center, increases property values, whereas the distance to New Bern was not statistically significant. The coefficient for the distance to parks has the expected sign but is not statistically significant. A higher percentage of owner-occupied property in a neighborhood increases property values. A one percentage point increase in the percentage of owner-occupied properties results in a \$483 increase in property values. Our results also suggest that commute time to work is a significant factor. Given the average commute time in our data (22 minutes), increasing the commute time by one standard deviation (3.86 minutes) results in an \$8,187 decrease in property values. Higher population density in a neighborhood is associated with higher property values, and the composition of race also has a strong effect on property values in the study area.

Conclusions

This study estimates the amenity value of wetlands to nearby residential property with data

³ Several previous studies have documented price reductions from location in a floodplain (Bin and Polasky; Harrison, Smersh, and Schwartz; MacDonald, Murdoch, and White; Shilling, Benjamin, and Sirmans). These studies generally find that location within a floodplain lowers property values from 4% to 12%.

from Carteret County, NC. The estimation results indicate in a rural setting that i) higher wetland percentage within a quarter mile of a property, ii) closer proximity to the nearest wetland, and iii) larger size of the nearest wetland are negatively related to residential property values regardless of wetland type. Our results on the amenity value of wetlands provide an interesting contrast to the earlier hedonic studies in urban areas that have generally found a positive association between proximity to wetlands and property values (Doss and Taff; Earnhart; Lupi, Graham-Tomasi, and Taff; Mahan, Polasky, and Adams). In urban areas, both open space and wetlands can be in short supply. However, Carteret County is a rural county with lots of open space and literally thousands of wetlands. There is no shortage of either open space or wetlands. Given its geographic location, Carteret County contains substantial other water resources for recreational purposes. Negative aspects of wetlands such as disease potential (e.g., mosquitoes and West Nile Virus) and limited mobility might be more pronounced. Rural landowners, therefore, might view wetlands as more of a nuisance than as an attractive (scarce) resource. Combined with the results of previous studies, our results raise the plausible hypothesis that local scarcity of an environmental resource plays a large role in determining its value. The amenity value of wetlands might depend at least as much on the characteristics of the area being considered as it does on the characteristic of the wetlands.

Although the hedonic property price method has many attractive features, such as the use of market-generated data, the application of this method to estimating the value of wetlands or other environmental features has limitations. Most importantly, the hedonic property price method provides only a limited measure of total economic benefits. The estimates in this study measure only the amenity value of proximity to wetlands as perceived by nearby residential property owners. Wetlands provide many other services to society, such as water quality improvements, biodiversity, and wildlife habitat. The value of these services might not be fully reflected in prop-

erty values if either they are not fully perceived by property owners or the services are public goods. Therefore, the estimates of value generated in a hedonic study such as this typically capture only a subset of values and will not represent the full value of the amenities provided by wetlands or other environmental resources. Because many of the ecosystem services provided by wetlands are public goods to some degree, a low or negative amenity value of wetlands in a hedonic property price study is not sufficient evidence to conclude that wetlands need not be protected. However, a negative value from a hedonic study is a clear signal that nearby property owners will not have the incentive to protect wetlands. Therefore, wetlands conservation in rural areas such as Carteret County will likely have to be made on grounds other than appeals to increased property value from environmental protection. Other studies, including combined ecological and economic studies of wetland function and the production of ecosystem service, along with studies of the value of these ecosystem services by contingent or other valuation methods, are clearly necessary to provide a more complete picture on the total economic value of wetlands.

[Received October 2003; Accepted June 2005.]

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