

Economic Valuation of Riparian Corridors and Upland Wildlife Habitat in an Urban Watershed

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In 1973, the Oregon State Legislature passed statewide land-use planning goals. These goals describe the state's policies on land use and related topics such as citizen involvement, housing, recreation, energy conservation, and natural resources. Goal 5 requires local governments to adopt programs to "protect natural resources and conserve scenic, historic, and open space resources for present and future generations" (Oregon Department of Land Conservation and Development 1996).

Metro, the directly elected regional government that includes 25 cities and parts of three counties in the Portland metropolitan area, adopted a long-range growth management plan in 1995 that included the protection of natural areas. In 2001, Metro initiated a three-step process to develop and implement a regional fish and wildlife protection program.

In the first step, Metro conducted an inventory of riparian corridors and upland wildlife habitat within its jurisdiction and categorized these areas according to their ecological values. The criteria used to evaluate riparian habitat included microclimate and shade, bank stabilization, sediment and pollution control, streamflow and water storage, woody debris and channel dynamics, and organic matter input. Upland wildlife habitat was categorized based on habitat patch size, the habitat area in the center of the patch, the distance between habitat patches (connectivity), access to water, and whether the habitat plays an important role in the overall ecosystem or is vulnerable to being lost (Metro 2005).

In total, approximately 80,000 acres were identified as regionally significant habitat, representing around 30 percent of the land within Metro's jurisdiction. Half of this land is zoned for residential uses, 20 percent for parks and open

spaces, and 14 percent for industrial uses with the remaining 16 percent zoned for rural, mixed-use or commercial uses (Metro 2005a).

The second step examined the economic, social, energy and environmental (ESEE) consequences of allowing, limiting, or prohibiting the development of regionally significant habitat. This analysis considered issues such as ecosystem values, the potential consequences on the supply of buildable land of restricting development, and intergenerational equity.

A program for protecting regionally significant habitat—the third and final step in the process—was adopted by the Metro Council in September 2005 as part of its Nature in the Neighborhood program. Metro's fish and wildlife habitat protection program combines a regulatory approach for high value riparian habitat with education, restoration and stewardship, and a willing-seller acquisition program for land that is determined to be regionally significant (Metro 2005b). Cities and counties within Metro's jurisdiction have until 2007 to adopt local programs to implement Metro's fish and wildlife protection program.

The effect of Metro's fish and wildlife habitat protection program on the sale price of single-family residential properties within its jurisdiction is unknown. This study uses the hedonic price method to examine how the quantity of upland wildlife habitat, and the quantity and quality of riparian corridors, are related to the sale price of single-family residential properties. These estimates can be used to evaluate the effects of restoration projects in the study area. These estimates, however, capture only those effects capitalized into the sale price of properties and will not reflect other use and non-use values associated with restoration projects.

Literature

While numerous studies have documented the relationship between the sale price of single-family residential properties and water quality (Wilson and Carpenter 1999) and tree canopy (Anderson and Cordell 1988, Tyrvainen and Miettinen 2000), relatively few papers have explored how property values are affected by riparian vegetation (Mooney and Eisgruber 2001, Colby and Wishart 2002) or the restoration of urban stream corridors (Streiner and Loomis 1995).

Mooney and Eisgruber (2001) examine how the assessed value of residential properties in the Mohawk Watershed in western Oregon are related to the size of treed riparian buffers. The study was motivated by a voluntary program, the Oregon Plan for Salmon and Watersheds, that was created to head off the listing of coastal salmon populations as threatened or endangered species. In addition to its focus on agriculture and industry, the program encouraged private property owners to plant riparian buffers.

The authors' estimate that a one-foot increase in a treed riparian buffer decreases a property's assessed value by 0.06 percent. In a second model, the authors categorize properties based on the size of their riparian corridor. The authors' estimate that adding a foot to a small buffer—one that is less than 30 feet wide—leads to a decline in assessed property value that is four times greater than adding another foot to a buffer that is wider than 30 feet.

Colby and Wishart's (2002) study looks at how a home's sale price is affected by its proximity to a 15 mile-long stretch of the Tanque Verde Wash and nearby riparian corridors in the northeast Tucson metropolitan area. The authors' estimate premiums of 6 percent for homes located within 0.1 miles of a riparian corridor, 3.5 percent for homes 0.3 miles from a corridor, and 2.4 percent for homes within 0.5 miles of a corridor. Riparian corridors are estimated to increase the value of vacant land by 10 to 27 percent.

Streiner and Loomis (1995) present results from a hedonic analysis of urban stream restoration projects using seven projects located in three counties in California. The authors' estimate that restoration projects that reduce flood damage and improve fish habitat increase property values by 3 to 13 percent of the mean property price in the study area.

Research conducted in Portland, Oregon includes hedonic studies by Mahan, Polasky and Adams (2000) on the size, type and proximity of wetlands and research on open spaces (Lutzenhiser and Netusil 2001), environmental zoning (Netusil 2005a), and the ownership of land on which water resources and open spaces are located (Netusil 2005b). These studies provide evidence that tree canopy and water resources are being capitalized into the sale price of properties in the study area.

Study Area and Characteristics

The study area is the part of the Fanno Creek Watershed located within the city of Portland, Oregon. Eighty-two percent of the 4,529 acres in the study area are zoned single-family residential and seven percent are classified as parks and open space (Bureau of Environmental Services 2004).

The watershed contains steep slopes and, because it is heavily developed, approximately 33 percent of the watershed is classified as impervious surfaces (Bureau of Environmental Services 2004). Twenty-three miles of open streams are in the study area with an additional five miles in culverts and pipes. Riparian corridors are described as narrow and are populated with native species such as western red cedar and swordfern and non-native species such as English ivy. Biological communities are limited, although steelhead and cutthroat trout are present in the upper part of Fanno Creek.

Between January 1, 1999 and December 31, 2001, there were 1,665 single-family residential property sales in the study area. Summary statistics on real sale price (deflated using the CPI-U, U.S. city average (Bureau of Labor Statistics 2002)), age, lot square footage, building square footage, and distance from the center of the property to the nearest stream are provided in Table 1 (see Netusil 2005a for data sources).

The ecological value of riparian corridors and upland wildlife habitat were used to place these areas into different categories with Class I representing the highest value riparian corridors and Class A the highest value upland wildlife habitat (Table 2).

In this study, 259 properties have some riparian habitat (class I, II, III) on the property with an average coverage of 46.35 percent. Three-hundred and eighty five properties have upland wildlife habitat with an average coverage of 41.90 percent.

Table 1. Summary Statistics Sales Price and Home Characteristics

	Average	Standard Deviation	Maximum	Minimum
Real Sale Price (2000 dollars)	226,476	114,143	1,685,393	58,175
Age (years)	38	21	107	0
Lot Square Footage	10,284	6,940	134,036	2,053
Building Square Footage	1,790	763	8,000	480
Distance to Nearest Stream (feet)	535.65	375.48	1,914.04	4.04

N = 1,665

Table 2. Fish and Wildlife Habitat Classification System (Adapted from Metro 2003)

Riparian/Wildlife Corridors	Upland Wildlife Habitat
<p>Class I riparian/wildlife corridors Rivers, streams, stream-associated wetlands, undeveloped floodplains, forest canopy within 100 feet of a stream, and forest canopy within 200 feet of streams with adjacent steep slopes.</p> <p>Class II riparian/wildlife corridors Rivers, streams, 50-foot area along developed streams, forest canopy or low structure vegetation within 200 feet of streams, and portions of undeveloped floodplains extending beyond 300 feet of streams.</p> <p>Class III riparian/wildlife corridors Developed floodplains and small forest canopies disassociated from streams.</p>	<p>Class A upland wildlife habitat Large forests patches, wetland areas, and large contiguous patches.</p> <p>Class B upland wildlife habitat Forest patches with low structure connector patches along streams and rivers.</p> <p>Class C upland wildlife habitat Forest patches and smaller connector patches along streams and rivers.</p>

Sixty-nine properties in the study area have a stream on the property and 223 properties were identified as having a slope. Properties can have multiple resources, for example, 122 properties have both Riparian Class I and Class II habitat. Properties can also have multiple site characteristics, for example, twenty-one properties with Riparian Class I habitat have a stream and are sloped. A more detailed breakdown of the number of properties with riparian habitat, upland wildlife habitat, slope, stream, and environmental zoning is provided in Table 3.

A variable was created to capture the quantity and quality of riparian corridors within a half mile radius of each property. Values were assigned to ten-by-ten meter cells based on whether the riparian corridor within a cell had one or more ecological functions: microclimate and shade, bank stabilization, sediment and pollution control, streamflow and water storage, woody debris and channel dynamics. For example, cells with one ecological function were assigned a

value of 1, cells with two functions were assigned a value of 2, etc. The sum of the functional values within a half mile radius of each cell was calculated; summary statistics are presented in Table 4.

Hedonic Price Method

The hedonic price method uses the price of a marketed good, such as a property, to value a characteristic of the good that is not formally traded on a market (Freeman 2003). This technique has been used to estimate the value of different types of open spaces, air and water pollution, and scenic views.

The hedonic function can be represented by: $P_i = P(Q_S, Q_N, Q_E)$ where P_i is the sale price of a property, Q_S is a vector representing the structural attributes of a property, Q_N represents neighborhood attributes, and Q_E includes environmental attributes such as regionally significant habitat on a property and the quantity and quality of riparian corridors within a half mile radius of the property.

Table 3. Goal 5 Resources and Property Characteristics

	Riparian Class I	Riparian Class II	Riparian Class III	Upland Wildlife A	Upland Wildlife B	Upland Wildlife C
Number of Properties with Characteristic	151	185	53	80	259	49
Average Percentage Coverage (Standard Deviation)	40.64% (25.24)	22.21% (21.87)	33.20% (29.45)	47.84% (31.79)	39.60% (32.89)	41.90% (28.71)
Number of Properties with Stream	58	57	0	3	14	2
Number of Properties with Slope	43	41	5	55	53	7
Number of Properties with Environmental Zoning	125	124	3	20	93	8

Table 4. Sum of Riparian Functional Score

	Average	Standard Deviation	Maximum	Minimum
Sum of Riparian Functional Values	7,150	2,707	14,315	733

A number of models were estimated; results from two models that use a linear specification are presented in this paper. Models using a semi-log functional form generated similar results. The first model looks at the relationship between sale price and the percentage of a lot with regionally significant habitat. The second is a more detailed specification that includes the percentage of different habitat types on a lot. Both models control for home characteristics, base zoning, elevation, distance to the nearest stream, and environmental zoning. Additionally, the percentage of the area within a half mile radius of the property with tree canopy, different open space types and streams is included. A variable was created to capture properties that are sloped and have a stream.

Results

The estimated coefficients for the variables that are of interest are presented in Table 5 (full results are available from the author). The percentage of a lot with a stream is statistically significant and positive in both models. The estimated coefficients for the percentage of trails and specialty parks within ½ mile of a property are significant and positive while the percentage of streams within ½ mile is significant and negative. These results are consistent with earlier studies (Netusil 2005a, 2005b).

Close proximity to a stream is captured by two variables: the percentage of a lot with a stream and the distance from the lot's center to the nearest stream. The sign and magnitude of the estimated coefficients indicate that close proximity to a stream is a desirable attribute for properties located in the study area. A one standard deviation increase in the distance from a stream is estimated to decrease a property's sale price by \$6,526 in Model I and \$6,988 in Model II. These results are consistent with the literature.

In Model I, a property's sale price is estimated to increase as the percentage of regionally significant habitat on the lot increases, but at a decreasing rate. The percentage of lot coverage that maximizes a property's sale price is estimated to be approximately 22 percent, while the average coverage for properties with these resources in the study area is over 46 percent. Upland Wildlife Habitat Type A is estimated to have a positive, but declining effect on sale price in Model II. The maximum impact on sale price is when upland wildlife habitat coverage on a property is around 38 percent. The average coverage for properties with Type A habitat in the study area is almost 48 percent.

Riparian Corridor Class I has a positive, but declining effect on sale price although the coefficients are not statistically significant. This may

Table 5. Regression Results - Estimated Coefficients and Robust Standard Errors

Variable	Model I	Model II
Percentage of Lot with Stream	2,723.17*** (783.19)	2,665.10*** (805.15)
Percentage of Lot with Regionally Significant Resources	251.67 (187.69)	-
Percentage of Lot with Regionally Significant Resources Squared	-5.64*** (2.14)	-
Percentage of Lot with Riparian Class I	-	145.56 (315.44)
Percentage of Lot with Riparian Class I Squared	-	-4.60 (3.92)
Percentage of Lot with Riparian Class II	-	-339.85*** (108.10)
Percentage of Lot with Riparian Class III	-	-339.57 (213.56)
Percentage of Lot with Upland Wildlife Habitat Type A	-	2,176.05** (912.38)
Percentage of Lot with Upland Wildlife Habitat Type A Squared	-	-28.81*** (9.66)
Percentage of Lot with Upland Wildlife Habitat Type B	-	-170.25** (72.94)
Percentage of Lot with Upland Wildlife Habitat Type C	-	-155.95 (161.70)
Sum of Riparian Functional Value within ½ mile	3.96* (2.24)	3.17 (2.39)
Distance (in feet) from Center of Property to Nearest Stream	-17.38*** (3.98)	-18.61*** (4.09)
Percentage of Tree Canopy with ½ mile	521.42 (337.98)	581.09* (348.44)
Percentage of Streams within ½ mile	-55,089.7** (22,603)	-48,435.44** (24,100)
Percentage of Specialty Parks within ½ mile	6,470.87*** (1,856)	6,432.82*** (1,807)
R2	0.7758	0.7796
Observations	1,665	1,665

*** Indicates significance at the 1% level, ** the 5% level, and * 10% level

be caused by the omission of a floodplain variable or a result of multicollinearity. Results indicate that the maximum impact on sale price is when riparian corridor coverage on a property is around 16 percent, which is much smaller than the existing 41 percent coverage for properties with Riparian I habitat in this study.

The Upland Wildlife Habitat B & C and Riparian Corridor Classes II & III coefficients are negative, although only Upland Wildlife Habitat type B and Riparian Class II are statistically significant.

The riparian score is highly correlated with the percentage of streams within ½ mile of properties. Both variables are included since percentage stream

reflects the quantity of streams and the riparian score measures the “quality” of riparian corridors. The coefficients on the riparian score variable are positive in both models, but is statistically significant only in Model I. The estimated increase in sale price from a one standard deviation increase in riparian score is \$10,720 in Model 1 and \$8,581 in Model II.

Streams within ½ mile of properties are found to decrease sale price in both models. Earlier research has shown that the ownership of land on which streams are located is an important factor with streams on private land reducing surrounding property values and streams on public land increasing surrounding property values (Netusil 2005b). The study area has a relatively large percentage of privately owned land, so the estimated coefficients are consistent with earlier research.

Conclusion

The empirical analysis shows that habitat identified by the regional government as “regionally significant” is being capitalized into the sale price of single-family residential properties in the Fanno Creek watershed in Portland, Oregon. Property owners are placing a premium on lots with habitat providing the highest ecological values (Upland Wildlife Type A, Riparian Class I) and a discount on lots with lower-valued habitat (Upland Wildlife Types B and C; Riparian Class II and III). The amount and quality of riparian corridors within ½ mile of properties is also being capitalized into the sale price of properties.

An interesting result is that the amount of regionally significant habitat in Model 1, and the amount of Upland Wildlife Habitat Type A and Riparian Habitat Class I in Model 2 that maximizes the sale price of a property is less than the existing coverage. For Riparian Habitat Class I, current coverage is more than two and one-half times greater than the coverage that is estimated to maximize a property’s sale price. Thus, efforts by the regional government to preserve existing resources may run counter to the incentives of private landowners.

Metro’s fish and wildlife habitat protection program will regulate development on properties with Riparian Class I habitat and will use education, restoration and stewardship, and a willing-seller acquisition program to protect and restore properties

with Riparian Class II and III habitat and upland wildlife habitat. Metro’s program, to the extent that it focuses on projects that are valued by private landowners, will likely increase the sale price of properties in the study area. Many of the benefits from preserving these resources are, however, public goods such as improved air and water quality, reductions in the severity and frequency of flooding, and carbon sequestration and are unlikely to be fully capitalized into the sale price of properties.

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