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VALUING WATER RIGHTS IN DOUGLAS COUNTY, OREGON, USING THE HEDONIC PRICE METHOD[1]

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ABSTRACT: This paper uses the hedonic price method to estimate the value of an acre-foot of irrigation water in Douglas County, Oregon. The analysis uses detailed information from 113 arms-length transactions of farmland for 2000 and 2001. The estimated willingness-to-accept of $261 to sell an acre-foot of irrigation water is consistent with other studies and recent transactions in the study area. Estimates for the value of leasing water are provided using a range of discount rates and leasing periods.

(KEY TERMS: agriculture; economics; hedonic price method; instream flow; water right; water value.)

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INTRODUCTION

Inadequate streamflows, which contribute to higher water temperatures and increased pollution levels, have been identified throughout the Pacific Northwest as a factor in the decline of anadromous and resident fish populations. There are many reasons for decreased streamflows including municipal water use, variation in yearly precipitation, water held in reservoirs, and diversions for irrigation (Oregon Department of Fish and Wildlife, 2004). As government agencies and conservation organizations have worked to improve conditions for anadromous and resident fish, there has been an interest in finding cost-effective ways to increase flows.

Higher streamflows can be achieved using water saving technologies and by purchasing or leasing water rights. While the incorporation of water saving technologies may decrease the amount of water taken out of a stream by one user, these technologies do not guarantee that streamflows will increase because landowners with junior water rights may still withdraw water.

Because water rights can be purchased or leased in Oregon, instream flows can be enhanced by purchasing or leasing water rights and converting them to instream use. Many groups purchase and lease water rights in Oregon for this purpose including the Bonneville Power Administration, Oregon Water Trust, Deschutes Resource Conservancy, and the National Fish and Wildlife Foundation. As market-based solutions to low instream flows become more common, the need to estimate a value for water has arisen.

This paper contributes to the valuation of water rights by using the hedonic price method to estimate the minimum payment a seller would be willing-to-accept for the sale or lease of a water right in Douglas County, Oregon. The values estimated in this paper

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are derived from 113 arms-length transactions of farmland between 2000 and 2001. The use value of water for farms is estimated, that is, the amount that having a water right increases a farmer's profit or, alternatively, the minimum amount a farmer would be willing-to-accept to lease or sell a water right. A willingness-to-pay measure would incorporate nonuse values such as the values associated with threatened and endangered species (Loomis and White, 1996) and use values associated with increased recreation (Loomis, 2002; Table 8.2 in Shaw, 2005; Young, 2005). These values are beyond the scope of this paper.

The paper is organized as follows. The second section provides a detailed overview of the study area. This is followed by a review of relevant literature and a description of the hedonic price method. The final sections include a description of the data used in the analysis, study results, and conclusions and policy implications.

STUDY AREA

Douglas County, which is located in southwest Oregon, encompasses more than 3.2 million acres (Figure 1). Approximately 2.8 million acres of the Umpqua River Basin are located in Douglas County with 74% of land classified as forest, 16% as agriculture – primarily grazing and permanent hay fields – and 10% as urban and other uses (Umpqua Basin Local Advisory Committee and Oregon Department of Agriculture, 2003).

The Umpqua's headwaters begin in the Cascade mountain range and flow more than 100 miles before reaching the Pacific Ocean. Water rights for the North and South Umpqua rivers and their tributaries are heavily subscribed resulting in low instream flows for some streams during the summer months. Irrigation rights are no longer being granted for much of the basin including all of the South Umpqua and its tributaries. Many tributaries are included on the Clean Water Act 303 (d) list.

Spring and fall Chinook, coho, chum, summer and winter steelhead, sea-run cutthroat and resident cutthroat and resident rainbow trout are found in the basin (Oregon Water Trust, 2004). Coho are listed as threatened and coastal cutthroat are listed as endangered under the Endangered Species Act; Umpqua summer and winter steelhead are candidates for listing (NOAA, 2004). Recovery plans emphasize the importance of improving water quantity and enhan-

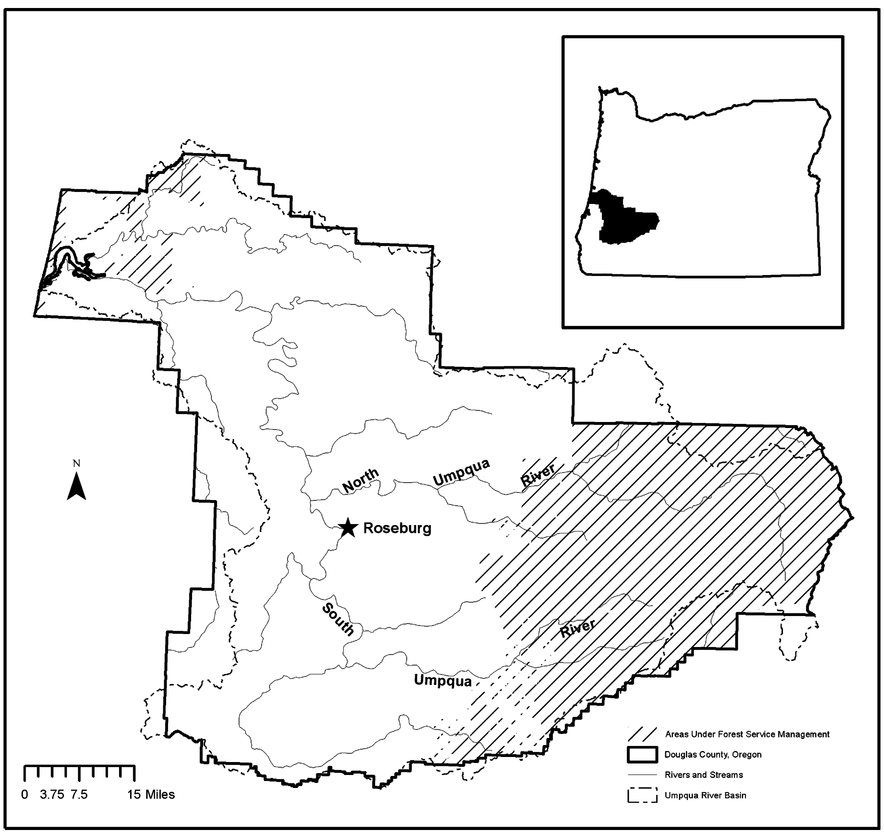

FIGURE 1. Douglas County, Oregon.

cing streamflows for aquatic habitat, fisheries, and ecological systems.

In 1987, the Oregon legislature recognized instream flows as a beneficial use. Therefore, the purchase or lease of a senior water right can provide greater certainty about streamflows as instream use is equivalent to other water rights under the doctrine of prior appropriation. In times of low flows, however, certain beneficial uses receive preferential treatment. Human consumption, livestock consumption, and irrigation of non-commercial gardens that do not exceed one-half acre are given preferential consideration in the Umpqua River Basin over other beneficial uses (Oregon Administrative Rules, Umpqua Basin Program, 2005).

LITERATURE

The value of water has been estimated using several techniques including direct observation of water rights markets, the hedonic price method, controlled field experiments, simulation modeling, farm crop budget analysis, and linear programming. Additional techniques for valuing water are discussed in Young (2005).

Crouter (1987) explores the possibility of separate markets for land and water in Weld Country, Colorado. Crouter hypothesizes that if the value for land and water rights can be estimated separately using the hedonic price method, and if water rights can be repackaged linearly, then a separate water market for land and water exists. Although Weld County has no legal restrictions preventing the formation of a separate market for land and water, Crouter was unable to establish their existence.

Faux and Perry (1999) use the hedonic price method to estimate the value of a water right for an acre-foot of water in Malheur County, Oregon. Because Malheur County is dry, the value of non-irrigated land is thought to be constant regardless of the soil quality. Therefore, Faux and Perry are able to estimate the value of irrigation water by subtracting the estimated value of non-irrigated land from the estimated value of irrigated land. The value of water per acre-foot is estimated to be $147 for the least fertile land and $729 for the most fertile land.

Farm crop budget analyzes use agricultural production budgets to estimate the value of water. The maximum amount a farmer would be willing-to-pay for water is estimated by taking the difference between total crop revenue and non-water input costs. This technique has been applied to wheat, grain sorghum, corn, cotton, soybeans, and rice (Gibbons, 1986).

Turner and Perry (1997) use the linear programming technique to estimate the price of irrigation water in the Deschutes Basin, Oregon. The authors' estimate that water needed to restore habitat in the Deschutes River could be purchased from the Central Oregon Irrigation District for less than $70 an acre-foot.

Jaeger (2004) estimates the long-run value of irrigation water for the Klamath Basin by comparing the difference in the value of irrigated and non-irrigated land. He finds that, on average, irrigation water adds about $1,000 per acre to the value of land. This translates into an annual per-acre value, using a 6% discount rate, of $121 for the most productive soil class to $9 for the least productive soil class with a weighted average across all soil classes of $60.

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 open space proximity (Lutzenhiser and Netusil, 2001; McConnell and Walls, 2005), improvements in air and water quality (Chattopadhyay, 1999; Leggett and Bockstael, 2000), and scenic views (Kulshreshtha and Gillies, 1993; Benson *et al*, 1998).

We can imagine two farms that are identical except that one has a property right for irrigation water and the other does not. The difference in the sale price of these farms provides an estimate of the value of irrigation water. In reality, the characteristics of farms vary dramatically, but the hedonic price method, a statistical technique, allows us to hold all other factors constant and to estimate the value of the property characteristic of interest, in our case, the value of irrigation water.

The hedonic function for farmland can be represented by:

$$P_{\mathrm{i}} = P(Q_{\mathrm{S}}, Q_{\mathrm{A}}, Q_{\mathrm{IMP}}, Q_{\mathrm{WR}}) \quad (1)$$

where P_{i} is the sale price of a property, Q_s is the vector representing soil quality, Q_A represents total acreage, Q_{IMP} is residential and non-residential improvements per-acre, and Q_{WR} is the water right.

The functional form for the hedonic price model is uncertain (Freeman, 2003), so a Box-Cox model was estimated to inform our decision of the most appropriate functional form. The results of this analysis suggested a semi-log model. Also, information on structural attributes is not recorded by the Douglas County Assessor's Office and had to by proxied for by the assessed value of residential and non-residential improvements. Econometric theory suggests that simpler functional forms such as the semi-log functional form produce better results when information is missing (Cropper *et al*, 1988).

Two models were estimated. Model 1, shown in Equation (2), incorporates total acres using a quadratic specification, while Model 2 uses the natural log of total acres (Equation (3))

$$\begin{aligned}\ln \text{ price } &= \beta_0 + \beta_1 Q_{\mathrm{S}} + \beta_2 Q_{\mathrm{A}} + \beta_3 Q_{\mathrm{A}} SQ + \beta_4 Q_{\mathrm{IMP}} \\ &+ \beta_5 Q_{\mathrm{WR}} + \beta_6 Q_{\mathrm{WR}} Q_{\mathrm{A}} + \ldots + u_{\mathrm{i}}\end{aligned} \quad (2)$$

$$\begin{aligned}\ln \text{ price } &= \alpha_0 + \alpha_1 Q_{\mathrm{S}} + \alpha_2 \ln Q_{\mathrm{A}} + \alpha_3 Q_{\mathrm{IMP}} + \alpha_4 Q_{\mathrm{WR}} \\ &+ \alpha_4 Q_{\mathrm{WR}} Q_{\mathrm{A}} + \ldots + u_{\mathrm{i}}\end{aligned} \quad (3)$$

where ln price is the natural log of the sale price per acre, $Q_{A}SQ$ is total acreage squared, $\ln Q_{A}$ is the natural log of total acreage, $Q_{WR}Q_{A}$ is a interactive variable for total acreage and a water right, and u_i is the error term. Table 1 provides a complete list of explanatory variables used in the regressions.

DATASET

Variables that reflect a property's characteristics and the productivity of the land on which the structure is located were obtained from the Douglas County, Oregon Assessor's "Farm Sales Report" (2000, 2001). Information on the physical location of the property was derived using the Douglas County, Oregon Assessor's website (2002). The dataset, after cleaning for missing values and checking for arms-length transactions, includes 195 of the 210 sales. Of the 195 sales, 113 were in the property classes designated for farmland.

The dependent variable is the natural log of sale price per acre. We follow Parsons (1990) suggestion that variables should be weighted by lot size to avoid biased estimators – an approach also used by Faux and Perry (1999). Explanatory variables and their hypothesized relationship to the dependent variable are listed in Table 1.

A hedonic price model typically includes detailed information about the structural attributes of residential and non-residential buildings and the age, type, and quantity of trees. This information is not collected by the Douglas County Assessor's Office, so the assessed value of residential buildings, non-residential buildings, and timber are used in our models.

The percentage of land in each land class was calculated for each property. Land classes, which capture soil productivity, are preferred to a condensed soil variable such as a soil quality index (Faux and Perry, 1999). The model also includes three dummy

TABLE 1. Explanatory Variables.

Variable Name	Description	Expected Sign
RES_IMPROVE	Assessed value of residential buildings divided by total acreage	Positive
NONRES_IMPROVE	Assessed value of non-residential improvements divided by total acreage	Positive
TIMBER	Assessed value of timber divided by total acreage	Positive
ACRES	Total acreage	Positive
ACRES2	Total acreage squared	Negative
WATER	Dummy variable = 1 if land has a water right	Positive
ACRES*WATER	Interactive variable: total acreage and irrigation	Negative
LAND1	Acres of land class k2 divided by total acreage	Positive
LAND2	Acres of land class k3 divided by total acreage	Positive
LAND3	Acres of land class b2 divided by total acreage	Positive
LAND4	Acres of land class b3 divided by total acreage	Positive
LAND5	Acres of land class b5 divided by total acreage	Positive
LAND6	Acres of land class h5 divided by total acreage	Positive
LAND7	Acres of land class h7 divided by total acreage	Positive
LAND8	Acres of land class ff divided by total acreage	Positive
PROP_A	Dummy variable = 1 if property has no water or designated forestland	Uncertain
PROP_B	Dummy variable = 1 if water is on the property	Uncertain
PROP_C	Dummy variable = 0 if the property has some designated forestland	Excluded
MILES	Distance from property to nearest county seat (Roseburg) (miles)	Negative

TABLE 2. Summary Statistics.

	Observations	Mean	Standard Deviation	Minimum	Maximum
Sale Price Per Acre					
Full Dataset	113	$7,001	$7,952	$414	$37,238
Properties with Water Rights	19	$6,919	$8,194	$414	$34,335
Total Acres					
Full Dataset	113	105	131.33	4.05	808.13
Properties with Water Rights	19	160	200.56	4.05	808.13

variables representing 31 property classes. These property classes help identify properties with special zoning restrictions or taxes. Many classes had only one or two observations so similar classes were grouped together.

The presence of a water right is included as a dummy variable (WATER). A review of water rights records determined that the 19 irrigated properties in this study are each allotted 2.5 acre-feet a year. We assume that the entire allocation is used but recognize that overuse will bias the value per acre-foot upward.

Seniority is not included in the model for two reasons. First, relative seniority is hard to identify. For example, a water right from 1950 may be the senior right on one tributary, while a water right from 1940 may be a junior right on a different tributary. Second, the sample contains only 19 irrigated properties. This limits our ability to create dummy variables to capture properties located on specific tributaries.

Finally, an interactive variable (ACRES*WATER) was generated to capture the interaction between total acreage and irrigation. Summary statistics are provided in Table 2.

TABLE 3. Regression Results: Dependent Variable Is the Natural Log of Sale Price per Acre (*t*-Statistics in Parentheses).

	Model 1	Model 2
RES_IMPROVE	0.00008 (5.10)	0.00008 (5.34)
NONRES_IMPROVE	0.00011 (9.82)	0.00009 (7.94)
TIMBER	0.00008 (0.61)	0.00007 (0.57)
ACRES	−0.006 (−6.63)	
ACRES2	6.96 e−6 (5.16)	
LNACRES		−0.3401 (−6.09)
WATER	0.2345 (1.66)	0.2535 (1.83)
ACRES*WATER	−0.00163 (−2.48)	−0.00100 (−2.03)
LAND1	0.4180 (1.59)	0.3645 (1.33)
LAND2	0.2615 (0.92)	0.3385 (1.17)
LAND3	0.1544 (0.62)	0.2177 (0.86)
LAND4	−0.0696 (−0.27)	−0.0041 (−0.02)
LAND5	0.1447 (−0.47)	0.2063 (0.66)
LAND6	−0.2183 (−0.96)	−0.1842 (−0.08)
LAND7	−0.0804 (−0.23)	−0.0337 (−0.09)
PROP_A	0.1214 (0.88)	0.0278 (0.19)
PROP_B	0.2994 (1.64)	0.1752 (0.94)
MILES	−0.00132 (−0.48)	−0.00099 (−0.35)
Constant	8.1729 (43.58)	9.0857 (30.25)
R-squared	0.8879	0.8800
Number of Observations	113	113

RESULTS

Two models were estimated to explain the sale price per acre of properties in the study area. Model 1 incorporates total acres using a quadratic specification, while Model 2 uses the natural log of total acres. Full results are reported in Table 3.

The variables representing the assessed value of residential and nonresidential improvements are positive and statistically significant. The assessed timber value per acre is positive, as expected, but not statistically significant in either model. The coefficients on these variables are interpreted as the percent increase in the mean sale price from a $1 increase in assessed value. For example, a $1,000 increase in the assessed value of non-residential improvements is estimated to increase a property's sale price per-acre by 11% or $770. This finding means that non-residential improvements are overvalued as the estimated increase in sale price per-acre is less than the increase in assessed value. Residential buildings and timber are also overvalued.

Total acreage is significantly negative and total acreage squared is significantly positive in Model 1. These results are counter to initial expectations, but can be explained by assuming that the land on which a residence is located is the most expensive piece of land. Given this assumption, as total acreage increases, the average sale price per acre decreases, but at a diminishing rate. The estimated coefficient on the natural log of acres in Model 2 indicates that the sale price per acre increases as acreage increases, but at a diminishing rate.

The coefficients on the property class dummies (PROP_A and PROP_B) are positive, but only the coefficient on PROP_B in Model 1 is significant at conventional levels. The PROP_A property class includes farmland with no water or designated forestland. Properties in this class are subject to fewer restrictions and tax considerations than other categories. Properties that intersect water are included in the PROP_B category. The presence of water on a property may reduce the amount of land available for farming. Additionally, these farms are subject to regulations that may increase the cost of farming because of their location in the Umpqua Basin Agricultural Water Quality Management Area. The presence of water may, however, increase a property's sale price if water is valued as an amenity. The estimated coefficients in both models for the PROP_B variable are positive and large in magnitude although the estimated coefficient is only significant in Model 1.

We were not able to determine if the properties in our study are zoned for exclusive farm use or if portions of the property can be developed. Faux and Perry (1999) find that the ability to add a residential building to a plot of land zoned for farming increases the sale price of the land by around $6,000.

The soil class variables are not statistically significant at conventional levels. The null hypothesis that all land classes are equal to each other is rejected for Model 1 at the 5% level [$F(6,95) = 2.22$] but cannot be rejected for Model 2 [$F(6,95) = 0.90$].

The dummy variable for irrigation (WATER) is positive and statistically significant. This coefficient is interpreted as the mean effect of irrigation water on a property's sale price. The presence of a water right is estimated to increase the sale price per-acre of property by over 26% in Model 1 and over 30% in Model 2.

The interaction variable for acres and irrigation (ACRES*WATER) is negative and significant in both models indicating that irrigation becomes less valuable on a per-acre basis as acreage increases. There are two explanations for this coefficient. First, the dummy variable representing water rights indicates that the property has a water right, but it does not mean that water is available for the entire property. Because land without a water right is less valuable then land with a water right, additional non-irrigated land decreases the expected sale price per-acre. Another explanation is that water rights holders with smaller allocations may use the right more efficiently, that is, the marginal product of a water right may decrease as more rights are obtained.

ESTIMATING A PRICE FOR IRRIGATION WATER

The estimated willingness-to-accept for an acre-foot of water is based on two coefficients: the irrigation dummy variable (WATER) and the acres and irrigation interactive variable (ACRES*WATER). Model 1 provides a slightly better fit than Model 2, so the estimated values are derived using the results from Model 1.

The estimated coefficient on the WATER variable means that a property with a water right is estimated to sell for 26.42% more than a property without a water right.[3] Multiplying this percentage increase by the average sale price per acre for all properties in the dataset ($7,001; Table 2) gives an estimated increase in sale price per acre from a water right of $1,850. Because the irrigated properties in our study are allotted 2.5 acre-feet a year, the value of an acre-foot of irrigation water, using just the estimated coefficient on the WATER variable, is $740.

This estimate must be combined with the effect from the interaction variable (ACRES*WATER) to determine the overall value of an acre-foot of water. The average size of properties in the dataset is 105 acres. Multiplying this value by the estimated coefficient on the ACRES*WATER variable and the mean sale price per-acre ($7,001) gives the value of a water right of –$1,198 or –$479 per acre-foot per year. Combining these two effects give a value of $261 for one acre-foot of water.[4] These calculations are illustrated in Eq. (4):

$$\text{Estimated value of one acre} - \text{foot of water} = \left(\frac{(\beta_5^*) * (\text{Average Sale Price per Acre})}{2.5}\right) + \left(\frac{(\beta_6^*) * (\text{Average Farm Size}) * (\text{Average Sale Price per Acre})}{2.5}\right) \quad (4)$$

[3]Model 1 is a semi-log model, so the exact estimated growth rate in sale price per acre equals $e^{\beta_5^*} - 1$. Where β_5^* is the estimated coefficient on the WATER variable.

[4]This estimate should be interpreted as an average value during the time period of our study (2000-01).

where β_5^* is the estimated coefficient on the variable WATER and β_6^* is the estimated coefficient on the ACRES*WATER interactive variable.

Many organizations are interested in short-term leases that will help increase streamflows in emergency situations. Thus 1, 3, and 5-year leases are common. Discount rates ranging from 2 to 10% were used to calculate the willingness-to-accept for a 1-year lease. A discount rate can be thought of as a reverse interest rate. A water rights holder will be paid up front for a lease. The lessor can then invest this money over the period of the lease with the expected return equal to the discount rate.

Table 4 displays the estimated price a farmer would be willing-to-accept for a 1-year lease of 1 acre-foot of water for discount rates ranging from 2 to 10%. Estimated values for an acre-foot of water range from $5.22 to $26.1, depending on the discount rate used.

Table 5 shows the willingness-to-accept for an acre-foot of water for contract lengths of 3-20 years and discount rates of 2-10%. Values range from a low of $15.05 for a 3-year lease evaluated using a 2% discount rate to $222.22 for a 20-year lease at a 10% discount rate.

TABLE 4. One-Year Lease.

Discount Rate (%)	Price per Acre-Foot
2	$5.22
5	$13.05
6	$15.66
7	$18.27
10	$26.10

TABLE 5. Multiple Time Frames and Discount Rates (Price per Acre-Foot).

Discount Rate (%)	3 Years	5 Years	10 Years	20 Years
2	$15.05	$24.60	$46.89	$85.35
5	$35.54	$56.49	$100.77	$162.63
6	$41.86	$65.96	$115.26	$179.62
7	$47.94	$74.91	$128.33	$193.55
10	$64.91	$98.91	$1160.38	$222.22

CONCLUSIONS AND POLICY IMPLICATIONS

Accurate valuation of water rights is essential because it helps us to understand the tradeoffs among water-using sectors. This issue is especially important in areas like Douglas County, Oregon where conflicts between agricultural and environmental uses of water exist. Market-based solutions for increasing streamflows such as leasing or purchasing water rights creates an opportunity to resolve these conflicts.

This paper has demonstrated that the hedonic price method can be used to estimate the willingness-to-accept of a water rights owner to sell or lease a water right. These estimates, which are specific to the study area, can provide a useful baseline for negotiating a water rights transfer. However, market-based solutions require the organization purchasing the water right to estimate its willingness-to-pay. This value, which may include use and nonuse benefits, is not estimated in this paper. However, if it exceeds a seller's willingness-to accept, then welfare gains are possible from a reallocation provided transaction costs are low.

The estimated willingness-to-accept for the purchase of an acre-foot of water in Douglas County, Oregon, is $261, which is very close to the reported average price per acre-foot of $243 (1999 dollars) for purchases in Oregon (Loomis *et al*, 2003). The willingness-to-accept for leasing is estimated using multiple discount rates and time horizons. The Office of Management and Budget (Office of Management and Budget, 1992) suggests using a real discount rate of 7% which gives a range of lease values per acre-foot of approximately $19 for a 1-year lease to approximately $194 for a 20-year lease.

Few water rights transactions have taken place in the Umpqua Basin, Oregon. The most recent lease, which was negotiated by the Oregon Water Trust, occurred in the summer of 2003. Oregon Water Trust paid $85 per-acre foot of water for a 5-year lease for one of the oldest water rights on the South Umpqua (Parrett, 2005). This negotiated amount is consistent with the results of this study assuming a 7% discount rate.

A challenge for organizations interested in the value of water is that estimates such as those provided in this study may have limited transferability to other study areas. However, this paper has demonstrated that it is possible to generate estimates for negotiating the sale or lease of water rights using standard econometric techniques and data available from most counties.

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LITERATURE CITED

Benson, E.D., J.L. Hansen, A.L. Schwartz Jr, and G.T. Smersh, 1998. Pricing Residential Amenities: The Value of a View. *Journal of Real Estate Finance and Economics* 16(1):55-73.

Chattopadhyay, S., 1999. Estimating the Demand for Air Quality: New Evidence Based on the Chicago Housing Market. *Land Economics* 75(1):22-38.

Cropper, M., L.B. Deck, and K.E. McConnell, 1988. On the Choice of Functional Form for the Hedonic Price Function. *Review of Economics and Statistics* 70(4):668-675.

Crouter, J., 1987. Hedonic Estimation Applied to a Water Rights Market. *Land Economics* 63(3):259-271.

Douglas County, Oregon Assessment & Taxation, 2000, 2001. *Farm Sales Report*. Douglas County, Oregon Assessment & Taxation.

Douglas County, Oregon Assessor Information, 2002. Assessment Information. http://www.co.douglas.or.us/puboaa/default.asp. Accessed February 5, 2003.

Faux, J. and G.M. Perry, 1999. Estimating Irrigation Water Value Using Hedonic Price Analysis: A Case Study in Malheur County, Oregon. *Land Economics* 75(3):440-452.

Freeman, M.A. III, 2003. *The Measurement of Environmental and Resource Values: Theory and Methods*. Resources for the Future, Washington, D.C.

Gibbons, D.C., 1986. *The Economic Value of Water*. Resources for the Future, Washington, D.C.

Jaeger, W.K., 2004. Conflicts over Water in the Upper Klamath Basin and the Potential Role for Market-Based Allocations. *Journal of Agricultural and Resource Economics* 29(2):167-184.

Kulshreshtha, S.N. and J.A. Gillies, 1993. "Economic Evaluation of Aesthetic Amenities: A Case Study of River View." *Water Resources Bulletin* 29(2):257-66.

Leggett, C.G. and N.E. Bockstael, 2000. "Evidence on the Effects of Water Quality on Residential Land Prices". *Journal of Environmental Economics and Management* 39:121-44.

Loomis, J., 2002. Quantifying Recreation Use Values from Removing Dams and Restoring Free-Flowing Rivers: A Contingent Behavior Travel Cost Demand Model for the Lower Snake River. *Water Resources Research* 38(6):1-8.

Loomis, J.B. and D.S. White, 1996. Economic Values of Increasingly Rare and Endangered Fish. *Fisheries* 21(November):6-10.

Loomis, J.B., K. Quattlebaum, T.C. Brown, and S.J. Alexander, 2003. Expanding Institutional Arrangements for Acquiring Water for Environmental Purposes: Transactions Evidence for the Western United States. *Water Resources Development* 19(1):21-28.

Lutzenhiser, M. and N.R. Netusil, 2001. The Effect of Open Spaces on a Home's Sale Price. *Contemporary Economic Policy* 19(July):291-98.

McConnell, V. and M. Walls, 2005. *The Value of Open Space: Evidence from Studies of Nonmarket Benefits*. Resources for the Future, Washington, D.C.

NOAA, 2004. Protected Resources: Anadromous and Marine Fishes. http://www.nmfs.noaa.gov/pr/species/fish/. Accessed January 12, 2004.

Office of Management and Budget, 1992. Circular No A-94, Revised Transmittal Memo No. 64 (October 29).

Oregon Administrative Rules, Umpqua Basin Program, 2005. Water Resources Department, Division 516. http://www.arcweb.sos.state.or.us/rules/OARS_600/OAR_690/690_516.html. Accessed June 26, 2005.

Oregon Department of Fish and Wildlife, 2004. Habitat: Conservation Summaries for Strategy Habitat. http://www.dfw.state.or.us/conservationstrategy/document_pdf/b-habitat.pdf. Accessed January 6, 2006.

Oregon Water Trust, 2004. Priority Basins: Umpqua River Basin. http://www.owt.org/. Accessed January, 12 2004.

Parrett, S., 2005. E-mail communication, July 26.

Parsons, G.R., 1990. Hedonic Prices and Public Goods: An Argument for Weighting Locational Attributes in Hedonic Regressions by Lot Size. *Journal of Urban Economics* 27(3):308-321.

Shaw, W.D., 2005. *Water Resource Economics and Policy: An Introduction*. Edward Elgar, Northampton, Massachusetts.

Turner, B. and G.M. Perry, 1997. Agriculture to Instream Water Transfers Under Uncertain Water Availability: A Case Study of the Deschutes River, Oregon. *Journal of Agricultural and Resource Economics* 22(2):208-221.

Umpqua Basin Local Advisory Committee and Oregon Department of Agriculture, 2003. Umpqua Basin Agricultural Water Quality Management Area Plan (October 16). http://www.egov.oregon.gov/ODA/NRD/docs/pdf/plans/umpq_2003_fnlpln.pdf. Accessed May 6, 2005.

Young, R.A., 2005. *Determining the Economic Value of Water: Concepts and Methods*. Resources for the Future, Washington, D.C.