Journal of Agricultural and Applied Economics, 37,1(April 2005):115–130

Estimating the Cost of Preserving Private Lands in Florida: An Hedonic Analysis

Sherry L. Larkin, Janaki R. Alavalapati, and Ram K. Shrestha

Florida's open-space land-acquisition program is one of most aggressive in the country, with $3.7 billion paid for 3.8 million acres since 1972. Using data from the Conservation and Recreational Lands (CARL) program, hedonic analyses found that acquiring private lands with valuable natural resources, habitat for rare species, and important historical sites for public preservation is more costly. Development potential and pressure also increased acquisition costs. The presence of additional endangered natural elements and needing to contract with additional landowners, however, were found to decrease the cost. Results provide a basis for landowners and land-acquisition agencies to negotiate.

Key Words: development pressure, Florida Forever, hedonic prices, implicit land values, land conversion, Preservation 2000

JEL Classification: Q24

Loss of rural farm and forestlands in the face of urban sprawl is a growing concern in the United States. This concern is, perhaps, more serious in Florida because it has the largest net domestic migration in the nation (U.S. Census Bureau). In addition, population growth in Florida during the 1990s (23.5%) and population density (296.4 per square mile) are both well above the national averages of 13.1% and 79.6 per square mile, respectively (U.S. Census Bureau). As human populations expand, water resources can become strained or polluted, crucial wildlife habitats may be threatened, and sensitive ecosystems may become fragmented. One method of limiting urban development, conserving open space, and ensuring ecosystem services is by purchasing private lands.

In Florida, a statewide public land-acquisition program was established by the Florida Legislature in 1972. This program focused on the purchase of environmentally endangered lands and continued through 1978, when it was expanded to include conservation lands. The revised program, the Conservation and Recreational Lands (CARL) program, continues today. Lands are acquired under the CARL program for conservation and protection of open spaces, unique natural areas, endangered species, unusual geologic features, wetlands, and historical sites. Since 1990, the CARL program has funded the purchase of over one million acres. By comparison, the Nature Con-

Sherry L. Larkin is assistant professor, Department of Food and Resource Economics, and Janaki R. Alavalapati is associate professor, School of Forest Resources and Conservation at the University of Florida, Gainesville, FL. Ram K. Shrestha is economist, Centers for Disease Control and Prevention, Atlanta, GA.

The authors would like to acknowledge the assistance of Jennie Varela, Research Intern, Institute of Food and Agricultural Sciences, University of Florida, and helpful comments by Mark Glissan, Florida Department of Environmental Protection. This research was supported by the Florida Agricultural Experiment Station and was approved for publication as Journal Series No. N-09009.

servancy has protected 15 million acres nationwide since the 1950s. In 2000, funding for the CARL program was extended until 2010.

The economic value of environmentally sensitive lands and open spaces is difficult to quantify because, in most cases, no active market or comparable sales records are available. Even if such data were available, the private values may not incorporate the public value of the land (Loomis, Rameker, and Seidl). However, the opportunity of cost of preserving environmentally sensitive lands and the effect of land attributes and other environmental features on the cost of preservation can be determined using a hedonic analysis. To date, hedonic price analyses of open-space lands have been conducted using data from individual transactions of undeveloped or nearby lands (e.g., agricultural lands or residential home sales) and with aggregated data from the census (e.g., at the county level) (Mendelsohn, Nordhaus, and Shaw; Plantinga and Miller). This technique estimates the implicit value of land attributes important for farming, environmental amenities, aesthetics, and recreation (Espey and Owusu-Edusei; Irwin; Lansford and Jones; Loomis, Rameker, and Seidl; Mahan, Polasky, and Adams; Nickerson and Lynch; Plantinga and Miller; Poor et al.; Tyrväinen and Miettinen). Many of these studies also estimated the implicit price associated with pressure to develop the land (Lansford and Jones; Mahan, Polasky, and Adams; Nickerson and Lynch; Plantinga and Miller; Tyrväinen and Miettinen). In general, findings have revealed that the type and size of open space are important determinants of the price paid for the land.

Despite the successful application of the hedonic technique to determine values for open-space environmental amenities based on sales of agricultural lands or nearby residential homes, there is little empirical investigation on the cost of public preservation of private lands. The recent study by Loomis, Rameker, and Seidl is an exception; the authors used supply-and-demand factors to explain prices paid for public lands in Colorado. Given the increase in public acquisition of private lands through ongoing government and nongovernment land-purchase programs and the availability of transactions data, hedonic valuation techniques can be applied to estimate the cost of preservation. These estimates can provide important insights on the value of environmental attributes directly as opposed to valuations that have been capitalized only in nearby land sales. Thus, although studies have shown that proximity to open space increases prices of nearby lands, few studies have estimated the effect of open-space land attributes on the cost of preserving open spaces. This is significant because implicit prices of nearby agricultural and forestry lands may not reflect the public cost of preservation of open spaces because of the variation in their size and attributes.

Our study attempts to add to the literature on the cost of public-land preservation with data on lands purchased by the State of Florida through the CARL program. Whether the natural attribute and conservation objectives of the state are systematically reflected in previous expenditures for lands under the CARL program is unknown. If hedonic analyses can reveal the implicit prices of specific land attributes, results could provide a credible alternative to traditional land-valuation methods used to obtain an estimate of a parcel's value. This tool would be useful to owners of diverse lands who are interested in selling land and to local public officials or land-trust agencies in the market to purchase lands for preservation. Moreover, the estimated implicit prices of natural land attributes and pressures to convert the open-space lands to urban uses will reflect the shadow value of preservation as opposed to the value inferred from nearby residential or agricultural uses. Given the magnitude of the CARL program and the diversity of lands that have been purchased for preservation, restoration, and recreation by the State of Florida, the results could provide a basis for a cost-transfer analysis to assess similar areas.

The CARL Program

The Conservation and Recreational Lands (CARL) program is the single largest and longest running state land-purchase program in

Table 1. Priority Criteria (PC) for Comparing the Characteristics of each CARL Project Area

Description of Criteria
1. A significant portion of the land in the project is in imminent danger of
a. development
b. loss of its significant natural attributes, or
c. subdivision, which will result in multiple ownership and make acquisition of the project more costly or less likely to be accomplished.
2. Compelling evidence exists that
a. the land is likely to be developed during the next 12 months or
b. appraisals made during the last 5 years indicate an escalation in land value that exceeds the average rate of interest likely to be paid on the bonds.
3. A significant portion of the land in the project serves
a. to protect or recharge groundwater,
b. to protect other valuable natural resources, or
c. to provide space for natural resource-based recreation.
4. The project can be purchased at 80% of appraised value or less.
5. A significant portion of the land in the project serves as habitat for endangered, threatened, or rare species or serves to protect natural communities that are listed by the FNAI[a] as critically imperiled or rare.
6. A significant portion of the land serves to preserve important archeological or historical sites.

[a] Florida Natural Areas Inventory (FNAI) has global (G) and state (S) rankings from 1 to 5 that reflect the level of importance of the area in terms of the inventory of threatened and endangered species (Florida Department of Environmental Protection 2001b). Lower numbers indicate higher importance.

Florida and perhaps the United States (Glissan, Florida Department of Environmental Protection, personal communication). Established by the Florida Legislature in 1979, the main purpose of the CARL program is "to conserve or restore environmentally unique ecosystems, landscapes, and forests, that are necessary to enhance or protect surface water, ground water, marine resources, sensitive ecosystems, and wildlife habitats" (Florida Statute §259.032(3)). The CARL program receives the largest share of legislatively allocated state conservation funds. Beginning in 1990, approximately $150 million was allocated annually to the CARL program. In 2000, the CARL program was extended until 2010 with $105 million in annual funding to protect lands serving statewide conservation and recreation needs.

Under the CARL program, umbrella project areas have been identified for potential acquisition by the state. These areas have been surveyed and inventoried in regard to geographical boundaries, natural characteristics, and impending change in land use (if any). As a means to systematically compare the characteristics of different project areas, a criterion matrix is used to identify whether 11 non-mutually exclusive land characteristics are present in each project area (Table 1). The criteria in this matrix were selected to represent priorities for purchase consideration and include natural attributes of the land and exogenous measures that reflect the land market and potential for conversion to urban use (Florida Statute §259.101(4)(a)).

In order to add a project area to the CARL list, appraisals are conducted by at least two independent licensed appraisers. The appraisals are based on traditional land-valuation techniques and, thus, reflect the market value of the land as implied by comparable sales information and the highest and best use of the land. The appraisers consider factors such as size, location, zoning, environmental sensitivity, and the relative quantity of submerged areas and wetlands. These appraisals are used to estimate the total potential cost of the program for legislative allocations and as the basis for negotiations with owners.

Each project area typically consists of several individually owned parcels. Every year, specific parcels are targeted for acquisition based on project-area rankings from the criterion matrix, which is revised annually.[1] Land owners, upon learning their land is a target for acquisition by the state during the next year, can request that their parcel be removed from consideration (during the next year or permanently). Across project areas, the state has purchased an average of 47% of the land within the defined project areas, but state land ownership by project area ranges from 0.3% to 98% (Florida Department of Environmental Protection, FDEP 2001b). The state cannot purchase all lands in defined project areas in a single year because the estimated market value of parcels remaining in private ownership well exceeds a billion dollars (FDEP 2002).

The state's umbrella conservation program is now titled Florida Forever, which is an extension of the Preservation 2000 program under which the CARL program was initiated. Florida Forever encompasses a wider range of goals, including restoration of damaged environmental systems, water-resource development and supply, increased public access, and increased protection of land by acquisition of conservation easements (FDEP 2001a).[2]

Data

The FDEP publishes annual reports on the CARL program. Using the 2000 report, detailed information was obtained on 65 project areas with lands that have been purchased by the State of Florida. This information includes the total price paid (P) and acres purchased (AC) through 1999 for each project area (a). On average, \$20.8 million has been spent for 15,716 acres within each project area, but there is considerable variation in total acreage and per-acre costs. The State of Florida owns at least 60 acres of each of the 65 project areas. The state owns less than 1,000 acres in 28% of the project areas, but more than 50,000 acres in 6% of project areas. The largest amount spent by the State of Florida to purchase parcels within any given CARL project area is over \$163.7 million. On a per-acre basis, the State of Florida has spent an average of \$1,326 per acre, which is approximately the value of unimproved pastureland in Florida (Reynolds and Deas). Of the 65 project areas, 11% are composed of hundreds or even thousands of subdivision lots and are, thus, classified as multiparcel, or *MEGA* project areas. These variables and other characteristics of the project areas discussed below are defined in Table 2. Corresponding descriptive statistics are presented in Table 3.

The Geographic Information System (GIS) was used to obtain a quantitative measure of location relative to urban population centers. Given that Florida has several population centers, communities with a population of at least 100,000 were selected to define urban centers. The midpoint of the project areas averaged 74.8 road miles to the nearest urban center

[1] Administration of the CARL program is divided among the Land Acquisition and Restoration Council (ARC), the Board of Trustees of the Internal Improvement Trust Fund (the Board), and the Division of State Lands (DSL). The ARC is responsible for establishing the geographic boundaries for each project area and maintaining the CARL priority list. The ARC is also responsible for developing the annual ranking of project areas for the purpose of identifying target parcels. ARC membership, as specified in Florida Statute §59.035(1), includes five leaders of various government agencies and four Governor appointees. The Board is composed of the Governor and Cabinet and is responsible for approving all acquisition projects. Although the Board can refuse to allocate money for a project, it cannot change the rankings determined by the ARC or add projects to the CARL list. The DSL, a division within the Florida Department of Environmental Protection (FDEP), is most active in negotiating purchases of land and provides the majority of support staff for the CARL program. The DSL coordinates the program, obtains all appraisals and closing documents, prepares the purchase offers, and manages the purchases.

[2] Conservation easements cost less than land purchases and eliminate expenses incurred by the state to manage the land. Such agreements are often used to protect buffer zones and not large areas that are needed to satisfy the goals of the CARL and Florida Forever programs. Thus, land purchases are expected to continue under the CARL program as legislated through 2010.

Table 2. Variable Definitions and Descriptions

Variable	Description and Source
Project area (a) data as of 2000 (a = 1, 2, . . . , 65)	
P_a	Total price paid for AC (US$)
AC_a	Total acres purchased by 2000 in each project mean a
SM_a, LG_a	$SM = 1$ if $AC < 1{,}000$, 0 otherwise; $LG = 1$ if $AC > 50{,}000$, 0 otherwise
$MEGA_a$	Dummy variable for numerous parcels (1 if yes, 0 otherwise)[a]
$DISTANCE_a$	Distance to nearest city with population >100,000 by road (miles)
$COAST_a$	Dummy variable for coastal property (1 if touches the coast, 0 otherwise)
WMD_d	Water Management District (WMD) variables for region
$d = NW_a$	1 if Northwest WMD, 0 otherwise (base category).
$d = SR_a$	1 if Suwannee River WMD, 0 otherwise
$d = STJ_a$	1 if St. Johns River WMD, 0 otherwise
$d = SW_a$	1 if Southwest Florida WMD, 0 otherwise
$d = SFL_a$	1 if South Florida WMD, 0 otherwise
$FNAI_a$	Number of Florida Natural Area Inventory (FNAI) elements
$FNAI\_SIGI_a$	Number of FNAI with a S1 or G1 critically endangered rating
PC_c	Priority criteria variables (Table 1)
$c = DEV1_a$	1 if project area satisfies criteria 1a, 0 otherwise
$c = LOSS_a$	1 if project area satisfies criteria 1b, 0 otherwise
$c = FRAG_a$	1 if project area satisfies criteria 1c, 0 otherwise
$c = DEV2_a$	1 if project area satisfies criteria 2a, 0 otherwise
$c = ESCA_a$	1 if project area satisfies criteria 2b, 0 otherwise
$c = PROT_a$	1 if project area satisfies criteria 3a and 3b, 0 otherwise
$c = RECR_a$	1 if project area satisfies criteria 3c, 0 otherwise
$c = VALU_a$	1 if project area satisfies criteria 4, 0 otherwise
$c = RARE_a$	1 if project area satisfies criteria 5, 0 otherwise
$c = HIST_a$	1 if project area satisfies criteria 6, 0 otherwise
$PCTOTAL_a$	Total number of PC_c criterion met (ΣPC_c)
Project area data by year (t, a = 1, 2, . . . , 300)	
Y_P_{ta}	Total price paid for Y_AC (US$)
Y_AC_{ta}	Total acres purchased during year t in each project area a
Y_SM_{ta}, Y_LG_{ta}	$Y\_SM = 1$ if $Y\_AC < 70$, 0 otherwise; $Y\_LG = 1$ if $Y\_AC > 6{,}000$, 0 otherwise
Y_N_{ta}	Number of agreements executed to purchase Y_AC
Y_t	Year (t = 1989, 1990, . . . , 1999)

[a] *MEGA* project areas are "mega/multiparcels projects in which a major portion of the property is composed of hundreds or thousands of subdivision lots" (Florida Department of Environmental Protection 2001b, p. 50).

(*DISTANCE*), but distances ranged from 18.5 to 202.7 miles. Project areas containing coastal lands were identified with a dummy variable. Of the 65 project areas with lands owned by the state, 18% include coastal areas of either the Gulf of Mexico or the Atlantic Ocean (i.e., $COAST = 1$).[3]

The CARL project areas are distributed across the state. Of the five Water Management Districts (WMDs) that cover the State of Florida, the Suwannee River WMD in north central Florida manages the fewest acres

[3] The set of variables used to describe the location of each project area was based on previous studies, statistical comparison of the variables, and empirical analysis. The quantitative tools reduced the set of variables to those best reflecting lands in Florida. In particular, these tools resulted in an increase in the population used to define an urban center, elimination of the distance to the coast and distance to the nearest major road, and a merge of dummy variables distinguishing between the east and west coasts.

Table 3. Descriptive Statistics on CARL Purchases and Project Areas

	Statistical Measure			
Variable	Mean	Standard Deviation	Minimum	Maximum
2000 project area data (n = 65)				
P	20,855,040	31,130,644	36,126	163,746,785
AC	15,716.3	31,202.8	60.00	179,327
SM	0.28	0.43	0	1
LG	0.06	0.27	0	1
MEGA	0.11	0.31	0	1
DISTANCE	74.84	36.30	18.47	202.72
COAST	0.18	0.39	0	1
WMD_SR	0.09	0.29	0	1
WMD_STJ	0.29	0.46	0	1
WMD_SW	0.18	0.39	0	1
WMD_SFL	0.32	0.47	0	1
FNAI	24.14	14.18	2	74
FNAI_SIG1	1.68	2.02	0	7
PC_DEV1	0.64	0.48	0	1
PC_LOSS	0.24	0.43	0	1
PC_FRAG	0.23	1.42	0	1
PC_DEV2	0.20	0.40	0	1
PC_ESCA	0.05	0.21	0	1
PC_PROT	0.53	0.50	0	1
PC_RECR	0.56	0.50	0	1
PC_VALU	0.02	0.12	0	1
PC_RARE	0.91	0.29	0	1
PC_HIST	0.24	0.43	0	1
PCTOTAL	4.20	2.12	0	9
1989–99 project area data (n = 300)				
Y_P	4,582,627	9,035,859	1,500	96,066,121
Y_AC	2,236.2	6,643.4	0.57	59,521.5
Y_SM	0.27	0.44	0	1
Y_LG	0.07	0.26	0	1
Y_N	49.1	185.8	1	2,077

owned under the CARL program (9%). The majority of CARL lands (32%) are located in the South Florida WMD. In addition, although the average cost of CARL lands purchased in the South Florida WMDs was $10,869 per acre, the average cost for each acre of land in the Suwannee River WMD was just $566. The higher prices paid in South Florida are indicative of the scarcity of open spaces due to increased conversion of rural lands to urban development (Reynolds and Deas). The Suwannee River WMD accounted for the smallest share of funds spent and acreage purchased; however, this region is relatively small in terms of total acreage compared with the other WMDs.

All natural elements (i.e., any exemplary or rare component of the natural environment such as a species, natural community, bird rookery, spring, sinkhole, or cave) present within each project area are listed in the GIS-based Florida Natural Areas Inventory (FNAI) database (Florida Resources and Environmental Analysis Center). The FNAI database also includes the Global (G) and State (S) rankings for each element on a scale of 1–5, indicating whether the element is critically imperiled to demonstrably secure, respectively. For example, an element with a rank of G5/S1 is demonstrably secure globally but critically imperiled within Florida. Two variables are derived from this database to account for FNAI elements on CARL project areas. The first variable is a count of the number of elements. This variable, *FNAI,* averaged 24 elements per project area although the number of elements in a given project area ranged from 2 to 74. The second variable is a count of the number of critically imperiled elements, *FNAI_S1G1,* which is the number of FNAI with an S1 or G1 ranking. On average, there were 1.7 elements with an S1 or G1 ranking on each project area, although the number ranged from zero to seven.

The CARL program criteria defined in Table 1 were used to generate 10 dummy variables (Table 2).[4] Criteria 5 (*PC_RARE* = 1) was the most prevalent, indicating that 91% of the project areas support rare or endangered species. At the other extreme, criteria 2b and 4 (*PC_ESCA* = 1 and *PC_VALU* = 1, respectively), which identified lands with relatively high or low current values, characterized just 5% and 2%, respectively, of the project areas (Table 3). The remaining criteria characterize from 20% to 64% of the project areas. Overall, the total number of criterion (*PCTOTAL*) satisfied averaged 4.18 but ranged from zero to nine.

Using the annual CARL program reports from years 1990–2000, information on land purchases by project area (a) was obtained for 1989–1999. This information included the total acres purchased (*Y_AC*), total price paid (*Y_P*), and the total number of transactions (contracts) executed to acquire the purchased acreage (*Y_N*). If the State of Florida purchased parcels within each of the 65 project areas in each year (t), there would be a total of 715 observations. Due to limited funding, parcels in a given project area are rarely purchased in each year. In total, there were 300 observations on the total quantity of land purchased, total price paid, and total number of transactions by year and project area.

From 1989 through 1999, annual expenditures under the CARL program by project area ranged in value from $1,500 to over $96 million for 0.57 acres to 59,521 acres (Table 3). These purchases were accomplished with as few as one transaction (e.g., from a single owner) to as many as 2,077 transactions. The average number of transactions in a given year was 49, which corresponds to an average of 2,221 acres for approximately $4.6 million or $2,050 per acre.

In summary, two data sets are available on land purchases made under the CARL program. Both reflect a degree of aggregation over individual transactions, which is analogous to the use of census data. For example, a recent study of housing transactions investigated the implications of using different resolutions of the census data (Shultz and King). This study will examine the available CARL data at two resolutions (project level and annually). Whether the specified models adequately capture the observed price variation will indicate the need for reexamination using data at the contract level. Although data on individual transactions are typically considered preferable for hedonic analysis, the two data sets in this study are hypothesized to adequately capture information on the cost of public preservation of private lands because attributes are constant within a project area.

Model Specification

The basic form of an hedonic equation expresses the price paid for a product or service as a function of the characteristics that are believed to have affected the negotiated transaction price. In the case of undeveloped land, the characteristics often include measures of area, location, development pressure, natural attributes, and site quality. The explanatory variables can be continuous measures, such as miles to the nearest urban center or total acreage, or they can represent a dichotomous dis-

[4] The Pearson correlation coefficient was .94 (and statistically significant at the 5% level) between criteria 3a and 3b such that these attributes were jointly represented by the *PC_PROT* variable. Eight other pairs of variables (of 45 total) were also statistically significant; however, the coefficients ranged from −0.37 to 0.46, indicating they should not cause multicollinearity problems in the model.

tinction, such as whether the land includes coastal areas or contains an historical site.

The most challenging aspect of an hedonic analysis is the determination of the functional form to specify the continuous variables, especially those that are typically not normally distributed (e.g., price). One of the most commonly estimated forms is the double-log because it provides direct estimates of price elasticities that can facilitate the interpretation and comparison of results. In this study, a Box-Cox transformation was first used to identify the most appropriate functional form for the dependent variable (Faux and Perry; Milon, Gressel, and Mulkey). With this procedure, the appropriate functional form for a nonnegative dependent variable, such as price (P), is determined by finding the value of the power transformation (λ) that maximizes the likelihood of $[P^{\lambda} - 1]/\lambda$ when $\lambda \neq 0$ and $\ln(P)$ when $\lambda = 0$. The most appealing feature of the Box-Cox transformation is that it requires no prior restrictions on the form. The value of λ indicates the functional form of price (P) that best fits the data. For example, λ values of -1.0, 0.0, and 0.5 indicate that the inverse, natural logarithm, and square-root transformations should be applied to the price variable. A λ value of 1.0 would indicate that no transformation is warranted.

Using the data on CARL acquisitions as of 2000, a power transformation was estimated for the price paid for lands within a given CARL project area (P_a). In particular, P_a was transformed for all values of λ between -2 and 2 in 0.01 increments using a Box-Cox macro in SAS. The highest log likelihood value ($-1{,}014.1$) was associated with $\lambda = 0.08$, although values of λ ranging from -0.4 to 0.17 fell within the 95% confidence interval. Because the confidence interval contained $\lambda = 0$, the following general model was deemed appropriate for this study:

$$(1) \qquad \ln(P_a) = \alpha + \sum_i \beta_i f(X_{ia}) + \sum_j \gamma_j Z_{ja} + \sum_k \phi_k D_{ka}.$$

In Equation (1), the natural logarithm of price is explained by the characteristics of the project area (a) that are measured as continuous variables in either a nonlinear, $f(X)$, or linear, Z, form and by dummy variables, D. Classifying the independent variables is important because the calculation of relative price impacts differs. The statistical model resulting from the Box-Cox analysis contained two nonlinear continuous variables ($i = 1, 2$), three linear continuous variables ($j = 1, 2, 3$), and 16 dummy variables ($k = 1, 2, \ldots, 16$).[5]

The price of land that has been purchased for inclusion in the CARL program is expected to vary by the size of the land purchased for each project area in acres (AC). For rural land, price is expected to have a negative relationship with acreage because larger areas have fewer potential buyers (Reynolds and Regalado) or the landowner would incur additional costs to subdivide, including the installation of basic infrastructure that is typically capitalized in the value of smaller parcels (Lin and Evans). Using the natural logarithm of acres allows for the direct estimation of the price elasticity of demand (Lin and Evans; Loomis, Rameker, and Seidl; Mahan, Polasky, and Adams; Nickerson and Lynch). To account for distinct price effects by the total acreage of land purchased (Lin and Evans), dummy variables were created for small and large areas (*SM* and *LG*, respectively) and were used to create an interaction term with total acreage. The characteristics of private land ownership, in terms of whether the project area consists of a substantial number of subdivision lots (*MEGA*), was also included to account for transactions costs involved with conducting and executing additional appraisals, offers, and closings (*ceteris paribus*). The interpretation of this variable should be distinguished from other land-valuation studies that assume subdivisions and multiple owners indicate the land is more suitable for development and, thus, should command a higher

[5] The Box-Cox analysis was conducted using a macro in SAS that only examined transformations of the dependent variable. Thus, the analysis was conducted for all plausible functional forms for the continuous explanatory variables. The run with the lowest likelihood value as reported in the text corresponded with the specifications discussed below.

price. In this study, development pressures are captured directly by other variables in the model. Thus, in the case of open-space land with characteristics attractive for inclusion in the CARL program, multiple owners indicate an additional cost to the buyer for the same quantity of land. Multiple owners, especially when considering hundreds or even thousands as indicated by the *MEGA* variable, could also reduce the possibility that an area could be protected if some owners may not want to sell.

Six variables were included to account for location. Distance to the nearest city with population above 100,000 (*DISTANCE*) was the only continuous location variable. It is one proxy used to capture future rents to development following the theoretical residential location models that predict a negative rent–distance relationship (Reynolds and Regalado). Dummy variables included whether the project area includes coastal property (*COAST*) and five geographic regions based on the WMD where the area is located (*WMD_d*). The water-management districts were included to account for land premiums associated with regionally diverse lands. Lands in coastal and southern areas in Florida are expected to be valued higher because of greater population pressure, commercial uses, and environmental sensitivity.

The last group of explanatory variables described other land attributes as identified from the CARL project area summaries. Two continuous variables reflect the presence of endangered or threatened natural communities and species of animals and plants: the number of FNAI elements (*FNAI*) and, of those, the number with a state or global ranking as critically endangered (*FNAI_S1G1*). Because the presence of natural elements can restrict future land use, an increase in FNAI elements is expected to reduce land values; however, whether the number of critically endangered elements (*FNAI_S1G1*) reinforces or modifies the initial *FNAI* effect is unknown. That is, because rare and endangered species have been found to provide positive economic benefits in several stated preference studies, an increase in *FNAI_S1G1* elements could partly or wholly offset the reduced economic value due to restrictions on development. This effect would be captured in the hedonic analysis to the extent that these elements support the broad goals of the program, which include conserving lands for public use, such as recreation and tourism activities.

The remaining variables are those derived from the CARL program criteria (Table 1). The development and land market variables (i.e., criteria 1a, 1c, 2, and 4) indicate an urgency or opportunity to purchase parcels within a given project area during the next year. These variables are expected to increase the cost of preserving the lands as landowners become aware that their land is a target for acquisition by the state and the potential for competing bids that can result.[6] The remaining criteria (i.e., 1b, 3, 5, and 6) support recreation, tourism, and ecosystem needs that are expected to increase the cost of preservation to the state, which will be captured in the hedonic analysis to the extent that these functions also support the commercialization of the land by private owners. To account for the cumulative effect of satisfying multiple criteria, the square of the total number of criteria satisfied (*PCTOTAL*) was also included. This variable also serves to adjust the total estimated implicit values of all criteria for a given project area that would be implied by a summation of

[6] A reviewer wondered whether these variables should be considered endogenous. In general, endogeneity can be identified with a Hausman test. If detected, an instrumental-variables approach could be used to eliminate the bias caused by including these criteria in Equation (1). This approach requires instruments that are highly correlated with the endogenous variables they are trying to predict. It also requires a sufficient number of exogenous variables and degrees of freedom. An instrumental-variables approach was not considered because the five suspect variables were not highly correlated with each other or any of the other variables. In addition, we could not lag the suspect endogenous variables because they are binary. It is our contention that the criteria can be appropriately considered as exogenous because their values are determined prior to acquisition decisions and these variables are analogous to the inclusion of distance variables that have been widely accepted as proxies for development pressure. Because eliminating variables that are *a priori* expected to affect price would introduce specification bias into the model, all variables were retained.

*PC_* coefficients; thus, a negative sign is expected.

The second statistical model uses the annual observations on transactions by project area. For consistency with model (1), price (Y_P) and acreage (Y_AC_{at}) were transformed with the natural logarithm. The total number of transactions that occurred during the year (Y_N_{at}) was included to capture the implicit price associated with each individual transaction (contract), information that can help the FDEP anticipate the costs associated with acquiring the remaining lands. Because observations were available for each year, dummy variables for years 1990–1999 (Y_t) were also included,

$$\begin{aligned} (2) \quad & \ln(Y\_P_{at}) \\ & = \alpha + \beta_0 \ln(Y\_AC_{at}) + \beta_1 \ln(Y\_AC_{at}) Y\_SM_{at} \\ & \quad + \beta_2 \ln(Y\_AC_{at}) Y\_LG_{at} + \gamma Y\_N_{at} \\ & \quad + \sum_{t=1990}^{1999} \delta_t Y_t. \end{aligned}$$

As with model (1), two dummy variables were defined to identify small and large acquisitions (in terms of acreage) under the hypothesis that they may have distinct price effects. For this model, small land acquisitions ($Y\_SM = 1$) and large land acquisitions ($Y\_LG = 1$) were defined as less than 70 acres and greater than 6,000 acres, respectively. It was necessary to define these categories because the range of acreage differed (e.g., average values for *AC* and *Y_AC* were approximately 15,700 and 2,200 acres, respectively). For consistency, however, both the small and large dummy variables were selected such that the proportion of observations in each category was similar.

The 300 observations used to estimate model (2) included transactions for lands in 104 project areas.[7] If model (2) explains a majority of the price variation and the variable coefficients are statistically significant, detailed data-collection efforts on project areas (such as annual updates of FNAI counts and revisions of the priority criterion matrix) may not be necessary for predicting costs. Moreover, if any of the annual dummy variables are statistically significant, it could suggest bias in model (1), which does not distinguish among purchases conducted during different points in time.

The hedonic models (1) and (2) were specified and estimated by ordinary least squares (OLS) in SAS, then subjected to White's general specification test after tests involving specific variables (e.g., *AC* and *Y_AC*) were not found to distinctly affect the model errors. The results of this test varied by model specification; in particular, the standard errors for model (2) estimated with OLS were biased. Thus, the statistical significance of the estimated coefficients was determined using a consistent estimate of the covariance matrix. Because the resulting standard errors are correct regardless of the presence of heteroskedasticity, they were used and are presented for each model. The results of each model are discussed in turn.

Results

Model 1: Project Area Data, 2000

Model (1) had an adjusted R^2 of .81, indicating a relatively high degree of explanatory power. Twenty of the 24 estimated coefficients (83%) were statistically significant at the 5% level, indicating that the majority of the explanatory variables have had distinct effects on the cost of preserving land in Florida (Table 4). Due to the relatively high number of statistically significant variables, multicollinearity was not considered a problem and no variables were omitted.[8]

[7] There were more project areas in this data set because project areas are continually revised. Over time, project areas have been redefined, renamed, and merged. As such, detailed project-area data were not readily available on all project areas. Within this context, one purpose of model (2) is to capture the possible effect of land price inflation.

[8] A moderately high Pearson correlation coefficient between *FNAI* and *FNAI_S1G1* (.74), the highest between any two variables in the model, might explain the statistical insignificance of the latter variable. None of the remaining three statistically insignificant variables had correlation coefficients above .42 with any of the other variables in the model, although *PC_VALU* did have relatively low incidence in the data set (i.e., only 2% of project areas satisfied criteria 4).

To quantitatively compare implicit attribute prices, the following equations were used to transform the coefficients from model (1) for the logged continuous, leveled continuous, and dummy variables, respectively:

$$\text{(3a)} \quad \frac{\partial \ln P}{\partial \ln X_i} = \hat{\beta}_i$$

$$\text{(3b)} \quad \frac{\partial \ln P}{\partial Z_j} = \hat{\gamma}_j \bar{Z}_j$$

$$\text{(3c)} \quad \frac{\partial \ln P}{\partial D_k} = \exp\left[\hat{\phi}_k - \frac{\text{SE}(\hat{\phi}_k)^2}{2}\right] - 1,$$

where SE(·) is the standard error of the corresponding coefficient estimate. Equations (3a) and (3b) are both elasticities, providing the percentage change in purchase price from a 1% change in the explanatory variable calculated at the means. Equation (3c) provides the percentage change in purchase price associated with the addition of each dummy characteristic (Kennedy).[9] As will be shown, Equations (3b) and (3c) produce price effects that differ appreciably, but in a nonsystematic manner, from the direct interpretation of the coefficients.

One of the most important variables in hedonic studies of open-space lands is a measure of area, which can be used to determine the relationship between sale price and area (i.e., total area of lands purchased under the CARL program by project area). In this study, the relationship is elastic, indicating that the percentage change in price exceeds the percentage change in acreage. For total acquisitions in excess of 50,000 acres, a 1% increase in acreage caused price to increase by 1.10%. For land purchases that ranged from 1,000 through 50,000 acres, a 1% increase in acreage caused price to increase by 1.16%. For land purchases of less than 1,000 acres, a 1% increase in acreage increased price by 1.52%. The increased sensitivity of price for the smallest land purchases is not surprising given that small areas can be associated with unique natural features.[10]

Lands purchased in CARL project areas composed of a large number of parcels (*MEGA* = 1) were purchased for a 54% discount, holding all other attributes constant. Thus, having to negotiate and contract with hundreds or thousands of landowners significantly reduced the costs of acquiring the lands. The administrators of the program should consider whether these costs savings are sufficient to cover the expenses associated with the additional contracts.

The distance variable indicated that project areas located further from large metropolitan areas reduced land prices in accordance with land rent theory. Specifically, a 1% increase in distance from an urban center reduced acquisition costs by 0.76%. At the means, a 50% increase in distance from 74.8 to 112.2 miles (approximately the standard deviation) reduced price 38% from $20.9 million to $12.9 million ($7,128 to $4,419 per acre). Project areas with coastal lands increased land prices. This result supports previous studies that have investigated the effects of waterfront property values (Lansford and Jones; Loomis, Rameker, and Seidl). If the purchased lands included coastal waterfront, then price increased 509% (e.g., $20.9 million to $106.4 million, which is well below the maximum observed value). The *COAST* variable had the largest estimated effect of the dummy variables, indicating that coastal property is the most costly type of land to preserve.

In terms of general geographic region, as represented by the WMDs, lands in the Suwannee River region were purchased for less and lands in the southwest and south Florida WMDs were purchased for more compared with the northwest region (i.e., Panhandle). Lands in the Suwannee River WMD were pur-

[9] The more exact measure of the effect of a dummy variable (i.e., Equation 3c) in a semilogarithmic model, which uses the hypergeometric function (van Garderen and Shah), did not change the estimates.

[10] The per-acre specification is common in hedonic studies of agricultural lands, where parcel size is often highly variable compared with residential parcels (Nickerson and Lynch). Redefining the dependent variable only changed the coefficient on ln(*AC*), which fell by one (i.e., from 1.16 to 0.16). Given the similarity of results, the results with price on a per-acre basis are not presented.

Table 4. Estimation Results and Price Effects from the 2000 Project Area Data, Model 1 ($n = 65$)

Variable	Parameter[a]	Standard Error[b]	Price Effect[c]
Intercept	4.876*	0.9606	NA
Size			
Ln(*AC*)	1.163*	0.0862	1.16
Ln(*AC*)*SM*	0.357*	0.0575	1.52
Ln(*AC*)*LG*	−0.064*	0.0327	1.10
Ownership			
MEGA	−0.731*	0.3011	−0.54
Location			
DISTANCE	−0.010*	0.0036	−1.76
COAST	1.857*	0.3158	5.09
WMD_SR	−1.205*	0.2612	−0.71
WMD_STJ	0.250	0.2591	NS
WMD_SW	0.673*	0.2375	0.91
WMD_SFL	0.495*	0.2514	0.59
Other attributes			
FNAI	−0.031*	0.0105	−0.75
FNAI_S1G1	0.084	0.0674	NS
PC_DEV1	0.750*	0.2249	1.06
PC_LOSS	1.027*	0.2427	1.71
PC_FRAG	1.503*	0.3129	3.28
PC_DEV2	1.118*	0.3197	1.91
PC_ESCA	1.635*	0.4090	3.72
PC_PROT	1.897*	0.8903	3.49
PC_RECR	−0.465	0.8546	NS
PC_VALU	0.906	0.5058	NS
PC_RARE	0.900*	0.3279	1.33
PC_HIST	0.555*	0.2558	0.69
$PCTOTAL^2$	−0.061*	0.0186	−2.16

[a] Asterisks indicate statistical significance at the 5% level.
[b] Asymptotic standard errors resulting from use of White's heteroskedastic consistent covariance matrix.
[c] NA indicates the measure is not applicable for that variable. NS identifies variables that were not statistically significant and could not be used to calculate reliable price effects. The price effects were calculated using Equations (3a), (3b), and (3c) for the double-log, semi-log, and log-linear specifications, respectively.

chased for 71% below those purchased in the northwest WMD. Conversely, lands in southern Florida were purchased at 59–91% premiums in the south Florida and southwest Florida WMDs, respectively (*ceteris paribus*). These observed regional differences are in line with a recent rural land valuation survey (Reynolds and Deas).

An increasing number of threatened or endangered elements on the land (*FNAI*) reduced the purchase price, as hypothesized. The presence of a large number of threatened or endangered species (*FNAI*) could constrain or preclude alternative commercial uses due to existing environmental regulations. A 50% increase in *FNAI* elements (from the mean of 24.1 to 36.1) would reduce price by 37.5% ($20.9 million to $15.6 million, or $7,128 to $5,346 per acre). Although an increase in the number of S1 or G1 rankings increased the prices paid for CARL lands, as would be suggested in contingent valuation studies, the finding was not statistically significant. Overall, the presence of FNAI elements reduced the cost of preserving the habitat.

Eight of the 10 dummy variables reflecting the priority criteria were statistically significant and all were positive, indicating they increased the prices paid for CARL lands (i.e., increased the costs of preservation). Five of the eight reflected pressure to develop the land and the land market overall. If the land was in imminent danger of development, loss of significant natural attributes, or subdivision (criterion 1a–1c), land prices were 106, 171, and 328% higher, respectively. If compelling evidence existed that the land would be developed within the next year or that recent appraisals indicate a land rent that exceeds the average rate of interest likely to be paid on the bond, then land prices were 191 and 372% higher, respectively. These results support the recent findings that open space may be most valued for providing absence of development (Irwin: p. 465) but may also be reflecting the underlying value to the statewide economy of maintaining undeveloped lands that support a current use that is not captured in the model. Interestingly, having an opportunity to purchase the lands at less than the appraised value did not lower the cost.

In terms of land attributes, if a significant portion of the project area serves to protect or recharge groundwater and protects other valuable natural resources, the cost to preserve the lands increased 349%. The relatively large effect associated with protecting groundwater and other natural resources versus development is not surprising given the importance of groundwater to the State of Florida, which will only increase with the population (Reynolds and Regalado). Alternatively, these areas are likely to be uplands that are more suitable for development (Glissan), such that the increase may in fact be reflecting development potential. If these lands are suitable for development, ownership by the State of Florida could be viewed as a speculative venture because the state has the authority to approve resale of the lands.

Lands that serve as habitat for endangered, threatened, or rare species (*PC_RARE* = 1) were purchased for a 133% premium; however, this effect would need to be adjusted downward by the number of FNAI elements that are likely to be present. For example, at the mean FNAI, price would be reduced by 75%, resulting in a net effect (exclusive of the total number of priority criterion satisfied) of a 58% price increase. If the lands serve to preserve an important archaeological or historical site (*PC_HIST* = 1), the purchase price increased 69%, perhaps indicating the potential for tourism revenues, as suggested in the general project descriptions (FDEP 2001b).

The individual effects of the priority criteria exclude the cumulative effect of multiple criteria. The negative effect of the total number of priority criteria indicates that the increased purchase price associated with having satisfied more criteria is not constant, but declining. Thus, the positive price effects associated with criteria 1a, 1b, 1c, 2a, 2b, 3b, 5, and 6 (i.e., development pressure, increasing land values, potential fragmentation, loss of natural attributes, protection of groundwater and other valuable natural resources, habitat, or archeological or historical sites) should not be summed to predict the total price effect. This is because the addition of any single criteria would increase price from 69% to 372%; however, a 100% increase in the total number of criteria (*PCTOTAL*), such as moving from one to two criteria, would reduce price 216%. Thus, it is possible that the presence of certain criteria will reduce preservation costs. Land attributes that are likely to cost more to preserve due to their relatively large individual effects include whether the lands are in imminent danger of fragmentation, lands for which price has escalated in recent years, and lands protecting valuable natural resources (i.e., *PC_FRAG* = 1, *PC_ESCA* = 1, and *PC_PROT* = 1, respectively).

Table 5. Estimation Results for the 1989–1999 Project Area Data, Model 2 (n = 300)

Variable	Parameter[a]	Standard Error
Intercept	10.268*	0.4969
Size		
Ln(*Y_AC*)	0.655*	0.0475
Ln(*Y_AC*)*Y_SM*	0.054	0.0743
Ln(*Y_AC*)*Y_LG*	−0.019	0.0366
Ownership		
Y_N/1,000	−0.816*	0.4041
Annual fixed effects		
Yt = 1990	0.027	0.5242
Yt = 1991	0.614	0.5066
Yt = 1992	0.195	0.4766
Yt = 1993	0.299	0.4844
Yt = 1994	0.149	0.4784
Yt = 1995	0.108	0.4811
Yt = 1996	0.302	0.4816
Yt = 1997	−0.132	0.4789
Yt = 1998	0.334	0.4664
Yt = 1999	−0.152	0.4528

[a] Asterisks indicate statistical significance at the 5% level based on the asymptotic standard errors from White's heteroskedastic consistent covariance matrix.

Model 2: Project Area Data, 1989–1999

Model (2) explained 57% of the variation in annual transactions prices according to the adjusted R^2. Only two of the 14 explanatory variables were statistically significant: the quantity of land purchased in a given year, ln(*Y_AC*), and the corresponding number of transactions (contracts) required to purchase the land, *Y_N* (Table 5). The partial elasticity of land price with respect to acreage purchased indicates that, on average, holding all other variables constant, a 1% increase in acreage leads to an average 0.655% increase in price (preservation costs), regardless of how much land was purchased. By comparison, the project area data through 2000 found an elastic price response that fell with larger land purchases.

An increase in the number of transactions required to purchase lands within a given project area and year reduced the price paid for the land (i.e., reduced the cost of preserving the land). Specifically, if the number of transactions increased by 100, purchase price fell by 8.16%. At the mean level of 49 transactions per year, the partial elasticity of land price with respect to the number of transactions is 0.04, indicating that a 1% increase in transactions will reduce price by 0.04%. This variable is similar in interpretation to *MEGA* used in model (1), which identified project areas composed of hundreds or even thousands of individually owned parcels. For example, considering 1,000 sellers, the estimated *MEGA* coefficient indicates the property would be 73.1% less expensive and the *Y_N/1000* coefficient indicates the property would be 81.6% less expensive compared with a single seller.

It was expected that the parameter estimates for each year would be positive and successively larger, reflecting inflation; however, none of the annual fixed effects were statistically significant.[11] This result is consistent with a recent analysis of wetland values in Florida whereby the yearly dummy variables were statistically insignificant (Reynolds and Regalado). Thus, the costs of purchasing lands under the CARL program have not increased over time, *ceteris paribus*. The temporal stability indicated by the lack of statistically significant annual fixed effects suggests that the use of data aggregated at the project-area level did not bias results.[12]

Summary and Discussion

This paper applied the hedonic property price approach to estimate the cost of lands acquired by the State of Florida for public preservation. Implicit prices were estimated for land attributes (including size, location, and natural amenities) and measures of the pressure to and potential for development. Within this context, the hedonic model is explaining the payments to landowners whose parcels were selected for inclusion in a CARL Project Area. Given that negotiated prices were subject to a competitive bid process that may have excluded the value of unmeasured benefits, the resulting implicit prices should be considered lower-bound estimates of the total public or social value of these lands.

Overall, all types of attributes were found to affect property prices, indicating that the value of the natural attributes, including those with nonuse benefits, has been capitalized into the value of public lands in Florida. Because the explanatory power of the model with the natural attributes was relatively high and the majority of variables were statistically significant, it could be used to estimate the shadow prices of lands for preservation. In effect, the use of an empirically estimated hedonic model quantifies information on comparable sales and next best-use information that is to be considered in traditional appraisals. Unlike the partial implicit prices derived from nearby land sales, such as with residential home sales, using data from a public land-acquisition program allowed for more direct estimates of attribute values. These values could shed light on how the state values having an adequate supply of lands to satisfy the current and future needs of its residents. Given that lands could always be resold, paying the market price for undeveloped lands based on the potential for development (or any other private commercial use) could be considered a low-

[11] This finding is consistent with Tyrväinen and Miettinen and was supported by a joint F-test of the annual fixed effects. The hypothesis of annual coefficients equal to zero could not be rejected. A subsequent estimation without the fixed effects did not change the magnitude or statistical significance of the remaining variables and, thus, these results are not presented here.

[12] To increase the number of observations with the detailed project area descriptions, the annual transactions information (i.e., year, price, acreage, and transactions; $n = 300$) was merged with the detailed project-area information ($n = 65$) to create a model with 34 explanatory variables. Although the explanatory power increased to 73% from 57%, as indicated by the adjusted R^2, the parameters were remarkably robust, although there were fewer statistically significant variables. Thus, the results are not presented.

risk strategy for procuring the natural inputs required to support the economy.

Results show that natural attributes of the land appear to increase the cost of preservation. In general, current natural elements had higher implicit prices than historical elements, which may help to place relative values and priorities on the revenue-generating capability of proposed state parks as considered in the project-area descriptions (FDEP, 2001b). One exception is the presence of FNAI elements, which are plant and animal species supported by the habitat. An increase in the number of FNAI elements reduced acquisition costs, likely because it reduces the potential for higher valued commercial uses. For example, wetlands are typically characterized by a relatively high level of biodiversity and are subject to increasingly stringent regulations regarding development. If the open-space lands were likely to be converted to urban use or subdivided, the costs of preserving these lands increased. The urgency with which the impending development might occur further increased costs. If, however, the targeted lands were already subdivided into hundreds or even thousands of parcels, the costs to acquire the lands were lower. The administrators of the program need to consider whether these costs savings are sufficient to cover the expenses associated with the additional contracts.

If, as in this study, natural attributes are found to affect land values, it cannot be concluded that the primary benefit of open-space preservation is the prevention of development. As suggested by Irwin, it is the relative implicit values that are of importance. In the case of conservation lands in Florida, the value of recharging groundwater and protecting other natural benefits had the largest effect on the prices paid under the CARL program, second to whether coastal lands were included. That said, this study revealed that the total number of land criteria (natural or development related) needs to be considered because there are decreasing economic returns to the addition of criteria.

There are some caveats to the general results. First, the estimated price effects represent marginal changes and, as such, do not theoretically pertain to nonmarginal (or large-scale) changes. Second, because the data include transactions only from lands purchased by the State under the CARL program, sample selection could be an issue. Are undeveloped lands not included in a CARL project area systematically different from those that are? Are sellers to the state systematically different than nonsellers? Analysis of individual transactions data or of open-space lands purchased adjacent to CARL program areas could shed light on the extent of this problem. Third, this analysis included only information on land acquisitions, not conservation easements. Although there is not yet sufficient data on conservation-easement arrangements under the CARL program, the purchase of easements (the rights to future development) are a current priority of the program. The comparison of implicit prices from acquisitions and easements and the comparison of easement valuations between programs could help determine the optimal portfolio of land-preservation tools.

With these caveats, the results do provide compelling evidence that both natural attributes, providing both use and nonuse benefits, and measures of development pressure and potential should be considered when estimating the cost of lands for preservation. The relative effects of these components can indicate whether preservation lands are valued more on the absence of development, as found by Irwin, or with more natural attributes, as suggested by stated preference studies. The continuation of the CARL program and similar programs around the United States at the county level and by land-trust agencies highlights the need for such information, which could be used in cost-transfer analyses. For example, the Alachua County Land Conservation Board has recently rated and ranked (independent of CARL lands) six environmentally sensitive properties for purchase. The lands total nearly 11,000 acres and appraisals estimate the cost at nearly $20 million, to be predominantly financed by the issuance of new bonds. Because the attributes of the land are likely to match at least some of those included in the CARL data set, our results could be used to compare the appraised value with that of similar lands across the state. Such information could reduce administrative costs for Alachua County and for counties that have similar land-conservation programs.

[Received September 2002; Accepted July 2004.]

References

Espey, M., and K. Owusu-Edusei. "Neighborhood Parks and Residential Property Values in Greenville, South Carolina." *Journal of Agricultural and Applied Economics* 33(December 2001): 487–92.

Faux, J., and G.M. Perry. "Estimating Irrigation Water Value Using Hedonic Price Analysis: A Case Study in Malheur County, Oregon." *Land Economics* 75(August 1999):440–52.

Florida Department of Environmental Protection. DEP State Lands: Florida Forever & P2000 Home Page. http://www.dep.state.fl.us/lands/carl_ff/index.htm. (Accessed September 6, 2002).

———. "Eva Armstrong Sizes up Florida Forever." *State of Our Lands*. Fall 2001. Tallahassee, FL: Office of Environmental Services, 2001a.

———. *The 2000 CARL Annual Report*. Tallahassee, FL: Office of Environmental Services, 2001b.

Florida Resources and Environmental Analysis Center. "FNAI—Florida Natural Areas Inventory." Tallahassee, FL: Institute of Science and Public Affairs. Internet site: http://www.fnai.org/.

Irwin, E.G. "The Effects of Open Space on Residential Property Values." *Land Economics* 78(November 2002):465–80.

Kennedy, P. *Econometric Analysis*, 4th ed. Cambridge, MA: The MIT Press, 1998.

Lansford, N.H., Jr., and L.L. Jones. "Marginal Price of Lake Recreation and Aesthetics: An Hedonic Approach." *Journal of Agricultural and Applied Economics* 27(July 1995):212–23.

Lin, T., and A.W. Evans. "The Relationship Between the Price of Land and Size of Plot when Plots are Small." *Land Economics* 76(August 2000):386–94.

Loomis, J.B., V. Rameker, and A. Seidl. "A Hedonic Model of Public Market Transactions for Open Space Protection." *Environmental Planning and Management* 47(January 2004):83–96.

Mahan, B.L., S. Polasky, and R.M. Adams. "Valuing Urban Wetlands: A Property Price Approach." *Land Economics* 76(February 2000): 100–13.

Mendelsohn, J.F., W.D. Nordhaus, and D. Shaw. "The Impact of Global Warming on Agriculture: A Ricardian Analysis." *American Economic Review* 84(September 1994):753–71.

Milon, J.W., J. Gressel, and D. Mulkey. "Hedonic Amenity Valuation and Functional Form Specification." *Land Economics* 60(November 1984):378–87.

Nickerson, C.J., and L. Lynch. "The Effect of Farmland Preservation Programs on Farmland Prices." *American Journal of Agricultural Economics* 83(May 2001):341–51.

Plantinga, A.J., and D.J. Miller. "Agricultural Land Values and the Value of Rights to Future Development." *Land Economics* 77(February 2001):56–67.

Poor, P.J., K.J. Boyle, L.O. Taylor, and R. Bouchard. "Objective Versus Subjective Measures of Water Clarity in Hedonic Property Value Models." *Land Economics* 77(November 2001):482–93.

Reynolds, J.E., and A. Deas. "Florida Agricultural Land Values Increases: 2000 Survey Results." *Florida Food and Resource Economics*, July–August 2002, No. 145. Gainesville, Fl: University of Florida Cooperative Extension Service.

Reynolds, J.E., and A. Regalado. "The Effects of Wetlands and Other Factors on Rural Land Values." *Appraisal Journal* 70(April 2000):182–91.

Shultz, S.D., and K.A. King. "The Use of Census Data for Hedonic Price Estimates of Open Space Amenities and Land Use." *Journal of Real Estate Finance and Economics* 22(March/May 2001):239–52.

Tyrväinen, L., and A. Miettinen. "Property Prices and Urban Forest Amenities." *Journal of Environmental Economics and Management* 39(March 2000):205–23.

U.S. Census Bureau. Data derived from *Population Estimates, 2000 Census of Population and Housing*. Washington, DC. Internet site: http://www.census.gov/ (Accessed September 20, 2003).

van Garderen, K.J., and C. Shah. "Exact Interpretation of Dummy Variables in Semilogarithmic Equations." *Econometrics Journal* 5(2002): 149–59.