ESTIMATING RECREATION VALUES ASSOCIATED WITH LAND USE CHANGES

Wesley N. Musser and Rod F. Ziemer

Achieving optimal use of wildlife resources is a classic problem in natural resource economics. Ciriacy-Wantrup argued that wildlife resources are a case of a fugitive resource for which private property rights cannot easily be defined and therefore government policy may be necessary to obtain optimal use [5, pp. 141-145]. Land use planning is one area of government policy in which limited attention has been given to management of wildlife resources. One reason for the neglect may be the lack of emphasis on estimating the value of wildlife recreation experiences associated with particular land uses. An exception is the work of Martin, Tinney, and Gum [16] who did not look at marginal land use changes but did consider the termination of all cattle ranching in Arizona and its effect on recreational and agricultural economic surpluses.

The authors adapt standard wildlife recreation demand methodology to provide estimates of value of a particular land use for wildlife recreation experiences. In this analysis, land use is treated as defining unique recreational opportunities, a concept which has been considered in previous recreation demand studies [2, 4, 7, 18]. Using this concept, one can estimate the value of a particular land use as the change in consumer surplus arising from a change in the opportunity set defined by a particular land use.

The specific objectives of this article are: (1) to review the theoretical justifications for considering recreational opportunities in recreation demand functions, (2) to present an empirical model for big game hunting demand in Georgia which includes forestland acreage, an indicator of available hunting opportunities, as an independent variable, and (3) to adapt standard methodology to provide an estimate of changes in consumer surplus for big game hunting due to recent changes in forestland in Georgia.

RECREATION DEMAND AND THE AVAILABILITY OF OPPORTUNITIES

Various theoretical justifications appear in the literature for the relevance of recreational opportunity sets to demand. Opportunity effects were first discussed by Clawson who asserted that recreation demand was a function of changing recreational opportunities as well as factors normally ascribed to demand [6, p. 116]. He implied, but did not explicitly state, that the availability of opportunities affected demand through an adaptation of Arrow's learning by doing concept [1]. Cicchetti, Seneca, and Davidson [4, p. 55] and Davis and Seneca [7] formally employed this concept to rationalize the inclusion of lagged variables reflecting past availability of recreation opportunities in a demand model.

Learning by doing was later cast in the static Lancaster theory of demand [2]. Within such a framework, households are considered akin to small factories combining such inputs as raw materials, capital goods, and labor to produce consumption commodities [12, p. 340]. In this approach learning by doing affects demand for recreation experiences through the consumer's production technology [2, p. 102] which is altered by large changes in prices resulting from changes in the availability of recreational opportunities.

Consumer choice for recreational experiences could be approached similarly within Becker's framework which also abandons the traditional separation between production and consumption. Preferences are assumed a function of a set of commodities produced by the households themselves by combining different market goods, time, and other inputs in the production function, particularly "environmental variables." Environmental variables appear in the demand function because the input-output relationships in the household production function are altered by changes in these variables [3, pp. 41-48]. In a recreational context, the availability of recreational opportunities could be considered an environmental variable which alters the amount of inputs required to produce the recreational experience. Oliveira and Rausser [18] combined the Becker theory with the Lancaster theory in conceptualizing recreational demand.

Maler employs a more neoclassical approach to considering environmental effects in

Wesley N. Musser is Associate Professor and Rod. F. Ziemer is Graduate Research Assistant, Department of Agricultural Economics, University of Georgia.

Webb M. Smathers, Jr., Fred C. White, and Robert N. Shulstad gave helpful comments on drafts of this article.

consumer choice. His approach specifies the utility function as being a function of commodities purchased in the market and environmental quality over which the consumer has no control. Within this framework, recreational experiences would be a market commodity for which demand functions would include prices, income, and environmental quality [15, pp. 109-112]. By this approach, available recreational opportunities would be included in demand functions if they were complementary to the recreational experience. This approach has two desirable theoretical features. Following Hicks' use of Occam's razor [13, p. 18], Maler's approach is simpler, requiring only a utility function and an income constraint to deduce the hypothesis that availability of recreational opportunities affects demand for recreation. In contrast, other approaches yield the same reduced form demand equation from a more complex theoretical structure. In addition, Maler's theory establishes that changes in consumer surplus resulting from shifts in demand curves due to changes in environmental quality can be interpreted as the value of environmental quality [15, pp. 178-191].

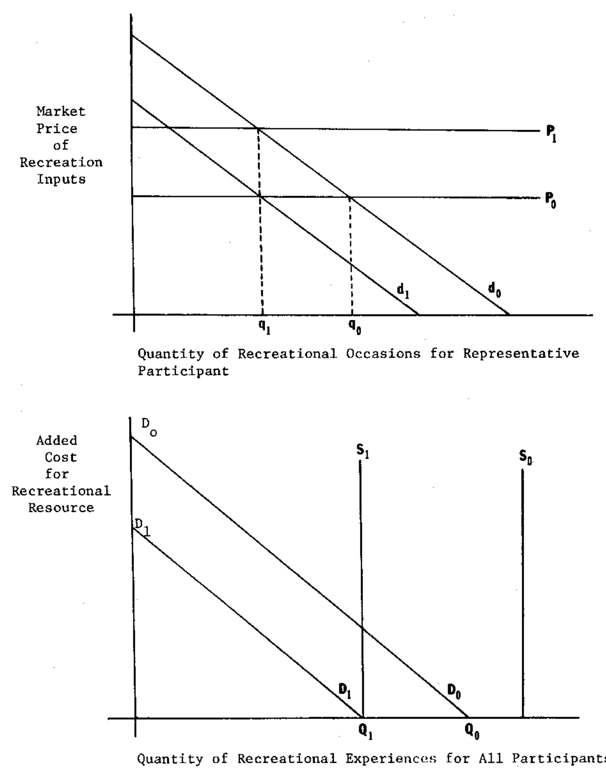
This theoretical review indicates that at least four theoretical frameworks justify inclusion of factors affecting recreational opportunities, such as land use changes, in recreational demand functions. However, previous applications are unclear as to how the supply function for recreational activities interacts with the demand function. Though this identification problem is not important for forecasting, it is important for estimation of consumer surplus of recreational resources. A theoretical model that addresses this issue is illustrated in Figure 1. Components of this model appear in the literature, but this particular presentation is unique as far as the authors are able to determine.

The upper graph represents the decision process of a representative recreator in reference to participation in recreation activities and is similar to a model of Kalter and Gosse [14]. Initially, the recreator has a demand curve d_o for an experience of a particular quality. Under the assumption that his individual recreation decisions do not affect the aggregate availability or quality of experiences to him, the supply curve is horizontal and represents the market cost of inputs necessary to participate in the recreation activity. With an initial price of P_o, the equilibrium of the representative recreator is q_o.

The lower graph in Figure 1 represents aggregate demand and supply for the nonmarket resources utilized in this recreational experience. Following standard methodology [6, 11, 20], one derives this second stage demand curve from the participation decisions of all recreators represented in the upper diagram. Two aspects of D_o can be related to d_o. First, the horizontal intercept of D_o, Q_o, is the sum of q_o, which are the equilibrium quantities from individual decisions. Second, the slope of D_0 represents the slope derived from the slopes of the individual (d_o) demand curves.

Wildlife recreational resources are generally not marketed because of the exclusion problem, but are provided as a joint product with other land uses or as a government service, thus the supply curves are perfectly inelastic. If the supply of recreational opportunities is represented by S_o, the supply is greater than the quantity demanded at zero price and supply does not affect demand. If supply is represented by S_1, the recreational market does have an interaction between supply and demand. Even though aggregate demand equals aggregate supply at a nonzero price, recreators still attempt to consume Q_o because a market does not exist for the natural resources utilized in the recreation experience. The excess demand, Q_1Q_o, however, results in a restriction in the number of recreational opportunities of the same quality. The quality of the recreational experience can have several important dimensions; fishing success [20] and congestion [8, 17] are two quality dimensions given emphasis in past studies.

FIGURE 1. A THEORETICAL MODEL OF INTERACTION BETWEEN SUPPLY AND DEMAND OF RECREATION OPPORTUNITIES



These restrictions in the availability of recreation experiences of a given quality can affect the decisions of participants in two different ways. If quality is localized, the recreator can achieve the same experience, but at a higher price. In Figure 1, the individual supply curve shifts upward to P_1 resulting in a reduction in quantity demanded to q_1. This reduction in quantity demanded in turn causes a shift of the derived demand to D_1 where Q_1 represents the sum of q_1. If the deterioration is more general, consumers will be unwilling to consume as many recreational experiences and the individual demand curve shifts to d_1. Equilibrium is achieved when the aggregate demand curve shifts to D_1 where the excess demand causing the quality deterioration is eliminated. In many cases, shifts in both individual demand and price contribute to the equilibration process.

From this perspective, supply of recreational opportunities serves as a demand shifter similar to other economic and preference variables. For empirical application, the hypothesis that the availability of recreation opportunities affects demand can be tested by inclusion of the appropriate supply variable in the demand model. If this hypothesis is true S_1 represents the appropriate supply curve; if false, the appropriate supply curve is S_o and the availability of recreational opportunities does not affect demand.

EMPIRICAL DEMAND MODEL

The empirical demand model used in this article is adapted from a previous study of wildlife recreation in Georgia [22]. The hypothesis that the amount of available forestland affects demand for big game hunting was tested by using the following model:

$$(1)\quad \ln Q_h = a + b_1 AC_h + b_2 I_h + b_3 H_h + b_4 F_h + u_h$$

where

$\ln Q_h$ = the natural log of the quantity of big game hunting occasions consumed by household h

a = an intercept term

AC_h = average cost per occasion for household h

I_h = income for household h

H_h = last year's big game harvest per person in the household's county of residence

F_h = last year's number of forestland acres divided by the total land acres in the household's county of residence

u_h = an error term.

All current data are for 1971 and are from a Georgia survey completed in 1974 [10]; lagged harvest and forestland acreage are for 1970 [11].

Except for forestland acreage, all independent variables have been used in previous recreation demand studies. Average cost has become a standard price "proxy" in recreation demand equations and income has appeared in a number of past studies [2, 4, 6, 19]. The inclusion of lagged harvest, an indicator of hunting quality, is also consistent with past studies [7, 19]. Though individual observations on harvest would have been superior, unavailability of such data required an assumption that hunting success was constant for all participants in each county. The large number of counties in Georgia (159) makes this assumption less critical than it would be for a state with fewer counties. Land use variables such as water acreage were used by Davis and Seneca [7] but were found not to be significantly related to hunting demand. The land use variable considered, forestland acreage, was proportioned for two reasons: (1) to forestall heteroskedasticity and (2) to reflect the hypothesis that congestion in use of forestland for hunting was related to demand for hunting experiences.

The empirical model incorporates two assumptions that are more specific than the theoretical framework considered in the preceding section. First, use of amount of forestland in county of residence reflects the assumption that this forestland represents hunting opportunities available to the recreator. Because all of Georgia is heavily forested and supports a large game population, this assumption seems reasonable. Even the counties in which the major cities of Atlanta, Augusta, Columbus, Macon, and Savannah are located had an average deer population of 1210 compared with the state average of 1400 per county in 1970 [10]. Though recreators probably do not confine all their hunting to their home county, any alternative formulation seems even more arbitrary. The second assumption is that the forestland variable reflects congestion and other factors associated with quality other than harvest. This assumption is based on the view that forestland is not sufficiently limited as to affect harvest; this view is supported by a low correlation coefficient, .14, between the harvest and forestland variables.

Ordinary least squares regression results for equation 1 are presented in Table 1. The questionnaire used in the recreation survey included discontinuous income questions which necessitated the use of dummy variables to represent income in the regression equation. The dummy variables cover the range from \$3000 to over \$25,000 (the under \$3000 dummy was dropped and an intercept term included). Signs for all coefficients of the independent variables are consistent with a priori expectations. Of particular note is that the coefficient for forestland acreage is positive and significant at the $\alpha = .05$ level, implying that land use changes which alter the amount of available forestland in Georgia will also affect the demand for big game hunting experiences. This result supports the hypothesis that the amount of available forestland, an indicator of the availability of big game hunting recreation experiences, has a significant effect on demand.

TABLE 1. REGRESSION RESULTS FOR BIG GAME HUNTING DEMAND IN GEORGIA, 1971

Independent variable	Coefficient	t-score
Intercept	-.037444	- .06
Average variable cost	-.012606	-2.89***
Big game harvest	11.718141	2.60**
Forestland acreage	1.407567	2.00**
Family income dummy (\$3001 to \$5000)	1.103520	1.68*
Family income dummy (\$5001 to \$7000)	1.140482	2.36**
Family income dummy (\$7001 to \$10,000)	1.268458	2.71***
Family income dummy (\$10,001 to \$15,000)	1.182463	2.46**
Family income dummy (\$15,001 to \$20,000)	1.228255	2.34**
Family income dummy (\$20,001 to \$25,000)	1.673347	3.00***
Family income dummy (over \$25,000)	1.284536	2.46**

***Significant at the .01 level $R^2 = .25$

**Significant at the .05 level

*Significant at the .10 level

Number of observations = 91

VALUE OF FORESTLAND TO HUNTING PARTICIPANTS

Consumer surplus, an indicator of the value of recreational resources, is often estimated from recreation demand equations. To derive such an estimate for big game hunting in Georgia, equation 1 was rewritten as:

$$(2) \quad \ln Q_h' = a + b_1 (AC_h + c) + \sum_k b_k X_{hk} + u_h$$

where

Q_h' = the estimated number of occasions demanded by houshold h

c = the added cost (such as a site entrance fee)

$\sum_k b_k X_{hk}$ = the sum of the other independent variable effects

u_h = an error term.

Gum and Martin [11] suggest subtracting equation 1 from equation 2 to derive a relationship that can be estimated. Simplifying yields:

$$(3) \quad Q_h' = e^{b_1 c} Q_h.$$

Integrating equation 3 over c from zero to a value at which no occasions are demanded, ($Q^1 = 0$), yields an estimate of consumer surplus. If b_1 is assumed to be negative (implying a downward sloping demand curve), no value of c will result in zero occasions demanded because $f(c) \rightarrow 0$ as $c \rightarrow .\infty$. Letting t equal such a value of c, one can estimate consumer surplus for household h, (CS_h), as:

$$(4) \quad CS_h = \lim_{t \to \infty} \int_0^t e^{b_1 c} Q_h dc$$

which converges. Consumer surplus values were calculated for each household with equation 4 and summed to attain a sample estimate.

To predict the effect of a change in forestland on the quantity of big game hunting occasions demanded, equation 1 was rewritten:

$$(5) \quad \ln Q_h'' = a + b_4 (F_h + f_h) + \sum_k b_k X_{hk} + u_h$$

where f_h = the change in available forestland divided by the total land acres in the household's county of residence and Q_h'' = the estimated number of occasions demanded by household h given a change in available forestland. Subtracting equation 4 from equation 5 and simplifying yields:

$$(6) \quad Q_h'' = e^{b_4 f_h} Q_h.$$

Substituting Q_h'' from equation 6 for Q_h in equation 4 results in an estimate for consumer surplus for household h under 1971 demand conditions with a change in forestland of the magnitude f_h.

For an empirical application of this model, the changes in forestland for the four-year period 1973-1976 estimated in a recent study of crop production shifts in Georgia [20] were used to estimate f_h. Big game hunting surpluses, with and without a forestland change (f_h), were then estimated. These sample estimates were multiplied by an appropriate expansion factor to derive state estimates.[1] Results of this analysis are presented in Table 2.

TABLE 2. THE EFFECTS OF FORESTLAND CHANGES ON QUANTITY DEMANDED OF AND CONSUMER SURPLUS FOR BIG GAME HUNTING IN GEORGIA

Estimated Hunting Occasions, 1971	1,398,843
Estimated Hunting Occasions with Forestland Changes	1,391,199
Consumer Surplus, 1971	$110,965,690
Consumer Surplus with Changes in Forestland	$110,351,110
Acres of Reduction in Forestland	402,918

Ceteris paribus, the 1973-1976 reduction in forestland would have resulted in a reduction of 7,644 hunting occasions demanded and a consumer surplus reduction of $614,580. The change in surplus per acre of forestland change is $1.53.

This change in surplus can be interpreted as the recreation value of the forestland that shifted into crop production between 1973 and 1976. In terms of efficiency, the recreation benefits would not be sufficient to have justified preventing these changes with public policy. This proposition is based on the view that landowners would require larger increases in rent than $1.53 per acre to not convert forestland to agriculture. However, other collective benefits of forestland in addition to big game hunting could still justify maintenance of forestland. Conceptually, a complete analysis would entail deriving such collective benefits to other groups and comparing these with the benefits to consumers of agricultural products that would be gained if the forestland moved into crop production. Because all collective benefits would be extremely difficult if not impossible to measure, a more feasible approach would be to compare the recreation consumer surplus effects of a land use change with the economic surplus effects to agriculture.[2]

CONCLUSIONS

The authors develop a method of estimating the value of particular land uses to participants in wildlife recreation. The method is based on the theoretical view that recreation opportunity sets affect recreation demand. This view is supported with a demand equation for big game hunting in Georgia which includes forestland as an explanatory variable. Using adaptations of standard recreation methodology, the authors estimated the effects of forestland reduction on consumer surplus of big game hunters. The $1.53 loss in surplus does not appear significant enough to have warranted policies to forestall the land use change from forestland. However, in situations with more big game hunters and/or less available forestland, the benefits to recreators may be sufficient to justify compensation of landowners. Furthermore, other types of recreation and other demands for forestland of a collective nature, such as those of conservationists, were not considered in the analysis. Consideration of these demands may result in much greater consumer surplus changes than are indicated here. In addition, it must be stressed that the reduction in forestland did involve a redistribution of welfare away from big game hunters to other groups such as consumers of agricultural commodities.

In general, the results of this study indicate that land use changes may affect various types of recreation demand. Such effects could be predicted prior to policy decisions if knowledge of the sensitivity of recreation demand to certain land use changes were available. The findings of this study suggest that additional research on the relationship between land use and recreation demand for different geographic areas and recreation activities is warranted. In particular, the effects of relaxing the assumptions used in this study about the relationship between forestland acreage and recreational demand should be examined.

[1]The expansion factor used was 1528.79 which is equal to the number of households in the state as of 1970 (1,374,384) divided by the total number of households (899) from the sample upon which this empirical study was based. The random sample included participants in wildlife recreation activities other than game hunting, as well as households that did not participate in any form of wildlife recreation.

[2]See Martin et al. [16] for one such analysis between hunting and cattle ranching in Arizona.

REFERENCES

[1] Arrow, Kenneth J. "The Economic Implications of Learning by Doing," *Review of Economic Studies,* Volume 29, pp. 155-173.

[2] Batie, S. S., R. B. Jensen, and G. L. Hogue. "A Lancasterian Approach for Specifying Derived Demands for Recreational Activities," *Southern Journal of Agricultural Economics,* Volume 8, July 1976, pp. 101-107.

[3] Becker, Gary S. *Economic Theory.* New York: Alfred A. Knopf, Inc., 1971.

[4] Cicchetti, Charles J., Joseph J. Seneca, and Paul Davidson. *The Demand and Supply of Outdoor Recreation.* Rutgers, New Jersey: Bureau of Economic Research, 1969.

[5] Ciriacy-Wantrup, S. V. *Resource Conservation: Economics and Policies,* revised edition, California Agricultural Experiment Station, 1963.

[6] Clawson, Marion and J. L. Knetsch. *Economics of Outdoor Recreation.* Baltimore: Johns Hopkins Press, 1966.

[7] Davis, Robert K. and Joseph J. Seneca. "Model for Supply and Demand Analysis in State Fish and Game Planning," *Thirty-Seventh North American Wildlife Conference,* 1972, pp. 234-245.

[8] Dwyer, John F. and Michael D. Bowes. "Concepts of Value for Marine Recreational Fishing," *American Journal of Agricultural Economics,* Volume 60, December 1978, pp. 1008-1012.

[9] Environmental Research Group. *A Guide to the Data Collecting and Processing System. Economic Evaluation of Wildlife and Wildlife Oriented Resources in the Southeastern U.S.* Atlanta: Georgia State University, 1972.

[10] Georgia State Game and Fish Commission. *1970 Georgia Wildlife Habitat and Resource Inventory,* Atlanta, 1970.

[11] Gum, Russell L. and William E. Martin. "Problems and Solutions in Estimating the Demand for and Value of Rural Outdoor Recreation," *American Journal of Agricultural Economics,* Volume 57, November 1975, pp. 558-566.

[12] Hagarty, Thomas F. and Robert J. Mackay. "Some Implications of the New Theory of Consumer Behavior for Interpreting Estimated Demand Elasticities," *American Journal of Agricultural Economics,* Volume 57, May 1975, pp. 340-343.

[13] Hicks, J. R. *Value and Capital,* second edition. London: Oxford University Press, 1946.

[14] Kalter, Robert J. and Lois E. Gosse. "Recreation Demand Functions and the Identification Problem," *Journal of Leisure Research,* Volume 2, Winter 1970, pp. 43-53.

[15] Maler, Karl-Goran. *Environmental Economics: A Theoretical Inquiry.* Baltimore: Resources for the Future, Inc., Johns Hopkins University Press, 1974.

[16] Martin, William E., J. Craig Tinney, and Russell L. Gum. "A Welfare Economic Analysis of the Potential Competition Between Hunting and Cattle Ranching," *Western Journal of Agricultural Economics,* Volume 3, December 1978, pp. 87-97.

[17] McConnell, Kenneth E. "Congestion and Willingness to Pay: A Study of Beach Use," *Land Economics,* Volume 53, May 1977, pp. 185-195.

[18] Oliveira, Ronald A. and Gordon C. Rausser. "Daily Fluctuations in Campground Use," *American Journal of Agricultural Economics,* Volume 59, May 1977, pp. 283-293.

[19] Shulstad, Robert N. and Herbert H. Stoevener. "The Effects of Mercury Contamination in Pheasants on the Value of Pheasant Hunting in Oregon," *Land Economics,* Volume 54, February 1978, pp. 39-49.

[20] Stevens, Joe B. "Recreation Benefits from Water Pollution Control," *Water Resources Research,* Volume 2, 1966, pp. 167-182.

[21] White, Fred C. et al. *The Environmental and Economic Impact of Placing Soil Bank, Marginal, and Submarginal Land in Crop Production in Georgia,* Final Report for Grant No. R804510 with the Environmental Protection Agency, Athens, Georgia, in preparation.

[22] Ziemer, Rod F. and Wesley N. Musser. *The Demand for and Value of Wildlife Recreation in Georgia,* Georgia Agricultural Experiment Station, Research Bulletin No. 220, June 1978.