A COMPARISON OF LONG-RUN FORECASTS OF DEMAND FOR FISHING, HUNTING AND NONCONSUMPTIVE WILDLIFE RECREATION BASED ON THE 1980 and 1985 NATIONAL SURVEYS

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ABSTRACT

The purpose of this report is to compare two long-run forecasts of participation in fishing, hunting, and nonconsumptive wildlife recreation based on the 1980 and 1985 national surveys. The study addresses the question of stability in the empirical relationships and long-run predictability of the logit model. The research procedure follows federal guidelines recommending that forecasts of recreation demand be based on multiple regression analysis which provides coefficients estimating how much each of the explanatory variables causes participation to vary. When one or more of the determinants of demand is expected to change in future years, its effect on consumption can be estimated. Participation in both years is shown to be a function of population, a travel cost proxy for price, the price of substitutes, income, age, residence, and other socioeconomic characteristics of individuals, quality of the experience, and availability of resources. Both forecasts are based on predicted changes in these exogeneous variables available from the U.S. Census and other published sources.

Indications are that nonconsumptive wildlife recreation will be the fastest growing activity. This trend is evident in both the 1980 and 1985-based forecasts with virtually identical results, assuming medium population growth. The historical growth in fishing is expected to continue with growth in coldwater fishing more than twice that of warmwater. The 1980 and 1985-based forecasts of fishing are not significantly different, with the more recent forecast indicating slightly more growth in coldwater fishing and slightly less increase in warmwater. The hunting forecasts are mixed with small game hunting expected to decrease slightly, big game hunting to be unchanged, and migratory waterfowl hunting to increase. The 1985-based forecasts indicate less decline in small game and big game hunting, and more increase in migratory waterfowl hunting. The tentative conclusion is that replication of the earlier study yields generally consistent results.

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A COMPARISON OF LONG-RUN FORECASTS OF PARTICIPATION IN FISHING, HUNTING, AND NONCONSUMPTIVE WILDLIFE RECREATION BASED ON THE 1980 AND 1985 NATIONAL SURVEYS

Richard G. Walsh, Kun H. John, and John R. McKean*

INTRODUCTION

The purpose of this report is to compare long-run forecasts of demand for fish and wildlife recreation based on the 1980 and 1985 national surveys. A logit model is used to forecast the proportion of the population of the continental United States who are expected to participate in (1) nonconsumptive wildlife recreation trips; (2) fishing for cold water and warm water species; and (3) hunting big game, small game, and migratory waterfowl in the years 2000, 2010, 2020, 2030 and 2040. The study addresses the question of stability in the empirical relationships and long-run predictability of the logit model. Participation in both years is expected to be a function of population, a travel cost proxy for price and the price of substitutes, income, age, residence, and other socioeconomic characteristics of individuals, quality of the experience, and availability of resources.

The procedure used in this study follows the federal guidelines (U.S. Water Resources Council, 1983) which recommend that forecasts of recreation demand be based on multiple regression analysis, providing coefficients estimating how much each of the explanatory variables causes demand to vary.

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When one or more of the determinants of demand is expected to change in future years, its effect on consumption can be estimated. A limitation of the multiple regression approach is that it assumes the relationship between demand and its determinants, as shown by their regression coefficients, will remain sufficiently stable so that inserting expected changes in their values will accurately predict the future. The technique implicitly assumes that the variables determining recreation behavior in the future will be the same as those at the time of the study. For example, it assumes a constant relationship between demand and resource supply over time. Thus, the method cannot foresee the effect of large changes in preferences, institutions, or biological breakthroughs in the production of fish and wildlife. For this reason, national participation surveys are undertaken every five years to provide the data base necessary to update the demand for fish and wildlife.

CURRENT SITUATION AND RECENT TRENDS

Wildlife-related activities currently represent one of the most important forms of outdoor recreation in the United States. Table 1 shows that the most popular activity is warm water fishing, with 18 percent of the population 16 years of age and older participating in 1985 (preliminary estimate). Roughly 7.4 percent participate in cold water fishing for trout and salmon. Approximately 7.0 percent participate in hunting for big game (deer, elk, etc.), 6.4 percent for small game (rabbits, squirrels, etc.), and 2.9 percent for migratory birds (geese, ducks, etc.). Less than 1.5 percent of the population hunt for other types of animals such as fox and raccoon which are omitted from this study.

A reported 16 percent of the population take nonconsumptive trips for the primary purpose of observing, photographing, or feeding wildlife. Apparently, fish and wildlife have a special importance to people, not only because of the

Table 1. Descriptive Statistics for Participation in Wildlife Recreation, United States, 1980 and 1985

Variable	Unit of Measure	Participants: Nonconsumptive Wildlife-Related Trips		Fishing: Cold Water		Fishing: Warm Water		Hunting: Big Game		Hunting: Small Game		Hunting: Migratory Birds	
Year		1980	1985	1980	1985	1980	1985	1980	1985	1980	1985	1980	1985
Number of Persons	Millions	28.8	29.3	11.4	13.5	29.5	33.1	11.8	12.5	12.4	10.8	5.3	5.0
Proportion of Population	Percent	17.0	16.0	6.7	7.4	17.4	18.1	7.0	7.4	7.3	6.4	3.1	2.9
Total Expenditures	Billion Dollars	$4.0	$4.4	$1.5	$3.8	$5.4	$8.9	$1.6	$2.5	$1.1	$1.2	$0.6	$0.6
Per Participant													
Trips	Trips/year	11 (0.81)	9 (-) (0.25)	10 (1.00)	15 (+) (0.43)	18 (0.69)	17 (0.31)	8 (0.61)	9 (0.10)	12 (0.77)	12 (0.09)	8 (0.67)	8 (0.07)
Days	Days/year	13 (0.84)	12 (0.30)	12 (1.00)	15 (+) (0.25)	20 (0.75)	28 (+) (0.15)	10 (0.53)	12 (+) (0.09)	12 (0.77)	12 (0.08)	8 (0.72)	8 (0.08)
Expenditures	Dollars/year	$139 (4.47)	$142 (4.80)	$132 (10.22)	$282(+) (3.94)	$183 (8.62)	$270(+) (2.17)	$132 (7.25)	$199(+) (2.11)	$89 (5.49)	$112(+) (1.33)	$120 (7.25)	$109 (1.67)

Source: U.S. Fish and Wildlife Service (1982; 1988) and subsample estimates to separate fresh water fishing into cold water and warm water fishing.

[a] Standard error of the mean is shown in parenthesis. A plus (+) indicates a significant increase in the mean at the .10 level and a minus (-) a significant decrease.

fishing and hunting they provide, but also because of their important ecological role in the environment (Shaw and Mangun, 1984).

Table 1 illustrates several important economic aspects of wildlife recreation. Expenditures for the types of fishing, hunting, and nonconsumption wildlife-related trips studied amount to about $21.4 billion per year. Participants report spending a range of about $110 to $200 per year for hunting, $270 to $282 for fishing, and $142 for primarily nonconsumptive wildlife-related trips. Expenditures represent primarily the variable or direct costs of transportation, lodging, added food, licenses, fees, and miscellaneous expenses. To a considerable extent, fishermen and hunters pay for public management program through license fees and through excise taxes on equipment purchased while nonconsumptive users, for the most part, do not.

The level of participation is limited, of course, by legal and institutional restrictions, seasonal access, and availability of fish and wildlife. However, the surveys indicate that participation in warmwater fishing increased from an average of 20 days in 1980 to 28 days in 1985 primarily on multiple-day trips. Participation in coldwater fishing increased from 12 to 15 single-day trips, and big game hunting from 10 to 12 days with fewer single-day trips. By comparison, nonconsumptive wildlife recreation decreased slightly from 13 to 12 days, mostly single-day trips. Wildlife-related recreation activities account for an increasing share of the estimated 100 days per year the average participant engages in outdoor recreation in the United States (Walsh, 1986).

Table 2 compares the socioeconomic characteristics of participants and nonparticipants in wildlife recreation for 1980 and 1985. Hunters tend to be younger white men with larger families living in nonurban regions with somewhat lower education and income. Anglers are somewhat older, more likely to be

Table 2. Socioeconomic Characteristics of Participants and Nonparticipants in Wildlife Recreation, United States, 1980 and 1985

Variable	Unit of Measure	Non-participants 1980	Non-participants 1985	Nonconsumptive Wildlife-Related Trips 1980	Nonconsumptive Wildlife-Related Trips 1985	Fishing: Cold Water 1980	Fishing: Cold Water 1985	Fishing: Warm Water 1980	Fishing: Warm Water 1985	Hunting: Big Game 1980	Hunting: Big Game 1985	Hunting: Small Game 1980	Hunting: Small Game 1985	Hunting: Migratory Birds 1980	Hunting: Migratory Birds 1985
Income	Thousand Dollars	18.0 (0.27)	25.9 (+) (0.37)[b]	23.6 (0.55)	33.2 (+) (0.71)	25.0 (0.69)	32.4(+) (0.60)	21.1 (0.28)	29.9(+) (0.39)	22.0 (0.42)	30.3(+) (0.40)	22.1 (0.45)	30.4(+) (0.45)	26.1 (0.78)	33.3 (+) (0.74)
Employment	Percent Employed	0.48	0.50	0.65	0.67	0.70	0.68	0.67	0.66	0.74	0.75	0.73	0.74	0.72	0.76
Age	Years	45.6 (0.45)	48.9 (+) (0.38)	36.4 (0.60)	37.5 (0.56)	36.4 (0.75)	37.0 (0.51)	36.6 (0.35)	37.9(+) (0.35)	35.8 (0.53)	36.5 (0.35)	34.0 (0.52)	35.0(+) (0.39)	32.4 (0.73)	35.4 (+) (0.60)
Education	Years	11.7 (0.09)	12.4 (+) (0.07)	13.3 (0.14)	12.5 (-) (0.11)	13.0 (0.16)	13.0 (0.08)	11.7 (0.08)	12.0(+) (0.06)	13.3 (0.12)	13.4 (0.06)	13.1 (0.12)	13.2 (0.07)	13.0 (0.16)	12.5 (-) (0.10)
Marital Status	Percent Married	0.54	0.68	0.64	0.63	0.67	0.65	0.71	0.59	0.70	0.62	0.66	0.65	0.61	0.69
Family Size[a]	Persons	2.8 (0.03)	2.5 (-) (0.02)	3.4 (0.07)	2.5 (-) (0.04)	3.2 (0.07)	2.6(-) (0.03)	3.4 (0.04)	2.4(-) (0.02)	3.6 (0.06)	2.4(-) (0.02)	3.7 (0.06)	2.3(-) (0.03)	3.5 (0.09)	2.3 (+) (0.04)
Race	Percent White	0.81	0.84	0.91	0.94	0.95	0.94	0.93	0.92	0.97	0.97	0.96	0.95	0.98	0.99
Sex	Percent Male	0.44	0.39	0.48	0.49	0.70	0.72	0.69	0.68	0.89	0.91	0.92	0.93	0.95	0.96
Residence[a]	Percent Urban	0.79	0.55	0.66	0.49	0.60	0.48	0.55	0.38	0.43	0.31	0.47	0.30	0.56	0.35
Sample Size		2,021	2,550	608	719	616	884	1,757	2,084	1,041	1,740	986	1,380	452	624

Source: Subsample estimates from the Census Survey reported in U.S. Fish and Wildlife (1982; 1988).

[a] The Census definition of family size and urban residence changed between the 1980 and 1985 surveys; therefore, they re not comparable.

[b] Standard error of the mean is shown in parenthesis. A plus (+) indicates a significant increase in the mean at the .10 level and a minus (-) a significant decrease.

married, and to live in urban areas. More women participate in fishing than in hunting. More women than men participate in nonconsumptive wildlife recreation. Also, more nonconsumptive users live in urban areas with somewhat higher education and income than consumptive users. By comparison, nonparticipants in wildlife recreation are older, fewer are employed, with somewhat lower education and income. Fewer are married and household size is smaller. More are nonwhite women living in urban areas.

The relationships which were apparent in 1980 appear to have continued in 1985. Household income in current dollars, not deflated for inflation, increased at about the same rate for participants and nonparticipants. Average age of all groups increased somewhat as expected, with nonparticipants experiencing the largest increase. Average education of nonconsumptive wildlife recreation users decreased and increased for nonparticipants. The measure of family size decreased significantly for all groups because in 1985, the question asked for number of persons five years of age and older. These variables are identifed in Table 2 with a plus for significant increase at the .10 level and a minus for decrease. It was not possible to test the significant difference between the means of categorical variables, including employment, marital status, race, sex, and residence. Employment rates were nominally the same in the two years. Substantially more nonparticipants were married in 1985, as were migratory bird hunters, while fewer married persons participated in warmwater fishing and big game hunting. Considerably more women and whites were nonparticipants in 1985. The measure of urban residence decreased substantially for all groups because of a change in Census definition, but the relationship among groups did not change between the two years.

The demand for wildlife-based recreation activities is related to how many people choose to participate and how often. Table 3 illustrates the historic trend in consumption of fishing and hunting by persons 12 years of age and older for 25 years from 1955 to 1980. The data show that the compound annual growth in total days of freshwater fishing, for example, was approximately 3.8 percent. Population growth of 1.8 percent accounted for nearly half of this. The proportion of the population participating grew at a compound annual rate of only 1.0 percent, as did the average number of days per participant. By comparison, the compound annual growth in total days of small game hunting was 3.6 percent with an increase in the number of days per participant accounting for 2.0 percent or more than half. The proportion of the population participating actually declined at a rate of -0.2 percent per year. However, population growth more than offset the decline, so that the total number of persons participating increased by 1.6 percent per year. Table 3 also shows the variation in growth of big game and migratory bird hunting.

Table 3. Compound Annual Growth of Participation in Fishing and Hunting, United States, 1955-1980

		Hunting		
Compound Annual Growth in ...	Freshwater Fishing	Big Game	Small Game	Migratory Birds
			(Percent)	
Participation				
Proportion of Population	1.0	2.5	-0.2	0
Number of Persons	2.8	4.3	1.6	1.8
Days per Participant	1.0	1.3	2.0	-0.6
Total Days	3.8	5.6	3.6	1.2

Source: Calculated from data in U.S. Fish and Wildlife Service (1982; p. 134) using compound growth tables.

LOGIT REGRESSION MODEL

Decisions to participate in wildlife-related recreation activities represent a series of discrete choices. Individuals select from a finite set of alternatives to reach a decision about which activity they will participate in at a particular time and place. Binominal choice models with a 0-1 dependent variable are a particular type of discrete choice models which are frequently used in recreation research (Miller and Hay, 1981; Hay and McConnell, 1984). The SPSS-X program uses the maximum likelihood technique to estimate a logistic regression of the form $\log [P/(1-P)] = BX$, where P = probability of participation; B = the vector of coefficients; and X = a vector of explanatory variables.

The pioneering studies of participation in outdoor recreation by Davidson, et al. (1966) and Cicchetti, et al. (1969, 1972, 1973) used ordinary least squares (OLS) procedures since algorithms for logit estimates were not widely available at the time. However, there are a number of problems in using the OLS approach. First, if the error terms are not normally distributed, heteroscedasticity results in inefficient estimators. Second, if the error terms are not normally distributed, t-tests of significance are meaningless. Third, predicted probabilities from the estimated equation are likely to range outside the 0-1 probability interval. Fourth, there are difficulties in interpreting the R^2 measure of goodness-of-fit. Finally, there are questions about the appropriateness of the essentially linear functional form.

The logit model has the advantage, according to Stynes and Peterson (1984), that its underlying functional form is "bounded and doubly asymptotic, approaching $y = 0$ and $y = 1$ as X approaches negative infinity and positive infinity respectively. The function is (especially) well suited to processes which have start-up impediments and saturation effects, as the curve grows slowly at first, reaches a maximum rate of growth, and then proceeds to increase at a decreasing rate, approaching the saturation point as a limit." Further, maximum likelihood estimation of the model yields coefficients which are asymptotically consistent, efficient, and normally distributed. Therefore the t-test is a valid test of significance.

Figure 1 illustrates the difference between the logit and linear OLS probability models. The linear model assumes that a unit change in a causal variable (X) always creates a constant rate of change in predicted probability

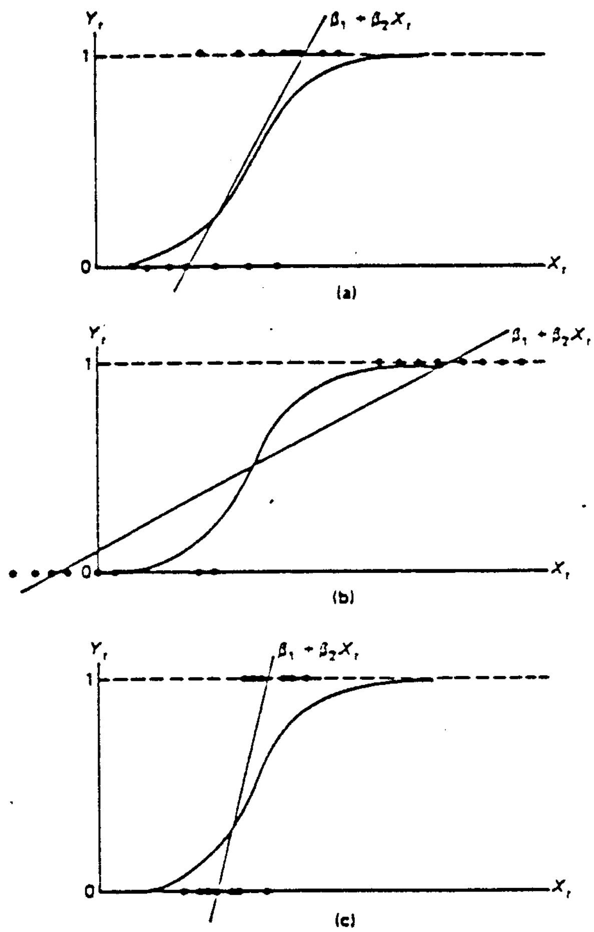

Figure 1. Comparison of Logit and OLS Linear Probability Models

Source: Hanushek and Jackson, 1977.

(Y). It is usually more realistic to assume that change in an exogenous variable has less and less effect on probability as it approaches either zero or unit, resulting in an S-shaped curve. Panel (a) portrays a case where the OLS line and the logit curve are nearly coincident within the middle range of probabilities. In such a case, both models would yield nearly identical probability estimates. This is supported empirically by Smith and Munley (1978) who, in comparing the results of OLS and logit analysis, report little difference in their relative predictive performance or ability to identify key variables. Panels (b) and (c) illustrate cases in which the estimated probabilities obtained using a logit model and those obtained using OLS are likely to diverge substantially in the middle range of probability. In such a case, Bell and Leeworthy (1987) conclude that in terms of intra-sample predictive ability, OLS was superior to logit for the data set which they used.

Thus, while there are theoretical reasons for using logit analysis, the choice of methodology remains unclear in applied research. In a practical sense, logit is somewhat less tractable than is the OLS regression technique. It is computationally more time consuming and expensive. Since the logit regressions error term is not based on the normal distribution, many of the familiar tests of significance do not apply. For this reason, it is difficult to judge the reliability associated with the forecasts of probability in the majority of cases. Nevertheless, the logit model is employed in this study to maintain consistency in estimation procedures between 1980 and 1985. The approach has the advantage of reducing bias in probability estimation due to a nonlinear distribution function (referred to as Jensen's inequality).

SOURCES OF DATA AND RESEARCH PROCEDURE

The basic data for this study are from the 1980 and 1985 national survies (U.S. Fish and Wildlife Service, 1982; 1988). These are the sixth and seventh in a series of surveys at 5-year intervals since 1955. They were conducted by the U.S. Bureau of the Census in two phases. First, a sample of about 120,000 households nationwide were interviewed to determine who in the household hunted, fished, or engaged in some nonconsumptive wildlife recreation. Information was obtained on the usual socioeconomic variables and days of participation in hunting and fishing. Also recorded were the annual days on trips primarily for the purpose of nonconsumptive wildlife recreation, i.e., observing, photographing, or feeding wildlife. Information on household members 6 years of age and older was obtained from an adult member of each household. A 95 percent response rate was achieved. For purposes of this study, subsamples of individuals 16 years of age and older was randomly drawn from the Census sample of users and nonusers.

In the second phase of the survey, detailed personal interviews were conducted with samples of fishermen, hunters, and nonconsumptive users identified in the first phase interviews. Detailed information was obtained on types of hunting, fishing, and nonconsumptive wildlife recreation, destination, duration, and variable costs. The sample was limited to persons 16 years of age and older because of the length and complexity of the questionnaires. For purposes of this study, subsamples of individuals who participated in fishing, hunting, and nonconsumptive use were randomly drawn from the Census samples. Our study is limited to fish and wildlife related activities reported by individuals who live in the continental United States. Excluded are residents of the states of Alaska and Hawaii, and foreign travelers to the United States for the purpose of fish and wildlife related activities. Also excluded from the study are U.S. citizens who make trips abroad to hunt or fish. Participants are identified by their state of residence where most participation occurs, however, some participation may occur in other states as well as in the state where they live.

The surveys did not directly differentiate between cold water and warm water fishing. We separated these two activities according to the catch of fresh water fish species classified as either cold water or warm water species (Walsh, et al. 1987). Cold and warm water fishing is limited to inland waters such as rivers, lakes, streams, and ponds. Excluded are the Great Lakes--Superior, Michigan, Huron, Erie and Ontario, tributaries and connecting waters, such as Lake St. Clair, and the St. Lawrence River, south of the bridge at Cornwall, New York, and rivers that run into the Great Lakes (U.S. Fish and Wildlife Service, 1982; 1988). Also excluded is all saltwater fishing in oceans, bays, sounds and tidal waters of rivers and streams.

The Census samples are designed to provide statistically reliable results at the state level for fishing and hunting and at the regional level for nonconsumptive activities. This results in disproportionate sampling of individuals from small states, urban areas, and by level of activity. Thus, the logit equations are estimated with a weighted log likelihood function, as suggested by Manski and Lerman (1977). The normalized weights used are derived from the sample expansion factors provided by the Census.

Estimating the probability of participation in an activity requires that the general population be sampled to include some who participate and some who do not. In this case, the household survey includes those who hunt, for example, and those who do not, but does not indicate what kind of hunting is engaged in. More detailed information is available from the follow-up survey by personal interview, i.e., whether they hunt for big game, small game, or migratory birds. Hence, the probability estimation is divided into two steps: (1) the probability that an individual engages in hunting of any kind, and (2) given that he/she hunts, the probability of hunting a particular type of wildlife. A similar procedure is followed for each type of hunting and fishing. For example, the probability of participating in cold water fishing is estimated, conditional on participation in fishing. This assumes that the decision process is, first, whether or not to fish, and then what kind of fish to seek, as suggested by McConnell (1985). The proportion of the population who participate is modeled as follows:

I. Fishing (First stage)
   1. Cold water fishing (Second stage)
   2. Warm water fishing (Second stage)

II. Hunting (First stage)
   1. Big game hunting (Second stage)
   2. Small game hunting (Second stage)
   3. Migratory waterfowl hunting (Second stage)

III. Nonconsumptive use

These are not exclusive categories, since many individuals report that they engage in more than one type of fishing and hunting, and in addition, take nonconsumptive wildlife recreation trips.

Table 4 defines the explanatory variables included in the equations. Most are standard socioeconomic measures and require no further explanation. Perhaps a brief comment on the proxy for price and quality of the resource would be useful. Economic theory suggests that more individuals will choose to participate in states or regions where average variable costs are lower. The specification of nonparticipant price adopted in this study is limited to interstate or regional variation. Omitted is the possible effect of instate variation across individuals, which may also affect decisions to participate. Moreover, nonparticipants are likely to face a somewhat higher entry price than

Table 4. Definition of Independent Variables in the Logit Regressions

Variable Name	Definition	Unit of Measurement
Price	Average variable cost or miles per participant in respondent's region of residence	Dollars or miles
Cross-Price	Average variable cost or miles per participant in other fish and wildlife activities in respondent's region of residence	Dollars or miles
Income	Respondent's gross household income	Thousand dollars
Employment	Respondent worked for wages last week	1 = employed 0 = unemployed
Age	Age of respondent	Years
Education	Years of education completed by respondent	Years
Marital Status	Respondent's marital status	1 = married 0 = unmarried
Household Size	Number of persons living in respondent's household	Persons/household
Race	Respondent's household race	1 = white 0 = other
Sex	Sex of respondent	1 = male 0 = female
Residence	Respondent's place of residence	1 = urban 0 = rural
Success Rate	Average number of fish caught or wildlife bagged per day or season in respondent's region of residence	Number
Forest[a]	Forest land, public and private in respondent's state of residence	Million acres
Range[a]	Pasture and range land in respondent's state of residence	Million acres
Water[b]	Total fishable water in respondent's state of residence	Million acres
Cold Water[c]	Fishable cold water in respondent's state of residence	Percent
Warm Water[c]	Fishable warm water in respondent's state of residence	Percent
Habitat[d]	Migratory waterfowl habitat in respondent's state of residence	100,000 acres
Big Game[e]	Population of big game in respondent's state of residence	Thousand Animals

[a] U.S. Forest Service, 1981.
[b] U.S. Fish and Wildlife Service, 1966.
[c] Vaughan and Russell, 1982.
[d] U.S. Bureau of Sport Fisheries and Wildlife, 1970.
[e] U.S. Fish and Wildlife Service, 1983.

participants owing to fixed start-up costs. Another problem is that the variable costs reported by participants may not equal the total cost of participation. However, it is not likely that the amount that costs are understated would vary systematically across regions. For purposes of forecasting the behavior of individual participants, their perceived travel cost or miles traveled is expected to explain actual behavior better than alternative measures that might be used.

The resource-related variables used in this study are based on state and regional level data from sources other than the Census surveys. They are assigned to each individual in the sample based on state of residence. Aggregation of the resource variables to the state or regional level is necessary because the available information on wildlife and fish resources does not permit the identification of the quantity of resources at any finer level (county, for example). Thus, the resource variables involve the implicit assumption that suitable resources are distributed so that typical residents in a state or region, both participants and nonparticipants, face a similar resource situation.

The second phase of the Census surveys provide detailed information on the success rate for fishing and hunting in 1980 and for fishing in 1985. Within the institutional constraints on daily or seasonal catch or bag, success rate depends on the skill of individual participants and the availability of fish and wildlife. To isolate the effect of management programs on availability of fish and wildlife, it is necessary to hold the effects of individual skill constant. It seems reasonable to assume that individual skill would not vary systematically across states and regions of the United States. Thus, the average catch per state or region can be used as an effective indicator of the quality of resource (Charbonneau and Hay, 1978; Vaughan and

Russell, 1982; Hay and McConnell, 1984). Accordingly, the participation equations for types of hunting and fishing may contain a variable, success rate, defined as the average number of fish caught or wildlife bagged per participant in the respondent's region of residence.

PROBABILITY OF PARTICIPATION EQUATIONS

Tables 5, 6, and 7 present the estimated logit equations for participation in wildlife recreation. Table 5 estimates the probability that an individual will engage in any type of fishing, hunting, and nonconsumptive wildlife related trips. Table 6 and 7 contain estimates of the probability that individuals will engage in each type of hunting given that they hunt or in each type of fishing given that they fish. The maximum likelihood coefficients are asymptotically consistent, normally distributed, and is a valid test of significance.

The equations show the estimated relationship between participation and 14 hypothesized determinants of demand. The coefficients for each of the independent variables represent the derivatives of the log of the odds (logit) of participation. The relationship of the explanatory variables to the probability of participation is nonlinear at both ends of the S-shaped curve. Thus, the probability computed from the value of the explanatory variables reported by each individual respondent in 1985 is more precise than the probability computed for the sample means of the explanatory variables in 1980 (Lehmann, 1983, p. 50). The standard errors shown in parentheses beneath the coefficients indicate that more of the variables (62 in 1985 and 57 in 1980) included in the 16 equations are significant at the 0.10 level or above in 1985 than in 1980. Omission of a variable indicates that it is not related to participation.

Table 5. Logit Equations for the Probability of Participation in Fishing, Hunting, and Nonconsumptive Wildlife Recreation Trips, United States, 1980 and 1985

Variables[a]	Description of Variables	Nonconsumptive Wildlife Related Trips[b] 1980	1985	Total Fishing[c] 1980	1985	Total Hunting[d] 1980	1985
Constant		2.99045* (0.30)[a]	3.78513* (+) (0.30)	3.65911* (0.16)[a]	3.75187* (0.17)	3.99810* (0.17)[a]	3.04149* (-) (0.29)
Price	Travel cost or miles	-0.004895* (0.02)	-0.00027 (0.0002)	-0.00056* (0.0003)	-0.00043 (0.0003)	-0.00069* (0.0003)	-0.05036* (+) (0.008)
Cross-Price (1)	Travel cost or miles	0.001230 (0.001)	-0.00334* (0.001)	0.00100* (0.0003)	0.00040 (0.0004)	0.00124* (0.0006)	0.00612* (+) (0.002)
Cross-Price (2)	Travel cost or miles	0.00209 (0.002)	0.00403 (+) (0.002)	0.04346* (0.02)	0.00075 (-) (0.0006)	--	--
Income	Thousand dollars per household or capita	0.00942* (0.002)	0.01538* (0.003)	0.01060* (0.003)	0.00255* (-) (0.001)	0.00591 (0.004)	0.00298 (0.004)
Age	Years	0.02854* (0.01)	0.00436 (-) (0.007)	0.00190 (0.007)	0.00747 (0.007)	-0.01269* (0.001)	0.00085 (0.01)
Age Square	Years^2	-0.00044* (0.00009)	-0.00019* (-) (0.00008)	-0.00015* (0.00008)	-0.00020* (0.00007)	--	-0.00019* (0.0001)
Marital Status	1=married 0=unmarried	--	--	0.36033* (0.05)	0.20515* (-) (0.05)	0.17085* (0.05)	0.31453* (+) (0.08)
Household Size	Persons	0.02875* (0.02)	0.00090 (0.02)	--	--	0.09288* (0.01)	0.00460 (-) (0.03)
Race	1=white 0=other	0.36260* (0.08)	0.50265* (0.09)	0.25801* (0.07)	0.27214* (0.07)	0.46608* (0.08)	0.56526* (+) (0.14)
Sex	1=male 0=female	--	--	0.56336* (0.04)	0.56411* (0.04)	0.13683* (0.04)	1.43239* (+) (0.09)
Residence	1=urban 0=rural	--	--	-0.19950* (0.04)	-0.24104* (0.04)	-0.46669* (0.04)	-0.41714* (-) (0.07)
Resource Availability	1,000 acres per capita	0.00211* (0.001)	0.00468* (+) (0.0009)	0.14687* (0.03)	0.16803* (0.03)	0.00827* (0.002)	0.00739* (-) (0.002)

[a] Standard errors are shown in parentheses below the coefficients. An * indicates that a variable is significant at the .10 level or above. A plus (+) indicates a significant increase in the coefficient at the .10 level and a minus (-) a significant decrease. Sample size is 4,000 individuals.

[b] Own price for 1980 is specified as thousands of total annual miles per participant in the region of residence and for 1985, one-way miles to the usual place of participation in the state of residence; cross-price (1) for hunting is total annual variable costs per participant in the region of residence; cross-price (2) for fishing is total annual variable costs per participant in the region of residence; income is per capita; and resource availability is total forest, pasture, and range land per capita in the state of Colorado.

[c] Own price for participants is their reported total annual variable costs, and for nonparticipants it is the regional total annual variable costs; cross-price (1) for hunting is total annual variable costs of participants and regional total variable costs for nonparticipants; cross-price (2) for nonconsumptive use is total annual miles in the region of residence; income is gross household income; and resource availability is total fishable water per capita in the state of residence.

[d] Own price for 1980 is specified as total annual variable costs per participant in the state of residence and for 1985, annual variable cost in the state and region of residence; cross-price for nonconsumptive use is total miles per trip in the state of residence; income is gross household income in 1980 and per capita in 1985; and resource availability is total forest, pasture, and range land per capita in the state of residence.

Table 6. **Logit Equations for the Probability of Participation in Cold Water and Warm Water Fishing Conditional on Participation in Fishing, United States, 1980 and 1985**

Variables	Description of Variables[a]	Cold Water[b] 1980	Cold Water[b] 1985	Warm Water[c] 1980	Warm Water[c] 1985
Constant		3.75319* (0.39)[a]	2.36250* (-) (0.31)	4.46183* (0.43)	5.35057* (+) (0.22)
Price	Miles traveled	-0.00163* (0.002)	-0.01111* (0.0008)	-0.00413* (0.0006)	-0.00566* (0.0008)
Cross-Price	Travel cost or miles	0.00296* (0.0009)	0.17814* (0.02)	0.00248* (0.0002)	0.00380* (0.0009)
Income	Dollars per year ($1,000)	0.00825* (0.003)	-0.00125 (-) (0.002)	--	--
Employment	1=employed 0=unemployed	0.02146 (0.08)	-0.04625 (0.06)	0.08589 (0.08)	0.03002 (0.06)
Age	Years	0.00241 (0.002)	0.00940 (0.01)	0.01892 (0.01)	-0.00803* (0.002)
Age Squared	$Years^2$	--	-0.00014 (0.0001)	-0.00022 (0.0001)	--
Education	Years	0.02220* (0.01)	0.03928* (0.01)	-0.01774 (0.01)	-0.04453* (+) (0.01)
Marital Status	1=married 0=unmarried	-0.08492 (0.08)	-0.03279 (0.06)	-0.04702 (0.09)	0.13467* (+) (0.06)
Household Size	Persons	-0.04958* (0.02)	-0.04466* (0.02)	0.03316 (0.03)	-0.07230* (0.02)
Race	1=white 0=other	0.05630 (0.14)	0.37706* (0.12)	0.07386 (0.07)	0.21254* (0.10)
Sex	1=male 0=female	0.11703 (0.07)	0.32143* (+) (0.06)	0.07297 (0.07)	0.10756* (+) (0.05)
Residence	1=urban 0=rural	0.14198* (0.07)	0.15269* (0.05)	-0.05825 (0.06)	-0.18324* (0.05)
Success Rate	Number of trout per day	0.03088 (0.09)	0.00305* (0.0006)	0.12151* (0.05)	0.01189* (-) (0.002)
Resource Availability	Percent cold water	0.01233* (0.002)	3.87368* (+) (0.15)	--	1.28285* (0.12)

[a] Standard errors are shown in parentheses below the coefficients. An * indicates that a variable is significant at the .10 level or above. A plus (+) indicates a significant increase in the coefficient at the .10 level and a minus (-) a significant decrease. Sample size is 2,212 in 1980 and 3,000 in 1985.

[b] Own price for 1980 is specified as the reported total annual miles for participants, and regional total annual miles for nonparticipants; own price for 1985 is specified as one-way miles to the usual place of coldwater fishing in the region of residence; cross-price for warmwater fishing in 1980 is the same as own price; for 1985, cross-price is variable cost per day per participant in the region of residence; income is total household income; success rate is regional average catch per day in 1980 and per year in 1985; resource availability is the proportion of cold water to total fishable water in the state of residence.

[c] Own price for 1980 is specified as reported total annual miles for participants, and regional total annual miles for nonparticipants; own price for 1985 is specified as one-way miles to the usual place of warmwater fishing in the region of residence; cross-price for coldwater fishing is the same as own price in 1980 and one-way miles to the usual place of coldwater fishing in the region of residence in 1985; success rate is regional average catch per day; resource availability is the proportion of cold water to total fishable water in the state of residence.

Table 7. Logit Equations for the Probability of Participation in Hunting Big Game, Small Game, and Migratory Birds Conditional on Participation in Hunting, United States, 1980 and 1985

Variables[a]	Description of Variables	Big Game[b] 1980	Big Game[b] 1985	Small Game[c] 1980	Small Game[c] 1985	Migratory Birds[d] 1980	Migratory Birds[d] 1985
Constant		4.93365* (0.26)	4.92797* (0.19)	5.74007* (0.22)	5.35524* (-) (0.17)	3.24927* (0.46)	2.54835* (0.26)
Price	Travel cost or miles	-0.00313* (0.001)	-0.01070* (+) (0.002)	-0.00272* (0.0008)	-0.00128* (-) (0.0004)	-0.01561* (0.002)	-0.00125* (0.0004)
Cross-Price (1)	Dollars per day	-0.00185* (0.0008)	0.00603* (+) (0.002)	--	--	0.00623* (0.002)	0.00803* (0.003)
Cross-Price (2)	Dollars per day	--	--	--	--	-0.00083 (0.0007)	0.00053* (0.0003)
Income	Thousand dollars per capita	-0.01025* (0.005)	-0.00780* (0.003)	-0.00112 (0.002)	-0.00021 (0.001)	0.01406* (0.003)	0.00344* (-) (0.002)
Employment	1=employed 0=unemployed	--	--	--	--	-0.24949* (0.08)	0.02344 (0.06)
Age	Years	0.03442* (0.01)	0.02495* (0.008)	-0.01087* (0.002)	0.00760* (-) (0.002)	-0.01023* (0.003)	-0.00254 (-) (0.002)
Age Square	$Years^2$	-0.00037* (0.0001)	-0.00030* (0.00009)	--	--	--	--
Education	Years	--	--	-0.01651* (0.009)	-0.01092 (-) (0.008)	0.06028* (0.01)	0.06466* (0.01)
Marital Status	1=married 0=unmarried	--	--	0.01932 (0.08)	-0.13563* (+) (0.05)	-0.09641 (0.08)	-0.08445 (0.06)
Household Size	Persons	--	--	--	--	-0.02420 (0.02)	-0.01321 (0.02)
Race	1=white 0=other	0.38322* (0.13)	0.39312* (0.11)	0.06516 (0.15)	-0.19036* (0.11)	0.06438* (0.02)	0.48912* (+) (0.17)
Sex	1=male 0=female	--	--	0.41890* (0.09)	0.36376* (-) (0.07)	0.66523* (0.12)	0.43605* (0.10)
Residence	1=urban 0=rural	-0.24539* (0.06)	-0.18499* (0.05)	0.06588 (0.06)	-0.06035 (0.05)	0.16260* (0.06)	0.04879 (0.06)
Success Rate	Number per day	--	--	0.03963 (0.04)	--	0.10919* (0.03)	--
Resource Availability	1,000 animals or acres	0.02488* (0.004)	0.01980* (0.004)	--	0.00276* (0.002)	--	0.09163* (0.04)

[a] Standard errors are shown in parentheses below the coefficients. An * indicates that a variable is significant at the .10 level or above. A plus (+) indicates a significant increase in the coefficient at the .10 level and a minus (-) a significant decrease. Sample size is 1,445 in 1980 and 2,570 in 1985.

[b] Own price is specified as variable cost per day per participant in the region of residence; cross-price for small game is variable cost per day per participant in the region of residence, for 1985, cross-price for migratory bird hunting is variable cost per day; income is per capita; and resource availability is thousands of big game animals in the state of residence.

[c] Own price is specified as total annual variable costs for small game hunting in the region of residence; income is total household income; resource availability is thousands of acres of habitat in the state of residence.

[d] Own price for 1980 is specified as total annual variable cost per participant in the region of residence; for 1985 is as one-way miles to the usual place to hunt migratory birds in the region of residence; cross-price (1) for small game hunting is variable cost per day per participant in the region of residence; cross-price (2) for big game is total annual variable cost per participant in the aggregate region of residence; income is total household income; resource availability is thousand acres of total wetland in the state of residence.

Since the logit model is estimated by the maximum likelihood method, a coefficient of multiple correlation is not generated. However, an R^2 like measure can be calculated which gives an indication of the ratio of the explained variation in the dependent variables to total variation in the equation (Pindyek and Rubinfield, 1981, p. 312). These values were estimated for the 1985 equations as follows: nonconsumptive wildlife recreation, 0.06; total fishing, 0.11; coldwater, 0.36; warmwater, 0.67; total hunting, 0.17; big game, 0.16; small game, 0.32; and migratory bird, 0.06. These results are consistent with R^2 levels reported by recreation demand studies based on cross-sectional data from household surveys (Walsh, 1986).

The price proxy has the correct sign and is significant in 14 of the 16 regressions. The negative coefficients indicate that with future increases in travel costs, license fees, access fees, and other expenses associated with wildlife recreation, the proportion of the population participating will decrease, other variables constant. Although the travel cost or distance proxy for price necessarily lacks precision, the coefficients suggest that participation in wildlife recreation may be price inelastic. Price elasticity indicates the effect future expansion of public and private management programs through increases in user fees would have on the proportion of the population who participate.

At least one cross-price variable for alternative wildlife recreation activities in the state or region of residence is significant in 15 of the regressions. A positive coefficient indicates that an alternative recreation activity is a substitute and a negative coefficient indicates that it is a complement. The most important tentative finding with respect to cross-prices is that nonconsumptive wildlife recreation substitutes for hunting. This is indicated by the positive coefficient for the cross-price of nonconsumptive trips in the hunting equation. If hunting and nonconsumptive wildlife recreation are substitutes, it would have important implications for public policy. Increases in the price of hunting not only decrease participation in that activity but increase demand for nonconsumptive trips. In the 1980 total fishing equation, the positive cross-price coefficient for hunting indicates that it substitutes for fishing. This suggests that increases in the price of hunting may have contributed to decreased participation in that activity and the increased demand for fishing.

The income variable is significant in 9 of the regressions. The positive coefficients for income shown in Table 5 indicate that wildlife recreation is a normal good. This means that as future incomes rise, the proportion of the population participating in fishing and nonconsumptive wildlife recreation also will increase, all else constant. The income coefficient for total hunting is positive but not significant. The negative coefficient for income in the big game hunting equation shown in Table 6 indicates that given one is a hunter, the probability of big game hunting will fall as incomes rise. This reflects the changing relative preference of hunters for migratory bird hunting, which has a positive income coefficient.

Age, a measure of the physical ability and inclination to engage in wildlife recreation, is a significant explanatory variable in 12 of the regressions. The quadratic relationship between age and participation in fishing, hunting, and nonconsumptive wildlife recreation indicates that increasing age affects participation positively up to a point and then has an overall negative effect, other things being equal.

The residence variable is significant in 10 of the regressions. The negative coefficients for warmwater fishing, small game hunting, and big game hunting indicate that persons living in urban areas are less likely to participate in these activities than individuals in rural areas, other things being equal. This is due, in part, to limited access to opportunities in urban areas (Miller and Hay, 1981). The positive coefficients for cold water fishing and migratory bird hunting indicate that as urbanization increases, urban residents are likely to increasingly choose these activities.

Other demographic variables also are important. Race is positive and significant in 13 of the regressions. This means that whites are more likely to participate in most types of wildlife recreation than nonwhites. The race variable is positive and significant for nonconsumptive wildlife recreation and for consumptive wildlife recreation activities except small game hunting which is significantly negative in 1985. Trends in racial mix indicate future increases in nonwhites who are less likely to participate in most types of wildlife recreation. Not surprisingly, the coefficient for the sex variable is positive and significant in 10 of the regressions. This is consistent with the observation that more men participate in wildlife recreation than women. Household size is significant in 5 of the regressions. The variable is positively related to participation in coldwater fishing, warmwater fishing, total hunting and nonconsumptive wildlife recreation. Parents may introduce their children to these wildlife recreation activities. This would be consistent with family participation in most types of outdoor recreation (Walsh, 1986). Education is significant in 6 of the regressions. It is positively related to participation in cold water fishing, warmwater fishing, and migratory bird hunting. It is negatively related to small game hunting.

Resource availability is significant with the expected positive sign in 13 of the regressions. The positive coefficient for available resources show that participation in hunting, fishing, and nonconsumptive wildlife recreation is expected to increase with improved resource management programs. Success rate (per day in 1980 and per season in 1985) is significant with the expected positive sign in 4 of the regressions for types of fishing and hunting where data on success rate is available. It was not available for hunting in 1985. The positive coefficient for success rate indicates that participation in cold and warm water fishing and migratory bird hunting is expected to increase with improved resource management programs that enhance the quality of the fishing or hunting experience by increasing catch or bag rate.

To address the question of stability in the empirical relationships between 1980 and 1985, the model and specification of variables were held constant insofar as possible. Initial attempts at uniform specification of the variables proved successful in the case of total fishing and small game hunting. For the other six regressions, some minor adjustments were considered necessary. All were within the range of acceptable practice in recreation demand analysis. For the nonconsumptive wildlife recreation equation, the 1980 specification of own price, total annual miles traveled per participant, was insignificant when tried in the 1985 equation, so price was specified as one-way miles per trip. For the total hunting equation, the 1980 price was specified as annual variable travel cost in the state of residence, caused cross-price to be insignificant when tried in the 1985 equation, so price was changed to annual variable travel cost in the state and region of residence. Also, income was changed from per capita to total household income in order to obtain a positive coefficient for household size.

For the big game hunting equation, the 1980 specification of cross-price, variable travel cost per day of small game hunting, was not significant in 1985, so it was changed to migratory bird hunting. For the migratory bird hunting equation, the 1980 specification of own price, annual variable travel cost, was not significant when tried in the 1985 equation, so it was changed to one-way miles per trip. For the coldwater fishing equation, the 1980 specification of own price, annual miles per participant, was not effective when tried in the 1985 equation, so price was specified as one-way miles per trip. Cross-price was also changed in this way. For the warmwater fishing equation, the 1980 specification of own price, total annual miles per participant, was not significant in 1985, so it was changed to one-way miles per trip. Cross-price was also changed.

The standard errors were used to test for significant difference between the coefficients in the two years (Steel and Torrie, 1980, p. 253). T-statistics were computed for the difference between the coefficients in the 1980 and 1985 equations, and then a table was consulted to determine significance at the .10 confidence level (Clark and Schkade, 1974, p. 351). Indications are that most (58) of the 94 coefficients in the eight equations for the two years were not significantly different at the .10 level. Of the 37 variables with significantly different coefficients, the changes tended to be offsetting with 18 increased and 19 decreased. These variables are identified in Tables 5, 6 and 7 with a (+) for increase and a (-) for decrease. The coefficient of four additional variables would have been significantly different if their definitions had not changed between the two years. These include the price variable in the coldwater fishing and migratory bird hunting equations and the cross-price variable in the coldwater and warmwater fishing equations. The total hunting equation had the largest number of significant changes in coefficients, nine of the 12 variables which could be compared. The small game equation had the second largest number of changes, six of 10 variables that could be compared. This may explain, in part, why the 1985-based forecasts increase for hunting.

The standard errors also were used to test for significant difference between the mean of the variables shown in Table 8 for 1980 and Table 9 for 1985. The variables are identified in Table 9 with a plus for significant increase at the .10 level and a minus for decrease. It was not possible to

Table 8. Mean Value of the Explanatory Variables in the Logit Equations, 1980

Variables	Description of Variables	Nonconsumptive Wildlife-Related Trips	Fishing			Hunting			
			Total	Cold Water	Warm Water	Total	Big Game	Small Game	Migratory Waterfowl
Price	Dollars or miles	2.814 (0.02)	122.926 (1.14)	578.912 (6.04)	142.460 (1.17)	175.165 (1.22)	132.976 (0.88)	89.820 (1.14)	75.321 (0.41)
Cross-Price (1)	Dollars or miles	162.595 (0.46)	163.059 (0.89)	142.460 (1.17)	578.912 (6.05)	176.649 (0.58)	89.820 (1.14)	--	89.820 (1.14)
Cross-Price (2)	Dollars or miles	123.215 (0.20)	2.814 (0.02)	--	--	--	--	--	132.976 (0.88)
Income (household)	Dollars/year ($1,000)	--	--	21.762 (0.28)	21.762 (0.28)	--	--	22.324 (0.33)	22.324 (0.33)
Income (per capita)	Dollars/year ($1,000)	7.705 (0.09)	7.705 (0.09)	--	--	7.705 (0.09)	7.427 (0.15)	--	--
Employment	1=employed 0=unemployed	--	0.556	0.669	0.669	0.587	0.723	0.723	0.723
Age	Years	41.491 (0.29)	41.491 (0.29)	36.600 (0.33)	36.600 (0.33)	41.491 (0.29)	35.205 (0.40)	35.205 (0.40)	35.205 (0.40)
Age Squared	Age^2	2067.583 (27.72)	2067.583 (27.72)	--	1579.790 (28.70)	--	--	--	--
Education	Years	--	--	12.383 (0.07)	12.383 (0.07)	--	12.079 (0.09)	12.079 (0.09)	12.079 (0.09)
Marital Status	1=married 0=unmarried	0.597	0.597	0.701	0.701	0.597	0.677	0.677	0.677
Family Size	Persons	3.173 (0.03)	3.191	3.376 (0.03)	3.376 (0.03)	3.173 (0.03)	3.574 (0.04)	3.574 (0.04)	3.574 (0.04)
Race	1=white 0=other	0.857	0.857	0.927	0.927	0.857	0.955	0.955	0.955
Sex	1=male 0=female	0.484	0.484	0.685	0.685	0.484	0.894	0.894	0.894
Residence	1=urban 0=rural	0.694	0.694	0.552	0.552	0.694	0.471	0.471	0.471
Success Rate	Number of Fish or Wildlife	--	--	3.088 (0.01)	5.143 (0.02)	--	3.439 (0.09)	2.134 (0.03)	3.393 (0.06)
Resource Availability	Acres or Percent	5.094 (0.16)	0.322 (0.01)	15.605 (0.49)	--	5.094 (0.16)	8.224 (0.26)	7.031 (0.37)	0.133 (0.01)

[a]Standard error of the mean is shown in parenthesis.

Table 9. Mean Value of the Explanatory Variables in the Logit Equations, 1985

Variables	Description of Variables	Nonconsumptive Wildlife-Related Trips	Fishing: Total	Fishing: Cold Water	Fishing: Warm Water	Hunting: Total	Hunting: Big Game	Hunting: Small Game	Hunting: Migratory Waterfowl
Price	Dollars or miles	178.940 (2.12)	151.952(+) (1.01)	118.370 (0.99)	150.064 (0.85)	14.163 (0.08)	19.113 (0.24)	111.965(+) (1.33)	88.431 (2.25)
Cross-Price (1)	Dollars or miles	178.819(+) (0.39)	179.091(+) (0.75)	8.741 (0.02)	129.013 (0.98)	16.479 (0.33)	17.636 (0.29)	13.343	30.776 (0.19)
Cross-Price (2)	Dollars or miles	149.789(+) (0.21)	162.353 (0.56)	--	--	--	--	--	199.222 (2.11)
Income	Dollars/year ($1,000)	13.723(+) (0.14)	29.407(+) (0.28)	30.715(+) (0.32)	--	13.723(+) (0.14)	13.172(+) (0.17)	31.155(+) (0.33)	31.155(+) (0.33)
Employment	1=employed 0=unemployed	--	--	.676	.676	--	--	--	.755
Age	Years	43.284(+) (0.29)	43.284(+) (0.29)	38.047(+) (0.28)	38.047(+) (0.28)	43.284(+) (0.29)	36.685(+) (0.30)	36.685(+) (0.30)	36.685(+) (0.30)
Age Squared	Age^2	2199.354(+) (27.54)	2199.354(+) (27.54)	1690.792(+) (25.09)	--	2199.354(+) (27.54)	1571.001(+) (25.28)	--	--
Education	Years	--	--	12.658 (0.05)	12.658(+) (0.05)	--	--	12.535(+) (0.05)	12.535(+) (0.05)
Marital Status	1=married 0=unmarried	--	.622	.676	.676	.622	.674	.674	.674
Family Size	Persons	2.407(-) (0.02)	--	2.169(-) (0.02)	2.169(-) (0.02)	2.407(-) (0.02)	--	--	2.426(-) (0.02)
Race	1=white 0=other	.872	.872	.920	.920	.872	.958	.958	.958
Sex	1=male 0=female	--	.470	.664	.664	.470	--	.911	.911
Residence	1=urban 0=rural	--	.506	.415	.415	.506	.333	.333	.333
Success Rate	Number of Fish or Wildlife	--	--	40.545 (0.75)	33.056 (0.35)	--	--	--	--
Resource Availability	Acres or Percent	5.156 (0.17)	.392(+) (0.01)	.157(+) (0.004)	.842 (0.004)	5.156 (0.17)	9.131(+) (0.20)	19.318(+) (0.28)	.495(+) (0.01)

[a] Standard error of the mean is shown in parenthesis. A plus (+) indicates a significant increase in the mean at the .10 level and minus (-) a significant decrease.

test the significant difference between the means of categorical variables, including employment, marital status, race, sex, and residence. Of the remaining variables with identical specification in both years, nearly all of the means were significantly different. The mean of resource availability for hunting was not significantly different in the two years. Price and cross-price, reported in current undeflated dollars, increased in those cases where the two years could be compared. The same was true for household income, also in current dollars. The measure of family size decreased significantly for all groups because in 1985, the question asked for number of persons five years of age and older. The measure of urban residence decreased substantially for all groups because of a change in Census definition, but the relationship among groups did not change between 1980 and 1985.

PROJECTION OF THE EXPLANATORY VARIABLES

Tables 10 and 11 shows the projections of the indicators for the explanatory variables for each decade from the base year of 1985 to 2040. The multiple regression method of forecasting relies upon projections of the determinants of demand, such as population, income, price, age, substitutes, and other demand shifters. The U.S. Bureau of the Census routinely prepares long-run forecasts for many of these determinants. An advantage of the uniform application of recognized and acceptable sources is that any two studies can be compared. However, other values are less readily available and must be projected using historic data from the Census and other agencies, as in Hof and Kaiser (1983).

The population projections are from the U.S. Census and represent the high, low, and medium assumptions of the 1990 RPA Assessment (U.S. Forest Service, 1986). Average household income before taxes is based on forecasts of

Table 10. Projections of the Indicators for the Explanatory Variables in the Logit Equations, 1985

Employment	Year	National Population (Millions)	Median Age (Years)	Race (Percent White)	Sex (Percent Male)	Disposable Personal Income Per Capita ($1000s 1982)	(Percent Employed)
Initial Condition	1985	239.3	31.3	85.1	48.7	10.6	65.1
	2000	288.9	35.6	82.4	48.7	14.4	70.4
	2010	322.6	36.8	80.7	48.7	17.2	67.9
High	2020	358.6	36.7	79.2	48.7	20.0	64.1
	2030	394.9	37.3	77.7	48.7	23.9	61.8
	2040	430.5	37.1	76.4	48.7	29.3	59.3
	2000	274.9	36.3	83.1	48.7	13.9	68.1
	2010	294.3	38.5	81.7	48.7	16.7	65.9
Medium	2020	312.1	39.3	80.5	48.7	19.7	63.2
	2030	325.5	40.8	79.3	48.5	23.5	60.9
	2040	333.4	41.6	78.1	48.5	28.8	58.5
	2000	262.8	37.0	83.4	48.7	13.2	64.8
	2010	271.8	40.0	82.2	48.7	15.7	61.8
Low	2020	276.5	41.7	81.0	48.5	18.4	59.3
	2030	274.9	43.9	79.8	48.2	22.0	56.9
	2040	266.3	45.2	78.6	47.9	26.9	54.6

Table 10. Projections of the Indicators for the Explanatory Variables in the Logit Equations (continued)

	Year	Education (Years)	Residence (Percent Urban	Marital Status (Percent Married)	Family Size (Number)	Average Variable Cost/Day (Dollars)
Initial Condition	1985	12.8	73.7	60.6	3.22	23.70
	2000	13.9	69.9	59.9	3.27	27.25
	2010	14.5	68.0	59.8	3.26	28.96
High	2020	15.1	66.1	59.7	3.25	30.32
	2030	15.7	64.2	59.6	3.24	32.07
	2040	16.3	62.3	59.5	3.23	33.83
	2000	13.4	73.9	59.2	3.06	26.37
	2010	13.8	74.0	58.2	2.94	28.12
Medium	2020	14.2	74.1	57.2	2.82	29.87
	2030	14.6	74.2	56.3	2.70	31.62
	2040	15.0	74.3	55.3	2.58	33.37
	2000	13.0	77.5	57.2	2.82	25.09
	2010	13.2	79.4	55.3	2.59	26.38
Low	2020	13.4	81.3	53.3	2.35	27.96
	2030	13.6	83.2	51.4	2.12	29.53
	2040	13.8	85.1	49.4	1.88	31.13

Table 11. Projections of the Indexes for the Explanatory Variables in the Logit Equations, 1985

	Year	National Population (Millions)	Median Age (Years)	Race (Percent White)	Sex (Percent Male)	Disposable Personal Income Per Capita ($1000s 1982)	Employment (Percent Employed)
Initial Condition	1985	1.000	1.000	1.000	1.000	1.000	1.000
	2000	1.207	1.137	0.968	1.000	1.358	1.081
	2010	1.348	1.176	0.948	1.000	1.623	1.043
High	2020	1.499	1.172	0.931	1.000	1.887	0.985
	2030	1.650	1.192	0.913	1.000	2.254	0.949
	2040	1.790	1.185	0.898	1.000	2.764	0.911
	2000	1.149	1.160	0.976	1.000	1.311	1.046
	2010	1.230	1.230	0.960	1.000	1.575	1.012
Medium	2020	1.304	1.256	0.946	1.000	1.858	0.971
	2030	1.360	1.304	0.932	0.996	2.217	0.935
	2040	1.393	1.329	0.918	0.996	2.717	0.899
	2000	1.098	1.182	0.980	1.000	1.245	0.995
	2010	1.136	1.278	0.966	1.000	1.481	0.949
Low	2020	1.155	1.332	0.952	0.996	1.736	0.911
	2030	1.149	1.403	0.938	0.990	2.075	0.874
	2040	1.113	1.444	0.924	0.984	2.538	0.839

Table 11. Projections of the Indexes for the Explanatory Variables in the Logit Equations, 1985 (continued)

	Year	Education (Years)	Residence (Percent Urban	Marital Status (Percent Married)	Family Size (Number)	Average Variable Cost/Day (Dollars)
Initial Condition	1985	1.000	1.000	1.000	1.000	1.000
	2000	1.086	0.948	0.988	1.016	1.150
	2010	1.133	0.923	0.987	1.012	1.222
High	2020	1.180	0.897	0.985	1.009	1.279
	2030	1.227	0.871	0.983	1.006	1.353
	2040	1.273	0.845	0.982	1.003	1.427
	2000	1.047	1.003	0.977	0.950	1.113
	2010	1.078	1.004	0.960	0.913	1.186
Medium	2020	1.109	1.005	0.944	0.876	1.260
	2030	1.141	1.007	0.929	0.839	1.334
	2040	1.172	1.008	0.913	0.801	1.408
	2000	1.016	1.052	0.944	0.876	1.059
	2010	1.031	1.077	0.913	0.804	1.113
Low	2020	1.047	1.103	0.880	0.730	1.180
	2030	1.063	1.129	0.848	0.658	1.246
	2040	1.078	1.155	0.815	0.584	1.314

per capita disposable personal income by Wharton Associates for the 1990 RPA Assessment. The range from low to high is proportional to the range in the previous RPA Assessment (U.S. Forest Service, 1981). Median age, percent of the population that is white, and percent that is male are derived from the same source as the population projections (U.S. Bureau of the Census, 1984). The projections of employment is from the Bureau of Economic Analysis (1985). The range from low to high is assumed to be proportional to the range in income contained in the previous RPA Assessment (U.S. Forest Service, 1981). The education projections are based on Census data reported in Hof and Kaiser (1983).

Projections of the proportion of urban residence are based on Census data. The low scenario assumes that the trend will continue upward at the 1960-80 average rate. The medium scenario assumes that the nominal rate of change from 1970 to 1980 will continue in future years. The high projection represents a reversing of the 1960-80 trend, based on the expectation that in the future, more people will want to live in rural areas rather than urban.

The projections for marital status also represent three assumed growth paths. The medium projection is a linear extension of the midpoint of the 1950-70 average rate of change. The low scenario represents a continuation of the trend at the full rate of decline. The high scenario assumes virtually no change in the married proportion of the population in future years.

The medium projection of household size is based on U.S. Census estimates of the 1940-80 trend. The low scenario assumes that family size will decline at twice that rate. The high scenario assumes that with population growth, family size will stabilize in future years with virtually no decline.

Price and cross-price estimates are based on projections of the historic trend in the average variable costs per day (in constant dollars) of fishing and hunting from 1955 to 1980, as reported by the U.S. Fish and Wildlife Service (1982). The range from low to high is proportional to the projected range in per capita disposable income (U.S. Forest Service, 1981).

The indicator for resource availability is set equal to 1.0 in the medium, low and high scenarios. This assumes that resource availability will change at the same rate as demand changes between 1985 and the year 2040. Sensitivity to alternative resource management programs could be tested by assuming a 20 percent decrease and a 20 percent increase, consistent with projections of the availability of fish and wildlife resources (U.S. Fish and Wildlife Service, 1968).

LONG-RUN FORECASTS OF PARTICIPATION

Figure 2 and Table 12 show the forecasts of the number of persons expected to participate in fishing, hunting, and nonconsumptive wildlife recreation trips in the United States from the base year to the year 2040. Indications are that nonconsumptive wildlife recreation will be the fastest growing activity. This trend is evident in both the 1980 and 1985-based forecasts with virtually identical results, assuming medium population growth. The historical growth in fishing is expected to continue with growth in coldwater fishing more than twice that of warmwater. The 1980 and 1985-based forecasts of fishing are not significantly different, with the more recent forecast indicating slightly more growth in coldwater fishing and slightly less increase in warmwater. The hunting forecasts are mixed with small game hunting expected to decrease slightly, big game hunting to be unchanged, and migratory waterfowl hunting to increase. The 1985-based forecasts indicate less decline in small game and big game hunting, and more increase in migratory waterfowl hunting. The tentative conclusion is that replication of the earlier study yields generally consistent results.

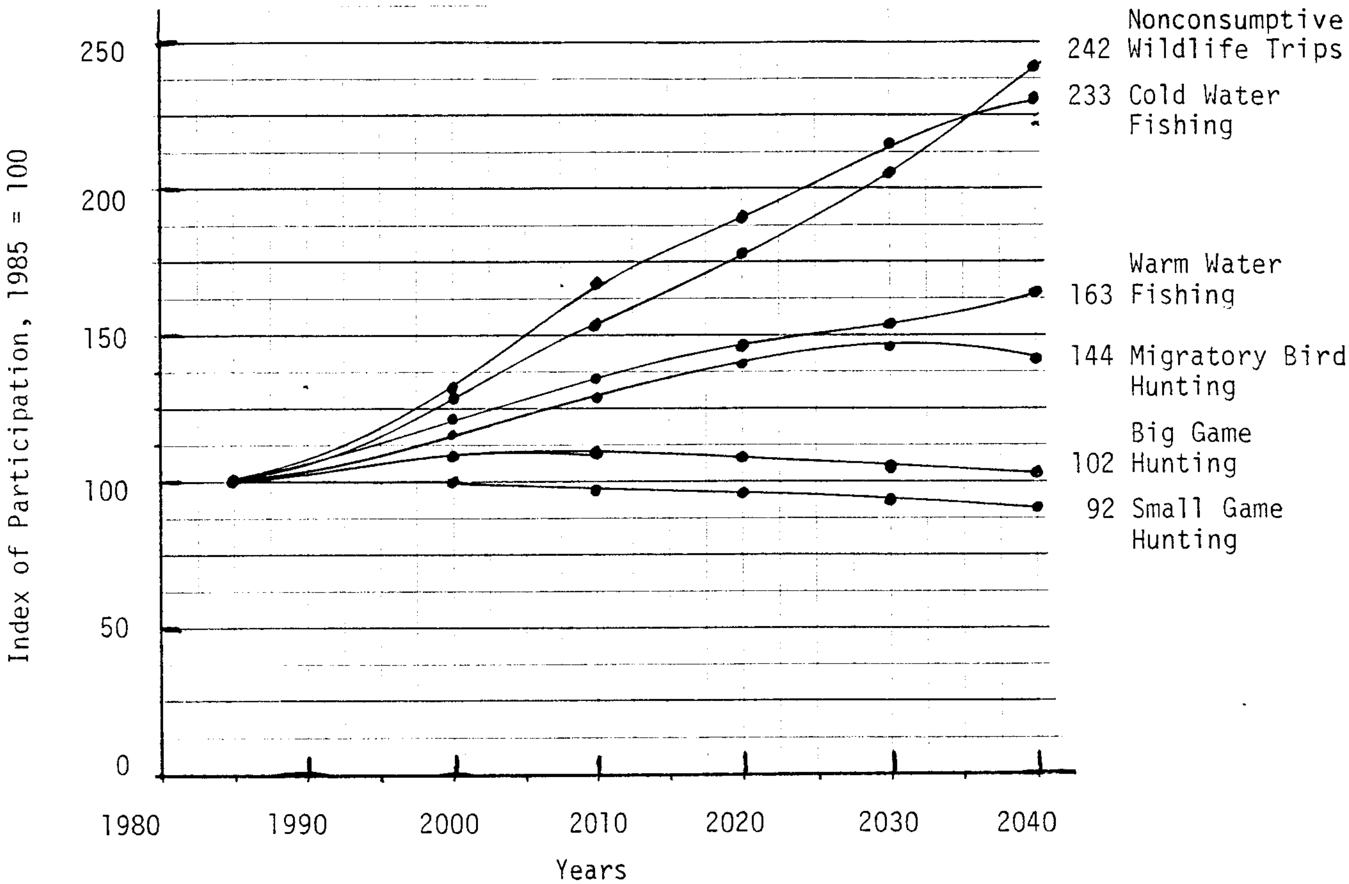

Figure 2. Forecasts of the Number of Persons Participating in Wildlife Recreation Activities Under Medium Level Population Assumptions, United States, 1985 to 2040

The forecasts of number of persons participating in Table 12 are presented as indexes to simplify comparisons among the wildlife related activities. With 1985 indexed at 100, for example, the number of persons participating in big game hunting under medium level population assumptions for the year 2040, is forecast to increase to an index of 102 and small game hunting to decrease to 92, while migratory bird hunting would increase to 144. This compares to a medium population forecast equal to an index of 139 for the same time period. Apparently, the proportion of the population participating in hunting will decrease. By comparison, warm water fishing is forecast to increase to 163,

Table 12. Forecasts of the Number of Persons Participating in Fishing, Hunting, and Nonconsumptive Wildlife Recreation Trips, United States, 2000 to 2040.

		Nonconsumptive Wildlife-Related Trips		Fishing				Hunting					
				Cold Water		Warm Water		Big Game		Small Game		Migratory Birds	
Base Year		1980	1985	1980	1985	1980	1985	1980	1985	1980	1985	1980	1985
Initial Condition		100	100	100	100	100	100	100	100	100	100	100	100
High	2000	156	138	136	148	133	125	109	110	101	104	107	126
	2010	186	167	164	181	154	142	117	115	107	109	126	147
	2020	216	200	204	211	181	158	127	119	120	117	164	171
	2030	254	245	248	249	209	174	135	122	128	122	200	198
	2040	295	302	311	293	244	195	142	118	140	125	259	224
Annual Growth Rate		1.8	1.8	1.9	1.8	1.5	1.1	0.6	0.2	0.6	0.4	1.6	1.4
Medium	2000	145	131	129	139	121	120	97	108	89	100	93	116
	2010	168	154	147	165	133	132	95	109	84	99	97	127
	2020	191	178	173	189	147	142	94	107	84	99	109	138
	2030	214	207	196	215	157	151	90	104	79	94	116	147
	2040	235	242	228	233	169	163	86	102	76	92	130	144
Annual Growth Rate		1.4	1.4	1.4	1.4	0.9	0.9	-0.3	0.0	-0.5	-0.1	0.4	0.6
Low	2000	133	123	121	130	109	115	86	108	77	98	81	107
	2010	149	143	133	149	112	123	78	108	66	93	75	111
	2020	162	155	146	164	114	127	70	101	59	87	74	112
	2030	173	172	156	179	115	129	61	94	50	78	69	111
	2040	180	190	169	188	114	129	53	83	43	70	68	109
Annual Growth Rate		1.0	1.1	0.9	1.1	0.2	0.4	-1.1	-0.3	-1.4	-0.5	-0.6	0.1

cold water fishing to 233, and nonconsumptive wildlife recreation to 242. Also shown are the compound annual growth rates to facilitate comparison of these results with other research.

Statistical procedures are not currently available to estimate a 95 percent confidence interval around these point estimates. However, Table 12 does show a range of forecasts in participation based on the low and high projections of population and other determinants of demand. The low and high forecasts result from inserting the low and high projections of the variables into the equations. With 1985 set at 100, the number of persons participating in big game hunting in the year 2040 ranges from a low of 83 to a high of 118, while small game hunting ranges from 70 to 125, and migratory bird hunting from 109 to 224. Thus, with the high population growth scenario, the number of persons participating in hunting would increase in future years.

The forecasts are based on the logit regressions and the projections of the independent variables. The sample means of the explanatory variables are multiplied by their regression coefficients, summed and added to the constant term. The resulting value is then substituted into the logit formula. This yields the probability of participation or the proportion of the population participating in the base year. Then, the process is repeated with the mean value of each variable multiplied by the expected value of the variable in the future year. In the two-stage procedure, the forecast probabilities for total hunting and fishing, respectively, are multiplied by the second stage forecast for each activity. The resulting forecast of the proportion of the population participating is multiplied by an index of projected population in the future year compared to the base year. Then this is divided by the estimated proportion of the population participating in the base year.

CONCLUSIONS

This study addressed the problem of forecasting participation in fishing, hunting, and nonconsumptive wildlife recreation in the long-run. The purpose was to evaluate stability in the empirical relationships and long-run predictability of the logit model. The statistical research procedure followed federal guidelines recommending that forecasts of recreation demand be based on multiple regression analysis. Participation in both years was shown to be a function of population, a travel cost proxy for price and the price of substitutes, income, age, residence, and other socioeconomic characteristics of individuals, quality of the experience, and availability of resources. Both forecasts were based on predicted changes in the exogeneous variables available from the U.S. Census and other published sources.

The results showed that nonconsumptive wildlife recreation will be the fastest growing activity. This trend was evident in both the 1980 and 1985-based forecasts with virtually identical results, for medium population growth. The historical growth in fishing is expected to continue with growth in coldwater fishing more than twice that of warmwater. The 1980 and 1985-based forecasts of fishing were not appreciably different, with the more recent forecast indicating slightly more growth in coldwater fishing and slightly less increase in warmwater. The hunting forecasts were mixed with small game hunting expected to decrease slightly, big game hunting to be unchanged, and migratory waterfowl hunting to increase. The 1985-based forecasts indicated less decline in small game and big game hunting, and more increase in migratory waterfowl hunting. The tentative conclusion was that replication of our earlier study obtained generally consistent results.

The study should be useful to natural resource managers and planners since the variables which affect participation often can be influenced by public agencies, in particular the range in prices and supply of resources provided. Such information is essential in planning a suitable range of fishing, hunting, and nonconsumptive wildlife recreation opportunities. In particular, with the expected slow down in the historic increase in number of persons participating, fish and wildlife managers have an opportunity to emphasize programs designed to increase quality of the experience.

The empirical estimates presented in this study should be viewed as tentative, first approximations to be verified or rejected by further study. Much more analysis is needed before we will understand all of the important determinants of participation in fishing, hunting and nonconsumptive wildlife recreation. Further research is recommended using future national surveys to test the reliability of the results reported here.

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