Wildlife and Fish Use Assessment: Long-Run Forecasts of Participation In Fishing, Hunting and Nonconsumptive Wildlife Recreation

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ABSTRACT

A logit model is used to estimate the proportion of the population of the United States who 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 birds in 1980. The logit equations are then used to forecast the number of persons who are likely to participate in these activities from 1990 to the year 2040. Indications are that nonconsumptive wildlife recreation will be the fastest growing activity. The historic growth in fishing is expected to continue, although at somewhat lower levels owing to slower increases in population. Hunting is forecast to decrease in the long run, consistent with preliminary findings of the 1985 National Survey of Fishing, Hunting, and Wildlife Associated Recreation. Participation is shown to be a function of changes in 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 study replicates previous research with respect to specific indicators of resource quality and availability. It attempts to correct a bias introduced into previous participation functions caused by the omission of price and cross-price variables. It presents a tentative empirical test of the effect of variable travel costs or miles traveled on the probability of participation in these activities, based on a comparison of with and without forecasts.

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Long-Run Forecasts of Participation in Fishing, Hunting, And Nonconsumptive Wildlife Recreation

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INTRODUCTION

Forest managers provide the opportunity for recreational use of fish and wildlife resources as one of several important outputs of USDA Forest Service programs. Section 2 of the Forest and Rangeland Renewable Resources Planning Act (RPA) of 1974 (88 Stat. 476; 16 USC, 1601) directs the Secretary of Agriculture to ". . . prepare a Renewable Resource Assessment. . ." that includes "an analysis of present and anticipated uses, demand for, and supply of the renewable resources of forest, range, and other associated land. . ." The Act requires that 50-year management plans be prepared for each national forest every 10 years.

The purpose of this report is to develop forecasts of the recreation use of fish and wildlife resources through the year 2040 for the 1990 RPA. A logit model is used to forecast the proportion of the population of the continental United States who will participate in (1) nonconsumptive wildlife recreation trips; (2) fishing for cold water and warm water species; and (3) hunting big

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game, small game, and migratory birds. Participation is 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. This study represents a statistical verification of the proxies of resource quality and availability used in previous research. So far as is known, this is the first successful attempt to correct the specification bias introduced into previous wildlife recreation participation functions which omitted effective proxies for price and cross-price variables. It presents a tentative empirical test of the effect of variable travel costs or miles traveled on the probability of participation in wildlife recreation activities.

This study is based on federal guidelines (U.S. Water Resources Council, 1983) which recommend that forecasts of recreation consumption be based on multiple regressions, providing coefficients to estimate how much each of the explanatory variables causes demand 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. The approach provides decisionmakers with reasonably accurate predictions of the amount and type of recreation use of fish and wildlife.

Critics of the approach assert that the application of scientific methods to forecasting human behavior denies free will. This is not true. Forecasting does not deny free will, although there are legal restrictions on individual decisions as to when to participate in fishing and hunting, acceptable methods to use, and how many fish or animals can be legally taken. These constraints obviously enlarge the opportunities for more individuals to participate in sport fishing and hunting. Within these constraints, individuals freely choose to enter into or discontinue participation in wildlife recreation activity during a given year. Large groups of individuals exhibit measurable patterns of freely chosen behavior that are related to their circumstances. As a result, the proportion of the population deciding to participate is predictable.

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 inserted 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. Most applications also implicitly assume 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 (Hoekstra and Hof, 1985). For this reason, national participation surveys are undertaken every 5 years to provide the data base necessary to update multiple regression forecasts of demand for fish and wildlife.

Several studies have used data from earlier national surveys to estimate the proportion of the population who are expected to participate in wildlife-based recreation. In an exploratory study, Hay and McConnell (1979, 1981) used data from the 1975 National Survey of Fishing, Hunting, and Wildlife Associated Recreation to estimate a national equation for the probability of participation in the nonconsumptive recreation activities of observing, photographing, and feeding wildlife. Subsequently, Miller and Hay (1981) used the same data set to estimate a national equation for the probability of hunting, and a regional equation for the probability of hunting migratory waterfowl in the Central

Flyway. The authors chose the logit model as theoretically and statistically superior to alternative techniques such as ordinary least squares (OLS). Vaughan and Russell (1981, 1982) used the 1975 survey to estimate a national logit equation for the probability of fishing, and a conditional equation for the probability of cold water and warm water fishing. In draft reports to the U.S. Fish and Wildlife Service, McConnell (1984, 1985) explored the suitability of using the 1980 Survey of Fishing, Hunting, and Wildlife Related Recreation to estimate logit equations for the probability of hunting and fishing in the United States, and conditional equations to estimate the probability of deer hunting, duck hunting, etc. A logit equation for the probability of participation in wildlife recreation was applied to the choice between consumptive and nonconsumptive wildlife activities (Hay and McConnell, 1984). Based on the 1975 survey, the authors observe that individuals who hunt often participate in nonconsumptive activities, i.e., a complementary relationship. Most recently, the 1980 survey was used to estimate a conditional probability model of participation in fee hunting on private land by 8 percent of the hunters (Langner, 1987). These studies provide a benchmark to compare the reasonableness of the procedures adopted in this study.

The next section of this report illustrates several important dimensions of the problem, using descriptive statistics on participation from the Census survey to illustrate historic trends. The third section contains a discussion of the statistical specification of the logit equation. In the fourth section is a discussion of data sources and research procedures. The fifth section contains empirical results of the logit analysis with emphasis on first, the travel cost or miles traveled proxy for price and the price of substitutes; and second, on the variables measuring availability of resources suitable for wildlife-related activities. This is followed by a section describing the projections of the independent variables. Then, the estimated long-run forecasts are presented for each decade to the year 2040. The concluding section contains a summary of the results, illustrations of how they could be used in wildlife policy analysis, and suggestions to improve recreation participation studies.

CHARACTERISTICS OF PARTICIPANTS AND HISTORIC TRENDS IN PARTICIPATION

Wildlife-related activities represent one of the most popular forms of outdoor recreation in the United States. Table 1 shows that the largest activity is warm water fishing, with nearly 17.4 percent of the population of 169.9 million persons 16 years of age and older participating in 1980. Approximately 6.9 percent participate in cold water fishing such as for trout and salmon. About 7.2 percent who engage in saltwater fishing and 1.8 percent in Great Lakes fishing are omitted from this study.

By comparison, roughly 7.0 percent of the population 16 years of age and older participate in some kind of hunting for big game (deer, elk, etc.), 7.3 percent for small game (rabbits, squirrels, etc.), and 3.1 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 17 percent of the population take nonconsumptive trips primarily for the purpose of observing, photographing, or feeding wildlife. Apparently, fish and wildlife have a special importance to people, not only because of the fishing and hunting they provide, but also because of their important ecological role in the environment (Shaw and Mangun, 1984).

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

		Participants					
		Nonconsumptive	Fishing		Hunting		
Variable	Unit of Measure	Wildlife-Related Trips	Cold Water	Warm Water	Big Game	Small Game	Migratory Birds
Number of Persons	Millions	28.8	6.9	29.5	11.8	12.4	5.3
Proportion of Population	Percent	17.0	4.1	17.4	10.2	7.3	3.1
Total Expenditures	Billion Dollars	$4.0	$1.5	$6.3	$2.8	$1.7	$0.6
Per Participant							
Trips	Trips/year	11	10	18	8	12	8
Days	Days/year	13	12	20	10	12	8
Expenditures	Dollars/year	$139	$314	$275	$236	$135	$120

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

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 $16.9 billion per year. Participants report spending an average of $120 to $236 per year for hunting, $275 to $314 for fishing, and $139 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 institutional restrictions, seasonal access, and availability of fish and wildlife. However, warm water angler participation averages 20 days per year, primarily on single-day trips. By comparison, small game hunting averages 12 days per year. Participation in nonconsumptive wildlife-related trips is equal to 13 days per year. These wildlife-related recreation activities account for a substantial amount of the estimated 100 days 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. 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 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

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

Variable	Unit of Measure	Non-participants	Participants					
			Nonconsumptive Wildlife-Related Trips	Fishing		Hunting		
				Cold Water	Warm Water	Big Game	Small Game	Migratory Birds
Income	Thousand Dollars	18.0	23.6	25.0	21.1	22.3	22.1	26.1
Employment	1=employed 0=unemployed	0.48	0.65	0.70	0.67	0.74	0.73	0.72
Age	Years	45.6	36.4	36.4	36.6	35.8	34.0	32.4
Education	Years	11.7	13.3	13.1	12.3	12.0	12.0	13.0
Marital Status	1=married 0=unmarried	0.54	0.64	0.67	0.71	0.70	0.66	0.61
Family Size	Persons	2.8	3.4	3.2	3.4	3.6	3.7	3.5
Race	1=White 0=Other	0.81	0.91	0.95	0.93	0.97	0.96	0.98
Sex	1=Male 0=Female	0.44	0.48	0.70	0.69	0.89	0.92	0.95
Residence	1=urban 0=rural	0.79	0.66	0.60	0.55	0.43	0.47	0.56
Sample Size		2,021	608	616	1,757	1,041	986	452

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

income. Fewer are married and household size is smaller. More are nonwhite women living in urban areas.

The demand for wildlife-based recreation activities is a product of 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

Compound Annual Growth in ...	Freshwater Fishing	Hunting: Big Game	Hunting: Small Game	Hunting: 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 discrete and finite set of mutually exclusive alternatives to reach a decision about which activity they will participate in at a particular time and place. The modeling of discrete choice is well documented in the literature. Discrete choice models have been used in a wide variety of applications, such as transportation (Domencich and McFadden, 1975), housing (Anas, 1982), biomedical research (Finney, 1971), and recreation (Miller and Hay, 1981; Hay and McConnell, 1984). Binominal choice, or models with a 0-1 dependent variable, are a subset of discrete choice models which are frequently used in recreation research.

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, the error terms are not normally distributed and are heteroscedastic. This results in inefficient estimators. Second, because the error terms are not normally distributed, t-tests of significance are meaningless (Goldberger, 1964). Third, predicted probabilities from the estimated equation are likely to range outside the 0-1 probability interval (Fomby, et al., 1984). Fourth, there are difficulties in interpreting the R^2 measure of goodness-of-fit (Neter and Maynes, 1970). Finally, there are substantive questions about the appropriateness of this essentially linear functional form (Harushek and Jackson, 1977).

The logit model, based on the logistics function, is the current state-of-the-art in binary choice models. The probability of participation is described in a logit model as:

$$P = \frac{1}{1+e^{-X_i B_i}}$$

Rearrangement of this expression gives:

$$L = \log \left[\frac{P}{1-P}\right] = X_i B_i$$

where L is the logit, or log of the odds ratio; P = probability of participation; B = a vector of coefficients; and X = a vector of explanatory variables.

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 (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

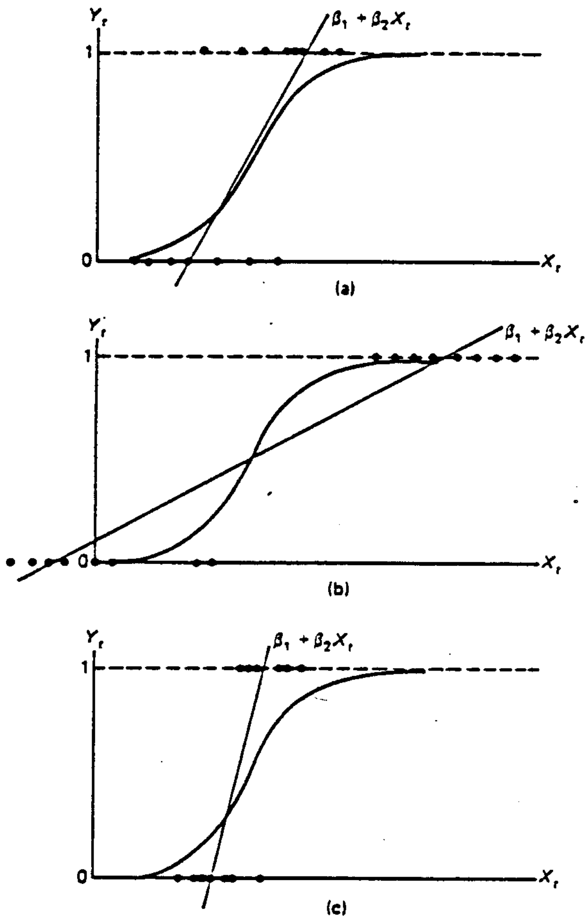

Figure 1. Comparison of Logit and OLS Linear Probability Models

Source: Hanushek and Jackson, 1977.

or unity, 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 compelling 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 error term is not based on the normal distribution, many of the familiar tests of significance do not apply. In addition, the methodology for estimating confidence intervals of the forecasts remains unclear. For this reason, it is difficult to judge the reliability associated with the point forecasts of probability in the majority of cases.

SOURCES OF DATA AND RESEARCH PROCEDURE

The basic data for this study are from the 1980 National Survey of Fishing, Hunting, and Wildlife Associated Recreation (U.S. Fish and Wildlife Service, 1982). This is the sixth in a series of surveys at 5-year intervals since 1955. The survey was conducted by the U.S. Bureau of the Census in two phases. First, a sample of more than 116,000 households nationwide were interviewed mostly by telephone to determine who in the household had hunted, fished, or engaged in some nonconsumptive wildlife recreation in 1980. Information was obtained on the usual socioeconomic variables with total annual variable costs 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 340,000 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, a subsample of 4,000 individuals 16 years of age and older was randomly drawn from the Census sample of users and nonusers. This is consistent with subsample size in previous research based on the national survey. For example, McConnell (1984, 1985) drew a subsample of 3,200 from the telephone interview tape. Indications are that a subsample of this approximate size will provide a 95 percent confidence interval of ± 3 percent.

In the second phase of the survey, detailed personal interviews were conducted with subsamples of 35,615 fishermen and hunters, and 6,949 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 3,000 individuals who participated in fishing and hunting, and 3,970 nonconsumptive users, were randomly drawn from the Census samples.

This 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. 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. Other restrictions of the sample are described in Table 4.

The Survey of Hunting and Fishing for 1980 did not directly differentiate between cold water and warm water fishing. The following methodology was employed to separate these two activities. All fresh water fish species were recoded to either a cold water species or a warm water species. The average catch per day of each type of fish was then accumulated across all sites visited. At each of the five sites tabulated, if the first species recorded as being sought at that site was a warm water species, then all fishing trips, days, and roundtrip mileage to that location were attributed to warm water fishing. The percentage of days devoted by each fisherman to warm water fishing and to cold water fishing was then calculated. Total variable costs were allocated to cold water and warm water fishing according to the percent of each activity. Cold and warm water fishing is limited to inland waters such as rivers, lakes, streams, and ponds. Excluded are the Great Lakes -- 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). 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. Because of the disproportionate sampling, the following equations are estimated with a weighted log likelihood function, as suggested by Manski and Lerman (1977).

Table 4. Census Survey Definitions of the Types of Fishing, Hunting, and Nonconsumptive Wildlife Recreation Included in the Long-Run Forecasts

Type of Activity	Census Survey Definition
Nonconsumptive Trips	Trips or outings of at least 1 mile from home for the primary purpose of observing, photographing, or feeding wildlife, without which the trip or activity would not have been undertaken. Trips to zoos, circuses, aquariums, and museums, and trips to fish or hunt are not included.
Fishing, Total	The sport of catching or attempting to catch fish with hook and line or by archery, spearing, gigging or shooting frogs, seining and netting (but not for bait). Related pursuits that are not considered fishing in the survey include commercial fishing and catching or gathering shellfish (crabs, clams, oysters, etc.).
Cold Water	Includes freshwater trout, kokanee, and anadromous fishes such as salmon and steelhead.
Warm Water	Includes small mouth, large mouth, and black bass, ponfish such as bluegill and crappie, walleye and northern pike, muskie, catfish, bullheads, etc.
Hunting, Total	The sport of searching for wildlife with firearms or archery equipment. Only hunting for pleasure or recreation is included. Excluded are trapping animals, commercial hunting, searching for animals to photograph, capturing animals live (e.g., to put in a zoo or for biological research), and hunting for frogs. Excluded are those who did not have a weapon but may have accompanied others in the field.
Big Game	Large wild animals hunted for sport or food, including deer, elk, bear, antelope, and wild turkey.
Small Game	Smaller sized wild animals, such as rabbits, quail, grouse and pheasant, which are hunted for sport or for food, not including waterfowl, other migratory birds, and animals generally considered to be pests or varmints.
Migratory Birds	Birds regularly moving seasonally from one region or climate to another for feeding or breeding, for example, ducks, geese, doves, and woodcock.

Source: U. S. Fish and Wildlife Service (1982).

The weights used are derived from the sample expansion factors provided by the Census. Each observation in any given subsample of a Census sample are weighted as follows:

$$_{ss}WT_i = \frac{_{c}weight_i}{\frac{\sum_{1}^{n} {}_{ss}WT_i}{n}}$$

where: ss indicates a subsample weight;

c indicates a weight furnished by the Census; and

n = the number of observations in the subsample.

The availability of Census weights for the 1980 survey avoids a controversy that arose in previous research. The 1975 survey was conducted by a private research company that drew a similar disproportionate sample but did not provide individual weights. As a result, a randomly drawn subsample for logit regression analysis resulted in biased estimates of the probability of fishing in 1975, owing to the bias introduced by the larger quantity of fishable water in states with small population and disproportionately large samples (Vaughan and Russell, 1981, 1982). This would likely be true for use of the 1980 survey data without inserting the Census weights provided. The authors corrected for disproportionate sampling in the 1975 survey by drawing a subsample based on the proportion of state and urban population. Hay and McConnell (1981) report that disproportionate sampling in 1975 has no significant effect on the probability of participation in nonconsumptive wildlife-based recreation. However, they recommend that future research using data from the national survey should apply the weighted logit regression technique.

Estimating the probability of participation in an activity requires that the sample of individuals include some who participate and some who do not. In this case, the telephone 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 5 defines the explanatory variables included in the equations. Most are standard socioeconomic measures and require no further explanation.

Table 5. 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
Income	Respondent's per capita 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	Forest land, public and private in respondent's state of residence	Million acres
Range	Pasture and range land in respondent's state of residence	Million acres
Water	Total fishable water in respondent's state of residence	Million acres
Cold Water	Fishable cold water in respondent's state of residence	Percent
Warm Water	Fishable warm water in respondent's state of residence	Percent
Habitat	Migratory waterfowl habitat in respondent's state of residence	100,000 acres
Song Birds	Maximum value of number of song bird species per ecological stratum in state of residence	Species
Big Game	Population of big game in respondent's state of residence	Thousand Animals

Household income includes the total money income of all current household members, 14 years of age or older, during calendar year 1980. Included as income are wages and salaries, net income from a person's own business, professional practice, or farm and other income payments such as pensions, dividends, and interest, as well as other kinds of periodic money income other than earnings. Household size is defined to include any individual living or staying at the sample address. Household members include all individuals who usually live there and lodgers, boarders, or employees who reside there. Residence is defined as the place where the respondent lives or the place where the respondent was staying while on vacation or while on a trip for another purpose; the starting point of a wildlife-related trip. Residence is a categorical variable equal to one if the respondent's residence is located in an urban area with 2,500 or more inhabitants and zero if located in a rural area. Race is also a categorical variable equal to one if the respondent's household is white and zero if black, hispanic, oriental, or American Indian.

The price variable for individual participants is either the reported costs of transportation, food, lodging, fees, and other miscellaneous expenses, or miles traveled. These specifications are consistent with the definition of the participants' own price in the travel cost method (TCM) of estimating the demand for outdoor recreation. For individual nonparticipants, the price variable is assumed to be equal to the average of these costs or miles reported by participants in each state or Census region. This aggregation of the price variable is necessary because the cost and miles information available in the survey excludes nonparticipants. The choice of these price variables for nonparticipants involves the implicit assumption that their residential locations relative to recreation sites are distributed in the same pattern as for participants in the same state or region.

Economic theory suggests that more individuals will choose to participate in states or regions where average variable costs are lower. The specification of price adopted in this study is limited to measures of the cross-state 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 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 individuals, perceived travel cost or miles traveled as a proxy for price reported by participants is expected to have more explanatory power than alternative measures that might be used such as U.S. Department of Transportation estimates.

An alternative proxy for price, resource area divided by total area in each state, was tried and rejected owing to its high (.85) intercorrelation with the variable for resource availability, resource area per capita. The alternative was used as a proxy for price by Vaughan and Russell (1984), in a study of fishing based on the 1975 national survey. The proposed proxy defines the necessary travel distance in each state, a frequently used proxy for price in recreation economics. The authors had recommended that both areas of fishable water per capita and the proposed price proxy be included as independent variables in probability of participation equations.

There is a need to test for possible simultaneity bias between price and resource availability or supply as constituted in this study. Because of limited time and resources available for this study, it is assumed that little or no simultaneity bias is present. The supply of wildlife and fish resources is affected by programs to improve water quality, forest quality, etc., which are influenced by national objectives with respect to public health, timber management, etc., as well as by specific fish and wildlife programs (Hof and Kaiser, 1983). Fees for licenses, excise taxes on equipment, and site access fees represent the supply price of hunting and fishing. But they usually represent a small proportion of the total direct cost or price paid by individuals to fish and hunt including transportation, lodging, added food, and other miscellaneous expenses.

The resource-related variables are based on state and regional level data from sources other than the 1980 survey. 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.

To the extent possible, the selection of activity-specific resource variables relies upon measures that have been successfully used in previous research. For example, the probability-of-hunting equation includes total forest, pasture, and range land, both public and private, to represent the relative availability of resources, in each state suitable for hunting. A per capita measure of the variable is used to capture the effect of the population of states and congestion pressures on the availability of opportunities for hunting as in previous research (Hay and McConnell, 1984).

Forest land is defined to include all areas of 1 acre or more at least 10 percent covered by trees of any size. Pasture and range land is defined as areas on which the vegetation is predominantly grasses, legumes, forbs, or shrubs suitable for grazing. It excludes land used for the production of crops for harvest, orchards and vineyards. Although some cropland is utilized for hunting, it is excluded on the assumption that increases in cropped acres usually destroy game habitat and that the use of herbicides and pesticides often affect game populations adversely. McConnell (1984) found that cropland decreased the likelihood of hunting for big game, small game, and migratory birds. The 1985 Conservation Reserve Program provides for the 10-year set aside of some 45 million acres or about 10 percent of the total cropland in wildlife plantings, perennial grasses, shrubs, and trees as windbreaks. Most of this new forest and grass land will provide additional habitat for wildlife in the long run.

The equation for fishing includes the total acreage of fishable water in each state divided by the 1980 population in each state. For cold and warm water sport fishing, the resource variable is the proportion of fishable water in each state suitable for each activity (Vaughan and Russell, 1982). The acres of fishable water for 1966 is reported in U.S. Fish and Wildlife Service (1968) and extrapolated to 1980. This measure is considered superior to the alternative, total acres of inland water, because only about two-thirds of that is suitable for sport fishing, owing to pollution, salinity, and intermittent flow. A Resources for the Future (1980) survey for each of the states provides an estimate of the proportion of fishable water that is suitable for cold water and warm water fishing.

The equation for primary nonconsumptive trips includes acres of forest, grazing, and range land per capita in each of the states as a proxy for the resource availability. In a separate equation, not shown, an alternative proxy for resource availability also was significant. The alternative specification measured the presence of song birds to represent a proxy of the relative abundance of wildlife available for viewing, as in Hay and McConnell (1979, 1984). It is the maximum value of the number of species of breeding birds observed in various ecological strata within each state. There are 56 strata in all. The data were compiled from results of annual breeding bird surveys between 1968 and 1973 (Peterson, 1975). The variable measures the number of species of breeding birds in the most prolific area of each state. It represents the attractiveness or relative opportunity in each state for bird watching. The measure is not affected by the total number of individual birds, however, it is highly correlated with species diversity indexes for the periods 1968-73 and 1966-79, which include the total number of birds observed (Robbins, et al., 1986). The correlation between average state values for the two species diversity indexes is 0.74 and the number of species of breeding birds is significantly related to the species diversity index for the same years:

$$\underset{}{SBB} = \underset{(0.78)}{14.06} + \underset{(2.15)}{10.19}\ INDX \qquad \text{Adjusted } R^2 = 0.07$$

where SBB = species of breeding birds; and INDX = species diversity index. The t-statistic, shown in parenthesis below the coefficient, is significant at the 0.05 level. Ideally, a comparable measure of species diversity and abundance of wildlife other than birds would also be included. Unfortunately, insufficient data are available to provide such a measure for most of the states (U.S. Fish and Wildlife Service, 1983).

Acres of habitat and associated food supply affect the number of fish and wildlife available for harvest by fishermen and hunters. As a result, studies of participation can often use acres of habitat, number of wildlife present, or harvest rate as interchangeable indicators of the effect of available resources on quality of the experience. The second phase of the Census survey provides detailed information on the success rate in fishing for cold water and warm water species, and hunting for big game, small game, and migratory birds. Within the institutional constraints as to daily or seasonal limitations on 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 in recreation demand analysis, 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. The average catch per site, 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 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.

The equation for migratory bird hunting includes the average number of birds harvested per day, as reported by participants in each Census region. A variable estimating acres of available waterfowl habitat in the hunter's state of residence was tested, but was not significant. This can be explained by the inclusion of doves, woodcock, and other species that are not waterfowl in the migratory bird category (Langner, 1987). The unsuccessful variable, acreage of waterfowl habitat per capita in each state, had been successfully used by

Miller and Hay (1981). The measure of waterfowl habitat was based on the Flyway Habitat Management Unit Project (U.S. Bureau of Sport Fisheries and Wildlife, 1970). The study measured the acreage of waterfowl habitat available for hunting in 1965 with estimates for the year 2000. An estimate of waterfowl habitat for 1980 was extrapolated from this data, as more recent measures were not available.

The equation for small game hunting includes the average number of animals harvested per day, as reported by participants in each Census region. It represents the attractiveness or relative opportunity in each region for small game hunting. Acres of habitat and food supply affect the number of small game available for harvest. However, success rate was found to be more significant than the total acres of forest, pasture, and range land, both public and private, in each state of residence.

In the equation for big game hunting, the measure of resources available is the estimated population of big game animals in each state. The wildlife divisions of most states reported (U.S. Forest Service, 1981) the total number of big game animals present in 1979, similar to data reported in U.S. Fish and Wildlife Service (1983). For purposes of this report, big game is defined to include deer, elk, moose, pronghorn, bear, sheep, goat, boar, and wild turkey. Total acres of forest land, both public and private, within each of the states also is an effective proxy of available habitat for big game animals, similar to the findings of McConnell (1984, 1985).

Finally, it is important to note that the significance of the resource availability variable can be influenced by the inclusion of other variables in the equation. McConnell (1984) experimented with the introduction of a "habit" variable in which participation in 1975 was used as a predictor of the probability of participation in 1980. While the role of habitual behavior is intuitively appealing, he found that previous participation rates capture the effect of the availability of resources. When 1975 participation was removed from the equation, supply of resources was a stronger predictor of 1980 participation.

PROBABILITY OF PARTICIPATION EQUATIONS

Tables 6 and 7 present the logit equations for participation in wildlife recreation. Table 6 estimates the probability that an individual will engage in any type of fishing, hunting, and nonconsumptive wildlife related trips. Table 7 contains estimates of the probability that an individual will engage in each type of hunting given that he/she hunts or in each type of fishing given that he/she fishes. The SPSS-X program available at Colorado State University uses the maximum likelihood estimation technique to estimate a logistic regression of the form $[\ln(P/(1-P))/2+5] = BX$, where P = probability of participation; B = a vector of coefficients; and X = a vector of explanatory variables. The maximum likelihood coefficients are asymptotically consistent, normally distributed, and the t-test 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. The t-statistics, shown in parentheses beneath the coefficients indicate that 3 to 10 of the variables in each of the equations are significant at the 0.10 level or above. Mean values of the explanatory variables are shown in Table 8. To illustrate the strength of the relationships, Table 9 shows the partial derivatives at mean values of

Table 6. Logit Equations for the Probability of Participation in Fishing, Hunting, and Nonconsumptive Wildlife Recreation Trips, United States, 1980

Variables	Description of Variables	Nonconsumptive Wildlife-Related Trips[b]	Total Fishing[c]	Total Hunting[d]
Constant		2.99045* (10.13)[a]	3.65911* (22.40)	3.99810* (23.08)
Price	Dollars or miles	-0.04895* (-2.02)	-0.00056* (-2.08)	-0.00069* (-2.31)
Cross-Price (1)	Dollars or miles	0.01230 (1.25)	0.00100* (3.19)	0.00124* (2.15)
Cross-Price (2)	Dollars or miles	0.00209 (1.18)	0.04346* (2.36)	-
Income	Dollars/year ($1,000)	0.00942* (2.25)	0.01060* (3.09)	0.00591 (1.36)
Age	Years	0.02854* (3.81)	0.00190 (0.27)	-0.01269* (-8.58)
Age Squared	$Years^2$	-0.00044* (-5.04)	-0.00015* (-2.00)	--
Marital Status	1=married 0=unmarried	--	0.36033* (7.01)	0.17085* (3.55)
Household Size	Persons	0.02875* (1.86)	--	0.09288* (6.35)
Race	1=white 0=other	0.36260* (4.27)	0.25801* (3.71)	0.46608* (5.95)
Sex	1=male 0=female	--	0.56336* (14.00)	0.13683* (3.25)
Residence	1=urban 0=rural	--	-0.19950* (-4.96)	-0.46669* (-10.71)
Resource Availability	Acres/Capita	0.00211* (1.78)	0.14687* (4.49)	0.00827* (4.60)
Probability	Percent of Population	0.135	0.212	0.167
Sample Size	Individuals	4,000	4,000	4,000

[a]T-statistics are shown in parentheses below the coefficients. An * indicates that a variable is significant at the .10 level or above.

[b]For nonconsumptive wildlife-related trips: own price is specified as total annual miles per participant in the region 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 residence.

[c]For fishing: 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]For hunting: own price is specified as total annual variable costs per participant in the state of residence; cross-price (1) for nonconsumptive use is total miles per trip by participants in the state of residence; income is gross household income; and resource availability is total forest, pasture, and range land per capita in the state of residence.

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

Variables	Description of Variables	Fishing: Cold Water[b]	Fishing: Warm Water[c]	Hunting: Big Game[d]	Hunting: Small Game[e]	Hunting: Migratory Birds[f]
Constant		3.75319* (9.70)[a]	4.46183* (10.29)	4.93365* (19.03)	5.74007* (25.96)	3.24927* (7.11)
Price	Dollars or miles	-0.00163* (-8.29)	-0.00413* (-7.05)	-0.00313* (-2.53)	-0.00272* (-3.43)	-0.01561* (-2.10)
Cross-Price (1)	Dollars or miles	0.00296* (3.47)	0.00248* (13.38)	-0.00185* (-2.21)	--	0.00623* (2.85)
Cross-Price (2)	Dollars or miles	--	--	--	--	-0.00083 (-0.48)
Income	Dollars/year ($1,000)	0.00825* (3.30)	--	-0.01025* (-1.97)	-0.00112 (-0.47)	0.01406* (5.57)
Employment	1=employed 0=unemployed	0.02146 (0.28)	0.08589 (1.01)	--	0.01894 (0.26)	-0.24949* (-3.20)
Age	Years	0.00241 (0.97)	0.01892 (1.49)	0.03442* (3.44)	-0.01087* (-4.71)	-0.01023* (-3.76)
Age Squared	$Years^2$	--	-0.00022 (-1.59)	-0.00037* (-3.09)	--	--
Education	Years	0.02220* (2.11)	-0.01774 (-1.54)	--	-0.01651* (-1.74)	0.06028* (5.61)
Marital Status	1=married 0=unmarried	-0.08492 (-1.05)	-0.04702 (-0.52)	--	0.01932 (0.25)	-0.09641 (-1.20)
Household Size	Persons	-0.04958* (-2.09)	0.03316 (1.33)	--	--	-0.02420 (-1.17)
Race	1=white 0=other	0.05630 (0.39)	0.07386 (0.51)	0.38322* (2.84)	0.06516 (0.45)	0.64380* (3.18)
Sex	1=male 0=female	0.11703 (1.61)	0.07297 (0.95)	--	0.41890* (4.54)	0.66523* (5.36)
Residence	1=urban 0=rural	0.14198* (2.11)	-0.05825 (-0.80)	-0.24539* (-4.11)	0.06588 (1.07)	0.16260* (2.56)
Success Rate	Number of Fish or wildlife	0.03088 (0.34)	0.12151* (2.22)	--	0.03963 (1.09)	0.10919* (3.78)
Resource Availability	Acres or Percent	0.01233* (7.11)	--	0.02488* (6.54)	--	--
Probability	Percent of Population	0.132	0.929	0.690	0.718	0.281
Sample Size	Individuals	2,212	2,212	1,445	1,445	1,444

[a]T-statistics are shown in parentheses below the coefficients. An * indicates that a variable is significant at the .10 level or above.

[b]For cold water fishing, own price for participants is their reported total annual miles, and for nonparticipants it is regional total annual miles; cross-price for warm water fishing is the same as above; income is household income in thousands; success rate is regional average catch per day; resource availability is the proportion of cold water to total fishable water in state of residence.

[c]For warm water fishing, variables are defined the same as for cold water fishing; the cross-price variable is for cold water fishing.

[d]For big game hunting, own price is total annual variable cost per participant in the region of residence; cross-price for small game hunting is total annual variable cost per participant in the region of residence; income is per capita; success rate is regional average total bag per hunter; and resource availability is thousands of big game animals in the state of residence.

[e]For small game, own price is the total annual variable cost per participant in the region of residence; income is household income in thousands; success rate is regional average bag per day.

[f]For migratory bird hunting, own price is total annual variable cost per participant in the region of residence; cross-price (1) for small game hunting is defined the same; cross-price (2) for big game hunting is the same; income is household income in thousands; success rate is regional average bag per day.

Table 8. Mean Values of the Explanatory Variables in the Logit Equations

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	2.814	122.926	578.912	142.460	175.165	132.976	89.820	75.321
Cross-Price (1)	Dollars or miles	162.595	163.059	142.460	578.912	176.649	89.820	132.976	89.820
Cross-Price (2)	Dollars or miles	123.215	2.814	--	--	--	75.321	75.321	132.976
Income (household)	Dollars/year ($1,000)	--	--	21.762	21.762		7.427	22.324	22.324
Income (per capita)	Dollars/year ($1,000)	7.705	7.705	--	--	7.705	--	--	--
Employment	1=employed 0=unemployed	--	0.556	0.669	0.669	0.587	0.723	0.723	0.723
Age	Years	41.491	41.491	36.600	36.600	41.491	35.205	35.205	35.205
Age Squared	Age^2	2067.583	2067.583	1579.790	--	1466.499	--	--	--
Education	Years	12.383	--	12.383	12.383	12.383	12.079	12.079	12.079
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	3.191	3.376	3.376	3.173	3.574	3.574	3.574
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	5.143	--	3.439	2.134	3.393
Resource Availability	Acres or Percent	5.094	0.322	15.605	--	5.094	8.224	7.031	0.133

Table 9. Partial Derivatives at Mean Values of the Explanatory Variables in the Logit Equations[a]

Variables	Nonconsumptive Wildlife Trips	Fishing			Hunting			
		Total	Cold Water	Warm Water	Total	Big Game	Small Game	Migratory Birds
Price	-0.001148	-0.00018	-0.00037	-0.00054	-0.00019	-0.00116	-0.00110	-0.00620
Cross-Price (1)	0.000286	0.000334	0.000678	0.000327	-	-0.00068	-	0.00252
Cross-Price (2)	0.000487	0.014523	-	-	0.000344	-	-	-0.00034
Income	0.002195	0.003542	0.00189	-	0.001643	-0.00378	-0.00046	0.00568
Employment	-	-	0.004917	0.01133	-	-	0.00766	-0.10076
Age	0.006652	0.000634	0.000552	0.002495	-0.00352	0.01270	-0.00440	-0.00414
Age^2	-0.0001	-0.00005	-	-0.00002	-	-0.00014	-	-
Education	-	-	0.005087	-0.00234	-	-	-0.00668	0.02434
Marital Status	-	0.120416	-0.01945	-0.0062	0.047497	-	0.00782	-0.03894
Household Size	0.006701	-	-0.04958	0.004374	0.025821	-	-	-0.00978
Race	0.084579	0.086222	0.0563	0.009743	0.129574	0.14138	0.02638	0.26000
Sex	-	0.188266	0.11703	0.009626	0.038039	-	0.16956	0.26864
Residence	-	-0.06666	0.14198	-0.00728	-0.12974	-0.09052	0.02666	0.06566
Success Rate	-	-	0.03088	0.016029	-	-	0.01604	0.04410
Resource Availability	0.000491	0.049081	0.01233	-	-	0.00918	-	-
Total	0.089822	0.396115	0.06407	0.037125	0.111756	0.06698	0.24148	0.51078

[a] The partial derivative for the logit model used is $\partial P/\partial x_i = 2P(1-P)B_i$, where P is the probability of participation and B_i is the coefficient for the ith variable of the logit model.

the explanatory variables. Miller and Hay (1981) illustrate how partial derivatives can be applied to important policy questions, similar to the use of elasticities of demand. The treatment of missing data is straightforward; the following variables are assigned the subsample average value if no individual value are reported: income, age, education, and number of big game animals.

Since the logit model is estimated by the maximum likelihood method, a coefficient of multiple correlation is not generated. However, several R^2 like measures can be calculated which give an indication of the amount of the variation in the dependent variable which is explained by variation in the independent variables. The SPSS-X program used at Colorado State University is designed for use with aggregate data. The data used in this study are the responses of individuals. For this reason, the likelihood ratio index recommended by Domencich and McFadden (1975) could not be calculated. However, by utilizing some of the output from SPSS-X, an alternate R^2 analog was calculated for the cold water fishing equation. A program was written which compared the predicted probability that a given individual would be a cold water fisherman with his actual participation in this activity. If the predicted probability was greater than .5, the individual was judged to have been predicted to be a cold water fisherman. If it was .5 or less the individual was judged not to have been a cold water fisherman. The logit model for cold water fishermen correctly predicted whether an individual was, or was not, a cold water fisherman in 84.5% of the cases. Based on this representative case, the logit models which were developed in this study are thought to be relatively robust.

Price is defined as average total variable cost or miles traveled per year in the state or region of residence. The price proxy has the correct sign and is significant in all of the 8 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 would decrease, other variables constant. Although the proxy for price necessarily lacks precision, the coefficients suggest that participation in wildlife recreation may be price inelastic. This means that future expansion of public and private management programs through increases in licenses, excise taxes, and access fees would have a small effect on the proportion of the population who participate.

Cross-price is defined as the average total variable cost per year of alternative wildlife recreation activities in the state or region of residence. At least one cross-price variable is significant in 7 of the 8 regressions. A positive coefficient indicates that an alternative recreation activity is a substitute and a negative coefficient that it is complementary. The most important tentative finding with respect to cross-price is that the general population seems to consider nonconsumptive wildlife recreation a substitute for hunting. This is indicated by (1) the positive coefficient for the cross-price of hunting in the nonconsumptive trips equation and (2) the positive coefficient for the cross-price of nonconsumptive trips in the hunting equation, shown in Table 6.

This adds an important new dimension to previous research based on a participation variable rather than cross-price (Hay and McConnell, 1984). 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 increases demand for nonconsumptive trips. Programs that improve access to (and reduce the price of) nonconsumptive wildlife resources will tend to increase participation in the activities of observing, photographing, and feeding wildlife, and reduce hunting pressures on wildlife populations. In the fishing equation shown in Table 6, the positive cross-price coefficient for hunting indicates that it substitutes for fishing. This suggests that recent increases in the price of hunting may have contributed to decreased participation in that activity and the increased demand for fishing.

Income per capita or household is significant in 5 of the 8 regressions. The positive coefficients for income shown in Table 6 indicate that wildlife recreation is a normal good. This means that as future incomes rise, the proportion of the population participating in fishing, hunting, and nonconsumptive wildlife recreation also will increase, all else constant. The positive influence of income in the nonconsumptive wildlife equation is consistent with the findings of Hay and McConnell (1979, 1984). Thus, as incomes grow, nonconsumptive activities will probably grow. In the Miller and Hay (1981) study of participation in hunting based on the 1975 national survey, income per capita was not significant. An important difference between their study and this one is the inclusion of significant price and cross-price variables. Thus, it seems that the procedure used in this report has the advantage of allowing income to enter as a significant variable in the hunting equation. A number of recreation demand studies have concluded that it is not possible to correctly specify a demand function for outdoor recreation if income is not included as a determinant of demand.

The negative coefficient for income in the big game hunting equation shown in Table 7 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, with a positive income coefficient. Income is not a significant determinant of the probability of participation in small game hunting, given that one is a hunter, nor in warm water fishing, given that one is an angler. This suggests that the relative preference for participation in warm water fishing and small game hunting may not be affected by future changes in income.

Age is a measure of the physical ability to engage in wildlife recreation. It is a significant explanatory variable in 6 of the 8 regressions. The quadratic relationship between age and participation in fishing, big game 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 inverted U-shape relationship indicates that the probability of participation is higher for middle age groups than for young and retired persons. This is similar to the findings of Miller and Hay (1981) who reported that the maximum probability of hunting occurs at age 39. The effect of age on the probability of participation is distinctly different for total hunting and migratory bird hunting. Here the effect is negative throughout, with no inverted U-shape relationship.

Residence is a categorical variable equal to 1.0 for respondents living in urban areas and 0 for rural areas. The residence variable is significant in 5 of the 8 regressions. The negative coefficients for total fishing, total 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 indicates that as urbanization increases, participants are likely to increasingly choose these activities. Insignificant coefficients for residence suggest that future increases in urbanization are not likely to affect participants choices of warm water fishing, small game hunting, and nonconsumptive wildlife recreation.

Race is a categorical variable equal to 1.0 for white and 0 for nonwhite. Race is positive and significant in 5 of the 8 regressions. This means that whites are more likely to participate in wildlife recreation than nonwhites. The race variable is significant for consumptive wildlife recreation activities--total fishing, total hunting, big game hunting, and migratory bird hunting--as well as nonconsumptive wildlife recreation. Trends in racial mix show increases in nonwhites who are less likely to participate in wildlife recreation. Insignificant coefficients for race suggest that changes in the proportion of nonwhites is not likely to affect participation in small game hunting or cold and warm water fishing.

Sex is a categorical variable equal to 1.0 for male and 0 for female. Not surprisingly, the sex variable is positive and significant in 5 of the 8 regressions. This is consistent with the observation that more men participate in consumptive wildlife recreation than women. The variable is significant for most consumptive wildlife recreation activities--total fishing, total hunting, cold water fishing, small game hunting, and migratory bird hunting. However, the variable is not significant for warm water fishing, big game hunting, and nonconsumptive wildlife recreation.

Employment is a categorical variable equal to 1.0 for employed and 0 for unemployed. This variable is significant in only one of the eight regressions. Migratory bird hunting is negatively related to employment. Insignificant coefficients for employment suggest that changes in the proportion of the adult population employed is not likely to affect participation in most wildlife recreation activities, both consumptive and nonconsumptive.

Household size is significant in 3 of the 8 regressions. The variable is positively related to participation in hunting and nonconsumptive wildlife recreation. Parents introduce their children to these wildlife recreation activities. This is consistent with family participation in most types of outdoor recreation (Walsh, 1986). Household size is negatively related to participation in cold water fishing. Perhaps few children participate in the activity. Insignificant coefficients for the variable suggest that changes in household size is not likely to affect participation in the three types of hunting, total fishing, warm water fishing, and nonconsumptive wildlife recreation.

Education is defined as the number of years formal school completed. The variable is significant in 3 of the 8 regressions. It is positively related to participation in cold water fishing and migratory bird hunting. It is negatively related to small game hunting. Insignificant coefficients suggest that changes in educational attainment is not likely to affect participation in total fishing, warm water fishing, hunting, big game hunting, and nonconsumptive wildlife recreation.

Resource availability is defined as the amount of suitable habitat for fish and wildlife in states. The variable is significant with the expected positive sign in 5 of the 8 regressions. The positive coefficient for the indicators of available resources show that participation in total hunting and fishing, big game hunting, cold water fishing, and nonconsumptive wildlife recreation is expected to increase with improved resource management programs.

The insignificant coefficients for warm water fishing and migratory bird hunting suggests that the percent warm water and acres of waterfowl habitat are not efficient indicators of resource availability.

Success rate is defined as the number of fish caught or wildlife bagged per day of fishing and hunting. The regional variable is significant with the expected positive sign in 3 of the 5 regressions for types of fishing and hunting where data on success rate is available. 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. The insignificant coefficient for success rate in big game hunting suggests that change in harvest is less important than management programs that enhance the number of animals present. It may also be affected by multicollinearity, although the correlation matrix indicated an acceptable level. In the case of big game hunting, the number of big game animals present is significant. Small game hunting is the only wildlife recreation activity studied for which neither success rate nor resource availability proved statistically significant in explaining the decision to participate.

Participation equations can be used to test hypotheses about determinants of participation and to forecast the number of participants in an activity. Hypothesis testing in terms of the effect of price, cross-price, income, age, and other variables was discussed above. Forecasting will be discussed in the following sections, along with use of the estimates for important policy purposes.

PROJECTIONS OF EXPLANATORY VARIABLES

Table 10 shows the projections of the indicators for the explanatory variables for each decade from the base year of 1980 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 values. 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). In order to develop a reasonable range for the forecasts of wildlife recreation participation, three alternative scenarios are presented. They can be interpreted as high, medium, and low deviations from present conditions with respect to projections of the explanatory variable. The scenarios will result in high, medium, and low forecasts of recreation participation.

The population projections in Table 10 are those of the U.S. Census (1984). They represent the high, low, and medium assumptions of the 1989 RPA Assessment (U.S. Forest Service, 1986). Changes in population affect demand for wildlife recreation activities. A number of studies have concluded that a 1 percent increase in population results in a 1 percent rise in participation, other things being equal. Changes in population also influence the size of the labor force and in other ways affect the level of economic activity. Population increased by 100 million during the past 50 years and it is expected to grow by 60 million during the 50 years, 1990-2040, medium projection. The decline in the rate of population growth is based on assumptions regarding immigration, deaths, and fertility rates. The annual rate of growth is expected to decline from 0.9 percent in the 1990s to 0.1 percent in the decade,

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

	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	1980	227.8	30.0	85.9	48.7	9.7	63.6
	1990	254.1	32.7	84.1	48.7	11.5	68.0
	2000	281.5	35.6	82.4	48.7	14.5	70.4
High	2010	310.0	36.8	80.7	48.7	17.3	67.9
	2020	340.8	36.7	79.2	48.7	20.4	64.1
	2030	369.8	37.3	77.7	48.7	23.7	61.8
	2040	398.5	37.1	76.4	48.7	27.8	59.3
	1990	249.7	33.0	84.4	48.7	11.3	66.9
	2000	267.9	36.3	83.1	48.7	14.0	68.1
Medium	2010	283.2	38.5	81.7	48.7	16.8	65.9
	2020	296.6	39.3	80.5	48.7	20.1	63.2
	2030	304.8	40.8	79.3	48.5	23.3	60.9
	2040	308.6	41.6	78.1	48.5	27.3	58.5
	1990	245.8	33.2	84.6	48.7	11.0	64.8
	2000	256.1	37.0	83.4	48.7	13.3	64.8
Low	2010	261.5	40.0	82.2	48.7	15.8	61.8
	2020	262.7	41.7	81.0	48.5	18.8	59.3
	2030	257.4	43.9	79.8	48.2	21.8	56.9
	2040	246.5	45.2	78.6	47.9	25.5	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	1980	12.7	73.7	61.1	3.29	22.87
	1990	13.3	71.8	61.0	3.28	25.03
	2000	13.9	69.9	59.9	3.27	27.25
High	2010	14.5	68.0	59.8	3.26	28.96
	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
	1990	13.0	73.8	60.1	3.17	24.62
	2000	13.4	73.9	59.2	3.06	26.37
Medium	2010	13.8	74.0	58.2	2.94	28.12
	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
	1990	12.8	75.6	59.2	3.06	23.83
	2000	13.0	77.5	57.2	2.82	25.09
Low	2010	13.2	79.4	55.3	2.59	26.38
	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

2030-2040. This represents an important change from historic growth rates. The annual growth from 1955 to 1980 averaged 1.8 percent. The lower growth rates are expected to have a significant effect on participation in wildlife-related recreation.

Average household income before taxes is estimated using the projection of per capita disposable personal income in 1982 dollars from the 1989 RPA Assessment as an indicator of change. This is derived from gross national product projections prepared by the Wharton Econometric Forecasting Associates (1985) assuming Census middle population projections. Historically, disposable personal income has equaled about 70 percent of the gross national product. Disposable personal income is defined as income from all sources available for spending or saving, i.e. personal income minus tax and other payments for government services. The range from low to high is proportional to the range in Hof and Kaiser (1983) and to assumptions in the previous RPA Assessment (U.S. Forest Service, 1981).

Projections of median age, percent of the population that is white, and percent that is male are from the same source as the population projections (U.S. Bureau of the Census, 1984). These Census projections are used as indicators of the variables: average age, percent white, and percent male in the regression equations. The age distribution of the population, in particular, is important in estimating participation in wildlife-related recreation activities. During most of the period 1990-2040, the Census projections of age indicate a substantial increase in the proportion of people in the middle-age group. They have the highest levels of income and are most likely to engage in wildlife-related recreation (Miller and Hay, 1981).

The employment variable is the proportion of the population 16 years of age and older that is employed. The median projection is from the Bureau of Economic Analysis (1985) based on medium projections of GNP and population projections by the Census Bureau. The range from low to high is assumed to be proportional to the range in income contained in Hof and Kaiser (1983) and to assumptions in the previous RPA Assessment (U.S. Forest Service, 1981).

Other socioeconomic variables included in the equations are projected using data available from the Census or other agencies. The historic trend of an indicator is used to project the explanatory variables. Generally, the medium scenario represents a linear projection of a series of at least 10 but not more than 40 years of historic observations. The high scenario reflects an accelerated rate of change. The low scenario assumes less change.

The education variable is the number of years of formal schooling completed by the general population 25 years of age and older. Average education attainment increased rapidly from 10.6 years in 1960 to 12.1 years in 1970, and then slowed to 12.5 years in 1980. The medium scenario assumes that the slower rate of change from 1970 to 1980 will continue in future years. The high and low projections are from Hof and Kaiser (1983) based on published and unpublished data from the U.S. Census.

The residence variable is the percent of the total population living in urban areas. The 1980 Census defines the urban population as including persons who live in incorporated places of 2,500 or more inhabitants. The historic trend in urbanization, i.e. the movement of the population from rural to urban areas, has slowed considerably in recent years. The percent urban increased substantially from 69.9 percent in 1960, to 73.6 percent in 1970, and then leveled off at 73.7 percent in 1980. 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.

Marital status represents the proportion of the population 14 years of age and older reporting that they are married, with or without the spouse present in the home. The percent married decreased from 68.2 percent in 1950 to 67.6 percent in 1960, 64.3 percent in 1970, and 61.1 percent in 1980. The medium projection is a linear extension of the midpoint of the 1950-70 average rate of change. This represents a dampening of the decline in marriage in the long-run. 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 indicator for the household size variable is the number of persons in the family, as reported by the Census. Average family size has declined from 3.76 persons in 1940 to 3.29 persons in 1980. The medium projection is an extension of this trend. The low scenario assumes that family size will decline at twice that rate, similar to the rate of decline in household size during the same period (from 3.67 persons in 1940 to 2.76 persons in 1980). The high scenario assumes that with population growth, family size will stabilize in future years with virtually no decline. A household is defined as an occupied housing unit with one or more individuals living at the same address including lodgers, boarders, and employees who reside there. A family is defined to include two or more related persons, one of whom owns or rents the residence. The number of persons per household and per family were not significantly different in 1940, but recent trends show substantially fewer members of households:

	1940	1950	1960	1970	1980
Household size	3.67	3.37	3.33	3.14	2.76
Family size	3.76	3.54	3.67	3.58	3.29

The more rapid decrease in household size relative to family size is related to trends in single-person households--unmarried young persons, divorced, and widowed senior citizens, who a generation ago might have lived with the families of grown children.

Price and cross-price estimates are based on projections of the historic trend in the average variable costs per day of fishing and hunting from 1955 to 1980, as reported by the U.S. Fish and Wildlife Service (1982). Included are the individual reported costs of transportation, food, lodging, fees, and other miscellaneous expenses. The sum of these costs increased from $18.49 per day in 1955 to $22.49 in 1980, in constant 1982 dollars based on the GNP implicit price deflator. For purposes of forecasting the behavior of individuals, perceived travel costs reported by participants are usually expected to have more explanatory power than alternative measures that might be used, such as the trend in the consumer price index for transportation relative to the general consumer price index. Changes in the costs of food and lodging away from home differ from trends in transportation costs as do access fees and licenses to fish and hunt. The range from low to high is proportional to the projected range in per capita disposable income (U.S. Forest Service, 1981), assuming that ability to pay will affect payment.

The indicator for resource availability is set equal to 1.0 in the medium, low and high scenarios. This assumes that resource availability will

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

	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	1980	1.000	1.000	1.000	1.000	1.000	1.000
	1990	1.115	1.090	0.979	1.000	1.186	1.069
	2000	1.236	1.187	0.959	1.000	1.495	1.107
High	2010	1.360	1.227	0.939	1.000	1.784	1.068
	2020	1.496	1.223	0.922	1.000	2.103	1.008
	2030	1.623	1.243	0.905	1.000	2.443	0.973
	2040	1.749	1.237	0.889	1.000	2.866	0.932
	1990	1.096	1.100	0.983	1.000	1.165	1.052
	2000	1.176	1.210	0.967	1.000	1.443	1.071
Medium	2010	1.243	1.283	0.951	1.000	1.732	1.025
	2020	1.302	1.310	0.937	1.000	2.072	0.994
	2030	1.338	1.360	0.923	0.996	2.402	0.958
	2040	1.355	1.387	0.909	0.996	2.814	0.920
	1990	1.079	1.107	0.985	1.000	1.134	1.019
	2000	1.124	1.233	0.971	1.000	1.371	1.019
Low	2010	1.148	1.333	0.957	1.000	1.629	0.972
	2020	1.153	1.390	0.943	0.996	1.938	0.932
	2030	1.130	1.463	0.929	0.990	2.247	0.895
	2040	1.082	1.507	0.915	0.984	2.629	0.858

Table 11. Projections of the Indexes 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	1980	1.000	1.000	1.000	1.000	1.000
	1990	1.047	0.974	0.998	0.997	1.094
	2000	1.094	0.948	0.980	0.994	1.192
High	2010	1.142	0.923	0.979	0.991	1.266
	2020	1.189	0.897	0.977	0.990	1.326
	2030	1.236	0.871	0.975	0.985	1.402
	2040	1.283	0.845	0.974	0.982	1.479
	1990	1.024	1.001	0.984	0.964	1.077
	2000	1.055	1.003	0.969	0.930	1.153
Medium	2010	1.087	1.004	0.953	0.894	1.230
	2020	1.118	1.005	0.936	0.857	1.306
	2030	1.150	1.007	0.921	0.821	1.383
	2040	1.181	1.008	0.905	0.784	1.459
	1990	1.008	1.026	0.969	0.930	1.042
	2000	1.024	1.052	0.936	0.857	1.097
Low	2010	1.039	1.077	0.905	0.787	1.154
	2020	1.055	1.103	0.872	0.714	1.223
	2030	1.071	1.129	0.841	0.644	1.291
	2040	1.087	1.155	0.809	0.571	1.361

not change between 1980 and the year 2040. Sensitivity to alternative resource management programs is tested by assuming a 20 percent decrease and a 20 percent increase, consistent with projections of the availability of fish and wildlife resources. For example, fishable water is expected to increase from 87.1 million acres in 1980 to 104.6 million acres in the year 2040, an increase of 20 percent (U.S. Fish and Wildlife Service, 1968). The projection is based on expectations that additional reservoirs will be constructed, stocking programs will be accelerated, and water quality will be improved in existing waterways.

The projections of the indicators for the explanatory variables are converted to an index with the base year, 1980, set equal to 1.0. Table 11 contains the indexes for 10-year periods from 1980 to the year 2040. For example, the indexes for the projected 2040 values in the medium forecast are: price (annual variable cost), 1.46; annual household income, 2.805; residence (percent urban), 1.016; age, 1.387; education (years completed), 1.187; race (percent white), 0.910; sex (percent male), 0.99; employment (percent employed), 0.92; marital status (percent married), .904; household size, 0.786; and resource availability, 1.0. Interpretation of the indexes is as follows. The value of 2.805 for household income shows that in the year 2040 it is expected to be 2.805 times the base year. Indexes are also shown for the high and low scenarios from 1980 to 2040.

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, 1980, to the year 2040. The forecasts are based on the logit regressions and the projections of

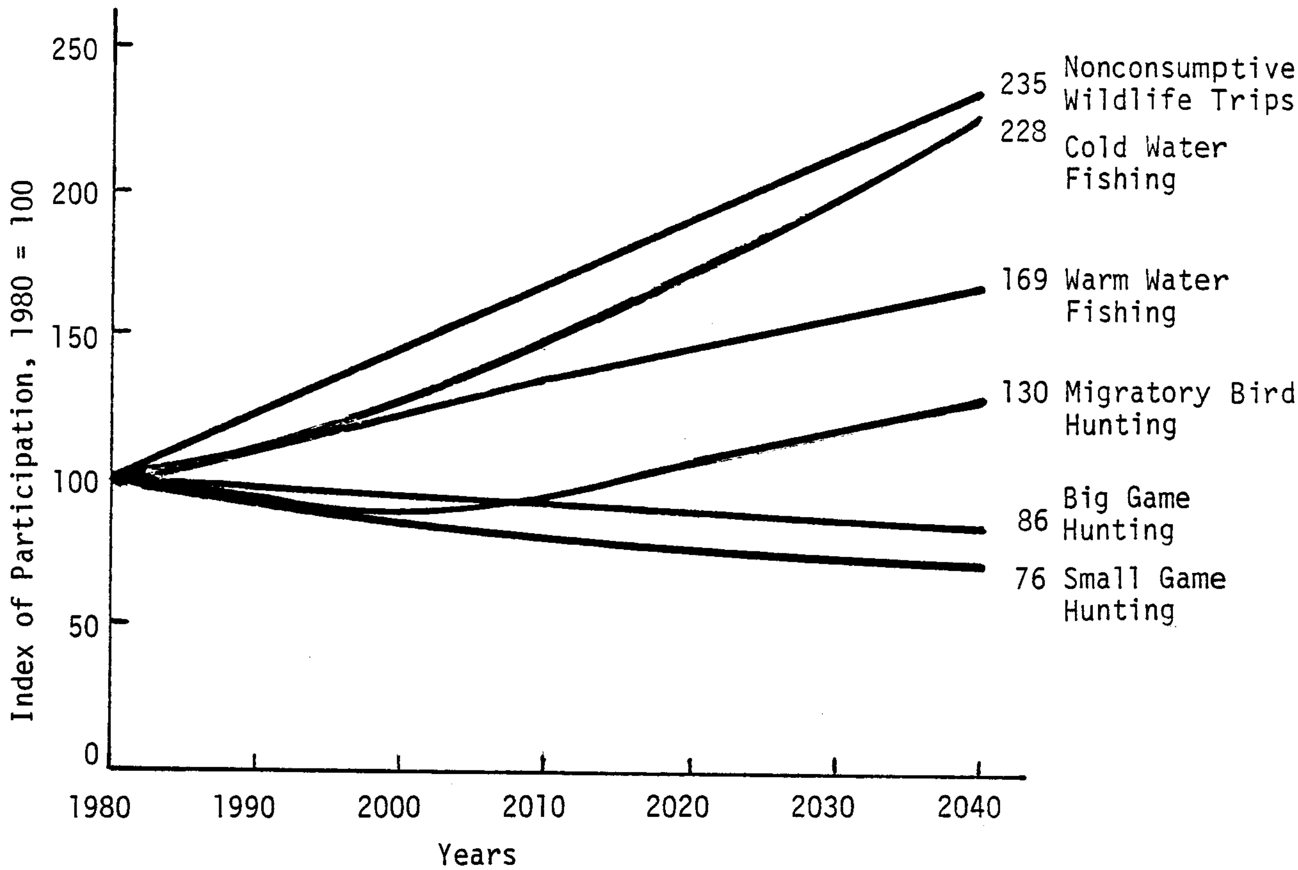

Figure 2. Forecasts of the Number of Persons Participating in Major Wildlife Recreation Activities Under Medium Level Population Assumptions, United States, 1980 to 2040

Table 12. Forecasts of the Number of Persons Participating in Fishing, Hunting, and Nonconsumptive Wildlife Recreation Trips, United States, 1980 to 2040.

	Year	Nonconsumptive Wildlife-Related Trips	Fishing		Hunting		
			Cold Water	Warm Water	Big Game	Small Game	Migratory Birds
Initial Condition	1980	100	100	100	100	100	100
	1990	124	114	115	105	101	101
	2000	156	136	133	109	101	107
High	2010	186	164	154	117	107	126
	2020	216	204	181	127	120	164
	2030	254	248	209	135	128	200
	2040	295	311	244	142	140	259
Annual Growth Rate		1.819	1.909	1.498	0.586	0.562	1.599
	1990	121	112	111	100	96	94
	2000	145	129	121	97	89	93
Medium	2010	168	147	133	95	84	97
	2020	191	173	147	94	84	109
	2030	214	196	157	90	79	116
	2040	235	228	169	86	76	130
Annual Growth Rate		1.434	1.383	0.878	-0.251	-0.456	0.438
	1990	116	110	106	95	91	90
	2000	133	121	109	86	77	81
Low	2010	149	133	112	78	66	75
	2020	162	146	114	70	59	74
	2030	173	156	115	61	50	69
	2040	180	169	114	53	43	68
Annual Growth Rate		0.984	0.878	0.219	-1.053	-1.397	-0.641

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 for B_iX_i in the logit formula. This yields the probability of participation or the proportion of the population participating in the base year, 1980. Then the process is repeated with the mean value of each variable multiplied by an index of 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. The result is a forecast of the index for the number of persons expected to participate in the future year compared with the base year.

For example, to forecast the number of persons participating in cold water fishing under medium level population assumptions for the year 2040, the procedure is as follows:

	Total Fishing		Cold Water Fishing		Population Index		Percent Participating
1980	0.21206	×	0.13235	×	1.000	=	0.0281
2040	0.25313	×	0.18702	×	1.355	=	0.0641
Forecast:	0.0641/0.0281 = 2.28						

This means that with 1980 set at an index of 1.0 (or 100), the number of persons participation in cold water fishing is forecast as 2.28 (or 228) in the year 2040.

Figure 2 shows that nonconsumptive wildlife recreation will be the fastest growing activity. The historic growth in fishing is expected to continue although at somewhat lower levels owing to slower increases in population. Hunting is forecast to decrease in the long run, consistent with the preliminary findings of the 1985 national survey. With 1980 set at 100, the number of persons participating in big game hunting under medium level population assumptions for the year 2040, is forecast to decrease to 86 and small game hunting to 69, while migratory bird hunting would increase to 130. This compares to a medium population forecast equal to 135.5 for the same time period. Apparently, the number of persons participating in hunting will decrease despite the increase in population. By comparison, warm water fishing is forecast to increase to 169, cold water fishing to 228, and nonconsumptive wildlife recreation to 235. 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 shows 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 1980 set at 100, the number of persons participating in big game hunting in the year 2040 ranges from a low of 53 to a high of 142, while small game hunting ranges from 43 to 140, and migratory bird hunting from 68 to 259. Thus, with the high population growth scenario, the number of persons participating in hunting would increase in future years.

The forecasts of participation are comparable to the preliminary findings of the 1985 national survey (U.S. Fish and Wildlife Service, 1987). With 1980 set at 100, the number of persons participating in wildlife-related recreation activities in 1985 is approximately the following:

	Participation Index, 1985	
	Survey	Forecast
Nonconsumptive Use	121	110
Fresh Water Fishing	110	106
Big Game Hunting	106	100
Small Game Hunting	87	98
Migratory Bird Hunting	94	97

Compared to the preliminary estimates for 1985, the forecasts appear to underpredict somewhat the increase in nonconsumptive use, fresh water fishing, and big game hunting. The forecasts also underpredict the decrease in small game hunting and migratory bird hunting. It seems likely that, for the most part, the change from 1980 to 1985 will continue in the same direction but the rate of change will slow down in the long run.

The forecasts are sensitive to the availability of suitable resources. For example, setting the resource variable at 1.2 and 0.8 of the base case provides a statistical estimate of the effect of improved fish and wildlife management programs. As a result, the forecast of the index of number of persons participating in the year 2040 changes as follows:

	Participation Index		
Resources	Nonconsumptive Wildlife	Cold Water Fishing	Big Game Hunting
Base Case, 1.0	235	228	86
Increase, to 1.2	236	246	90
Decrease, to 0.8	234	211	82

This suggests that a 20 percent increase in suitable resources would increase participation in cold water fishing by 7.9 percent, compared to big game hunting which increases 4.6 percent, and virtually no change in nonconsumptive wildlife recreation. Hay and McConnell (1984) reported that resource availability was not a determinant of participation in nonconsumption wildlife recreation. Their findings and those reported here may be the result of the inability to correctly measure resource availability rather than an insignificant or small effect on nonconsumptive participation.

Another indicator of the effectiveness of fish and wildlife management is success rate, i.e. the number of fish caught or wildlife bagged. For example, setting the success rate variable at 1.2 and 0.8 of the base case provides a statistical estimate of the effect of management programs designed to achieve these levels of resource availability. The forecast of the index of the number of persons participating in the year 2040 changes as follows:

	Participation Index			
Resource Success Rate	Cold Water Fishing	Warm Water Fishing	Small Game Hunting	Migratory Bird Hunting
Base Case, 1.0	228	169	76	130
Increase, to 1.2	236	170	77	142
Decrease, to 0.8	221	167	64	118

This suggests that a 20 percent increase in success rate would increase participation in migratory bird hunting by 9.2 percent compared to cold water fishing, 3.5 percent, and virtually no change in small game hunting. Neither the cold water nor the small game coefficients for success rate are significant at the 0.10 level.

Another important policy question that can be addressed using the equations has to do with research procedures. Specifically, what is the effect of variable omission on estimates of the probability of participation in wildlife recreation activities? Allen, et al. (1981) show that omission of important economic variables causes divergent estimates of recreation demand. Caulkins, et al. (1985) demonstrate that omission of cross-price variables can have positive or negative effects on demand estimates depending on the location of the alternative sites. This literature suggests that previous studies of wildlife recreation activities may have introduced a possible bias into participation functions by omitting a proxy for price and cross-price variables.

The effect is illustrated in Appendix Table 13 by comparing otherwise identical equations with and without the price and cross-price variables. The results suggest that long-run forecasts can be substantially changed by excluding price and cross-price variables. The number of persons participating in fish and wildlife recreation under medium level population assumptions for the year 2040 would decline as follows:

	With	Without	Change
Nonconsumptive Use	235	180	-55
Cold Water Fishing	228	296	68
Warm Water Fishing	169	140	-29
Big Game Hunting	86	93	7
Small Game Hunting	76	76	0
Migratory Bird Hunting	130	169	39
Weighted Average	164	147	-17

On average, the forecasts of participation in fish and wildlife recreation decline from an index of 164 with price and cross-price variables to 147 without, a loss of nearly one-fourth of the forecast growth. Without price variables, the forecast is only slightly more than the medium level population growth index of 135.5. Non-consumptive wildlife use is particularly affected, falling from the most rapidly growing wildlife activity with an index of 235, to an index of 180, ranking second to cold water fishing with an index of 237.

Participation in warm water fishing also is adversely affected, losing nearly all of the forecast growth. It is currently the most popular wildlife recreation activity in the United States and participation seems likely to grow in the future, in part, because of the relative abundance of fishable warm water near population centers (U.S. Forest Service, 1981). Also, in the two-stage procedure, the forecast of warm water fishing is a product of two equations: the probability of participation in fishing and given that one is a fisherman, the probability of warm water fishing. Table 13 shows that total fishing is forecast to increase with inclusion of the price variables and to decrease without them. This is due, in part, to their effects on other variables. For example, with the inclusion of price variables, income becomes significant with the correct sign in the equation for total fishing.

Of course, the most prominent effect of including a price variable, with its negative sign, is to dampen the forecast of participation as relative prices are expected to rise in the future. When an alternative activity is a complement as indicated by a negative coefficient for cross-price, an increase in its price level has a negative effect on participation in the activity studied. However, when a substitute wildlife recreation activity has a positive cross-price coefficient, an increase in its price level has a positive effect on participation. Table 13 shows that without price, estimates of participation in big game and migratory bird hunting rise. This is also due, in part, to the effect of price on other variables; for example, without price the resource availability variable increases in the big game hunting equation.

Finally, the national equations can be used to forecast regional participation by substitution of indexes for the predicted regional means of socioeconomic variables and population. When the USDA Forest Service 1990 RPA estimates of regional means become available, it will be a relatively simple matter to forecast regional participation in wildlife recreation activities.

CONCLUSIONS

This report addressed the problem of forecasting participation in fishing, hunting, and nonconsumptive wildlife recreation in the long-run. Indications are that nonconsumptive wildlife recreation will be the fastest growing activity. The historic growth in fishing is expected to continue, although at somewhat lower levels owing to slower increases in population. Hunting is forecast to decrease in the long run, consistent with the preliminary findings of the 1985 national survey. 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.

Information about the variables that influence participation can help an agency make effective operating and planning decisions. Some variables can be influenced by public agencies -- the range in prices and supply of resources provided, for example -- and it is important to know the effects of altering them if effective price and resource management decisions are to be made. Knowledge of the effect of the price of services on demand for participation is essential in establishing a suitable range of fishing, hunting, and nonconsumptive wildlife recreation opportunities at alternative prices, while knowledge of the effect of changes in the availability of resources is important in assessing the desirability of new more productive fish and wildlife programs.

Although many variables included in the regressions are outside the control of public agencies, they can be influenced by effective educational programs. For example, information programs can be directed at particular groups of potential participants such as younger women and minorities with higher income, and married couples with children living in urban areas. In addition, estimates of the sensitivity of participation to long-run changes in population, family size, and income can enhance an agency's ability to predict future growth potential and to establish effective long-run programs.

The estimates presented in this report should be viewed as tentative--first approximations to be verified or rejected by further study. Tests of the effect of variable omission show that the probability of participation equations would change substantially without the measures of price and cross-price introduced in this study. The results suggest that long-run forecasts can be improved by including effective price and cross-price variables. Much more analysis is needed of these and other variables before we will understand all of the persistent determinants of participation in fishing, hunting and nonconsumptive wildlife recreation. Further research is recommended using the 1985 national survey to test the reliability of the results reported here based on the 1980 survey. The logit model appears to be sufficiently promising to indicate that the technique should be used in future work. It dampens the effect of very large and small changes in the determinants of demand, which is consistent with economic theory and human behavior.

APPENDIX A

WITH AND WITHOUT COMPARISONS

Table 13. Comparison of Logit Equations With and Without Price and Cross-price Variables, Probability of Participation in Wildlife Recreation, United States, 1980

	Nonconsumptive Wildlife-Related Trips			Total Fishing			Total Hunting		
Variables	With	Without	Change	With	Without	Change	With	Without	Change
Constant	2.99045* (10.13)	3.29315* (19.03)	0.30270 (8.90)	3.65911* (22.40)	3.90257* (26.77)	.24346 (4.37)	3.99810* (23.08)	4.11589* (32.64)	0.11779 (9.56)
Price	-0.04895* (-2.02)	-	-	-0.00056* (-2.08)	-	-	-0.00069* (-2.31)	-	-
Cross-Price (1)	0.0123 (1.25)	-	-	0.00100* (3.19)	-	-	0.00124* (2.15)	-	-
Cross-Price (2)	0.00209 (1.18)	-	-	0.04346* (2.36)	-	-	-	-	-
Income Per Capita	0.00942* (2.25)	0.00978* (2.35)	0.00036 (0.10)	0.01060* (3.09)	0.01078* (3.15)	0.00018 (0.06)	0.00591 (1.36)	0.00512 (1.18)	0.00079 (0.14)
Age	0.02854* (3.81)	0.02816* (3.77)	0.00038 (0.04)	0.00190 (0.27)	0.00120 (0.17)	-0.0007 (-0.10)	-0.01269* (-8.58)	-0.01265* (-8.57)	-0.00004 (-0.01)
Age Squared	-0.00044* (-5.04)	-0.00044* (-5.02)	(0.00) (-0.02)	-0.00015* (-2.00)	-0.00015* (-1.92)	0.0 (0.08)	-	-	-
Marital Status	-	-	- (7.01)	0.36033* (7.13)	0.36590* (0.12)	0.00557 (3.55)	0.17085 (3.59)	0.17222* (0.04)	0.00137
Household Size	0.02875* (1.86)	0.02904* (1.88)	0.00029 (0.02)	-	-	- (6.35)	0.09288 (6.35)	0.09284* (0.00)	0.00004
Race	0.36260* (4.27)	0.37573* (4.47)	0.01313 (0.20)	0.25801* (3.71)	0.23084* (3.35)	-0.02717 (-.36)	0.46608 (5.95)	0.46097* (5.92)	0.00511 (0.03)
Sex	-	-	- (14.0)	0.56336* (13.97)	0.55986* (-.03)	-0.0038 (3.25)	0.13683* (3.25)	0.13666* (0.00)	0.00017
Residence	-	-	- (-4.96)	-0.19950* (-4.98)	-0.1996* (-0.02)	0.0001 (-10.71)	-0.46669 (-10.96)	-0.47618* (-0.25)	-0.00949
Resource Availability	0.00211* (1.78)	0.00374* (3.82)	0.00163 (2.04)	0.14687* (4.49)	0.15087* (4.64)	0.004 (0.15)	0.00827* (4.60)	0.00774* (4.33)	0.00053 (0.27)
Probability									
1980	0.135	0.132	0.003	0.212	0.205	-.007	0.167	0.167	0.00
2040	0.234	0.182	0.052	0.253	0.208	-.045	0.121	0.110	0.011
Change	0.099	0.050	-	0.041	0.003	-	0.046	0.057	-
Sample Size	4,000	4,000	-	4,000	4,000	-	4,000	4,000	-

[a]T-statistics are shown in parentheses below the coefficients. An * indicates that a variable is significant at the .10 level or above.

Table 13. Comparison of Logit Equations With and Without Price and Cross-Price Variables, Probability of Participation in Wildlife Recreation, United States, 1980 (Continued)

Variables	Cold Water Fishing			Warm Water Fishing		
	With	Without	Change	With	Without	Change
Constant	3.75319* (9.70)	1.82647* (5.91)	1.92672 (3.79)	4.46183* (10.29)	3.99163* (12.42)	0.4702 (2.13)
Price	-0.00163* (-8.29)	-	-	-0.00413* (-7.05)	-	-
Cross-Price (1)	0.00296* (3.47)	-	-	0.00248* (13.38)	-	-
Cross-Price (2)	-	-	-	-	-	-
Income	0.00825* (3.30)	0.00934* (3.91)	0.00109 (0.61)	-	-	-
Employment	0.02146 (0.28)	0.06900 (0.93)	0.04754 (0.65)	0.08589 (1.01)	0.0224 (0.29)	0.06349 (0.72)
Age	0.00241 (0.97)	0.00271 (1.11)	0.00030 (0.14)	0.01892 (1.49)	0.02793* (2.41)	0.00901 (0.92)
Age Squared	-	-	-	-0.00022 (-1.59)	-0.00033* (-2.58)	0.00011 (0.99)
Education	0.02220* (2.11)	0.02365* (2.28)	0.00145 (0.17)	-0.01774 (-1.54)	-0.03363* (-3.14)	0.01589 (1.60)
Marital Status	-0.08492 (-1.05)	-0.14938* (-1.91)	0.06446 (0.86)	-0.04702 (-0.52)	0.01904 (0.23)	0.02798 (0.29)
Household Size	-0.04958* (-2.09)	-0.04472* (-1.95)	0.00486 (0.14)	0.03316 (1.33)	0.04201* (1.83)	0.00885 (0.50)
Race	0.05630 (0.39)	0.05665 (0.41)	0.00035 (0.02)	0.07386 (0.51)	0.15228 (1.15)	0.07842 (0.64)
Sex	0.11703 (1.61)	0.12600 (1.75)	0.00897 (0.14)	0.07297 (0.95)	0.11840 (1.73)	0.04543 (0.78)
Residence	0.14198* (2.11)	0.16670* (2.53)	0.02472 (0.42)	-0.05825 (-0.80)	-0.01923 (-0.30)	0.03902 (0.50)
Success Rate	0.03088 (0.34)	0.44093* (7.17)	0.41005 (6.83)	0.12151* (2.22)	0.29965* (9.81)	0.17814 (7.59)
Resource Availability	0.01233* (7.11)	0.02062* (15.85)	0.00829 (8.74)	-		-
Probability						
1980	0.132	0.148	0.016	0.929	0.881	0.048
2040	0.187	0.319	0.132	0.970	0.895	0.075
Change	0.055	0.171	0.116	0.041	0.014	0.027
Sample Size	2,212	2,212	-	2,212	2,212	-

[a]T-statistics are shown in parentheses below the coefficients. An * indicates that a variable is significant at the .10 level or above.

Table 13. Comparison of Logit Equations With and Without Price and Cross-price Variables, Probability of Participation in Wildlife Recreation, United States, 1980 (Continued)

	Big Game Hunting			Small Game Hunting			Migratory Bird Hunting		
Variables	With	Without	Change	With	Without	Change	With	Without	Change
Constant	4.93365*	4.36663*	0.56702	5.74007*	5.62126*	0.11881	3.24927*	2.67634*	0.57293
	(19.03)	(19.77)[a]	(0.74)	(25.96)	(25.91)	(0.05)	(7.11)	(8.90)	(1.79)
Price	-0.00313*	-	-	-0.00272*	-	-	-0.01561*	-	-
	(-2.53)			(-3.43)			(-2.10)		
Cross-Price (1)	-0.00185*	-	-	-	-	-	0.00623*	-	-
	(-2.21)						(2.85)		
Cross-Price (2)	-	-	-	-	-	-	-0.00083	-	-
							(-0.48)		
Income	-0.01025*	-0.01125*	0.00100	-0.00112	-0.00159	0.00047	0.01406*	0.01404*	0.00002
	(-1.97)	(-2.17)	(0.2)	(-0.47)	(-0.66)	(0.19)	(5.57)	(5.58)	(0.01)
Employment	-	-	-	0.01894	0.01891	0.00003	-0.24949*	-0.24645*	0.00304
				(0.26)	(0.26)	(0.00)	(-3.20)	(-3.18)	(0.02)
Age	0.03442*	0.03468*	0.00026	-0.01087*	-0.01019*	0.00068	-0.01023*	-0.01114*	0.00091
	(3.44)	(3.52)	(0.08)	(-4.71)	(-4.46)	(0.25)	(-3.76)	(-4.12)	(0.36)
Age Squared	-0.00037*	-0.00037*	0	-	-	-	-	-	-
	(-3.09)	(-3.13)	(0.04)						
Education	-	-	-	-0.01651*	-0.01568	0.00083	0.06028*	0.05969*	0.00059
				(-1.74)	(-1.66)	(0.08)	(5.61)	(5.58)	(0.03)
Marital Status	-	-	-	0.01932	0.00996	0.00936	-0.09641	-0.08350	0.01291
				(0.25)	(0.13)	(0.12)	(-1.20)	(-1.05)	(0.15)
Household Size	-	-	-	-	-	-	-0.02420	-0.02401	0.00019
							(-1.17)	(-1.16)	(0.01)
Race	0.38322*	0.42007*	0.03685	0.06516	0.03984	0.02532	0.64380*	0.63863*	0.00517
	(2.84)	(3.17)	(0.33)	(0.45)	(0.28)	(0.17)	(3.18)	(3.17)	(0.01)
Sex	-	-	-	0.41890*	0.44930*	0.03040	0.66523*	0.63613*	0.02910
				(4.54)	(4.93)	(0.39)	(5.36)	(5.14)	(0.22)
Residence	-0.24539*	-0.26547*	0.02008	0.06588	0.03820	0.02768	0.16260*	0.16708*	0.00448
	(-4.11)	(-4.51)	(0.40)	(1.07)	(0.63)	(0.44)	(2.56)	(2.67)	(0.11)
Success Rate	-	-	-	0.03963	-0.02409	0.06372	0.10919*	0.08136*	0.02733
				(1.09)	(-0.78)	(1.87)	(3.78)	(5.98)	(2.20)
Resource Availability	0.02488*	0.01868*	0.00620	-	-	-	-	-	-
	(6.54)	(5.28)	(1.26)						
Probability									
1980	0.690	0.686	0.004	0.718	0.717	0.001	0.281	0.282	0.001
2040	0.607	0.717	0.110	0.558	0.608	0.050	0.372	0.531	0.159
Change	0.083	0.031	-	0.160	0.109	-	0.091	0.218	-
Sample Size	1,445	1,445	-	1,445	1,445	-	1,444	1,445	-

[a]T-statistics are shown in parentheses below the coefficients. An * indicates that a variable is significant at the .10 level or above.

APPENDIX B

USER DAYS

Since the work of Davidson, et al., (1966), it has been customary to model recreation behavior as the result of two kind of decisions. The first concerns whether to participate in a particular recreation activity. For example, a person decides whether to be a hunter. The second decision concerns the frequency of participation: how many hunting days per year to take? Thus far, this report focused solely on the question whether to participate. This Supplement to the Wildlife and Fish Use Assessment addresses the second question: level of participation. Both decisions are potentially important as data on historical trends indicate. Total participation in wildlife recreation in the future will be affected by changes in the annual number of days per participant as well as how many people participate.

The concept of demand for days of wildlife recreation is based on the economics of consumer demand. A rational individual with a limited wildlife recreation budget will attempt to allocate his/her days of wildlife recreation so as to maximize the satisfaction derived from the experience. Level of participation is hypothesized to be a function of travel costs, income, age, residence, and other characteristics of individuals, quality of the experience, and availability of suitable resources.

Following the usual procedure in recreation demand analysis, the ordinary least-squares (OLS) statistical method is used to estimate the relationship of annual days to costs per day and other important variables for the representative individual participant. Tables 14, 15, and 16 present the semi-logarithmic specification of level of participation equations in which the dependent variable, annual days of participation, is logged and the explanatory variables are linear. Alternative forms of the equation were tried, including linear, quadratic, semi- and double-logarithmic. The semi-logarithmic model

Table 14. OLS Equations for the Number of Annual Days per Participant in Fishing, Hunting, and Nonconsumptive Wildlife Recreation Trips, United States, 1980

Variables	Description of Variables	Nonconsumptive Wildlife-Related Trips	Fishing	Hunting
Constant		2.27284* (6.74)[a]	2.05365* (9.48)	2.09905* (9.31)
Price	Dollars/day	-0.00485* (-2.55)	-0.01844* (-11.44)	-0.01938* (-13.46)
Cross-Price	Dollars/day	--	0.00371* (1.91)	0.00630* (2.25)
Income	Dollars/year ($1,000)	--	--	-0.00609 (-1.59)
Employment	1=employed 0=unemployed	--	-0.11667 (-1.35)	0.26980* (2.40)
Age	Years	--	0.00508* (1.99)	--
Education	Years	0.04339* (2.02)	--	0.01842 (1.34)
Marital Status	1=married 0=unmarried	-0.23952* (-1.75)	--	--
Household Size	Persons	0.07516* (1.89)	0.03540 (1.39)	--
Race	1=white 0=other	--	-0.16205 (-1.18)	--
Sex	1=male 0=female	--	0.40168* (4.59)	0.24354 (1.49)
Residence	1=urban 0=rural	--	--	-0.19476* (-2.11)
Resource Availability	Acres/Capita	--	0.14225* (2.36)	--
F Significance		3.89	22.13	28.81
Adjusted R^2		0.06	.15	.30
Sample Size		177[b]	996	458

[a]T-statistics are shown in parentheses below the coefficient. An * indicates that a variable is significant at the .10 level or above.

[b]Sample of individuals reporting both in-state and out-of-state trips primarily for the purpose of observing, photographing or feeding wildlife.

Table 15. OLS Equations for the Number of Annual Days per Participant in Cold and Warm Water Fishing and Hunting for Big Game, Small Game, and Migratory Birds, United States, 1980

Variables	Description of Variables	Fishing: Cold Water	Fishing: Warm Water	Hunting: Big Game	Hunting: Small Game	Hunting: Migratory Birds
Constant		1.51463* (7.35)[a]	2.26982* (11.16)	3.29890* (7.00)	2.49579* (8.67)	1.63800* (6.73)
Price	Dollars/day	-0.00250* (-2.40)	-0.00930* (-4.94)	-0.21481* (-8.28)	-0.00673* (-4.87)	-0.01093* (-3.71)
Cross-Price (1)	Dollars/day	--	--	-0.38517* (-2.55)	-0.11737* (-2.12)	--
Cross-Price (2)	Dollars/day	--	--	--	0.04273 (1.31)	--
Income	Dollars/year ($1,000)	--	--	0.06523 (1.28)	--	--
Employment	1=employed 0=unemployed	--	--	-0.12414* (-1.80)	-0.24338* (-3.28)	-0.21612* (-1.90)
Age	Years	0.00769* (2.58)	0.00280 (1.35)	-0.25670* (-2.88)	-0.01197 (-5.45)	-0.00921* (-2.56)
Education	Years	--	-0.01824* (-2.01)	0.04595 (1.16)	--	--
Marital Status	1=married 0=unmarried	--	-0.10652 (-1.51)	0.23225* (2.95)	--	--
Household Size	Persons	-0.07322* (-2.34)	--	-0.11254* (-1.68)	--	--
Race	1=white 0=other	--	--	--	-0.20192 (-1.27)	--
Sex	1=male 0=female	0.18188* (1.79)	0.23805* (3.79)	0.39447* (4.34)	0.58065* (4.83)	0.66505* (2.98)
Residence	1=urban 0=rural	-0.25518* (-2.74)	-0.25348* (-4.21)	-0.23120* (-3.88)	-0.15563* (-2.33)	-0.18872* (-1.89)
Success Rate	Number of Wildlife Bagged	--	--	0.06181* (2.58)	0.07789* (1.69)	--
Resource Availability	Acres, Percent or Animals	0.00535* (3.43)	0.00260 (1.61)	0.02536 (1.16)	0.00328* (2.79)	0.00988 (1.24)
F Significance		8.58	11.24	12.13	10.99	6.92
Adjusted R^2		0.07	0.04	0.11	0.09	0.07
Sample Size		616	1,757	1,041	986	452

[a]T-statistics are shown in parentheses below the coefficients. An * indicates that a variable is significant at the .10 level or above.

Table 16. Mean Values of the Explanatory Variables in the OLS Equations

Variables	Nonconsumptive Wildlife-Related Trips[a]	Fishing			Hunting			
		Total[b]	Cold Water[c]	Warm Water[d]	Total[e]	Big Game[f]	Small Game[g]	Migratory Birds[h]
Price	23.479	14.026	20.711	11.850	25.786	9.738	10.584	11.896
Cross-Price (1)	-	7.245	11.405		8.840	7.622	12.630	--
Cross-Price (2)	-		-	-	-	--	7.831	--
Income[a]	9.401	22.664	25.036	21.071	22.092	19.125	22.083	26.117
Employment	0.647	0.680	0.697	0.672	0.737	0.736	0.729	0.722
Age	36.238	38.202	36.424	36.620	35.034	32.950	34.006	32.403
Education	13.828	12.681	13.103	12.298	12.211	11.201	12.021	13.034
Marital Status	0.564	0.715	0.667	0.706	0.647	0.699	0.660	0.612
Household Size	3.111	3.363	3.163	3.406	3.585	3.248	3.659	3.530
Race	0.894	0.915	0.951	0.925	0.945	0.966	0.956	0.982
Sex	0.490	0.698	0.704	0.691	0.921	0.885	0.918	0.946
Residence	0.675	0.585	0.604	0.547	0.510	0.430	0.474	0.562
Success Rate	-	-	3.403	5.247	-	1.623	2.115	3.897
Resource Availability	3.835	0.403	37.313	88.956	8.003	512.859	25.395	6.244
Annual Days	17.43	9.44	11.901	20.017	7.92	6.110	13.305	9.519

[a]For nonconsumptive wildlife-related trips: own price is variable cost per user day; income is annual income per capita; resource availability is the song bird index in state of residence.

[b]For total fishing: own price is variable cost per user day; cross-price is variable cost per user day of hunting; income is gross household income; resource availability is total acres of fishable water per capita in the state of residence.

[c]For cold water fishing: own price is variable cost per user day; income is gross household income; success rate is the average catch per participant per year.

[d]For warm water fishing: own price is varible cost per user day; income is gross household income; success rate is the average catch per participant per year; resource availability is the percentage of fishable warm water in the state of residence.

[e]For total hunting: own price is variable cost per user day; cross-price is variable cost per fishing day; income is gross household income; resource availability is total acres of forest, pasture, and range land per capita in the state of residence.

[f]For big game: own price is variable cost per user day; cross-price is variable cost per user day of migratory bird hunting; income is gross household income; success rate is regional average total annual bag per hunter; resource availability is thousands of big game animals in state of residence.

[g]For small game: own price is variable cost per user day; cross-price (1) is variable cost per user day of big game hunting and cross-price (2) is variable cost per user day of migratory bird hunting; income is gross household income; success rate is regional average total annual bag per hunter; resource availability is thousand acres of cropland and pasture land in the state of residence.

[h]For migratory birds: own price is variable cost per user day; income is gross household income; resource availability is hundred thousand acres of wetland in the state of residence.

provides the best fit of the relationship of primary interest for all activities except big game hunting where the double-logarithmic form is used. In this case, both the annual days of participation and the explanatory variables are logged.

The coefficient of determination, R^2, adjusted for degrees of freedom, indicates that 4 to 30 percent of the total variation in participation is explained by the variables included in the equations. Although the explanatory power of the equations is generally low, the levels of explanation are consistent with past studies (Miller and Hay, 1981) based on data from a cross-sectional survey of national participation. Observations, numbering 177 to 1,757, are sufficient for statistically significant analysis at the 0.10 level. The overall equations are significant at the 0.01 level, as indicated by F values of 3.89 to 28.81.

The regression coefficient for each independent variable indicates the marginal relationship between that variable and level of participation, holding constant the effect of all the other variables in the equation. The numbers in parentheses below each regression coefficient represent t-ratios, indicating the significance level of the coefficient. An * indicates that a variable included in the equation is significantly different from zero at the 0.10 level or better. That is, we can reject at the 90 percent confidence level the hypothesis that the variable is unrelated to annual days. The variables appear to have the expected sign, which means their positive or negative effects are intuitively plausible. The usual tests of the assumptions of the regression model such as multicollinearity reveal no appreciable effects on the study results.

The sample for each equation consists only of respondents who participate in the particular wildlife recreation activity. The individual's own price in each fishing and hunting equation is an approximation of the average variable costs per day reported by each individual. It is customary in recreation economic research to use travel cost as a proxy for price. Miller and Hay (1981) used the 1975 national survey to estimate the relationship between annual days of participation and distance traveled, a frequently used measure of travel cost. Nonetheless, the equations for level of participation should not be interpreted as travel cost (TCM) demand functions for recreation sites. It is not possible to estimate zonal population, trips, and trip costs that are site specific since the Census, operating under the nondisclosure rule, does not release zip codes. The equations indicate the aggregate demand for a recreation activity by the representative individual participant in a region with the average supply of recreation opportunities, population, and travel characteristics.

The Census survey defines a recreation day as any part of a calendar day spent participating in a given activity. For instance, if someone hunts 2 hours per day and 3 hours another day, it would be recorded as 2 days of hunting. If someone hunts 2 hours in the morning and 1 hour during the evening of the same day, it would be considered 1 day of hunting. Actual trips would be the preferred dependent variable rather than days. However, the only quantity variable available on the overall fishing and hunting tape, is annual days. The tapes for big game hunting, small game hunting, migratory bird hunting, cold water fishing, warm water fishing, and primary nonconsumptive trips contain both trips and days. For these activities, the difference between using days and trips is slight since participants report taking mostly single-day trips.

Tables 14, 15, and 16 list the variables that are significantly associated with annual days. As is typical of the demand for most goods and services, a reduction in variable costs per day causes an increase in demand for days of wildlife recreation, and conversely, an increase in variable costs leads to a decrease in demand. The semilog and double-log forms permit the effect of cost per day to change as its level changes. The larger the cost variable, the smaller the marginal effect of changes in costs on annual days. Changes such as these represent movements along the demand curve illustrated in Figure 3 for cold water fishing.

A change in demand--a shift from one demand curve to another--indicates a change in one or more of the other determinants of demand, the nonprice variables in the demand functions. This means that at each price the annual days demanded is either more or less than before, depending on whether the demand curve has shifted to the right or the left. For example, consider the effect of shifts in the demand curve from A to B in Figure 3. The new demand curve B illustrates the effect of a 20 percent increase in the proportion of fishable cold water in each of the states with all other nonprice variables unchanged. The representative individual angler would demand about 0.40 more days per year, as shown by demand curve B. With variable costs of $20 per user day, annual participation would increase from 10.0 days to 10.4 days, or by 4.0 percent.

Similarly, several other nonprice variables have a significant effect on the level of participation in fishing and other wildlife recreation activities. For example, the positive relationship between age and annual days of fishing indicates that within the range of observations, increasing age affects participation positively, whereas age has a negative effect on hunting. Not

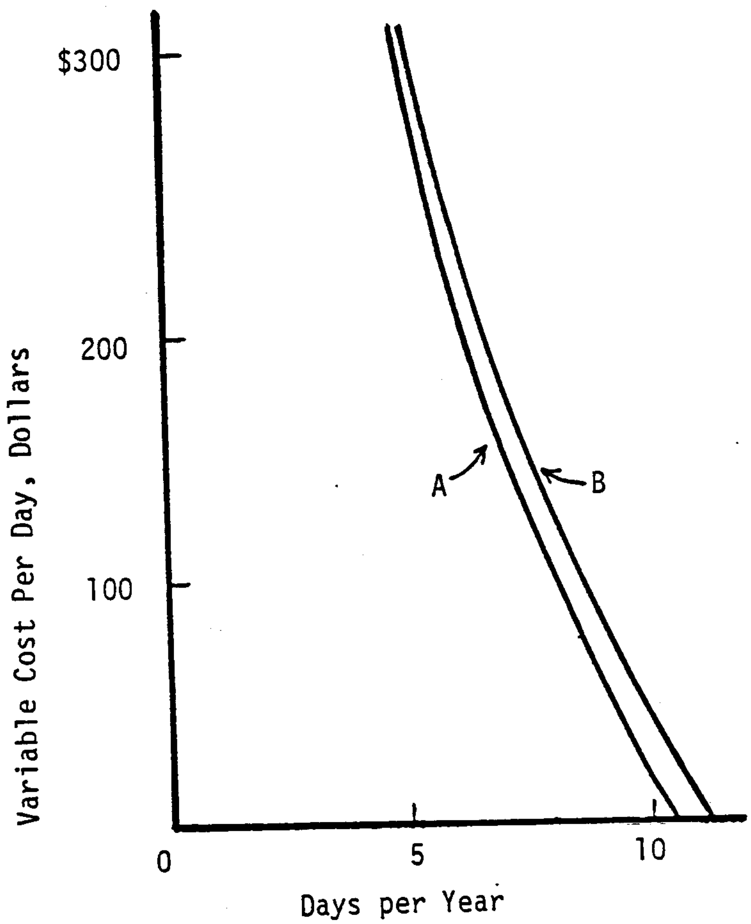

Figure 3. Resource Quality Shifts in the Level of Participation Functions for Cold Water Fishing

surprisingly, men participate more than women. The negative coefficient for residence indicates that persons living in urban areas participate fewer days than individuals in rural areas, other things equal. The negative income coefficient for total hunting indicates that as incomes rise, fewer total days of hunting are taken. However, the positive income coefficient for big game hunting reflects the relative preference for days of that activity as incomes rise. The positive coefficients for education and household size in the equation for nonconsumptive days reflect knowledge levels and possibly the teaching of children about fish and wildlife.

Table 17 shows the forecasts of annual days per participant in wildlife-related recreation. With 1980 set at an index of 100, the number of cold water fishing days per participant is forecast to increase to 114 by the year 2040, while warm water fishing days are expected to decline somewhat to an index of 95. This compares to an index of 85 for days of hunting migratory birds, 80 for big game, and 72 for small game. Also shown is a range of forecasts based on the low and high projections of the determinants of demand. For example, cold water fish days are expected to range from a low of 107 to a high of 122.

The forecasts are sensitive to the availability of suitable resources. For example, setting the resource variable at 1.2 and 0.8 of the base case provides an estimate of the effect of improved fish and wildlife management programs. As a result, the forecast of the level of participation in the year 2040 changes as follows:

Index of Days per Participant
When Resource Level is Varied

Resources	Cold Water Fishing	Warm Water Fishing	Big Game Hunting	Small Game Hunting	Migratory Bird Hunting
Base case, 1.0	114	95	80	72	85
Increase, to 1.2	119	100	81	73	86
Decrease, to 0.8	110	91	80	70	84

Table 17. Forecasts of Annual Days per Participant in Wildlife Recreation, United States, 1980 to 2040

	Year	Nonconsumptive Wildlife-Related Trips	Fishing		Hunting		
			Cold Water	Warm Water	Big Game	Small Game	Migratory Birds
		(Index of Annual Days)					
Initial Condition	1980	100	100	100	100	100	100
High	2040	112	107	93	83	76	90
Medium	2040	102	114	95	80	72	85
Low	2040	94	122	98	82	71	82

This suggests that a 20 percent increase in suitable resources would increase days of cold water fishing by 4.4 percent and warm water fishing by 5.3 percent, compared to hunting for big game which increases 1.3 percent; small game, 1.4 percent; and migratory birds, 1.2 percent. Neither the big game nor the migratory bird hunting coefficients for resource availability are significant at the 0.10 level.

Another indicator of the effectiveness of fish and wildlife management is success rate, i.e. the number fish caught or wildlife bagged. For example, setting the success rate variable at 1.2 and 0.8 of the base case provides a statistical estimate of the effect of management programs designed to achieve these levels of resource availability. The forecast of the index of the level of participation in the year 2040 changes as follows:

Index of Days per Participant
When Success Rate is Varied

	Big Game Hunting	Small Game Hunting
Base Case, 1.0	80	72
Increase, to 1.2	81	74
Decrease, to 0.8	79	69

This suggests that a 20 percent increase in success rate would increase days of big game hunting by 1.3 percent compared to small game hunting which increases 2.8 percent. Such small estimates may be the result of an inability to correctly measure success rate rather than an insignificant or small effect on days of participation.

The following methodology was employed to generate the predictions of days of participation reported in Table 17. First, the antilog of both sides of the estimated function was taken. Then, for the 1980 predictions, each coefficient was multiplied by its respective sample mean. These intermediate values were then summed and added to the intercept term. Next, an additional term was added to account for transformation bias (Goldberger, 1968; Stynes, Peterson, and Rosenthal, 1986). The resulting value is the estimated number of days of participation. For years beyond 1980, the methodology is identical except that the mean values of the explanatory variables were first multiplied by the index for the appropriate year.

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