1997

A Double-Hurdle Expenditure Analysis of Nonconsumptive Wildlife-Related Recreation.

Yeong-nain Chi
Louisiana State University and Agricultural & Mechanical College

INFORMATION TO USERS

This manuscript has been reproduced from the microfilm master. UMI films the text directly from the original or copy submitted. Thus, some thesis and dissertation copies are in typewriter face, while others may be from any type of computer printer.

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleedthrough, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send UMI a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

Oversize materials (e.g., maps, drawings, charts) are reproduced by sectioning the original, beginning at the upper left-hand corner and continuing from left to right in equal sections with small overlaps. Each original is also photographed in one exposure and is included in reduced form at the back of the book.

Photographs included in the original manuscript have been reproduced xerographically in this copy. Higher quality 6" x 9" black and white photographic prints are available for any photographs or illustrations appearing in this copy for an additional charge. Contact UMI directly to order.

UMI

A Bell & Howell Information Company
300 North Zeeb Road, Ann Arbor MI 48106-1346 USA
313/761-4700 800/521-0600

A DOUBLE-HURDLE EXPENDITURE ANALYSIS OF NONCONSUMPTIVE WILDLIFE RELATED RECREATION

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

in

The Department of Agricultural Economics and Agribusiness

by
Yeong-Nain Chi
B.S., College of Chinese Culture, 1979
M.S., National Taiwan University, 1983
December 1997

ACKNOWLEDGMENTS

Although it was a unique learning experiences, this research was at times arduous. Many individuals helped and supported me throughout this process. I wish to thank all those who made the completion of this studies possible, specifically:

Dr. E. Jane Luzar, my major professor, who provided guidance, support, and a lot of understanding during this process and throughout my academic training. I thank her for sharing her expertise and always giving the right suggestions. Working with Dr. Luzar has been in many ways an extremely enriching experience.

Committee members Drs. Kenneth W. Paxton, Richard F. Kazmierczak, Jr., and P. Lynn Kennedy of the Department of Agricultural Economics and Agribusiness; Dr. R. Carter Hill of the Department of Economics; and Dr. Andrew A. Christie of the Department of Accounting for their support and advice during my graduate training and for their suggestions and careful review of this manuscript.

Dr. Leo J. Guedry, former Head, Dr. Kenneth W. Paxton, Head, Department of Agricultural Economics and Agribusiness, the faculty, staff, and my fellow graduate students for their assistance and support during my academic training.

My brothers and sisters-in-law for their encouragement, advice, and help especially during difficult times.

My parents-in-law, Feng-Xin Liou and Xiu-Ying Lin, and my brothers-in-law and sisters-in-law for their understanding and supporting specially during this time.

My friend Lai's family, Wan's family, Steve and Amy Lee, Louis S. Illar, Michael R. and Theresa M. Fuller, and Leandro and Lynnette Gutierrez for their encouragement and supporting during this process.

Special thanks to my wife, Huey-Minn Liou, my son, Orson (Der-Youh) Chi, and my daughter, Jennifer (Jo-Yun) Chi, for their unconditional love, and for giving me every day the strength to go forward.

Most of all, I am giving this dissertation in memory to my parents, Shao-Guang Chi and Xin-Yi Wang, for their endless love.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

This study utilized cross-sectional data obtained from the 1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation to analyze the expenditures and consumption of nonconsumptive wildlife related recreation in the Lower Mississippi Valley Ecosystem area. In the process of selecting an appropriate model most consistent with individuals' consumption behavior associated with nonconsumptive wildlife related recreation, the tobit model and the double-hurdle model for both the primary nonresidential and residential expenditure models were evaluated. Based on the Lagrange multiplier test and the likelihood ratio test results, the double-hurdle model fit the data much better than the tobit model. The hypothesis that there are heteroscedastic problems associated with the error terms was rejected based on the likelihood ratio test result.

In the primary nonresidential expenditure model, income, education, ethnicity, public lands, and forest lands had a significant effect on nonconsumptive wildlife related recreation expenditures. The total consumption was predicted to increase $0.000337 with income growth, increase $16.92 with increases in educational status, increase $16.29 when participants are Caucasian, increase $27.44 with use of public lands, and increase $30.04 with use of forest lands.

In the primary residential expenditure model, gender, employment status, ethnicity, wildlife including birds, mammals, insects, and fish, maintaining natural areas for fish or wildlife, and visiting public parks or natural areas had a significant effect on

nonconsumptive wildlife related recreation expenditures. The total consumption was predicted to increase $1.57 when participants are male, increase $2.92 when participants are employed, increase $3.06 when participants are Caucasian, increase $7.99 when observing birds, increase $1.83 when observing mammals, increase $1.85 when observing insects, increase $2.53 when observing fish, increase $3.47 when participants maintain natural areas for fish or wildlife, and increase $2.87 when participants visit public parks or natural areas.

The results in this study provide insight into determinants of nonconsumptive wildlife related recreation expenditures which can be used for planning and decision making purposes for nonconsumptive wildlife management. This study also provides guidance in the choice of empirical model for use in this type of expenditure analysis. Together, these results provide a rigorous analysis of nonconsumptive wildlife related recreation expenditures.

CHAPTER 1

INTRODUCTION

Currently, wildlife related recreation activities including consumptive recreation (such as fishing and hunting) and nonconsumptive recreation (such as observing, feeding, and photographing wildlife) play an increasingly important role in outdoor recreation in the United States. In 1991, for example, 108.7 million U.S. residents sixteen years and older participated in some type of wildlife-related recreation activity. During that year, 35.6 million Americans fished, 14.1 million Americans hunted, and 76.1 million Americans took nonconsumptive trips for the primary purpose of observing, feeding, and photographing wildlife (U.S. Department of the Interior, 1993).

Among anglers, hunters, and nonconsumptive participants, sixty-nine percent of the hunters also fished, twenty-seven percent of the anglers also hunted, and fifty percent of the anglers and fifty-seven percent of the hunters also participated in primary nonconsumptive wildlife related recreation activities, such as observing, feeding, and photographing wildlife. In addition, twenty-six percent of all primary nonconsumptive participants also reported hunting and/or fishing in 1991 (U.S. Department of the Interior, 1993).

Walsh, et al. (1989), using the data from 1980 and 1985 National Surveys of Fishing, Hunting, and Wildlife-Associated Recreation (NSFHWAR), used logit regressions to forecast the number of persons expected to participate in fishing, hunting, and nonconsumptive wildlife-related recreation trips in the United States from the base

year to the year 2040. With 1985 indexed at 100, the number of persons participating in big game hunting under medium population assumptions for the year 2040 was forecast to increase to an index of 102 and the number participating in small game hunting to decrease to 92, whereas the number participating in migratory bird hunting was forecast to increase to 144. By comparison, warm-water fishing was forecast to increase to 163, cold-water fishing increased to 233, and nonconsumptive wildlife related recreation increased to 242.

In addition to the growth in participation in nonconsumptive wildlife related recreation, expenditures on these activities are large enough to now rival many consumptive wildlife recreation activities. For example, total expenditures associated with wildlife related recreation activities were $59 billion, with $22.8 billion (38.6 percent) spent on trip-related costs, $28.5 billion (48.3 percent) spent on equipment, and $7.8 billion (13.1 percent) spent on other related items in 1991. Anglers spent a total of $24 billion (40.7 percent), hunters spent a total of $12.3 billion (20.8 percent), and primary nonconsumptive participants spent a total of $18.1 billion (30.7 percent) in 1991 (U.S. Department of the Interior, 1993). In $18.1 billion total nonconsumptive wildlife related recreation expenditures, nonconsumptive participants spent $7.5 billion (41.4 percent) on trip-related costs, spent $9.6 billion (53.0 percent) on equipment, and spent about $1 billion (5.6 percent) on other related items (U.S. Department of the Interior, 1993). This growth in nonconsumptive wildlife related recreation and expenditures occurs at a time when research and public investment (land and management) is primarily focused on consumptive wildlife recreation activities.

Nonconsumptive Wildlife Related Recreation

The Fish and Wildlife Conservation Act (Nongame Act, 1992) provides states with incentives to develop conservation plans for nongame fish and wildlife. Hence, natural resource managers, especially wildlife managers, are increasingly aware of a changing constituency for natural resource management plans, especially wildlife management plans. These plans reflect a widespread and growing public interest in nongame wildlife, and nonconsumptive wildlife related recreation. Hay and McConnell (1984) citing recent trends, note that the number of nonconsumptive wildlife related recreation participants will grow more rapidly than consumptive wildlife related recreation participants.

In spite of plans to conserve nongame fish and wildlife, it can be argued that there has been relative neglect of nonconsumptive wildlife related recreation uses. In planning and managing for nonconsumptive wildlife related recreation uses, natural resource managers are often faced with the problem of where and how to obtain revenues to support public policies for nonconsumptive wildlife related recreation uses.

In general, funding for fishing and hunting is provided by the individuals who go hunting and fishing on a regular basis by revenues from license sales and by federal excise taxes on fishing and hunting equipment. In contrast, there has traditionally been limited funding for the management of nonconsumptive wildlife related recreation uses. Hence, natural resource managers are faced with increasing participation in nonconsumptive wildlife related recreation activities relative to consumptive wildlife recreation activities, but with experience and funding sources primarily in support of

consumptive wildlife re-creation activities (Hay and McConnell, 1984). Generally, it has been hypothesized that dollars spent on nonconsumptive wildlife related recreation uses were dollars that would not get spent in support of anglers and hunters.

Based on this growing demand for nonconsumptive wildlife related recreation, private agencies might also propose investment plans and promotion programs to address this potential market. However, as the following review of research suggests, there is insufficient demand-related information to provide private agencies with incentives to develop appropriate investment plans and promotion programs for supporting nonconsumptive wildlife related recreation.

Nonconsumptive Wildlife Related Recreation Research

In spite of its growing popularity, nonconsumptive wildlife related recreation has received only cursory attention in the literature of natural resource economics and related fields. Most research conducted on nonconsumptive wildlife related recreation has been on the participation aspects (Hay and McConnell, 1979; Hay and McConnell, 1984; Shaw and Mangun, 1984; Rockel and Kealy, 1991; Smith and Luzar, 1995). There have been only a few studies on leisure expenditures (Thompson and Tinsley, 1978; Dardis, et al., 1981; Dardis, et al., 1994), and fewer on nonconsumptive wildlife related recreation activities (Shaw and Mangun, 1984). In addition, there also have been only a few studies on valuation of nonconsumptive wildlife related recreation sites (Clayton and Mendelsohn, 1993).

Following Wagar's (1969) concept of nonconsumptive use which provides people with experiences rather than products, Duffus and Dearden (1990) define

nonconsumptive wildlife related recreation as "a human recreational engagement with wildlife wherein the focal organism is not purposefully removed or permanently affected by the engagement" (p.215). Nature observing, wildlife watching, and wildlife photography are typical nonconsumptive wildlife related recreation activities. They also describe the interaction among three foundations for nonconsumptive wildlife related recreation management: the ecology of the focal species, the recreational participants, and the historical context of the human-wildlife relationship. This framework provides the linkage between the growth and development of nonconsumptive wildlife related recreation (Duffus and Dearden, 1990).

Vaske, et al. (1982) suggest that consumptive and nonconsumptive wildlife related recreation activities differ in two important dimensions. First, the goals of a consumptive activity are more specific and observable when compared to the goals of a nonconsumptive activity. Second, the attainment of goals of a consumptive activity are less predictable and expected when compared to the goals of a nonconsumptive activity. They also report respondents' satisfaction ratings for specific outdoor recreation experiences and find large differences between ratings of consumptive and nonconsumptive recreationists. Consumptive recreationists consistently recorded lower satisfaction scores using a standardized scale than did nonconsumptive recreationists (Vaske, et al., 1982).

Duffus and Dearden (1990) suggest that a larger population of people has engaged in nonconsumptive wildlife related recreation activities than in traditional wildlife pursuits. As a result of the growth of nonconsumptive wildlife related recreation

activities, and the associated growth in nonconsumptive wildlife related recreation expenditures on trip-related costs and equipment, an analysis of these expenditures could provide valuable insight into this recreation area. Expenditure analyses can provide important but currently unavailable information about the demand for nonconsumptive wildlife related recreation. In particular, expenditure analyses provide information about how different socio-economic groups allocate their resources toward this recreation activity. In the absence of this information, it is assumed that no difference exists between consumptive and nonconsumptive recreationists in their demand for wildlife related recreation.

Research Problem

The existing research on nonconsumptive wildlife related recreation expenditures is quite limited and does not take advantage of current advancements in expenditure analysis. An analysis of nonconsumptive wildlife related recreation expenditures can benefit from the use of more appropriate economic analysis and measurement to comprehend the full value of this type of recreation activity within the framework of natural resource management.

In particular, analyzing nonconsumptive wildlife related recreation expenditures in the framework of an individual who must allocate a constrained budget to maximize utility improves our understanding of the tradeoffs made in this process. Also, recognition of sample and data related issues (censored, truncated samples and heteroscedastic data) common to expenditure models can improve measurement reliability.

This research is justified by the need for more appropriate theoretical and empirical treatment of analyses of nonconsumptive wildlife related recreation expenditures. An analysis of the relationships between socio-economic variables and household consumption patterns on nonconsumptive wildlife related recreation expenditures may contribute to a better understanding of current and future household consumption patterns on nonconsumptive wildlife related recreation. These results may provide valuable information to policy makers who wish to use expenditure analysis mechanisms as an effective management tool to address nonconsumptive wildlife related recreation issues.

Objectives

General Objective

The general objective of this study is to analyze the socio-economic characteristics associated with household consumption patterns of nonconsumptive wildlife related recreation expenditures at a regional level.

Specific Objectives

The specific objectives of this study are:

1. To identify and evaluate national and regional nonconsumptive wildlife related recreation trends;

2. To develop a hypothetical expenditure model useful in explaining the relationship between household consumption patterns and expenditures on nonconsumptive wildlife related recreation;

3. To empirically estimate the hypothetical expenditure model at a regional level; and

4. To provide recommendations based on this analysis to policy makers who wish to use expenditure analysis mechanisms as an effective wildlife management instrument to address nonconsumptive wildlife related recreation issues.

Research Procedures

Objective One

The first objective of this study will be accomplished by a qualitative review of the relevant literature in order to develop a thorough background in the area of nonconsumptive wildlife related recreation and expenditures from both national and regional aspects. Studies on recreation expenditures, nonconsumptive wildlife related recreation expenditures, and relevant empirical studies will be reviewed.

Objective Two

To achieve the second objective of this study, a conceptual model of factors influencing expenditures on nonconsumptive wildlife related recreation will be developed using economic theory and guidance from literature reviewed in Objective 1. Based on general microeconomic theory, the Engel curve, which can be defined as the relationship between the consumer's expenditure on a commodity and his/her money income derived from the income-consumption curve, is an important concept for household expenditure studies. As Blundell (1988) notes, the Engel curve can provide a micro interpretation of a relationship between consumers' expenditure and income. Traditionally, an expenditure function is specified as a function of income.

Socio-economic factors such as income, education, age, gender, ethnicity, residence, employment, marital status, and family size have consistently been shown to

play a determining role in explaining the relationships between socio-economic factors and household consumption patterns. For example, Thompson and Tinsley (1978) used per capita recreation expenditures and included expenditures on vacations, club dues, sporting equipment and tickets to sporting events and movies as the dependent variable, and per capita take home pay as the independent variable. Dardis, et al. (1981) analyzed expenditures on total recreation and included expenditures on vacation homes, boats, wheel goods, lodging and transportation, television and other recreational items as the dependent variable, and household income, age, marital status, race, occupation, education of household head, presence of children under six, location, and employment status of the wife as the independent variables. Similarly, Dardis, et al. (1994) analyzed household expenditures for active leisure, passive leisure, and social entertainment. Income, age, marital status of household head, number of adults, number of children, education, race of household head, and household location were included as the independent variables in this analysis.

Accordingly, a conceptual model will be proposed to estimate the appropriate function from cross-sectional data on nonconsumptive wildlife related recreation expenditures. The conceptual model will serve as a basis for obtaining estimates of household expenditure responses due to income differences and to certain identifiable socio-economic characteristics. To understand the relationships between socio-economic factors and nonconsumptive wildlife related recreation expenditures, this research will explore the hypothesis that the factors influencing nonconsumptive wildlife related recreation expenditures are similar to other expenditure studies. Further, it will also

explore the hypothesis that the factors influencing nonconsumptive wildlife related recreation experiences are not similar to other consumptive wildlife related recreation expenditure studies.

Objective Three

The third objective constitutes the empirical part of this study. Household consumption patterns for nonconsumptive wildlife related recreation expenditures at a regional level will be estimated based on selected socio-economic variables. The study area will be limited to portions of the Lower Mississippi Valley, which is a highly unique ecosystem because of its specific biological and hydrological functions (U.S. Fish and Wildlife Service, 1994). This area (Figure 1) includes portions of Louisiana, Mississippi, and Arkansas, accounting for approximately 90 percent of the total area of the Lower Mississippi Valley.

Data

The data used for this study will be obtained from the 1991 NSFHWAR for Louisiana, Mississippi, and Arkansas residents (U.S. Department of the Interior, 1993). This national survey is comprised of two phases, an initial screening of households to determine who participated or intended to participate in nonconsumptive wildlife related recreation activities in the household, and a series of follow-up interviews to collect detailed data about nonconsumptive wildlife related recreation activities and expenditures (Figure 2). The first questionnaire identified basic household and socio-economic characteristics of respondents, including income, education, gender, ethnicity, residence, age, employment and marital status. There are six sections in the follow-up

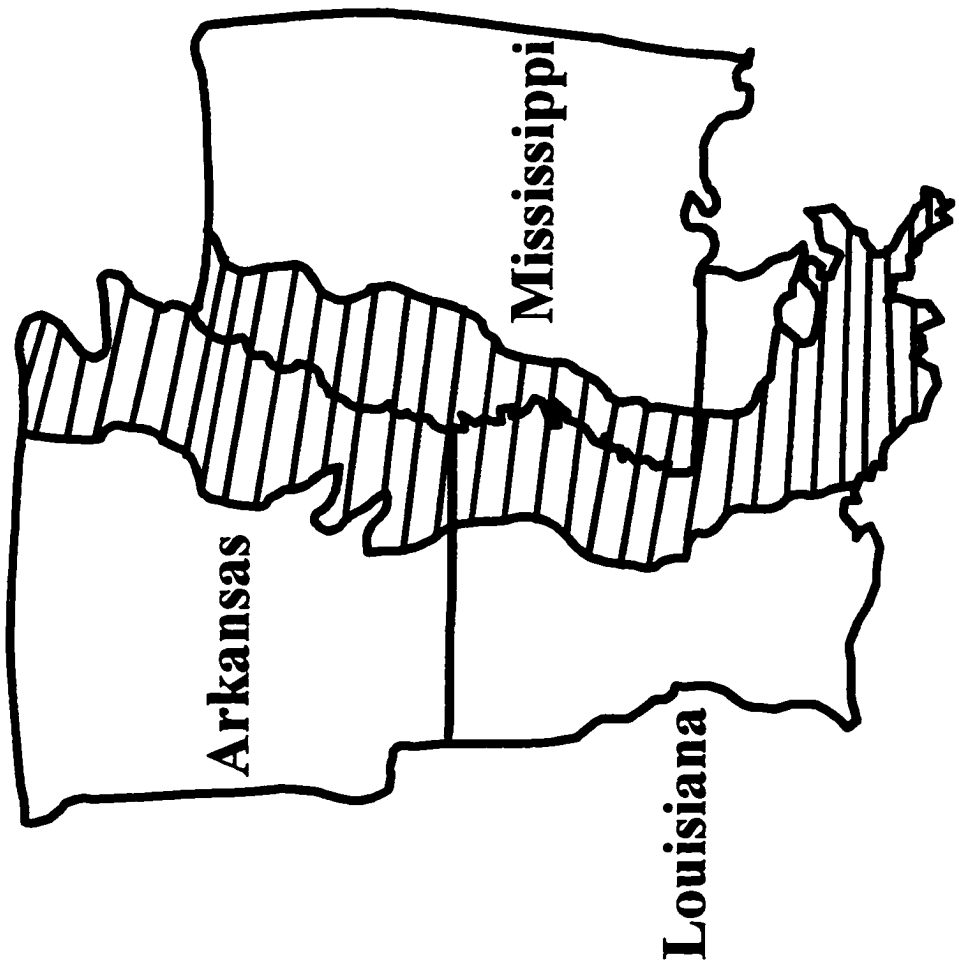


Figure 1. Lower Mississippi Valley Ecosystem

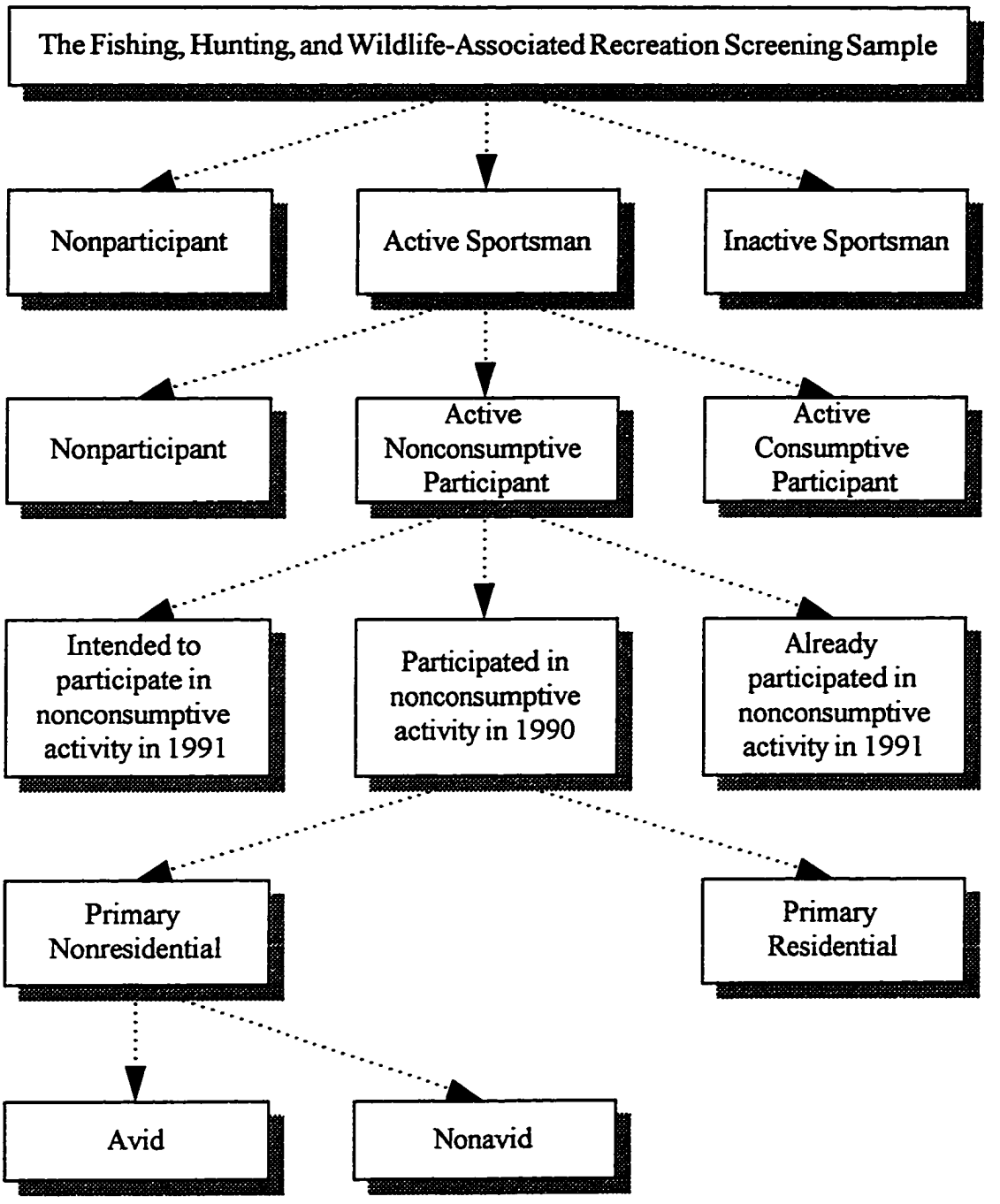


Figure 2. Sample Design Procedure for
Nonconsumptive Wildlife Related Recreation
Source: 1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation

interviewing questionnaire on nonconsumptive wildlife related recreation activities: (1) primary trip information; (2) primary residential wildlife experiences; (3) equipment expenditures; (4) annual equipment expenditures; (5) annual residential wildlife experiences; and (6) economic evaluation, and other activities.

About 102,400 households were completed in the first screening phase for fishing, hunting, and wildlife related recreation. Overall, about 40,100 active and inactive sportsmen were surveyed in the detailed interview phase. About 26,700 active nonconsumptive participants were completed in the detailed sample. Based on the distance traveled by the individual to participate in the nonconsumptive activity, primary nonresidential, which is defined as a person who took a trip of one mile or more to participate in a nonconsumptive activity, and primary residential, which is defined as a person who participated in a nonconsumptive activity less than one mile from home, can be stratified from nonconsumptive participants who participated in 1990. Based on expenditures and the number of days of participation, primary nonresidential is categorized into two substrata: avid and nonavid. Avid is defined as a person who participated at least 30 days or spent at least $300 on nonconsumptive activities. Nonavid is defined as a person who participated between one and 29 days and spent less than $300 on nonconsumptive activities. Overall, about 6,500 avid nonconsumptive participant surveys were completed in the detailed sample (U.S. Department of the Interior, 1993).

Empirically, most household expenditure studies have to confront the problem of how to handle individual households which do not purchase a particular commodity

in the survey period. Hence, zero expenditure in an individual household consumption pattern for a particular commodity implies a corner solution, posing some interesting econometric problems (Blundell, 1988). The tobit model (Tobin, 1958) may be the oldest and best known of the econometric models used to estimate the demand for consumption of some commodities.

The tobit model, also named the censored regression model, originally proposed by Tobin (1958), assumes that household expenditures and the demand for consumption of some commodities often have values clustered at a limiting value, usually zero. Under the tobit specification, zero expenditure implies zero consumption and hence represents a true corner solution (Gould, 1992). Mathematically, the standard tobit model can be defined as follows:

$$\begin{aligned} y_i^* &= x'_i\beta + e_i && i = 1, 2, ..., n \\ y_i &= y_i^* && \text{if } y_i^* > 0 \\ y_i &= 0 && \text{otherwise} \end{aligned} \qquad (1)$$

where β is a vector of unknown parameters, y_i is a vector of individual households' observed expenditures, y_i^* is a vector of the corresponding desired or potential expenditures for some commodities, x_i is a vector of household characteristics that influence expenditure, and e_i is an independently distributed error term with distribution $N(0,\sigma^2)$ (Fair, 1977; McDonald and Moffitt, 1980; Maddala, 1983; Amemiya, 1984; Judge, et al, 1988; Greene, 1993).

Although the tobit model is commonly a useful model in household expenditure studies, it may not be entirely appropriate for the analysis of nonconsumptive wildlife

related recreation expenditures. In a censored sample, observations on all independent variables for the population are available even when the dependent variable is unobservable or truncated. In a truncated sample, observations on the independent variables for the population are available only when the dependent variable is observable. According to the sample design procedures for the 1991 NSFHWAR of nonconsumptive wildlife related recreation, the resulting sample can be treated as a truncated sample associated with nonconsumptive wildlife related recreation participation. The ordinary least squares (OLS) estimator has been shown to yield biased and inconsistent parameter estimates for the tobit model based on a truncated sample (Tobin, 1958; Ziemer, et al., 1982).

Therefore, to achieve the third objective of this study, the double-hurdle model will be considered in the estimation of the theoretical expenditure function. The double-hurdle model, originally proposed by Cragg (1971), offers a useful extension of the tobit model since it allows two separate decisions, consisting of participation and consumption. According to the double-hurdle model, individuals have to pass two separate hurdles before they are observed with a positive level of consumption. Mathematically, the double-hurdle model can be described as follows:

(i) participation equation

$$w_i = z_i'\alpha + u_i \qquad (2)$$

(ii) expenditure equation

$$y_i = y_i^* \quad \text{if } w_i > 0$$

$$= 0 \quad \text{otherwise} \qquad (3)$$

where y_i and y_i^* can be treated the same as in the tobit model, α is a vector of unknown parameters, w_i characterizes the decision of whether to participate, z_i denotes a vector of regressor that influence participation, and u_i is an independently distributed error term with distribution N(0,1) (Jones, 1989). Hence, the double-hurdle model can be considered as the combination of a probit model and a tobit model for a positive expenditure.

To compare the tobit model and double-hurdle model, all observations can be used in the estimation for the tobit model, based on a censored sample, but only positive observations which pass participation and consumption decisions simultaneously can be used in the estimation for the double-hurdle model based on a censored and truncated sample. Based on this understanding, the double-hurdle model is an appropriate model to consider for this analysis of nonconsumptive wildlife related recreation expenditures, not only because the sample is truncated by the people who participated or intended to participate in nonconsumptive wildlife related recreation, but also because positive values are observed about whether to consume and how much to consume to participate in nonconsumptive wildlife related recreation.

The applications of the double-hurdle model include Blaylock and Blisard(1992), Burton, et al. (1994), Jones (1989), Lin and Milon (1993), Reynolds (1990), Yen (1993), Yen, et al. (1995), and Yen and Jones (1997). Jones (1989) used the double-hurdle approach to model the UK cigarette consumption in which participation and consumption should be regarded as separate consumer choices. Reynolds (1990) used the double-hurdle model to analyze fresh vegetable consumption using household survey

data and also showed that the tobit model underestimated the impact of the explanatory variables on fresh vegetable expenditures. Following the stochastic specification of a double-hurdle model proposed by Jones (1989), Blaylock and Blisard (1992) showed that smoking participation and consumption decisions are separate choices. They also estimated several dominate models which assume that standard corner solutions are not applicable.

Lin and Milon (1993) used the double-hurdle model to evaluate attribute and safety perceptions of shellfish demand which may influence decisions about whether to consume and how much to consume. Yen (1993) proposed the Box-Cox double-hurdle model (using the Box-Cox transformation) to analyze household expenditures on food away from home using the Bureau of Labor Statistics' 1989 Consumer Expenditure Diary Survey. Burton, et al. (1994) used the double-hurdle model to provide a better understanding of the determinants influencing UK household meat purchase behavior and the separate decisions of participation and consumption. Yen, et al. (1995) used the Box-Cox double-hurdle model to estimate the determinants of crawfish consumption in South Louisiana, taking into account both participation and consumption decisions. Yen and Jones (1997) extended the double-hurdle model to the analysis of cheese consumption using the inverse hyperbolic sin transformation. Therefore, as a result of using the double-hurdle framework, results of this analysis will provide information not only on expenditures but also the decision to participate in nonconsumptive wildlife related recreation.

Objective Four

The final objective of this study will be achieved through a generalization of findings resulting from the previous objectives of the expenditure analysis on nonconsumptive wildlife related recreation. Results will be interpreted in light of the information needs of policy makers of natural resource management in both private and public sectors. This information should be useful in identifying the target groups for developing production and marketing promotion strategies. In addition, this information should be useful to state and federal government agencies exploring funding options based on willingness-to-pay for participating in nonconsumptive wildlife related recreation activities or user-based tax collections.

Outline of the Dissertation

Chapter 1 presents the research problem, justification for the research, objectives of the study, and procedures for the research. Chapter 2 presents national and regional nonconsumptive wildlife related recreation trends. Chapter 2 also gives a review of relevant literature about expenditure analyses, the tobit model, and the double-hurdle model, and proposes a conceptual model to estimate the relationships between nonconsumptive wildlife related recreation expenditures and certain identifiable socio-economic characteristics. Chapter 3 includes data collection, empirical analysis, and empirical results. Chapter 4 summaries the findings and presents the conclusions, along with revelant policy recommendations.

CHAPTER 2

OVERVIEW OF NONCONSUMPTIVE WILDLIFE RELATED RECREATION

Recent trends in wildlife related recreation have documented a preference shift from traditional consumptive wildlife recreation activities (e.g., fishing and hunting) toward nonconsumptive wildlife recreation activities such as wildlife observing, photographing, or feeding. The main purpose of this chapter is to document and describe these changes in participation and the associated expenditures on nonconsumptive wildlife related recreation. The information presented in this chapter focuses on patterns of primary nonresidential and residential participation, since these activities represent direct involvement in observing, photographing, or feeding wildlife. The second purpose of this chapter is to identify the characteristics of individuals who participated in nonconsumptive wildlife related recreation, not only based on the reported results of the National Surveys of Fishing, Hunting, and Wildlife-Associated Recreation (NSFHWAR) (1980, 1985, 1991), but also based on the results of previous related research on outdoor and wildlife recreation research. Based on these research findings and relevant economic theory, this chapter will propose a conceptual model relating nonconsumptive wildlife related recreation participants' expenditures and their income and socio-economic background.

National Survey of Nonconsumptive Wildlife Related Recreation

The NSFHWAR is developed by the U.S. Fish and Wildlife Service and conducted by the U.S. Bureau of the Census every five years since 1955. The comprehensive NHFHWAR has repeatedly documented that most Americans enjoyed some form of wildlife related recreation and spent significant sums of money in pursuing these activities, especially on nonconsumptive wildlife related recreation.

The 1980 NSFHWAR provided the first comprehensive opportunity to gather region-level information on nonconsumptive wildlife related recreation. The 1985 NSFHWAR also provided the first opportunity to collect state-level information on nonconsumptive wildlife related recreation. The 1991 NSFHWAR provided a more precise opportunity to collect both state- and region-level information on nonconsumptive wildlife related recreation, especially information of expenditures. The major characteristics (e.g., survey design and sampling) of the 1980, 1985, and 1991 NSFHWAR are shown in Table A.1 (Appendix A). These national surveys provide strong and valid evidence of the economic importance of public interest in wildlife related recreation, especially in nonconsumptive wildlife related recreation. The data from these national surveys can be used by federal and state fish and wildlife agencies to estimate demand for nonconsumptive wildlife related recreation and to identify trends in participation and expenditures. The following sections review major changes in participation trends for the U.S. and for states comprising the Lower Mississippi Valley Ecosystem: Arkansas, Louisiana, and Mississippi.

Changes in Participation: U.S.

Results of the 1980 NSFHWAR (U.S. Department of the Interior, 1982) reported that 99.8 million U.S. residents sixteen years and older participated in some form of wildlife related recreation. These recreationists included 42.1 million anglers, 17.4 million hunters, and 83.2 million participants in nonconsumptive wildlife related recreation. Results of the 1985 NSFHWAR (U.S. Department of the Interior, 1988) reported that 77 percent of the U.S. population sixteen years and older participated in some form of wildlife related recreation. These recreationists included 46.4 million anglers, 16.7 million hunters, and 134.7 million participants in nonconsumptive wildlife related recreation. More recently, results of the 1991 NSFHWAR (U.S. Department of the Interior, 1993) reported that 108.7 million Americans sixteen years and older participated in some form of wildlife related recreation. These recreationists included 35.6 million anglers, 14.1 million hunters, and 76.1 million participants in nonconsumptive wildlife related recreation (Table A.2).

Changes in Participation: The Lower Mississippi Valley

For Arkansas, the 1980 NSFHWAR (U.S. Department of the Interior, 1982) reported that 579 thousand Arkansas residents sixteen years and older fished, 378 thousand Arkansas residents sixteen years and older hunted, and 703 thousand Arkansas residents six years and older participated in primary nonconsumptive activities. The 1985 NSFHWAR (U.S. Department of the Interior, 1988) reported that 1.5 million Arkansas residents sixteen years and older participated in some form of wildlife related recreation. Of the total number of participants in 1985, 673 thousand fished, 350

thousand hunted, and 1.2 million participated in primary nonconsumptive activities. The 1991 NSFHWAR U.S. Department of the Interior, 1993) reported that 1.2 million Arkansas residents sixteen years and older participated in some form of wildlife related recreation. Of the total number of participants in 1991, 493 thousand fished, 264 thousand hunted, and 812 thousand participated in primary nonconsumptive activities.

For Louisiana, the 1980 NSFHWAR (U.S. Department of the Interior, 1982) reported that 899 thousand Louisiana residents sixteen years and older fished, 485 thousand Louisiana residents sixteen years and older hunted, and 1.1 million Louisiana residents six years and older participated in primary nonconsumptive activities. The 1985 NSFHWAR (U.S. Department of the Interior, 1988) reported that 2.4 million Louisiana residents sixteen years and older participated in some form of wildlife related recreation. Of the total number of participants in 1985, 1.1 million fished, 517 thousand hunted, and 1.9 million participated in primary nonconsumptive activities. The 1991 NSFHWAR (U.S. Department of the Interior, 1993) reported that 1.8 million Louisiana residents sixteen years and older participated in some form of wildlife related recreation. Of the total number of participants in 1991, 801 thousand fished, 333 thousand hunted, and 1.1 million participated in primary nonconsumptive activities.

For Mississippi, the 1980 NSFHWAR (U.S. Department of the Interior, 1982) reported that 572 thousand Mississippi residents sixteen years and older fished, 385 thousand Mississippi residents sixteen years and older hunted, and 569 thousand Mississippi residents six years and older participated in primary nonconsumptive activities. The 1985 NSFHWAR (U.S. Department of the Interior, 1988) reported that

1.6 million Mississippi residents sixteen years and older participated in some form of wildlife related recreation. Of the total number of participants in 1985, 713 thousand fished, 404 thousand hunted, and 1.1 million participated in primary nonconsumptive activities. The 1991 NSFHWAR (U.S. Department of the Interior, 1993) reported that 1.1 million Mississippi residents sixteen years and older participated in some form of wildlife related recreation. Of the total number of participants in 1991, 506 thousand fished, 292 thousand hunted, and 742 thousand participated in primary nonconsumptive activities (Table A.2)

Because the survey methods of the detailed phase of the 1991 NSFHWAR were changed, the data reported in the 1991 NSFHWAR should not be directly compared with that of the 1980 and 1985 NSFHWAR reports. However, the trend information of the relative differences in wildlife related recreation participation can be compared from the screening phases of the 1980, 1985, and 1991 NSFHWAR (Aiken, 1994). With 1980 as the base year, the trend of primary nonresidential activity increased 63 percent in the U.S. between 1980 and 1990, this trend also increased 86 percent in Arkansas, increased 42 percent in Louisiana, and increased 122 percent in Mississippi (Table A.3). In the U.S., the trend of residential wildlife observing increased 90 percent, photographing increased 109 percent, but feeding decreased 5 percent between 1980 and 1990. In Arkansas, the trend of residential wildlife observing increased 112 percent, photographing increased 144 percent, but feeding decreased 4 percent between 1980 and 1990. In Louisiana, the trend of residential wildlife observing increased 54 percent, photographing increased 113 percent, but feeding decreased 8 percent between 1980 and

1990. In Mississippi, the trend of residential wildlife observing increased 115 percent, photographing increased 209 percent, but feeding decreased 7 percent between 1980 and 1990 (Aiken, 1994).

In summary, these surveys show that the growth of nonconsumptive wildlife related recreation has increased more significantly relative to that of fishing and hunting over the past decade. This increasing trend of nonconsumptive wildlife related recreation provides useful information concerning how to support and manage this growing demand for participation in nonconsumptive wildlife related recreation.

Changes in Expenditures: U.S.

In 1980, the results of 1980 NSFHWAR (U.S. Department of the Interior, 1982) reported that total expenditures associated with wildlife related recreation were $41 billion. Anglers spent a total of $17.3 billion, hunters spent a total of $8.5 billion, and nonconsumptive participants spent a total of $14.8 billion in 1980. Of the $14.8 billion total nonconsumptive wildlife related recreation expenditures, nonconsumptive participants spent a total of $4.0 billion on trip-related costs, spent a total of $6.6 billion on equipment, and spent about a total of $4.2 billion on other related items. In 1985, the results of 1985 NSFHWAR (U.S. Department of the Interior, 1988) reported that total expenditures associated with wildlife related recreation were $55.7 billion. Anglers spent a total of $28.1 billion, hunters spent a total of $10.1 billion, and nonconsumptive participants spent a total of $14.3 billion in 1985. Of the $14.3 billion total nonconsumptive wildlife related recreation expenditures, nonconsumptive participants

spent a total of $4.4 billion on trip-related costs, spent a total of $9.4 billion on equipment, and spent about a total of $480 million on other related items.

In 1991, the results of 1991 NSFHWAR (U.S. Department of the Interior, 1993) reported that total expenditures associated with wildlife related recreation were $59 billion. Anglers spent a total of $24 billion, hunters spent a total of $12.3 billion, and nonconsumptive participants spent a total of $18.1 billion in 1991. Of the $18.1 billion total nonconsumptive wildlife related recreation expenditures, nonconsumptive participants spent a total of $7.5 billion on trip-related costs, spent a total of $9.6 billion on equipment, and spent about a total of $1 billion on other related items. (Table A.4 and Table A.5).

Changes in Expenditures: The Lower Mississippi Valley

In 1985, Arkansas residents spent $350 million for fishing, $208 million for hunting, and $78 million for primary nonconsumptive activities in the United States (U.S. Department of the Interior, 1988). Of the $78 million total nonconsumptive wildlife related recreation expenditures in 1985, nonconsumptive participants spent a total of $28 million on trip-related costs, spent a total of $46 million on equipment, and spent about a total of $4 million on other related items. Arkansas residents spent $906 million on wildlife related recreation, $286 million for fishing, $288 million for hunting, and $189 million for primary nonconsumptive activities in the United States in 1991 (U.S. Department of the Interior, 1993). Of the $189 million total nonconsumptive wildlife related recreation expenditures in 1991, nonconsumptive participants spent a

total of $45 million on trip-related costs, spent a total of $136 million on equipment, and spent about a total of $8 million on other related items.

In 1985, Louisiana residents spent $598 million for fishing, $326 million for hunting, and $77 million for primary nonconsumptive activities in the United States (U.S. Department of the Interior, 1988). Of the $77 million total nonconsumptive wildlife related recreation expenditures in 1985, nonconsumptive participants spent a total of $28 million on trip-related costs, spent a total of $46 million on equipment, and spent about a total of $3 million on other related items. Louisiana residents spent $1.5 billion on wildlife related recreation, $686 million for fishing, $434 million for hunting, and $222 million for primary nonconsumptive activities in the United States in 1991 (U.S. Department of the Interior, 1993). Of the $222 million total nonconsumptive wildlife related recreation expenditures in 1991, nonconsumptive participants spent a total of $61 million on trip-related costs, spent a total of $153 million on equipment, and spent about a total of $8 million on other related items.

In 1985, Mississippi residents spent $387 million for fishing, $204 million for hunting, and $78 million for primary nonconsumptive activities in the United States (U.S. Department of the Interior, 1988). Of the $78 million total nonconsumptive wildlife related recreation expenditures in 1985, nonconsumptive participants spent a total of $18 million on trip-related costs, spent a total of $58 million on equipment, and spent almost $2 million on other related items. Mississippi residents spent $986 million on wildlife related recreation, $263 million for fishing, $402 million for hunting, and $233 million for primary nonconsumptive activities in the United States in 1991 (U.S.

Department of the Interior, 1993). Of the $233 million total nonconsumptive wildlife related recreation expenditures in 1991, nonconsumptive participants spent a total of $59 million on trip-related costs, spent a total of $166 million on equipment, and spent about a total of $8 million on other related items (Table A.4 and Table A.5).

Even though the expenditures have been overestimated from a 12-month recall period rather than that from a 4-month recall period, the expenditures on nonconsumptive wildlife related recreation still increased both nationally and regionally. More than fifty percent of expenditures relate to equipment associated with nonconsumptive wildlife related recreation. Likewise, the trip related cost still retains its proportion of total expenditures on nonconsumptive wildlife related recreation.

Changes in Participants' Characteristics

According to information from the NSFHWAR, it is evident that nonconsumptive wildlife related recreation has grown in popularity in the U.S. This increasing trend in nonconsumptive wildlife related recreation also shows that public interest in nonconsumptive wildlife recreation activities extends well beyond the traditional consumptive wildlife recreation activities. Figure 3 and Figure 4 show that people participated in nonconsumptive wildlife related recreation more than that in consumptive wildlife recreation both nationally and regionally. Figure 5 and Figure 6 show that expenditures on nonconsumptive wildlife related recreation were growing greater than that on consumptive wildlife recreation both nationally and regionally. This is further seen in Tables A.6 -- A.26 which present selected descriptive statistics for the three survey periods (U.S. Department of the Interior, 1982, 1988, 1993). The following

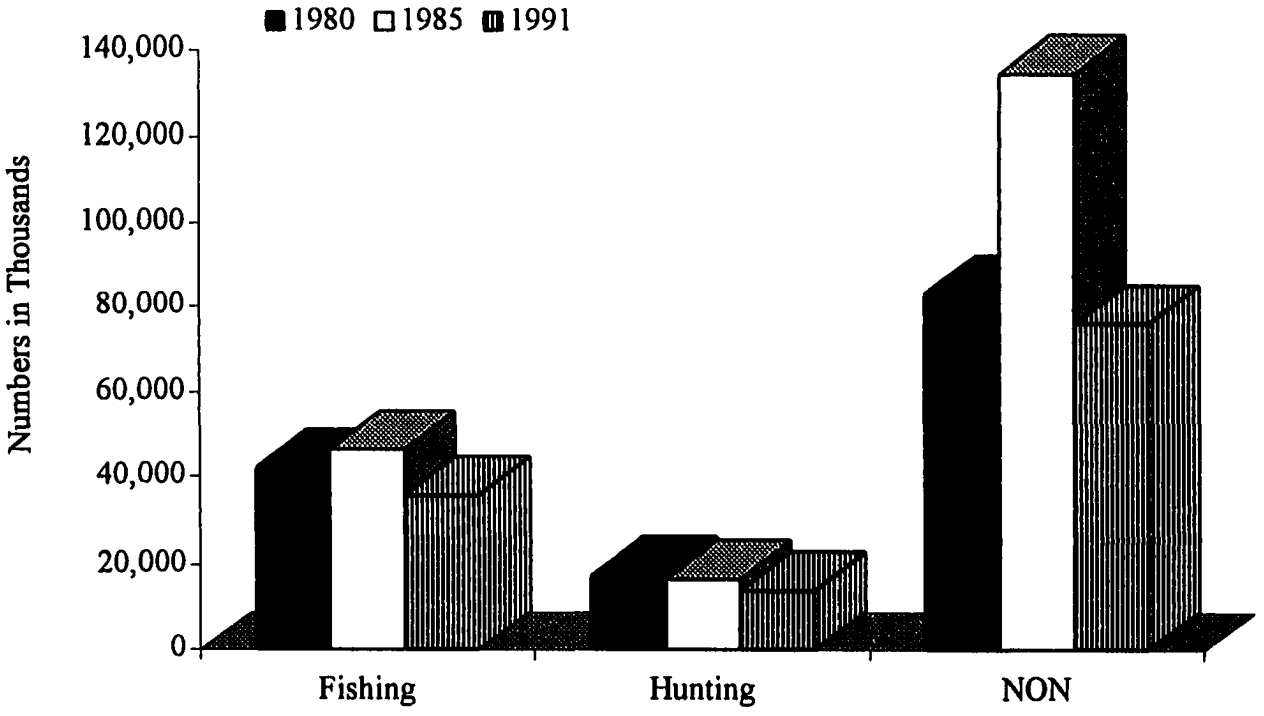


Figure 3. Changes in Participation by Activity Category for U.S.

Source: 1980, 1985, 1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation

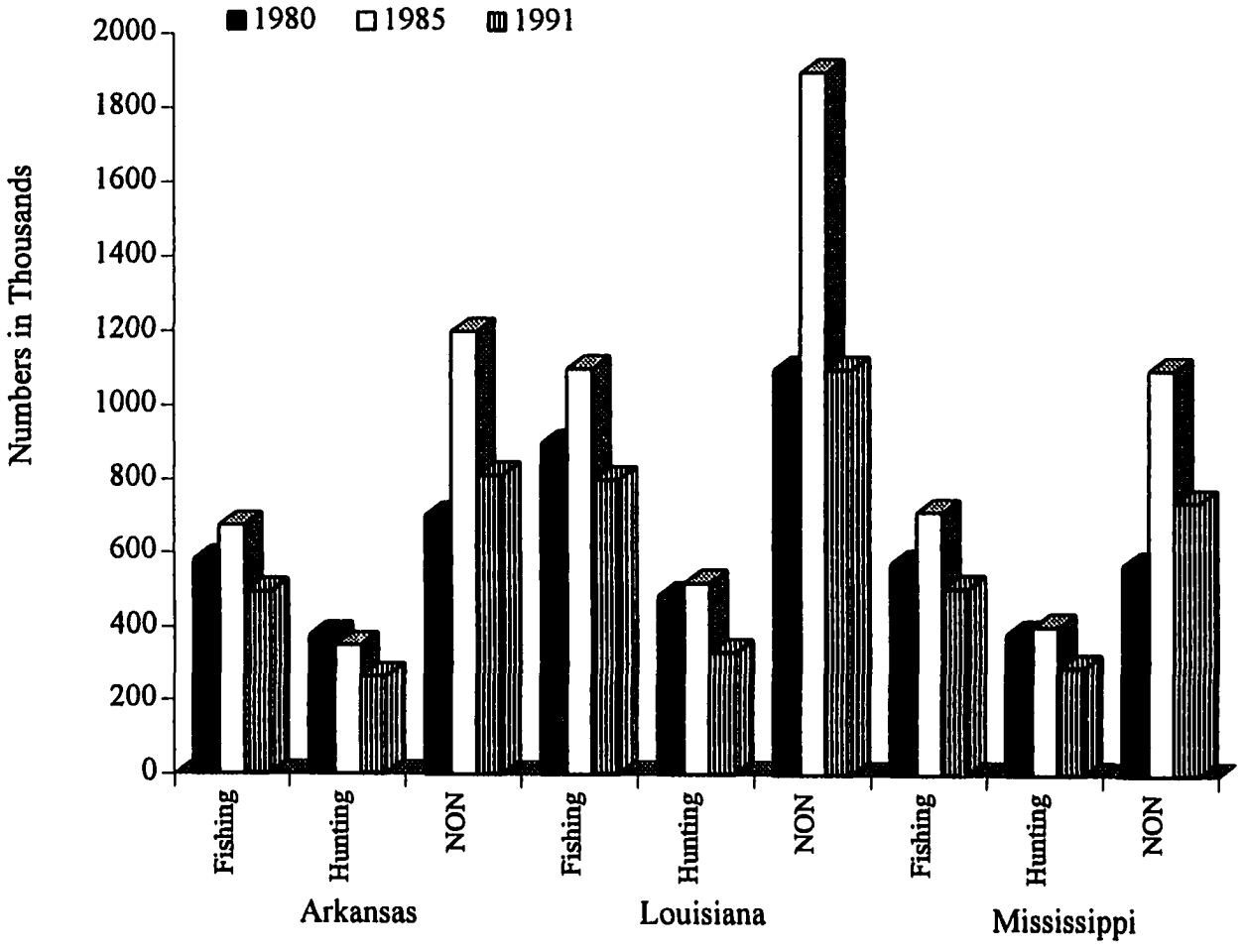


Figure 4. Changes in Participation by Activity Category for the Lower Mississippi Valley

Source: 1980, 1985, 1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation

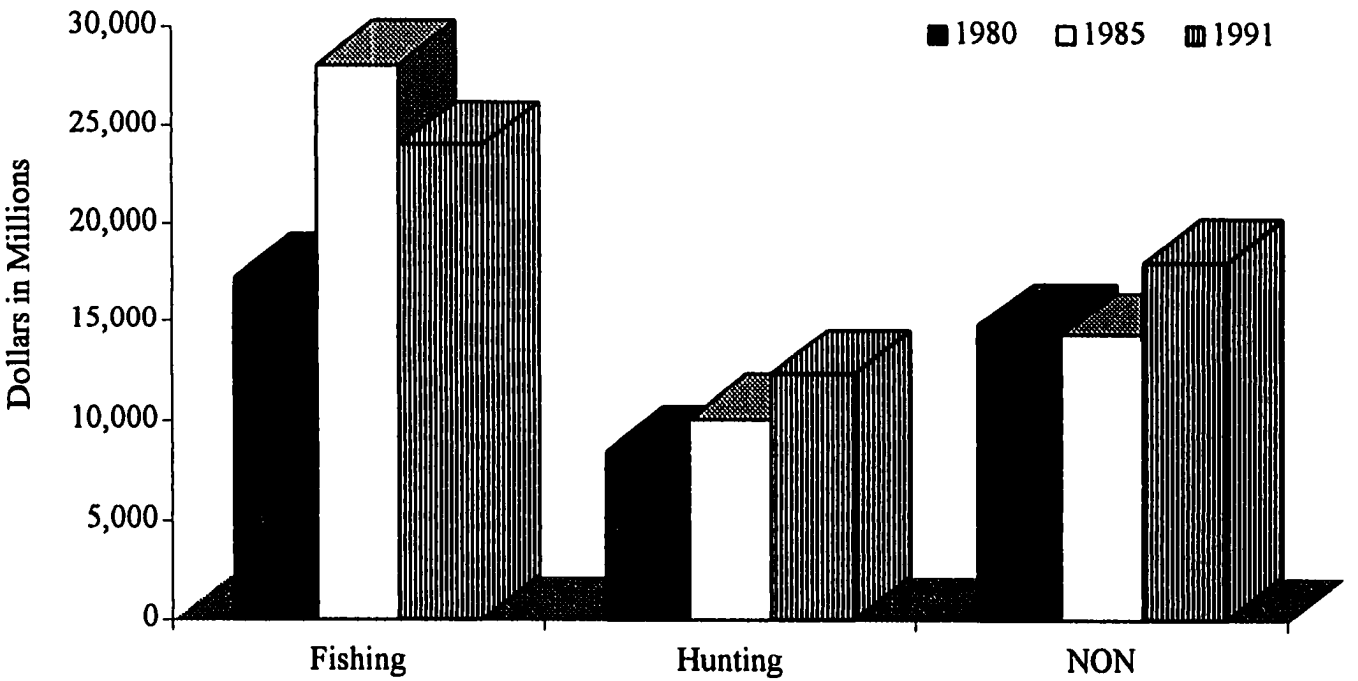


Figure 5. Changes in Expenditures by Activity Category for U.S.

Source: 1980, 1985, 1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation

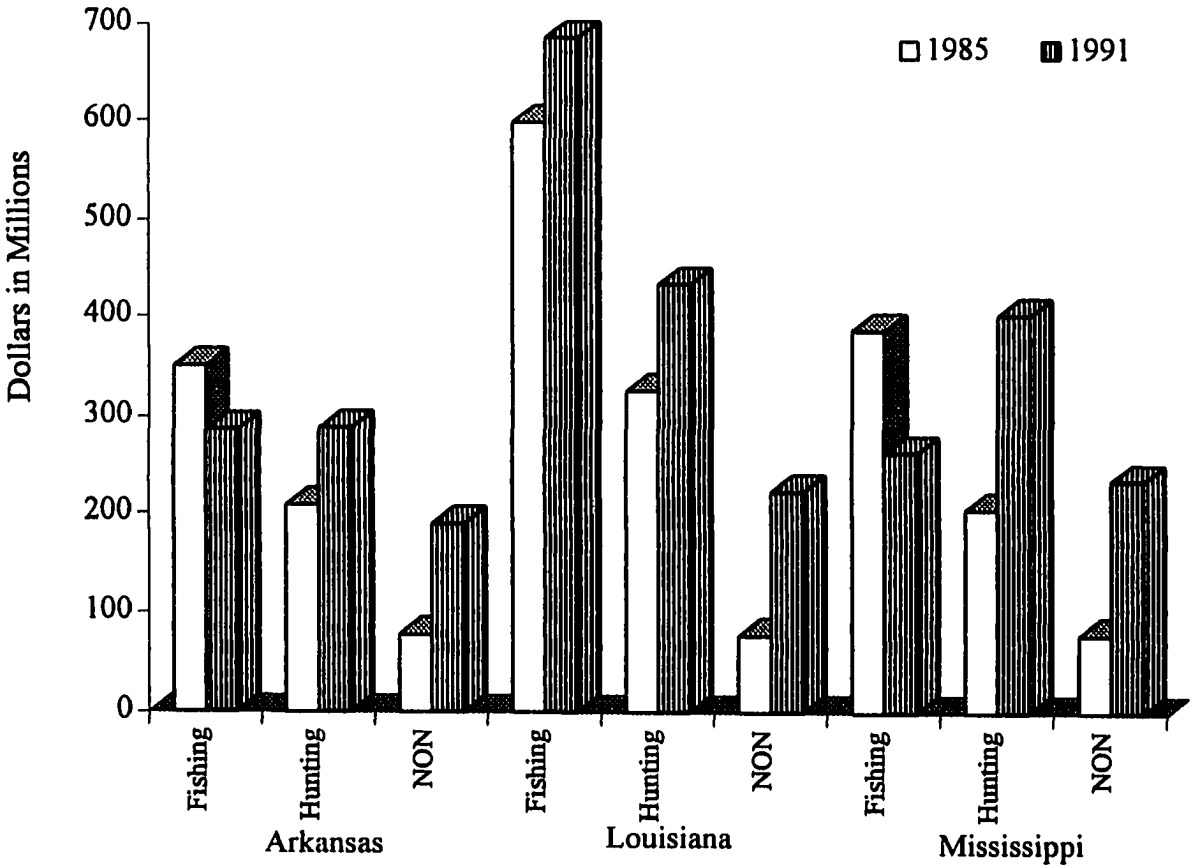


Figure 6. Changes in Expenditures by Activity Category for Lower Mississippi Valley

Source: 1980, 1985, 1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation

sections review important trends by socio-economic characteristics, including age, gender, ethnicity, residence, education, and income.

Age

All age groups can participate in some form of nonconsumptive wildlife related recreation. Age groups from eighteen years through fifty-four years exhibited the largest percentage of participating in primary nonresidential activities, while participants whose age groups were greater than twenty-five years showed the largest percentage of participation in primary residential activities (Table A.6 and Table A.7). This pattern also appeared in Arkansas, Louisiana, and Mississippi (Table A.8, Table A.9, and Table A.10).

Gender

Unlike hunting and fishing which were dominated by male participants, the number of female participants in primary residential activities was slightly larger than male participants, both nationally and regionally. In 1985, the number of female participants in primary nonresidential activities was slightly larger than male participants, but the number of male participants in primary nonresidential activities was slightly larger than female participants in 1991 (Table A.11). This pattern was similar in Louisiana, but the number of male participants in primary nonresidential activities was slightly larger than female participants for both Arkansas and Mississippi (Table A.12). However, the number of nonconsumptive participants in primary activities was nearly equivalent for both female and male.

Ethnicity

Nationally, more than 90 percent of those who reported participating in some form of nonconsumptive wildlife related recreation were white (Table A.13). Nonconsumptive wildlife related recreation participation in primary activities went up slightly in terms of percentage for whites in Arkansas, Louisiana, and Mississippi (Table A.14).

Residence

The number of urban participants in primary activities was slightly larger than rural participants nationally (Table A.15). This pattern was similar in Louisiana, but the number of rural participants in primary activities was slightly larger than urban participants for both Arkansas and Mississippi (Table A.16).

Education

Nonconsumptive wildlife related recreation participation in primary activities was strongly associated with education level (Table A.17 and Table A.18). Although a higher proportion of participants with some college background participated in primary activities, nonconsumptive wildlife related recreation participants were still predominately persons with a high school education or less. This pattern was similar for Arkansas, Louisiana, and Mississippi (Table A.19, Table A.20, and Table A.21). A strong relationship between educational level and primary nonresidential activities was found for nonconsumptive wildlife related recreation.

Income

For nonconsumptive wildlife related recreation, there is a consistent relationship between income and primary activities (Table A.22 and Table A.23). Even though a larger percentage of participants in higher income groups participated in primary activities, there still was a great number of participants in middle and lower income groups. Of the participants in primary residential activities, both the higher income groups and the lower income groups increase their participation. This pattern was similar for Arkansas, Louisiana, and Mississippi (Table A.24, Table A.25, and Table A.26).

In general, it can be seen that nonconsumptive wildlife related recreation participants in primary nonresidential activities were mainly white males whose age ranged from eighteen through fifty-four years who had college backgrounds and a relatively high income, living in an urban environment. The participants in primary residential activities were mainly white females whose age was greater than twenty-five years, who had at least a high school education level, and were middle income, living in an urban area.

In summary, this review of trends in nonconsumptive wildlife related recreation indicates that the magnitude of participation in primary nonresidential activity increased 63 percent; while the magnitude of participation in primary residential activity increased 112 percent in observing wildlife, increased 109 percent in photographing wildlife, but decreased 5 percent in feeding wildlife, respectively, between 1980 and 1990 nationally. Significantly, this trend reveals a large growth in primary residential participation. With

regard to expenditures, the magnitude of expenditures in nonconsumptive wildlife related recreation increased 112 percent between 1980 and 1990 nationally.

By comparison, the Lower Mississippi Valley States present a relatively higher participation rate in both primary nonresidential and residential activities between 1980 and 1990. Between 1985 and 1990, the magnitude of expenditures in nonconsumptive wildlife related recreation increased 242 percent in Arkansas, increased 288 percent in Louisiana, and increased 298 percent in Mississippi. Obviously, this trend reveals a large growth in nonconsumptive wildlife related recreation expenditures regionally. As seen in the following section, participants' characteristics provide some useful information in terms of explaining expenditures on nonconsumptive wildlife related recreation.

Conceptual Model

The conceptual model of nonconsumptive wildlife related recreation expenditures proposed here is illustrated by Figure 7. This conceptual model consists of five major components identified as socio-economic attributes, the recreational user, wildlife and its habitat, nonconsumptive wildlife use, and utility (benefit) maximization. The conceptual model combines the independent variables such as household income used to describe nonconsumptive wildlife related recreation to explain participants' expenditure patterns and the explanatory variables (socio-economic and wildlife-attribute variables) commonly considered in economic modeling and wildlife-based recreation management. Choice of income as an explanatory variable is justified by economic theory. Selection of the independent variables other than income is based on previous studies by Thompson and Tinsley (1978), Dardis, et al. (1981), and Dardis, et

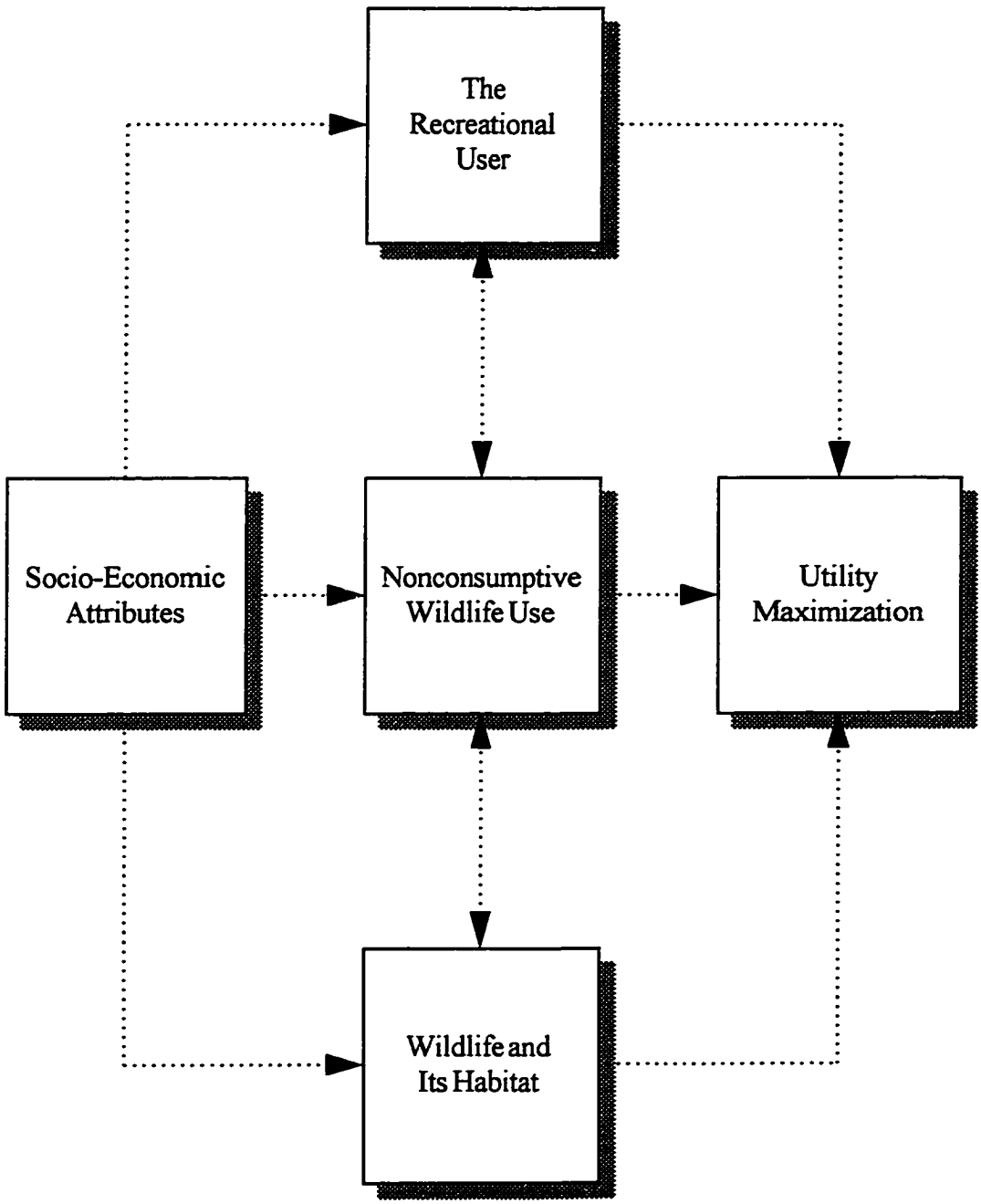


Figure 7. Nonconsumptive Wildlife Related Recreation: A Conceptual Model

al. (1994). These results have established the role of socio-economic characteristics as important explanatory factors in participation, expenditure, and attitudes toward wildlife.

The recreational user's tastes and preferences are shaped by society and their role in society. For example, an older, well educated female would be more likely to participate in nonconsumptive wildlife related recreation than hunting due to typical tastes and preferences. The societal effects on the recreational user can be measured in this model through the use of socio-economic attributes. From an economic perspective, the total value of wildlife and its habitat can also be affected by society. For example, an endangered wildlife species might focus more public attention on itself. Therefore, the societal effects on the wildlife and its habitat can also be measured by the use of socio-economic attributes. The interaction between the recreational user and wildlife and its habitat (in this case, nonconsumptive wildlife use) will also be affected by society.

In order to achieve the utility (benefit) maximization subject to budget constraint associated with nonconsumptive wildlife related recreation, this conceptual model can be used to explain the relationship between the recreational user and wildlife and its habitat from an economic perspective. Likewise, this conceptual model can also describe the influencing factors (socio-economic attributes, the recreational user, and wildlife and its habitat) affecting nonconsumptive wildlife related recreation in terms of utility maximization subject to budget constraint. Most important issue in this study is understanding the influencing factors associated with household consumption patterns of nonconsumptive wildlife related recreation expenditures.

The concept of utility provides the economic basis for the conceptual model of nonconsumptive wildlife related recreation. Given individual's income level, the concept of utility, the satisfaction obtained by an individual from the consumption of goods and services, helps explain the behavior of the individual which purchases the goods and services required to participate in nonconsumptive wildlife related recreation.

In order to achieve a total recreation experience, nonconsumptive wildlife related recreation participants have to anticipate and plan to participate in nonconsumptive wildlife related recreation, travel to the actual site which can provide such kinds of opportunities or activities, engage in activities on the actual site (on-site activities), travel home, and recollect the experiences from nonconsumptive wildlife related recreation. This has been described in terms of five phases of nonconsumptive wildlife related recreation experiences (Clawson and Knetsch, 1969). In this case, the concept of recreation experiences is identical to the concept of utility in terms of its social behavior aspects.

Socio-economic attributes can be treated as external influences on the recreational user, wildlife and its habitat, and nonconsumptive wildlife use. They are included in the conceptual model not only because economic theory suggests that they affect the individual's consumption behavior, but also because wildlife managers indicate that they play a significant role in wildlife management policy. These external socio-economic attributes are often closely linked with political reactions, such as adding some tax on the specific equipment for wildlife related recreation. However, they will also affect the context of the human-wildlife relationship, which is nonconsumptive

wildlife use. They also directly affect the participants' expenditure patterns on nonconsumptive wildlife related recreation.

The recreational user can be treated as the demand sector in the conceptual model. The individual's tastes and preferences will affect the individual's consumption behavior of nonconsumptive wildlife related recreation. Additional explanatory variables included in the conceptual model are wildlife habitat attributes which can be treated as the supply sector. Without wildlife and its habitat, there would be far fewer or no participants in nonconsumptive wildlife related recreation. In comparison with consumptive wildlife related recreation, nonconsumptive wildlife related recreation provides a broad interpretation of the role of wildlife and its habitat in terms of economic value. Based on the reported results of the NSFHWAR (U.S. Department of the Interior, 1980, 1985, 1991), it appears that nonconsumptive wildlife related recreation is not only a significant economic benefit to communities which provide the opportunities for it, but also proves beneficial for wildlife and its habitat. Wildlife observing, for example, is a typical nonconsumptive wildlife related activity which demonstrates the context of the human-wildlife relationship. Nonconsumptive wildlife use can be viewed as an intermediate interface between the recreational user and wildlife and its habitat.

In summary, the conceptual model provides a framework which illustrates and explains that utility (benefit) maximization subject to budget constraint is the ultimate objective for the recreational user achieving total recreation experiences from nonconsumptive wildlife related recreation in terms of the expenditure-income

relationship. In order to recognize the rational nonconsumptive wildlife related recreation participant's satisfaction-seeking behavior, theoretically, the recreational user would pursue the higher level of satisfaction (utility) as his/her money income is increased, by purchasing certain items at constant prices for nonconsumptive wildlife related recreation. In order to know how the nonconsumptive wildlife related recreation participant would respond to changes in income, the derivation of utility maximization yields the expenditure-income relationship which relates income to the demand for certain items at constant prices for nonconsumptive wildlife related recreation. Therefore, consumer demand theory can be used to explain the variation in individual or household expenditures on nonconsumptive wildlife related recreation.

Theoretical Model

According to consumer demand theory, the nonconsumptive wildlife related recreation participant attempts to maximize his/her utility from nonconsumptive wildlife related recreation subject to his/her budget constraint. Thus, the maximization of the utility function for individual consumption behavior can be stated as follows:

$$\text{maximize} \quad u = u(q_i)$$

$$\text{subject to} \quad INC = \sum p_i q_i \quad i = 1, \ldots, n \tag{4}$$

where u(.) represents the utility function which is assumed to be continuous, increasing, and quasi-concave, q_i is a vector of market goods the individual purchased in the marketplace, p_i is a vector of corresponding market prices for market goods q_i, and INC is the individual's income. The Lagrange function can be formed as follows:

$$\mathcal{L} = u(q_i) + \lambda(INC - \sum p_i q_i) \quad i = 1, \ldots, n \tag{5}$$

The individual's ordinary (Marshallian) demand function can be derived from the analysis of utility maximization by solving the first-order conditions of the Lagrange function. The individual's ordinary demand function can be expressed as:

$$q_i = g_i (p_i, INC) \qquad i = 1, ..., n \qquad (6)$$

Generally, the demand function gives the quantity of a market good that the individual will purchase as a function of market prices and the individual's income. This relationship is referred to as an Engel curve. The Engel curve can be used to estimate the relationship between expenditures and income, holding price constant. Hence, given the individual's income and prices of goods, the quantities demanded by the individual can be determined from the individual's demand functions. In general, the quantity demanded of each good can be expressed as a function of the individual's income, own price, and the prices of substitutes and complements (Deaton and Muellbauer, 1980; Henderson and Quandt, 1980; Silberberg, 1990; Varian, 1992).

Based on the conceptual model proposed in Figure 7 and consumer demand theory, the demand function for nonconsumptive wildlife related recreation can be expressed in terms of household expenditures as functions of INC, SE, HC, and WH:

$$EXP = f(INC, SE, HC, WH) \qquad (7)$$

where EXP is household expenditures on nonconsumptive wildlife related recreation, SE is social-economic characteristics, HC is household characteristics, and WH is wildlife habitat attributes. Here, household expenditures are dependent on household income, external social-economic factors, internal household characteristics, and wildlife habitat attributes that might affect participation and consumption on nonconsumptive wildlife

related recreation. Prices are typically assumed constant with the cross-sectional data that are usually used to estimate Engel functions.

In analyzing household expenditure behavior using data from cross-sectional survey data, emphasis has been placed on expenditure-income relationships. However, all households may not face the same prices, and further, tastes and preferences for the market goods also may not be the same across households. Thus, the effects of household income, socio-economic factors, household characteristics, and wildlife habitat attributes on expenditure patterns should be considered simultaneously.

In practice, the sample containing observations with reported zero expenditures presents a unique problem with cross-section survey data. Using standard econometric techniques, the parameter estimates are biased and inconsistent (Maddala, 1983). However, some commonly used econometric techniques can be used to deal with this unique problem of zero expenditures, including the Tobit model, the Heckman model, the infrequency-of-purchase model, and the double-hurdle model. The source of the zero expenditures makes the definitive difference in choice among these models.

The Tobit model assumes that all zero expenditures represent standard corner solutions in consumer choices (Tobin, 1958).The Heckman model assumes that all potential consumers are observed with a positive consumption and thus no one is at a corner solution (Heckman, 1979). The infrequency-of-purchase model assumes that zero expenditures result from either traditional corner solutions or infrequency of purchases (Blisard and Blaylock, 1993). The double-hurdle model assumes that every consumer has positive expenditures, conditional on a positive response in the participation decision

(Cragg, 1971; Jones, 1989). Cragg's double-hurdle model is one type of double-hurdle model with independence between the error terms for the participation and consumption decisions. Given recognition of sample selection properties which are illustrated in Figure 2 and positive expenditures, the double-hurdle model is the appropriate econometric model to deal with such problems for this specific case study.

Summary

By recognizing the increasing trends in participation and expenditures on nonconsumptive wildlife related recreation and the characteristics of nonconsumptive wildlife related recreation participants, a conceptual model based on consumer demand theory including socio-economic attributes, the recreational user, wildlife and its habitat, nonconsumptive wildlife use, and utility maximization was developed. From the derivation of utility maximization, the Engel curve can provide valuable information regarding consumption patterns for different commodities and for different individuals associated with nonconsumptive wildlife related recreation. With the existence of specific sample selection properties and positive expenditures, the double-hurdle model is the appropriate econometric model for use in estimation using data provided by the NSFHWAR.

The next chapter will empirically test the conceptual and theoretical model presented. After reviewing the data collection procedures explained earlier in Chapter 1, the empirical model will be presented. Then, estimation results of the empirical model will be reported and discussed.

CHAPTER 3

EMPIRICAL ANALYSIS

The previous chapter reviewed the changes in participation, expenditures, and participants' characterics of nonconsumptive wildlife related recreation and proposed a general conceptual model relating the relationship between nonconsumptive wildlife related recreation participants and wildlife and its habitat. Following the conceptual model, the previous chapter also proposed a theoretical model based on consumer demand theory.

This chapter reviews the data source, and data compilation procedures. Drawing on the theoretical model presented in Chapter 2, a series of models are specified for empirical analysis. Given the censored and truncated structure of the data set used here, appropriate econometric models are identified and reviewed. This chapter then presents and discusses the estimation techniques and the results of the empirical estimations.

Data Source and Compilation

The data used for this study were obtained from NSFHWAR for Arkansas, Louisiana, and Mississippi residents over sixteen years of age (U.S. Department of the Interior, 1993). As reported in Chapter 2, this national survey was composed of two phases, the first (or screening) phase and the second (detailed) phase. The main purpose of the screening phase was to collect basic information from respondents in order to develop a sample of potential nonconsumptive wildlife related recreation participants for the detailed phase. The screening phase identified basic household and socio-economic

characteristics of respondents, including income, education, gender, ethnicity, residence, age, employment and marital status.

The detailed phase was a series of three interviews conducted at four-month intervals eliciting information on fishing, hunting, and nonconsumptive wildlife related recreation activities. Based on responses to questions in the screening phase eliciting information on nonconsumptive wildlife related recreation activities, the detailed phase collected information primarily on residential and nonresidential activities, public and private land use, frequency of activities, days of participation, and expenditures for nonconsumptive wildlife related recreation activities.

The total number of Arkansas, Louisiana, and Mississippi residents from the national survey was 12,205 observations, including 3,355 Arkansas residents, 5,235 Louisiana residents, and 3,615 Mississippi residents. The total number of Arkansas, Louisiana, and Mississippi residents over sixteen years of age was 2,718 observations, including 612 Arkansas residents, 938 Louisiana residents, and 628 Mississippi residents. Thus, the final data used for this study included 2,718 observations on Arkansas, Louisiana, and Mississippi residents over sixteen years of age, 252 (11.57 percent of the total) of whom participated in and consumed primary nonresidential nonconsumptive wildlife related recreation activities, and 232 (10.65 percent of the total) of whom participated in and consumed primary residential nonconsumptive wildlife related recreation activities.

Empirical Models

As noted earlier, an understanding of the factors which affect the demand for nonconsumptive wildlife related recreation is valuable in establishing the empirical models for both primary nonresidential and residential expenditure models. Traditional studies of wildlife related recreation have focused on consumptive uses of resources such as hunting and fishing activities. Overall, previous research on recreation expenditures suggests that income level has a strong influence on recreation expenditures, as do other socio-economic characteristics including education, age, race, gender, and marital status (Dardis, et al., 1981; Bergstrom and Cordell, 1991; Cordell and Bergstrom, 1991; Davis and Mangan, 1992; Dardis, et al., 1994). The family life cycle also appears to play a key role in determining recreation expenditures (Lawson, 1991). Hartmann and Cordell (1989) presented a literature review of the more commonly studied social and demographic influences on recreation behavior, including age, gender, income, education, and occupation. In addition, quality of wildlife habitat and quantity of wildlife viewing, photographing, or feeding may also appear to play a key role in determining wildlife recreation expenditures.

The literature from the related field of participation rates is also of interest. Although the decision to participate in a particular activity is not the same as the decision to maximize utility by spending a particular amount, research regarding participation rates can none the less help shed light on some of the socio-economic factors that may influence recreation expenditures (Hartmann and Cordell, 1989; O'Leary et al., 1989). Most of the these studies have been designed to understand recreation participation

behavior, including characteristics of the individual, characteristics of the resource, and willingness to pay for the recreation experience (Hof and Kaiser, 1983; Hartmann and Cordell, 1989).

Primary Nonresidential Expenditure Model

The primary nonresidential expenditure model evaluates the relationship between the expenditures on primary nonresidential nonconsumptive related wildlife recreation and economic and socio-economic and wildlife-attribute variables. The following primary nonresidential expenditure model can be specified for empirical estimation:

$$EXP = F(INCOME,AGE,AGESQ,FEMALE,MARRIED,COLLEGE,RURAL,EMPLOY,WHITE,PRIVATE,PUBLIC,WOOD,BRUSH,OPEN,MANMADE,BIRDTRIP,LANDMTRP,\epsilon) \quad (8)$$

Detailed definitions of explanatory variables for the primary nonresidential expenditure model are presented in Table 3.1. The dependent variable for the model is the annual total expenditures on primary nonresidential nonconsumptive wildlife related recreation. Given the definition of nonresidential activity, total expenditures for the primary nonresidential activity include equipment expenditures, annual equipment expenditures, and trip related expenditures. Equipment expenditures include binoculars, cameras, special lenses, or other photography equipment, film and developing; day packs, carrying cases, or special clothing; commercially prepared and packed wild bird food, other bulk food used to feed wild birds, nest boxes, bird houses, feeders, or baths; magazines or other periodicals specifically devoted to fish or wildlife; dues or contributions to national, state, or local conservation or wildlife-related organizations; and any other purchases.

Table 3.1 Explanatory Variables for Primary Nonresidential Expenditure Model Associated with Nonconsumptive Wildlife Related Recreation

VARIABLE	DEFINITION
INCOME	Respondent's total household income
AGE	Respondent's age (16 years old and older)
AGESQ	Respondent's age, Squared
FEMALE	Respondent's gender; 1 if female; 0 otherwise
MARRIED	Respondent's marital status; 1 if married; 0 otherwise
COLLEGE	Respondent's educational level; 1 if at least attended college; 0 otherwise
RURAL	Respondent's residence; 1 if grew up in the rural area; 0 otherwise
EMPLOY	Respondent's employment status; 1 if employed; 0 otherwise
WHITE	Respondent's ethnicity; 1 if white; 0 otherwise
PRIVATE	1 if the respondent visited any areas on private land more than one mile from home; 0 otherwise
PUBLIC	1 if the respondent visited any areas on public land more than one mile from home; 0 otherwise
WOOD	1 if the respondent observed, photographed, or fed wildlife on woodland more than one mile from home; 0 otherwise
BRUSH	1 if the respondent observed, photographed, or fed wildlife at a brush-covered area more than one mile from home; 0 otherwise
OPEN	1 if the respondent observed, photographed, or fed wildlife at an open field more than one mile from home; 0 otherwise
MANMADE	1 if the respondent observed, photographed, or fed wildlife at a man-made area more than one mile from home; 0 otherwise
BIRDTRIP	1 if the respondent observed, photographed, or fed birds on a trip more than one mile from home; 0 otherwise
LANDMTRP	1 if the respondent observed, photographed, or fed land mammals on a trip more than one mile from home; 0 otherwise

Annual equipment expenditures include tents, traps, frame packs, backpacking equipment, other camping equipment, off-the-road vehicle, travel or tent trailer, motor home, pickup, camper, van, and any other purchases. Trip related expenditures include food, drink, and refreshments; lodging at motels, cabins, lodges, campground; public transportation, including airplanes, trains, or car rentals; round trip cost for transportation by private vehicle; guide fees, pack trip, or package fees; public land use or access fees; private land use or access fees; rental of equipment such as boats or camping equipment; and any other purchases (U.S. Department of the Interior, 1993).

Hypotheses

Primary nonresidential nonconsumptive wildlife related recreation and related equipment are expected to be normal goods. As an individual's earnings grow, the individual is hypothesized to have more disposable income to spend on equipment, annual equipment, or trip related expenditures for primary nonresidential activities. Holding the price of primary nonresidential activity constant, one would expect the expenditures on primary nonresidential activities to be positively correlated with income. Thus, income is hypothesized to have a positive impact on primary nonresidential nonconsumptive wildlife related recreation expenditures. This hypothesis is further supported by findings from previous leisure and outdoor recreation expenditures studies (Thompson and Tinsley, 1978; Dardis, et al., 1981; Wagner and Washington, 1982; Blaine and Mohammad, 1991; Dardis, et al., 1994).

The role of age, a measure of the physical ability and inclination to engage in wildlife recreation, may influence primary nonresidential participants' consuming

behavior. One's stage in the life cycle hypothetically plays a major role in determining leisure or outdoor recreation expenditures (Rapoport and Rapoport, 1975; Hartmann and Cordell, 1989; Lawson, 1991; Dardis, et al., 1994). In general, the demand for outdoor recreation would follow a life cycle pattern, with greater demand for the middle-age individuals than younger or older individuals. Younger individuals may have more time to participate in but be less likely to consume outdoor recreation activities because of financial constraints, while older individuals may also have more time to participate in but be less likely to consume outdoor recreation activities, not only because of physical considerations, but also because of more expenditures on health and security (Hartmann and Cordell, 1989; Lawson, 1991). Studies also have reported that older individuals spent less than younger individuals on leisure or outdoor recreation (Dardis, et al., 1981; Hill, 1985; Dardis, et al., 1994). It is arguable that middle-age individuals may also be less likely to consume outdoor recreation because of family responsibilities and high child-rearing expenses.

However, reasons for expenditures on leisure or outdoor recreation may not be clear for middle-age individuals (Lawson, 1991). In addition, primary nonresidential nonconsumptive wildlife related recreation activities are not typically so strenuous as to discourage or exclude younger and older individuals. Thus, primary nonresidential participants' consuming behavior may or may not follow a life cycle pattern. In order to test the role of age in nonconsumptive wildlife related recreation expenditures, age squared is included in the model. Opposite signs for the coefficients for age and age squared would be expected in this case.

Gender is hypothesized to be an important factor in primary nonresidential nonconsumptive wildlife related recreation expenditures. According to traditional studies of consumptive wildlife related recreation such as hunting and fishing, men tend to dominate consumptive wildlife related recreation and spend more on such kinds of recreation activities than women, either due to preferences or social custom. Studies suggest that status differences between males and females leads to an inequality in access to leisure time in general (Henderson, et al., 1988; Shaw, 1985). As nonconsumptive wildlife related recreation is a relatively new means of accessing natural resources, females should not be expected to be excluded from primary nonresidential activities. Zuzanek (1978) points out that nonworking women have a slightly higher participation rates than employed women in most leisure activities. Information from the 1985-1987 Public Area Recreation Visitors Survey also shows that a higher percentage of females participated in walking for pleasure than males (Hartmann and Cordell, 1989). However, being female is still hypothesized to have a negative impact in the primary nonresidential expenditure model due to different life styles and different time constraints (Becker, 1981; Dardis, et al., 1981; Hill, 1985; Dardis, et al., 1994).

Marital status may be an influential factor in primary nonresidential nonconsumptive wildlife related recreation expenditures. Marital status may be considered as a potential social barrier to participation in nonconsumptive wildlife related recreation due to joint consumption decisions (Smith and Luzar, 1995). According to Lawson (1991), married individuals with no children appear to prefer to participate in wildlife related recreation, but this situation may be the opposite in the

case of married individuals with children. For nonconsumptive wildlife related recreation, parents may provide some forms of educational opportunities to their children from this type of wildlife related recreation. Thus, the direction of this effect would be uncertain for the primary nonresidential expenditure model.

Education is hypothesized to be an another important factor in primary nonresidential nonconsumptive wildlife related recreation expenditures. In most leisure and recreational activities, level of education reportedly has a positive effect on the rates of participation (Zuzanek, 1978). Fazio and Belli (1977) also report that level of education has an observable tendency for increasing participation in nonconsumptive wildlife related recreation, i.e., the level of education increases, the higher the percentage of individuals participating in nonconsumptive wildlife related recreation. Hammitt et al. (1993) mention that knowledge of identifying the specific type of wildlife will increase the chance of observing wildlife. Hence, level of education in college is hypothesized to have a positive impact on the primary nonresidential expenditure model.

Residence (rural versus urban) is also hypothesized to be another important factor in primary nonresidential nonconsumptive wildlife related recreation expenditures. Individuals living in urban areas may be less likely to participate in wildlife related recreation activities than individuals living in rural areas (Walsh, et al., 1989a; Walsh, et al., 1989b; Walsh, et al., 1992). Urban residence may increase the time cost of participation due to distance from wildlife (Miller and Hay, 1981), even though primary nonresidential nonconsumptive wildlife related recreation may be a form of low-cost family recreation. In addition, individuals growing up in rural environments may be

more familiar with wildlife than individuals in urban environments. Thus, residence in a rural area would be expected to have a positive effect on the primary nonresidential expenditure model.

Employment status is hypothesized as another influential factor in determining primary nonresidential nonconsumptive wildlife related recreation expenditures. Non-working individuals, especially retirees, may have more available time to participate in wildlife related recreation than do employed individuals. Zuzanek (1978) reviews the literature on recreation associated with occupation and concludes that occupation has a positive effect on leisure participation. For an employed individual, primary nonresidential nonconsumptive wildlife related recreation may provide some form of opportunity to refresh one's family life with a relatively low expenditure. Thus, the direction of this effect would be uncertain for the primary nonresidential expenditure model.

Ethnicity is also hypothesized as another influential factor in determining primary nonresidential nonconsumptive wildlife related recreation expenditures. In general, non-white individuals have been observed to have a much lower preference for participation in most types of wildlife related recreation than do white individuals (Walsh, et al., 1992). Smith and Luzar (1995), summarizing the role of socialization and social status in recreation, suggest that minority status may be a primary barrier to participation in nonconsumptive wildlife related recreation. Hence, ethnicity, defined in terms of white individuals, would be expected to have a positive impact on the primary nonresidential expenditure model.

Resource availability is reported as a significant factor in providing opportunities for primary nonresidential nonconsumptive wildlife related recreation (Shaw and Mangun, 1984; Walsh, et al., 1989a; Walsh, et al., 1989b; Walsh, et al., 1992). Private or public land area, a measure of resource availability for primary nonresidential nonconsumptive wildlife related recreation, is hypothesized to be an important factor in primary nonresidential nonconsumptive wildlife related recreation expenditures. Quality and quantity of wildlife observing, photographing, or feeding can be taken as a measure of satisfaction (Hammitt, et al., 1993). Many studies report that the opportunity for wildlife related recreation should consider species and numbers of wildlife that participants want to see, what species actually are seen, and how many visual encounters with wildlife are made, and the quality of the experiences (Decker, et al., 1980; Heberlein, et al., 1982; Drive, 1985; Vaske, et al., 1986; Hammitt, et al., 1989; Hammitt, et al., 1993; Manfredo and Larson, 1993). Thus, use of public versus private land, taken as measure of resource availability, would be expected to have a positive effect on primary nonresidential expenditure model in this case.

Woodland, brush-covered area, open field, or man-made area, a measure of wildlife habitat, is also hypothesized to be an important factor in primary nonresidential nonconsumptive wildlife related recreation expenditures. Wildlife habitats and populations can be viewed as supply shifters, as with an increase in ecosystem and biodiversity of wildlife, the more primary nonresidential participants would participate in and consume (Charbonneau and Hay, 1978; Miller and Hay, 1981). From an ecological and biological perspective, presence of woodland and brush-covered areas

would be expected to have a positive effect on the primary nonresidential expenditure model, while open field and man-made areas would be expected to have a negative effect on the primary nonresidential expenditure model due to habitat diversity considerations.

The purpose of a trip taken for observing, photographing, or feeding birds or land mammals may also be hypothesized as another influential factor in determining primary nonresidential nonconsumptive wildlife related recreation expenditures. Birding, for example, is one of the most popular nonconsumptive wildlife related recreation activities in the United States. McFarlane (1994) reports that birdwatchers spend their money on their birding trips because of achievement, appreciative, or conservation orientation. Studies also report that birdwatchers like to take a birding trip to a specific setting at a specific time (Hvenegaard, et al., 1989; Wiedner and Kerlinger, 1990; Eubanks, et al., 1993). Thus, the purpose of trip taken for observing, photographing, or feeding birds or land mammals would be expected to have a positive impact on the primary nonresidential expenditure model.

In summary, the primary nonresidential expenditure model attempts to capture key elements of the life cycle which traditionally influences expenditures, including income, age, gender, marital status, education, residence, occupation, and race, in this case on primary nonresidential nonconsumptive wildlife related recreation. In addition, the relationship between human and wildlife may also influence expenditures on primary nonresidential nonconsumptive wildlife related recreation.

Primary Residential Expenditure Model

The primary residential expenditure model evaluates the relationship between the expenditures on primary residential nonconsumptive related wildlife recreation and economic and socio-economic and wildlife-attribute variables. The following primary residential expenditure model can be specified for empirical estimation:

$$EXP = F(INCOME,AGE,AGESQ,MALE,MARRIED,COLLEGE,URBAN,EMPLOY,WHITE,BIRD,MAMMAL,REPTILE,INSECT,FISH,NATURAL MAINTAIN,PLANTING,\epsilon) \quad (9)$$

Detailed definitions of explanatory variables for the primary residential expenditure model are presented in Table 3.2. The dependent variable for the model is the annual total expenditures on primary residential nonconsumptive wildlife related recreation. Given the definition of residential activity, total expenditures for the primary residential activity only include equipment expenditures such as binoculars, cameras, special lenses, or other photography equipment, film and developing; day packs, carrying cases, or special clothing; commercially prepared and packed wild bird food, other bulk food used to feed wild birds, nest boxes, bird houses, feeders, or baths; magazines or other periodicals specifically devoted to fish or wildlife; dues or contributions to national, state, or local conservation or wildlife-related organizations; and any other purchases (U.S. Department of the Interior, 1993).

Hypotheses

Primary residential nonconsumptive wildlife related recreation and related equipment are expected to be normal goods. As an individual's earnings grow, the individual is hypothesized to have more disposable income to spend on equipment

Table 3.2 Explanatory Variables for Primary Residential Expenditure Model Associated with Nonconsumptive Wildlife Related Recreation

VARIABLE	DEFINITION
INCOME	Respondent's total household income
AGE	Respondent's age (16 years old and older)
AGESQ	Respondent's age, Squared
MALE	Respondent's gender; 1 if male; 0 otherwise
MARRIED	Respondent's marital status; 1 if married; 0 otherwise
COLLEGE	Respondent's educational level; 1 if at least attended college; 0 otherwise
URBAN	Respondent's residence; 1 if grew up in the urban area; 0 otherwise
EMPLOY	Respondent's employment status; 1 if employed; 0 otherwise
WHITE	Respondent's ethnicity; 1 if white; 0 otherwise
BIRD	1 if the respondent observed birds around home; 0 otherwise
MAMMAL	1 if the respondent observed mammals around home; 0 otherwise
REPTILE	1 if the respondent observed reptiles or amphibians around home; 0 otherwise
INSECT	1 if the respondent observed insects or spiders around home; 0 otherwise
FISH	1 if the respondent observed fish or other wildlife around home; 0 otherwise
NATURAL	1 if the respondent visited any public parks or natural areas near home; 0 otherwise
MAINTAIN	1 if the respondent maintained any natural areas around home for fish or wildlife; 0 otherwise
PLANTING	1 if the respondent planted around home for fish or wildlife; 0 otherwise

expenditures for primary residential activities. Holding the price of primary residential activity constant, one would expect the expenditures on primary residential activities to be positively correlated with income. Thus, income is hypothesized to have a positive impact on primary residential nonconsumptive wildlife related recreation expenditures based on previous leisure and outdoor recreation expenditures studies and economic theory (Thompson and Tinsley, 1978; Dardis, et al., 1981; Wagner and Washington, 1982; Blaine and Mohammad, 1991; Dardis, et al., 1994).

The role of age, a measure of leisure time in wildlife recreation, may influence primary residential participants' spending behavior. One's stage in the life cycle hypothetically plays a major role in determining leisure or outdoor recreation expenditures (Rapoport and Rapoport, 1975; Hartmann and Cordell, 1989; Lawson, 1991; Dardis, et al., 1994). Stafford and Duncan (1985) and Hill (1985) conclude that older individuals spent more time than younger individuals on passive leisure activities which do not demand active participation on the part of the individuals. Also, studies have shown that older individuals spent less than younger individuals on leisure or outdoor recreation expenditures (Dardis, et al., 1981; Hill, 1985; Dardis, et al., 1994). Middle-age individuals may not have much time to participate in and be less likely to consume primary residential activities because of family responsibilities and high child-rearing expenses.

It is also arguable that the middle-age individuals may use their leisure time to participate in and consume primary residential activities because of family life needs and children's educational considerations. In general, primary residential nonconsumptive

wildlife related recreation activities can be treated as a part of family life activities. However, expenditures on leisure or outdoor recreation may be less clear for middle-age individuals (Lawson, 1991). In summary, primary residential participants' spending behavior may follow a life cycle pattern. Thus, age and age squared are included in the model, and opposite signs for the coefficients for age and age squared would be expected in this case.

Gender is hypothesized to be an important factor in primary residential nonconsumptive wildlife related recreation expenditures. In general, men tend to dominate consumptive wildlife related recreation and spend more on consumptive wildlife related recreation than women, due either to preferences or social custom. Although nonconsumptive wildlife related recreation is a relatively new means of accessing natural resources, males still also significantly tend to participate in and consume primary residential nonconsumptive wildlife related recreation. Hence, male is hypothesized to have a positive impact on the primary residential expenditure model (Dardis, et al., 1981; Hartmann and Cordell, 1989; Walsh, et al., 1989; Dardis, et al., 1994).

Marital status may be an influential factor in primary residential nonconsumptive wildlife related recreation expenditures. Marital status may be considered a barrier to participation in nonconsumptive wildlife related recreation (Smith and Luzar, 1995). For primary residential nonconsumptive wildlife related recreation, married individuals with children may consider it as providing some form of educational opportunities for their children, either in their own backyard or community parks near home. Married

individuals with no children may have less of a preference to participate in primary residential nonconsumptive wildlife related recreation due to employment commitments or social preferences. There may also be some interactive effects between marital status and age. This can be seen that older, married individuals are more likely to spend time watching and feeding birds or other wildlife. Thus, the direction of this effect would be uncertain for the primary residential expenditure model.

Education is hypothesized to be another important factor in primary residential expenditures. Fazio and Belli (1977) point out that level of education has an observable tendency for influencing participation in nonconsumptive wildlife related recreation. As level of education increases, the higher percentage of individuals participating in nonconsumptive wildlife related recreation. Hammitt et al. (1993) also mention that knowledge of identifying the specific type of wildlife will increase the chance of observing wildlife. As primary nonconsumptive wildlife related recreation is a relatively new means of accessing natural resources, individuals would easily recognize types of wildlife around their home due to daily contact. Meanwhile, species and number of wildlife would also be constrained by this man-made environment due to biological needs. Thus, the direction of this effect associated with level of education would be uncertain for the primary residential expenditure model.

Residence is also hypothesized to be an important factor in primary residential nonconsumptive wildlife related recreation expenditures. Individuals living in urban environments may be less likely to participate in primary residential nonconsumptive wildlife related recreation because urban residents would have fewer opportunities for

contact with wildlife at their residences (DeGraaf and Payne, 1975; Ulrich and Addoms, 1981; Dick and Hendee, 1986). Alternatively, Brown, et al. (1979) report that observations of wildlife occur most frequently around one's home, because one's own backyard may be the most convenient place for contact with wildlife. Thus, in this specification, residence in urban areas would be expected to have a negative effect on the primary residential expenditure model.

Employment status is hypothesized as another influential factor in determining primary residential nonconsumptive wildlife related recreation expenditures. In general, non-working individuals may have more available time to participate in primary residential nonconsumptive wildlife related recreation than do employed individuals. This may be especially so due to occupational status that is determined by the life cycle, i.e., unemployment due to retirement. As mentioned earlier, Zuzanek (1978) reviews the literature on recreation associated with occupation and concludes that occupation has a positive effect on leisure participation. As an employed individual, they might participate in some forms of primary residential nonconsumptive wildlife related recreation due to employment related time constraints which limit other forms of recreation. Thus, the direction of this effect would be uncertain for the primary residential expenditure model.

Ethnicity is again hypothesized to be an influential factor in determining primary residential nonconsumptive wildlife related recreation expenditures. As identified earlier, non-white individuals reportedly have much lower preferences for participating in most types of wildlife related recreation than do white individuals (Walsh, et al., 1992).

Primary residential nonconsumptive wildlife related recreation is a form of low-cost recreation, regardless of ethnicity. However, ethnicity, defined in terms of white individuals, would still be expected to have a positive impact on the primary residential expenditure model.

Observing, photographing, or feeding wildlife is hypothesized to be an important factor in primary residential nonconsumptive wildlife related recreation expenditures. DeGraaf and Payne (1975) mention that the potential for wildlife enjoyment derived from bird watching could be extremely large. According to educational functions, observing wildlife including birds, mammals, reptiles or amphibians, insects, and fish or other wildlife around one's home can provide an educational experience for the family. Wildlife preferences might affect individuals focusing on certain types of wildlife. However, observing, photographing, or feeding wildlife around home would be expected to have a positive impact on the primary residential expenditure model.

Public parks or natural areas near home, a measure of resource availability for primary residential nonconsumptive wildlife related recreation, is also hypothesized to be an important factor in primary residential nonconsumptive wildlife related recreation expenditures. For urban residents, urban parks offer a good opportunity, allowing them contact with urban wildlife by hearing, seeing, photographing, feeding, or studying (Dick and Hendee, 1986). Show and Mangan (1984) suggest that resource availability is one of the most important factors in providing opportunities for nonconsumptive wildlife related recreation, because it would provide opportunities for desired human benefits, especially for urban residents. Thus, availability of well managed public parks

or natural areas would be expected to have a positive effect on the primary residential expenditure model in this case.

Maintaining natural areas or planting for fish or wildlife around home, a measure of wildlife habitat provision, may be hypothesized as an influential factor in determining primary residential nonconsumptive wildlife related recreation expenditures. Wildlife habitat provision can be viewed as a demand shifter, as given an increase in natural environments for wildlife needs, the more opportunities would be provided for primary residential activities (Charbonneau and Hay, 1978; Miller and Hay, 1981). According to the recreation opportunity model (Manfredo and Larson, 1993), preferred wildlife setting, preferred primary residential activities, and desired wildlife enjoyment outcomes can be obtained by maintaining or planting for fish or wildlife around home. Hence, maintaining natural areas or planting for fish or wildlife around home would be expected to have a positive impact on the primary residential expenditure model.

In summary, the primary residential expenditure model attempts to capture key elements of the life cycle which traditionally influences expenditures, including income, age, gender, marital status, education, residence, occupation, and race, in this case on primary residential nonconsumptive wildlife related recreation. In addition, the relationship between humans and wildlife may also influence expenditures on primary residential nonconsumptive wildlife related recreation.

The primary residential expenditure model differs from the primary nonresidential expenditure model by wildlife-based attributes associated with human-created environment involvements. As described earlier, the primary nonresidential

expenditure model focuses on wildlife habitat which can provide opportunities for primary nonresidential participants, whereas the primary residential expenditure model focuses on wildlife itself which can be observed, photographed, or fed easily by primary residential participants. In addition, the life cycle factors such as age and gender, and the demographic attributes such as residence, might also provide some different information between the primary nonresidential and residential expenditure models.

Econometric Models

In order to develop the relationship between expenditures on nonconsumptive wildlife related recreation and participants' income and their socio-economic characteristics, a better understanding of the nature of the data helps in selecting the appropriate econometric model.

Referring to equation (7) in Chapter 2, statistically, the expenditure model for nonconsumptive wildlife related recreation can be expressed as follows:

$$Y = X'B + E \qquad (10)$$

where Y is a vector of total expenditures on nonconsumptive wildlife related recreation, X is a vector of explanatory variables, B is a vector of unknown parameters, and E is a vector of the error term.

Tobit Model

As noted earlier, the tobit model (Tobin, 1958) is a commonly used econometric technique which can be used for estimating the consumption pattern for nonconsumptive wildlife related recreation. Re-writing equation (1) in Chapter 1, the tobit model can be written as:

$$y_i = y_i^* \qquad \text{if } y_i^* = x_i'\beta + e_i > 0 \quad i = 1, \ldots, n$$

$$y_i = 0 \qquad \text{if } y_i^* = x_i'\beta + e_i \leq 0 \tag{11}$$

For the observations y_i that are zero,

$$\text{Prob}\,(y_i = 0) = 1 - \text{Prob}\,(y_i > 0)$$

$$= 1 - \Phi(x_i'\beta/\sigma) \tag{12}$$

For the observations y_i that are greater than zero,

$$\text{Prob}\,(y_i > 0)\, f(y_i \mid y_i > 0) = (1/\sigma)\phi[(y_i - x_i'\beta)/\sigma] \tag{13}$$

where $\phi(.)$ and $\Phi(.)$ are the standard normal density and distribution functions, respectively. Using 0 to denote zero observations and + to denote positive observations, the likelihood function for the tobit model can be specified as (Madalla, 1983; Amemiya, 1984; Judge, et al., 1985; Judge, et al., 1988; Greene, 1993):

$$L = \Pi_0 [1 - \Phi(x_i'\beta/\sigma)]\, \Pi_+ \{(1/\sigma)\phi[(y_i - x_i'\beta)/\sigma]\} \tag{14}$$

The maximum likelihood estimation technique can be used to estimate the unknown parameters for the primary nonresidential and residential models presented earlier. On statistical grounds, the tobit model is very restrictive in its parameterization which implies that the probability of consumption and the level of consumption are determined by the same sets of variables, (x_i), and parameters, (β). Hence, drawing inferences from the tobit model would lead to erroneous conclusions (Bockstael, et al., 1990).

Double-Hurdle Model

The double-hurdle model may provide a better interpretation of consumer behavior which takes into account the probability of consumption and the level of consumption (Cragg, 1971; Blundell and Meghir, 1987; Jones, 1989). The double-hurdle

model is established as a useful extension of the univariate tobit model because it allows two separate stochastic processes, in this case, for participation and consumption. Re-writing equation (2) and (3) in Chapter 1, the double-hurdle model can be written as:

$$y_i = y_i^* \quad \text{if } w_i = z_i'\alpha + u_i = 1,\ y_i^* = x_i'\beta + e_i > 0 \quad i = 1, \ldots, n$$

$$y_i = 0 \quad \text{if } w_i = z_i'\alpha + u_i = 1,\ y_i^* = x_i'\beta + e_i \le 0$$

$$\text{or } w_i = z_i'\alpha + u_i = 0,\ y_i^* = x_i'\beta + e_i > 0$$

$$\text{or } w_i = z_i'\alpha + u_i = 0,\ y_i^* = x_i'\beta + e_i \le 0 \qquad (15)$$

where $w_i = 1$ if individual i participates in nonconsumptive related wildlife recreation, and $w_i = 0$ if individual i does not participate in nonconsumptive related wildlife recreation. The basic double-hurdle model (Cragg, 1971) assumes independence between the error terms of the two hurdles.

For the observations y_i that are zero,

$$\text{Prob}(y_i = 0) = 1 - \text{Prob}(w_i > 0)\ \text{Prob}(y_i > 0)$$

$$= 1 - \Phi(z_i'\alpha)\Phi(x_i'\beta/\sigma) \qquad (16)$$

For the observations y_i that are greater than zero,

$$\text{Prob}(y_i > 0)\ f(y_i \mid y_i > 0) = \Phi(z_i'\alpha)(1/\sigma)\phi[(y_i - x_i'\beta)/\sigma] \qquad (17)$$

Using 0 to denote zero observations and + to denote positive observations, the likelihood function for the double-hurdle model can be specified as (Cragg, 1971; Blundell and Meghir, 1987; Jones, 1989; Jones, 1990):

$$L = \Pi_0 [1 - \Phi(z_i'\alpha)\Phi(x_i'\beta/\sigma)]\ \Pi_+ \{\Phi(z_i'\alpha)(1/\sigma)\phi[(y_i - x_i'\beta)/\sigma]\} \qquad (18)$$

The maximum likelihood estimation technique can also be used in this case to estimate the unknown parameters for the primary nonresidential and residential models. The

double-hurdle model is identical to the tobit model when $\Phi(z_i'\alpha) = 1$, as the tobit model is nested in the double-hurdle model. Selection between the specifications can be tested conveniently by the Lagrange multiplier (LM) test and the likelihood ratio (LR) test.

Theoretically, the tobit model is a particular form of the double-hurdle model with $z_i = x_i$ and $\alpha = (\beta/\sigma)$ in this case (Cragg, 1971). As theory provides no guidance in the choice of regressors to explain the first and second hurdles, empirically, the same set of explanatory variables (e.g., in this case, $z_i = x_i$) is used in both the participation and consumption equations (Jones, 1989; Burton, et al., 1994). The LM test is the valid test for a comparison between the tobit model and the double-hurdle model. This is accomplished by testing the restriction $\alpha = (\beta/\sigma)$ in the double-hurdle model. The LM test is based on the tobit estimates only, and it does not require estimation of the double-hurdle model (Lin and Schmidt, 1984). Statistically, the LM test is based on the statistic:

$$\lambda_{LM} = Q(\theta)'[I(\theta)]^{-1}Q(\theta) \qquad (19)$$

where $Q(\theta)$ is the first partial of the log-likelihood function evaluated at θ, $I(\theta)$ is the information matrix evaluated at θ, and θ is the maximum likelihood estimates subject to the restriction (e.g., in this case, $\alpha - (\beta/\sigma) = 0$) being tested. The null hypothesis, which is $\alpha = (\beta/\sigma)$ in this case, is rejected when $\lambda_{LM} > \chi^2_c$, where χ^2_c is a chosen critical value from the $\chi^2_{(k)}$ distribution, and k is the number of the explanatory variables under the null hypothesis (Lin and Schmidt, 1984).

In limited dependent variable models, the maximum likelihood estimates are inconsistent if heteroscedasticity is ignored (Maddala, 1983; Judge, et al., 1985; Judge,

et al., 1988; Greene, 1993). To correct for potential heteroscedastic errors, the standard deviation σ_i can be specified as:

$$\sigma_i = \sigma \exp(s_i'\gamma) \tag{20}$$

where σ is a constant, s_i is a vector of exogenous variables, and γ is a conformable parameter vector (Greene, 1995). The exponential form in (20) is common among heteroscedastic specifications in traditional regression models and limited dependent variable models. Selection between the homoscedastic and heteroscedastic double-hurdle models can be tested by the LR test, which is based on the principle of maximum likelihood estimation. It can be used to test the hypotheses that the tobit model performs as well as the double-hurdle model, and there are heteroscedastic problems associated with the error terms in modeling the primary nonresidential and residential expenditure models, respectively, by comparing the values of the maximized likelihood functions under the restricted (H_0) and unrestricted (H_1) models. Systematically, the LR test is based on the statistic:

$$\lambda_{LR} = -2\,[L(H_0) - L(H_1)] \tag{21}$$

where $L(H_0)$ and $L(H_1)$ are the maximized values of the log-likelihood function under the restricted and unrestricted models, respectively. The null hypothesis (H_0) is rejected when $\lambda_{LR} > \chi^2_c$, where χ^2_c is a chosen critical value from the $\chi^2_{(J)}$ distribution, and J is the number of the restrictions under the null hypothesis (Judge, et al., 1985; Judge, et al., 1988; Greene, 1993; Griffiths, et al., 1993).

In order to better understand the predictive ability of the double-hurdle model, it is important to derive the effects of changes in the explanatory variables. Based on the

assumptions of normality and independence of the error terms, the probability of non-zero consumption can be expressed as (Cragg, 1971; Blundell and Meghir, 1987; Jones, 1990):

$$\text{Prob}\ (y_i > 0) = \Phi(z_i'\alpha)\Phi(x_i'\beta/\sigma) \tag{22}$$

The marginal effects of the independent variables on the probability of non-zero consumption can be specified as:

$$\partial \text{Prob}\ (y_i > 0)/\partial x_{ij} = \phi(z_i'\alpha)\Phi(x_i'\beta/\sigma)\alpha_j + \Phi(z_i'\alpha)\phi(x_i'\beta/\sigma)(\beta_j/\sigma) \tag{23}$$

where α_j and β_j are the jth component of α and β, respectively. From (23), it can be seen that the marginal changes of the probability of non-zero consumption depend upon both the first-hurdle parameters, (α), and the second-hurdle parameters, (β). Thus, if major interest lies in the value of marginal changes in the probability of non-zero consumption of a recreation activity, then estimates of (23) should be considered.

Because the dependent variable y_i is truncated at zero, the expected value of conditional consumption is simply $x_i'\beta$ plus the expected value of the truncated normal error term, which can be expressed as (Amemiya, 1973; Madalla, 1983; Judge, et al., 1985; Greene, 1993):

$$E(y_i \mid y_i > 0) = x_i'\beta + \sigma\,[\phi(x_i'\beta/\sigma)/\Phi(x_i'\beta/\sigma)] \tag{24}$$

The marginal effects of the expected value of conditional consumption with respect to the independent variables can be shown as (McDonald and Moffit, 1980):

$$\partial E(y_i \mid y_i > 0)/\partial x_{ij} = \beta_j \{1 - (x_i'\beta/\sigma)[\phi(x_i'\beta/\sigma)/\Phi(x_i'\beta/\sigma)] - [\phi(x_i'\beta/\sigma)/\Phi(x_i'\beta/\sigma)]^2\} \tag{25}$$

If interest lies in the value of marginal changes in conditional consumption of a recreation activity, then estimates of (25) should be used.

Based on (22) and (24), the expected value of total consumption is directly related to the expected value of conditional consumption via the probability of non-zero consumption. The expected value of total consumption can be expressed as:

$$E(y_i) = \text{Prob}(y_i > 0)E(y_i \mid y_i > 0)$$

$$= \Phi(z_i'\alpha)\Phi(x_i'\beta/\sigma)\{x_i'\beta + \sigma[\phi(x_i'\beta/\sigma)/\Phi(x_i'\beta/\sigma)]\} \quad (26)$$

Following McDonald and Moffitt (1980), the marginal effects of the expected value of total consumption with respect to the independent variables can be decomposed as:

$$\partial E(y_i)/\partial x_{ij} = \text{Prob}(y_i > 0)\partial E(y_i \mid y_i > 0)/\partial x_{ij} + E(y_i \mid y_i > 0)\partial E(y_i \mid y_i > 0)/\partial x_{ij}$$

$$= \Phi(z_i'\alpha)\Phi(x_i'\beta/\sigma)\beta_j + \phi(z_i'\alpha)[(x_i'\beta)\Phi(x_i'\beta/\sigma) + \sigma\phi(x_i'\beta/\sigma)]\alpha_j \quad (27)$$

From (27), it can be seen that the marginal changes of the expected value of total consumption also depends upon both the first-hurdle parameters, (α), and the second-hurdle parameters, (β). This decomposition of the change in the expected value of total consumption with respect to the independent variables includes two effects: the change in the expected value of conditional consumption weighted by the probability of non-zero consumption (the first term on the right hand side of (27)); and the change in the probability of non-zero consumption weighted by the expected value of conditional consumption (the second term on the right hand side of (27)). As a result, the change in the expected value of total consumption with respect to the independent variables can

be decomposed into two additive terms: the conditional effect plus the probability effect. These effects are useful for interpretation of the estimates of the double-hurdle model.

The probability of non-zero consumption in the double-hurdle model considered here requires consideration of the probability from the participation and consumption equations simultaneously. Otherwise, the maximum likelihood estimates and the estimates of the marginal effect of the expected value of total consumption with respect to the explanatory variables would be biased.

Empirical Results

Primary Nonresidential Expenditure Model

For primary nonresidential participants, the average total expenditures was $59.92 for all participants and $517.86 for the participants who had positive expenditures on primary nonresidential activities. Descriptive statistics for all variables used in estimation for all participants and nonparticipants samples are presented in Table B.1.

The tobit model and the double-hurdle model for primary nonresidential expenditure were estimated by maximizing the logarithm of the likelihood functions (14) and (18) using the censored and truncated regression procedures in LIMDEP (Greene, 1995), respectively. In the double-hurdle model, the same set of explanatory variables for the primary nonresidential expenditure model were used in both the participation and consumption equations (Jones, 1989; Burton, et al., 1994).

In social-economic data, there often exists a problem with multicollinearity between variables, resulting in estimates that are unstable and have high standard errors.

In order to test which variables are nearly collinear with other variables, collinearity diagnostic tests based on condition indexes were performed. The value of the largest condition index resulting from the principal components analysis performed was 12.55 for the primary nonresidential expenditure model. As Belsley, et al. (1980) suggested, the explanatory variables in this case selected to explain nonconsumptive wildlife related recreation expenditures associated with nonresidential activities were not correlated.

In the tobit model, the empirical results tend to support previously stated hypotheses for the primary nonresidential expenditure model, with the exception of two insignificant and positive variables, FEMALE and MANMADE. Both were hypothesized to negatively influence expenditures. The variables INCOME, WHITE, PRIVATE, PUBLIC, and WOOD are significant and of the hypothesized sign in the tobit model, which capture both participation and consumption decisions. Overall, the empirical results of the tobit model for primary nonresidential expenditure model indicate that white individuals with higher income level would observe, photograph, or feed wildlife on woodland either on private or public land away from home more than one mile. Empirical results of the tobit analysis for the primary nonresidential expenditure model are presented in Table B.2.

Based on the LM test result, the hypothesis that $\alpha = (\beta/\sigma)$ in the double-hurdle model in this case is strongly rejected ($\chi^2 = 15475$, degree of freedom = 17) at the 0.05 significance level. In addition, the value of $\Phi(z_i'\alpha) = 0.104466$ which is not equal to one. Thus, the double-hurdle model is not identical to the tobit model in this case.

Based on the log-likelihood values of the double-hurdle model and the tobit model estimated for the primary nonresidential expenditure model, the LR test result suggests the rejection of the tobit model ($\chi^2 = 269.6772$, degree of freedom = 17) at the 0.05 significance level. Thus, the hypothesis that the tobit model performs as well as the double-hurdle model in modeling the primary nonresidential expenditure model is strongly rejected. In other words, participation and consumption decisions in the primary nonresidential expenditure model are not based on the same decision-making structure. Therefore, drawing inferences about the effects of the explanatory variable on participation and consumption based on the tobit model for primary nonresidential expenditure model would lead to erroneous conclusions (Bockstael, et al., 1990).

Empirical results of the double-hurdle model for primary nonresidential expenditure model are presented in Table B.3. The heteroscedastic double-hurdle model for primary nonresidential expenditures is also estimated by the maximum likelihood estimation method in LIMDEP (Greene, 1995). Based on the log-likelihood values of the homoscedastic and heteroscedastic double-hurdle models estimated for the primary nonresidential expenditure model, the LR test result suggests the rejection of the heteroscedastic double-hurdle model ($\chi^2 = 388.486$, degree of freedom = 1) at the 0.05 significance level. Thus, the hypothesis that there are heteroscedastic problems associated with the error terms in modeling the primary nonresidential expenditure model is strongly rejected. Overall, the double-hurdle estimates for the primary nonresidential expenditure model are homoscedastic and consistent. Thus, drawing inferences about the effects of the explanatory variables on participation and

consumption based on the homoscedastic double-hurdle model for the primary nonresidential expenditure model would not lead to inconsistent conclusions. Empirical results of the comparison between the homoscedastic and heteroscedastic double-hurdle models for the primary nonresidential expenditure model are presented in Table B.4.

Unlike the tobit model, the double-hurdle estimates indicate that the explanatory variables have different impacts on participation and consumption decisions in sign or magnitude. In the double-hurdle model, the variables MARRIED, BRUSH, OPEN, MANMADE, and BIRDTRIP all have different signs in the participation and consumption equations. In addition, although having the same sign, the variables INCOME and COLLEGE are significant in the consumption equation but not significant in the participation equation, whereas variables WHITE, PUBLIC, and WOOD are significant in the participation equation but not significant in the consumption equation. These different and opposite effects of the explanatory variables are not allowed by the restrictive parameterization of the tobit model. Therefore, they highlight the importance of the double-hurdle parameterization. However, there is no strong economic theoretical basis to suggest what explanatory variables should be in each hurdle or for predicting the signs of estimated coefficients in each hurdle (Jones, 1989; Burton, et al., 1994).

In general, the empirical results tend to support previously stated hypotheses for the primary nonresidential expenditure model. As theorized, the variables INCOME, COLLEGE, WHITE, PUBLIC, and WOOD all are positively related to primary nonresidential nonconsumptive wildlife related recreation expenditures for both participation and consumption decisions. The positive sign for INCOME suggests that

primary nonresidential nonconsumptive wildlife related recreation is a normal good for which demand increases with income. The positive sign on COLLEGE suggest that the demand for primary nonresidential nonconsumptive wildlife related recreation increases with higher levels of education. The positive sign on WHITE suggest that whites are more likely to participate in and consume, and also tend to consume more when they consume for primary nonresidential activities. The positive signs on PUBLIC and WOOD suggest that the demand for primary nonresidential nonconsumptive wildlife related recreation increases are associated with use of public forest land.

As noted earlier, the double-hurdle estimates provide more information for participation and consumption simultaneously associated with primary nonresidential activities than the tobit model. According to previous studies using the double-hurdle model, there is no certain interpretation for the double-hurdle estimates. Even though the following variables are not statistically significantly related to primary nonresidential nonconsumptive wildlife related recreation expenditures on both participation and consumption decisions, a possible interpretation for each variable is provided based on coefficient signs and magnitudes.

Empirical results associated with the variable MARRIED suggest that married participants are more likely to participate in and consume but tend to consume much less when they consume for primary nonresidential activities. Similarly, the variables OPEN or BIRDTRIP can be interpreted to suggest that participants are more likely to participate in and consume but tend to consume much less when they consume for primary nonresidential activities at an open field or on a trip for birding. On the other

hand, the interpretation of the variables BRUSH or MANMADE suggest that participants are less likely to participate in and consume but tend to consume much more when they consume for primary nonresidential activities at a brush-covered area or a man-made area.

As theorized, the variables RURAL, EMPLOY, PRIVATE, and LANDMTRP all are positively but insignificantly related to primary nonresidential nonconsumptive wildlife related recreation expenditures on both participation and consumption decisions. The positive signs of RURAL or EMPLOY indicate that participants living in rural areas or employed participants are more likely to participate in and consume and also tend to consume more when they consume for primary nonresidential activities. Similarly, the positive signs for PRIVATE or LANDMTRP indicate that participants are more likely to participate in and consume and also tend to consume more when they consume for primary nonresidential activities on private land or on a trip for viewing land mammals.

In addition, the insignificant coefficients for AGE and AGESQ result in a concave parabola consistent with the life cycle hypothesis. Other things equal, expenditures on primary nonresidential activities increase with age during a person's younger years, reach a maximum at age forty-two, and decline thereafter. Finally, the variable FEMALE is positively but insignificantly related to primary nonresidential nonconsumptive wildlife related recreation expenditures on both participation and consumption decisions. The positive sign for FEMALE suggest that females are more likely to participate in and consume and also tend to consume more when they consume for primary nonresidential activities. This would seem to counter with earlier research

which suggests that males tend to dominate wildlife related recreation and spend more on wildlife related recreation than do females.

Theoretically, the double-hurdle model implies that the demand curve for primary nonresidential nonconsumptive wildlife related recreation should be estimated over the entire population including participants and non-participants. Empirically, there is no further information that can be provided if only the double-hurdle estimates are reported. The double-hurdle estimates for the primary nonresidential expenditure model cannot be directly interpreted as the effect on total consumption on primary nonresidential activities, given a change in the independent variables. According to the nature of the double-hurdle model, the marginal effects of the independent variables on consumption which were derived earlier would be ambiguous if the independent variable has opposite signs in the participation and consumption equations. The marginal effects of the probability of non-zero consumption, the expected value of conditional consumption, and the expected value of total consumption with respect to the independent variables are evaluated at the means of all the independent variables. Empirical results of the marginal effects for the double-hurdle model for the primary nonresidential expenditure model are presented in Table B.5.

In 1991, the demand for primary nonresidential nonconsumptive wildlife related recreation would result in a $0.000337 increase in total expenditure with increases in income. The total expenditure on primary nonresidential activities for well-educated participants was $16.92 more than others in terms of lower levels of education. Similarly, the total expenditure on primary nonresidential activities for whites was

$16.29 more than non-whites. The total expenditure on primary nonresidential activities would result in a $27.44 increase if it occurred on public land. Similarly, the total expenditure on primary nonresidential activities would result in a $30.04 increase if it occurred on forest land. In addition, the total expenditure on primary nonresidential activities would result in a $17.63 increase if it occurred on private land. The total expenditure on primary nonresidential activities for females was $4.74 more than males.

On the other hand, the total expenditure on primary nonresidential activities for married participants was $4.33 less than single participants. The total expenditure on primary nonresidential activities would result in a $1.93 decrease if it occurred in open field areas. Similarly, the total expenditure on primary nonresidential activities would result in a $3.11 decrease if it occurred on a trip for birding, but a $13.85 increase if it occurred on a trip for observing land mammals.

In summary, the empirical results of the double-hurdle model for the primary nonresidential expenditure model indicate that well-educated, white individuals with higher income levels would observe, photograph, or feed wildlife on public forest land away from home more than one mile.

Primary Residential Expenditure Model

For primary residential participants, the average total expenditures was $12.85 for all participants and $120.67 for the participants who had positive expenditures on primary residential activities. Descriptive statistics for all variables used in estimation for all participants and nonparticipants are presented in Table B.6.

The tobit model and the double-hurdle model for the primary residential expenditure model were also estimated by maximizing the logarithm of the likelihood functions (14) and (18) using the censored and truncated regression procedures in LIMDEP (Greene, 1995), respectively. In the double-hurdle model, as was the case for the previous model, the same set of explanatory variables for the primary residential expenditure model were used in both the participation and consumption equations (Jones, 1989; Burton, et al., 1994).

As was the case for the previous model, the value of the largest condition index was 11.48 for the primary residential expenditure model. Based on the collinearity diagnostic test, hence, the explanatory variables in this case selected to explain nonconsumptive wildlife related recreation expenditures associated with residential activities were also not correlated (Belsley, et al., 1980).

In the tobit model, the empirical results tend to support previously stated hypotheses for the primary nonresidential expenditure model, except for an insignificantly positive impact on the variable URBAN, which was hypothesized to be negative for the model, and an insignificantly negative impact for the variable REPTILE, which was hypothesized to be positive for the model. The variables MALE, EMPLOY, WHITE, BIRD, MAMMAL, NATURAL, and MAINTAIN are significant in the tobit model which captures both participation and consumption decisions. Overall, the empirical results of the tobit model for the primary residential expenditure model indicate that white employed males would observe birds and mammals around home or at any public parks or natural areas near home. In addition, they would maintain any

natural areas around home for fish or wildlife. Empirical results of the tobit model for the primary residential expenditure model are presented in Table B.7.

Again, the hypothesis that $\alpha = (\beta/\sigma)$ in the double-hurdle model in this case is strongly rejected ($\chi^2 = 16446$, degree of freedom = 17) at the 0.05 significance level based on the LM test result. In addition, the value of $\Phi(z_i'\alpha) = 0.043295$ which is not equal to one. Thus, the double-hurdle model is not identical to the tobit model in this analysis.

Based on the log-likelihood values of the double-hurdle model and the tobit model estimated for the primary residential expenditure model, the LR test result suggests the rejection of the tobit model ($\chi^2 = 161.7150$, degree of freedom = 17) at the 0.05 significance level. Thus, the hypothesis that the tobit model performs as well as the double-hurdle model in modeling the primary residential expenditure model is strongly rejected. In other words, the double-hurdle model appeared to fit the data much better than the tobit model. Empirical results of the double-hurdle model for primary residential expenditure model are presented in Table B.8.

The heteroscedastic double-hurdle model for the primary residential expenditure model was also estimated by the maximum likelihood estimation method in LIMDEP (Greene, 1995). Based on the log-likelihood values of the homoscedastic and heteroscedastic double-hurdle models estimated for the primary residential expenditure model, the LR test result suggests the rejection of the heteroscedastic double-hurdle model ($\chi^2 = 219.068$, degree of freedom = 1) at the 0.05 significance level. Thus, the hypothesis that there are heteroscedastic problems associated with the error terms in

modeling the primary residential expenditure model is strongly rejected. Overall, the double-hurdle estimates for the primary residential expenditure model are homoscedastic and consistent. Empirical results of the comparison between the homoscedastic and heteroscedastic double-hurdle models for primary residential expenditure model are presented in Table B.9.

Unlike the tobit model, the double-hurdle estimates indicate that the explanatory variables have different impacts on participation and consumption decisions in sign or magnitude. For example, in the double-hurdle model, the variables MARRIED, COLLEGE, URBAN, NATURAL, and PLANTING all have different signs in the participation and consumption equations. In addition, although having the same sign, the variables MALE and FISH are significant in the consumption equation but not significant in the participation equation, whereas the variables WHITE, BIRD, MAMMAL, INSECT, NATURAL, and MAINTAIN are significant in the participation equation but not significant in the consumption equation. Only the variable EMPLOY is significant in both participation and consumption equations in the model. These different and opposite effects of variables are not allowed by the restrictive parameterization of the tobit model, again emphasizing the importance of the double-hurdle parameterization. However, again, there is no theoretical basis useful in suggesting which explanatory variables should be in each hurdle or for the signs of estimated coefficients in each hurdle (Jones, 1989; Burton, et al., 1994).

In general, the empirical results tend to support previously stated hypotheses for the primary residential expenditure model. As theorized, the variables MALE,

EMPLOY, WHITE, BIRD, MAMMAL, INSECT, FISH, and MAINTAIN all are positively related to primary residential nonconsumptive wildlife related recreation expenditures on both participation and consumption decisions. The positive signs of MALE suggest that males are more likely to participate in and consume and also tend to consume more when they consume for primary residential activities. This would seem to be consistent with earlier research which suggests that males tend to dominate wildlife related recreation and spend more on wildlife related recreation than do females. Similarly, the positive signs on EMPLOY suggest that employed participants are more likely to participate in and consume and also tend to consume more when they consume for primary residential activities. The positive signs of WHITE suggest that whites are more likely to participate in and consume and also tend to consume more when they consume for primary residential activities. The positive signs of BIRD, MAMMAL, INSECT, and FISH suggest that the demand for primary residential nonconsumptive wildlife related recreation associated with birds, mammals, insects or spiders, and fish or other wildlife. The positive signs on MAINTAIN also suggest that the demand for primary residential nonconsumptive wildlife related recreation with maintaining any natural areas for fish or wildlife.

In addition, the variable NATURAL is positively related to primary residential nonconsumptive wildlife related recreation expenditures on the participation decision but negatively on consumption decision. Hence, the variable NATURAL suggests that participants are more likely to participate in and consume but tend to consume much less when they consume for primary residential activities at any public parks or natural areas.

As was the case for the previous model, a possible interpretation for the following variables, which are not statistically significantly related to primary residential nonconsumptive wildlife related recreation expenditures on both participation and consumption decisions, is provided based on coefficient signs and magnitudes. The interpretation for the variable MARRIED is that married participants are more likely to participate in and consume but tend to consume much less when they consume for primary residential activities. On the other hand, the explanation for variables COLLEGE or URBAN is that participants with higher levels of education or those who grew up in urban areas are less likely to participate in and consume but tend to consume much more when they consume for primary residential activities. Similarly, the interpretation for variable PLANTING is that participants are less likely to participate in and consume but tend to consume much more when they consume for primary residential activities associated with planting for fish or wildlife.

As theorized, the variable INCOME is positively but insignificantly related to primary nonresidential nonconsumptive wildlife related recreation expenditures on both participation and consumption decisions. The positive signs on INCOME suggest that primary residential nonconsumptive wildlife related recreation is a normal good for which demand increases with income. In addition, the insignificant coefficients for AGE and AGESQ result in a convex parabola consistent with the life cycle hypothesis, inversely. Other things equal, expenditures on primary residential activities decline with age during a person's younger years, reach a minimum around age forty-two, and increase thereafter. One possible alternative interpretation would be that aged or retired

people would be more likely to spend time and money on primary residential activities. Finally, the variable REPTILE is negatively but insignificantly related to primary residential nonconsumptive wildlife related recreation expenditures on both participation and consumption decisions. The negative sign on REPTILE suggest that participants are less like to participate in and consume and also tend to consume much less when they consume for primary nonresidential activities with reptiles or amphibians. This would seem to conflict with earlier hypothesis perhaps due to personal preferences or attitudes.

Empirically, as was the case in the previous model, there is no further information which can be provided if only reporting the double-hurdle estimates. Hence, the marginal effects of the probability of non-zero consumption, the expected value of conditional consumption, and the expected value of total consumption with respect to the independent variables were evaluated at the means of all the independent variables. Empirical results of marginal effects for the double-hurdle model for the primary residential expenditure model are presented in Table B.10.

In 1991, the total expenditure on primary residential activities for males was $1.57 more than for females. The total expenditure on primary residential activities for employed participants was $2.92 more than non-working participants. Similarly, the total expenditure on primary residential activities for whites was $3.06 more than for non-whites. Meanwhile, the total expenditure on primary residential activities would result in a $7.99 increase associated with birds, a $1.83 increase with mammals, a $1.85 increase with insects or spiders, and a $2.53 increase with fish or other wildlife. The total expenditure on primary residential activities would result in a $2.87 increase if they

occurred at public parks or natural areas. Similarly, the total expenditure on primary residential activities would result in a $3.47 increase associated with maintaining any natural areas for fish or wildlife.

In addition, the demand for primary residential nonconsumptive wildlife related recreation would result in only a $0.00001356 increase in total expenditures with changes in income. The total expenditure on primary residential activities for well-educated participants was $0.78 more than others in terms of lower levels of education. Similarly, the total expenditure on primary residential activities for urban residents was $0.76 more than for rural residents. The total expenditure on primary residential activities would result in a $1.15 increase associated with planting for fish or wildlife. On the other hand, the total expenditure on primary nonresidential activities for married participants was $0.72 less than for single participants. Similarly, the total expenditure on primary residential activities would result in a $1.34 decrease with reptiles or amphibians.

In summary, the empirical results of the double-hurdle model for the primary residential expenditure model indicate that white employed males would observe, photograph, or feed birds, mammals, insects or spiders, and fish or other wildlife around home or at any public parks or natural areas near home. In addition, they would maintain any natural areas around home for fish or wildlife.

Summary

This chapter reviews the data source and describes briefly data compilation procedures. The data set used to empirically analyze the empirical model was obtained

from the 1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation for Arkansas, Louisiana, and Mississippi residents over sixteen years of age (U.S. Department of the Interior, 1993). The data set includes 2,718 observations, 252 observations of whom were primary nonresidential participants, and 232 of whom were primary residential participants.

Following the theoretical framework for analyzing nonconsumptive wildlife related recreation expenditures presented in Chapter 2, this chapter presents a series of empirical models developed to capture the factors which affect the demand for nonconsumptive wildlife related recreation for both primary nonresidential and residential expenditure models, respectively. Based on previous research on recreation expenditures and participation rates, hypotheses are proposed for the specification of the empirical models for both primary nonresidential and residential expenditure models, respectively.

Considering the nature of the data set and the framework of the theoretical model, the hypothesized explanatory factors for the primary nonresidential expenditure model includes income, age, gender, marital status, level of education, residence, employment status, ethnicity, wildlife habitat attributes, and purpose of trip. Similarly, the hypothesized explanatory factors for the primary residential expenditure model includes income, age, gender, marital status, level of education, residence, employment status, ethnicity, wildlife characteristics, and wildlife management attributes. Thus, the empirical models attempt to capture key elements of the life cycle and wildlife and its

habitat attributes for both primary nonresidential and residential expenditure models, respectively.

Given the censored and truncated structure of the data set, the tobit model is initially used for estimating participants' consuming behavior for nonconsumptive wildlife related recreation. As a result of the restrictive parameterization of the tobit model, drawing inferences from the tobit model would result misleading conclusions. Therefore, based on empirical results of these models, the double-hurdle framework is superior in this study because it provides a better explanation for participants' consuming behavior which takes into account both the probability of consumption and the level of consumption.

As no further information can be provided for interpreting the effect of total consumption on nonconsumptive wildlife related recreation over the entire population, the marginal effect of the expected value of total consumption with respect to the explanatory variables is useful for interpretation of the estimates of the double-hurdle model. This can be decomposed into the conditional effect plus the probability effect.

Based on the LM test and the LR test, the tobit model is rejected at the 0.05 significance level for both the primary nonresidential and residential expenditure models. Therefore, the double-hurdle model is the appropriate model in this case. Similarly, the double-hurdle model associated with heteroscedastic error terms is also rejected at the 0.05 significance level for both the primary nonresidential and residential expenditure models based on the LR test. Thus, there is no evidence of heteroscedasticity with the data set in this case.

According to the empirical results of the double-hurdle model for the primary nonresidential expenditure model, participants' income, level of education, and ethnicity are important factors in terms of the life cycle which affect participants' consuming behavior on primary nonresidential nonconsumptive wildlife related recreation activities. The variables the public and woodland, reflecting wildlife environmental attributes, are also important factors which affect participants' consuming behavior. In addition, the positive signs for the variable FEMALE suggest that females are more likely to participate in and consume and also tend to consume more when they consume for primary nonresidential activities.

The empirical results of the double-hurdle model for primary residential expenditure model indicate that, participants' gender, employment status, and ethnicity are important factors in terms of the life cycle which affect participants' consuming behavior on primary residential nonconsumptive wildlife related recreation activities. The variables birds, mammals, insects or spiders, and fish or other wildlife (wildlife attributes) and the variables maintain and public parks or natural areas near the home (environmental attributes), all are important factors which affect participants' consuming behavior. In addition, the variable public parks or natural areas near home suggests that participants are more likely to participate in and consume but tend to consume much less when they consume for primary residential activities at any public parks or natural areas.

The final chapter provides a summary of this research and draws conclusions suggested by the empirical results obtained. The fourth chapter also offers policy recommendations based on the empirical results. In addition, suggestions for future research are discussed.

CHAPTER 4

SUMMARY AND CONCLUSIONS

Based on the results from National Surveys of Fishing, Hunting, and Wildlife-Associated Recreation (NSFHWAR), public interest in nonconsumptive wildlife related recreation encompasses more than traditional fishing and hunting activities. In 1991, for example, 76.1 million Americans participated in nonconsumptive wildlife related recreation, and spent a total of $18.1 billion to observe, photograph, or feed wildlife. This growth in nonconsumptive wildlife related recreation and expenditures occurs at a time when research and public investment is primarily focused on consumptive wildlife related recreation.

Nonconsumptive Wildlife Related Recreation

Nonconsumptive wildlife related recreation emphasizes the interaction with the human-wildlife relationship but does not remove or affect the wildlife resource. Wildlife observing, photographing, and feeding are typical nonconsumptive wildlife related recreation activities. Due to interest in pursuing this human-wildlife recreation experience, participants are willing to participate in and spend money on equipment and trip-related costs for nonconsumptive wildlife related recreation activities.

As a result of the growth of participation in nonconsumptive wildlife related recreation and the associated growth in nonconsumptive wildlife related recreation expenditures, an analysis of these economic impacts could provide valuable insight into this recreation area. Thus, expenditure analysis can provide important information about

the demand for nonconsumptive wildlife related recreation and how different participants allocate their resources toward this recreation activity.

Since the existing research on nonconsumptive wildlife related recreation expenditures is quite limited, this study, an analysis of nonconsumptive wildlife related recreation expenditures, may contribute to a better understanding of current and future participants' consumption patterns in nonconsumptive wildlife related recreation.

Objectives of the Study

The general objective of this study was to analyze the socio-economic characteristics associated with participants' consumption patterns of nonconsumptive wildlife related recreation expenditures at a regional level. This study was specifically designed to: (1) provide an overview of national and regional nonconsumptive wildlife related recreation; (2) develop a conceptual framework integrating the relationship among recreation participants, wildlife and its habitat, and the interaction with recreation participants and wildlife and its habitat; (3) propose a hypothetical expenditure model useful explaining the relationship between participants' consumption patterns and expenditures on nonconsumptive wildlife related recreation; (4) empirically estimate the hypothetical expenditure model at a regional level; and (5) provide policy recommendations for nonconsumptive wildlife management associated with outdoor recreation activities. Procedures for achieving these objectives and empirical results obtained are summarized in the following sections.

Profile of Nonconsumptive Wildlife Related Recreation

As the profile of nonconsumptive wildlife related recreation at national and regional levels reveal, primary nonresidential participants were mainly white males whose age ranged from eighteen through fifty-four years, who had college backgrounds, a relatively high income, and were living in an urban environment. Similarly, primary residential participants were mainly white females whose age was greater than twenty-five years, who had at least a high school level of education, were middle income, living in an urban area.

Conceptual Framework

The conceptual framework assumes that utility maximization is the ultimate objective for primary nonresidential or residential participants achieving total recreation experiences from nonconsumptive wildlife related recreation in terms of the expenditure-income relationship. In order to understand the participant's satisfaction-seeking behavior, theoretically, consumer demand theory can be used to explain the variation in participant expenditures on nonconsumptive wildlife related recreation.

According to consumer demand theory, primary nonresidential or residential participants attempt to maximize his/her utility from nonconsumptive wildlife related recreation subject to his/her budget constraint. Theoretically, the participant's demand function can be derived from the analysis of utility maximization by solving the first order conditions of the Lagrange function. Given the participants' demand functions, the Engel curve can be used to interpret the relationship between expenditures and income, holding price constant.

Empirical Models

The empirical expenditure models were proposed for primary nonresidential and residential participants based on the theoretical model developed. For both primary nonresidential and residential expenditure models, in addition to economic variables and socio-economic characteristics of the participant which are traditionally explanatory variables used in expenditure analysis, the attributes of wildlife and its habitat were also included as explanatory variables in the empirical models.

Empirical Analysis

The data set used to analyze primary nonresidential and residential expenditure models were obtained from the 1991 NSFHWAR for Arkansas, Louisiana, and Mississippi residents over sixteen years of age. The data set included 2,718 records, including 252 primary nonresidential participants' records, and 232 primary residential participants' records.

Given the censored and truncated structure of the dependent variable, the annual total expenditures on nonconsumptive wildlife related recreation, theoretically, the tobit model and the double-hurdle model were identified as two possible econometric models appropriate for estimating the participants' consuming behavior for nonconsumptive wildlife related recreation. Based on the LM test and the LR test, the double-hurdle model is the acceptable econometric model for both primary nonresidential and residential expenditure models in this case. In addition, there is no problem with the error terms associated with heteroscedasticity for both primary nonresidential and residential expenditure models based on the LR test.

Primary Nonresidential Expenditure Model

The variables INCOME and COLLEGE were significant in the consumption equation but not in the participation equation, whereas the variables WHITE, PUBLIC, and WOOD were significant in the participation equation but not in the consumption equation. Overall, the empirical results of the double-hurdle model for the primary nonresidential expenditure model indicated that well-educated, white participants with a higher income level were more likely to participate in and consume primary nonresidential activities occurring on public forest lands.

Empirically, the demand for primary nonresidential nonconsumptive wildlife related recreation would result in a $0.000337 increase in total expenditures with an increase in income; a $16.92 with an increase associated with a higher level of education; a $16.29 with an increase associated with being a white; a $27.44 with an increase if the recreation occurred on public land; and a $30.04 increase if the recreation occurred on forest lands.

Primary Residential Expenditure Model

The variables MALE and FISH were significant in the consumption equation but not in the participation equation, whereas the variables WHITE, BIRD, MAMMAL, INSECT, NATURAL, and MAINTAIN were significant in the participation equation but not in the consumption equation. Only the variable EMPLOY was significant in both the participation and consumption equations. Overall, the empirical results of the double-hurdle model for the primary residential expenditure model indicate that white employed male participants were more likely to participate in and consume primary residential

activities such as observing, photographing, or feeding birds, mammals, insects or spiders, and fish or other wildlife around their home or public parks or natural areas near their home. They were also more likely to maintain any natural areas for fish or wildlife around their home.

Empirically, the total expenditures on primary residential nonconsumptive wildlife related recreation would result in a $1.57 increase associated with being male; a $2.92 increase associated with employed participants; a $3.06 increase associated with being white; a $7.99 increase associated with observing birds; a $1.83 increase associated with observing mammals; a $1.85 increase associated with observing insects or spiders; a $2.53 increase associated with observing fish or other wildlife; a $2.87 increase if this recreation occurred at public parks or natural areas; and a $3.47 increase associated with maintaining any natural areas for fish or wildlife.

Conclusions

This study has provided an empirical analysis of individuals' consuming behavior for observing, photographing, or feeding wildlife around home or more than one mile away from home at a regional level using data from the 1991 NSFHWAR. The expenditure analysis of nonconsumptive wildlife related recreation in this case is a necessary step in understanding the relationship between individual consumption patterns and the socio-economic characteristics of the individual and the attributes of wildlife and its encounter.

The results of this study are multi-dimensional. First, gender does not appear to be a constraining factor in primary nonresidential activities. Thus, wildlife managers

have an opportunity to include a previously excluded user group into their plans for wildlife management, expanding a shrinking constituency. National forest lands play an important role for primary nonresidential participants allowing them to participate in and consume nonconsumptive wildlife related recreation activities. As nonconsumptive wildlife related recreation is a relatively new means of accessing natural resources, community parks or natural areas play an important role in the provision of opportunities for environmental education, especially for individuals in the urban environment. In addition, primary residential nonconsumptive wildlife related recreation activities can be treated as family activities associated with natural resources, as these activities are not significantly associated with income level. The results show that male individuals significantly dominate the nonconsumptive wildlife related recreation in primary residential activities. This information provides some help identifying who will be potential consumers for primary residential activities.

From an empirical perspective, the double-hurdle model provides a better choice for dealing with the high proportion of zero responses in the cross-sectional data from the national survey. It also provides a better interpretation of individual consuming behavior, allowing two separate stochastic processes for participation and consumption. The probability of non-zero consumption in the double-hurdle model takes into account the probabilities of participation and consumption simultaneously. The marginal effect of the expected value of total consumption for nonconsumptive wildlife related recreation with respect to the independent variables can be derived in order to explain the possible outcomes for the entire population.

Finally, this expenditure analysis of nonconsumptive wildlife related recreation using the double-hurdle model can be regarded as a blueprint for targeting the potential consumers for marketing considerations, the potential audiences for political needs, or the potential stakeholders for conservation activities. Natural resource managers and planners also can use this information for development of the management policies and planning guidelines.

Policy Implications

Nonconsumptive wildlife management concerns all kinds of wildlife for recreational use (or appreciative use) other than nongame wildlife management and consumptive wildlife management (Fazio and Belli, 1977). Traditionally, wildlife management, especially consumptive wildlife management, has been supported and funded through license fees and excise taxes by anglers and hunters. Nongame wildlife management also has been supported by contributors, or supported and funded by state or federal governments (Bury, et al., 1980; Moss, et al., 1986; Eubanks and Wyckoff, 1989).

As recently documented, participation in nonconsumptive wildlife related recreation is substantial, but the nonconsumptive wildlife related recreation participants have never been taxed (Macaluso, 1997). Macaluso's review of a Louisiana proposal reports that Louisiana residents participating in nonconsumptive wildlife related recreation on state-owned wildlife management areas would have to pay $5 as a participation fee. According to the Wild Louisiana Stamp Program, this participation fee would bring as much as $5 million to the State of Louisiana, annually (Macaluso, 1997).

As Lyons (1982) notes, it is difficult to identify nonconsumptive wildlife related recreation participants based on the site of their activity or the focus of their interest. However, with regard to nonconsumptive wildlife related recreation, most studies still remain at the stage of describing categories of participants by using national survey information (Lyons, 1982; Fisher and Grambsch, 1989; Mangun, et al., 1992). Therefore, there is little political and financial support for nonconsumptive wildlife management.

Nonconsumptive wildlife related recreation expenditures provide a good source of revenue for improving local and regional economies. Hay (1989) reports that public lands are widely used for observing, photographing, or feeding wildlife, especially by primary nonresidential participants. This study indicates that for this region, many nonconsumptive wildlife related recreation activities occur on National Forest Service lands. Hence, nonconsumptive wildlife related recreation on National Forest lands can provide national, regional, and local economies with important sources of jobs, income, and other benefits.

By recognizing the contributions of nonconsumptive wildlife related recreation, this study should provide useful information for forest resource managers and planners. According to the empirical results of this study, forest resource managers and planners should consider how to provide possible educational or recreational opportunities for the potential nonconsumptive participant, a well-educated, white individual with a relatively high income level. Some of the variables which affect nonconsumptive wildlife related recreation expenditures can be influenced by public agencies, in particular the ranges of

participation fee or entrance fee and the human-wildlife interaction relationship. Such information is essential in managing and planning a suitable range of nonconsumptive wildlife related recreation opportunities for the public. In summary, although expenditures do not generate price elasticities, they do provide information useful as an indicator for improving local and regional resource management.

The empirical results of this study associated with primary residential activities can also provide information useful for local and regional industries who provide food and shelter for fish and wildlife for primary residential participants. An additional contribution of this study is to provide information useful in developing marketing strategies for targeting the potential nonconsumptive participant.

Future Study

Although the national survey provides useful data for analyzing the economic impacts of nonconsumptive wildlife related recreation, for some specific sites or local or regional perspectives, additional data are needed for research. For example, information about individual preferences and attitudes towards nonconsumptive wildlife related recreation may provide further insights for nonconsumptive wildlife management. This information might help public agencies, or local or state governments interested in targeting individuals most likely to support policies for nonconsumptive wildlife related recreation in the future (Shaw and King, 1980; Moss, et al., 1986). This could be accomplished by collecting data for regional or state level expenditure analyses which includes variables not found in the national survey. Family size, for example, has been established to be an important explanatory variable in previous expenditure analysis

studies. This could also be accomplished by collecting data for regional or state level expenditure analyses of nonconsumptive wildlife related recreation.

As Hay (1988) notes, expenditures can be used as an important indicator of nonconsumptive wildlife related recreation for local, regional, or national economies, but can not be used to measure economic benefits to either the individual participant or society directly. In order to estimate the total economic value for nonconsumptive wildlife related recreation, combining the contingent valuation method and the double-hurdle model might be a possible way to deal with the typically high proportion of zero or negative responses to contingent valuation questions. Willingness-to-pay for a participation fee or excise tax on equipment for nonconsumptive wildlife related recreation could provide additional information in question for contingent valuation analysis associated with nonconsumptive wildlife related recreation use.

REFERENCES

Aiken, R. "*1980-1990 Fishing, Hunting, and Wildlife-Associated Recreation Trends (State and Regional Trends).*" Addendum to 1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. Rep. 91-2. Washington, D.C.: U.S. Department of the Interior, Fish and Wildlife Service. 17pp. 1994.

Amemiya, T. "Regression Analysis When the Dependent Variable is Truncated Normal." *Econometrica* 41(1973):997-1016.

Amemiya, T. "Tobit Models: A Survey." *Econometrics* 24(1984):3-61.

Becker, G. "Division of Labor in Households and Families." pp.14-37. In Becker, G. *A Treatise on the Family.* Cambridge, MA: Harvard University Press. 1981.

Belsley, D.A., Kuh, E., and Welsch, R.E. *Regression Diagnostics.* New York: John Wiley & Sons, Inc. 1980.

Bergstrom, J.C., and Cordell, H.K. "An Analysis of the Demand for and Value of Outdoor Recreation in the United States." *Journal of Leisure Research* 23(1991):67-86.

Blaine, T.W., and Mohammad, G. "An Empirical Assessment of U.S. Consumer Expenditures for Recreation-Related Goods and Services: 1946-1988." *Leisure Sciences* 13(1991):111-122.

Blaylock, J.R., and Blisard, W.N. "U.S. Cigarette Consumption: The Case of Low-Income Women." *American Journal of Agricultural Economics* 74(1992):698-705.

Blisard, N., and Blaylock, J. "Distinguishing Between Market Participation and Infrequency of Purchase Models of Butter Demand." *American Journal of Agricultural Economics* 75(1993):314-320.

Blundell, R., and Meghir, C. "Bivariate Alternatives to the Tobit Model." *Journal of Econometrics* 34(1987):179-200.

Blundell, R. "Consumer Behavior: Theory and Empirical Evidence - A Survey." *The Economic Journal* 98(1988):16-65.

Bockstael, N.E., Strand, I.E., McConnell, K.E., and Aksanjani, F. "Sample Selection Bias in the Estimation of Recreation Demand Functions: An Application to Sportfishing." *Land Economics* 66(1990):40-49.

Brown, T.L., Dawson, C.P., and Miller, R.L. "Interest and Attitudes of Metropolitan New York Residents About Wildlife." *Transactions of North American Wildlife and Natural Resources Conference* 44(1979):117-128.

Burton, M., Tomlinson, M., and Young, T. "Consumer's Decisions Whether or Not to Purchase Meat: A Double Hurdle Analysis of Single Adult Households." *Journal of Agricultural Economics* 45(1994):202-212.

Bury, R.B., Campbell, H.W., and Scott, N.J., Jr. "Role and Importance of Nongame Wildlife." *Transactions of North American Wildlife and Natural Resources Conference* 45(1980):202-212.

Charbonneau, J.J., and Hay, M.J. "Determinants and Economic Values of Hunting and Fishing." *Transactions of North American Wildlife and Natural Resources Conference* 43(1978):391-403.

Clayton, C., and Mendelsohn, R. "The Value of Watchable Wildlife: A Case Study of McNeil River." *Journal of Environmental Manag*ement 39(1993):101-106.

Clawson, M., and Knetsch, J.L. *Economics of Outdoor Recreation.* Baltimore, MD: The Johns Hopkins Press. 1969.

Cordell, H.K., and Bergstrom, J.C. "A Methodology for Assessing National Outdoor Recreation Demand and Supply Trends." *Leisure Sciences* 13(1991):1-20.

Cragg, T.C. "Some Statistical Models for Limited Dependent Variables with Application to the Demand for Durable Goods." *Econometrica* 39(1971):829-844.

Dardis, R., Derrick, F., Lehfeld, A., and Wolfe, K.E. "Cross-Section Studies of Recreation Expenditures in the United States." *Journal of Leisure Research* 13(1981):181-194.

Dardis, R., Soberon-Ferrer, H., and Patro, D. "Analysis of Leisure Expenditures in the United States." *Journal of Leisure Research* 26(1994):309-321.

Davis, B., and Mangan, J. "Family Expenditure on Hotel and Holidays." *Annuals of Tourism Research* 19(1992):691-699.

Deaton, A., and Muellbauer, J. *Economics and Consumer Behavior*. New York, NY: Cambridge University Press. 1980.

Decker, D.J., Brown, T.L., and Guttierrez, R.J. "Future Insights into the Multiple Satisfactions Approach for Hunter Management." *Wildlife Society Bulletin* 8(1980):323-331.

DeGraaf, R.M., and Payne, P.R. "Economic Values of Non-Game Birds and Some Urban Wildlife Research Needs." *Transactions of North American Wildlife and Natural Resources Conference* 40(1975):281-287.

Dick, R.E., and Hendee, J.C. "Human Responses to Encounters with Wildlife in Urban Parks." *Leisure Sciences* 8(1986):63-77.

Drive, B.L. "Specifying What is Produced by Management of Wildlife by Public Agencies." Leisure Sciences 7(1985):281-295.

Duffus, D.A., and Dearden, P. "Non-Consumptive Wildlife-Oriented Recreation: A Conceptual Framework." *Biological Conservation* 53(1990):213-231.

Eubanks, L., and Wyckoff, J. "Voluntary Contributions to State Nongame Wildlife Programs." *Journal of Environmental Economics and Management* 16(1989):38-44.

Eubanks, T.E., Kerlinger, P., and Rayne, R.H. "High Island, Taxes." *Birding* 25(1993):415-420.

Fair, R.C. "A Note on the Computation of the Tobit Estimator." *Econometrica* 45(1977):1723-1727.

Fazio, J.R., and Belli, L.A. "Characteristics of Nonconsumptive Wildlife Users in Idaho." *Transactions of North American Wildlife and Natural Resources Conference* 42(1977):117-128.

Fisher, W.L., and Grambsch, A.E. "Development, Use, and Future of the National Survey of Fishing, Hunting, and Wildlife-Associated Recreation." *Wildlife Society Bulletin* 17(1989):538-543.

Gould, B.W. "At-Home Consumption of Cheese: A Purchase-Infrequency Model." *American Journal of Agricultural Economics* 74(1992):453-459.

Greene, W.H. *Econometric Analysis*. New York, NY: Macmillan Publishing Company. 1997.

Greene, W.H. *LIMDEP: User's Manual.* Version 7.0. Bellport, NY: Econometric Software, Inc. 1995.

Griffiths, W.E., Hill, R.C., and Judge, G.G. *Learning and Practicing Econometrics.* New York, NY: John Wiley & Sons, Inc.1993.

Hartmann, L.A., and Cordell, H.K. "An Overview of the Relationship Between Social and Demographic Factors and Outdoor Recreation Participation." pp.255-274. In Watson, A.E., Comp., *Outdoor Recreation Benchmark 1988: Proceedings of the National Outdoor Recreation Forum;* 1988 January 13-14; Tampa, FL. Gen. Tech. Rep. SE-52. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station. 1989.

Hammitt, W.E., Dulin, J.N., and Wells, G.R. "Determinants of Quality Viewing in the Great Smoky Mountains National Park." *Wildlife Society Bulletin* 21(1993):21-30.

Hay, M.J., and McConnell, K.E. "An Analysis of Participation in Nonconsumptive Wildlife Recreation." *Land Economics* 55(1979):460-471.

Hay, M.J., and McConnell, K.E. "Harvesting and Nonconsumptive Wildlife Recreation Decisions." *Land Economics* 60(1984):388-396.

Hay, M.J. "*Net Economic Values of Nonconsumptive Wildlife-Related Recreation.*" Rep. 85-2: Analysis of the 1985 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. Washington, D.C.: U.S. Department of the Interior, Fish and Wildlife Service. 12 pp. 1988.

Hay, M.J. "*Wildlife Related Recreation on Public Lands, 1985.*" Rep. 85-3: Analysis of the 1985 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. Washington, D.C.: U.S. Department of the Interior, Fish and Wildlife Service. 18 pp. 1989.

Heberlein, T.A., Trent, J.N., and Baumgartner, R.M. "The Influence of Hunter Density on Firearm Deer Hunters' Satisfaction: A Field Experiment." *Transactions of North American Wildlife and Natural Resources Conference* 47(1982):665-676.

Heckman, J.J. "Sample Selection Bias as a Specification Error." *Econometrica* 47(1979):153-161.

Henderson, J.M., and Quandt, R.E. *Microeconomic Theory: A Mathematical* Approach. New York, NY: McGraw-Hill, Inc.1980.

Henderson, K.A., Stainaker, D., and Taylor, G. "The Relationship Between Barriers to Recreation and Gender Role Personality Traits for Women." *Journal of Leisure Research* 20(1988):69-80.

Hill, M.S. "Patterns of Time Use." pp. 133-166. In Juster, F.T., and Stafford, F.P. (Eds.), *Time, Goods, and Well-Being*. Ann Arbor, MI: Institute for Social Research.

Hof, J.G., and Kaiser, H.F. "Long-Term Outdoor Recreation Participation Projections for Public Land Management Agencies." *Journal of Leisure research* 15(1983):1-14.

Hvenegaard, G.T., Butler, J.R., and Krystofiak, D.K. "Economic Values of Bird Watching at Point Pelee National Park, Canada." *Wildlife Society Bulletin* 17(1989):526-531.

Jones, A.M. "A Double-Hurdle Model of Cigarette Consumption." *Journal of Applied Econometrics* 4(1989):23-39.

Jones, A.M. "A Note on Computation of the Double-Hurdle Model with Dependence with an Application to Tobacco Expenditure." *Bulletin of Economic Research* 44(1992):67-74.

Judge, G.G., Hill, R.C., Griffiths, W.E., Lütkepohl, H., and Lee, T.C. *Theory and Practice of Econometrics*. New York, NY: John Wiley & Sons, Inc.1985.

Judge, G.G., Hill, R.C., Griffiths, W.E., Lütkepohl, H., and Lee, T.C. *Introduction to the Theory and Practice of Econometrics*. New York, NY: John Wiley & Sons, Inc.1988.

Lawson, R. "Patterns of Tourist Expenditure and Types of Vacations Across the Family Life Cycle." *Journal of Travel Research* 20(1991):12-18.

Lin, C.T. Jordan, and Milon, J.W. "Attribute and Safety Perceptions in a Double-Hurdle Model of Shellfish Consumption." *American Journal of Agricultural Economics* 75(1993):724-729.

Lin, T.F., and Schmidt, P. "A Test of the Tobit Specification Against an Alternative Suggested by Cragg." The Review of Economics and Statistics 66(1984):174-177.

Lyons, J.R. "Nonconsumptive Wildlife-Associated Recreation in the U.S.: Identifying the Other Constituency. *Transactions of North American Wildlife and Natural Resources Conference* 47(1982):677-685.

Macaluso, J. "New Program Means New Tax." Sunday *Advocate* (Outdoors) (1997):20C, Baton Rouge, LA.

Maddala, G.S. *Limited-Dependent and Qualitative Variables in Econometrics*. New York, NY: Cambridge University Press. 1983.

Manfredo, M.J., and Larson, R.A. "Managing for Wildlife Viewing Recreation Experiences: An Application in Colorado." *Wildlife Society Bulletin* 21(1993):226-236.

Mangun, J.C., O'Leary, J.T., and Mangun, W.R. "Nonconsumptive Wildlife-Associated Recreation in the United States: Identity and Dimension." Chapter 8. pp.175-200. In Mangun, W.R., Ed., *American Fish and Wildlife Policy: The Human Dimension*. Southern Illinois University Press. 1992.

McDonald, J.F., and Moffitt, R.A. "The Uses of Tobit Analysis." *The Review of Economics and Statistics* 62(1980):318-321.

McFarlane, B.L. "Specialization and Motivation of Birdwatchers." *Wildlife Society Bulletin* 22(1994):361-370.

Miller, J.R., and Hay, M.J. "Determinants of Hunter Participant: Duck Hunting in the Mississippi Flyway." *American Journal of Agricultural Economics* 63(1981):677-684.

Moss, M.B., Fraser, J.D., and Wellman, J.D. "Characteristics of Nongame Fund Contributors vs. Hunters in Virginia." *Wildlife Society Bulletin* 14(1986):107-114.

O'Leary, J.T., Dottavio, F.D., and McGuire, F. "Social Factors in Recreation Participation and Demand: Implications from National Surveys." pp.275-289. In Watson, A.E., Comp., *Outdoor Recreation Benchmark 1988: Proceedings of the National Outdoor Recreation Forum;* 1988 January 13-14; Tampa, FL. Gen.Tech. Rep. SE-52. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station. 1989.

Rapoport, R., and Rapoport, R.N. *Leisure and the Family Life Cycle*. Boston, MA: Routledge and Kegen Paul. 1975.

Reynolds, A. "Analyzing Fresh Vegetable Consumption from Household Survey Data." *Southern Journal of Agricultural Economics* 22(1990):31-38.

Rockel, M.L., and Kealy, M.J. "The Value of Nonconsumptive Wildlife Recreation in the United States." *Land Economics* 67(1991):422-434.

Shaw, S.M. "Gender and Leisure: Inequality in the Distribution of Leisure Time." *Journal of Leisure Research* 17(1985):266-282.

Shaw, W.W., and King, D.A. "Wildlife Management and Nonhunting Wildlife Enthusiasts." *Transactions of North American Wildlife and Natural Resources Conference* 45(1980):219-225.

Shaw, W.W., and Mangun, W.R. *Nonconsumptive Use of Wildlife in the United States: An Analysis of Data from the 1980 National Survey of Fishing, Huntng and Wildlife-Associated Recreation.* Resource Publication 154, U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. 1984. 20pp.

Silberberg, E. *The Structure of Economics: A Mathematical Analysis.* New York, NY: McGraw-Hill, Inc. 1990.

Smith, B.C., and Luzar, E.J. *An Economic Analysis of Potential Barriers to Participation in Nonconsumptive Recreation in Louisiana.* SP-95-07, Department of Agricultural Economics and Agribusiness, Louisiana State University. 1995.

Stafford, F.P., and Duncan, G.J. "The Use of Time and Technology by Households in the United States." pp. 245-282. In Juster, F.T., and Stafford, F.P. (Eds.), *Time, Goods, and Well-Being.* Ann Arbor, MI: Institute for Social research.

Thompson, C.S., and Tinsley, A.W. "Income Expenditure Elasticities for Recreation: Their Estimation and Relation to Demand for Recreation." *Journal of Leisure Research* 11(1979):265-270.

Tobin, J. "Estimation of Relationships for Limited Dependent Variables." *Econometrica* 26(1958):24-36.

Ulrich, R.S., and Addoms, D.L. "Psychological and Recreational Benefits of a Residential Park." *Journal of Leisure Research* 13(1981):43-65.

U.S. Department of the Interior, Fish and Wildlife Service, and U.S. Department of Commerce, Bureau of the Census. *1980 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation*. U.S. Government Printing Office, Washington, D.C. 1982.

U.S. Department of the Interior, Fish and Wildlife Service, and U.S. Department of Commerce, Bureau of the Census. *1980 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, Arkansas*. U.S. Government Printing Office, Washington, D.C. 1982.

U.S. Department of the Interior, Fish and Wildlife Service, and U.S. Department of Commerce, Bureau of the Census. *1980 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, Louisiana*. U.S. Government Printing Office, Washington, D.C. 1982.

U.S. Department of the Interior, Fish and Wildlife Service, and U.S. Department of Commerce, Bureau of the Census. *1980 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, Mississippi*. U.S. Government Printing Office, Washington, D.C. 1982.

U.S. Department of the Interior, Fish and Wildlife Service, and U.S. Department of Commerce, Bureau of the Census. *1985 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation*. U.S. Government Printing Office, Washington, D.C. 1988.

U.S. Department of the Interior, Fish and Wildlife Service, and U.S. Department of Commerce, Bureau of the Census. *1985 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, Arkansas*. U.S. Government Printing Office, Washington, D.C. 1988.

U.S. Department of the Interior, Fish and Wildlife Service, and U.S. Department of Commerce, Bureau of the Census. *1985 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, Louisiana*. U.S. Government Printing Office, Washington, D.C. 1988.

U.S. Department of the Interior, Fish and Wildlife Service, and U.S. Department of Commerce, Bureau of the Census. *1985 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, Mississippi*. U.S. Government Printing Office, Washington, D.C. 1988.

U.S. Department of the Interior, Fish and Wildlife Service, and U.S. Department of Commerce, Bureau of the Census. *1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation.* U.S. Government Printing Office, Washington, D.C. 1993.

U.S. Department of the Interior, Fish and Wildlife Service, and U.S. Department of Commerce, Bureau of the Census. *1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, Arkansas.* U.S. Government Printing Office, Washington, D.C. 1993.

U.S. Department of the Interior, Fish and Wildlife Service, and U.S. Department of Commerce, Bureau of the Census. *1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, Louisiana.* U.S. Government Printing Office, Washington, D.C. 1993.

U.S. Department of the Interior, Fish and Wildlife Service, and U.S. Department of Commerce, Bureau of the Census. *1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, Mississippi.* U.S. Government Printing Office, Washington, D.C. 1993.

U.S. Fish and Wildlife Service. "Applying an Ecosystem Approach to Fish and Wildlife Conservation." *Fiscal Year 1995-97 Budget Plan for the U.S. Fish and Wildlife Service, Lower Mississippi Valley*, 1994.

Varian, H.R. *Microeconomic Analysis.* New York, NY: W. W. Norton & Company, Inc. 1992.

Vaske, J.J., Donnelly, M.P., Heberlein, T.A., and Shelby, B. "Difference in Reported Satisfaction Rating by Consumptive and Nonconsumptive Recreationists." *Journal of Leisure Research* 14(1982):195-206.

Vaske, J.J., Fedler, A.J., and Graefe, A.R. "Multiple Determinants of Satisfaction from a Specific Waterfowl Hunting Trip." *Leisure Sciences* 8(1986):149-166.

Wagar, J.A. "Nonconsumptive Uses of the Coniferous Forest, with Special Relation to Consumptive Uses." In *Coniferous Forest of the Northern Rock Mountains: Proceedings of the 1968 Symposium*, Taber, R.D. Ed. University of Montana Foundation, Missoula, pp.255-270. 1969.

Wagner, F., and Washington, V.R. "An Analysis of Personal Consumption Expenditures as Related to Recreation 1946-1976." *Journal of Leisure Research* 14(1982):37-46.

Walsh, R.G., Harpman, D.A., Hof, H.J., John, K.H., and McKean, J.R. "Long-Run Forecasts of Participation in Fishing, Hunting, and Nonconsumptive Wildlife Recreation." pp.187-202. In Watson, A.E., Comp., *Outdoor Recreation Benchmark 1988: Proceedings of the National Outdoor Recreation Forum;* 1988 January 13-14; Tampa, FL. Gen. Tech. Rep. SE-52. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station. 1989a.

Walsh, R.G., John, K.H., McKean, J.R., and Hof, J.G. "Comparing Long-Run Forecasts of Demand for Fish and Wildlife Recreation." *Leisure Sciences* 11(1989b):337-351.

Walsh, R.G., John, K.H., McKean, J.R., and Hof, J.G. "Effects of Price on Forecasts of Participation in Fish and Wildlife Recreation: An Aggregate Demand Model." *Journal of Leisure Research* 24(1992):140-156.

Wiedner, D., and Kerlinger, P. "Economics of Birding: A National Survey of Active Birders."*American Birds* 44(1990):209-213.

Yen, S.T. "Working Wives and Food Away From Home: The Box-Cox Double-Hurdle Model." *American Journal of Agricultural Economics* 75(1993):884-895.

Yen, S.T., Dellenbarger, L.E., and Schupp, A.R. "Determinants of Participation and Consumption: The Case of Crawfish in South Louisiana." *Journal of Agricultural and Applied Economics* 27(1995):253-262.

Yen, S.T., and Jones, A.M. "Household Consumption of Cheese: An Inverse Hyperbolic Sine Double-Hurdle Model with Dependent Errors." *American Journal of Agricultural Economics* 79(1997):246-251.

Ziemer, R.D., Musser, W.N., White, F.C., and Hill, R.C. "Sample Selection Bias in Analysis of Consumer Choice: An Application to Warmwater Fishing Demand." *Water Resources Research* 18(1982):215-219.

Zuzanek, J. "Social Difference in Leisure Behavior: Measurement and Interpretation." *Leisure Sciences* 1(1978):271-293.

APPENDIX A

SELECTED DESCRIPTIVE STATISTICS: NONCONSUMPTIVE WILDLIFE-ASSOCIATED RECREATION SURVEY 1980, 1985, 1991

Table A.1 Major Characteristics of National Survey of Fishing, Hunting, and Wildlife-Associated Recreation: 1980, 1985, 1991.

Characteristics	1980	1985	1991
Survey Design:			
Screening interview mode and population of interest	Telephone/Personal interview, 6 years old and older.	Telephone/Personal interview, 6 years old and older.	Telephone/Personal interview, 6 years old and older.
Detailed interview mode and population of interest	Personal interview, 16 years old and older.	Personal interview, 16 years old and older.	Telephone/Personal interview, 16 years old and older, respondents interviewed 3 times at 4-month intervals.
Sample Size:			
Screening Phase (Household)	116,025	102,694	102,804
Detailed Phase (Individuals):			
Fishing and Hunting	30,291	28,011	23,179
Nonconsumptive Activity	5,997	26,671	22,723
Response Rates:	%	%	%
Screening Phase	95	93	95
Detailed Phase:			
Fishing and Hunting	90	92	95
Nonconsumptive Activity	95	94	95
Level of Reporting	State and National	State and National	State and National

Source: 1980 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, 1982.
1985 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, 1988.
1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, 1993.

Table A.2 Change in Participation by Activity Category for Wildlife Related Recreation

(Numbers in Thousands)

Activity	Year	U.S.	Arkansas	Louisiana	Mississippi
	1980	42,100	579	899	572
Fishing	1985	46,400	673	1,100	713
	1991	35,600	493	801	506
	1980	17,400	378	485	385
Hunting	1985	16,700	350	517	404
	1991	14,100	264	333	292
Nonconsumptive	1980	83,200	703	1,100	569
Activity	1985	134,700	1,200	1,900	1,100
	1991	76,100	812	1,100	742

Source: 1980 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, 1982.
1985 National Survey of Fishing, Hunting, and Wildlife-Associated Receration, 1988.
1991 National Survey of Fishing, Hunting, and Wildlife-Associated Receration, 1993.

Table A.3 Index of Participation by State of Residence for Nonconsumptive Wildlife Related Recreation

(1980 is the Base Year)

Trend	Year	U.S.	Arkansas	Louisiana	Mississippi
	1980	100	100	100	100
Nonresidential Activity	1985	149	149	127	123
	1991	163	186	142	222
	1980	100	100	100	100
Residential Observe	1985	141	139	125	130
	1991	190	212	154	215
	1980	100	100	100	100
Residential Photograph	1985	140	141	133	182
	1991	209	244	213	309
	1980	100	100	100	100
Residential Feed	1985	106	108	112	108
	1991	95	96	92	93

Source: 1980-1990 Fishing, Hunting, and Wildlife-Associated Recreation Trends, 1994.

Table A.4 Change in Expenditures by Activity Category for Wildlife Related Recreation

(Dollars in Millions)

Activity	Year	U.S.	Arkansas	Louisiana	Mississippi
	1980	17,300	----	----	----
Fishing	1985	28,100	350	598	387
	1991	24,000	286	686	263
	1980	8,500	----	----	----
Hunting	1985	10,100	208	326	204
	1991	12,300	288	434	402
Nonconsumptive	1980	14,800	----	----	----
Activity	1985	14,300	78	77	78
	1991	18,100	189	222	233

Source: 1980 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, 1982.
1985 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, 1988.
1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, 1993.

Table A.5 Change in Expenditure by Cost Category for Nonconsumptive Wildlife Related Recreation

(Dollars in Millions)

Cost	Year	U.S.	Arkansas	Louisiana	Mississippi
	1980	4,000	----	----	----
Trip Related Cost	1985	4,400	28	28	18
	1991	7,500	45	61	59
	1980	6,600	----	----	----
Equipment	1985	9,400	46	46	58
	1991	9,600	136	153	166
	1980	4,200	----	----	----
Other Items	1985	480	4	3	2
	1991	1,000	8	8	8

Source: 1980 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, 1982.
1985 National Survey of Fishing, Hunting, and Wildlife-Associated Receration, 1988.
1991 National Survey of Fishing, Hunting, and Wildlife-Associated Receration, 1993.

Table A.6 Changes in Age Distributions by Nonconsumptive Wildlife Related Recreation Activity for U.S. Nonresidential Participants

(Numbers in Thousands)

Activity	Year	16-17	18-24	25-34	35-44	45-54	55-64	>64
	1980	1,383	5,960	9,236	4,796	3,340	2,482	1,625
Total	1985	1,307	4,217	9,231	7,216	3,077	2,519	1,779
	1991	889	3,170	8,862	7,744	4,303	2,601	2,431
	1980	1,383	5,945	9,208	4,778	3,326	2,461	1,582
Observe	1985	1,297	4,196	9,153	7,141	3,060	2,498	1,712
	1991	831	3,067	8,618	7,412	4,078	2,459	2,347
	1980	627	2,548	4,217	1,809	1,397	947	271
Photograph	1985	416	1,889	4,667	3,588	1,485	970	547
	1991	430	1,249	4,225	4,103	2,092	1,107	1,018
	1980	625	2,570	4,633	2,147	1,492	996	638
Feed	1985	589	1,979	4,638	3,095	1,309	929	523
	1991	454	1,479	4,133	3,537	1,801	1,047	855

Source: 1980 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, 1982.
1985 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, 1988.
1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, 1993.

Table A.7 Changes in Age Distributions by Nonconsumptive Wildlife Related Recreation Activity for U.S. Residential Participants

(Numbers in Thousands)

Activity	Year	16-17	18-24	25-34	35-44	45-54	55-64	>64
	1980	3,229	10,967	20,154	13,172	10,575	10,663	10,909
Total	1985	3,811	12,034	22,851	21,317	14,189	14,440	16,644
	1991	1,961	6,007	16,823	17,263	10,891	9,193	11,765
	1980	2,032	7,129	14,202	9,233	7,683	7,778	7,814
Observe	1985	2,105	6,803	14,224	13,353	8,861	8,595	9,700
	1991	1,283	3,991	12,271	12,681	8,257	7,060	9,110
	1980	827	2,140	4,061	2,040	1,458	1,103	772
Photograph	1985	919	2,279	5,037	4,194	2,275	1,936	1,407
	1991	453	1,263	3,934	4,470	2,917	2,002	1,949
	1980	2,052	7,561	15,209	10,102	8,523	9,434	9,583
Feed	1985	2,573	8,456	16,770	16,899	11,715	11,902	14,192
	1991	1,523	4,334	13,741	14,679	9,652	8,291	10,912

Source: 1980 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, 1982.
1985 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, 1988.
1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, 1993.

Table A.8 Changes in Age Distributions by State of Residence for Arkansas Primary Participants

(Numbers in Thousands)

Residence	Year	16-17	18-24	25-34	35-44	45-54	55-64	>64
	1980	----	----	----	----	----	----	----
Total	1985	47.7	153.0	198.1	242.2	149.6	209.8	187.9
	1991	23.6	93.4	159.7	169.9	121.9	109.6	133.7
	1980	----	----	----	----	----	----	----
Nonresidential	1985	----	46.1	57.4	62.8	22.8	18.1	----
	1991	----	48.3	83.9	62.7	34.4	23.8	17.6
	1980	56.7	159.7	232.6	176.8	151.6	153.7	196.0
Residential	1985	43.1	150.1	194.0	232.1	143.2	209.8	187.9
	1991	21.8	89.8	150.1	166.1	121.9	109.6	131.8

Source: 1980 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (Arkansas), 1982.
1985 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (Arkansas), 1988.
1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (Arkansas), 1993.

Table A.9 Changes in Age Distributions by State of Residence for Louisiana Primary Participants

(Numbers in Thousands)

Residence	Year	16-17	18-24	25-34	35-44	45-54	55-64	>64
	1980	----	----	----	----	----	----	----
Total	1985	72.3	204.3	465.4	291.9	334.4	227.4	272.1
	1991	36.4	96.2	214.1	253.8	200.3	112.8	146.7
	1980	----	----	----	----	----	----	----
Nonresidential	1985	21.1	60.1	147.2	58.0	35.2	----	----
	1991	----	34.5	87.3	96.4	48.5	----	----
	1980	93.5	295.6	415.9	284.3	252.2	214.4	194.7
Residential	1985	69.9	186.3	443.9	271.8	333.3	227.4	272.1
	1991	36.4	88.7	214.1	251.2	199.4	112.8	146.7

Source: 1980 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (Louisiana), 1982.
1985 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (Louisiana), 1988.
1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (Louisiana), 1993.

Table A.10 Changes in Age Distributions by State of Residence for Mississippi Primary Participants

(Numbers in Thousands)

Residence	Year	16-17	18-24	25-34	35-44	45-54	55-64	>64
	1980	----	----	----	----	----	----	----
Total	1985	39.0	98.8	231.8	127.0	156.6	175.3	278.2
	1991	21.3	75.9	165.2	182.9	116.6	91.3	89.1
	1980	----	----	----	----	----	----	----
Nonresidential	1985	----	21.5	52.0	14.4	24.6	----	----
	1991	----	35.4	69.1	59.0	37.6	14.1	----
	1980	72.5	181.7	255.0	181.9	151.1	143.7	172.7
Residential	1985	39.0	86.9	226.3	127.0	156.6	175.3	278.2
	1991	21.3	72.0	157.4	182.0	113.8	91.3	89.1

Source: 1980 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (Mississippi), 1982.
1985 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (Mississippi), 1988.
1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (Mississippi), 1993.

Table A.11 Changes in Gender Distributions by Nonconsumptive Wildlife Related Recreation Activity for U.S. Primary Participants

(Numbers in Thousands)

		Nonresidential		Residential	
Activity	Year	Male	Female	Male	Female
	1980	14,911	13,912	37,012	42,657
Total	1985	14,421	14,926	47,930	57,356
	1991	15,868	14,132	35,925	37,978
	1980	14,827	13,855	25,887	29,984
Observe	1985	14,265	14,792	29,403	34,239
	1991	15,255	13,557	26,676	27,976
	1980	5,898	5,919	6,333	6,067
Photograph	1985	6,472	7,091	8,453	9,595
	1991	7,339	6,886	8,135	8,855
	1980	6,048	7,053	27,071	35,392
Feed	1985	5,741	7,322	35,774	46,734
	1991	6,729	6,577	29,965	33,167

Source: 1980 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, 1982.
1985 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, 1988.
1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, 1993.

Table A.12 Changes in Gender Distributions by State of Residence for the Lower Mississippi Valley Primary Participants

(Numbers in Thousands)

		Arkansas		Louisiana		Mississippi	
Residence	Year	Male	Female	Male	Female	Male	Female
	1980	----	----	----	----	----	----
Total	1985	538.7	649.4	855.5	1,012.0	525.2	580.3
	1991	392.1	419.8	489.0	571.4	349.0	393.4
	1980	----	----	----	----	----	----
Nonresidential	1985	121.5	110.0	161.0	181.0	86.2	48.4
	1991	151.8	126.7	179.3	126.4	137.0	93.8
	1980	666.3	697.7	1,034.2	1,114.9	693.0	741.7
Residential	1985	516.8	643.1	818.8	985.7	512.0	577.0
	1991	374.0	417.1	479.6	569.8	336.8	390.2

Source: 1980 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (Arkansas, Louisiana, Mississippi), 1982.
1985 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (Arkansas, Louisiana, Mississippi), 1988.
1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (Arkansas, Louisiana, Mississippi), 1993.

Table A.13 Changes in Race Distributions by Nonconsumptive Wildlife Related Recreation Activity for U.S. Primary Participants

(Numbers in Thousands)

		Nonresidential			Residential		
Activity	Year	White	Black	Others	White	Black	Others
	1980	27,347	961	514	73,926	4,511	1,233
Total	1985	28,065	810	472	96,867	6,460	1,960
	1991	28,479	678	843	69,049	3,049	1,806
	1980	27,246	941	495	52,565	2,484	822
Observe	1985	27,778	809	470	59,610	3,041	990
	1991	27,360	643	810	51,685	1,906	1,062
	1980	11,257	313	247	11,726	460	214
Photograph	1985	12,810	423	330	17,124	517	406
	1991	13,441	239	545	16,436	299	255
	1980	12,462	397	243	58,145	3,468	850
Feed	1985	12,488	416	159	76,065	5,023	1,420
	1991	12,445	399	462	59,123	2,541	1,468

Source: 1980 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, 1982.
1985 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, 1988.
1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, 1993.

Table A.14 Changes in Race Distributions by State of Residence for the Lower Mississippi Valley Primary Participants

(Numbers in Thousands)

		Arkansas			Louisiana			Mississippi		
Residence	Year	White	Black	Others	White	Black	Others	White	Black	Others
	1980	----	----	----	----	----	----	----	----	----
Total	1985	1079.5	97.4	----	1478.1	385.0	----	905.1	200.3	----
	1991	773.7	32.4	----	921.8	119.9	----	599.0	139.7	----
	1980	----	----	----	----	----	----	----	----	----
Nonresidential	1985	217.0	----	----	292.5	46.3	----	117.7	----	----
	1991	273.5	----	----	278.7	26.1	----	200.3	26.8	----
	1980	1204.9	145.2	13.8	1764.7	378.9	5.5	1054.7	372.8	7.2
Residential	1985	1056.9	92.8	----	1430.9	369.2	----	887.6	200.3	----
	1991	753.8	31.5	----	913.2	117.6	----	585.2	138.2	----

Source: 1980 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (Arkansas, Louisiana, Mississippi), 1982.
1985 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (Arkansas, Louisiana, Mississippi), 1988.
1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (Arkansas, Louisiana, Mississippi), 1993.

Table A.15 Changes in Residential Distributions by Nonconsumptive Wildlife Related Recreation Activity for U.S. Primary Participants

(Numbers in Thousands)

		Nonresidential		Residential	
Activity	Year	Urban	Rural	Urban	Rural
	1980	15,177	13,646	43,057	36,613
Total	1985	19,132	10,215	67,312	37,974
	1991	19,498	10,501	47,939	25,964
	1980	15,127	13,556	29,251	26,620
Observe	1985	18,921	10,136	39,527	24,115
	1991	18,676	10,137	34,330	20,322
	1980	6,971	4,846	6,738	5,662
Photograph	1985	9,143	4,419	10,717	7,331
	1991	9,454	4,771	10,137	6,853
	1980	7,568	5,534	33,519	28,944
Feed	1985	9,346	3,717	53,203	29,305
	1991	9,068	4,238	40,357	22,774

Source: 1980 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, 1982.
1985 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, 1988.
1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, 1993.

Table A.16 Changes in Residential Distributions by State of Residence for the Lower Mississippi Valley Primary Participants

(Numbers in Thousands)

		Arkansas		Louisiana		Mississippi	
Residence	Year	Urban	Rural	Urban	Rural	Urban	Rural
	1980	----	----	----	----	----	----
Total	1985	545.3	642.8	1000.0	867.5	467.8	638.8
	1991	353.1	458.8	683.9	376.4	310.9	431.5
	1980	----	----	----	----	----	----
Nonresidential	1985	96.8	134.7	181.5	160.6	69.3	65.3
	1991	130.1	148.4	199.3	106.4	105.9	124.9
	1980	204.9	1159.1	1004.1	1145.0	200.4	1234.3
Residential	1985	529.4	630.6	964.0	840.5	459.0	630.1
	1991	348.3	442.8	676.4	372.9	302.1	425.0

Source: 1980 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (Arkansas, Louisiana, Mississippi), 1982.
1985 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (Arkansas, Louisiana, Mississippi), 1988.
1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (Arkansas, Louisiana, Mississippi), 1993.

Table A.17 Changes in Education Distributions by Nonconsumptive Wildlife Related Recreation Activity for U.S. Nonresidential Participants

(Numbers in Thousands)

Activity	Year	< 9 years	9-11 years	12 years	1-3 college years	4 years college	> 4 years college
	1980	1,621	3,543	10,580	6,100	3,359	3,588
Total	1985	820	3,115	9,829	7,428	4,102	4,054
	1991	578	2,323	10,258	7,242	4,819	4,765
	1980	1,602	3,543	10,517	6,070	3,359	3,560
Observe	1985	813	3,094	9,727	7,370	4,040	4,012
	1991	547	2,175	9,912	6,966	4,665	4,532
	1980	484	1,273	4,088	2,621	1,763	1,571
Photograph	1985	161	1,172	4,098	3,718	2,149	2,266
	1991	141	949	4,392	3,611	2,484	2,645
	1980	717	1,675	5,168	2,574	1,505	1,433
Feed	1985	394	1,466	4,528	3,482	1,646	1,546
	1991	291	1,140	4,714	3,326	1,945	1,878

Source: 1980 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, 1982.
1985 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, 1988.
1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, 1993.

Table A.18 Changes in Education Distributions by Nonconsumptive Wildlife Related Recreation Activity for U.S. Residential Participants

(Numbers in Thousands)

Activity	Year	< 9 years	9-11 years	12 years	1-3 college years	4 years college	> 4 years college
	1980	7,968	11,672	29,455	14,437	7,856	8,281
Total	1985	8,545	14,478	40,015	21,837	10,606	9,806
	1991	3,617	7,155	28,595	15,525	10,293	8,719
	1980	5,249	7,802	20,242	10,409	5,860	6,309
Observe	1985	4,148	8,164	23,635	14,193	6,872	6,630
	1991	2,393	4,817	20,809	11,570	7,943	7,120
	1980	465	1,493	3,915	3,175	1,666	1,671
Photograph	1985	418	2,068	6,073	4,759	2,365	2,364
	1991	291	1,163	6,023	4,189	2,725	2,598
	1980	6,784	9,278	23,727	10,739	6,268	5,666
Feed	1985	7,260	11,233	31,814	16,666	8,004	7,532
	1991	3,250	6,164	24,831	13,289	8,393	7,204

Source: 1980 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, 1982.
1985 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, 1988.
1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, 1993.

Table A.19 Changes in Education Distributions by State of Residence for Arkansas Primary Participants

(Numbers in Thousands)

Residence	Year	< 9 years	9-11 years	12 years	1-3 years college	> 4 years college
	1980	----	----	----	----	----
Total	1985	190.2	232.9	374.1	199.0	192.1
	1991	56.8	110.0	342.8	159.7	142.7
	1980	----	----	----	----	----
Nonresidential	1985	----	42.8	67.7	64.7	37.9
	1991	----	35.9	120.7	65.3	53.9
	1980	449.5	255.4	390.0	137.8	131.2
Residential	1985	185.5	223.7	369.7	197.2	184.0
	1991	56.8	108.1	334.6	151.2	140.4

Source: 1980 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (Arkansas),1982.
1985 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (Arkansas),1988.
1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (Arkansas),1993.

Table A.20 Changes in Education Distributions by State of Residence for Louisiana Primary Participants

(Numbers in Thousands)

Residence	Year	< 9 years	9-11 years	12 years	1-3 years college	> 4 years college
	1980	----	----	----	----	----
Total	1985	231.9	338.2	672.3	304.0	321.3
	1991	55.2	142.2	389.4	226.3	247.3
	1980	----	----	----	----	----
Nonresidential	1985	38.1	68.9	108.3	49.8	77.1
	1991	----	29.4	83.5	102.2	88.8
	1980	657.3	354.9	618.7	257.5	260.7
Residential	1985	231.9	326.4	645.8	294.0	306.5
	1991	54.3	142.2	382.9	222.6	247.3

Source: 1980 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (Louisiana), 1982.
1985 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (Louisiana), 1988.
1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (Louisiana), 1993.

Table A.21 Changes in Education Distributions by State of Residence for Mississippi Primary Participants

(Numbers in Thousands)

Residence	Year	< 9 years	9-11 years	12 years	1-3 years college	> 4 years college
	1980	----	----	----	----	----
Total	1985	195.0	177.8	352.4	153.6	227.9
	1991	56.5	89.7	292.4	153.8	149.9
	1980	----	----	----	----	----
Nonresidential	1985	----	----	31.5	22.8	52.5
	1991	----	14.0	69.6	59.2	74.9
	1980	462.6	270.9	356.1	182.4	162.7
Residential	1985	195.0	173.5	348.0	146.9	225.8
	1991	56.5	89.7	289.8	145.2	145.7

Source: 1980 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (Mississippi),1982.
1985 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (Mississippi),1988.
1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (Mississippi),1993.

Table A.22 Changes in Annual Household Income Distributions by Nonconsumptive Wildlife Related Recreation Activity for U.S. Nonresidential Participants

(Numbers in Thousands)

Activity	Year	< 10,000	10,000 -19,999	20,000 -24,999	25,000 -29,999	30,000 -49,999	50,000 -74,999	> 75,000	Not Reported
	1980	3,822	7,249	4,999	3,572	4,312	1,171	----	3,697
Total	1985	2,544	5,579	3,254	4,385	8,646	2,501	1,487	950
	1991	1,470	3,768	2,291	3,121	8,402	5,203	3,148	2,597
	1980	3,794	7,221	4,980	3,558	4,277	1,171	----	3,681
Observe	1985	2,495	5,524	3,182	4,333	8,621	2,466	1,487	950
	1991	1,402	3,659	2,221	3,049	8,038	4,945	3,022	2,476
	1980	1,294	3,164	2,150	1,424	1,846	536	----	1,402
Photograph	1985	1,026	2,122	1,710	2,088	4,086	1,406	731	394
	1991	521	1,571	989	1,453	4,123	2,729	1,741	1,099
	1980	1,816	3,174	2,189	1,717	2,038	435	----	1,732
Feed	1985	1,294	2,508	1,314	1,730	4,094	1,026	724	363
	1991	630	1,909	1,056	1,440	3,780	2,179	1,382	930

Source: 1980 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, 1982.
1985 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, 1988.
1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, 1993.

Table A.23 Changes in Annual Household Income Distributions by Nonconsumptive Wildlife Related Recreation Activity for U.S. Residential Participants

(Numbers in Thousands)

Activity	Year	< 10,000	10,000 -19,999	20,000 -24,999	25,000 -29,999	30,000 -49,999	50,000 -74,999	> 75,000	Not Reported
	1980	13,711	19,185	12,412	8,641	11,069	3,014	----	11,637
Total	1985	13,792	21,785	9,819	14,460	27,436	8,432	4,530	5,034
	1991	5,196	10,446	6,239	7,697	18,603	11,471	6,557	7,695
	1980	8,846	13,531	8,846	6,551	7,839	2,057	----	8,200
Observe	1985	7,242	12,828	6,162	8,575	17,315	5,520	3,017	2,982
	1991	3,664	7,607	4,404	5,670	14,019	8,688	5,042	5,559
	1980	1,416	2,969	1,849	1,622	2,356	672	----	1,517
Photograph	1985	1,495	3,089	1,907	2,315	5,148	2,165	1,045	885
	1991	649	1,784	1,325	1,901	4,814	3,136	1,844	1,538
	1980	11,394	14,766	9,722	6,653	8,553	2,184	----	9,193
Feed	1985	11,525	17,082	7,785	10,940	21,238	6,524	3,420	3,995
	1991	4,483	8,951	5,439	6,411	15,994	9,906	5,478	6,470

Source: 1980 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, 1982.
1985 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, 1988.
1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, 1993.

Table A.24 Changes in Annual Household Income Distributions by State of Residence for Arkansas Primary Participants

(Numbers in Thousands)

Residence	Year	< 10,000	10,000 -19,999	20,000 -24,999	25,000 -29,999	30,000 -49,999	> 50,000	Not Reported
	1980	----	----	----	----	----	----	----
Total	1985	266.9	308.0	90.5	131.9	222.4	139.3	29.3
	1991	80.8	174.1	92.2	101.6	174.7	109.5	79.0
	1980	----	----	----	----	----	----	----
Nonresidential	1985	20.6	73.1	33.6	37.2	42.8	----	----
	1991	25.1	53.9	31.7	43.2	59.0	41.5	24.2
	1980	411.1	397.1	149.2	100.8	113.2	34.2	158.4
Residential	1985	263.8	301.2	89.5	121.9	215.2	139.3	29.3
	1991	72.4	174.1	88.4	101.6	166.1	109.5	79.0

Source: 1980 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (Arkansas), 1982.
1985 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (Arkansas), 1988.
1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (Arkansas), 1993.

Table A.25 Changes in Annual Household Income Distributions by State of Residence for Louisiana Primary Participants

(Numbers in Thousands)

Residence	Year	< 10,000	10,000 -19,999	20,000 -24,999	25,000 -29,999	30,000 -49,999	> 50,000	Not Reported
	1980	----	----	----	----	----	----	----
Total	1985	432.6	428.8	223.5	212.1	340.1	174.5	56.3
	1991	96.5	178.7	47.4	125.7	271.1	250.2	90.7
	1980	----	----	----	----	----	----	----
Nonresidential	1985	65.4	60.3	44.2	64.7	62.3	33.9	----
	1991	----	39.7	----	27.4	113.6	85.2	17.6
	1980	489.4	492.3	375.8	201.6	272.5	82.1	226.4
Residential	1985	415.4	415.5	220.1	203.6	329.9	165.2	54.9
	1991	94.9	178.7	47.4	125.7	263.4	249.3	90.0

Source: 1980 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (Louisiana), 1982.
1985 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (Louisiana), 1988.
1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (Louisiana), 1993.

Table A.26 Changes in Annual Household Income Distributions by State of Residence for Mississippi Primary Participants

(Numbers in Thousands)

Residence	Year	< 10,000	10,000 -19,999	20,000 -24,999	25,000 -29,999	30,000 -49,999	> 50,000	Not Reported
	1980	----	----	----	----	----	----	----
Total	1985	234.2	304.5	73.3	170.7	239.5	51.5	----
	1991	90.7	146.8	56.9	104.3	163.0	121.3	59.3
	1980	----	----	----	----	----	----	----
Nonresidential	1985	26.3	46.8	----	19.8	20.8	----	----
	1991	20.4	37.8	15.9	29.0	48.7	56.7	22.3
	1980	434.9	404.0	170.9	131.8	132.6	404.0	120.1
Residential	1985	234.2	301.6	71.0	166.2	235.9	47.2	----
	1991	90.7	144.5	55.4	102.8	156.4	119.0	58.3

Source: 1980 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (Mississippi), 1982.
1985 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (Mississippi), 1988.
1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (Mississippi), 1993.

APPENDIX B

EMPIRICAL RESULTS FOR THE PRIMARY NONRESIDENTIAL EXPENDITURE MODEL AND THE PRIMARY RESIDENTIAL EXPENDITURE MODEL ASSOCIATED WITH NONCONSUMPTIVE WILDLIFE RELATED RECREATION

Table B.1 Descriptive Statistics for Variables in Primary Nonresidential Expenditure Model Associated with Nonconsumptive Wildlife Related Recreation

Variable	Total Sample (N = 2178)		Participants Sample (N = 252)		Non-Participants Sample (N = 1926)	
	Mean	Standard Deviation	Mean	Stantard Deviation	Mean	Standard Deviation
TOTEXP	59.9183	677.1915	517.8651	1933.75	------	------
INCOME	27212.53	19880.93	33184.52	20494.14	26431.15	19671.01
AGE	42.3664	18.5456	42.0000	15.7766	42.4143	18.8809
AGESQ	2138.69	1783.88	2011.91	1474.49	2155.28	1820.15
FEMALE	0.5335		0.4722		0.5415	
MARRIED	0.6019		0.7540		0.5820	
COLLEGE	0.3384		0.4444		0.3245	
RURAL	0.7200		0.2579		0.7170	
EMPLOY	0.5661		0.6984		0.5488	
WHITE	0.7567		0.9444		0.7321	
PRIVATE	0.0308		0.2540		0.0016	
PUBLIC	0.0349		0.2937		0.0010	
WOOD	0.0418		0.3571		0.0005	
BRUSH	0.0312		0.2619		0.0010	
OPEN	0.0266		0.2262		0.0005	
MANMADE	0.0129		0.1071		0.0005	
BIRDTRIP	0.0386		0.3254		0.0010	
LANDMTRP	0.0367		0.3095		0.0010	

Table B.2 Empirical Results for the Tobit Analysis of Primary Nonresidential Expenditure Model Associated with Nonconsumptive Wildlife Related Recreation

Variable	Parameter Estimate	Standard Error	T-Ratio
CONSTANT	-5451.00	664.36	-8.205*
INCOME	0.00929	0.00457	2.033*
AGE	42.36	29.12	1.454
AGESQ	-0.3591	0.3065	-1.172
FEMALE	170.65	174.15	0.980
MARRIED	80.14	205.17	0.391
COLLEGE	297.53	183.61	1.620
RURAL	11.93	192.82	0.062
EMPLOY	121.15	207.65	0.583
WHITE	745.72	255.84	2.915*
PRIVATE	968.39	517.46	1.871*
PUBLIC	1252.90	493.35	2.540*
WOOD	1624.60	572.30	2.839*
BRUSH	578.97	489.76	1.182
OPEN	-250.72	481.79	-0.520
MANMADE	342.64	506.49	0.676
BIRDTRIP	388.84	474.71	0.819
LANDMTRP	641.82	474.77	1.352
σ	2168.50	103.93	20.865*
Log-Likelihood		-2552.5740	

N = 2178

*The critical t-statistic at the 95 percent confidence level is 1.645

Table B.3 Empirical Results for the Double-Hurdle Analysis of Primary Nonresidential Expenditure Model Associated with Nonconsumptive Wildlife Related Recreation

	Participation (N = 2178)			Consumption (N = 252)		
Variable	Parameter Estimate	Standard Error	T-Ratio	Parameter Estimate	Standard Error	T-Ratio
CONSTANT	-2.53070	0.29980	-8.440*	-10634.00	2914.80	-3.648*
INCOME	0.0000035	0.0000022	1.552	0.0344	0.0156	2.207*
AGE	0.02052	0.01384	1.482	146.91	133.90	1.097
AGESQ	-0.00017	0.00014	-1.173	-1.3626	1.4730	-0.925
FEMALE	0.09934	0.08398	1.183	404.02	666.25	0.606
MARRIED	0.08870	0.09979	0.889	-653.36	804.69	-0.812
COLLEGE	0.02195	0.09219	0.238	1968.90	638.01	3.086*
RURAL	0.00587	0.09357	0.063	56.61	719.27	0.079
EMPLOY	0.08285	0.10014	0.827	342.81	819.51	0.418
WHITE	0.42164	0.11988	3.517*	1259.90	1575.10	0.800
PRIVATE	0.84280	0.65906	1.279	750.22	972.81	0.771
PUBLIC	1.50480	0.53904	2.792*	860.76	951.78	0.904
WOOD	1.30950	0.60242	2.174*	1478.90	1173.90	1.260
BRUSH	-0.07619	0.59044	-0.129	1445.20	932.50	1.550
OPEN	0.22114	0.59590	0.371	-579.23	878.07	-0.660
MANMADE	-0.28580	0.66236	-0.431	935.28	933.33	1.002
BIRDTRIP	0.81121	0.51228	1.584	-919.25	867.28	-1.060
LANDMTRP	0.66864	0.47059	1.421	578.64	935.53	0.619
σ	-------	-------	-------	2016.30	104.16	19.357*
Log-Likelihood		-503.6474			-1914.0880	

*The critical t-statistic at the 95 percent confidence level is 1.645

Table B.4 Maximum Likelihood Estimates with Homoscedastic and Heteroscedastic Errors for the Double-Hurdle Analysis of Primary Nonresidential Expenditure Model Associated with Nonconsumptive Wildlife Related Recreation

	Homoscedastic Errors (Consumption)			Heteroscedastic Errors (Consumption)		
Variable	Parameter Estimate	Standard Error	T-Ratio	Parameter Estimate	Standard Error	T-Ratio
CONSTANT	-10634.00	2914.80	-3.648*	-1808.50	5498.30	-0.329
INCOME	0.0344	0.0156	2.207*	0.0112	0.0210	0.531
AGE	146.91	133.90	1.097	42.38	208.66	0.203
AGESQ	-1.3626	1.4730	-0.925	-0.3827	2.3381	-0.164
FEMALE	404.02	666.25	0.606	129.38	1021.00	0.127
MARRIED	-653.36	804.69	-0.812	-206.30	970.31	-0.213
COLLEGE	1968.90	638.01	3.086*	598.83	1226.80	0.488
RURAL	56.61	719.27	0.079	17.79	1048.10	0.017
EMPLOY	342.81	819.51	0.418	95.98	1192.30	0.081
WHITE	1259.90	1575.10	0.800	322.43	2395.80	0.135
PRIVATE	750.22	972.81	0.771	256.22	1175.40	0.218
PUBLIC	860.76	951.78	0.904	246.45	1217.80	0.202
WOOD	1478.90	1173.90	1.260	487.83	1525.90	0.320
BRUSH	1445.20	932.50	1.550	521.18	1069.90	0.487
OPEN	-579.23	878.07	-0.660	-222.83	937.27	-0.238
MANMADE	935.28	933.33	1.002	359.39	1175.20	0.306
BIRDTRIP	-919.25	867.28	-1.060	-327.42	1122.70	-0.292
LANDMTRP	578.64	935.53	0.619	193.26	1188.80	0.163
σ	2016.30	104.16	19.357*	1878.40	4066.30	0.462
Log-Likelihood		-1914.0880			-2108.3310	

*The critical t-statistic at the 95 percent confidence level is 1.645

Table B.5 Marginal Effects for the Double-Hurdle Analysis of Primary Nonresidential Expenditure Model Associated with Nonconsumptive Wildlife Related Recreation

	Probability Level	Conditional Level	Unconditional Level
Variable	Esitmate	Estimate	Estimate
CONSTANT	-0.458480	-10838.00	-123.712261
INCOME	0.00000063	0.035008	0.000337
AGE	0.003717	149.72	1.515475
AGESQ	-0.000031	-1.39	-0.013784
FEMALE	0.017998	411.75	4.743004
MARRIED	0.016069	-665.87	-4.327107
COLLEGE	0.003977	2006.60	16.917709
RURAL	0.001064	57.696	0.556658
EMPLOY	0.015009	349.38	4.005125
WHITE	0.076386	1284.10	16.290314
PRIVATE	0.152690	764.58	17.633628
PUBLIC	0.272610	877.24	27.442431
WOOD	0.237250	1507.30	30.042976
BRUSH	-0.013803	1472.90	11.180335
OPEN	0.040062	-590.33	-1.925588
MANMADE	-0.051777	953.20	4.064814
BIRDTRIP	0.146960	-936.86	-3.114762
LANDMTRP	0.121140	589.72	13.849994

Table B.6 Descriptive Statistics for Variables in Primary Residential Expenditure Model Associated with Nonconsumptive Wildlife Related Recreation

Variable	Total Sample (N = 2178)		Participants Sample (N = 232)		Non-Participants Sample (N = 1946)	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
TOTEXP	12.8535	86.7412	120.6681	240.5042	------	------
INCOME	27212.53	19880.93	33171.34	20292.73	26502.13	19716.73
AGE	42.3664	18.5456	43.1595	15.8107	42.2718	18.8465
AGESQ	2138.69	1783.88	2111.64	1491.14	2141.92	1815.94
MALE	0.4665		0.5129		0.4609	
MARRIED	0.6019		0.7543		0.5838	
COLLEGE	0.3384		0.4267		0.3279	
URBAN	0.2801		0.2672		0.2816	
EMPLOY	0.5661		0.6897		0.5514	
WHITE	0.7567		0.9397		0.7348	
BIRD	0.1129		0.7974		0.0313	
MAMMAL	0.0877		0.6207		0.0242	
REPTILE	0.0363		0.2759		0.0077	
INSECT	0.0344		0.2716		0.0062	
FISH	0.0321		0.2414		0.0072	
NATURAL	0.0216		0.1595		0.0051	
MAINTAIN	0.0262		0.2112		0.0041	
PLANTING	0.0133		0.1034		0.0026	

Table B.7 Empirical Results for the Tobit Analysis of Primary Residential Expenditure Model Associated with Nonconsumptive Wildlife Related Recreation

Variable	Parameter Estimate	Standard Error	T-Ratio
CONSTANT	-671.930	91.078	-7.377*
INCOME	0.000692	0.000636	1.087
AGE	-2.3162	4.2008	-0.551
AGESQ	0.0278	0.0447	0.622
MALE	40.620	24.246	1.675*
MARRIED	7.561	29.304	0.258
COLLEGE	4.057	25.931	0.156
URBAN	12.812	26.785	0.478
EMPLOY	95.324	30.570	3.118*
WHITE	109.610	40.017	2.739*
BIRD	438.770	40.686	10.784*
MAMMAL	76.592	39.049	1.961*
REPTILE	-36.461	44.039	-0.828
INSECT	50.026	41.895	1.194
FISH	61.017	43.165	1.414
NATURAL	92.449	44.292	2.087*
MAINTAIN	109.630	44.024	2.490*
PLANTING	45.612	58.083	0.785
σ	256.400	12.395	20.686*
Log-Likelihood		-1780.9520	

N = 2178

*The critical t-statistic at the 95 percent confidence level is 1.645

Table B.8 Empirical Results for the Double-Hurdle Analysis of Primary Residential Expenditure Model Associated with Nonconsumptive Wildlife Related Recreation

	Participation (N = 2178)			Consumption (N = 232)		
Variable	Parameter Estimate	Standard Error	T-Ratio	Parameter Estimate	Standard Error	T-Ratio
CONSTANT	-2.70240	0.36820	-7.340*	-878.43	381.55	-2.302*
INCOME	0.0000042	0.0000028	1.505	0.0000487	0.0021786	0.022
AGE	-0.00477	0.01792	-0.266	-1.8364	17.1290	-0.107
AGESQ	0.00007	0.00019	0.363	0.0337	0.1831	0.184
MALE	0.08068	0.10693	0.754	148.45	85.45	1.737*
MARRIED	0.13294	0.12958	1.026	-127.84	102.43	-1.248
COLLEGE	-0.05568	0.11548	-0.482	107.95	88.77	1.216
URBAN	-0.01413	0.12010	-0.118	91.21	88.88	1.026
EMPLOY	0.31980	0.13464	2.375*	216.93	112.20	1.933*
WHITE	0.43599	0.16643	2.620*	191.24	206.86	0.924
BIRD	2.06940	0.16904	12.242*	172.20	142.27	1.210
MAMMAL	0.32579	0.18966	1.718*	91.39	108.37	0.843
REPTILE	-0.11287	0.24115	-0.468	-111.89	113.29	-0.988
INSECT	0.44598	0.24611	1.812*	51.34	100.49	0.511
FISH	0.13713	0.24279	0.565	237.60	110.15	2.157*
NATURAL	0.98845	0.27442	3.602*	-25.08	109.03	-0.230
MAINTAIN	0.91936	0.27666	3.323*	67.87	102.25	0.664
PLANTING	-0.06524	0.36631	-0.178	153.36	124.99	1.227
σ	-------	-------	-------	296.30	18.43	16.080*
Log-Likelihood		-312.9545			-1387.1400	

*The critical t-statistic at the 95 percent confidence level is 1.645

Table B.9 Maximum Likelihood Estimates with Homoscedastic and Heteroscedastic Errors for the Double-Hurdle Analysis of Primary Residential Expenditure Model Associated with Nonconsumptive Wildlife Related Recreation

	Homoscedastic Errors (Consumption)			Heteroscedastic Errors (Consumption)		
Variable	Parameter Estimate	Standard Error	T-Ratio	Parameter Estimate	Standard Error	T-Ratio
CONSTANT	-878.43	381.55	-2.302*	-88.08	456.13	-0.193
INCOME	0.0000487	0.0021786	0.022	-0.0000632	0.0017323	-0.036
AGE	-1.8364	17.1290	-0.107	-0.3755	17.3580	-0.022
AGESQ	0.0337	0.1831	0.184	0.0090	0.1910	0.047
MALE	148.45	85.45	1.737*	51.21	78.84	0.650
MARRIED	-127.84	102.43	-1.248	-44.39	91.06	-0.488
COLLEGE	107.95	88.77	1.216	40.36	87.01	0.464
URBAN	91.21	88.88	1.026	31.39	76.80	0.409
EMPLOY	216.93	112.20	1.933*	71.13	125.44	0.567
WHITE	191.24	206.86	0.924	57.22	281.97	0.203
BIRD	172.20	142.27	1.210	53.57	213.61	0.251
MAMMAL	91.39	108.37	0.843	29.98	120.34	0.249
REPTILE	-111.89	113.29	-0.988	-38.49	121.98	-0.316
INSECT	51.34	100.49	0.511	17.59	80.04	0.220
FISH	237.60	110.15	2.157*	88.58	122.95	0.720
NATURAL	-25.08	109.03	-0.230	-8.91	103.00	-0.087
MAINTAIN	67.87	102.25	0.664	23.83	99.22	0.240
PLANTING	153.36	124.99	1.227	60.68	100.84	0.602
σ	296.30	18.43	16.080*	236.41	375.41	0.630
Log-Likelihood		-1387.1400			-1496.6740	

*The critical t-statistic at the 95 percent confidence level is 1.645

Table B.10 Marginal Effects for the Double-Hurdle Analysis of Primary Residential Expenditure Model Associated with Nonconsumptive Wildlife Related Recreation

	Probability Level	Conditional Level	Unconditional Level
Variable	Estimate	Estimate	Estimate
CONSTANT	-0.248300	-63.428	-16.219850
INCOME	0.00000039	0.00000352	0.00001356
AGE	-0.000438	-0.1326	-0.031160
AGESQ	0.000006	0.0024	0.000517
MALE	0.007413	10.7190	1.565921
MARRIED	0.012215	-9.2310	-0.715898
COLLEGE	-0.005116	7.7949	0.781333
URBAN	-0.001298	6.5857	0.763042
EMPLOY	0.029384	15.6640	2.919286
WHITE	0.040058	13.8090	3.055059
BIRD	0.190140	12.4340	7.991450
MAMMAL	0.029933	6.5988	1.826986
REPTILE	-0.010370	-8.0791	-1.342971
INSECT	0.040976	3.7071	1.848176
FISH	0.012599	17.2560	2.531316
NATURAL	0.090819	-1.8108	2.867245
MAINTAIN	0.084471	4.9003	3.473886
PLANTING	-0.005994	11.0740	1.153331

VITA

Yeong-Nain Chi was born in Keelung, Taiwan, on September 27, 1956. He earned a bachelor's degree in Forestry at the College of Chinese Culture in June 1979, and earned a master's degree in Forest Management at National Taiwan University in June 1983. Upon completion his military service in the Navy, he worked as a teaching assistant in the Department of Landscape Architecture at Tunghai University, and as an assistant research fellow in the Department of Forestry at National Taiwan University. In 1988, he worked as an instructor in the Department of Forestry at National I-Lan Institute of Agriculture and Technology. In 1993, he accepted a National Science Council Fellowship and joined Louisiana State University to pursue graduate studies in Forestry. In August of 1994, he enrolled in the doctoral program in Agricultural Economics, focusing on Natural Resource Economics, and will receive his doctor of philosophy degree in December, 1997.

DOCTORAL EXAMINATION AND DISSERTATION REPORT

Candidate: Yeong-Nain Chi

Major Field: Agricultural Economics

Title of Dissertation: A Double-Hurdle Expenditure Analysis of Nonconsumptive Wildlife Related Recreation

Approved:

E. Jane Luzar
Major Professor and Chairman

Dean of the Graduate School

EXAMINING COMMITTEE:

R. Carter Hill

Kenneth W. Paxton

Richard J. Kopp Jr

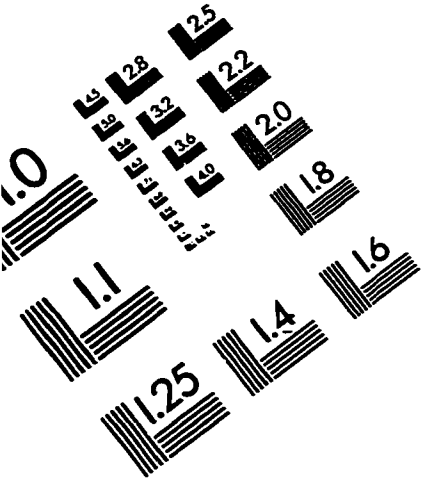
Andrew B. Christie

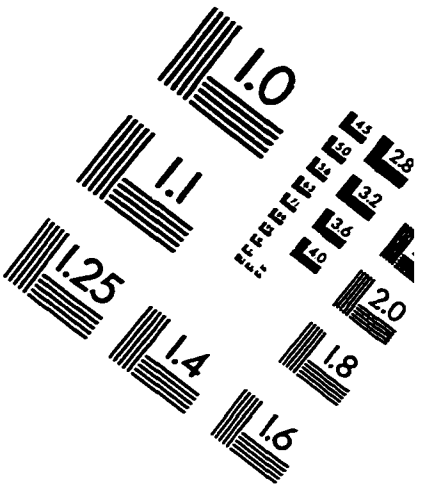
P. Lynn Kennedy

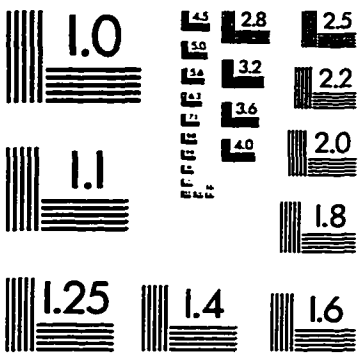
Date of Examination:

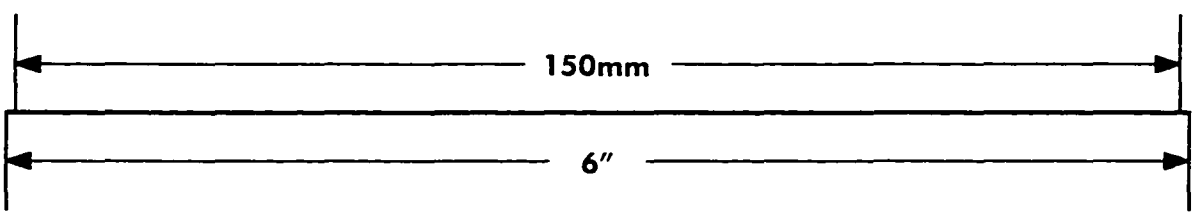
August 29, 1997

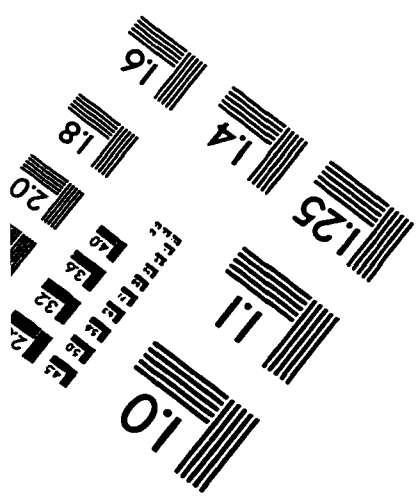
IMAGE EVALUATION TEST TARGET (QA-3)

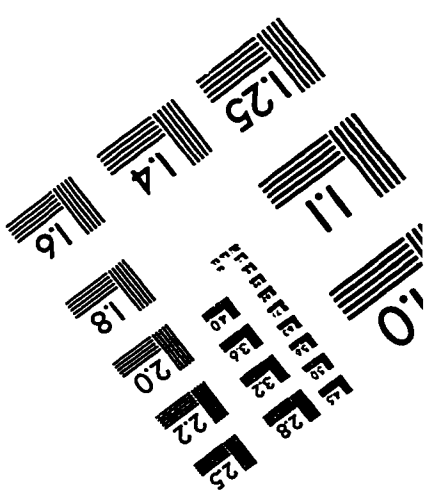












APPLIED IMAGE, Inc
1653 East Main Street
Rochester, NY 14609 USA
Phone: 716/482-0300
Fax: 716/288-5989