DISSERTATION

ESTIMATING THE EFFECTS OF FEE INCREASES ON PARTICIPATION AND REVENUE FOR DEER AND ELK HUNTING IN COLORADO

Submitted by

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WE HEREBY RECOMMEND THAT THE DISSERTATION PREPARED UNDER OUR SUPERVISION BY PETER J. FIX ENTITLED ESTIMATING THE EFFECTS OF FEE INCREASES ON PARTICIPATION AND REVENUE FOR DEER AND ELK HUNTING IN COLORADO BE ACCEPTED AS FULFILLING IN PART REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY.

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ABSTRACT OF DISSERTATION

ESTIMATING THE EFFECTS OF FEE INCREASES ON PARTICIPATION AND REVENUE FOR DEER AND ELK HUNTING IN COLORADO

There is an increasing trend towards user fees across a wide variety of government services, including recreation on public lands. Because user fees for recreation have historically been limited in their application, managers lack experience in charging fees. Issues that arise when implementing fees include how recreation areas and activities serve as substitutes and compliments, how participation will change in response to a fee, the amount of revenue that will be generated from the fee, how different methods of fee implementation will affect willingness to pay for the fee, and how different types of user groups respond to fees. The contingent valuation method (CVM) and an analysis of historic fee and participation data are two economic tools that can assist in addressing these issues. Refinements were made to these tools to improve their utility in addressing issues revolving around implementing fees.

For the first part of this dissertation, a contingent valuation study was designed to present simultaneously resident and nonresident hunters with a randomly assigned Colorado deer and elk hunting license price. Respondents were given the option of purchasing a deer license only, an elk license only, both a deer and an elk license, or neither. Two different analyses were conducted to examine how elk and deer licenses

serve as substitutes and compliments, logistic regression and crosstabs. Results of the logistic regression suggest elk hunting serves as a substitute for deer hunting, but deer hunting does not substitute for elk hunting. This analysis suggested deer hunting is a compliment to elk hunting. The crosstab analysis indicated that at low prices, elk and deer hunting serve as compliments, but as one license price is increased in relation to the other, hunters will substitute with the lower priced hunting license.

For deer and elk hunting in Colorado, demand was found to be inelastic. As fees are increased, revenue to the agency will increase. However, as licenses fees increase demand eventually changes to elastic, and revenue will decrease below baseline levels at all fees. The point at which this change from inelastic demand to elastic demand occurs varies by the type of license. When an advanced draw is required, participation and revenue decrease. For both resident and nonresident deer and elk hunters, groups differing by the primary motivation of solitude, meat, or trophy did not differ in their responses to fee increases. The results of part one of the dissertation have several implications. User fees may have an undesired effect on other recreation areas or activities, either by increasing densities of use through substitution or decreasing use when the areas or activities serve as compliments. Attention should be given to the elasticity of demand to ensure fees are not set a level where revenue begins to decline. Although in this study different types of hunters responded similarly to fee increases, it is critical to examine how different groups with different motivations respond to fees.

The second part of this dissertation compared results of the CVM estimates of participation and revenue for deer and elk hunting in Colorado to estimates from an analysis of historic deer and elk license price and sales data. Both methods provided estimates of license sales at increased fees. Since there are no actual data on license sales at these fees, one way to assess validity of the estimates is to test for convergence of the results. Estimates of elk license sales from the CVM and the historic analysis showed strong convergence. The ratio of the CVM to historic estimates ranged from .98 to 1.01 for predicted sales at fees from $40 to $70, representing a $10 to $40 increase in fees. Estimates of deer license sales from the two methods showed a similar pattern of responses; however, convergence was not strong. An explanation for why convergence varied for these two methods may be the recently changing characteristics of the deer hunts offered. The elk hunting experience in Colorado has remained relatively constant throughout recent years. In contrast, deer hunting, in recent years, has been characterized by a perception of poor quality arising from a general concern over declining herds. As a result, deer license sales have declined since 1990. It appears that when the product being offered remains similar, the different methods produce converging estimates of participation. However, when the product changes, estimates of participation do not converge as strongly. Moreover, when the product is changing, other sources of information may become more critical in estimating participation.

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John became a good friend who was always available to provide advice, hit the ski slopes, or both. Dr. Jerry Vaske and Dr. Maureen Donnelly provided me with considerable valuable advice and guidance over the years, as well as becoming friends and research partners. I look forward to working with Jerry and Mo in the future.

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CHAPTER I. BACKGROUND / THEORETICAL OVERVIEW

Overview

This dissertation presents two manuscripts that will be submitted for publication in peer reviewed journals. The articles discuss issues in the application of economics to recreation management. The focus of the articles is on refining economic tools that can be used in determining appropriate fees to charge for recreation. The activities used for this study are deer and elk hunting in Colorado. The first manuscript presents methods for using the contingent valuation method (CVM) to address issues of substitute and compliment goods, pricing, and how groups with different motivations react to price changes. The second article uses historic license sales and price data to estimate sales of deer and elk licenses at various prices. These estimates are compared to CVM estimates to assess validity.

This chapter provides a brief overview of user charges and the increasing trend toward their use. User charges in recreation applications have two main goals: raising revenue and allocating use over time and space. Critical to predicting effects of both of these goals is estimating how demand changes with price. Economic methods that can be used to estimate the relationship between price and quantity demand include analysis of historic price and sales data and the CVM. The price elasticity of demand is a tool that quantifies the relationship between price, quantity demand, and revenue. This tool is valuable for predicting the effects of a fee increase on revenue.

Chapter II is a manuscript titled "Estimating Demand for, and Revenue from, Elk and Deer Hunting Licenses in Colorado Under Different Pricing Scenarios." This manuscript addressed issues of substitutes and compliments, pricing, and differing motivations for hunting. A dichotomous choice contingent valuation survey was used to estimate license sales at various deer and elk license fee increases for residents and nonresidents. The contingent valuation question that was used varied the price of both an elk and deer license simultaneously, because the demand for one may be influenced by the price of the other. After being presented with the prices for a deer license and an elk license, the respondents were asked if they would purchase a deer license, an elk license, both a deer and elk license, or neither. This question format allowed for examination of how the relative price of each license affects demand for the other. From these responses, the relationship between deer and elk licenses as substitutes for each other was examined. Participation at different license fee increases was estimated. The estimates of participation were used to predict revenue to the agency under different fee scenarios. The price elasticity of demand for deer and elk licenses was calculated at different fees. In addition, the effect of increased fees on participation was analyzed across three groups with different primary motivations for hunting in Colorado. Previous research has identified different motivations for hunting in Colorado such as harvest, out-group contact, and nature (Brown, Hautaluoma, & McPhail, 1977); it is of interest to management to see if any particular group will respond differently to license fee increases.

Chapter III contains a manuscript titled "Assessing Validity of Estimates of Elk and Deer License Sales using Contingent Valuation and Historic Data." This manuscript presents research that used two different methods to estimate the relationship between elk and deer hunting fees and participation. One method was an analysis of historic license fees and participation, and the second method was a dichotomous choice contingent valuation survey. The results of the historic license sales analysis method were compared to the results from the dichotomous choice contingent valuation study to test for convergent validity. The results of the two elk hunting models showed strong correspondence. While the two deer hunting models showed similar patterns in participation, the actual estimates of participation varied by a relatively large amount. In addition, divergent validity of the CV data was tested by comparing the WTP responses for elk and deer licenses. If respondents are distinguishing between these two goods, responses to the WTP questions should diverge as the price difference between the two licenses become larger.

Chapter IV provides a summary and discussion of the two manuscripts. Potential future direction for this type of research are highlighted. An appendix follows chapter IV, containing the survey instrument used for the manuscripts in Chapters II and III.

Study Introduction

The purpose of this dissertation was to refine tools that can be used to help predict the effects of recreation user charges. Recreation user charges have two main purposes: 1) to raise revenue and 2) to allocate use over time and space (Harris & Driver, 1987). Predicting the effectiveness of fees in achieving these goals requires an estimation of the relationship between price and participation levels, not only within an area or activity, but also across different areas and activities. The focus of this dissertation was on economic tools that can estimate this relationship.

Background of User Charges

User charges for recreation are wide-ranging and include entrance fees, fees for special services or facilities such as boat ramps, fees for special use permits, excise taxes on specialized equipment, special stamps (i.e., waterfowl stamps), or licenses for activities such as hunting or fishing (Congressional Budget Office, 1993; Driver, Bossi, & Cordell, 1985; United States General Accounting Office, 1996). User charges have increased across a wide variety of federal programs since the mid 1980s, increasing as a percentage of the federal budget by 54 percent between 1980 and 1991 (Congressional Budget Office, 1993, p. *x*). This trend toward more reliance on user charges rather than general tax funding can be attributed in part to persistent federal deficits (which have created incentives for increased user fees), the passage of the 1985 Balanced Budget Act, and the 1990 Budget Enforcement Act (which reinforced incentives to charge user fees) (Congressional Budget Office, 1993; United States General Accounting Office, 1997). Agencies providing recreation on public land, such as the National Park Service (NPS), USDA Forest Service (USFS), and U.S. Bureau of Land Management (BLM) are included in this trend toward increasing user charges. The recently implemented fee demonstration program (P.L. 104-134) is one example of agencies' willingness to implement user fees to address their budgetary concerns, as illustrated by the fact that as of September 1998, fees were in place at 312 sites, out of a possible 400 sites, across the four agencies participating in the program (United States General Accounting Office, 1999, p.1). A unique feature of the fee demonstration program is that it allows at least 80 percent of the fees collected to be used for local maintenance projects. Thus, this program has provided agencies with an additional incentive to charge fees (U.S. Forest Service, 2000; United States General Accounting Office, 1999).

Challenges in Implementing Fees

Although the current political climate supports recreation user fees, and it appears fees will become a common part of recreation's future, implementing fee programs is not without challenges. Because of the history of inconsistent legal authority to charge user fees, with cycles of authority to charge fees being granted and then repealed, most agencies have relatively little experience in charging fees[1] (Driver, et al., 1985). This lack of experience in charging fees contributes to two interrelated concerns: 1) equity and social issues, and 2) what price to charge.

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[1] Driver, Bossi, and Cordell give a brief history of user fees. They state that in the 1920s there was strong sentiment against fees and certain user fees were repealed by congress. Leading up to the middle of the century, support for user fees increased leading to the passage of the Land and Water Conservation Fund Act in 1965. The LWCFA was repealed in 1968, and reinstated in 1970. Amendments were made in 1972 and 1973 that restricted the areas in which fees could be charged.

The first concern has two parts. The first part relates to the longstanding debate over whether or not fees result in greater subsidization for the disadvantaged or have discriminatory impacts. The second part of this concern questions if fees will lead to commodification of recreation activities, resulting in diminished experiences for the users (Cockrell & Wellman, 1985; Crandall & Driver, 1984; Ellerbrock, 1982; McCarville, 1995; More, 1999; Schultz, McAvoy, & Dustin, 1988). Although researchers have studied users' perceptions of fees and displacement resulting from fees, results have been mixed, and there is not a clear understanding of these issues.

For example, results from some studies suggest user patterns remain the same when fees are implemented, (Leuschner, Cook, Roggenbuck, & Oderwald, 1987; Stevenson, 1989), while others indicate fees do have discriminatory impacts (Reiling, Cheng, & Trott, 1992; Schneider and Budruck, 1999). Research has found that the majority of visitors to eight national wildlife refuges that charge fees under the fee demonstration program feel fees are "about right" and relatively few visitors would be displaced (Vaske, Donnelly, & Taylor, 1999; Taylor, Vaske, Shelby, Donnelly, & Browne-Nunez, in review). It has also been found that NPS managers feel results of the fee demonstration program are generally positive (Krannich, Eisenhauer, Field, Pratt, & Luloff, 1999). In contrast, other authors suggest that the fee demonstration program may not be adequately addressing concerns raised in the literature (Martin, 1999). In addition, some of the issues debated seem to be rooted in values, (e.g., "equity" and "fairness") and most likely will remain controversial (Fulton, Manfredo, & Libscomb, 1996; Vaske & Donnelly, 1999). With respect to concern over commodification of recreation experiences, there has not been a long enough history of fees to determine if this phenomenon is occurring.

The equity and social issues are influenced by the price of the fee, which is the second concern. Because of this influence, the pricing decision is a critical component of a fee program. The price must achieve the goals of the fee program, raising revenue and allocating use over time and space, while addressing equity and impacts on the experience. If the price is set too low, in an attempt to achieve fairness, revenues may not offset the cost of fee collections, raise sufficient revenues to cover costs of programs, or cause a large enough change in visitor behavior to allocate use over time and space. If the fee is set too high, not only could the fee increase negative public sentiment, but actually result in decreased revenue. If the goal is to allocate use, too high of a fee may reduce use to a level lower than targeted. This displacement may place extra costs, including a diminished recreation experience, on other recreation sites in the area.

Economic Tools to Assist in Determining the Appropriate Fee Level

To determine the revenue that will be generated from a recreation fee, or the magnitude of the shift in use in response to a fee, the relationship between price and quantity demanded must be estimated. That is, how do use patterns change as fees increase or decrease? If a fee has been charged in the past, and participation records have been kept, historic data can be used to estimate this relationship. If historic data are not available, what is referred to as "nonmarket valuation" techniques may be used to estimate the price quantity relationship. Appropriate nonmarket valuation techniques include the travel cost method (TCM), hedonic property method (HP), and CVM (Loomis & Walsh, 1997).

Analysis of Historic Price and Participation

In some cases, fees have a continuous history of being charged. Continuity is one requirement for conducting an analysis of historic price and participation. A second requirement is that accurate records of participation have been kept. When both historic price and participation data are available, multiple regression can be used to estimate the relationship between price and quantity demanded (Teisl, Boyle, & Record, 1999). The underlying economic assumption is that the quantity purchased will change as price varies (Anderson, Reiling, & Criner, 1985). This variation in price and quantity demanded forms the basis for the demand curve, which traces the quantity demanded at different prices (Varian, 1990).

Economic theory also predicts that other factors will affect market demand. These factors include the price of substitutes, the number of potential buyers in the population represented by the human population of the region, the price of necessary inputs for the activity (such as gas), and income. A variable can be included to test for a systematic trend in the data. The general form of the model expressing this relationship is as follows:

License sales = *function*(license price, price of substitutes, human population, price of inputs, income, trend).

Written in equation format the model is:

$$\text{License sales} = x_0 + x_1\text{license price} + x_2\text{price of substitutes} + x_3\text{human population} + x_4\text{price of inputs} + x_5\text{income} + x_6\text{trend}$$

The regression coefficients, e.g., $x_1, \ldots x_6$, quantify the change in license sales as the corresponding independent variable, e.g., license price, ... trend, changes by one unit. The estimated coefficient x_1 expresses the effect of license price on license sales. Theory predicts this relationship will be negative, estimating a downward sloping demand curve. The size of the coefficient for license price indicates the decline in license sales when price increases by one dollar. The size of the coefficient answers the question of how participation will change. To address questions of how revenue will change, the relative change in participation must be compared to the relative change in price. Calculating the price elasticity of demand, defined as the percentage change in quantity demanded as price changes by one percent, is one method by which to compare these relative changes in participation and price (Loomis & Walsh, 1997).

Using the CVM to Predict Participation at Increased Fees

The CVM is a technique that uses a survey instrument to elicit a person's "maximum willingness to pay" (WTP) for a good. The "good" may be defined as participation in a recreation activity, habitat preservation, or avoiding the loss of a recreation area / activity (Mitchell & Carson, 1988). The CVM's roots trace back to 1947 when Ciriacy-Wantrup suggested that "individuals of a sample or of a social group as a whole may be asked how much money they are willing to pay for additional quantities of a collective extra market good" (Ciriacy-Wantrup, 1947 p. 1189).

When using the CVM, a survey instrument must be developed to present the respondent with a description of the good in question, how the payment would be collected, and a question to elicit their WTP for the good. The survey can be administered on-site, by mail, or telephone. Examples of how payment could be collected include an increase in taxes, user fees, or a donation. The WTP can be elicited through an open ended question, "what is the most you would pay?"; a bidding process, "would you pay $20, $25, $30, etc?"; or a dichotomous choice question, "would you pay $40 (yes or no)?" The different types of WTP questions each has its advantages and disadvantages. The open-ended question directly elicits maximum WTP, but most respondents will not be familiar with stating their maximum WTP for a good. The bidding process is more like a market than the open-ended question, but requires the use of an interviewer, which can increase costs. The dichotomous choice format is most similar to how consumers purchase goods and can be used in different survey formats such as telephone, mail, and on-site. However, with the dichotomous choice format, statistical methods must be used to elicit maximum WTP. However, because of dichotomous choice's similarity to how markets work, a panel selected to evaluate the contingent valuation method for NOAA recommended CV studies use the dichotomous choice format (Arrow, Solow, Portney, Leamer, Radner & Schuman, 1993).

Issues in Use of the CVM

Substitutes in the CVM

One of the concerns when using nonmarket valuation techniques to estimate demand is accounting for the price of substitute goods[2] (Rosenthal, 1993; Arrow et al., 1993). Substitutes are goods that can be exchanged in consumption (Hyman, 1988). For example, two hiking trails may serve as substitutes to each other if hikers obtain similar enjoyment hiking on either trail. When goods are substitutes, if the price of one good increases, demand for the other will increase. In other words, if goods A and B are substitutes, as the price of A increases, the demand for B increases.

Failing to account for substitute goods may lead to an over-estimation of demand. When many substitutes are available, demand may be more sensitive to price (Willis, Canavan, & Bond, 1975). This price sensitivity is common with outdoor recreation. If several campgrounds with relatively similar features exist in close proximity to each other, they may act as substitutes. The implication is if the fee at one campground is increased in relation to the others, campers will most likely switch to the less expensive campground. Thus, the revenue generation goal of a fee may be rendered ineffective if many substitutes exist in close proximity.

Accounting for substitutes is also critical if the goal of charging a fee is to distribute use over time and space. To achieve this goal, use will have to shift from the recreation site in question to a substitute site or activity. If the recreation site is unique, without adequate substitute sites, it may take a relatively high price to achieve the desired

[2] Substitutes in this dissertation are defined from an economics perspective. There are other definitions of substitution used in recreation. See Manfredo and Anderson (1987) and Shelby and Vaske (1991) for alternative definitions of recreation substitutes.

reduction in use. In contrast, if many lower-priced substitutes exist in close proximity to the site in question, more users may shift to different sites than anticipated. This substitution may impose additional costs on another recreation area, or diminish the quality of the experience for the users of the substitute site.

Compliments in the CVM

When evaluating the effects of fees, the concept of complimentary goods should also be considered. When goods are compliments, the demand for each good is inversely related to the price of the other good. When the price of a good goes up, demand decreases not only for that good, but also for its complimentary goods (Hyman, 1988). Failing to consider compliments may result in undesired decreases in visitation, and perhaps revenue, to other recreation sites, or businesses, in the area.

Also, it is possible, depending on the relative price of two goods, they may take on the roles of both compliment and substitute. For example, if deer and elk permits are similar in price, and both relatively low in price, they may act as compliment goods. However, if the price of elk permits increase to a level much greater than a deer permit, elk hunters may substitute with a deer permit rather than not hunt at all. The shift from compliment to substitute is another factor that should be considered when implementing fees.

The CVM has been applied to a wide variety of outdoor recreation activities including deer hunting (Duffield & Neher, 1990; WU, 2000), elk hunting (Duffield, 1988; Fried, Adams, Berrens, & Berglund, 1995), pheasant hunting (Remington, Manfredo, Vaske, & Demasso, 1996), fishing (Sutton, Stoll, & Dittion, 2001), and recreational boating (Sellar, Stoll, & Chaves, 1985). However, while many of these studies vary the quality of the good being valued, they present only the price of the good under question when evaluating WTP. This narrow focus presents limitations in determining demand as the price of relevant substitute and compliment goods change. The relevant substitutes and compliments to be accounted for will vary across situations and depend on the activities being studied.

Pricing

There are several ways in which the CVM can assist the pricing decision. The first is to predict revenue at different fees; the second is to test the effect of different collection methods, e.g., how the good is sold, on WTP for the good.

Because quantity demanded decreases as price increases, a higher price may not result in greater revenue. Therefore, the relationship between price and quantity must be taken into account when determining the price that maximizes revenue. The CVM estimates a demand curve for a good, which plots out the amount purchased at different prices. The price can be multiplied by the quantity to determine the total revenue at different prices.

There may be different methods to collect fees. For example, use permits could be obtained on-site via self-registration, at a visitor center or some other central location, or in some cases by applying in advance. The context of how a good is presented in a WTP survey can affect responses (Arrow et al., 1993; Barro, Manfredo, Brown, & Peterson, 1996; McCarville, 1991). Therefore, it would be expected that these different methods of selling the use permits might influence respondents' willingness to purchase the permits. Certain methods may render the fee program ineffective. When using the CVM, different question formats can be identified to test the effect of different payment / allocation methods.

Validity

There are concerns over the CVM (Diamond & Hausman, 1994). The hypothetical nature of the CVM provides great flexibility to estimate the value of many different goods. This flexibility is the major advantage of the CVM. However, the creation of hypothetical scenarios to value goods also provides a potential source of bias in the CVM. Some question whether or not the CVM measures true intentions to pay the stated amount (Cummings, Harrison, & Rutstrom, 1995; Diamond & Hausman, 1994) and if accurate estimates of benefits can be obtained (Ajzen & Peterson, 1988). Even though there are concerns with the CVM, it has been recommended by federal agencies for performing benefit cost analysis (U.S. Water Resources Council, 1983) as well as valuing damage incurred to natural resources (U.S. Department of the Interior, 1986).

Price Elasticity of Demand

Another economic concept relevant to the topics discussed in this dissertation is the price elasticity of demand. To predict the impacts of a fee, the relationship between price and quantity must be estimated. If the goal of a fee is revenue generation, the analysis must be taken one step further to estimate the relationship between price, quantity, and total revenue. This relationship is defined in economics as the price elasticity of demand (Hyman, 1988). More specifically, the price elasticity of demand is the percent change in quantity demanded resulting from a one percent change in price, with the following general formula:

$$\text{Price elasticity} = \frac{\text{Percent change in quantity}}{\text{Percent change in price}}$$

Thus, elasticity is computed as a specific number. The value of the elasticity provides a general indication of what will happen to revenue when price changes. Elasticity is classified as one of three different types depending on its absolute value: *inelastic*, absolute value < 1; *unit elastic*, absolute value = 1; and *elastic*, absolute value > 1. With inelastic demand, participation decreases at a rate that is less than the rate of the price increase, and revenue will increase (Table 1.1). Inelastic demand is usually associated with unique goods for which there are few substitutes, or when the price of the good is relatively small. When demand is elastic, participation will decline at a rate larger than the rate of the fee increase, and revenue will decrease. Elastic demand is usually associated with goods that have many substitutes, or if the price increase is large relative to the total cost of the good. When demand is unit elastic, the fee increase and decrease in participation offset each other and revenue stays the same.

Table 1.1. Different Types of Elasticities

	Elasticity		
	Inelastic	Elastic	Unit elastic
Effect on revenue from a price increase	*Increase*	*Decrease*	*No change*

It is important to note that a specific elasticity only applies to a range around a given price. As price increases, demand may change from inelastic to elastic (Figure

1.1). For the demand curve illustrated in Figure 1.1, the demand is inelastic up to a fee of $40. For fee increases within this range, revenue will increase. At fees above $60, demand changes to elastic. For fee increases in the range of the demand curve above $60, revenue will decrease.

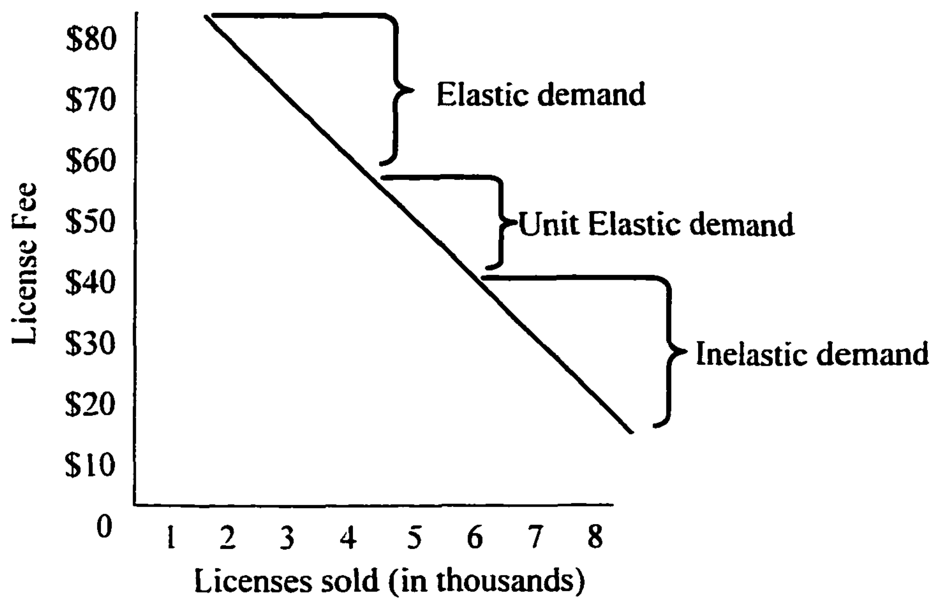

Figure 1.1. Elasticity for Hunting Licenses Along a Hypothetical Demand Curve

Calculating elasticity

There are two ways to calculate the price elasticity of demand from the estimated demand curve. One way to estimate the elasticity is to use actual data on the quantity sold at various prices. From these data, the *arc elasticity* can be estimated (Tiesl et al., 1999). The arc elasticity is defined as follows:

$$\text{Price elasticity} = \frac{\text{Change in quantity} \div \text{Original quantity}}{\text{Change in price} \div \text{Original price}}$$

When multiple regression is used to estimate the demand curve, the elasticity can be estimated from the price variable's coefficient using the following formula:

Price elasticity = price coefficient * (mean price / mean quantity)

In a log-log regression, the coefficient can be interpreted directly as the elasticity. However, logistic regression requires special considerations, and it may be best to calculate license sales at various prices and use the arc elasticity formula.

Approach for this Dissertation

The goal of this dissertation was to refine these economic methods to address issues faced by recreation managers when implementing fees. This goal was achieved by applying these tools to a case study of funding issues faced by the Colorado Division of Wildlife (CDOW).

<u>Case Study</u>

The CVM and analysis of historic data were applied to estimate deer and elk hunting license sales in Colorado under different license prices. This recreation activity is regulated by the CDOW and requires a user fee, in the form of a license, to participate. License fee are central to two issues currently faced by the CDOW: revenue to the agency, and the allocation of hunting opportunities.

The sale of licenses traditionally has provided the majority of the CDOW's revenue, providing 76, 71, 72, 73 and 63 percent of their total budget between 1996 and 2000, respectively. However, with no increase in license fees, inflation adjusted license revenue is expected to decline by 23 percent by fiscal year 2003-2004 (CDOW, 2000). This projected decrease in revenue has two main causes: inflation and decreasing license sales for deer hunting. Deer and elk license fees last increased during the period of 1990-1992. As a result, the "inflation-adjusted" prices of licenses have decreased, while expenses have kept pace with inflation. For example, the inflation-adjusted elk license price was $12.50 in 1999. In comparison, the 1975 inflation-adjusted elk license price was $17.76. The declining-inflation adjusted license prices have led to a decrease in "real" revenue. Compounding this problem, deer license sales have declined since 1990, caused in part by a concern over chronic wasting disease and a perception of poor hunting quality. It is predicted that deer licenses will continue to decline. This decline will result in a decrease in revenue from deer license sales.

The CDOW predicts that without a license fee increase, services will have to be cut by $27 million annually by fiscal year 2003-2004 (CDOW, 2000, p. 1). These cuts in services would likely come from recreation programs, capital construction and capital improvements (McClosky, 2000, p. 2).

Concurrent to this problem of declining revenue, stakeholders have expressed concerns over too many hunters in the field, especially nonresident hunters, and a lack of quality hunting. For example, the 2000-2004 five-year big game policy season structure adopted limits on the number of nonresident big game hunters and a specific number of units that would managed for "trophy" animals, with limitations on hunting (CDOW, 1999). Both of these policy adaptations could be achieved through pricing or requiring advanced draws for licenses. However, given the CDOW's current financial status, care must be taken to avoid detrimental impacts to revenue if these strategies are used.

Study Objectives

Given the current situation faced by the CDOW, the following study objectives were developed. Objectives one through four were addressed in the first paper and objective five in the second.

Objective 1: Explore how deer and elk licenses serve as compliment and substitute goods.

Objective 2: Estimate how participation and revenue for deer and elk hunting in Colorado change as license fees change.

Objective 3: Examine the effects of requiring a draw on participation and license sales for deer and elk hunting in Colorado.

Objective 4: Test if groups with different motivations for hunting in Colorado differ in their response to fees.

Objective 5: Assess the validity of license sales estimates from the analysis of historic data and estimates from the CVM by examining convergent validity.

Data Collection

Contingent valuation

A contingent valuation survey was designed and administered to over 4000 randomly chosen resident and nonresident deer and elk hunters in Colorado. The survey was administered in 1997. The survey presented the respondents with a randomly assigned combination of prices for a deer and elk license. There were 10 prices for deer licenses and 10 prices for elk, resulting in 100 different combinations of prices. The respondents were then allowed to respond by purchasing a deer license, an elk license, both a deer and elk license, or neither. It is important to note that currently in Colorado hunters can participate in both elk and deer hunts during the same season (when the study took place there were three different rifles seasons in which a hunter could purchase both a deer and elk license). Therefore, the hunters are familiar with the idea of purchasing two licenses. The WTP question was asked under two different scenarios: 1) no advanced draw required, and 2) an advanced draw required.

Historic license sales

For this study, historic data for resident deer and elk licenses sales and price in Colorado from 1975 to 1999 were obtained from the CDOW. The substitute goods were measured as the price of nonresident deer and elk licenses in Wyoming. Data on human population, the price of gas, wages, and the consumer price index for these years were obtained from the U.S. Census Bureau and the U.S. Bureau of Labor Statistics. Historic license sales were regressed on license prices, human population, and the price of a substitute.

CHAPTER II. ESTIMATING DEMAND FOR, AND REVENUE FROM, ELK AND DEER HUNTING LICENSES IN COLORADO UNDER DIFFERENT PRICING SCENARIOS

Introduction

The contingent valuation method has become increasingly useful in natural resource management decisions. It has frequently been used to estimate the value of non-market goods such as wildlife (Roach, Loomis, & Motroni, 1996), water resources for recreation (Creel & Loomis, 1992), as well as recreation activities such as hunting (Donnelly & Nelson, 1986; Duffield, 1988; Duffield & Neher, 1990; Sorg & Nelson, 1986) and fishing (Jakus, Dowell, & Murray, 2000). Another common application of this technique is to analyze demand for activities, including visits to a wetland (Kontogianni, Skourtos, Langford, Bateman, & Geourgiou, 2001), participation in pheasant hunting in Colorado (Remington, Manfredo, Vaske, & DeMasso, 1996), and changes in fishing participation (Sutton, Stoll, & Ditton, 2001). The CVM has also been used to estimate the potential to generate funds for natural resource programs through taxes (Barro, Manfredo, Brown, & Peterson, 1996; Jakus, Fly, & Stephens, 1997).

While the CVM has been extensively applied, there are concerns regarding its use (Diamond & Hausman, 1994). There are concerns over designing the survey to ensure the respondents consider substitute goods (Arrow, Solow, Portney, Leamer, Radner, &

Schuman, 1993), whether or not the CVM measures true intentions to pay the stated amount (Cummings, Harrison, & Rutstrom, 1995; Diamond & Hausman, 1994), and if accurate estimates of benefits can be obtained (Ajzen & Peterson, 1988). There are also concerns over the context of how the question is asked or framed (Kahneman & Knetsch, 1992).

These issues are debated in the literature (Hanemann, 1994; Portney, 1994; Smith, 1992), and as research continues to address them, a better understanding of the CVM's utility in the natural resource decision framework is emerging (Barro, Manfredo, Brown, & Peterson, 1996; Giraud, 1999; Harris, Driver, McLaughlin, 1989; Kerr & Manfredo, 1991; Loomis, Brown, Lucero, & Peterson, 1996; Smith, 2000; Whittaker & Vaske, 1998). This study refined applications of the CVM to address issues in natural resource management, specifically implementing recreation fees.

Study Objectives

This study explored several issues regarding the use of the CVM in assisting the implementation of recreation fee programs. These issues included how activities trade off as substitute and compliment goods; how the CVM can be used in pricing and the effects of different payment / allocation methods; and how price affects participants with different motivations for hunting. Deer and elk hunting in Colorado was the area of focus in which these issues were explored.

Substitute / Compliment Goods

Economic theory states that the demand for a good is influenced not only by its own price, but also by the price of other goods. When the price of a good rises relative to other possible goods, consumers may purchase less expensive goods instead. When this switch occurs, the goods are said to be substitute goods. Examples of substitute goods may be two hiking trails with similar attributes in close proximity to each other. In other cases, goods may be purchased together and are referred to as compliment goods (Hyman, 1988). An example of compliment goods would be fly fishing rods and reels. When two goods are compliments, as the price of one good increases, and its demand decreases, demand for the other good also decreases. It has been suggested that substitute goods should be accounted for when analyzing recreation demand (Arrow et al., 1993; Rosenthal, 1987). Usually, two goods are discussed as having either a substitute or complimentary relationship. However, in the case of recreation, it may be possible that two activities or sites may serve as both compliments and substitutes. With respect to deer and elk hunting, both activities can take place at the same time. Thus, the incremental cost of doing the second hunting activity on the same trip is minimal: essentially the cost of the additional license. In this situation, hunters may choose to do both. However, if one fee is increased in relation to the other, some hunters may choose to purchase the less expensive license only. This study examined the substitute and compliment relationship between deer and elk hunting licenses.

Pricing

Achieving the goals of implementing fees for recreation programs depends on the relationship between fees and participation. Estimating price and participation serves two purposes: 1) to estimate how use changes with fees, and 2) to estimate revenue from fees. However, the context in which the payment is collected, or the licenses allocated, also influences participation and revenue. Participation and revenue were estimated at various fees, and the effects of requiring an advanced draw for a license on revenue was examined.

Differing Motivation Groups

The demand for elk hunting licenses was compared among hunter groups for which the most important reason for hunting was meat, trophy, or solitude. These three reasons were developed from previous research that identified different types of motivation for recreation including enjoying nature, escaping physical pressure, and achievement/stimulation (Driver, Tinsley, & Manfredo, 1991; Manfredo, Driver, & Tarrant, 1996). These reasons for hunting were also based on research specific to deer and elk hunting in Colorado that identified hunters with differing motivations and management preferences (Brown, Hautaluoma, & McPhail, 1977; Humphry, 1976). A CVM study of Colorado hunters found that hunters with different motivations varied in their WTP for deer hunts (Miller, Prato, & Young, 1977). Knowing how groups with differing hunting motivations react to prices offers insight into potential opposition to license fee increases and areas where differential license pricing may be appropriate.

Specific Objectives

Objective 1. Examine if the relative prices of deer and elk licenses cause them to serve as substitutes and compliments to each other. This objective has two hypotheses. H1a: At low fees, deer and elk licenses will serve as compliments, and hunters will tend to purchase both licenses. H1b: When the price of a deer [elk] license increases relative to the price of an elk [deer] license, elk [deer] licenses will serve as a substitute.

Objective 2. Examine the price elasticity of demand for deer and elk licenses. It is expected that demand for both deer and elk licenses will initially be inelastic, but will switch to elastic as fees increase. For both licenses, it is expected that a point will be reached where revenue decreases as fees are increased.

Objective 3. Examine the effects of requiring an advanced draw for licenses. Based on research that suggests hunters avoid constraints (Fix, Pierce, & Manfredo, 2001), this objective has two hypotheses. H3a: When a draw is required, demand for licenses will be more elastic than without a draw required. H3b: When a draw is required, revenue will decrease across license fee increases.

Objective 4. Compare hunters with different motivations' responses to license fee increases. Based on Miller, Prato, and Young's (1977) finding that WTP varied by different hunting motivations (with those seeking solitude having a lower WTP than those seeking meat), it is expected that trophy hunters will be the least responsive to price, followed by meat hunters and those interested in solitude. This will tested by the price coefficient from the logistic regression equation. Specifically, x_{1price} trophy < x_{1price} meat < x_{1price} solitude.

Study Area

To test these hypotheses, a study was designed to measure WTP for deer and elk licenses in Colorado. The sale of hunting and fishing licenses is a critical source of revenue for the Colorado Division of Wildlife (CDOW). For example, during the time period from 1996 to 1999, license sales made up 76, 71, 72, and 73 percent of CDOW's revenue, respectively. However, for a variety of reasons, including inflation and a decline in sales of certain licenses, the CDOW projected that revenue would decline over the period from fiscal year 2001-2002 through fiscal year 2003-2004. The CDOW predicts that without a license fee increase, services will have to be cut by $27 million annually by fiscal year 2003-2004 (CDOW, 2000). These cuts in services would likely come from recreation programs, capital construction, and capital improvements (McClosky, 2000, p. 2).

Concurrent to this problem of declining revenue, stakeholders have expressed concerns over too many hunters in the field, especially nonresident hunters, and a lack of quality hunting. For example, the 2000-2004 five-year big game policy season structure adopted limits on the number of nonresident big game hunters and a specific number of units that would be managed for "trophy" animals, with limitations on hunting (CDOW, 1999). Both of these policy adaptations could be achieved through pricing or requiring advanced draws for licenses. However, given the CDOW's current financial status, care must be taken to avoid detrimental impacts to revenue if these strategies are used.

Methods

Survey Design

Price variables

A survey was developed that simultaneously varied the price of an elk hunting license and a deer hunting license. There were 10 different prices for both elk and deer licenses. This survey produced 100 different combinations of license prices. Based on results of an open-ended WTP pretest, the values of the elk licenses ranged from $35 to $280 for residents and from $260 to $750 for nonresidents. The values of the deer licenses ranged from $25 to $170 for residents and $160 to $400 for nonresidents. When the study was conducted, the prices for elk licenses were $30 and $250 for residents and nonresidents, respectively, and $20 and $150 for resident and nonresident deer licenses, respectively.

WTP question

After being presented with a randomly assigned deer and elk license fee increase, the respondents were asked if they would purchase a 1) deer license, 2) an elk license, 3) both a deer and elk license, or 4) neither. When the study took place, hunters could hunt both deer and elk in one of three rifle seasons. Thus, the hunters were familiar with the idea of purchasing both licenses. Two questions were asked of each respondent to assess willingness to pay. The first asked WTP for deer and elk licenses under a scenario in which no advanced draw is required to purchase a license, the second asked WTP under a scenario in which an advanced draw was required.

Motivations

To measure the different hunter motivations, the respondents were asked, "We would like you to rank, among 3 factors, what is the most important to you when big game hunting in Colorado: few contacts with other hunters, obtaining meat, or harvesting a trophy animal?" The respondents were also asked their second and least most important factors. The motivation groups were created from the respondents' most important reason for big game hunting in Colorado.

Data gathering

A systematic random sample of 6,785 resident and nonresident hunters who had purchased a deer or elk license in 1996 was drawn from CDOW records. The survey was administered by telephone. The respondents were called during 1997. The respondents were asked questions regarding past participation, willingness to pay for license increases, and the importance of different aspects of the hunting experience in Colorado. The survey took approximately 12 minutes to complete.

Data Analysis

The goal of this analysis is to examine the effect of license fees on willingness to pay for a license. Regression analysis is one tool to examine this relationship.
In such an analysis, the willingness to pay for a license is the dependent variable.
The general form of the equation is as follows:

$$\text{WTP} = f(\text{price, factors economic theory predicts affect demand})$$

Factors that theory predicts affect demand include income, the price of substitutes, compliments, motivations for participating, and human population of the region. This relationship is essentially an inverse demand function because price is the dependent variable rather than quantity.

Logistic regression

For the logistic regression analysis, the willingness-to-pay question format was collapsed into dichotomous choice, that is, would respondents purchase a license or not at a given fee. Therefore, the dependent variable was coded as a dummy variable, with a "1" indicating the respondent would purchase a license, and a "0" indicating the respondent would not purchase a license. When the dependent variable is coded 0 / 1, one of the appropriate regression analysis techniques is logistic regression (Greene, 1997). The general form of the logistic model is as follows:

$$\text{Probability of a "yes"} = \frac{1}{e^{-b0+b1X1+b2X2+\ldots+bnXn}}$$

Where $b1 \ldots bn$ are the coefficients and $X1 \ldots Xn$ are the variables included in the model.

Logistic regression was used to estimate the relationship between license sales and price. This technique was used to test deer and elk licenses as substitutes and compliments, estimate participation and revenue, calculate elasticities, and test the effects of different hunter motivations on the relationship between price and demand for licenses. The specific model used for this study is as follows:

$$\text{Probability of purchasing a license} = \frac{1}{1+e^{-(\text{constant} + x1 \cdot \text{elk license fee increase} + x2 \cdot \text{price of substitute})}}$$

Crosstabs

For hypothesis 1, crosstabs were used to compare responses to the willingness-to-pay question across relative differences in the deer and elk fees and the magnitude of the fees. There were 10 different fees for deer and elk licenses creating a 10 x 10 matrix for both residents and nonresidents. The matrix was split into quadrants based on the relative prices of the licenses (Table 2.1). The quadrants shown in Table 2.1 were based on the mid-points of the bid amounts.

Table 2.1. Quadrants for Matrix of Bid Amounts to Test for Relative Effects of Price

<table>
<tr><th></th><th colspan="10">Elk Bid Amount (nonresident in parentheses)</th></tr>
<tr><th>Deer $</th><th>5(10)[a]</th><th>10(30)</th><th>20(40)</th><th>30(50)</th><th>40(70)</th><th>50(80)</th><th>70(100)</th><th>100(150)</th><th>150(300)</th><th>250(500)</th></tr>
<tr><td>5 (10)[b]</td><td colspan="5" rowspan="5">Quadrant 1, elk and deer $ relatively low</td><td colspan="5" rowspan="5">Quadrant 3. elk $ high, deer $ low</td></tr>
<tr><td>10 (20)</td></tr>
<tr><td>15 (30)</td></tr>
<tr><td>20 (40)</td></tr>
<tr><td>30 (50)</td></tr>
<tr><td>40 (60)</td><td colspan="5" rowspan="5">Quadrant 2, deer $ high, elk $ low</td><td colspan="5" rowspan="5">Quadrant 4, both elk and deer $ relatively high</td></tr>
<tr><td>50 (70)</td></tr>
<tr><td>70 (100)</td></tr>
<tr><td>100 (150)</td></tr>
<tr><td>150 (250)</td></tr>
</table>

a. These are the license fee *increases* that respondents were asked to evaluate. The license fees are calculated by adding $30 to the resident elk licenses, $250 to the nonresident elk licenses, $20 to resident deer licenses, and $150 to the nonresident deer licenses.
b. This column presents the deer bid amounts, with the nonresident bids in parentheses.

If deer and elk licenses serve as both compliments and substitutes, one might expect the following: at the price combinations in quadrant 1, the majority of hunters will purchase both an elk and deer license; at combinations in quadrant 2, hunters should purchase relatively more elk licenses and fewer deer licenses; in quadrant 3, hunters should purchase relatively more deer licenses and fewer elk licenses; and in quadrant 4 hunters will be more likely to state they would purchase neither.

Elasticity

To explore objectives 2 and 3, the elasticity of demand was calculated. The following "arc" elasticity formula was used to calculate elasticity:

$$\text{Price elasticity} = \frac{\text{Change in quantity} \div \text{Original quantity}}{\text{Change in price} \div \text{Original price}}$$

The change in quantity was obtained from the results of the logistic regression and corresponds to the change in price. With this formula, the elasticity was calculated for each price increase.

Results

Of the 6,785 hunters sampled, 2,012 residents and 2,099 nonresidents completed the telephone survey. Adjusting for non-working telephone numbers, using the Council of American Survey Research Organizations' response rate formula resulted in a response rate of 76 percent (Frankel, 1982). A nonresponse test was conducted of those who did not respond. The nonresponse test consisted of two questions: gender and participation in 1996. No difference between respondents and nonrespondents was found for nonresidents. For residents, respondents were more likely to have hunted in 1996. However, because of the high response rate, the data were not weighted (Babbie, 1992, p. 267).

Objective 1: Influence of Relative License Prices on Substitute / Compliment Relationship

To examine how the relative prices of deer and elk licenses influence the demand of one to the other, logistic regression was used to determine if the price of one (i.e., the price of deer license) influences demand for the other (i.e., elk license sales). A variable representing the ratio of the license prices was also tested with logistic regression. It is possible to include such a variable because the price of both an elk license and deer license were varied. Since the definition of substitute goods relates to relative price of the goods, the ratio of prices may be a better measure of substitute than using only the price of the substitute good.

Elk hunting

The coefficients from the logistic regression quantify the effect the independent variables (license fee, substitutes) have on the probability of purchasing a license. For resident and nonresident elk, the coefficient on the price variable was negative and significant, indicating a downward sloping demand curve consistent with economic theory. However, the price of a deer license was not significant in predicting the number of resident elk licenses sold. The price of a deer license was significant in predicting the number of nonresident elk licenses sold, indicating nonresident deer and elk licenses are substitutes (Table 2.2). The ratio of the price of a deer license to the price of an elk license was significant in predicting the number of resident and nonresident elk licenses sold (Table 2.3). This finding indicates that as the price of deer licenses become more expensive relative to elk licenses, elk licenses sales increase. This increase indicates that elk licenses substitute for deer licenses. That is, as deer licenses become relatively more expensive, hunters will purchase more elk licenses.

Table 2.2. Logistic Regression for Resident and Nonresident Elk License Fee Increase, with Price of Deer License as the Substitute Variable

		Coefficient	Std. error	Wald-stat[1]	Prob.
Residents[2]	Price elk lic.	-.017	.001	224	<.001
	Price deer lic.	.001	.001	.42	.517
	Constant	.661	.093	50	<.001
Nonresidents[3]	Price elk lic.	-.008	.001	231	<.001
	Price deer lic.	.001	.001	4.2	.039
	Constant	.842	.088	92	<.001

1. The Wald-statistic is used by SPSS to test the null that the coefficient is equal to zero. The Wald-statistic has a Chi-square distribution and is equivalent to the square of the t-statistic.
2. $R^2 = .17$, $n = 1936$
3. $R^2 = .17$, $n = 2026$

Table 2.3. Logistic Regression for Resident and Nonresident Elk License Fee Increase, with Ratio of Deer License Price to Elk License Price as the Substitute Variable

		Coefficient	Std. error	Wald-stat[1]	Prob.
Residents[2]	Price elk lic.	-.015	.001	151	<.001
	Ratio deer / elk	.073	.016	21	<.001
	Constant	.399	.095	17	<.001
Nonresidents[3]	Price elk lic.	-.007	.001	184	<.001
	Ratio deer / elk	.058	.02	8.5	.003
	Constant	.796	.086	86	<.001

1. The Wald-statistic is used by SPSS to test the null that the coefficient is equal to zero. The Wald-statistic has a Chi-square distribution and is equivalent to the square of the t-statistic.
2. $R^2 = .18$, $n = 1936$
3. $R^2 = .18$, $n = 2026$

Deer hunting

These methods were also applied to resident and nonresident deer hunting. Deer license sales also exhibited a downward sloping demand curve. For the resident deer license fee increase, the price of a resident elk license was negative and significant (Table 2.4). This finding indicates deer hunting is complimentary to elk hunting, meaning that as elk licenses increase in price, and fewer elk licenses are sold, fewer deer licenses are sold. The ratio of the price of a deer license to the price of an elk license was not significant (Table 2.5).

Table 2.4. Logistic Regression for Resident and Nonresident Deer License Fee Increase, with Price of Elk License as the Substitute Variable

		Coefficient	Std. error	Wald-stat[1]	Prob.
Residents[2]	Price deer lic.	-.027	.002	201	<.001
	Price elk lic.	-.002	.001	5.3	.021
	Constant	.478	.096	24	<.001
Nonresidents[3]	Price deer lic.	-.01	.001	110	<.001
	Price elk lic.	.000	.000	.235	.628
	Constant	.077	.087	.765	.382

1. The Wald-statistic is used by SPSS to test the null that the coefficient is equal to zero. The Wald-statistic has a Chi-square distribution and is equivalent to the square of the t-statistic.
2. $R^2 = .15$, n = 1936
3. $R^2 = .07$, n = 2026

Table 2.5. Logistic Regression for Resident and Nonresident Deer License Fee Increase, with Ratio of Deer License Price to Elk License Price as the Substitute Variable

		Coefficient	Std. error	Wald-stat[1]	Prob.
Residents[2]	Price deer lic.	-.028	.002	162	<.001
	Ratio deer / elk	.015	.020	.566	.452
	Constant	.354	.080	20	<.001
Nonresidents[3]	Price elk lic.	-.01	.001	83	<.001
	Ratio deer / elk	-.011	.023	.251	.616
	Constant	.055	.075	.54	.463

1. The Wald-statistic is used by SPSS to test the null that the coefficient is equal to zero. The Wald-statistic has a Chi-square distribution and is equivalent to the square of the t-statistic.
2. $R^2 = .15$, n = 1936
3. $R^2 = .07$, n = 2026

Mixed conclusions arise from the results of the logistic regression. The price of a deer license was not significant in the resident elk equation, but it was in the nonresident elk equation. The ratio of the deer to elk license price was significant in both the resident and nonresident elk equations. In the three equations in which the deer hunting substitute variable was significant in predicting elk licenses, the coefficient's sign was positive. However, when predicting deer licenses, the elk hunting substitute variable was only significant in the resident equation. In this equation, the sign on the elk price was negative.

Analysis of change in license purchase patterns

When analyzing license purchase patterns, the logistic regression analyzes only whether or not a hunter would purchase a deer or elk license based on its price, holding other factors such as the price of substitutes constant. However, the WTP question used in the survey presented the respondents with different prices for deer and elk licenses and allowed them to purchase a deer license, an elk license, both an elk license and deer license, or neither. An alternative method to the examination of compliments and substitutes is to analyze how the pattern of responses to the WTP question changes as the relative prices change. This analysis was done by collapsing the 100 price combinations into four levels: 1) both elk and deer prices low, 2) deer price high, elk price low, 3) elk price high, deer price low, and 4) both prices high.

A chi-square test was used to test similarity of the response categories of purchasing a deer license only, purchasing an elk license only, purchasing both a deer and elk license, or purchasing neither across the 4 categories of license fees. The chi-square tests the equality of percentages in each response category (Glass & Hopkins, 1996).

For residents, the chi-square test indicates the responses differed across response categories ($X^2 = 627$, $p < .001$) (Table 2.6). When both deer and elk licenses were relatively low, the majority indicated they would purchase both an elk and deer license (39 percent). When deer licenses became relatively more expensive than elk licenses, more hunters indicated they would purchase an elk license only (45 percent) as compared to when both licenses were relatively low. This change was caused by hunters substituting an elk license for a deer license. When elk licenses became relatively more expensive than deer licenses, 27 percent of hunters indicated they would purchase only a deer license and 50 percent of hunters indicated they would purchase neither. This finding suggests that while there are some hunters who will substitute a deer hunt for an elk hunt, there is a group of hunters who feel deer hunting is not a good substitute for elk hunting. When both elk and deer licenses were relatively expensive, a large majority (74 percent) indicated they would purchase neither an elk or deer license (Table 2.6). In addition, the total percentages purchasing an elk and deer license, as shown in the last two columns of Table 2.6, indicate that hunters tend to purchase both an elk and deer license when both are priced low, but substitute with the lower-priced license when a deer or elk license increases in price relative to the other.[3]

[3] The Crosstab analysis was also conducted using the fee increase in which greater than 50 percent of respondents said "no" as the breakpoint. The chi-square statistic was also significant at $p = < .001$ and the percentages purchasing each license were similar.

Table 2.6. Response Pattern Across Relative License Prices for Residents

	Respondent would purchase[1] ...				Total purchasing a	
	Deer license only	Elk license only	Both a Deer and elk license	Neither a deer or elk license	Elk license	Deer license
Deer and elk $ low[2]	13%	18%	**39%**	30%	57%	52%
Deer $ high, elk $ low[3]	1%	**45%**	15%	39%	60%	16%
Deer $ low, elk $ high[4]	**27%**	7%	16%	50%	23%	43%
Deer and elk $ high[5]	4%	12%	10%	**74%**	22%	14%

1. $X^2 = 627, p < .001$ (Note. the total % purchasing a license was not included in the Chi-square test.)
2. Deer license fee $25 to $50; elk license fee $35 to $70.
3. Deer license fee $65 to $170; elk license fee $35 to $70.
4. Deer license fee $25 to $50; elk license fee $80 to $280.
5. Deer license fee $65 to $170; elk license fee $80 to $280.

For nonresidents a similar pattern emerged. The chi-square test indicated the responses differed across response categories ($X^2 = 351, p = < .001$) (Table 2.7). When both elk and deer license prices are low, 34 percent indicated they would purchase both licenses. When deer licenses became more expensive than elk licenses, 46 percent indicated they would purchase an elk license only. When elk license prices became relatively more expensive than deer licenses, 25 percent indicated they would purchase a deer license only. When both elk and deer license prices were high, the majority indicated they would purchase neither (Table 2.7). In addition, the total percentage of hunters purchasing an elk and deer license, as shown in the last two columns of Table 2.7, indicates that hunters tend to purchase both an elk and deer license when both are priced low, but substitute with the lower priced license when a deer or elk license increases in price relative to the other.

Table 2.7. Response Pattern Across Relative License Prices for Nonresidents

	Respondent would purchase[1]...				*Total purchasing a*	
	Deer license only	Elk license only	Both a deer and elk license	Neither a deer or elk license	Elk license	Deer license
Deer and elk $ low[2]	11%	31%	**34%**	24%	65%	45%
Deer $ high, elk $ low[3]	3%	**46%**	19%	32%	65%	22%
Elk $ high, deer $ low[4]	**25%**	13%	18%	44%	31%	43%
Deer and elk $ high[5]	9%	22%	15%	**54%**	37%	24%

1. $X^2 = 351, p < .001$ (Note, the total % purchasing a license was not included in the Chi-square test.)
2. Deer license fee $160 to $200; elk license fee $260 to $320.
3. Deer license fee $210 to $400; elk license fee $260 to $320.
4. Deer license fee $160 to $200; elk license fee $330 to $750.
5. Deer license fee $210 to $400; elk license fee $330 to $750.

For both resident and nonresidents, it appears that elk licenses have a stronger demand than deer licenses. This finding is indicated by the fact that even as elk licenses become relatively expensive, there is still a percentage of hunters who would purchase only an elk license. In contrast, as the relative price of a deer license increases, its demand drops to close to zero. Also, there seems to be a relatively stable group of hunters, approximately 10 percent to 20 percent, who would purchase both a deer and elk license irrespective of the price. The results of the crosstabs lend stronger support for both hypothesis H1a and H1b. It appears, then, that a complex relationship exists between elk and deer licenses. It may be possible that regression is not able to measure this complex relationship because it must quantify the relationship across the range of the data.

Objective 2: Examining the Price Elasticity of Demand for Deer and Elk Licenses

To examine this objective, the price elasticity of demand was calculated by applying the arc elasticity formula to estimates of license sales and the corresponding revenue at different license fees.

To calculate participation and revenue, the results of the logistic regression were used to calculate the probability of purchasing a license. This probability was then applied to the baseline number of licenses sold when the study took place. These numbers were 130,660 and 104,500 for elk and deer hunting, respectively. The following formula was used to calculate the percent of hunters purchasing a license at different license fees for resident elk hunters:

[1] $$\text{Probability of purchasing a license} = \frac{1}{1 + e^{-(.399 - .015 \cdot \text{elk license fee increase} + .073 \cdot \text{deer/elk ratio})}}$$

and for nonresident elk licenses:

[2] $$\text{Probability of purchasing a license} = \frac{1}{1 + e^{-(.796 - .007 \cdot \text{elk license fee increase} + .058 \cdot \text{deer/elk ratio})}}$$

For resident deer licenses the formula is as follows:

[3] $$\text{Probability of purchasing a license} = \frac{1}{1 + e^{-(.478 - .027 \cdot \text{deer license fee increase} - .002 \cdot \text{elk license fee increase})}}$$

and for nonresident deer licenses:

[4] $$\text{Probability of purchasing a license} = \frac{1}{1 + e^{-(-.01 \cdot \text{deer license fee increase})}}$$

The deer/elk price ratio used in the elk equations was .66 for resident and .60 for nonresidents. This ratio reflects the current price ratios. For consistency with the resident elk model, the nonresident equation with the deer / elk price ratio as the substitute variable was used for the estimates. A calibration factor was calculated to account for unexplained variance in the regression equation. This factor was calculated by dividing the baseline license sales by the prediction of license sales at a fee increase of zero. The calibration factor was multiplied by the license sales predicted by the model at the various fees levels (Table 2.8).

Table 2.8. Prediction of Participation and Revenue for Resident and Nonresident Elk License Fee Increases in Colorado, from Logistic Regression, no Draw Required

Residents			Nonresidents		
License Fee	Participation	Revenue	License Fee	Participation	Revenue
$35	126,808	$4,438,288[1]	$260	94,390	$24,541,424
$40	122,903	$4,916,118	$280	90,079	$25,222,209
$50	114,973	$5,748,636	$290	87,853	$25,477,226
$60	106,955	$6,417,289	$300	85,583	$25,675,034
$70	98,939	$6,925,702	$320	80,937	$25,899,808
$80	91,013	$7,281,070	$330	78,569	$25,927,895
$100	75,769	$7,576,946	$350	73,773	$25,820,464
$130	55,418	$7,204,288	$400	61,692	$24,676,729
$180	30,318	$5,457,160	$550	30,390	$16,714,235
$280	7,602	$2,128,442	$750	8,979	$6,734,513

1. The participation estimates from the logistic regression included fractions. The revenue was calculated from a spreadsheet that used the fractions of participation.

Across all fee increases, participation declines. However, revenue initially increases then decreases. For resident elk, revenue is maximized ($7,576,946) at a fee of approximately $100. For nonresident elk, revenue is maximized ($25,927,895) at a fee of $330. At fee levels greater than these, revenue will actually start to decline. A similar pattern of participation and revenue was found for deer hunting (Table 2.9). For residents deer revenue is maximized at a fee of approximately $60 and for nonresidents at $180.

Table 2.9. Prediction of Participation and Revenue for Resident and Nonresident Deer License Fee Increases in Colorado, from Logistic Regression, no Draw Required

Residents			Nonresidents		
License Fee	Participation	Revenue	License Fee	Participation	Revenue
$25	98,830	$2,470,740[1]	$160	68,474	$10,955,788
$30	93,051	$2,791,522	$170	64,891	$11,031,516
$35	87,214	$3,052,493	$180	61,344	$11,041,984
$40	81,372	$3,254,892	$190	57,850	$10,991,463
$50	69,883	$3,494,161	$200	54,423	$10,884,698
$60	58,976	$3,538,538	$210	51,080	$10,726,797
$70	48,964	$3,427,514	$220	47,832	$10,523,125
$90	32,349	$2,911,398	$250	38,770	$9,692,577
$120	16,055	$1,926,658	$300	26,300	$7,889,885
$170	4,470	$759,820	$400	10,937	$4,374,970

1. The participation estimates from the logistic regression included fractions. The revenue was calculated from a spreadsheet that used the fractions of participation.

Comparing elasticity of demand

The price elasticity of demand was calculated from the estimates of participation and revenue from the arc elasticity formula (Table 2.10).

Table 2.10. Price Elasticity of Demand for Elk and Deer Hunting Licenses in Colorado

Fee / Price elasticity of demand							
Resident elk		Nonresident elk		Resident deer		Nonresident deer	
Fee	*E*[1]	Fee	*E*	Fee	*E*	Fee	*E*
$35	-0.18	$260	-0.54	$25	-0.22	$160	-0.75
$40	-0.22	$280	-0.59	$30	-0.29	$170	-0.84
$50	-0.26	$290	-0.69	$35	-0.38	$180	-0.93
$60	-0.35	$300	-0.75	$40	-0.47	$190	-1.03
$70	-0.45	$320	-0.81	$50	-0.56	$200	-1.13
$80	-0.56	$330	-0.94	$60	-0.78	$210	-1.23
$100	-0.67	$350	-1.01	$70	-1.02	$220	-1.34
$130	-0.90	$400	-1.15	$90	-1.19	$250	-1.39
$180	-1.18	$550	-1.35	$120	-1.51	$300	-1.61
$280	-1.35	$750	-1.94	$170	-1.73	$400	-1.75

1. *E* refers to the price elasticity of demand

All four licenses exhibit the pattern of starting off as inelastic and becoming elastic as fees increase. This pattern indicates that initially revenue will increase with a fee increase, but a point will be reached where revenue will actually start to decline, consistent with the estimates of revenue. The nonresident licenses become inelastic at a relatively smaller fee increase. Nonresident deer licenses become inelastic at a fee increase of $40. This finding indicates that nonresident licenses, especially for deer, are more sensitive to fee increases. This sensitivity could be due in part to a large range of substitutes available for nonresident licenses, such as white tail deer hunting in many of the nonresidents' home state. In addition, since deer hunting may be commonplace to many nonresident hunters, the activity may not have as high of importance as elk hunting.

Objective 3: Examining how Demand and Revenue Change when a Draw is Required

Results of logistic regression when draw is required

To estimate license sales and revenue when an advanced draw was required, the logistic regression was estimated with the WTP responses when a draw was required. To be consistent with the equations used to estimate license sales when a draw was not required, for elk the ratio of the price of a deer license to elk license was used as the substitute variable (Table 2.11). For deer licenses, neither substitute variable was significant in the equations (Table 2.12).

Table 2.11. Logistic Regression for Elk Licenses when a Draw is Required

		Coefficient	Std. error	Wald-stat[1]	Prob.
Residents[2]	Price elk lic.	-.013	.001	130	<.001
	Ratio deer / elk	.066	.015	20	<.001
	Constant	.197	.093	4.4	.035
Nonresidents[3]	Price elk lic.	-.006	.001	121	<.001
	Ratio deer / elk	.042	.016	6.6	.01
	Constant	.154	.083	3.5	.06

1. The Wald-statistic is used by SPSS to test the null that the coefficient is equal to zero. The Wald-statistic has a Chi-square distribution and is equivalent to the square of the t-statistic.
2. R^2 = .16, n=1935
3. R^2 = .12, n=2005

Table 2.12. Logistic Regression for Deer Licenses when a Draw is Required

		Coefficient	Std. error	Wald-stat[1]	Prob.
Residents[2]	Price deer lic.	-.024	.002	160	<.001
	Constant	.034	.08	.18	.67
Nonresidents[3]	Price deer lic.	-.007	.001	57	<.001
	Constant	-.53	.079	45	<.001

1. The Wald-statistic is used by SPSS to test the null that the coefficient is equal to zero. The Wald-statistic has a Chi-square distribution and is equivalent to the square of the t-statistic.
2. R^2 = .12, n=1935
3. R^2 = .04, n=2005

To predict revenue and participation when a draw was required, the following formula was used for resident elk:

[5] Probability of purchasing a license =

$$\frac{1}{1 + e^{-(.197 - .013 \cdot \text{elk license fee increase} + .066 \cdot \text{deer/elk ratio})}}$$

and for nonresident elk licenses:

[6] Probability of purchasing a license =

$$\frac{1}{1 + e^{-(.154 - .006 \cdot \text{elk license fee increase} + .042 \cdot \text{deer/elk ratio})}}$$

For resident deer licenses the formula was as follows:

[7] Probability of purchasing a license =

$$\frac{1}{1 + e^{-(-.024 \cdot \text{deer license fee increase})}}$$

and for nonresident deer:

[8] Probability of purchasing a license =

$$\frac{1}{1 + e^{-(-53 - 007 \cdot \text{deer license fee increase})}}$$

Elasticity when draw is required

The price elasticity of demand was calculated for elk licenses when a draw was required. The patterns of elasticities are similar to when a draw was not required (Table 2.13). The elasticites for deer when a draw was required also showed a similar pattern to when a draw was not required (Table 2.14).

Table 2.13. Price Elasticity of Demand for Elk Hunting Licenses in Colorado

Residents			Nonresidents		
License Fee	Fee increase only	Fee increase plus draw	License Fee	Fee increase only	Fee increase plus draw
$35	-0.18	-0.21	$260	-0.54	-0.68
$40	-0.22	-0.21	$280	-0.59	-0.74
$50	-0.26	-0.25	$290	-0.69	-0.84
$60	-0.35	-0.33	$300	-0.75	-0.90
$70	-0.45	-0.42	$320	-0.81	-0.95
$80	-0.56	-0.51	$330	-0.94	-1.07
$100	-0.67	-0.61	$350	-1.01	-1.13
$130	-0.90	-0.80	$400	-1.15	-1.22
$180	-1.18	-1.05	$550	-1.35	-1.32
$280	-1.35	-1.25	$750	-1.94	-1.81

Table 2.14. Price Elasticity of Demand for Deer Hunting Licenses in Colorado

Residents			Nonresidents		
License Fee	Fee increase only	Fee increase plus draw	License Fee	Fee increase only	Fee increase plus draw
$25	-0.22	-0.23	$160	-0.75	-0.65
$30	-0.29	-0.32	$170	-0.84	-0.72
$35	-0.38	-0.40	$180	-0.93	-0.78
$40	-0.47	-0.49	$190	-1.03	-0.84
$50	-0.56	-0.57	$200	-1.13	-0.91
$60	-0.78	-0.77	$210	-1.23	-0.97
$70	-1.02	-0.98	$220	-1.34	-1.04
$90	-1.19	-1.12	$250	-1.39	-1.07
$120	-1.51	-1.41	$300	-1.61	-1.22
$170	-1.73	-1.63	$400	-1.75	-1.37

The elasticity of demand relates to the slope of the demand curve. The steeper the demand curve, the more inelastic is demand. A change in elasticity would indicate a change in the slope of the demand curve. The slope of the demand curve when a draw is not required appears to be similar to the slope of the demand curve when a draw is required. However, it is possible that while the slope of the demand curve stayed the same, the whole curve may have shifted inward. If this is the case, revenue will be lower at all fee increases. This possibility can be explored in two ways: 1) by pooling the data and including a dummy variable for when a draw was required to test for an intercept shift, and 2) by examining the predicted revenue when a draw is required. For both resident and nonresident elk, the dummy for a draw is significant, indicating the demand curve shifted (Table 2.15). Resident and nonresident deer also showed a shift in the demand curve (Table 2.16). For elk, requiring a draw does lower revenue, and the magnitude of this decrease is much greater for nonresident licenses (Table 2.17). For deer licenses, requiring an advanced draw also lowers revenue, again with a larger impact for nonresident revenue (Table 2.18). In fact, when a draw is required for nonresidents, revenue is below the baseline revenue - $24,116,750 and $10,811,100 - for elk and deer, respectively, at all fee increases.

Table 2.15. Testing Shift of Colorado Elk Hunting Demand Curve when a Draw is Required

		Coefficient	Std. error	Wald-stat[1]	Prob.
Residents[2]	Price elk lic.	-.014	.001	282	<.001
	Ratio deer / elk	.069	.011	41	.032
	Draw dummy variable[3]	-.154	.072	4.6	<.001
	Constant	.376	.076	24.7	<.001
Nonresident[4]	Price elk lic.	-.007	<.001	308	<.001
	Ratio deer / elk	.048	.013	15	<.001
	Draw dummy variable	-.557	.069	65	<.001
	Constant	.76	.069	120	<.001

1. The Wald-statistic is used by SPSS to test the null that the coefficient is equal to zero. The Wald-statistic has a Chi-square distribution and is equivalent to the square of the t-statistic.
2. R^2 = .17, n = 3871
3. The dummy variable was coded "0" for no draw and "1" for when a draw was required.
4. R^2 = .16, n = 4031

Table 2.16. Testing Shift of Colorado Deer Hunting Demand Curve when a Draw is Required

		Coefficient	Std. error	Wald-stat[1]	Prob.
Residents[2]	Price deer lic.	-.026	.001	361	<.001
	Price elk lic.	-.001	.001	5	.024
	Draw dummy variable[3]	-.222	.075	9	.003
	Constant	.392	.078	25	<.001
Nonresident[4]	Price elk lic.	-.009	.001	167	<.001
	Draw dummy variable	-.430	.071	37	<.001
	Constant	-.017	.004	.07	.788

1. The Wald-statistic is used by SPSS to test the null that the coefficient is equal to zero. The Wald-statistic has a Chi-square distribution and is equivalent to the square of the t-statistic.
2. R^2 = .14, n = 3871
3. The dummy variable was coded "0" for no draw and "1" for when a draw was required.
4. R^2 = .06, n = 4031

Table 2.17. Comparison of Revenue when an Advanced Draw is Required for Elk Licenses in Colorado

Residents			Nonresidents		
License Fee	No Draw	Draw	License Fee	No Draw	Draw
$35	$4,438,288	$4,076,888	$260	$24,541,424	$18,215,022
$40	$4,916,118	$4,520,800	$280	$25,222,209	$18,506,748
$50	$5,748,636	$5,303,245	$290	$25,477,226	$18,592,681
$60	$6,417,289	$5,947,114	$300	$25,675,034	$18,640,041
$70	$6,925,702	$6,456,740	$320	$25,899,808	$18,623,984
$80	$7,281,070	$6,838,605	$330	$25,927,895	$18,563,341
$100	$7,576,946	$7,254,016	$350	$25,820,464	$18,344,553
$130	$7,204,288	$7,168,994	$400	$24,676,729	$17,309,849
$180	$5,457,160	$5,909,389	$550	$16,714,235	$12,009,702
$280	$2,128,442	$2,819,937	$750	$6,734,513	$5,576,661

Table 2.18. Comparison of Revenue when an Advanced Draw is Required for Deer Licenses in Colorado

Residents			Nonresidents		
License Fee	No draw	Draw	License Fee	No draw	Draw
$25	$2,470,740	$2,036,466	$160	$10,955,788	$8,172,798
$30	$2,791,522	$2,289,105	$170	$11,031,516	$8,295,300
$35	$3,052,493	$2,492,756	$180	$11,041,984	$8,381,308
$40	$3,254,892	$2,649,881	$190	$10,991,463	$8,433,032
$50	$3,494,161	$2,837,033	$200	$10,884,698	$8,452,743
$60	$3,538,538	$2,879,217	$210	$10,726,797	$8,442,744
$70	$3,427,514	$2,808,324	$220	$10,523,125	$8,405,351
$90	$2,911,398	$2,450,604	$250	$9,692,577	$8,151,704
$120	$1,926,658	$1,730,072	$300	$7,889,885	$7,386,952
$170	$759,820	$783,867	$400	$4,374,970	$5,351,515

The expected relationships in objective three were partially supported. Although the elasticities did not differ when an advanced draw was required, indicating general patterns of participation are similar, revenue did decline. Rather than a change in the slope of the demand curve, the demand curve shifted inward. This shift indicates that some hunters will not participate when a draw is required irrespective of the fee charged.

Objective 4: Comparison of Different Hunting Motivations and WTP

To examine how hunting motivations affect the responsiveness to price, the respondents were placed into one of three motivation groups based on the responses to the following question: "We would like you to rank, among 3 factors, what is most important to you when big-game hunting in Colorado: few contacts with other hunters, obtaining meat, or harvesting a trophy animal?" The groups used for the analysis were labeled trophy, solitude, and meat.

Comparison of different elk hunter types

The logistic regression was estimated for each of the three resident elk-hunter groups for the scenario of a fee increase only (Table 2.19).

Table 2.19. Logistic Regression for Different Resident Elk Hunter Groups, Fee Increase Only

		Coefficient	Std. error	Wald-stat[1]	Prob.	n	R^2
Solitude	Price elk lic.	-.016	.002	67	<.001	557	.17
	Constant	.91	.136	45	<.001		
Meat	Price elk lic.	-.019	.002	133	<.001	1159	.18
	Constant	.64	.101	41	<.001		
Trophy	Price elk lic.	-.017	.004	24	<.001	164	.2
	Constant	1.1	.266	17	<.001		

1. The Wald-statistic is used by SPSS to test the null that the coefficient is equal to zero. The Wald-statistic has a Chi-square distribution and is equivalent to the square of the t-statistic.

The coefficient on the price variable was used to test if the groups respond differently to price. The larger the coefficient, the larger the change in license sales as fees increase. The price coefficients for the three different hunter types were not statistically different (Table 2.20). This finding indicates the effect of fees on license sales is the same across groups.

Table 2.20. 95 percent Confidence Intervals Around Price Variable for Four Resident Elk Hunter Groups

	Lower bound	Coefficient	Upper bound
All groups pooled	-.019	-.017	-.015
Solitude	-.019	-.016	-.012
Meat	-.023	-.019	-.015
Trophy	-.025	-.017	-.009

The different nonresident elk hunter groups were also compared (Table 2.21). The coefficients for the different non-resident hunter types differed from the residents,' reflecting differences in the slope of the demand curve. However, the coefficients were the same across the hunters in the different non-resident elk groups (Table 2.22).

Table 2.21. Logistic Regression for Different Nonresident Elk Hunter Groups, Fee Increase Only

		Coefficient	Std. error	Wald-stat[1]	Prob.	n	R^2
Solitude	Price elk lic.	-.008	.001	75	<.001	637	.18
	Constant	1.09	.125	75	<.001		
Meat	Price elk lic.	-.009	.001	60	<.001	539	.18
	Constant	1.03	.142	52	<.001		
Trophy	Price elk lic.	-.007	.001	90	<.001	770	.17
	Constant	.909	.111	67	<.001		

1. The Wald-statistic is used by SPSS to test the null that the coefficient is equal to zero. The Wald-statistic has a Chi-square distribution and is equivalent to the square of the t-statistic.

Table 2.22. 95% Confidence Intervals Around Price Variable for Four Nonresident Elk Hunter Groups

	Lower bound	Coefficient	Upper bound
All groups pooled	-.01	-.008	-.006
Solitude	-.01	-.008	-.006
Meat	-.01	-.009	-.007
Trophy	-.009	-.007	-.005

Comparison of different deer hunter types

The same analysis of different hunting motivations was applied to deer hunters. The logistic model was estimated for each of the three resident deer hunter groups (Table 2.23) as well as nonresident deer hunters (Table 2.24). The price coefficients for the three different resident and nonresident deer hunter types were not statistically different, indicating the responsiveness to price is the same across the groups (Table 2.25, Table 2.26).

Table 2.23. Logistic Regression for Different Resident Deer Hunter Groups, Fee Increase Only

		Coefficient	Std. error	Wald-stat[1]	Prob.	n	R^2
Solitude	Price deer lic.	-.03	.004	69	<.001	557	.18
	Price elk lic.	-.001	.001	.45	.5		
	Constant	.813	.177	21	<.001		
Meat	Price deer lic.	-.027	.003	110	<.001	1159	.15
	Price elk lic.	-.003	.001	7	.006		
	Constant	.339	.128	7	.008		
Trophy	Price deer lic.	-.022	.005	16.6	<.001	164	.14
	Price elk lic.	.001	.002	.053	.817		
	Constant	.455	.323	1.9	.16		

1. The Wald-statistic is used by SPSS to test the null that the coefficient is equal to zero. The Wald-statistic has a Chi-square distribution and is equivalent to the square of the t-statistic.

Table 2.24. Logistic Regression for Different Nonresident Deer Hunter Groups, Fee Increase Only

		Coefficient	Std. error	Wald-stat[1]	Prob.	n	R^2
Solitude	Price Deer lic.	-.012	.002	38	<.001	637	.08
	Constant	.155	.139	1.2	.26		
Meat	Price Deer lic.	-.013	.002	34	<.001	539	.09
	Constant	-.03	.156	.037	.847		
Trophy	Price Deer lic.	-.008	.001	37	<.001	770	.06
	Constant	.129	.116	1.2	.266		

1. The Wald-statistic is used by SPSS to test the null that the coefficient is equal to zero. The Wald-statistic has a Chi-square distribution and is equivalent to the square of the t-statistic.

Table 2.25. 95% Confidence Intervals Around Price Variable for Four Resident Deer Hunter Groups

	Lower bound	Coefficient	Upper bound
All groups pooled	-.031	-.027	-.023
Solitude	-.037	-.03	-.022
Meat	-.033	-.027	-.021
Trophy	-.032	-.022	-.012

Table 2.26. 95% Confidence Intervals for Price Variable for Four Nonresident Deer Hunter Groups

	Lower bound	Coefficient	Upper bound
All groups pooled	-.012	-.01	-.008
Solitude	-.016	-.012	-.008
Meat	-.017	-.013	-.009
Trophy	-.01	-.008	-.006

Conclusions

Objective 1: Influence of Relative Licenses Prices on Substitute / Compliment Relationship

The different analyses produced somewhat different results. The results of the logistic regression analysis showed that the relative price difference between deer and elk licenses is a significant factor in predicting demand for elk licenses. This analysis indicated elk hunting was a substitute for deer hunting. For deer hunting, the elk license price variable was significant in the resident deer demand equation only, and its sign was negative indicating deer hunting is a compliment good to elk hunting.

The crosstab analysis showed a more distinct pattern, with elk and deer licenses seeming to serve as compliments when both prices are low and substitutes when the price of one is increased relative to the other. It also appears there is a stronger demand for elk licenses. Even at higher elk licenses prices, there was still a percentage (15 percent to 19 percent for residents and nonresidents, respectively) of hunters who would purchase an elk license, whereas the demand for deer licenses dropped to almost zero as the fee increased.

Objective 2: Examining the Price Elasticity of Demand for Deer and Elk Licenses

The pattern of demand initially being inelastic (e.g., elasticity < 1) and changing to elastic (e.g., elasticity > 1) at higher fees was supported for resident and non-resident deer and elk licenses. For resident elk hunters, this point of change occurs somewhere between fees of $100 and $130, for nonresident elk hunters at approximately $330. Similarly, for resident deer hunters, the change takes place at approximately $60, for nonresident deer hunters at approximately $180. At fee increases below these amounts, revenue will increase; at fee increases above these levels, revenue will start to decrease.

Objective 3: Examining how Demand and Revenue Change when a Draw is Required

The relationships expected in this objective were partially supported. Although the pattern of elasticities was the same, the demand curve shifted inward, and revenue decreased when an advanced draw was required. Revenue decreased by a much greater amount for nonresident licenses. Requiring a draw for nonresidents would result in revenue that is below the baseline revenue when the study took place.

Objective 4: Comparison of Different Hunting Motivations and WTP

The expected relationships in this objective were not supported. Across all four comparisons of different hunter groups (e.g., resident and nonresident deer and elk hunters) the price coefficients were not significantly different. The price coefficient quantifies the change in demand as fees increase. The fact that the coefficients were the same indicates that these different groups have the same responsiveness to price. One possible explanation is that the question used to measure different motivations did not adequately measure this construct.

Discussion

It appears that both a complimentary and substitution relationship exist for deer and elk hunting in Colorado, depending on the absolute and relative price of licenses. This finding perhaps mirrors the case with many recreation activities and / or areas. Thus, this study has implications for both the effectiveness of a fee program and how a fee program may affect other areas. For example, failing to account for possible substitutes may offset the goal of raising revenues. It may also impose additional costs on other areas as demand shifts to these areas. It is also important to consider how recreation areas and activities act as compliments to each other. That is, do recreationists participate in both activities on the same trip? Not considering this relationship may have unintended effects on participation in other activities and visitation to other recreation sites.

The substitution and complimentary relationship of deer and elk licenses suggests that a study of demand for deer and elk hunting across western states would prove to be a useful tool to assess demand on a regional level. Such a study could take into account how hunters would trade off between hunts within a state as well as across states in a region. Findings would allow state fish and game agencies to better predict how regional trends affect demand within their state.

The price of a fee is critical in determining both how much demand and revenue will change. In general, use will decrease as fees increase. However, revenue is more difficult to predict. The price elasticity of demand is useful in determining if revenue will increase or decrease. While the examples used in this study showed demand staying inelastic for relatively high fee increases, this resilience may not always be the case. It cannot always be assumed revenue will increase if fees are increased.

The mechanism by which the fee is collected impacts the users' willingness to pay the fees. Requiring a draw for nonresident hunters decreased revenue from the baseline. Therefore, an important consideration besides the amount of the fee is how it will be implemented. Having a fee payment system that users feel is convenient may increase acceptance and compliance.

Finally, in this study hunters with different motivations did not have different responses to fee increases. However, when considering fee increases, different types of user groups should be accounted for. Knowing which groups may be more likely to oppose a fee will provide an opportunity to develop messages addressing this group, or perhaps to offer special fee structures.

Future research that examines demand for big game hunting licenses should account for this changing compliment / substitute relationship between licenses. Colorado provides a unique example of a state in which it is possible to hunt both deer and elk at the same time. However, the specific hunts that are acting as compliments and substitutes will vary by state. Different states will have specific types of hunts to consider.

CHAPTER III. ASSESSING VALIDITY OF ESTIMATES OF ELK AND DEER LICENSE SALES USING CONTINGENT VALUATION AND HISTORIC DATA

Introduction

Non-market valuation techniques such as the contingent valuation method (CVM), and the travel cost method (TCM) have become commonplace in the economic literature (Smith, 2000) and the natural resource decision process (U.S. Water Resources Council, 1983; Deck, 1997). These methods have also been used to estimate the economic value of recreation activities such as hunting and fishing (US Department of the Interior, 1997; Fried, Adams, Berras, & Bergland, 1995; Johnson & Walsh, 1988), and mountain biking (Fix & Loomis, 1997), as well as preserving endangered species (Bulte, Van Soest & Van Kooten, 2000), open space (Barro, Manfredo, Brown, & Peterson, 1996), and water levels in lakes (Loomis, 1989).

Advancements have been made in the methodology used in the non-market valuation field. These advancements include studying the effects of asking contingent valuation questions in different contexts (Loomis, 1988; Barro et al., 1996; Carson & Mitchell, 1995) and refining the statistical methods used for analyzing non-market valuation data (Englin & Shonkwiler, 1995; Kaoru, Smith, & Liu, 1995). However, concern still remains over the validity of non-market valuation (Arrow, Solow, Portney, Leamer, Radner, & Schuman, 1993; Diamond & Hausman, 1994; Kahneman, & Knetsch, 1992).

With respect to assessing the validity of CVM, there are several aspects of validity to consider, including construct validity, predictive validity, and content validity (Nunnally and Bernstein, 1994, p. 83). For example, studies have examined the predictive validity of CVM by using WTP estimates to predict voting behavior (Barro et al., 1996). To measure construct validity, it would be ideal to compare a nonmarket valuation estimate to an actual value, or criterion, of the good. In some cases, researchers have been able to simulate a market for the good being valued (Bishop & Heberlein, 1979). However, in most cases it is difficult to simulate a market. A method used to assess construct validity in the absence of a market involves comparing results from two nonmarket valuation studies measuring the same good. If independent studies measuring the value of the same good arrive at similar results, convergent validity is demonstrated (Nunnally & Bernstein, 1994, p. 92).

Measuring convergent validity has become the most common validation method for nonmarket valuation. This technique has been commonly used to compare estimates from the CVM, labeled "stated preference" (SP), to estimates from the TCM, labeled "revealed preference" (RP) (Carson, Flores, Martin, & Wright, 1996). The SP studies are so labeled because they measure a respondent's intention to pay for a good, while the RP studies are labeled such because the method uses actual transactions made by the respondent. The literature review by Carson et al. (1996) identifies 83 studies, which make 616 comparisons of SP estimates to RP estimates.

This study takes the basic approach of assessing convergent validity by comparing SP results to RP. The goods to which the CVM (i.e., the SP method) is applied in this study are deer and elk hunting licenses in Colorado. The RP method used is an analysis of historic deer and elk license sales and prices in Colorado. However, this study differs from others in the literature because it uses a different method to compare the SP estimates to RP estimates. Most comparisons focus on the net WTP, or consumer surplus. This study will compare estimates of participation and revenue at different fees estimated by the CVM survey data and by an analysis of historic data.

The comparison of the CVM and historic data estimates will also allow for an examination of social desirability bias. It has been suggested that CVM surveys conducted by telephone may result in higher WTP than mailed CVM studies (Whittaker & Vaske, 1998). Convergence of estimates would suggest that social desirability bias is minimal.

In addition, this study will examine how responses diverge when economic theory indicates they should. To assess construct validity, it is not enough to show that results of two separate studies converge. It must also be demonstrated that results do not correlate highly with studies intending to measure a different construct (Campbell & Fiske, 1959). This lack of correlation is referred to as divergent validity. One of the concerns with the CVM is that respondents do not give meaningful responses. One way to address this issue is to examine how responses vary to WTP questions that measure different goods. A common approach in the literature used to test the meaningfulness of responses has been to vary the magnitude of the good for which respondents are being asked their WTP, referred to as embedding or scope (Brown, Barro, Manfredo, & Peterson, 1995; Giraud, 1999; Kahneman & Knetsch, 1992; Loomis, Lockwood, & Delacy, 1993). As the good changes, if respondents are considering their answers, the responses should differ. If respondents are simply giving a value without considering the good (e.g., responding

$20), or responding "yes" to a given value in a dichotomous choice format, values will not differ across different goods.

Another related concern with CV studies, related to divergent validity, is strategic bias (Arrow et al., 1993). Strategic bias occurs when respondents state a high WTP value to make the good in question appear to have a higher value, or when respondents state a low WTP because they believe the information will be used to increase fees.

This study allowed for a unique assessment of divergent validity by presenting the respondents with randomly assigned prices for two different goods (deer and elk hunting licenses) and asking if they would purchase one or the other or both. If respondents are not considering the scope of the hunts or they are answering strategically, the respondents would most likely respond "yes" or "no" to both hunts, irrespective of the fee increase assigned to each hunt.

Study Objectives

Objective 1: Compare elk license sales estimated with the CVM to elk license sales estimated from historic data. It is expected that estimated elk license sales(CVM) will converge with estimated elk license sales(historic).

Objective 2: Compare deer license sales estimated with the CVM to deer license sales estimated from historic data. It is expected that estimated deer license sales(CVM) will converge with estimated deer license sales(historic).

Objective 3: Examine how responses to the WTP question differ based on the relative prices of the licenses. It is expected that when elk license prices are high relative to deer license prices, respondents will be more likely to purchase a deer license only. It is also expected that when deer license prices are relatively high compared to elk license prices, respondents will be more likely to purchase an elk license only.

Methods

Historic Data Model

Following a model used by Loomis and Fix (1998) to examine fishing license sales in Colorado, this study used historic participation and license fee records to estimate the effect of license fees on license sales. The price of elk and deer licenses and the number of licenses sold in Colorado for the years 1975 to 1999 were obtained from the Colorado Division of Wildlife (CDOW). The time period 1975 to 1999 was used for the elk analysis. However, in 1999 licenses were limited for deer, so the time period 1975 to 1998 was used for the deer analysis. The price of the license will be used to predict license sales along with other variables economic theory predicts will affect demand. These variables include the number of potential buyers in the population represented by the human population of the region, general economic indicators such as the price of gas and income, and a substitute variable. Following methods used by other studies, the substitute variable is the price of a nonresident license in an adjacent state, in this case an elk / deer license in Wyoming (Teisl, Boyle, & Record, 1999, Anderson, Reiling, & Criner, 1985).

The general form of the model was as follows:

License sales = *function*(license price, price of substitutes, human population, price of gas, trend, income).

Specifically, the estimated model was as follows:

[1] License sales = x_0 + $x_1$license price + $x_2$price of substitutes + $x_3$human population + $x_4$price of gas + $x_5$trend + $x_6$income

Please note: in this study, population always refers to the human population of the region.

Data analysis

The variable of interest in this model is the price of elk and deer licenses. The prices of the licenses are historic observations of license fees. Based on the face value, the prices of these licenses have increased over time. For example, in Colorado the price of elk licenses range from a value of $12.50 in 1975 to a value of $30.25 in 1999. The face value of the license prices indicates an increase of $17.75. However, in an analysis of the price of these licenses over time, one must take inflation into account. It may be the case that $12.50 in 1975 is equivalent to $30.25 in 1999. To account for inflation, consumer price index (CPI) data were obtained from the U.S. Bureau of Labor Statistics (BLS). The CPI can be used to adjust the price of the licenses to a common year. For this analysis, all licenses were adjusted to 1982 dollars. In other words, each year's license price was adjusted to its value based on the price level in 1982.

In an analysis that uses multiple regression, the variables included in the model must be tested for multicollinearity. The extent to which multicollinearity exists can be determined by examining the correlations between the variables to be included in the model. If two variables have a high pair-wise or zero-order correlation, one of the variables should be excluded from the regression analysis (Gujarati, 1995). Gujarati suggests that a high pair-wise or zero-order correlation is somewhere around 0.8 or above, but that multicollinearity can occur at correlations less than 0.8.

In this data set, each observation of participation, license sales, population, etc. in the data set corresponds to a specific year. Thus, the data are "time series" as opposed to "cross section." With time-series data, the previous observations of the dependent variable may influence subsequent observations. For example, if 100,000 licenses are sold in period x, it is likely that period x + 1 will have a value near 100,000. Statistically, the error terms of different observations may be related, violating one of the assumptions of regression. This problem is defined as autocorrelation (Gujarati, 1995). If autocorrelation is present and not corrected, it will bias the coefficients and change the values of the t-statistics. This problem can be addressed by certain statistical software packages. For the regression analysis of this study, the statistical package Econometric Views (E-views) was used. E-views allows for the correction of autocorrelation by using a lagged value of the variables in the regression. In addition, E-views provides a test for the presence of autocorrelation in its regression output, with the test statistic being the Durbin-Watson statistic. If the Durbin-Watson statistic is close to 2, autocorrelation is not present. There is a region around 2 (the region approximately 1.2 to 1.8 and 2.2 to 2.8) in which it is uncertain whether autocorrelation exists. Beyond this range autocorrelation is present (Greene, 1997).

The functional form of the data was analyzed by examining the plots of license sales against price. If the plots of the data indicate a non-linear functional form, a log-log transformation should be conducted on the data, e.g., take the natural log of the dependent and independent variables.

Contingent Valuation Method

A survey was developed that simultaneously manipulated the price of an elk hunting license and a deer hunting license. There were 10 different prices for both elk and deer licenses, resulting in 100 different combinations of license prices. The values of the resident elk licenses ranged from $35 to $280, and the values of the resident deer licenses ranged from $25 to $150. When this study was conducted, the price for a resident elk license was $30; a resident deer license was $20. The survey was designed to present the respondents with a price combination, after which they were asked if they would purchase 1) a deer license, 2) an elk license, 3) both an elk and deer license or 4) neither. In addition, the respondents were asked questions regarding past participation, willingness to pay for license increases, and the importance of different aspects of the hunting experience in Colorado.

A systematic random sample of 6,785 resident and nonresident hunters who had purchased a deer or elk license in 1996 was drawn from Colorado Division of Wildlife records. The respondents were administered the survey by telephone during 1997.

The responses to the WTP question were collapsed into yes / no (dichotomous) data. When the dependent variable is dichotomous, logistic regression is one of the appropriate statistical methods to analyze the data (Gujarati, 1995). Logistic regression uses the log of the odds ratio that a person will purchase a license to predict the number of licenses sold at a given license fee.

Convergent Validity

Convergent validity was examined by estimating license sales at 51 different prices for elk, ranging from $30 to $130, and 37 different prices for deer, ranging from $20 to $56. Methods outlined by Carson et al. (1996) were used to calculate the ratio between revealed preference and stated preference estimates (e.g., the CVM estimates of license sales divided by the analysis of historic data estimates). However, the Carson et al. method only looks at the magnitude of the difference. For a more rigorous test, confidence intervals should be estimated around the estimates of participation. When calculating confidence intervals around an estimate there are two sources of variance: 1) the estimated coefficients (i.e., the standard error of the regression), and 2) that the predicted value will not equal its actual value (i.e., the standard error of prediction) (Weisberg, 1985, p. 22). Therefore, the following formula must be used:

[2] Variance of prediction = variance regression + variance of the estimate.

$$\text{where variance of the estimate} = \text{Variance of regression}\left(\frac{1}{n} + \frac{(x_* - \bar{x})^2}{Var(x)}\right)$$

and x_* is the x value used to predict y.

The formula can be simplified as:

$$[3] \qquad \text{Std. error of regression}\left(1 + \frac{1}{n} + \frac{(x_* - \bar{x})^2}{Var(x)}\right)^{\frac{1}{2}}$$

As the values of x used to predict y become further from the mean of the x's included in the data set, the confidence interval will become larger. To illustrate, for elk, the values of license fees used to predict license sales (i.e., the x values used to predict license sales) increase from a fee of $30 to a fee of $280, values considerably above the mean value of x of $20.94. Therefore, it would be expected that the confidence intervals around the predicted values would be large.

The standard error of the regression is calculated from the residual sum of squares. However, the CVM data were analyzed with logistic regression, which uses maximum likelihood estimation. Because there are no sums of squares, the standard error of the CVM regression cannot be estimated.

To overcome this problem, regression analysis was used to examine how estimates vary by method. The estimates of license sales were then regressed on the fee and a dummy variable for the method that was used. If the estimate of license sales is independent of the method used, the dummy variable should not be significant.

Divergent Validity

In this study, respondents were presented with different fees for elk and deer licenses and asked if they would purchase an elk license, a deer license, or both. Respondents who may be answering with strategic bias would have the same responses, either "yes" or "no," for both deer and elk licenses. If respondents are not seriously considering the price of the license when giving their response, they most likely will give the same response for the deer and elk license irrespective of the dollar amount of the two licenses. If respondents are considering the prices of the licenses when asked their WTP, it would be expected that as prices of the licenses diverge (e.g., the difference becomes larger), a "no" response to the license with the higher fee is more likely.

In order to test this likelihood, two separate analyses were conducted. First, the responses to the dichotomous choice WTP questions for deer and elk licenses were correlated. This correlation was conducted by creating two separate variables for elk yes / no responses and deer yes / no responses. Because the bid amounts asked for deer and elk licenses varied, this correlation should not be close to one.

A variable was also created indicating whether both responses were the same, or there was an elk "yes" and deer "no," or an elk "no" and deer "yes" set of responses. An analysis of Variance (ANOVA) was then conducted to examine the difference, as well as directions of the difference, in the mean values of the WTP bid amounts. It would be expected that when the bid amounts are close, there was a "yes" to both licenses; when the elk bid amounts become relatively larger than deer bid amount, respondents will be more likely to respond "no" to the elk license; and when the deer bid amounts become relatively more than elk bid amounts, respondents will be more likely to respond "no" to deer licenses.

Results

Historic Data Model

Multicollinearity

The correlations for the elk hunting model indicate that several of the variables were strongly related. The general trend variable was highly correlated with population, the price of gas, and the wage rate (the measure of income). The wage rate was highly correlated to the price of the elk license and population (Table 3.1). The correlations for deer hunting showed a similar pattern (Table 3.2). Based on the adjustments for multicollinearity, the revised model estimated for both elk and deer was as follows:

[4] License sales = x_0 + $x_1$license price + $x_2$price of substitutes + $x_3$human population

Table 3.1. Correlations for Colorado Elk Hunting Data

	Trend	Price elk tag	Population	Price gas	Substitute
Trend					
Price elk tag	-.533*				
Population	.987**	-.568**			
Price gas	-.804**	-.022	-.747**		
Substitute	-.017	-.404*	-.097	.347	
Wage rate	-.945**	.631**	-.918**	.658**	-.16

* significant at the .05 level
** significant at the .01 level
n=25 (1975-1999)

Table 3.2. Correlations for Colorado Deer Hunting Data

	Trend	Price deer tag	Population	Price gas	Substitute
Trend					
Price deer tag	-.798**				
Population	.986**	-.808**			
Price gas	-.796**	.354	-.738**		
Substitute	.263	-.384	.349	.115	
Wage rate	-.940**	.849**	-.912**	.637**	-.368

* significant at the .05 level
** significant at the .01 level
n=24 (1975-1998)

Functional form

The plots of the elk hunting data appear to support a linear pattern; therefore, the linear regression was conducted without any transformations to the data (Figure 3.1). The deer hunting data also support the use of a linear model (Figure 3.2).

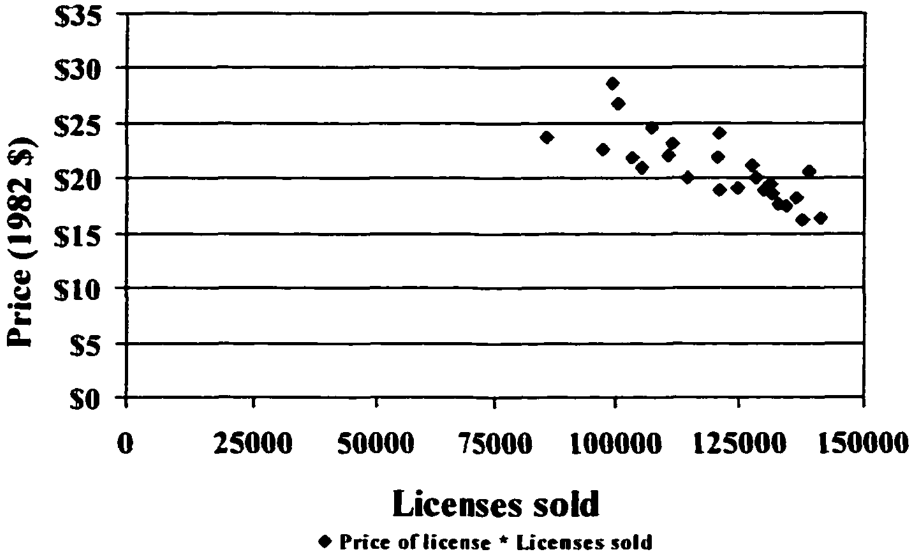

Figure 3.1. Plot of Historic Colorado Elk Hunting Data

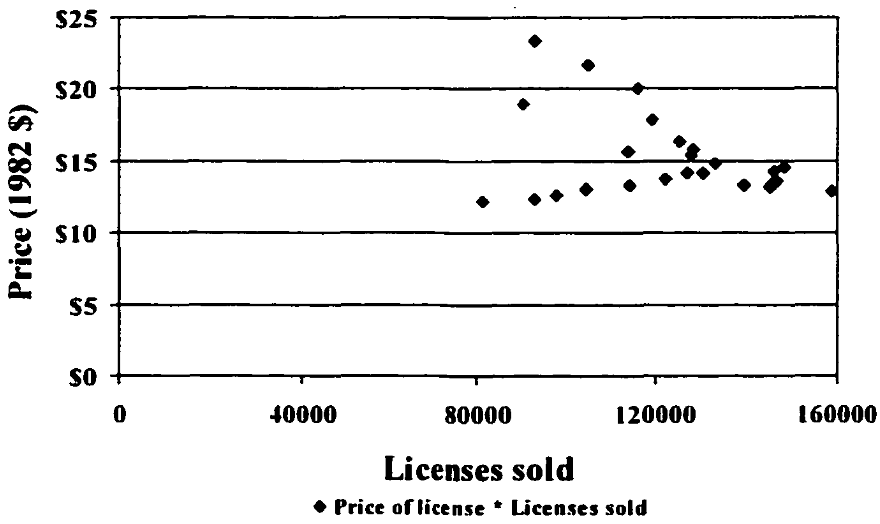

Figure 3.2. Plot of Historic Colorado Deer Hunting Data

Please note, in 1990 deer licenses started to decline as the real price declined. It appears as if it results in two demand curves, one pre-1990, that is downward sloping and a second from 1990-1999 that is shifting in toward the origin. The inward shifting demand curve is illustrated by the data points sloping downward toward the origin.

Regression analysis

For resident elk licenses in Colorado, the coefficient for the price variable was negative and significant, indicating a downward sloping demand curve (Table 3.3). The value of the coefficient was –1562. This finding means that as license fees increase by $1, holding all other variables constant, 1,562 fewer licenses will be sold. The correction for autocorrelation was also significant. The Durbin-Watson statistic was 1.4, the region in which it is uncertain whether or not autocorrelation is present. The variables for human population and the substitute elk license were not significant. However, their coefficients will be used in the equation to predict licenses sold to avoid omitted variable bias, because economic theory dictates that these variables should be included in the model.

For resident deer licenses in Colorado, the coefficient for the price variable was negative and significant (Table 3.4). The value of the coefficient was –3858, indicating that as license fees increase by $1, holding all other variables constant, license sales will decrease by 3,858. The correction for autocorrelation was significant and the Durbin-Watson statistic was 2.08, in the range where autocorrelation is not present. For the deer model, the variables for the human population and the price of the substitute were significant. However, the substitute variable did not have the sign predicted by theory. The substitute variable's sign may be due in part to the decline in license sales since 1990, a decline which resulted in the decrease of license sales as the price of substitutes increased during these years.

Table 3.3. Results of Linear Regression for Colorado Resident Elk, Historic Data

	Coefficient	T-stat / Significance	n[1]	R^2(adj)	Durbin Watson
Constant	107966	2.63 / .016	24	.76	1.4
Price of elk license[2]	-1562	-2.16 / .044			
Human population	.009	1.03 / .32			
Substitute elk	54	1.37 / .19			
AR(1)[3]	.56	3.28 / .004			

1. The time period 1975 to 1999 was used, but the autcorrelation correction results in 24 cases.
2. The prices of the elk licenses in the analysis were adjusted to 1982 dollars.
3. The AR(1) term is the correction for autocorrelation.

Table 3.4. Results of Linear Regression for Colorado Resident Deer, Historic Data

	Coefficient	T-stat / Significance	n[1]	R^2(adj)	Durbin Watson
Constant	572589	4.77 / <.001	23	.92	2.08
Price of deer license[2]	-3858	-4.34 / <.001			
Human population	-.10	-3.37 / .0034			
Substitute deer	-356	-3. 87 / .0014			
AR(1)[3]	.854	14.6 / <.001			

1. The time period 1975 to 1998 was used, but the autcorrelation correction results in 23 cases.
2. The prices of the deer licenses in the analysis were adjusted to 1982 dollars.
3. The AR(1) term is the correction for autocorrelation.

Predicting the number of licenses sold at increased fees

Using the estimated regression equation [5] for elk, the number of elk licenses that would be sold at different fees was estimated.

[5] Elk license sales = 107966 -1562*price of license +.009*human population +53.5*price of substitute

Participation was estimated at fees varying from $35 to $130. The estimated participation is shown in the first columns of Table 3.7 (see page 75). The participation in 1999, at a fee of $30, was 138,261. Applying the 1999 values for price[4] (adjusted to 1982 dollars), population, and the price of the substitute, the equation estimates that 134,729 elk licenses would be sold, within 2.6 percent of the actual value. At a fee of $35, the model predicts 130,101 licenses will be sold. The predicted number of licenses sold at a fee of $130 was 42,245.

For deer, the following estimated regression equation [6] was used to predict license sales.

[6] Deer license sales = 572589 -3858*price of license -.10*human population -356*price of substitute

Participation was estimated at fees ranging from $25 to $50. At $25, estimated participation was 84,816 (Table 3.8). Estimated participation declined to 14,407 at a fee of $50.

Contingent Valuation Survey Data

Response rate

Of the 6,785 hunters sampled, 2,012 residents and 2,099 nonresidents completed the telephone survey, resulting in a response rate of 76 percent using the Council of American Survey Research Organizations' estimator (Frankel, 1982). A nonresponse test was conducted of those who did not respond. The nonresponse test consisted of two questions: gender and participation in 1996. No difference between respondents and nonrespondents were found for nonresidents. For residents, respondents were more

[4] The price of the license and substitute were adjusted to 1982 dollars, because the coefficients were estimated from data adjusted to 1982 dollars.

likely to have hunted in 1996. However, because of the high response rate, the data were not weighted (Babbie, 1992, p. 267).

Logistic regression

The results of the logistic regression for elk showed that the price variable was negative and significant (Table 3.5).

Table 3.5. Results of Logistic Regression for Colorado Resident Elk Hunting, Survey Data

	Coefficient	Wald statistic[1]	Sig.	n	R^2(adj)
Constant	.399	87	< .001	1936	.18
Price of elk license	-.015	151	< .001		
Ratio deer $ / elk $[2]	.073	21	< .001		

1. The Wald-statistic is used by SPSS to test the null that the coefficient is equal to zero. The Wald-statistic has a Chi-square distribution and is equivalent to the square of the t-statistic.
2. This is a substitute variable representing the ratio of a deer license price to an elk license price.

The results of the logistic regression for deer hunting showed that the price variable was negative and significant (Table 3.6).

Table 3.6. Results of Logistic Regression for Colorado Deer Hunting, Survey Data

	Coefficient	Wald statistic[1]	Sig.	n	R^2(adj)
Constant	.478	24	< .001	1936	.15
Price of deer license	-.027	201	< .001		
Price of elk license[2]	-.002	5.3	.021		

1. The Wald-statistic is used by SPSS to test the null that the coefficient is equal to zero. The Wald-statistic has a Chi-square distribution and is equivalent to the square of the t-statistic.
2. This is a substitute variable representing the price of an elk license price.

Predicting the number of licenses sold at increased fees

The resulting equation used to estimate participation (i.e., license sales) for elk is listed below [7].

$$[7] \quad \text{Probability of purchasing a license} = \frac{1}{1 + e^{-(.399 - .015 \cdot \text{elk license fee increase} + .073 \cdot \text{deer/elk ratio})}}$$

The resulting equation used to estimate participation (i.e., license sales) for deer was as shown below [8].

$$[8] \quad \text{Probability of purchasing a license} = \frac{1}{1 + e^{-(.478 - .027 \cdot \text{deer license fee increase} - .002 \cdot \text{elk license fee})}}$$

For elk, participation was estimated at different fees, ranging from $35 to $130. The deer / elk price ratio used in the estimate was .66, reflecting the current price ratio. Participation at $35 was estimated at 126,808, while participation at $130 was estimated to be 55,418 (Table 3.7). Participation for deer hunting was estimated at different fees, ranging from $25 to $70. Participation at $25 was estimated at 98,830, while participation at $70 was estimated to be 48,964 (Table 3.8).

Table 3.7. Comparison of Estimated Participation and Revenue for Elk Hunting, Estimated with Historic and CV Data

	Historic data		CVM survey data	
License Fee	Participation	Revenue	Participation	Revenue
$35	130,101	$4,553,535	126,808	$4,438,288[1]
$40	125,477	$5,019,080	122,903	$4,916,118
$50	116,229	$5,811,450	114,973	$5,748,636
$60	106,981	$6,418,860	106,955	$6,417,289
$70	97,733	$6,841,310	98,939	$6,925,702
$80	88,485	$7,078,800	91,013	$7,281,070
$100	69,989	$6,998,900	75,769	$7,576,946
$130	42,245	$5,491,850	55,418	$7,204,288

1. The participation estimates from the logistic regression included fractions. The revenue was calculated from a spreadsheet that used the fractions of participation.

Table 3.8. Estimated Participation and Revenue for Deer Hunting in Colorado, Estimated with Historic and CV Data

	Historic data		CVM survey data	
License Fee	Participation	Revenue	Participation	Revenue
$25	84,816	$2,120,400	98,830	$2,470,740[1]
$30	61,347	$1,840,410	93,051	$2,791,522
$35	49,612	$1,736,420	87,214	$3,052,493
$40	37,887	$1,515,480	81,372	$3,254,892
$50	14,407	$720,350	69,883	$3,494,161
$60[2]	-	-	58,976	$3,538,538
$70	-	-	48,964	$3,427,514

1. The participation estimates from the logistic regression included fractions. The revenue was calculated from a spreadsheet that used the fractions of participation.
2. At fees of $60 or above, the historic model predicts negative values.

Objective 1: Predicted Elk License Sales(CVM) will Converge with Predicted Elk License Sales(historic)

SP/RP ratios

Across the 50 fees for elk, the ratios between the CVM data and historic data range from .97 to 1.31 (Table 3.9). However, it is only at fees larger than $104 that the ratio becomes larger than 1.1, below $104 the SP/RP ratios are between .97 and 1.09. Fees above $104 are most likely larger than a fee increase that would be considered by the CDOW, and prediction in this range may be less critical from a practical standpoint. For fees of $40 to $70, which would most likely contain the value of a fee increase, the SP/RP rations are between .98 and 1.01, indicating strong correspondence.

Table 3.9. Elk SP/RP Ratios of Predicted Sales at Various Increased Fees

License fee[1]	SP/RP ratio
$30	.97
$40	.98
$50	.989
$60	.999
$70	1.01
$80	1.03
$90	1.05
$100	1.08
$110	1.13
$130	1.31

1. For purposes of simplicity, this table shows only 10 of the 50 fees for which the SP/RP ratios were estimated.

Dummy variable regression to test effect of method

In order to further examine the estimates of license sales from the CVM and historic data, the estimates were regressed on the fee and a dummy variable indicating the method used. If the estimates from the two methods are the same, the dummy variable should not be significant. Two separate equations were estimated for elk licenses. The first equation tested the full range of estimates at fees from $30 to $130. The second equation tested fees truncated at $90, based on a visual inspection of the data that revealed estimates of license sales diverging at the upper range of fee increases (which most likely would be greater than the actual fee increase). Since the sales were estimated with the fees, the R^2 will be very large. However, the variable of interest is the method, which should be picked up by the regression equation. When estimates from fees of $30 to $130 are included in the analysis, there is a significant difference by method, with the CVM estimates being smaller than the historic data estimates. When the estimates are truncated at $90, the method is not significant. This finding is consistent with that drawn from a visual examination of the SP/RP ratios. Again, it is most likely that a fee increase for resident elk licenses will be below $90 (Table 3.10).

Table 3.10. Regression to Test Effect of Method on Elk License Sales Estimate

		Coefficient	T-stat	Sig.	n	R^2(adj)
Fees of $30 to $130					102	.991
	Constant	159,310	214	<.001		
	Fee	-845	-102	<.001		
	Method[1]	-3254	-6.7	<.001		
Fees of $30 to $90					72	.994
	Constant	158,542	287	<.001		
	Fee	-860	-101	<.001		
	Method	24	.078	.938		

1. The CVM data were coded 1, and the historic data coded 0.

Objective 2: Estimated Deer License Sales(CVM) will Converge with Estimated Deer License Sales(historic)

SP/RP ratios

For deer, the SP/RP ratios were further from 1, ranging from 1.25 at a fee of $21 to 194.12 at a fee of $56 (Table 3.11). However, below fees of $56, the SP/RP ratio is less than 25. The SP/RP ratios do not support strong convergence.

Table 3.11. Deer SP/RP Ratios of Predicted Sales at Various Increased Fees

License fee[1]	SP/RP ratio
$20	1.23
$25	1.35
$30	1.52
$35	1.76
$40	2.15
$45	2.89
$50	4.85
$53	9.03
$55	24.07
$56	194.12

1. For simplicity, this table only shows 10 of the 37 fees for which the SP/RP ratios were estimated.

Dummy variable regression to test effect of method

For deer, the method variable is highly significant, indicating the CVM and analysis of historic data are estimating different license sales (Table 3.12). There may be several explanations for this significance. One possible explanation is that since the 1990's, deer license sales have declined. Therefore the data do not fit a linear pattern well. However, while this possibility may provide a statistical explanation as to why the historic data model predicts a low number of licenses sold, it does not address the issue of validity.

Table 3.12. Regression to Test Effect of Method on Deer License Sales Estimate

	Coefficient	T- stat	Sig.	n	R^2(adj)
Fees of $20 to $56				74	.95
Constant	109091	38	<.001		
Fee	-1751	-25	<.001		
Method[1]	41194	27	<.001		

1. The CVM data was coded 1, and the historic data coded 0.

Objective 3: Response Patterns will Diverge as Relative License Fees Change

Correlation of responses

The correlation was calculated between the respondents' yes / no answer to purchase a deer license and their yes/no answer to purchase an elk license. If respondents were simply saying "yes" or "no" without considering the relative prices, it would be expected that these two variables would have a strong correlation. Across all cases in which there were responses for deer and elk licenses (n = 1939), the Pearson correlation between WTP responses was .303. Although the correlation was significant, with that large a sample, small correlations will most likely be significant. Based on the relatively small size of the correlation, it appears as if respondents are discriminating between the two products being offered based on the relative prices of each.

ANOVA

The ANOVA reveals that responses are in the direction that theory would dictate (Table 3.13). Respondents were more likely to respond "no" to an elk license and "yes" to a deer license when the elk license was relatively more expensive than the deer license, and more likely to respond "yes" to an elk license and "no" to a deer license when deer licenses were relatively more expensive. Interestingly, for an elk "no" and deer "yes," the elk license was on average $86.85 higher than the deer license. However, for an elk "yes" and deer "no," on average the deer license was only $33.53 higher. The results of the ANOVA indicate that respondents are distinguishing between deer and elk licenses, and not simply answer "yes" or "no," or engaging in strategic behavior. This finding also suggests it takes a relatively higher price to cause a shift from an elk license to a deer license than from a deer license to an elk license, indicating there is a stronger demand for elk licenses.

Table 3.13. Results of ANOVA Testing Bid Amount Differences by Responses to WTP

	Neither	Elk yes, deer yes	Elk yes, deer no	Elk no, deer yes	F / sig.
Mean difference in bid amount[1]	-$34.73	-$12.30	$33.53	-$86.85	144.3 / <.001

1. The difference was calculated as the deer bid amount *minus* the elk bid amount. Thus, a positive number indicates that the deer license bid amount was higher; a negative number indicates the elk license bid amount was higher.

Conclusions

The historic data and CVM survey data produced similar results for resident elk license sales, supporting convergent validity. Up to a fee of $90, differences between the two methods were not statistically significant. However, at fees above $90, the two methods produced results that were significantly different. However, fees above $90 are diverging far from the mean values of the data, resulting in more error in the predicted values.

In addition, economic theory would predict that elk and deer licenses may trade off (e.g., be substitutes) as the difference in the fees become relatively large. Respondents were asked differing fee amounts for elk and deer licenses. Results show that the magnitude of the difference between elk and deer licenses is significant in determining which combinations of licenses are purchased.

The estimates of license sales for deer did not converge as strongly as elk. The historic data model estimated a significantly lower number of licenses sold. The deer license sales data exhibited an unusual pattern of increasing then decreasing, making estimation with linear regression difficult. This anomaly may be due in part to a perception of low quality deer hunts and declining deer herds, a perception which became evident throughout public meetings in the state. To determine which method might provide a more accurate assessment, the quality of future deer hunts must be determined.

Discussion

The results of the study provided mixed results. In a situation where license sales had a relatively stable historic trend, estimates from historic data and the CVM converged. However, when the license sales fluctuated by a relatively large amount over time, the results did not converge as strongly. One possible approach for reconciling this discrepancy would be to remove the outliers from the data with a fluctuating trend to see if results converge. This approach was taken for deer hunting by truncating the data at

1990, when sales declined at a rapid rate. Truncating the data at 1990 improved convergence with SP/RP ratios ranging from .74 to 15.23 at fees from $20 to $54. The effect of method with the data truncated at 1991 was also tested using regression with a dummy variable for method. The method variable was still significant in the regression, but it did have a much smaller t-value than with the full range of data (3.87 vs. 27).

The implications for validity and applications of these methods to predict participation and revenue is that there must be correspondence between the product that was used to predict participation, or asked in a CVM survey, and the product being offered. For elk hunting in Colorado, the product has remained relatively constant throughout the historic time period used to predict future license sales. Likewise, there was high correspondence between the quality of the elk hunt when the WTP study was conducted and what can be provided by management currently and in the future. For deer hunting, however, the product has been changing. There have been concerns among hunters over the quality of deer hunts in the recent years. These concerns can be attributed to chronic wasting disease and declining deer herds. In a case as illustrated by deer hunting in Colorado, it may be that more weight should be given to other sources of information, such as managers' judgment of what types of products will be available, when assessing demand. The accuracy of demand assessments may have to take place on a case by case basis.

CHAPTER IV. DISCUSSION AND IMPLICATIONS

It appears as if the CVM can be useful tool to assist with current challenges of recreation management. One of these challenges appears with the trend toward increased reliance on user fees. The CVM can assist in implementing fees in several ways. First, CVM can be used to determine how recreation activities and areas serve substitute and compliment goods when price changes. This information can prove to be useful in developing a regional plan in which user fees will vary across different sites and activities.

Second, the CVM, or an analysis of historic data when available, can be used to predict participation and revenue under different fee increases. These predictions can serve two purposes. If the goal of a fee is to allocate use, the analysis will determine how responsive use is to fees and assist in determining the fee level needed to achieve the desired reduction in use. If the goal is to raise revenue, these tools will assist in setting a price that results in optimum revenue (which may not be maximum revenue). One concern may be ensuring the fee is high enough to cover costs of the fee program and to provide revenue to cover the costs of the recreation program. Another concern involves not setting the fee so high that revenue declines from its maximum level. The CVM can also be used to test different types of payment formats. The payment format may influence willingness to pay a fee, compliance with a fee, and acceptability of a fee. To test these different payment vehicles, a CVM survey instrument can be designed to ask a WTP question with the different payment formats.

Acceptability of fees across different types of users can also be examined with the CVM. It is important to note how groups with different motivations will react to fees. If there are differences among these groups, a fee program should be designed to best accommodate these groups, if possible. For example, perhaps differential pricing for different activities may be appropriate if there are differences in facilities required by different groups. This differentiation may help foster acceptance of the fee program.

Finally, it appears that the CVM and historic data analysis predicted licenses that were similar. However, there was less convergence in the deer license sales estimates than those for elk. With regard to deer license sales in Colorado, the product seems to be changing in terms of quality. This perception of lower quality has resulted in fluctuation in sales. In these situations, it may be necessary to rely on more sources of information than the estimates from these two (or other) demand estimation techniques. Managers' assessment of the supply may help in determining what products can be offered and in predicting demand.

Future Research

Future research should compare these estimates of license sales to actual license sales as the CDOW implements fee increases. This research would provide an actual criterion to assess validity of the CVM and an analysis of historic data. Special attention should be given to deer licenses. The link between perceived quality of the hunt and hunters' willingness to purchase a license could be one area of research to address the differences in estimates for deer license sales that was found between the CVM and the analysis of historic data. Another possibility is that the current situation with deer hunting in Colorado is only a temporary situation. Testing convergence of results by replicating this study in the future will provide insight into this possibility.

Future research should also focus on refining the question that was used to determine motivations for deer and elk hunting in Colorado. It appears that this single item did not adequately measure the respondents' motivation for hunting in Colorado. The different reasons of hunting in Colorado asked in the WTP survey - trophy, solitude, and meat - each has different constraints that the respondents may not have considered. For example, trophy hunting would require limitations on hunting which results in a sacrifice of time in the field (e.g., the frequency of hunting). Likewise managing for solitude may also require limitations on the frequency of participation in hunting. Managing to maximize meat may result in smaller animals being available for harvest. Questions to measure the reasons for hunting should be designed to ensure respondents consider these tradeoffs.

LITERATURE CITED

Ajzen I. & Peterson G. L. (1988). Contingent value measurement: The price of everything and the value of nothing? In Peterson, G. L., Driver, B. L., & Gregory, R. (*eds.*). *Amenity resource valuation.* Venture Publishing, Inc. State College Pennsylvania.

Anderson, M. W., Reiling, S. D., & Criner, G. K. (1985). Consumer demand theory and wildlife agency revenue structure. *The Wildlife Society Bulletin, 13*, 375-384.

Arrow, K., Solow, R., Portney, P. R., Leamer, E. E., Radner, R. & Schuman, H. (1993). Report of the NOAA panel on contingent valuation. *Federal Register*, *58*(10), 4601-4614.

Babbie, E. (1992). *The practice of social research.* Wadsworth Publishing, Belmont, California.

Barro, S. C., Manfredo, M. J., Brown, T. C. & Peterson, G. L. (1996). Examination of the predictive validity of CVM using an attitude-behavior framework. *Society and Natural Resources 9* 111-124.

Bishop, R. C. & Heberlein, T. A. (1979). Measuring values of extramarket goods: Are indirect measures biased? *American Journal of Agricultural Economics, 61*, 926-930.

Brown, T. C., Barro, S. C., Manfredo, M. J., & Peterson, G. L. (1995). Does better information about the good avoid the embedding effect. *Journal of environmental management, 44*(1), 1-10.

Brown, P. J., Hautalouma, J. E., & McPhail, S. M. (1977). Colorado deer hunting experiences. *Transactions of the 42nd North American Wildlife Conference*, 216-225.

Bulte, E. H., Van Soest, D. P. & Van Kooten, G. C. (2000). Economics, endangered species and biodiversity loss: The dismal science in practice. In Van Kooten, G. C., Bulte, E. H. & Sinclair, A. R. E. (*Eds.*), *Conserving nature's diversity: Insights from biology, ethics, and economics.* Ashgate Publishing, Burlington, Vermont.

Campbell, D. T. & Fiske, D. W. (1959). Convergent and discriminant validation by the multitrait-multimethod matrix. *Psychological Bulletin, 56*(2), pp. 81-105.

Carson, R. T., Flores, N. E. Martin, K. M. & Wright, J. L. (1996). Contingent valuation and revealed preference methodologies: Comparing the estimates for qausi-public goods. *Land Economics 72*(1), 80-99.

Carson, R. & Mitchell, R. (1995). Sequencing and nesting in contingent valuation surveys. *Journal of Environmental Economics and Management*, 28, 155-173.

Ciriarcy-Wantrup, S. V. (1947). Capital returns from soil-conservation practices. *Journal of Farm Economics, 29,* 1181-1196.

Cockrell, D. & Wellman, J. D. (1985). Against the running tide: Democracy and outdoor recreation user fees. *In proceedings national outdoor recreation trends symposium II, 2*, 119-203. Atlanta, GA: USDI National Park Service, Science Publications office.

Colorado Division of Wildlife. (1999). *5-year big game season structure final policy statements.* Colorado Division of Wildlife, Denver, CO.

Colorado Division of Wildlife. (2000). Colorado division of wildlife 1999-2000 financial snapshot. *DOWInsider*. Colorado Division of Wildlife Denver, CO.

Congressional Budget Office. (1993). *The growth of federal user charges*. Congressional Budget Office, Washington D.C.

Crandall, D. A. & Driver B.L. (1984). Recreation on public lands: Should the user pay? *American Forests, 90*(3), 10-11, 49-53.

Creel, M. & Loomis, J. (1992). Recreation value of water to wetlands in the San Joaquin Valley: Linked multinomial logit and count data trip frequency models. *Water Resources Research, 28*(10), 2597-2606.

Cummings, R., Harrison, G., & Rutstrom, E. E. (1995). Homegrown values and hypothetical surveys: Is dichotomous choice approach incentive compatible? *American Economic Review*, 85, 260-266.

Deck, L. (1997). Visibility at the Grand Canyon and the Navajo generating station. In R.D. Morgenstern, *Ed., Economic analysis at the EPA: Assessing regulatory impact*. Resources for the Future, Washington, D.C.

Diamond, P. A. & Hausman, J. A. (1994). Contingent valuation: Is some number better than no number? *Journal of Economic Perspectives 8*(4), 45-64.

Donnelly, D., & Nelson, L. J.. (1986). *Net economic value of deer hunting in idaho*. USDA Resource Bulletin RM-13. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Driver, B. L., Bossi, J. E., & Cordell, H. K. (1985). Trends in user fees at federal outdoor recreation areas. In *Proceedings national outdoor recreation trends symposium II, 1*, 222-241. Atlanta, GA: USDI National Park Service, Science Publications office.

Driver, B. L., Tinsley, H. E. A., & Manfredo, M. J. (1991). The paragraphs about leisure and recreation experience preference scales: Results from two inventories designed to assess the breadth of the perceived psychological benefits of leisure. In Driver, B. L., Brown, P. J. & Peterson, G. L. (eds.), *Benefits of Leisure.* Venture Publishing, Inc, State College, Pennsylvania.

Duffield, J. (1988). *The net economic value of elk hunting in montana.* Montana Department of Fish, Wildlife and Parks, Helena, MT.

Duffield, J. & Neher, C. (1990). *A contingent valuation assessment of montana deer hunting: attitudes and economic benefits.* Montana Department of Fish, Wildlife, and Parks, Helena, MT.

Ellerbrock, M. (1982). Some straight talk on user fees. *Parks and Recreation,* January, 59-62.

Englin, J. & Shonkwiler, J. S. (1995). Estimating social welfare using count data models: An application to lon-run recreation demand under conditions of endogenous stratification and truncation. *Review of Economics and Statistics 77*(1), 104-112.

Fix, P. & Loomis, J. (1997). The economic benefits of mountain biking at one of its meccas: An application of the TCM to Moab, Utah. *Journal of Leisure Research, 29*(3), 342-352.

Fix, P. J., Pierce, C. L., & Manfredo, M. J. (2001). Estimating demand for deer and elk hunting in Colorado. (Project Report No. 42.). Project report for the Colorado Division of Wildlife. Ft. Collins: Colorado State University, Human Dimensions in Natural Resources Unit.

Fried, B. M., Adams, R. M., Berrens, R. P. & Begland, O. (1995). Willingness to pay for a change in elk hunting quality. *Wildlife Society Bulletin 23*(4), 680-686.

Frankel, L. R. (1982). *On the definition of response rates.* A special report of the CASRO Task Force on completion rates. New York: Council of American Survey Research Organizations.

Fulton, D.C., Manfredo, M.J., & Lipscomb, J. (1996). Wildlife value orientations: A conceptual and measurement approach. *Human Dimensions of Wildlife, 1*(2) 24-47.

Giraud, K. L. (1999). *Testing for robustness of dichotomous choice contingent valuation willingness to pay estimates for threatened and endangered wildlife.* Unpublished Ph.D. dissertation, Depart of Agricultural and Resource Economics, Colorado State Univeristy, Fort Collins, CO.

Glass, G. V. & Hopkins, K. D. (1996). *Statistical methods in education and psychology, 3rd ed.* Allyn & Bacon, Boston, Massachusetts.

Greene W. H. (1997). *Econometric analysis, 3rd ed.* Prentice Hall, New Jersey.

Gujarati, D. N. (1995). *Basic econometrics, 3rd ed.* McGraw Hill, New York, NY.

Hanemann, M. W. (1994). Valuing the environment through contingent valuation. *Journal of Economic Perspectives, 8*(4), 19-43.

Harris, C. C. & Driver, B.L. (1987). Recreation user fees: I. Pros and cons. *Journal of Forestry*, May: 25-29.

Harris, C. C., Driver, B. L., McLaughlin, W. J. (1989). Improving the contingent valuation method: A psychological perspective. *Journal of Environmental Economics and Management, 17*, 213-229.

Humphrey, G. M. (1976). *Management preferences of several types of Colorado deer hunters*. Unpublished Master's Thesis, Recreation Resources Department, Colorado State University, Fort Collins, CO.

Hyman, D. N. (1988). Modern Microeconomics: *Analysis and applications, 2nd ed.* Irwin, Boston, MA.

Jakus, P. M., Dowell, P., & Murray, M. N. (2000). The effect of fluctuating water levels on reservoir fishing. *Journal of Agricultural and Resource Economics, 25*(2, 520-532.

Jakus, P. M., Fly, J. M., Stephens, B. (1997). Estimating Tennessee residents' willingness to pay for teaming with wildlife. *Human Dimensions of Wildlife, 2*(3), 15-25.

Johnson, D. M. & Walsh, R. G. (1988). Economic benefits of low medium and high skilled anglers. Paper presented at the 30th annual conference of the Western Social Science Association, Denver, CO, April, 29, 1988.

Kahneman, D. & Knetsch, J. K. (1992). Valuing public goods: The purchase of moral satisfaction. *Journal of Environmental Economics and Management, 22*, 55-70.

Kaoru, Y., Smith, V. K., Liu, J. L. (1995). Using random utility models to estimate the recreational value of estuarine resources. *American Journal of Agricultural Economics, 77*(1), 141-151.

Kerr, G. N. & Manfredo, M. J. (1991). An attitudinal based model of pricing for recreational services. *Journal of Leisure Research, 23*(1), 37-50.

Kontogianni, A., Skourtos, M. S., Langford, I. H., Bateman, I. J., & Georgiou, S. (2001). Integrating stakeholder analysis in non-market valuation of environmental assests. *Ecological Economics, 37*, 123-138.

Krannich, R. S., Eisenhauer, B. W., Field, D. R., Pratt, S., & Luloff, A. E. (1999). Implications of the National Park Service recreation fee demonstration program for park operators and management: Perceptions of NPS managers. *Journal of Park and Recreation Administration, 17*(3), 35-52.

Leuschner, W. A., Cook, P. S., Roggenbuck, J. W., & Oderwald, R. G. (1987). A comparative analysis for wilderness user fee policy. *Journal of Leisure Research, 19*(2), 101-114.

Loomis, J. B. (1988). Contingent valuation using dichotomous choice models. *Journal of Leisure Research, 20*(1), 45-56.

Loomis, J. B. (1989). Quantifying the economic value of public trust resources using the contingent valuation method: A case study of the Mono Lake decision. *Transactions of the 54th North American wildlife and natural resource conference.*

Loomis, J., Brown, T., Lucero, B. & Peterson, G. (1996). Improving validity experiments of contingent valuation methods: Results of efforts to reduce the disparity of hypothetical and actual willingness to pay. *Land Economics, 72*(4), 450-461.

Loomis, J. & Fix, P. (1998). Testing the importance of fish stocking as a determinant of the demand for fishing license and fishing effort in Colorado. *Human Dimensions of Wildlife 3*(3), 46-61.

Loomis, J., Lockwood, M., & DeLacy, T. (1993). Some empirical evidence on embedding effects in contingent valuation of forest protection. *Journal of Environmental Economics and Management, 24*, 45-55.

Loomis, J. B. & Walsh, R. G. (1997). *Recreation economic decisions: Comparing benefits and cost, 2nd ed.* Venture Publishing Inc., State College, PA.

Manfredo, M. J. & Anderson, D. (1987). The influence of activity importance and similarity on perception of recreation substitutes. *Leisure Sciences, 9*, 77-86.

Manfredo, M. J., Driver, B. L., & Tarrant, M. A. (1996). Measuring leisure motivation: A meta-analysis of the recreation experience preference scales. *Journal of Leisure Research, 28*(3), 188-213.

Martin, S. R. (1999). A policy implementation analysis of the recreation fee demonstration program: Convergence of public sentiment, agency programs, and policy principles? *Journal of Park and Recreation Administration, 17*(3), 15-34.

McCarville, R. E. (1991). An empirical investigation of the influence of cost information on willingness to pay for public aerobics classes. *Leisure Sciences, 13*, 85-96.

McCarville, R. E. (1995). Pricing for public leisure services: An ethical dilemma? *Journal of Applied Recreation Research, 20*(2), 95-108.

McCloskey, B. (2000, August 31). Memorandum to colorado wildlife commissioners regarding preliminary fee proposal. Colorado Division of Wildlife.

Miller, R. R., Prato, A. A., & Young, R. A. (1977). Congestion, success and the value of Colorado deer hunting experiences. *Transactions of the 42nd North American wildlife conference*, 129-136.

Mitchell, R. C. & Carson, R. T. (1988). Evaluating the validity of contingent valuation studies. In Peterson, G. L., Driver, B. L., & Gregory, R. (*eds.*). *Amenity Resource Valuation.* Venture Publishing, Inc. State College, Pennsylvania.

More, T. A. (1999). A functionalist approach to user fees. *Journal of Leisure Research, 31*(3), 227-244.

Nunnally, J. C. & Bernstein, I. H. (1994). *Psychometric theory.* McGraw-Hill, Inc., New York, New York.

Portney, P. R. (1994). The contingent valuation debate: Why economists should care. *Journal of Economic Perspectives, 8*(4), 3-17.

Reiling, S. D., Cheng, H. T., & Trott, C. (1992). Measuring the discriminatory impact associated with higher recreational fees. *Leisure Sciences, 14*, 121-137.

Remington, T. E., Manfredo, M. J., Vaske, J. J., & DeMasso, S. M. (1996). Fee Hunting in Colorado: Experimental Evidence. *Human Dimension of Wildlife, 1*(1), 51-59.

Roach, B., Loomis, J., & Motroni, R. (1996). Economic analysis of deer management alternatives on public lands in Northern California. *Human Dimensions of Wildlife, 1*(2), 14-23.

Rosenthal, D. H. (1987). The necessity for substitute prices in recreation demand analyses. *American Journal of Agricultural Economics*, November, 828-837.

Schneider, I. E. & Budruck, M. (1999). Displacement as a response to the federal recreation fee program. *Journal of Park and Recreation Administration, 17*(3), 76-84.

Schultz, J. H., McAvoy, L. H., & Dustin, D. L. (1988). What are we in business for? *Parks and Recreation*, January, 52-55.

Sellar, C., Stoll, J. R. & Chavas, JP. (1985). Validation of empirical measures of welfare change: A comparison of nonmarket techniques. *Land Economics 61*(2), 156-174.

Shebly, B. & Vaske, J. J. (1991). Resource and activity substitutes for recreational salmon fishing in New Zealand. *Leisure Sciences, 13*, 21-32.

Smith, V. K. (1992). Arbitrary values, good causes, and premature verdicts. *Journal of Environmental Economics and Management, 22*, 71-89.

Smith, V. K. (2000). *JEEM* and non-market valuation: 1974-1998. *Journal of environmental Economics and Management 39*, 351-374.

Sorg, C. F. & Nelson, L. J. (1986). *Net Economic Value of Elk Hunting in Idaho.* Resource Bulletin RM-12, USDA, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO., p. 1-21.

Stevenson, S. (1989). A test of peak load pricing on senior citizen recreationists; A case study of Steamboat Lake State Park. *Journal of Park and Recreation Administration, 7*(1): 58-68.

Sutton, S. G., Stoll, J. R., & Dittion, R. B. (2001). Understanding anglers' willingness to pay increased fishing license fees. *Human Dimensions of Wildlife, 6*(2), 115-130.

Taylor, J. G., Vaske, J. J., Shelby, L. B., Donnelly, M. P., & Browne-Nunez, C. M. (In review). Visitor displacement in response to demonstration fees at national wildlife refuges.

Teisl, M., Boyle, K. J., Record, R. E. Jr. (1999). License-sales revenues: Understanding angler and hunter reactions to changes in license prices. *Human Dimensions of Wildlife, 4*(4), 1-17.

United States General Accounting Office. (1996). *Fees for recreation special-use permits do not reflect fair market value.* Report to the Chairman, Subcommittee on Oversight of Government Management and the District of Columbia, Committee on governmental Affairs, U.S. Senate. GAO/RCED-97-16

United States General Accounting Office. (1997). *Federal user fees: Budgetary treatment, status, and emerging management issues.* Report to the Chairman, Committee on the Budget, House of Representatives. GAO/AIMD-98-11

United States General Accounting Office. (1999). *Recreation Fees: Demonstration program successful in raising revenues but could be improved.* Statement of Barry T. Hill, Associate Director, Energy, Resources, and Science Issues, Resources, Community, and Economic Development Division. Report number GAO/T-RCED-99-77.

U.S. Department of the Interior, Fish and Wildlife Service and U.S. Depart of Commerce, Bureau of the Census. (1997). *1996 National survey of fishing, hunting and wildlife associated recreation.* Washington, D.C.

U.S. Department of the Interior. (1986). Natural resource damage assessments; Final rule. *Federal Register 51*:148, 27674-27753.

U.S. Forest Service. (2000). *Recreation fee demonstration program: Investing in the great outdoors.* Report available online at www.fs.fed.us/recreation/fee_demo/fee_intro.shtml.

U.S. Water Resources Council. (1983, April 14). Principles, standards, and procedures for planning water and related land resources. *Federal Register 45*:73, 25301-25348.

Varian, H. R. (1990). *Intermediate Microeconomics: A Modern Approach 2nd ed.* New York, New York: W.W. Norton Co.

Vaske J. J. & Donnelly M. P. (1999). A value-attitude-behavior-model predicting wildland preservation voting intentions. *Society and Natural Resource 12*, pp. 523-537.

Vaske, J. J., Donnelly, M. P., & Taylor, J. G. (1999). The price is about right: National Wildlife Refuge visitors' evaluation of the fee demonstration program. *Human Dimension of Wildlife, 4*(4), 62-72.

Weisberg, S. (1985). *Applied linear regression, 2nd ed.* New York, NY, John Wiley & Sons.

Whittaker, D. & Vaske, J. J. (1998). Mail versus telephone surveys: Potential biases in expenditure and willingness-to-pay data. *Journal of Park and Recreation Administration, 16*(3), 15-30.

Willis, C. E., Canavan, J. J., & Bond, R. S. (1975). Optimal short-run pricing policies for a public campground. *Journal of Leisure Research, 7*(2), 108-113.

Wu, E. (2000). *Economic value of increased recreational deer harvest in the San Jacinto mountains of California: A comparison of travel cost and contingent valuation methodologies.* Unpublished Master's Thesis, Department of Agricultural and Resource Economics, Colorado State University, Fort Collins, CO.

APPENDIX A

SURVEY INSTRUMENT USED FOR CVM STUDY

1. Version Number.

| V| .| 0| 5| 1| 3| 9| 7| ,| | 5| :| 2| 5| | P| M|

2. Current date.

19|__|__|-|__|__|-|__|__|
Year Month Day

3. Interviewer name.

|__|__|__|__|__|

4. Is this a resident of Colorado or a nonresident?

|__| 1. RESIDENT
|__| 2. NONRESIDENT

5. What is the DEER license price increase amount for this subject?

|__|__|__|

6. What is the ELK license price increase amount for this subject?

|__|__|__|

7. Hello, my name is ________. I'm calling from Responsive Management on behalf of the Colorado Division of Wildlife. May I speak to ______?

|__| 1. YES . . . Thank you. (GO TO QUES. #9)
|__| 2. NO, THEY'RE NOT IN RIGHT NOW (GO TO QUES. #8)
|__| 3. NO, THEY ARE NOT AT THIS NUMBER (GO TO QUES. #11)
|__| 4. LANGUAGE PROBLEM (GO TO QUES. #11)
|__| 5. BAD NUMBER (BUSINESS, FAX, DISCONNECTED: GO TO Q. #11)
|__| 6. JUST PLAIN "NO" (GO TO QUES. #11)

8. Is there a better time when I could call back to reach him/her? (Record time to call back or if refusal). Thank you. Have a good evening.

|__| 1. Recorded better time and/or number to call back. (GO TO QUES. #30)
|__| 2. Do not call back: refusal. (GO TO QUES. #11)

9. Hello, my name is _________. I'm calling from Responsive Management. We're calling on behalf of the Colorado Division of Wildlife regarding your big game hunting experiences. The Colorado Division of Wildlife selected your name from a random sample of 1996 big game hunting licenses. We're calling this evening regarding your own hunting experiences and to get your input on management issues facing the Colorado Division of Wildlife. All of your answers will remain confidential. Would you have about 5 minutes to answer just a few questions? Before we begin, are you at least 18 years old?

|__| 1. YES (GO TO QUES. #13)
|__| 2. NO
|__| 3. NOT AN ADULT (GO TO QUES. #11)

10. Could you please answer just one quick question?

|__| 1. YES (GO TO QUES. #12)
|__| 2. NO

11. Sorry for disturbing you. Have a good evening.

|__| 1. Press return to continue (GO TO QUES. #28)

12. Thank you. Did you hunt in Colorado last year for either deer, elk, both deer and elk, or did you not hunt last year for deer or elk in Colorado?
(NOTE TO INTERVIEWER: THIS IS A NONRESPONSE QUESTION)

|__| 1. HUNTED FOR DEER ONLY (GO TO QUES. #27)
|__| 2. HUNTED FOR ELK ONLY (GO TO QUES. #27)
|__| 3. HUNTED FOR BOTH DEER AND ELK (GO TO QUES. #27)
|__| 4. DID NOT HUNT LAST YEAR FOR EITHER DEER OR ELK IN COLORADO (GO TO QUES. #27)

13. Thank you. First of all, did you hunt in Colorado last year for either deer, elk, both deer and elk, or did you not hunt last year for deer or elk in Colorado?

|__| 1. HUNTED FOR DEER ONLY
|__| 2. HUNTED FOR ELK ONLY
|__| 3. HUNTED FOR BOTH DEER AND ELK
|__| 4. DID NOT HUNT LAST YEAR FOR EITHER DEER OR ELK IN COLORADO

IF (QUES. #4 = 2) GO TO QUES. #19

14. The Colorado Division of Wildlife is faced with several problems in managing for big game hunting in Colorado. Important issues include complaints of crowding, declines in deer populations, and decreased availability of mature bulls and bucks. In the next few questions, we'll be asking about possible solutions that involve license fee changes. Currently, resident deer licenses cost $20 and elk licenses are $30.

15. One/Another approach is to increase license fees of both residents and nonresidents. This approach would reduce the number of other hunters and increase harvest rates. Assume you are considering big game hunting in Colorado next year. We would like to know whether you would buy a deer license if its price were increased by $ #5 and whether you would buy an elk license if its price were increased by $ #6. The process for obtaining a license would not change. Would you purchase:

|__| 1. A DEER LICENSE IN COLORADO (GO TO QUES. #17)
|__| 2. AN ELK LICENSE IN COLORADO (GO TO QUES. #17)
|__| 3. BOTH A DEER AND ELK LICENSE IN COLORADO (GO TO Q.#17);
|__| 4. NEITHER (GO TO QUES. #16)
|__| 5. BLANK/UNDECIDED (Don't read aloud) (GO TO QUES. #16)

16. Could you briefly describe why you would not purchase either a deer or elk license to hunt in Colorado?

____

____

17. One/another approach is to increase license fees while also placing limits on hunter numbers by requiring an advanced draw. In order to obtain a license to hunt DEER in Colorado, residents would have to apply for a deer license by the first week of April. Only those whose applications are drawn would be allowed to hunt. Applicants would be notified in early June. This approach would reduce the number of other hunters and increase harvest rates. Assume you are considering big game hunting in Colorado next year. We would like to know whether you would buy a deer license if its price were increased by $ #5 and whether you buy an elk license if its price were increased by $ #6, AND you had to participate in an advanced draw for deer licenses. Would you purchase:

|__| 1. A DEER LICENSE IN COLORADO (GO TO QUES. #24)
|__| 2. AN ELK LICENSE IN COLORADO (GO TO QUES. #24)
|__| 3. BOTH A DEER AND ELK LICENSE IN COLORADO; (GO TO Q. #24)
|__| 4. NEITHER (GO TO QUES. #18)
|__| 5. BLANK/UNDECIDED (Don't read aloud) (GO TO QUES. #18)

18. Could you briefly describe why you would not purchase either a deer or elk license to hunt in Colorado?

____

____

GO TO QUES. #24.

19. The Colorado Division of Wildlife is faced with several problems in managing for big game hunting in Colorado. Important issues include complaints of crowding, declines in deer populations, and decreased availability of mature bulls and bucks. In the next few questions, we'll be asking about possible solutions that involve license fee changes. Currently, nonresident deer licenses cost $150 and elk licenses are $250.

20. One/Another approach is to increase license fees of both residents and nonresidents. This approach would reduce the number of other hunters and increase harvest rates. Assume you are considering big game hunting in Colorado next Year. We would like to know whether you would buy a deer license if its price were increased by $ #5 and whether you would buy an elk license if its price were increased by $ #6. The process for obtaining a license would not change. Would you purchase:

|__| 1. A DEER LICENSE IN COLORADO (GO TO QUES. #22)
|__| 2. AN ELK LICENSE IN COLORADO (GO TO QUES. #22)
|__| 3. BOTH A DEER AND ELK LICENSE IN COLORADO (GO TO Q. #22);
|__| 4. NEITHER (GO TO QUES. #21)
|__| 5. BLANK/UNDECIDED (Don't read aloud) (GO TO QUES. #21)

21. Could you briefly describe why you would not purchase either a deer or elk license to hunt in Colorado?

____

____

22. One/another approach is to increase license fees while also placing limits on hunter numbers by requiring an advanced draw. In order to obtain a license to hunt BOTH DEER AND ELK in Colorado, nonresidents would have to apply for a deer or elk license by the first week of April. Only those whose applications are drawn would be allowed to hunt. Applicants would be notified in early June. This approach would reduce the number of other hunters and increase harvest rates. Assume you are considering big game hunting in Colorado next year. We would like to know whether you would buy a deer license if its price were increased by $ #5 and whether you would buy an elk license if its price were increased by $ #6, AND you had to participate in an advanced draw for both deer and elk licenses. Would you purchase:

|__| 1. A DEER LICENSE IN COLORADO (GO TO QUES. #24)
|__| 2. AN ELK LICENSE IN COLORADO (GO TO QUES. #24)
|__| 3. BOTH A DEER AND ELK LICENSE IN COLORADO (GO TO Q. #24);
|__| 4. NEITHER (GO TO QUES. #23)
|__| 5. BLANK/UNDECIDED (Don't read aloud) (GO TO QUES. #23)

23. Could you briefly describe why you would not purchase either a deer or elk license to hunt in Colorado?

____

____

24. Finally, we're interested in knowing what characteristics of your big game hunting experience are important to you. We would like you to rank, among 3 factors, what is most to least important to you when big game hunting in Colorado: few contacts with other hunters, obtaining meat, or harvesting a trophy animal. First, of these three, what is most important to you?

|__| 1. FEW CONTACTS WITH OTHER HUNTERS
|__| 2. OBTAINING MEAT; OR
|__| 3. TO GET A TROPHY ANIMAL
|__| 4. BLANK

25. What is the second most important type of experience to you?

|__| 1. FEW CONTACTS WITH OTHER HUNTERS
|__| 2. OBTAINING MEAT; OR
|__| 3. HARVESTING A TROPHY ANIMAL
|__| 4. BLANK

26. And so the least important thing to you is:

|__| 1. FEW CONTACTS WITH OTHER HUNTERS
|__| 2. OBTAINING MEAT; OR
|__| 3. HARVESTING A TROPHY ANIMAL
|__| 4. BLANK

27. Okay, that's all the questions I have tonight/today. Thank you very much for your time, your responses have been very valuable to us. Have a good evening/day (HANG UP.) Record gender (DO NOT ASK).

|__| 1. MALE
|__| 2. FEMALE
|__| 3. DON'T KNOW

28. Please record the subject's telephone number

|__|__|__|__|__|__|__|__|__|__|

29. Please record state of residence.

|__|__|__|

30. Finished. This is your last chance to check answers. What was the outcome of this call?

|__| 1. COMPLETED AN INTERVIEW
|__| 2. COMPLETED THE ONE NONRESPONSE QUESTION
|__| 3. REFUSAL
|__| 4. BAD NUMBER (WRONG NUMBER, DISCONNECTED, BUSINESS, FAX)
|__| 5. LANGUAGE BARRIER
|__| 6. CALLED 5 TIMES - DROP FROM LIST

33. Finished. This is your last chance to check answers. Do you wish to save?

|__| 1. YES
|__| 2. NO DON'T SAVE THIS