United States
Department of
Agriculture

Forest Service

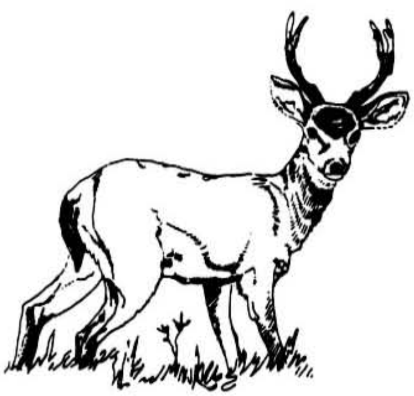
**Rocky Mountain
Forest and Range
Experiment Station**

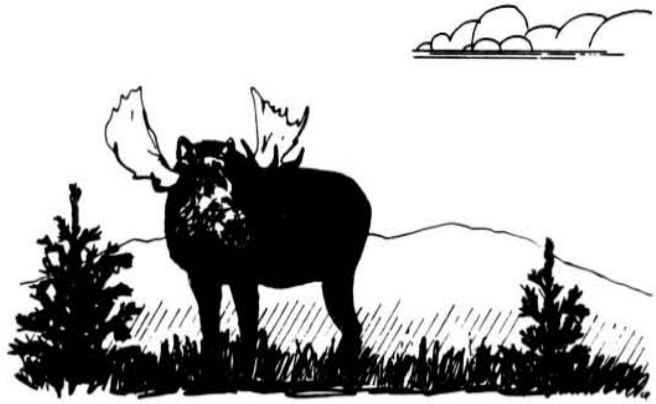
Fort Collins,
Colorado 80526

**Resource Bulletin
RM-16**

Economic Value of Big Game Hunting in Southeast Alaska

Cindy S. Swanson, Michael Thomas, and Dennis M. Donnelly





Acknowledgment

This study was a cooperative effort of the Alaska Department of Fish and Game and the USDA Forest Service.

Swanson, Cindy S.; Thomas, Michael; Donnelly, Dennis M. 1989. Economic value of big game hunting in southeast Alaska. Resour. Bull. RM-16. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 11 p.

Surveys in southeast Alaska in 1984 and 1985 were the basis for estimating net willingness to pay of hunters. Net willingness to pay was highest for resident deer hunters ($331) and lowest for nonresident moose hunters ($55). Relationship between willingness to pay and expenditures is discussed.

Keywords: Big game hunting, economic value, Travel Cost Method, southeast Alaska.

USDA Forest Service
Resource Bulletin RM-16

December 1989

Economic Value of Big Game Hunting in Southeast Alaska

Cindy S. Swanson, Economist
Rocky Mountain Forest and Range Experiment Station[1]

Michael Thomas, Biometrician
Alaska Department of Fish and Game

and

Dennis M. Donnelly, Research Forester
Rocky Mountain Forest and Range Experiment Station[1]

Abstract

Surveys of big game hunting in southeast Alaska provided data to estimate willingness to pay dollar values that complement earlier expenditure values based on the same data set. Big game species included Sitka black-tailed deer, mountain goat, and moose. Expenditures ranged from $529 for resident deer hunting to $2,557 for nonresident mountain goat hunting. Net willingness to pay was highest for resident deer hunting ($331) and lowest for nonresident moose hunting ($55). The appropriate use of, and relationship between, expenditures and net willingness to pay values are discussed. Management applications are given. (Dollar values are rounded to the nearest dollar.)

[1]Headquarters is in Fort Collins, in cooperation with Colorado State University. Swanson is now with the Northern Region (R1) of the USDA Forest Service, located in Missoula, Montana.

Contents

Economic Value of Big Game Hunting in Southeast Alaska

Cindy S. Swanson, Michael Thomas, and Dennis M. Donnelly

MANAGEMENT IMPLICATIONS

Because of the multiple resources held in public trust, federal legislation has obligated the USDA Forest Service (FS) to determine the ability of national forest lands to supply goods and services in response to society's demands. This mandate comes in the form of several key acts. The more noteworthy federal legislation addressing economics and wildlife include: the Multiple-Use and Sustained Yield Act of 1960, The National Environmental Policy Act of 1969, the Forest and Rangeland Renewable Resources Planning Act of 1974, the Sikes Act of 1974, and the National Forest Management Act of 1976.

The FS is required to consider both market and nonmarket goods in price determination. They are also required to use price-quantity relationships in developing their supply and demand curves. This economic information is then utilized during the planning process. Although the State of Alaska operates under no such mandate, the state's interest is also served by involvement in the valuation process.

The U.S. Water Resources Council's principles and guidelines (1983) sets guidelines for federal agencies to use in economic analysis of water resource development. It specifies that net willingness to pay should be the measure of value in all benefit-cost analyses or evaluation of federal actions related to water. Economic expenditures do not address the question of resource value, prompting the legislative direction to broaden the view to include economic efficiency value.

While not affected by the numerous multiple use laws, the U.S. Fish and Wildlife Service and National Park Service have recently been directed to consider economics in their decisionmaking. The U.S. Department of the Interior requires that its agencies assess natural resource changes due to management to determine, among other factors, gain or loss to society as measured in terms of net willingness to pay (USDI 1986). This analysis is exclusive of economic impact.

Although state statutory direction for resource management within Alaska is different than federal requirements, the Alaska legislature, nonetheless, addresses the need to consider economics on land retained for public use. Under Alaska Statute Title 38, economic values are considered. Section AS 38.04.015 lists, as one of the primary interests in retaining land in public use, the need to "guide the location of settlement and development to minimize public costs and maximize social and economic benefits." Furthermore, AS 38.04.065(b)(2) stipulates that when the state is considering inventory, planning, and classification of public lands, it should "consider physical, economic and social factors affecting the region or area and involve other agencies and the public in achieving a systematic interdisciplinary approach."

The Alaska Department of Fish and Game (ADF&G) would use both valuation and economic impact information to inform the state legislature about ADF&G programs and budgets. The operational costs associated with managing a program (for example, a sheep hunt) are more defensible if analysts can show lawmakers both the economic impact a hunt generates to the local economy and the value derived by participating residents. In addition, tourism is presently one of Alaska's largest industries and has much promise for future development. It is clean, renewable, and requires little capital investment. Wildlife-dependent tourism is a major source of revenue to Alaska. However, to realize this revenue, ADF&G needs to identify both the types and amounts of value associated with wildlife and work with the legislature to find ways to market its wildlife-related attractions.

When ADF&G and the state legislature consider a specific project, economic studies would increase understanding about the project by showing expenditures potentially stemming from it and the resulting impact on the regional economy. For example, several wildlife agencies in other states currently use economic expenditure information to track money generated to their state's economy as a result of wildlife-related activities. This information helps them assess economic impacts to local economies resulting from changes in hunting patterns. Impact information has also been successfully used in many states to help justify programs and annual budgets, including levels of hunting license and tag fees. Only a few states have tried computing the total economic value of wildlife and used these numbers to benefit allocation decisions.

Several states currently use economic value of wildlife to help in mitigation. When state agencies participate in a mitigation process, improved benefit-cost analysis would help in all its phases. More accurate estimates of costs incurred when wildlife-based recreation is lost, along with estimates of benefits, would help provide more complete information about a proposed project.

Informing and educating the public about the value of wildlife is an evolving process. ADF&G has several projects and organized functions designed to educate users and nonusers about wildlife, its management, and its role in Alaska. It is important for people to know that wildlife, in addition to having cultural and esthetic value, has real and positive effects on local economies.

In addition, knowledge of economic wildlife values serves to help management efforts (for example, helping assess reasonable fines for game taken illegally).

Ideally, economic information could be used in an allocation process such as benefit-cost analysis. Knowing the economic value of outcomes associated with use and management of the wildlife resource allows their comparison to values derived from competing resource uses. At the federal level, the USDA FS incorporates economic values in a linear programming allocation model called FORPLAN. The USDI Bureau of Land Management similarly uses SAGERAM in its allocation process.

Even if state agencies in general do not have a formal method for incorporating efficiency values into management decisions, economic information can also help all who participate in political decision processes that allocate budgets and develop relevant legislation.

INTRODUCTION

Alaska remains one of the world's last largely pristine and unspoiled areas with an abundance of wildlife. As increased numbers of tourists visit Alaska, the demand for wildlife-related recreation will continue to grow. Alaska is also increasing the development of its oil, hard mineral, and timber resources. Generally, this development and human encroachment is incompatible with wildlife habitat and wildlife-dependent recreation. These diverse demands on Alaska's wildlife resources will continue and likely increase through the rest of this century and beyond. Thus, the role of economics will increase in importance as resource managers and administrators are forced to make difficult allocation decisions.

Presently, most federal agencies are required to examine economic effects of management decisions and use this information when considering mitigation procedures. Alaska's statutes require that economic and social benefits be maximized on state lands. Knowledge of economic value is useful when considering the budgets of both federal and state resource agencies and in educating the public on the value of wildlife to society.

In the first comprehensive attempt to measure economic value of big game hunting in southeast Alaska, the ADF&G conducted economic surveys of goat, moose, and deer hunters during 1984 and 1985. The primary objective of this study was to gain information about resource use, economic expenditures, and economic values for area planning efforts to be incorporated in the Tongass National Forest management plan revision.

The survey was designed to elicit the following information: the role of hunt site characteristics in affecting a hunter's choice of sites; hunter demographics; transportation modes and travel times; other activities engaged in while hunting; and hunting trip expenditures and economic efficiency values. Reports by Fay and Thomas (1986a, 1986b, 1986c) summarize the expenditure data, desired hunt site characteristics, hunter demographics, transportation modes and times, and list other activities engaged in while hunting. This paper will present estimates of total and net value of hunting as determined by the Travel Cost Method (TCM) of analysis.

BACKGROUND

Southeast Alaska is part of the Alexander Archipelago, running from Dixon Entrance and the Canadian border in the south to the Malaspina Glacier and Yakutat in the north. Comprised of numerous islands and bordered on the east by ice fields and glaciers, and on the west by the Gulf of Alaska, southeast Alaska is very mountainous, with abundant rock, ice, and alpine tundra. Sitka spruce, hemlock, and cedar forest occupy valleys and lower mountain slopes. Suitable habitat for Sitka black-tailed deer and mountain goat habitat is present. Several discrete riparian systems provide habitat for relatively small populations of moose. Because of its isolation and limited transportation, southeast Alaska is sparsely populated, with the majority of human habitation confined to five relatively small communities. Increased tourism and a stable resident population with an interest in hunting have led to a general increased demand for big game.

The demand for moose hunting is ever increasing in southeast Alaska. Because moose habitat is limited, huntable populations of moose are limited to only a few areas; as a result, hunter demand exceeds supply. This has led to restrictive hunting regulations and low levels of hunting success (Doerr and Sigman 1986). Mountain goat hunting is held in high regard by a select few hunters. This is due, in part, to the tendency of goats to use inaccessible areas with extremely rough terrain. The primary large game species in southeast Alaska, in terms of number harvested and hunter participation, is Sitka black-tailed deer. Deer constitute over 90% of the total big game harvest in southeast Alaska (Doerr and Sigman 1986). Deer populations are plentiful across the islands of northern southeast Alaska and easily meet hunting demands, with isolated exceptions near larger communities. Central southeast Alaska has low populations of deer, with hunting restricted or closed over large areas. This is caused, in part, by a major decline in deer numbers related to extreme winters during the early 1970's. It is generally accepted that these continued low levels of deer are caused, in part, by predation and habitat loss. The southern portion of southeast Alaska contains intermediate and locally high levels of deer, with hunter success and participation good in most areas.

METHODS

Economic Definitions

Economic value can be divided into two broad categories: efficiency value and expenditure value. Efficiency value is often referred to as net willingness to pay (WTP) or consumer surplus and is used to determine an economically efficient use of resources in the absence of established markets and market prices. Efficiency value measures benefits to society from a particular use of a resource and is appropriate for benefit-cost analysis. In contrast, expenditure value shows the cash flow in a community as a result of a particular resource use.

The concept of economic efficiency is appropriate for any process of economic exchange, whether in an established market for well-defined goods, such as lumber, or in the nonmarket context that characterizes many products derived from wildland natural resources. In many functioning economic markets, especially those approximating perfect competition, WTP is the same as market price. The nature of the market is such that no one is willing to pay more than the market price. In other types of functioning markets characterized by traits economists call "market failures," there may well be net WTP in excess of price, and this net WTP is estimated by consumer surplus. Further, demand and exchange of some products derived from natural resources (for example, hunting) is carried on in a context where the nature of "market failure" is that no market exists. But net WTP still exists, and it is measured again as consumer surplus. The central idea here is that WTP exists in, and is a prerequisite for, all kinds of economic exchange situations. The nature of the exchange mechanism determines how total and net WTP are measured, i.e., by market price, consumer surplus, or both. For further reading on these ideas, see Rosenthal and Brown (1985).

Wildlife resources provide many different benefits to society, and the value of these can best be conceptualized by what has been referred to by Randall and Stoll (1983) as the "total value framework" (fig. 1). The components of total value include recreational, expenditure, commercial, bequest, existence, and option value. Values derived off-site include existence, option, and bequest values. Values from on-site uses can be further

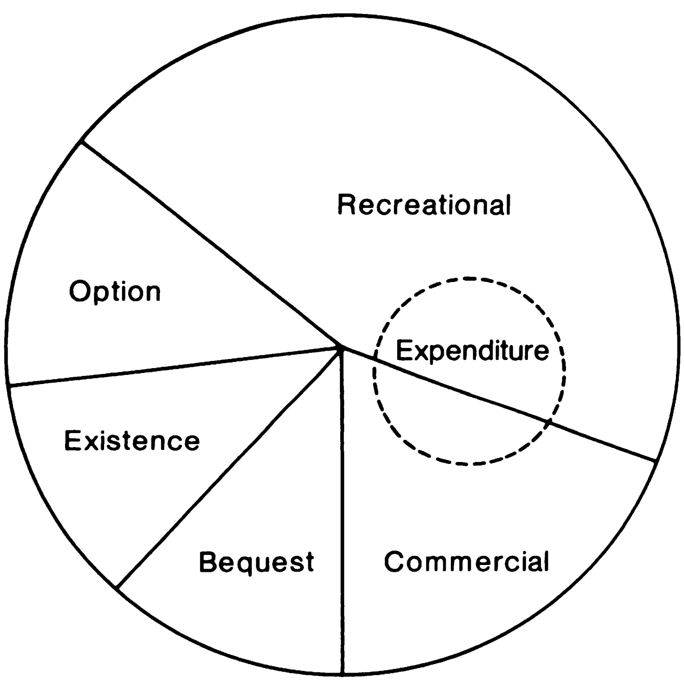


Figure 1.—Total value of wildlife.

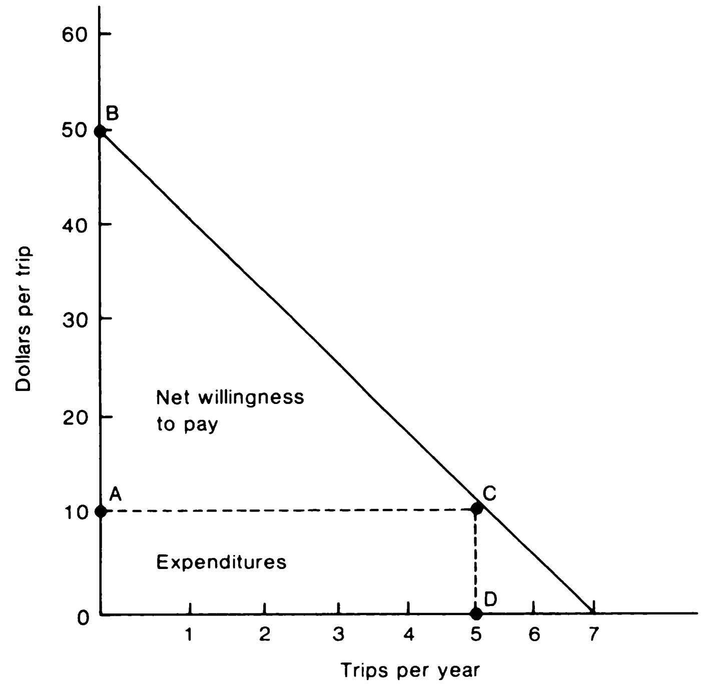


Figure 2.—Hypothetical hunter demand curve for moose hunting.

divided into consumptive (i.e., hunting and fishing) and nonconsumptive (i.e., viewing and photography) values.

Recreational net economic value represents a hunter's WTP over and above current expenditures for the hunting experience. Option value is WTP to maintain the resource so it is available to the individual in the future. Existence value is the benefit to the individual of simply knowing a resource exists even though he or she has no intention of using it. WTP to maintain a resource for future generations is referred to as bequest value.

Expenditures can be expressed in terms of gross hunting expenditures and are a component of both recreation and commercial values. Expenditures are important from the standpoint of local economies, but do not represent the total economic value of wildlife. Hunters' expenditures can be used to calculate the multiplier effects of expenditures on local income and employment; they do not represent the economic value of wildlife from an efficiency standpoint. The demand curve in figure 2 illustrates the difference between expenditures and net WTP. Consider the moose hunter who has the demand curve which shows the number of trips the hunter would take when faced with alternative travel costs (prices). From this curve, if travel costs are $10 per trip, the hunter will take 5 hunting trips per year. Therefore, total expenditures are $50 (in fig. 2, area OACD = 5 trips x $10 per trip) and net WTP equals the area above expenditures or $100 {area ABC = [($50-$10) × 5 trips] x 1/2}. The $50 provides information on community and multiplier impacts of these expenditures while the $100 represents the economic value used in benefit-cost analysis. The cost to the hunter is $50, but he is willing to pay a total of $150 (area OBCD) for those 5 trips; therefore, the hunter receives a "profit" (i.e., consumer surplus) of $100. The lower the cost of hunting, the higher the net benefit (surplus) that accrues to the hunter.

Techniques for Measuring Net WTP

The Travel Cost Method and Contingent Value Method are designed to estimate net economic values useful for analyses of the economic efficiency of resource allocation, especially in the absence of market prices.

Travel Cost Method (TCM)

TCM's are a subset of household production function models (Bockstael and McConnell 1981, 1983). In the household production approach, economists assume the household is, in effect, a "factory." Take hunting, for example. The household acquires factors of production such as time and travel, capital in the form of equipment, labor in the form of the individual's own exertions, and other resources in the form of habitat and animals. The household essentially "manufactures" hunting experiences from these factors of production. The TCM uses the price paid for a marketed input quantity, such as travel, to infer the price an individual is willing to pay for a trip to a specific site. TCM has had a wide application (Sorg and Loomis 1985) and is a technique recommended for recreation valuation studies by the U.S. Water Resources Council (1983). In the case of the southeast Alaska study, consumers experience hunting trips.

The key question one asks when using TCM is how much more would each participant be willing to pay, over and above current expenses, to gain the experience. That WTP in excess of current expenditures is consumer surplus. To estimate this benefit value, those using TCM collect expenditure and quality of experience data. These include distances traveled, both travel costs and other costs directly related to the trip, quality of experience data, potential site substitutes, and total number of trips.

A generalized regional TCM was used in this study. This model allowed incorporation of site substitute and quality variables for specific hunting sites (Cesario and Knetsch 1970, Hoehn and Krieger 1988). This method requires extensive data to allow estimation of trips per capita of the form:

$$V_{ij}/N_i = f(TC_{ij}, S_i, Q_j, E_i) \qquad [1]$$

where

V_{ij} = number of trips by residents in origin i to site j;
N_i = population of origin i;
TC_{ij} = average round-trip travel distance from origin i to site j;
S_i = measure of substitute sites available to origin i;
Q_j = measure of quality at site j;
E_i = socioeconomic variables of origin i.

The regional TCM requires that individuals be grouped based on communities (e.g., counties or states) of origin and uses the sum of trips across all individuals and a weighted average of round-trip travel distance within each origin. The dependent variable, trips per capita, adjusts for population differences between communities (states) of origin. Trips per capita takes into account the number of trips as a function of origin population. Independent variables that may explain variation in trips per capita include travel distance from the community of origin to the hunting site, quality of the hunting site, substitute sites available, per capita income of the originating community, and any other socioeconomic variables that are significant to predicting trips per capita. Quality measures can include harvest levels, hunting success rate, length of hunting season, or any other important physical or biological variables associated with the sites. Substitute measures may include travel cost to the next best site, harvest per mile traveled to the next best site, or total harvest at the next best site.

Equation [1] specifies the per capita demand curve for the hunting sites in the region. By setting the quality variable at a measure associated with a specific hunting unit, the generalized demand curve becomes the demand curve for trips to that site. Once the regression has been established as a demand curve, the second stage takes this demand curve and plots total trips to each site as a function of hypothetical added distances. These hypothetical distances are converted to travel costs (in dollars), and the area under the second stage demand curve (over and above actual costs) represents net WTP. It is net WTP because only the added cost is reflected in the second stage demand curve. Current costs are not included in the calculation.

Several key assumptions must be made to use TCM (Dwyer et al. 1977, Rosenthal et al. 1984). An individual is assumed to respond identically to either increases in entry fees or increases in travel costs. In either instance, the price of a trip and its associated experience has increased. The TCM is assumed to be properly specified with all relevant and statistically significant variables. Hunting capacity is assumed to be unlimited in the sense that all current demand can be accommodated. This particular assumption must be examined carefully when one estimates economic benefits for species or populations on which harvest quotas are imposed. When permits are limited, capacity is both biologically and administratively restricted. To account for these particular conditions with respect to permit-rationed hunting, the dependent variable of the TCM must reflect permit applications (Loomis 1982).

Contingent Valuation Method (CVM)

Although TCM relies on analysis of actual consumer behavior, CVM examines the intent of consumers contingent upon carefully specified conditions. The heart of the data gathering phase of CVM is a survey asking consumers how much they would be willing to pay for a given recreation experience. Questions are frequently phrased in a bidding game format and worded carefully to avoid several types of biased responses (see paper by Hoehn and Krieger (1988) for a complete discussion).

CVM techniques are operationally simpler than TCM, but wording and structure of the survey instrument must be sophisticated to minimize biased responses. A typical approach is to determine how much an activity would have to cost (this is called "threshold amount") before participants stop taking part or go elsewhere. This threshold amount is often approached incrementally, as a series of "bids," not as a single lump sum amount. The bid threshold is collected along with other data such as amount actually spent to participate, and relevant socioeconomic data such as education or income. These data allow the analyst to directly estimate WTP and test hypotheses about WTP as a function of the socioeconomic variables collected in the survey.

Introductory treatment of CVM is given in Dwyer et al. (1977) and Hoehn and Krieger (1988). Bishop and Heberlein (1979) and Schulze et al. (1981) discuss CVM biases. Brookshire et al. (1980) used CVM to conduct an experiment designed to compare WTP estimates to a study of property values based on attributes of the property and surrounding areas. The U.S. Water Resources Council (1983) also recommends CVM as a valuation technique.

Survey Design and Implementation

In 1984, ADF&G mailed a survey instrument (Fay and Thomas 1986b, 1986c)[2] to all resident and nonresident moose permit and harvest ticket holders (1,121 people), and all goat permit holders (537 people) eligible for hunting in southeast Alaska. A follow-up reminder postcard was mailed 2 weeks later. A second reminder and survey booklet were mailed to nonrespondents 4 weeks after the reminder postcard. The response rate was 52% for moose hunters and 69% for goat hunters. In 1985, the process was repeated with resident and nonresident southeast Alaska deer hunters (Fay and Thomas 1986a).[2] A 25% sample of harvest ticket recipients received a survey booklet, with a follow-up reminder postcard mailed 10 days later. Nonrespondents were mailed reminders and survey booklets 4 and 8 weeks later. The response rate was 64%. Table 1 shows sample size and response rates by species.

Table 1.—Permit numbers and sampling rate by species for 1984–1985 economic survey.[a]

Item	Mountain goat	Moose	Deer
No. of permits			
Residents	1,246	1,499[b]	12,312
Nonresidents	112	34	108
No. of active hunters			
Resident	525	1,091	8,426
Nonresident	97	30	76
Sampling rate (%)	100[c]	100[d]	25[e]
Respondents	360	581	1,819
Nonrespondents	165	540	1,040
Response rate[f] (%)	69	52	64

[a]For a complete breakdown by hunt unit see Fay and Thomas (1986a, 1986b, 1986c).
[b]Includes 250 harvest tickets.
[c]525 residents + 97 nonresidents - 85 multiple permit holders.
[d]100% of active hunters surveyed.
[e]25% of total permit holders.
[f]Response rate adjusted to account for undeliverable surveys.

Statistical Analysis

Travel Cost Analysis

Travel cost analysis for each species progressed in the following manner. The data were divided according to residents and nonresidents. A hunting trip for a resident was assumed to be single purpose and single destination; therefore, the values derived represent WTP for a hunting trip. Nonresidents were assumed to be willing to pay for a hunting experience in Alaska. While the primary purpose is hunting the species of interest and the hunting site is the primary destination, it was felt that part of the hunting experience was visiting Alaska. Hunting in Alaska may be a once-in-a-lifetime trip; therefore, part of the surplus will reflect this "Alaska experience" component. Because this situation does not apply to residents, the two groups were analyzed separately. What portion of nonresident value related to the hunting trip and what portion is derived from the Alaska experience cannot be determined from these data. Separating the components is not critical so long as the nonresident values reported are for an Alaska hunting experience.

Regression Analysis

Table 2 gives the resident and nonresident regressions along with relevant statistics. Data were grouped according to community (for near-distance origins) or multistate regional groups (for distant origins). The origin group mean air distance for each origin to each hunting site was used in analyzing the deer and mountain goat data. The origin group mean water distance for each origin/site was used in analyzing the moose data. Different distance measures were used to reflect the dominant mode of travel for each species. Total trips for each origin/site combination was divided by origin population to obtain trips per capita. Mean per capita income within the origin location was added to the data set. At this stage of aggregation, hunt site quality and substitute measures were calculated using data collected in the survey. Site quality measures were calculated to reflect hunting quality relevant to each site and substitute measures were calculated, providing a measure of the attractiveness of alternative hunting sites.

Quality variables tested and found statistically significant in the regression model varied by the species under consideration. Quality considered important to resident mountain goat hunters is reflected by the average number of days needed to harvest a goat in the hunt unit. This quality measure was significant and negative, indicating the fewer the days needed to harvest, the higher the quality of the site.

Miles of improved dirt roads available in a hunting site were significant and positive for the resident moose

[2]Copies of these reports may be available from Alaska Department of Fish and Game, Division of Habitat, P.O. Box 20, Douglas, AK 99824.

Table 2.—Regression results: the dependent variable in each case is the natural log of trips per capita, LTRIPCAP.[a]

	Intercept	MADI	CITYPCI	$CITYPCI^2$	XH855	SALL	SDALL	TOTSUE	HABS	TOTEUS	LN(IDIRT)	R^2	F	S E of regression	Sample size
Deer hunting															
Resident	-1.298	-5.86E-03	-1.67E-04		1.51	-4.48E-03	-1.22E-03	1.30				0.76	94.3	1.28	188
	(2.49)	(20.98)	(6.18)		(4.28)	(3.69)	(3.36)	(2.28)							
Nonresident	-7.93	-7.74E-04		-2.13E-08					2.10			0.94	65 27	0.33	17
	(6.01)	(10.44)		(8.39)					(1.94)						
Mountain goat hunting															
Resident	-11.41	-4.40E-03	-1.197E-03	4.59E-08						-1.65		0.91	96.82	0 90	42
	(4.63)	(18.32)	(3.68)	(4.38)						(2.48)					
Nonresident	-8.80	-5.56E-04	-2.79E-04									0.79	46 71	0.47	28
	(4.56)	(9.39)	(2.22)												
Moose hunting															
Resident	-2.64	-5.43E-03	-8.36E-09								0 328	0.71	34 27	1.46	46
	(4 18)	(9.08)	(3.77)							(4.18)					
Nonresident	-4.32	-8.73E-04	-4.52E-04									0.87	13.95	0.58	7
	(1.48)	(5.24)	(2.70)												

[a]*The t-statistic for each independent variable is shown in parentheses beneath its coefficient, where*
LTRIPCAP = natural log of trips per capita;
MADI = mean round-trip air (water) distance;
CITYPCI = origin mean per capita income;
XH855 = total hunter days weighted for hunt unit in 1985;
SALL = substitute measure based on pressure, density, and access for all closer/better sites;
SDALL = substitute measure based on number of animals harvested for closer/better sites;
TOTSUE = average number of deer per hunter day for hunt unit in 1985;
HABS = weighted value reflecting timber harvest densities and volumes for hunt unit;
TOTEUS = average days needed to harvest a mountain goat for hunt unit;
LN(IDIRT) = natural log of miles of improved dirt road in hunt unit.

hunters. With roads sparse in many areas of southeast Alaska, roaded hunting sites allow increased access and a higher probability of success. Use of this quality variable assumes, however, that hunter congestion will not be a problem.

The regression for nonresident deer hunters included a positive, significant quality variable reflecting the relative density of timber harvest for each hunt unit. Increased timber harvesting temporarily expands the field of vision for hunters resulting in a higher harvest and easier accessibility. It is also possible that clearings or stands thinned by timber harvest support increased browse species and contribute to increased deer numbers.

Two quality variables were found significant in the resident deer regression: total hunter days by all hunters in the hunt unit and average deer per hunter day spent in a hunt site. Increased hunter days reflects a more preferred hunt site and more average deer per hunter day suggests a higher success rate.

A variable to account for substitute hunting opportunities was introduced. This substitution variable allows for price, quality, and availability of substitute sites. Price is computed by using distance in miles from hunter origin i to substitute site k. The quality of substitute sites is a function of several variables describing site quality and availability including: number of public use cabins, number of harvested animals, inverse of total number of hunters frequenting the area, inverse of total hunter days spent in an area, miles of available boat anchor sites, miles of float plane access, miles of beach access, miles of road, and number of lakes. A substitution index for visited site j is calculated by finding the ratio of site quality and price not only for the visited site j, but also for each available substitute site. This ratio is the measure of cost effectiveness of alternative site k relative to recreation sites available from origin i. Any alternative site with a site quality ratio greater than the site under study becomes a cost-effective substitute. To determine the degree of substitutes for a site, the substitute ratios for all sites with substitute ratios larger than the "visited site" substitute ratio are summed for each alternative site k, origin i combination. The greater the availability of alternative sites for the site j visited, the larger the substitute index s_j. Mathematically,

$$S_j = \sum \frac{Q_k}{D_{ik}} \quad \text{for all} \quad \frac{Q_k}{D_{ik}} > \frac{Q_j}{D_{ij}} \qquad [2]$$

where

Q = quality at visited site j or alternative sight k;
D = distance from origin i to site j or k;
j = site visited;
k = potential substitute site.

With large substitute indices, there should be fewer visits and a negative sign for the substitute term regression coefficient.

Only the resident deer hunter regression produced significant substitute terms. Two substitute terms were found: a measure reflecting pressure, hunter density, and road and water access for all closer, less pressured sites; and a measure for harvested animals from closer, higher harvest sites. The first measure reflects hunter congestion and poor access while the second measure captures alternative site success rates.

Economic theory indicates that a measure of income should be included in the regression analysis to capture a recreationist's ability to purchase a hunting trip. Mean per capita income in the origin area was significant and negative in all regressions, implying that this income measure is inversely related to number of hunting trips. This may indicate an alternative type of hunting trip or different species is preferred as income increases.

A final issue relating to the regression analysis has to do with choice of functional form of the regression equation. The choice of functional form is often data dependent. Vaughan and Russell (1982) show in their study that the natural log of visits per capita better models the pattern by which trips per capita fall off at a higher travel cost than does a linear form. Bowes and Loomis (1980) suggest weighting the regression by the square root of the origin's population to correct for heteroskedasticity resulting from unequal origin populations. As with the choice of variable inclusion, choice of functional form is often left to the statistical analysis of the regression equations. A semilog model was used for all species.

Calculation of Consumer Surplus

The second stage demand curve is based on the site-specific demand curves estimated via the regression and is the basis for computing consumer surplus estimates. Theoretically, second stage curves relate price (cost for a trip) to quantity of trips taken. Site-specific regressions in this study, however, have distance, not dollars paid, as the primary independent variable. The first task in calculating consumer surplus benefits is to transform distance to dollars of travel cost, i.e., price paid for the trip.

Cost of travel from an origin to a site is comprised of transport costs and travel time costs. Transport costs, for example, are for fuel or fares. Travel time costs reflect consumer choices about expending their scarce time in an activity like hunting. Time constraints may deter some from traveling to otherwise desirable, but more distant, sites. This deterrent effect is typically modeled by valuing travel time at some fraction of the wage rate prevailing for hunters from a given origin. In this study, the specified value of travel time is $4.09.[3] This fraction is midway in a range of values found in the transportation planning literature and reflects only the time deterrent effect, not actual wages foregone because of travel (Cesario 1976).

Transforming travel distance to travel cost (price) involves the computation of cost per vehicle mile (CPVM). CPVM has two components, per person share of the vehicle cost (PPVC) and per person time cost (PPTC). This can be expressed as:

$$CPVM = PPVC + PPTC \qquad [3]$$

PPVC is the quotient of vehicle travel cost per mile (TCPM) and number of people in the hunting party (NPIP) that share the transport vehicle. Thus:

$$PPVC = TCPM / NPIP \qquad [4]$$

PPTC is the quotient of cost per person-hour (CPPH) and speed of the transport vehicle on average (SPED) Thus:

$$PPTC = CPPH / SPED \qquad [5]$$

The vertical axis of the second stage demand curve is rescaled from miles to dollars using the above relationships. For a given increment in distance, transportation cost and value of time hunters spend traveling are added together.

Finally, whenever hunters pay entry or license fees for access to public facilities or goods (e.g., hunting), the Water Resources Council (1983) notes that such payments should be counted as part of consumer surplus. Whenever hunters pay a fee to an agent of society, such as a state wildlife management agency, they are transferring a portion of total WTP (potential WTP) into actual WTP. However, from the point of view of net economic development, there is no change since it is a transfer of money from the hunter to the agency. Society has neither gained nor lost by payment of the fee. Such fees would count as benefits in a benefit-cost analysis. But, the fees must also be prorated over the number of trips taken. The net effect of including fees in the computation of benefits per trip depends on the fee magnitude and number of trips taken. Because fees are constant for a resident hunter and constant for a nonresident, they were not included in the regression analysis.

RESULTS AND DISCUSSION

Expenditures

Table 3 reports per hunter and per trip hunting expenditures by species for residents and nonresidents. Expenditures within these categories are divided into transportation/on-site costs and equipment costs. Transportation and on-site costs include boat, airplane, ferry, automobile, restaurant, lodging, license fee, and other site costs. Commercial airline fares may be an exception, particularly for nonresidents. Equipment costs include firearms, camping gear, maps, and other "prehunt" expenditures that usually are made at the individual's residence or origin. These two categories provide a rough indication of where expenses occur and, therefore, how much money is generated at both the hunt site and the hunter's origin location. For nonresidents, this information is particularly important to see how much new money is being brought into the southeast Alaskan economy.

On both a per hunter and a per trip basis, residents' expenditures were fairly evenly divided between transportation/on-site costs and equipment costs; for transportation/on-site costs, the highest average expenditure,

[3]The Alaska Department of Labor (Bruce McHardy, personal communication) reports 1983 median family income of $38,238 is earned by 1.5 individuals per family on average. Further, the $25,492 (38,238/1.5) per individual is earned working 2,080 hours per year, so the average individual hourly wage is $12.26 (25,492/2,080). One-third of this wage rate is $4.09 (12.26/3).

Table 3.—Average per hunter seasonal hunting values for 1984–1985 seasons.[a]

Item	Deer		Mountain goat		Moose	
	Resident	Nonresident	Resident	Nonresident	Resident	Nonresident
Expenditures/hunter[b,c]	$530	$1,301	$763	$2,557	$690	$2,490
Round-trip transportation and on-site expenditures	259	1,050	577	1,867	376	1,926
Equipment expenditures	279	251	378	689	307	563
Net willingness to pay/hunter	331	105	81	103	55	55
Total value/hunter	861	1,406	844	2,660	746	2,545
Expenditures/trip	239	1,249	643	2,504	609	2,351
Round-trip transportation and on-site expenditures	122	1,010	520	1,795	338	1,817
Equipment expenditures	131	241	341	663	276	531
Net willingness to pay/trip	155[d]	101[e]	73[f]	99[g]	50[h]	52[i]
Total value/trip	394	1,350	716	2,604	660	2,403

[a]*For a complete breakdown of expenditures by hunt unit see Fay and Thomas (1986a, 1986b, 1986c).*

[b]*Transportation and on-site plus equipment expenses do not necessarily sum to total expenditures as breakdown is based on hunters who had expenditures in that category. Total expenditures is over all hunters. Transportation expenditures (i.e., boat, plane, ferry, – automobile costs), on-site expenditures (i.e., restaurants, lodging, licenses, guides, etc.), and equipment expenditures (i.e., firearms, camping, maps, boats, etc.) are for those who purchased such goods and services.*

[c]*Fay and Thomas do not report resident-only expenditures. These values are obtained by determining the percent of expenditures attributable to residents. These were assumed to be 98%, 69%, and 92% for deer, mountain goat, and moose, respectively.*

[d]*95% sensitivity interval: $149 to $163.*

[e]*95% sensitivity interval: $92 to $110.*

[f]*95% sensitivity interval: $68 to $77.*

[g]*95% sensitivity interval: $78 to $110.*

[h]*95% sensitivity interval: $45 to $56.*

[i]*95% sensitivity interval: $50 to $55.*

$577, was by mountain goat hunters and the lowest, $259, was by deer hunters. Nonresidents spent significantly more money on transportation/on-site costs than they spent on equipment costs. Even allowing for fares paid to non-Alaskan commercial airlines, these on-site expenses suggest nonresidents are bringing outside money into the southeast Alaskan economy. The highest on-site average expenditure, $1,926, was by nonresident moose hunters. The lowest nonresident average expenses, $251, were for deer hunting equipment likely purchased in the hunter's community of origin.

Net Willingness To Pay

As shown, expenditures represent the cost to hunters of a hunting experience, and measure money spent in the hunt site location and money expended in the place of residence. While important to the local chamber of commerce, expenditure data give no indication of the efficient use of resources. In order to consider the efficient trade-off of several resources, one must look at net WTP values. These values are reported in table 3 and indicate how much more than their expenditures hunters are willing to pay for a hunting opportunity or hunting trip. As shown in the Applications section, if management had to decide between various uses of a parcel of land, net WTP (consumer surplus) values would be necessary for the analysis of economic efficiency. Net WTP was highest for resident deer hunters with an average value of $331 per hunter per season. This is not as surprising as a first glance might indicate since resident deer hunters have the lowest average expenditures—$530. The lowest consumer surplus was for nonresident moose hunters. The $55 average value represents WTP over and above their current average expenditures of $2,490. Put another way, moose hunters expend a large portion of their total WTP in their home and local Alaskan economies and, therefore, have little "left over" consumer surplus.

Table 3 also reports 95% sensitivity intervals for the net WTP trip values. These intervals give an indication of the sensitivity of consumer surplus values to variation within the travel cost data. The sensitivity intervals were derived in the following manner: benefits are computed three times--once with the distance ("price") coefficient at its best unbiased level, once with it at the lower level of its 95% confidence interval, and once with the distance coefficient at the upper level of its 95% confidence interval. This procedure shows how consumer surplus varies with respect to statistical variation in distance. Distance was chosen as the sensitivity variable because perturbations of this variable directly measure perturbations in hypothetical costs incurred by hunters. Sensitivity intervals had ranges of approximately $20. The narrowest interval was for nonresident moose hunters whose WTP per trip was $52 with a sensitivity interval of $50 to $55.

Total Use Value

Table 3 reports total hunting value for deer, mountain goat, and moose hunting for both residents and nonresidents on a per hunter and per trip basis. Nonresident mountain goat hunters had the highest average total value of $2,660 per hunter. The lowest average per hunter value was $746 for resident moose hunters. Figure 3 compares total hunting value for residents and nonresidents by species. The bar graph allows an easy visual distinction between expenditures, net WTP, and total value.

Figure 3 looks at total hunting value from the perspective of an average hunter. Figure 4 compares resident and nonresident hunting by species for all active hunters. For example, there are 525 active resident goat hunters (table 1). Assuming the average hunter is representative of all hunters, the number of active hunters is multiplied by the average resident goat hunter's expenditure and net WTP (table 3) to obtain average values of $400,575 and $42,525, respectively. This suggests an average total value across all active mountain goat hunters of $443,100.

Under current conditions, resident deer hunters are the largest group of active hunters. These 8,400 plus hunters, active when the 1984-85 economic survey was done, account for the greatest expenditures, net WTP, and total hunting value, $4,465,780, $2,789,006, and $7,254,786, respectively. These dollar value magnitudes may lead to the conclusion that resident deer hunting is the most economically viable hunting activity in southeast Alaska. However, several assumptions about the purpose of these values should be kept in mind.

From an expenditure standpoint, residents do not bring new money to southeast Alaska. They are recirculating money already existing in the state. Nonresident moose hunters bring in the most outside money (estimated at $1,926 per hunter for transportation and on-site expenditures). Also, less than 50% of potential resident mountain goat hunters are active; thus, current values do not accurately reflect potential values.

From an efficiency standpoint, resident deer hunting again appears the most valuable hunting resource (estimated at $331 per hunter). However, it is minimally valuable from a nonresident standpoint, especially considering the low number of nonresident hunters. The cost to the state of providing these hunting activities has not been considered. If more active management is needed to supply deer hunting, then these total values are misleading.

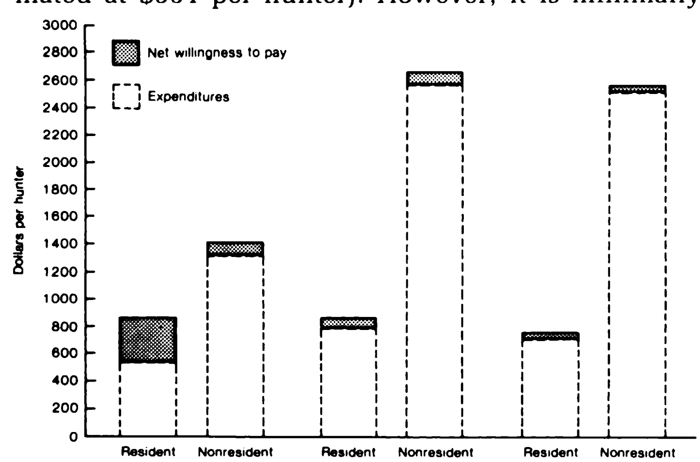


Figure 3.—Total hunting value per hunter.

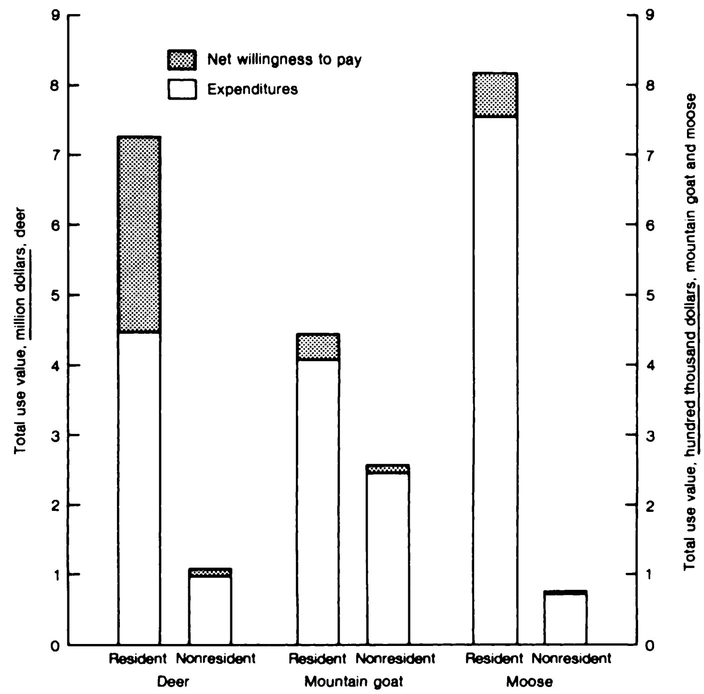


Figure 4.—Total use value for all active hunters.

Finally, only hunting values have been discussed. No consideration of nonconsumptive, option, or existence values has been made. Since deer hunting exists in most of the 50 states, it is probably safe to assume for deer hunting that these other components of total value are small and, thus, contribute little to the overall sum. Moose hunting and, even more so, mountain goat hunting, are not readily available in all 50 states. Therefore, the ability to view these species in their natural Alaskan habitat, the ability to retain an option for future use, and the desire to maintain the resource for future generations may make total value for moose and mountain goat much larger than that of deer. For a unique area such as southeast Alaska, these other values may greatly exceed deer hunting values.

The purpose of the above discussion is to point out the difficulties and subtleties of reported values. When asking questions regarding the value of wildlife, one must be specific about the context of the question and how the value derived is going to be used. Hopefully, this section helped point out the alternative issues that can be addressed in valuing wildlife.

Comparisons With Other Studies

Sorg and Loomis (1985) and Walsh et al. (1989) provide a review of Travel Cost and Contingent Value big game valuation applications. As such, the values reported are net WTP values. Walsh et al. (1989) report

1987 adjusted values for deer hunting that range from $20 to $159 for an activity day. Alaskan resident deer hunters hunted an average of 2.16 days per trip, resulting in a 1985 activity day value of $72. Nonresident hunters hunt an average of 4.13 days, resulting in an activity day value of $24. These values are well within the range found by Walsh et al. (1989).

Loomis et al. (1985) is a study that considered moose and mountain goat hunting. A travel cost study for 1984 Idaho residents reported an activity day value of $19 for moose hunting. Southeast Alaska residents hunt an average of 3.44 days, resulting in a 1984 value of $15. This value is very similar to the Idaho value. Loomis et al. (1985) report an activity day value of $48 for mountain goat in Idaho. An activity day value for residents and nonresident goat hunters in Alaska is $26 and $32, respectively, assuming 2.77 days and 3.1 days per trip. Again, these values are reasonably comparable.

APPLICATIONS

To evaluate the economic effects of tradeoffs associated with multiple use management of wildlife habitat, the following examples illustrate ways managers could use economic information.

Suppose a parcel of land could be managed such that moose numbers increase by 50%. Assume there is demand for increased moose hunting opportunities on this land. The correct way to calculate the additional benefits of this change in moose numbers and corresponding number of trips is to look at a shift in the demand curve for both residents and nonresidents. When moose numbers increase, it is assumed the demand curve shifts away from the origin as shown in figure 5. The increase in number of moose will result in current hunters taking more trips (value per hunter increases) and new hunters entering this hunt unit. If these additional moose result in 200 more resident moose trips, then the shaded area represents the increase in benefits (WTP). As a rough estimate of this area, the 200 additional resident trips is multiplied by the value per trip, $50 (from table 3), for increased benefits of $10,000. Further, assume nonresident trips increase by 50 and, thus, generate a nonresident benefit value of

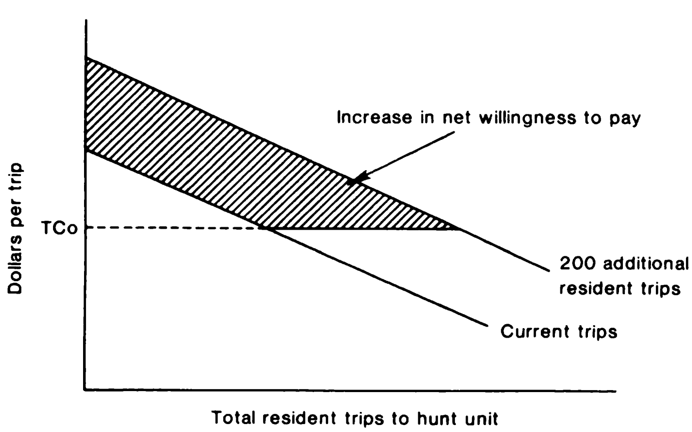


Figure 5.—Increased demand for moose hunting by resident hunters.

$2,600 (50 × $52). The total hunting value from these additional moose is $12,600. This WTP does not include other sources of total value (fig. 1).

This value of $12,600 must now be compared with the cost of managing the land to increase moose numbers. These costs may include prescribed burns, selective timber cuts, or reduced recreation traffic. If net WTP ($12,600) is greater than the cost associated with habitat improvements, economic efficiency is enhanced by the management action.

An issue separate from efficiency analysis often considered at both federal and local levels is that of impact analysis. Impact analysis does not look at the most efficient use of resources but rather the local effects of a management decision. A community may be depressed because of a loss of economic activity, such as a closed timber mill. Impact analysis would consider incremental money flow of increasing hunting trips to the local area. In this case, it would be appropriate to look at on-site trip expenditures for each additional trip. To continue our example, residents taking 200 additional moose hunting trips would spend an additional $67,600 (200 × $338). Care must be taken, however, with this resident value. If these additional trips are by people actually in the community, then the expenditures may be a reallocation of money already in the community. For example, a hunter may go to fewer movies or remove money from a local savings account in order to buy more gas for hunting trips. No money new to the community is being spent. The gas station is making more money at the expense of the movie theater or the local bank. However, money spent as a result of the 50 additional nonresident moose hunting trips is money new to the hunting community and to the state. The 50 nonresident trips in our example would each contribute $1,817 on average for a total of $90,850 of additional spending in the local economy. However, from a national standpoint it is again a reallocation of existing money since more money spent at the hunting site means less spent at the hunter's origin. As a result, impact analysis shows the movement of money from the lower 48 states to southeast Alaska but does not give any indication of the most efficient use of southeast Alaska resources.

CONCLUSIONS

Data collected in 1984 and 1985 by Alaska Department of Fish and Game were analyzed to derive expenditure and net WTP values for resident and nonresident deer, moose, and mountain goat hunters. Data were separated for analysis by resident and nonresident because the definition of a hunting trip is different for the two groups. Resident hunters are assumed to have made a trip primarily for hunting the species in question. In contrast, nonresident hunters are purchasing a more extensive hunting experience, which includes, as part of its value, an "Alaskan experience."

The results indicate that total *expenditures* per hunter are greatest for nonresident mountain goat hunters ($2,556). The greatest *net WTP value* per hunter of $331 is realized by resident deer hunters.

Travel Cost regression analysis suggests that site quality and hunt site substitutes are important factors in the choice of hunt site. This information is useful to the analysis of potential management alternatives. Additional significant variables in the regression included income and distance.

An additional and important objective of this report was to highlight the appropriate use of expenditure and net WTP value information. Expenditures show the flow of money between locations and indicate how much new money is brought into southeast Alaska as a result of big game hunting. Net WTP values are appropriate when issues of economic efficiency are being addressed. Care must be taken to use values correctly for a specific management scenario.

LITERATURE CITED

Bishop, Richard C.; Heberlein, Thomas A. 1979. Measuring values of extramarket goods: are indirect measures biased? American Journal of Agricultural Economics. 61(5): 926–930.

Bockstael, Nancy, E.; McConnell, Kenneth E. 1981. Theory and estimation of the household production function for wildlife recreation. Journal of Environmental Economics and Management. 8: 199–214.

Bockstael, Nancy E.; McConnell, Kenneth E. 1983. Welfare measurements in the household production framework. The American Economic Review. 3(4): 806–814.

Bowes, M. D.; Loomis, J. B. 1980. A note on the use of travel cost models with unequal zonal populations. Land Economics. 56(4): 465–470.

Brookshire, D. S.; Randall, A.; Stoll, J. R. 1980. Valuing increments and decrements in natural resource service flows. American Journal of Agricultural Economics. 62(3): 478–488.

Cesario, F. 1976. Value of time in recreation benefit studies. Land Economics. 52(1): 32–40.

Cesario, F.; Knetsch, J. 1970. Time bias in recreation benefit estimates. Water Resources Research. 6(3): 700–705.

Doerr, J.; Sigman, M. 1986. Human use of Pacific herring, shellfish, and selected wildlife species is southeast Alaska, with an overview of access for noncommercial harvest of fish and wildlife. Habitat Technical Report 86–5. Juneau, AK: Alaska Department of Fish and Game.

Dwyer, J. F.; Kelly, J. R.; Bowes, M. D. 1977. Improved procedures for valuation of the contribution of recreation to national economic development. Water Resources Center Report Number 128. Urbana, IL: University of Illinois. 218 p.

Fay, G.; Thomas, M. 1986a. Deer hunter economic expenditure and use survey, southeast Alaska. Habitat Technical Report 86–10. Juneau, AK: Alaska Department of Fish and Game.

Fay, G.; Thomas, M. 1986b. Mountain goat hunter economic expenditure and use survey, southeast Alaska. Habitat Technical Report 86–9. Juneau, AK: Alaska Department of Fish and Game.

Fay, G.; Thomas, M. 1986c. Moose hunter economic expenditure and use survey, southeast Alaska. Habitat Technical Report 86–8. Juneau, AK: Alaska Department of Fish and Game.

Hoehn, J. P.; Krieger, D. 1988. Methods for valuing environmental change. Staff Paper No. 88–30. Lansing, MI: Department of Agricultural Economics, Michigan State University.

Loomis, John. 1982. Effect on non-price rationing on benefits from publicly provided recreation. Journal of Environmental Management. 14: 283–289.

Loomis, John B.; Donnelly, Dennis M.; Sorg, Cindy F.; Oldenburg, Lloyd. 1985. Net economic value of hunting unique species in Idaho: bighorn sheep, mountain goat, moose, and antelope. Resour. Bull. RM–10. Fort Collins, CO: U.S. Department of Agriculture, Rocky Mountain Forest and Range Experiment Station. 16 p.

Randall, Alan; Stoll, John R. 1983. Existence value in a total value framework. In: Rowe, Robert D.; Chestnut, Lauraine G., eds. Managing air quality and scenic resources at national parks and wilderness areas. Boulder, CO: Westview Press.

Rosenthal, Donald H.; Brown, Thomas C. 1985. Comparability of market prices and consumer surplus for resource allocation decisions. Journal of Forestry. 83(2): 105–109.

Rosenthal, Donald H.; Loomis, John B.; Peterson, George L. 1984. The travel cost model: concepts and applications. Gen. Tech. Rep. RM–109. Fort Collins, CO. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 10 p.

Schulze, W. D.; d'Arge, R. C.; Brookshire, D. S. 1981. Valuing environmental commodities: some recent experiments. Land Economics. 57(2): 151–172.

Sorg, Cindy F.; Loomis, John B. 1985. An introduction to wildlife valuation techniques. Wildlife Society Bulletin. 13: 38–46.

U.S. Department of Interior. 1986. The natural resources damage assessments: final rule. 43 CFR, Part II. Federal Register 51(148), August 1.

U.S. Water Resources Council. 1983. Economic and environmental principles for water and related land resources implementation studies. Washington, DC: U.S. Government Printing Office. 137 p.

Vaughan, W. J.; Russell, C. S. 1982. Valuing a fishing day: an application of a systematic varying parameter model. Land Economics. 58(4): 450–463.

Walsh, Richard G.; Johnson, Donn M.; McKean, John R. 1989. Issues in nonmarket valuation and policy application: a retrospective glance. Western Journal of Agricultural Economics. 14(1): 178–188.

Rocky
Mountains

Southwest

Great
Plains

U.S. Department of Agriculture
Forest Service

Rocky Mountain Forest and Range Experiment Station

The Rocky Mountain Station is one of eight regional experiment stations, plus the Forest Products Laboratory and the Washington Office Staff, that make up the Forest Service research organization.

RESEARCH FOCUS

Research programs at the Rocky Mountain Station are coordinated with area universities and with other institutions. Many studies are conducted on a cooperative basis to accelerate solutions to problems involving range, water, wildlife and fish habitat, human and community development, timber, recreation, protection, and multiresource evaluation.

RESEARCH LOCATIONS

Research Work Units of the Rocky Mountain Station are operated in cooperation with universities in the following cities:

Albuquerque, New Mexico
Flagstaff, Arizona
Fort Collins, Colorado*
Laramie, Wyoming
Lincoln, Nebraska
Rapid City, South Dakota
Tempe, Arizona

*Station Headquarters: 240 W. Prospect Rd., Fort Collins, CO 80526