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January 11, 1990

Delani Wheeler
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Dear Delani,

Well, I'm finally done with my research. Enclosed is a copy of my paper and results. I would like to get together with you to discuss what they mean and how you could use them. Thank you for your patience with me. Last semester was a bear, but I managed to pull my first 4.0! Please feel free to call me at 491-0782 so that we can schedule a time to meet.

Sincerely,

Elayna M. Grody

Elayna M. Grody
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NONCONSUMPTIVE VALUE OF WILDLIFE WITH AN EMPHASIS
ON DEER IN BOULDER, COLORADO

Elayna M. Grody

INTRODUCTION

The nature of this thesis is to study the nonconsumptive values of wildlife to help estimate their economic values. This study focuses on the deer population in Boulder, Colorado. Because Boulder is located on the edge of the foothills and the residents nurture lush gardens and shrubs, mule deer are attracted into the city limits. With the deer come benefits such as the opportunity for residents to observe and photograph deer. However, the deer also generate costs by damaging gardens, shrubs and causing deer/vehicle collisions. The deer population is not being managed, but information about how to keep deer out of people's lawn is available. Deer within the city limits are not allowed to be hunted, and thus the economic value we are interested in is a nonconsumptive value. In order to estimate this nonconsumptive value, the Contingent Valuation Method was used in a survey of the citizens of Boulder.

"There is increasing evidence that land and water-based recreation resources provide substantial nonmarket benefits that contribute to the well-being of resident and nonresident participants. These benefits are equivalent to the dollar amount that participants would be willing to pay over and above their current expenditures to ensure the continued availability of opportunities to use recreation resources," (Walsh et.al. 1988).

The considerations of these nonconsumptive benefits will be discussed at the end of this paper.

THEORY

With interest in recreational goods increasing, natural resource managers need information about the value of these goods to maximize benefits from the spending of the managers' funds and use of the resources they manage. Unlike market goods, the value of nonmarket goods, such as the value for outdoor recreation, cannot be determined by expenditures in market transactions. This is because consumers rarely spend amounts on recreational goods that equal their value (i.e., just because money isn't spent to view deer in Boulder doesn't indicate the deer have a zero economic value). Lack of property rights to the deer doesn't allow a market to form to capture the nonconsumptive value. Therefore, a "price" needs to be determined for nonmarket goods to help managers make appropriate decisions regarding funding and resource allocation.

Two methods that have been used to obtain acceptable measures of economic value of nonmarket goods such as outdoor recreation are the Contingent Valuation Method and the Travel Cost Method. The Travel Cost approach relies on the user's direct out-of-pocket expenses and time costs of travel to estimate a demand curve for a resource. The Contingent Valuation Method (CVM) is a direct interview (survey) approach used to obtain the an estimate of the economic value of nonmarket goods such as recreation resources. This method is often used to

estimate the effect of changes in the recreation opportunity or the quality of the resource. CVM can also estimate the value of a nonmarket good to users and nonusers alike.

Since the citizens of Boulder generally do not travel to see deer, the Travel Cost Method would not be appropriate to estimate the value of deer in the city. Therefore, the Contingent Valuation Method would be the appropriate method to estimate the value of deer to Boulder citizens.

When using the CVM, a hypothetical market is simulated to identify values similar to those found in actual markets. In this hypothetical market, a sample of affected consumers is asked to identify its maximum willingness to pay (WTP) for a resource or for changes in the quality of the resource. The reliability of the estimates depends upon the nature of the hypothetical market, the change in the resource to be valued, the time period for valuation, the method of payment for the good, and the type of value question asked (Walsh, 1984).

If the survey is not properly designed with these criteria in mind, it may not obtain the consumer's true value for the nonmarket good. The resource must be clearly defined in quantity, quality, time, and place so that consumers have a clear understanding of the good to be valued and do not protest against the hypothetical market. The payment method chosen should be the most realistic or credible to consumers so it will have as little effect as possible on consumers' values.

Along with the estimated value of the resource or recreation

opportunity at different levels of quality or quantity (Q), the contingent valuation survey can be used to obtain additional information such as tastes and preferences (T), exposure to deer (E), and socioeconomic variables such as income (I), age (A), and education (S). These variables may influence the consumer's maximum Willingness To Pay (WTP) for the resource and could be used as independent variables in a regression equation to predict WTP. WTP could be the maximum amount that Boulder citizen would be willing to pay per household per year for the deer population and may be influenced by the above variables, (Equation 1).

Equation 1

$$WTP = f(Q, T, E, I, A, \dots)$$

Quantity (Q) and Exposure (E) refer to the number of deer seen (Q) and the frequency that the deer are seen (E). When consumers first see deer, demand theory suggests consumers would be willing to pay more for the deer because they are a scarce resource. However, in Boulder, the deer are commonplace; WTP for additional sightings may be insignificant and could become negative if the deer became a nuisance.

Tastes and preferences (T) refer to variables that describe a consumer's likes and dislikes. These variables may positively or negatively effect WTP depending on the consumer. As the consumer's stated preference for viewing deer increases, his WTP would be expected to increase. However, as the consumer's stated preference for gardening increases, his WTP for deer may decrease because of the damage deer do to gardens.

Socioeconomic variables refer to the consumer's demographic characteristics such as income (I), age (A), etc. These variables may also positively or negatively effect WTP. Income would be expected to positively influence WTP assuming the deer are a normal good. As the consumer's income increases, it would be expected that he would be willing and able to spend more on deer, therefore increasing WTP.

The effect that these variables have on WTP can be estimated by using multiple regression analysis. The ordinary least squared approach will be used to estimate a statistical demand function for the value of viewing deer in Boulder, Colorado. In other words, the regression analysis estimates the change in WTP caused from a one unit change in the independent variable holding all other variables constant (Walsh, 1984).

The demand function, where "a" is a constant and "b", "c", "d", etc., are coefficients, can be used to estimate an inverse demand curve for the deer (Equation 2).

Equation 2

$$WTP = a + bQ + cE + dT + eI + \dots$$

LITERATURE REVIEW

Only recently have economists used nonmarket valuation approaches such as the Travel Cost and Contingent Valuation methods to estimate the nonconsumptive values of wildlife.

Hay (1988) used the results of a 1985 nationwide survey to estimate "the net economic value of nonconsumptive wildlife related recreation." To determine the respondents' net WTP for

activities such as observing, photographing or feeding wildlife, the respondents were asked several Contingent Valuation questions during a personal interview. The results showed that "in 1985, twenty-nine million Americans age 16 years or older took trips of at least one mile from their homes for the primary purpose of observing, photographing or feeding wildlife." These participants spent over \$4.4 billion on trip-related expenses, not including the billions of dollars spent on equipment. One-hundred-five million people participated in primarily nonconsumptive activities near or at their homes. This made nonconsumptive wildlife activities "one of the nation's most widely enjoyed outdoor recreational activities."

Loomis (1988) used CVM to estimate the economic value of various activities, including nonconsumptive values of deer in California. He mailed surveys to 3,000 households and 15,300 hunters, of which 1,056 and approximately 9,180 respectively were returned. The results indicated nonconsumptive uses in California represented \$43 million per year, a 16 percent increase in the traditional estimates of the California deer value.

Richards and King (1982) measured nonconsumptive wildlife values in southeastern Arizona using the Travel Cost Method when surveying visitors of wildlife viewing areas. They estimated that 36,200 household days per year at three sites suggested "a total consumers' surplus value of \$2,859,800 for these sites." However, they indicated this estimate was probably an

overestimation because the responses were "not necessarily representative of most visitors to the sites."

STUDY DESIGN

The CVM was used in this study to estimate the nonconsumptive values of deer in Boulder. One hundred citizens of the city of Boulder were personally interviewed, twenty-five from each of four quadrants. Quadrants were determined by location of main streets and high road kill areas for the years 1985-1987. These individuals were chosen randomly from the Boulder phone directory. Individuals who lived outside of city limits were not included.

The survey was reviewed by nine professionals who had designed and used similar surveys. These individuals made suggestions that led to significant rewording and reorganizing of the questionnaire. The survey was then pretested on twenty-five citizens of Boulder. Since the pretest did not indicate further revisions were needed, these twenty-five completed surveys were included in the results.

The survey (Appendix A) was twenty-three questions long and included four parts: the individual's exposure to the deer, tastes and preferences, value of the deer (WTP), and socioeconomic information.

The survey began with questions about the individual's exposure to the deer. This was done to make the individual comfortable with the questioning and to avoid a defensive mode of thought. The next section consisted of mostly taste and

preference questions. These included questions such as the importance of preservation, existence, and bequest of the deer as well as where those surveyed preferred to see deer.

The valuation questions were next. The individuals were asked to report the largest amount they would be willing to pay per household per year for different levels of deer population. The individuals were also asked what proportion of the amounts reported they would be willing to pay for management of the deer. As stated earlier, the reliability of the WTP values reported depends upon the description of the hypothetical market, the change in the resource, the time period for valuation, and the payment vehicle as well as the type of value question. The valuation questions were open-ended so the individual could report any amount desired. The hypothetical market was designed to be as clear as possible and the payment vehicle was chosen to be as neutral as possible to lessen the possibility that individuals would render a protest bid. The payment vehicles consisted of a reduction in the respondent's income for two things: the deer population and the management of the deer population. The change in the resource and time period were set at one-half, current, and double the population and for one year respectively.

If an individual reported that he was willing to pay zero dollars for the deer, it had to be determined whether this was a protest bid or not. To determine this, the participants were asked to check which of the following reasons best described why

they bid zero:

1. I place a zero value on managing deer in Boulder.
2. I cannot afford a reduction in my income at this time.
3. I have a right to see deer in Boulder and should not have to pay.
4. Not enough information was provided to make a decision.
5. I object to these types of questions.

If the individuals checked 1 or 2, the zero value was their true value. However, if they checked 3, 4, or 5, their bid was determined to be a protest bid and was deleted from the survey.

The last set of questions was about the individual's socioeconomic characteristics. These questions were asked last because they were personal and could affect responses to other questions if they were asked at the beginning of the interview. Some of the socioeconomic questions asked were sex, age, years residing in Boulder, profession, and household income.

REGRESSION RESULTS

The ordinary least squared regression was used to estimate a "willingness to pay" function for deer at the current population level (WTPCUR). This procedure estimates the variables' coefficients which shows the change in WTP resulting from a one unit change in the independent variables. Three WTP bids were excluded from the regression because they were 5-13 standard deviations from the next highest bid.

The regression equation included the following independent variables:

Variable 1 (V1) - the percentage of time in the respondent's yard that the deer spent browsing the trees and shrubs.

Variable 2 (V2) - the number of years the respondent has been a resident of Boulder.

Variable 3 (V3) - if the respondent harassed the deer to get them out of their yard (yes = 1, no = 0).

Variable 4 (V4) - the importance to the individual of having deer available for future generations to see (No opinion = 0, Not important = 0, Somewhat important = 0, Very important = 1).

Variable 5 (V5) - the importance to the individual of active enjoyment of deer (same ranking system as in variable 4).

Variable 6 (V6) - the income of the household in thousands per year.

Variable 7 (V7) - the sex of the individual (Male = 0, Female = 1).

Table 1 shows the results of the regression.

LEAST SQUARES - DEPENDENT VARIABLE IS WTPCUR
 NUMBER OF OBSERVATIONS: 97

VARIABLE	COEFFICIENT	STD. ERROR	T-STAT	2-TAIL SIG.
C	30.66	12.13	2.53	0.01
V1	0.82	0.26	3.11	0.00
V2	-1.09	0.47	-2.31	0.02
V3	-49.59	26.40	-1.88	0.06
V4	21.19	10.25	2.07	0.04
V5	17.65	14.68	1.20	0.23
V6	0.0002	0.0002	1.13	0.26
V7	-23.27	9.37	-2.48	0.02

R-SQUARED	0.266	MEAN OF DEPENDENT VAR	34.53
ADJUSTED R-SQUARED	0.208	S.D. OF DEPENDENT VAR	50.64
S.E. OF REGRESSION	45.05	SUM OF SQUARED RESID	180641.1
DURBIN-WATSON STAT	2.10	F-STATISTIC	4.62
LOG LIKELIHOOD	-502.82		

TABLE 1. Regression results from 1989 Boulder deer CVM study.

Variable V1 had a coefficient of 0.82. Since the coefficient is positive, it indicates a one percent increase in V1 will cause a 0.82 increase in WTP. This was unexpected since it seemed unlikely a person would want to pay more for deer if the deer eat more of his trees and shrubs. One reason for this may be that if the deer are spending more time browsing trees and shrubs they would be spending less time browsing gardens. Therefore, the individual would prefer the deer to browse his trees and shrubs and not his garden. When estimating the equation with a variable indicating the percent of time the deer spend browsing gardens, the coefficient was negative, which may indicate respondents valued their gardens more than their trees and shrubs.

The coefficient for variable V2 was -1.09. This indicated

that the longer individuals lived in Boulder, the less they were willing to pay for the deer. This was expected because the deer may be unique and enjoyable to see at first exposure. But as the exposure increases, the deer become commonplace, less enjoyable and perhaps a nuisance.

The variable V3 coefficient was -49.59. This showed that as people's harassment of the deer increases, their WTP decreases. This was expected because harassment of the deer indicates a dislike for the deer, at least in certain areas such as the back yard. The size of the coefficient indicates that people are willing to pay a significant sum of money for equipment to harass the deer and drive them from the people's yards.

Variable V4 was a qualitative, 0-1 variable where the individuals that rated future generation preference as very important were given a value of one and all the rest were given a zero value. The coefficient for variable V4, 21.19, indicates that the individuals that rated making the deer available to future generations as very important were willing to pay \$21.19 per household per year more than those who didn't.

Variable V5 was a qualitative, 0-1 variable where the individuals that rated active enjoyment of deer as very important were given a value of one and all the rest were given a zero value. Variable V5 had a coefficient of 17.65. This indicated that the individuals that rated active enjoyment of deer as very important were willing to pay \$17.65 per household per year more than those who didn't. This was expected because if the

respondent preferred active enjoyment of the deer, he may obtain greater benefits from the deer than those who didn't and be willing to pay for those benefits. Even though this variable wasn't significant, it was left in the equation because it was considered a variable that should have an effect on WTP. Leaving the variable out may bias the equation, where leaving it in, even if it was truly unrelated, would only reduce the significance but still leave the results unbiased (Kelejian and Oates, 1974).

The coefficient for variable V6 was 0.0002, but was not significant at the 0.10 level. Income may not have been significant for this sample because the amount households were willing to pay was such a small percentage of their annual income (<0.001%). Income was included in the regression because economic theory indicated that it should be related to WTP thus, if income was left out the other regression coefficients would be biased. However, if it was left in, even if it was truly unrelated, the results would still be unbiased (Kelejian and Oates, 1974).

The variable V7 coefficient was -23.27. This variable represented the respondents' sex and was used in the regression as a qualitative variable (0 = male, 1 = female). It indicated that women were willing to pay less than men for nonconsumptive enjoyment of deer in Boulder.

CONCLUSION

There are two features about Boulder's deer population and its citizens that should be discussed. First, the deer in

Boulder are not necessarily sought after but are occurring there without the choice of the citizens. This situation can lead to the deer being perceived as a nuisance by some residents. Loomis (1988) found that the deer value in California increased when twice as many deer were seen on outdoor recreation trips. In Boulder, the value of the deer declined when there was hypothetically twice as many deer. This could be attributed to the damage deer do to yards, gardens, and cars as well as the danger to the deer themselves. In California, the people were traveling to see the deer and did not have the problems the deer caused in Boulder,

Second, there appeared to be four different types of respondents: those who liked deer a lot; those who liked deer a little; those who didn't like deer; and those who were indifferent. Combining these four different groups when analyzing the data provides general results but does not accurately describe any individual group. What might be done in the future is to separate each of these groups and obtain the values for deer for each group.

The null hypothesis was that the mean WTP for deer would be equal to the mean WTP to manage deer. The alternative hypothesis is that the mean WTP for deer would not be equal to the mean WTP to manage deer. The results indicate the null hypothesis for the current population of deer should be accepted at the eight percent level of significance. The mean WTP for deer at the current level is \$34.53 (S.D. = 50.64) per household per year

compared to the \$28.75 (S.D. = 49.01) mean WTP for management of the deer at the current level.

The importance of this study and the determination of the nonconsumptive values of wildlife lies in the information provided for wildlife managers to make better economic decisions when managing resources and allocating funds. At present, there is no management of the deer in Boulder. The results of this study that the deer are worth an average of \$34.53 per household per year indicate the deer have an economic value. This value can be compared to the cost of managing deer to determine an approximately optimal deer population level.

Presently, game species of wildlife are mostly managed for their consumptive values because that is where the agencies obtain most of their financing. Meanwhile, many nongame species are not managed. Even though no funds are spent for nonconsumptive uses of wildlife, this doesn't mean nonconsumptive values do not exist. With 80 percent of the U. S. population being nonhunters, "the nonconsumptive use of wildlife resources...can be expected to increase in importance and the corresponding demand on public land managers to provide opportunities for such use constitutes a potent political force. It would be beneficial to agencies and individuals concerned with wildlife management to be able to weigh the importance of alternative wildlife resource uses in commensurate terms," (Richards and King, 1982).

The Contingent Valuation and Travel Cost Methods can provide

managers with a way to estimate the nonconsumptive value of wildlife. "Such measures, wholly assessed, could permit the comparison of economic values between consumptive and nonconsumptive wildlife uses and the evaluation of the associated change in the consumer welfare resulting from alternative management activities," (Richards and King, 1982). Failure to include nonconsumptive values in estimates of wildlife economic values would result in insufficient resources being allocated to wildlife habitat and management.

LITERATURE CITED

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APPENDIX A

DEER VALUATION SURVEY

The deer population in Boulder is growing. This has resulted in opportunities to observe and photograph deer. Deer also damage ornamental plants and gardens and are involved in collisions with vehicles on city streets. Most of the damage has occurred in the western part of Boulder with increasing numbers of damage reports coming from the eastern part of the city.

Management of deer at present is simply to provide information about what plants attract deer, warning devices for automobiles, fencing out deer and other ways to control deer movement in residential areas. Also, there is enforcement of a law that forbids citizens from feeding the deer. However, there is no physical or biological management of deer at present.

With the growing deer population, their value needs to be determined. This study will help determine the appropriate size of the deer population and will help in managing deer at that population. Information from your responses will assist state and city officials determine to the value of the deer populations in Boulder.

1989 Contingent Valuation Survey

Elayna M. Grody

Good morning/afternoon. My name is Elayna Grody. I'm working with Colorado State University in Fort Collins and studying the value of deer and wildlife in Boulder. Would you mind if I ask you a few questions? It will probably take about ten to fifteen minutes. We are very interested in your opinion to help evaluate and make decisions regarding the deer population. Your answers will be confidential, and you personally will not be identified in reporting the results of the study.

1.) Have you ever seen deer in the city of Boulder?

Yes: 98 No: 2

a.) About how many times did you observe deer this week?

Times: 1.19

b.) Please estimate the number of days you observe deer in a single year on average.

Days: 67.33

c.) How close to your home can you observe deer (in miles one way)?

At your home

Miles 1.02

2.) Have you heard of or read about the deer population in Boulder from any of the following sources? (Circle all that apply) :1.97

- a. Television Programs
- b. Newspaper Articles
- c. Magazine Articles
- d. Books
- e. Pamphlets or Brochures
- f. Friend or Acquaintance
- g. Never heard or read about the deer
- h. Other (please specify)

3.) Whether or not you have ever heard of or seen deer in Boulder, there may be several reasons for valuing deer. For each of the reasons listed below, circle the number which best indicates your opinion.

Possible Reasons for Valuing Deer	No Opinion	Not Important	Somewhat Important	Very Important
a. Provides you with passive enjoyment such as seeing deer, etc.	1	9	47	43
b. Provides you with active enjoyment such as photographing deer, etc.	11	40	36	13
c. Knowing that in the future you have the option to see deer if you choose.	2	19	34	45
d. Knowing that future generations have the opportunity to see and enjoy deer.	1	10	27	62
e. Just knowing that the deer exist.	4	7	31	58

4.) How many times did you use the Boulder Open Space/Mountain Park area in the last year?

Times: 32.57

5.) How important to you is the preservation of wildlands around Boulder? (Check one)

No Opinion	Not Important	Somewhat Important	Very Important
0	1	12	87

6.) Do you garden? Yes: 58 No: 42

7.) While in your yard, approximately what percentage of the time were the deer

17.16% Passing through

7.40% Resting

11.52% Browsing trees, shrubs or flowers

5.04% Browsing garden

8.) During the previous twelve months have you taken any of the following actions?

1 Encourage deer to use your property

4 Used harassing methods to discourage deer from using your property?

4 Attempted to fence deer out of your property?

7 Applied commercial or homemade repellants to discourage browsing?

9.) On a scale from one to nine, rate where you prefer to see deer. (One being the lowest preference, nine the highest)

3.64 In your backyard 49(1), 6(2), 4(3), 3(4), 11(5), 1(6),
6(7), 1(8), 19(9).

7.09 In fields on the outskirts
of town 6(1), 2(2), 4(3), 2(4), 12(5), 3(6), 10(7),
12(8), 49(9).

8.65 In the mountains 1(3), 5(5), 1(7), 5(8), 88(9).

10.) The purpose of this survey is to find the value of deer in Boulder to help better manage deer. In order to find the economic value of deer we need to find the maximum amount you would you be willing to pay for different deer population levels. Keep in mind that this would reduce your annual income by the same amount. If this cost were charged in a fair and equitable manner between all households in Boulder, what is the largest amount you would be willing to pay each year for:

half the current population	the current population	double the population
\$29.53	\$34.53	\$21.90

11.) Of this amount, what proportion would you pay for management of the deer. Maintaining the deer in certain areas may require that the population be managed differently.

half the current population	maintain the current population	double the population
\$25.62	\$28.75	\$14.72

12.) If you answered zero dollars for questions 10 and/or 11, please choose the statement below which best describes your reason for not allowing a reduction in your annual income. (Check one response)

1. I place a zero value on managing deer in Boulder.
2. I cannot afford a reduction in my income at this time.
3. I have a right to see deer in Boulder and should not have to pay .
4. Not enough information was provided to make a decision.
5. I object to these types of questions.

The following questions ask for some information about yourself. Your answers will be confidential, and you personally will not be identified in reporting the results of the study.

13.) How much vacation do you take each year?

Days:27.55

14.) Are you: Male: 44 Female: 56

15.) What is your age? 37.21 years

16.) How many people are in your household including yourself?
2.74 total

17.) How long have you lived in Boulder? 11.85 years

18.) Do you own or rent your house? Rent: 51 Own: 49

19.) Do you belong to:

a. a sportsman organization yes: 7 no: 93

b. an environmental organization yes: 33 no: 67

20.) What is your occupation? (Job that accounts for more than half of your work-time)

1. Student - 16
2. Unemployed - 7
3. Retire - 10
4. Retail Trade - 6
5. Unskilled Blue Collar - 4
6. Skilled Blue Collar - 6
7. Professional - 43
8. Manager - 8

21.) What is the highest year of school you have completed(Circle one number): 15.04 years

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22

22.) To the best of your knowledge, what was your household income last year before taxes? (Check one): \$33,100

Under \$10,000	\$40,000 to \$50,000
\$10,000 to \$15,000	\$50,000 to \$60,000
\$15,000 to \$20,000	\$60,000 to \$70,000
\$20,000 to \$25,000	\$70,000 and above
\$25,000 to \$30,000	(Please specify to the
\$30,000 to \$35,000	nearest \$10,000)
\$35,000 to \$40,000	

23.) Is there anything else you would like to tell us about your interest in the deer population in Boulder? Any comment you wish to make that you think may help us in future efforts to understand what you want done about the deer will be appreciated.

Available upon request.