DOES GETTING A BULL SIGNIFICANTLY INCREASE VALUE? THE NET ECONOMIC VALUE OF MOOSE HUNTING IN MAINE

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ABSTRACT: Five years (1988-1992) of survey data on moose (*Alces alces*) hunting are analyzed to consider whether getting a bull significantly increases the net value of the hunt to participants. We find that getting a bull significantly increases net value for both resident and nonresident hunters. Nonresidents, however, are more likely to desire to shoot a bull and to actually shoot a bull. Thus, nonresident hunters are more likely to be trophy hunters and resident hunters may be more likely to balance the meat quality of the animal with the opportunity to take a trophy bull. Given these findings, the use of aggregate harvest records to monitor moose populations should investigate differences in resident and nonresident harvests and policies to manage moose populations may require differing regulations for resident and nonresident hunters.

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Since the current Maine moose (*Alces alces*) hunt was established in 1982, an annual survey of the hunters is required by law to monitor harvest trends (Maine Public Law, Chapter 118, 1981). Starting with the 1988 hunt we initiated questions in the survey to examine hunter preference regarding the sex and age of the moose they desire to shoot and to learn the value they place on their hunts. The purpose of this paper is to consider whether there are differences in hunter selectivity between resident and nonresident hunters and to learn whether bagging a bull significantly increases the net economic value of moose hunts for participants. We close with management implications drawn from our empirical findings.

STUDY AREA

Maine's annual moose hunt is restricted to 6 days each fall, and 1,000 permits (900 resident and 100 nonresident) are randomly assigned to hunters in a lottery. Each permit holder is assigned to a specific hunting zone (Fig. 1). Assignments are based on the hunters stated preferences in their applications for the hunt. Hunters are assigned to the zones of their first choice until the quota for a zone is full, and then assignments are based on hunters' second and third choices. Thus, hunters selected early in the lottery are more likely to hunt in their desired zone than are hunters selected late in the lottery. Permit holders may designate one subpermittee with whom they will hunt. Both the permittee and subpermittee are allowed to carry weapons,

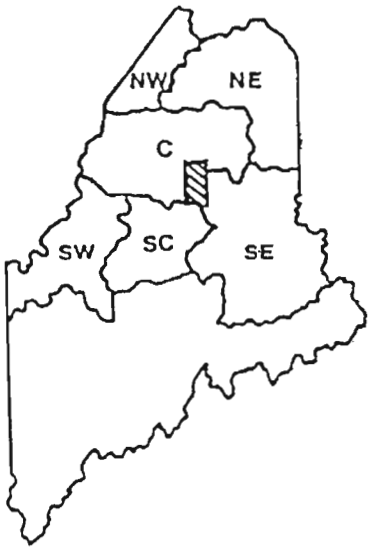

Fig. 1. Maine Moose Hunter Zones.

but may take only one moose of either sex. Other hunting partners, who do not carry weapons, may help scout for moose and remove a carcass from the woods.

Over the study period, the hunt was held in mid-October in 1988 (17-22) and 1989 (16-21), 24-29 September 1990, and in early October in 1991 (7-12) and 1992 (5-10). Changes in the timing of the hunt over the study period were due purely to political influences and not to biological considerations (Boyle *et al.*, 1993).

Successful moose hunters must report to a check-in station where the carcass is weighed and the sex and age of the animal are recorded. In addition, the required survey collects information to monitor hunting effort, hunter selectivity and characteristics of the hunters themselves. The questions for the current study were included in this survey.

METHODS

The annual survey of moose hunters is administered by mail using the Dillman (1978) Total Design Method. This method includes the design and lay out of the survey instrument and administration of the survey. In 1988, the design of the mail survey was changed dramatically from the surveys conducted from 1982-1987. The revised survey was pretested using a focus group of individuals who had participated in the 1987 hunt. Based on the results of the focus group, the questionnaire was revised and administered in a mail pretest to evaluate the potential response rate and to get an initial reading of the value hunters place on their moose hunting experiences. The final survey instrument was mailed to all individuals who received a permit for the 1988 hunt. Revisions have been made to the questionnaire in each subsequent year to improve the instrument. None of these revisions, however, resulted in changes in survey questions from which data were derived for the current analyses.

Implementation of the survey instrument followed the standard Dillman approach. All hunters receive information regarding the conduct of the survey by the University of Maine in the package of information accompanying their hunting permit. The surveys are sent to hunters about one week after the hunt. The survey mailing includes a cover letter, the questionnaire and an addressed, postage-paid return envelop. A letter to moose hunters, from the Commissioner of the Maine Department of Inland Fisheries and Wildlife (MIF&W), is printed on the inside cover of the questionnaire. About one week later a reminder/thank you post card is sent to all permits holders. Two weeks after the initial mailing a second copy of the questionnaire with cover letter and return envelop is sent to individuals who have not responded. Four weeks after the initial mailing a third copy of the questionnaire with cover letter and return envelop is sent via certified mail to individuals who had not responded. After 1988 the certified mailings were discontinued because two mailings yield a high response rate and the certified mailings are costly.

Hunter Selectivity

In the 1988, 1989 and 1990 surveys hunters were asked "what sex and age of moose do you prefer to shoot." Response categories were "calf", "yearling cow", "adult cow", "yearling bull" and "adult bull". For data analyses these data are recoded to a binary variable with calf, yearling cow and adult cow equaling 0 and yearling and adult bull equaling 1. This was done to maintain consistency with the way the MIF&W maintains harvest records from the check-in stations.

We test the hypothesis that the proportion of residents desiring to shoot a yearling or adult bull is the same as the proportion of nonresidents indicating this desire. A chi-square statistic is used with $\alpha = 0.10$.

Net Economic Value

The net economic value participants place

on moose hunting is defined as the maximum hunters would pay to hunt above and beyond their expenditures to participate in the hunt (Sorg and Loomis, 1985). This concept is shown as the shaded triangles in Fig. 2.

The vertical axis is the implicit cost of moose hunting, the expenses incurred to participate in the hunt. Note the quantity measure on the horizontal axis is not measured as number of moose shot. A hunter does not buy a moose. Rather, the hunter buys the opportunity to shoot a moose. The quantity dimension of this activity is generally measured in units of participation, trips or days. We define the horizontal axis in days here because the hunt is limited to six days and most hunters make one trip from their home to their hunting zone. If the length of the hunt were not set at six days by law, we expect permit holders would hunt on additional days until they reached the point where the demand function intersects the average cost of a day of hunting (i.e., the marginal value of hunting just equals the marginal cost of hunting at eight days in Fig. 2) or until they bagged a moose. Hunters would not hunt on additional days because the marginal cost of these additional days would exceed the marginal benefit for unsuccessful hunters. Successful hunters are constrained by the one-moose limit.

The demand curve, therefore, represents the maximum amount a hunter would pay for each day of hunting. The total area below the demand curve and to the left of six days is the total value an unsuccessful hunter places on moose hunting. The unshaded rectangle represents the hunters' expenditures ((cost/day) x (# of days)) to participate in the hunt. Net economic value is defined as the difference between the maximum the hunter would pay and the cost of the hunt, area A in Figure 2A. This net economic value is commonly referred to as consumer surplus, i.e., the surplus value remaining after all costs of participating in an activity are paid. Consumer surplus is the economic measure of the benefit a hunter receives from participating in the hunt and we will use this term synonymously with the benefit of moose hunting.

Although net economic value is synonymous with the benefits of moose hunting, this is not necessarily true with expenditures for two reasons (McCollum, Peterson and Swanson, 1992). First, for hunters' expenditures are actual out of pocket expenses that reduce their net value (consumer surplus). Second, from a social perspective, economic impacts may simply represent a transfer of wealth. Take an example where moose hunting is no longer allowed in Maine, resident

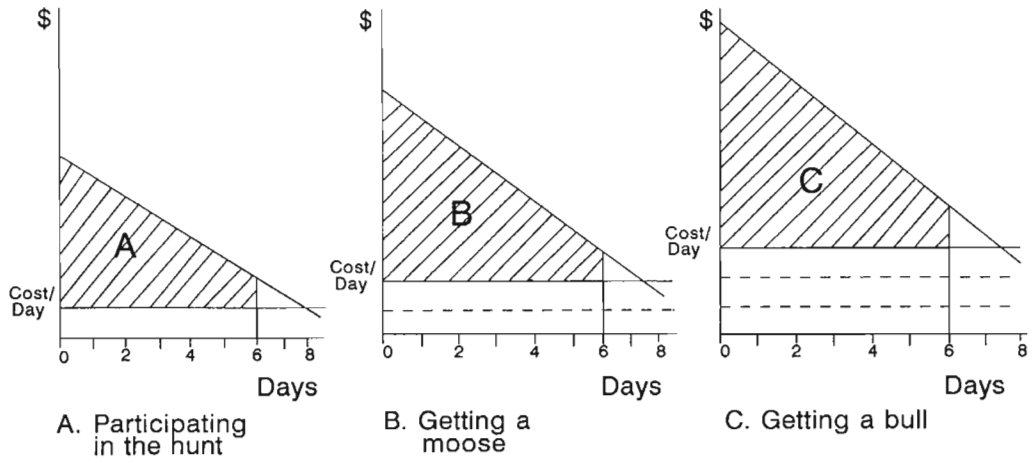

Fig. 2 Demand for days of moose hunting.

moose hunters may spend their money on other activities in Maine. Thus, these expenditures are not lost from the state's economy but are transferred to another segment of the Maine population. Conversely, expenditures by nonresident hunters may be considered as a benefit of moose hunting. If moose hunting is precluded, nonresident expenditures may be lost from Maine's economy because these individuals are likely to go elsewhere to hunt big game or to spend the money in their home state. It is necessary, however, to identify the share of nonresident expenditures that are actually incurred in Maine.

For the discussion here we focus on consumer surplus, the net value accruing to participants of the hunt, as the measure of the benefits to participants of the moose hunt. If the quality of the hunt is enhanced, we expect hunters' satisfaction to increase and this is represented by the demand curve shifting upward, thereby increasing consumer surplus. A decline in consumer surplus has the converse effect.

In Figure 2A let us assume an individual hunts the full six days and does not get a moose. If the hunter gets a moose on the last day of the hunt, we hypothesize the total value a hunter places on the hunt increases when a moose is bagged, and increases even more if the moose is a bull. These propositions are shown in Figures 2B and 2C. Getting a moose increases the quality of the hunt and shifts the demand curve upward so total value increases. Note that the cost per trip has increased because the hunters incur additional costs to have the carcass removed from the woods and to have the meat processed. Despite the increase in the cost of the hunt, we hypothesize the demand curve shifts sufficiently that consumer surplus in Figure 2B exceeds consumer surplus in Figure 2A (H_o: B>A). Bagging a bull is also assumed to increase the quality of the hunt and shifts the demand curve upward again. Hunter expenditures may increase again if the hunter has a trophy bull mounted. We hypothesize that consumer surplus in Figure 2C exceeds consumer surplus in both Figures 2A and 2B (H_o: C>B>A). (If the hunter gets a moose on the first day of the hunt or on any other day before the last day of the hunt, the individual's hunt is terminated because of the one moose limit. Figure 2 can be appropriately modified to represent this condition.)

We investigate these hypotheses using a contingent-valuation question to estimate consumer surplus (Mitchell and Carson, 1989). This is a direct questioning method of asking individuals to reveal their consumer surplus for an activity. Bishop and Heberlein (1990) have used parallel contingent-valuation and cash-transaction studies to demonstrate that contingent valuation is a valid method of estimating consumer surplus. In fact, the majority of their research was conducted for a one-day deer hunt in central Wisconsin where permits are issued by lottery, a hunting system not unlike moose hunting in Maine.

After having respondents recall their moose hunting expenses in the survey, they were asked the following contingent-valuation question: "would you still have gone hunting in 19-- if your total expenses had been $____ **more** than the total you just calculated?" Responses were "yes" or "no". See Boyle and Bishop (1988) for a discussion of various formats of asking contingent-valuation questions.

The contingent-valuation question was included in the surveys for all five years of the study and 88, 89, 90, 91 or 92 was entered in the question for the appropriate year. The dollar amounts were randomly assigned to each hunter's questionnaire. The dollar entries in the 1988 survey were based on the distribution of responses to a contingent-valuation question in the mail pretest of the questionnaire. The distributions of offer amounts in subsequent years were based on responses to the 1988 survey results. Dollar entries for the 1992 survey ranged from $9 to $4,320 and

this range is similar to preceding years.

The responses to the contingent-valuation questions were analyzed using a probabalistic-choice model. The basic framework for this analysis was developed by Hanemann (1984). The following logit model was estimated:

$$Pr(NO) = [1/(1+\exp(-BX))]$$

where

$$-BX = -(b_0 + b_1 OFFER + b_2 BAG + b_3 BULL)$$

and the b_i's are coefficients to be estimated, OFFER is the dollar amount from the contingent-valuation question, BAG is a binary variable that equals 1 if a respondent got a moose, and BULL is a binary variable that equals 1 if a respondent got a bull. The self-reported data on BAG and BULL are used to estimate the logit equations. Bowker and Stoll (1988) demonstrate that value estimates are similar for logit and probit models for large sample sizes. We use a logit model here for computational convenience.

It is expected that the probability of a "no" response increases as the dollar amount in the contingent-valuation question increases. Given the conceptual framework presented in Figure 2, we hypothesize that the probability of "no" decreases if a hunter gets a moose and decreases even more if the moose is a bull. Due to the nonlinear nature of the logit model, the expected sign on the coefficient for OFFER is positive and the coefficients on BAG and BULL are expected to be negative. These signs are reversed when the coefficients are multiplied by the implicit negative one.

Conditional estimates of consumer surplus for moose hunting are defined as:

$$E(\$|X) = \int_0^\infty [1-Pr(NO)]d\$.$$

We compute E($|BAG=0,BULL=0), E($|BAG=1,BULL=0) and E($|BAG=1,BULL=1) which are conditional estimates of mean consumer surplus for participating in the hunt, getting a moose and getting a bull, respectively. Numerical approximation is used to compute the integrals and the integration is truncated at a probability of 0.99.

Separate logit equations are estimated for resident and nonresident moose hunters using maximum likelihood procedures. We test the null hypothesis that the estimated vectors of coefficients are identical using a likelihood ratio test with $\alpha = 0.10$. Individual coefficients are examined for significance using t tests and $\alpha = 0.10$.

RESULTS

On average, about 90 percent of resident hunters and 91 percent of nonresident hunters responded to the survey over the study period (Table 1). The response rates were computed by dividing the number of usable surveys returned by the number of resident and nonresident hunters, respectively. These survey responses constitute the data set for the statistical analyses reported here. (These response rates are nearly identical to dividing the number of returned surveys by the number of valid addresses. Due to the permit system we did not have any invalid addresses and only one or two surveys per year were returned as unusable.)

Self reports of getting a moose averaged 90% over the study period for residents and 66%, on average, reported getting a bull (Table 2). In all cases the check-in station reports equal or exceed the self reports of resident hunters. With respect to getting a moose, none of the differences exceed 2%, but the differences for getting a bull were 11% and 9%, respectively, for 1990 and 1992. Nonresident self reports exceed the check-in station data for 1988 and the converse holds for

Table 1. Response rates to the mail survey (%).

Year	Residents	Nonresidents
1988	92	93
1989	91	95
1990	90	87
1991	87	86
1992	89	92

all other years. The largest differences are 6% for getting a moose in 1992 and for getting a bull in 1990.

Overall, nonresident harvest rates exceed resident harvest rates in all years. The average difference using either the self reports or the check-in station data was 3.6%. The percentages of nonresidents harvesting a bull also exceeded the resident figures in all years, but the average difference was more than twice as large (10.6% for self reports and 8.2% for check-in data) as the difference in harvest rates.

For both residents and nonresidents, harvest rates remained relatively stable over the study period. The percentages of hunters getting a bull increased by about 10% for both residents and nonresidents from 1988 to 1992. Thus, while nonresidents are more likely to take a bull, the percentages of bulls being taken is increasing for both residents and nonresidents.

Hunter Selectivity

The differences in resident and nonresident harvest of bulls are supported by the hunter preference data (Table 3). About 80% of resident hunters desire to shoot a yearling or adult bull and the comparable rate for nonresidents is 93%. The differences between the resident and nonresident rates are significant in all three years.

Consumer-Surplus Estimates

We began the analysis by estimating separate logit equations for residents and nonresidents for each of the five years. We noted similarities across years in the estimate logit equations and in turn stacked all five years of data for both residents and nonresidents. This compilation of the data does not reduce the generalizability of our findings and facilitates exposition.

Five additional variables were added to the equations. Four dummy variables were added to identify differences across years; D88, D89, D90 and D91. The coefficients on

Table 2. Percentages of hunters who bagged a moose and who bagged a yearling or adult bull (%).

Residency/Year	Bagged		Bull	
	Self Reported	Check-in Station Reports	Self Reported	Check-in Station Reports
Residents:				
1988	93	93	64	66
1989	91	92	61	65
1990	86	87	68	79
1991	94	96	72	75
1992	88	90	66	75
Nonresidents:				
1988	98	96	76	74
1989	92	93	70	74
1990	92	96	79	85
1991	96	99	81	83
1992	92	98	84	85

Table 3. Percentages of hunters desiring to shoot a yearling or adult bull (%).

Year	Residents	Nonresidents	Test statistics	
			χ^2 (1 df)	p
1988	79 (n=806)	92 (n=91)	11.72	<0.00
1989	78 (n=794)	92 (n=92)	12.45	<0.00
1990	85 (n=766)	94 (n=84)	6.21	0.01

these variables reflect differences between each of the respective years relative to 1992, the omitted category. With the separate equations for each year the coefficient on $ was the same in all years except 1988. In the stacked equations we included an interaction term to reflect this difference, D88*OFFER. We did not make any a priori hypotheses regarding the sign of the coefficients on these additional variables.

The estimated coefficients for the equations using the stacked data are reported in Table 4. All variables in the resident equation are significant, and OFFER, BAG and BULL have the expected signs. The signs on the dummy variables indicate that consumer surplus for 1988, 1989, 1990 and 1991 are lower than 1992, with consumer surplus declining from 1988 to 1989 and increasing thereafter. Nonresident equation (1) contains all of the same variables with different results. OFFER and BULL are significant and have the expected signs. The coefficients on BAG and D88, however, are insignificant. The signs of the dummy variables indicate that consumer surplus increases from 1988 to 1989, decreases in 1990, and increases thereafter.

The vectors of coefficients for the resident equation and for nonresident equation (1) are significantly different ($\chi^2 = 25.86$, 9 df, $p < 0.00$). We also tested the null hypothesis that the coefficients on BAG and D88 are simultaneously equal to zero in the nonresident (1) equation using a likelihood ratio test. The null hypothesis could not be rejected ($\chi^2 = 1.89$, 2 df, $p > 0.10$). In turn, we use equation (2) to compute consumer-surplus estimates for nonresidents.

Consumer-surplus estimates are computed from the logit equations for residents and nonresidents and all estimates are converted to 1992 dollars using a consumer-price index (Table 5). For residents the basic value of participating in the hunt ranges from $740 in 1988 to $1,262 in 1992. Resident consumer surplus increases by an average of $162 if a resident gets a moose and increases by an additional $120 on average if the moose is a bull.

The pattern of consumer-surplus estimates suggested by the coefficients on the dummy variables in the resident equation in Table 4, for each of the years prior to 1992, does not carry over to the means reported in Table 5 due to the conversion to 1992 dollars.

The average nonresident consumer surplus for participating in the hunt ranges from $1,331 in 1988 to $2,245 in 1992. Consumer-surplus estimates are not reported for getting a moose because the BAG variable was dropped from the nonresident equation. Getting a bull increases consumer surplus by an average of $384, about $100 more than for residents ($282 = $162 + $120).

Table 4. Maximum likelihood estimates of logit coefficients.

Variables	Residents	Nonresidents	
		1	2
Constant	1.1151*[a]	1.8783*	1.6265*
	(0.1530)[b]	(0.5323)	(0.3484)
OFFER ($)	-0.0011*	-0.0008*	-0.0008*
	(0.0001)	(0.0001)	(0.0001)
BAG (Bagged=1)	0.2603***	-0.5254	NA[c]
	(0.1436)	(0.4895)	
BULL (Bull=1)	0.1805**	0.5264***	0.4098
	(0.0852)	(0.2816)	(0.2592)
D88 (1988=1)	-0.3717**	0.6067	NA
	(0.1898)	(0.6747)	
D88*OFFER	-0.0007*	-0.0013**	-0.0008**
	(0.0002)	(0.0007)	(0.0003)
D89 (1989=1)	-0.7683*	0.5917***	-0.6917**
	(0.1244)	(0.3334)	(0.3188)
D90 (1990=1)	-0.5031*	-0.8160**	-0.9184*
	(0.1183)	(0.3391)	(0.3241)
D91 (1991=1)	-0.4082*	-0.7016**	-0.7974**
	(0.1197)	(0.3502)	(0.3401)
χ^2	725.23*	85.57*	83.68*
	(8 df)	(8 df)	(6 df)
n	3,680	437	437

[a]Single asterisk denotes significance at 0.01, double asterisk denotes significance at 0.05 and triple asterisk denotes significance at 0.10.
[b]Assymptotic standard errors.
[c]NA indicates that coefficient was not estimated.

DISCUSSION

The comparison of self reports and MIF&W check-in data suggest hunters are relatively accurate in answering the questions in the survey asking them whether they got a moose and the sex and age of the moose they got. However, in future analyses it would be interesting to compare consumer-surplus estimates using both the self reports of harvest and the check-in station harvest data.

Nonresidents may be more likely to get a moose for two reasons. First, given the expenses they must incur to come to Maine to hunt, they may be more serious and skilled hunters than is the average resident hunter. Second, nonresident hunters are more likely to use a guide for their hunts. For nonresidents, the insignificant coefficient on the BAG variable is consistent with the strong desire among nonresidents to get a bull and may also be reflective of most nonresidents actually bagging a bull.

Bagging a bull is important to both residents and nonresidents, but a larger proportion of nonresidents choose to take a bull. Nonresidents may be more likely to be trophy hunters because many come from states where the primary big game species is white-tailed deer (*Odocoileus virginianus*). In these states deer hunting may be managed with bucks-

Table 5. Moose hunting consumer surplus estimates (mean value per hunter per year, 1992 dollars)[a]

Residency/Year	Hunt	Bag	Bull
Residents:			
1988	$ 740	$ 861	$ 950
1989	796	1,061	1,186
1990	1,010	1,181	1,309
1991	1,028	1,198	1,323
1992	1,262	1,446	1,579
Nonresidents:			
1988	$1,331	NA[b]	$1,593
1989	1,776	NA	2,215
1990	1,473	NA	1,865
1991	1,521	NA	1,909
1992	2,245	NA	2,686

[a]The consumer price indices used to inflate estimates to 1992 dollars are 1.1862, 1.1313, 1.0730 and 1.0299, respectively for 1988, 1989, 1990 and 1991 (1992 equals 1.0).
[b]NA indicates that a mean was not calculated.

only regulations. Thus, they may feel pressure from peers to return with a trophy bull. Nonresidents may also prefer to get a trophy bull given the expense associated with getting a moose. Getting a moose increases the cost of the hunt due to the expenses associated with carcass handling, meat cutting and storage. Residents may have more opportunity to do these activities themselves, where as nonresidents may be more dependent on commercial operators to prepare the moose for transport to their homes. This may be even more problematic if the temperature is mild during the hunt. Finally, nonresidents may not be as aware of trade-offs regarding meat condition versus harvesting a trophy bull as are residents. Residents have more opportunities to talk to hunters who have taken a moose in previous years. Although smaller percentages of residents take a bull, getting a bull does significantly increase the consumer surplus of their hunts.

All nonresident consumer surplus estimates exceed comparable resident estimates with differences of about $600 in 1988 and nearly $1,000 in 1992. Thus, nonresidents place higher consumer surplus on their hunts than do residents and getting a bull adds more to nonresident consumer surplus than to resident consumer surplus.

Moose hunting in Maine is a highly valued activity. Walsh *et al.* (1988) reviewed 287 studies estimating consumer surplus for recreation activities, including hunting, across the United States. They found the average consumer surplus from 56 studies of big game hunting was $45 per day of participation, and estimates ranged from $20 per day for deer hunting in South Dakota to $142 per day for deer hunting on Colorado. Dividing our 1992 consumer surplus estimates for Maine moose hunters who did not get a moose in 1992 by the number of days in the hunt yields a consumer surplus of $210 per day ($1,262/6 days) for residents and $374 per day ($2,245/6 days) for nonresidents. Adjusting the Walsh mean consumer surplus of $45 per day for big game hunting to 1992 dollars results in an estimate of $56 per day. Thus, even the lowest consumer surplus for moose hunting in Maine is about four times larger than the Walsh estimate of central tendency. The high con-

sumer surplus for moose hunting in Maine is likely due to the rationed opportunity to participate in the hunt making the hunt a once-in-a-lifetime experience for many hunters, the high probabilities of getting a moose and of getting a bull, and the lack of alternative (substitute) big game hunting opportunities in the Northeast.

We only know of one other study that has estimated consumer surplus for moose hunting. Loomis *et al.* (1985) estimated a consumer surplus of $19 per day ($32 in 1992 dollars) for moose hunting in Idaho. One explanation for the higher values in Maine may be that more opportunities exist to hunt big game in western states. For example, elk hunting may be considered a better substitute for moose hunting than hunting white-tailed deer. Travel costs are another consideration. These expenses may be lower to travel within Maine and to Maine from other New England states than to travel to western states to hunt. More of moose hunters 'total value' remains as consumer surplus for moose hunting in Maine versus Idaho.

IMPLICATIONS

Given that nonresidents are more likely to harvest a bull than residents, wildlife managers who use harvest records to monitor the moose population should treat resident and nonresident harvest data separately. For example, future trends in harvest and hunter selectivity could be moving in different directions and these offsetting effects may not be obvious from aggregate data until the disparity becomes quite large. Moreover, management of the moose herd might be accomplished by changing the mix of resident and nonresident hunters or by applying different types of hunting regulations to resident and nonresident moose hunters.

Finally, as additional years of data are collected, opportunities can be exploited to see how weather variables and season timing affect consumer surplus for moose hunting and hunter selectivity. Also analyses could be conducted with hunter self reports and objective data collected at MIF&W check-in stations, to see if convergent validity of these two types of data is established.

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