A CHOICE MODELLING APPROACH TO MOOSE MANAGEMENT: A CASE STUDY OF THUNDER BAY MOOSE HUNTERS

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ABSTRACT: We demonstrate the application of one type of model available for managers to better understand the people side of resource management. This choice modelling approach allows us to study issues such as the hunting site choices of moose hunters. To showcase the approach, we use a case study based on predicting the site choices of resident moose (*Alces alces*) hunters from the Thunder Bay area. Our case study shows that resident moose hunters of Thunder Bay prefer short travel distances, few encounters with other hunters, areas with better vehicular accessibility, more moose, more water, and shorter regenerating vegetation in harvested areas. We demonstrate the practical applicability of the model by examining a hypothetical scenario involving the issue of hunting site closures in areas with new forest cutovers. The results of this hypothetical scenario demonstrate that one can use the model to: (1) predict changes to moose hunting effort associated with a site restriction; and (2) estimate the economic losses that would arise to hunters from this restriction. A manager should seek both of these pieces of information before implementing a change such as a site restriction.

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Resource management has changed considerably over the past 20 years to embrace an ecosystem perspective (Slocombe 1993, Grumbine 1994). This shift in emphasis to a holistic view of forested environments has also encouraged the view that people are part of ecosystems. As such, it is more important than ever to manage resources with a mindful eye on the uses and desires of the public. For moose (*Alces alces*) management, this creates a difficult problem for managers. On the one hand, there is a need to meet the demands of the hunting public. On the other hand, there is a need to control hunting pressure to ensure that moose populations are healthy and sustainable.

To meet this careful balance, a moose manager requires effective information on both the desires of hunters and the reactions that hunters may exhibit towards changes that affect the moose hunting experience. A study in northwestern Ontario by Bottan et al. (2001) collected both sources of information. In this paper, we focus solely on the results of a choice modelling exercise designed to determine the factors that lead hunters to select different areas to hunt moose. We showcase the usefulness of this approach by discussing the model results and by presenting a fictitious example of how the model can be applied in a management context. In the example, we will show that one can use a choice model to estimate

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changes in both hunting effort and economic values stemming from a management change. This modelling approach permits managers to forecast the likely effects of various management scenarios without actually implementing the scenarios on the landscape. In many situations, such as the call to limit hunting in areas with new cutovers, the approach offers information without possible confrontations with the hunting public.

The choice model of northwestern Ontario resident moose hunters emulates hunter behaviour on a hunting site scale that is finer than the wildlife management unit level. This choice of scale acknowledges that each management unit consists of a highly variable landscape that affords moose hunters with many different settings from which to choose a site to hunt. It is also important to emphasize that the study focuses solely on local moose hunters. It is expected that non-local and non-resident moose hunters will evaluate characteristics of a moose hunting site differently. Therefore, we suggest that readers avoid the temptation of concluding that all moose hunters in Ontario are captured by this study.

The paper is organized as follows. The next section provides an introduction to choice modelling and a review of relevant choice model studies on moose hunting. This section is followed by a discussion of the methods used to collect data from hunters and to model the behavioural site choices of hunters. The third section discusses the results of the study, followed by the presentation of a fictitious scenario that will illustrate the application of the model results. Finally, we conclude with a discussion that highlights key points from the paper.

CHOICE MODELLING BASICS AND RELEVANT STUDIES

Choice models work from the simple premise that the behaviours of individuals convey important information. For example, a hunter believes that his/her chosen site will yield the greatest net benefits of all available sites. One method of measuring net benefits is through utility, which is a measure of happiness or aggregate preference. By using utility, we can assume that a hunter's site choice is governed by or mimics utility maximization (i.e., he/she selects the site with greatest utility).

The utility of a hunting site is determined through the attributes (e.g., travel distance, moose abundance) that characterize that hunting site. To convert these attribute measures into utility, an individual must weight (i.e., parameterize) the attribute measures and combine these weighted attributes together in some fashion. A simple, but very popular, method to combine these weighted attributes is to add them together. This addition, which is consistent with information integration theory (Anderson 1981), suggests that a high weighted score for one attribute may offset a low weighted score for another attribute. This means that the model explicitly permits individuals to trade-off desirable and undesirable attributes when making a choice decision.

Although an individual is always expected to choose the hunting alternative with maximum utility, researchers do not observe the utility measures from the hunters. As well, researchers accept that despite their efforts to learn about the process, they do not know and cannot model all aspects of the process that leads a hunter to select a hunting site. Therefore, a researcher can only estimate a probability that a hunter would select a particular hunting site. It is under this foundation that choice modellers apply random utility theory (Thurstone 1927).

The researcher's task of estimating weights for each of the attributes is complicated by the uncertainty described above.

To estimate the attribute weights, researchers must turn towards a statistical model, which requires assumptions about the uncertainty. A basic statistical model that is often used by choice modellers is the conditional multinomial logit regression model (see equation 1 below). In equation 1, the probability of individual n selecting alternative i from a set of C_n alternatives equals the exponentiated attribute measures X_{in} that are weighted by parameters $ß_i$, which are estimated via maximum likelihood estimation. This exponential value is divided by the sum of the exponentiated values of all alternatives to produce the choice probability. The μ term, which relates to the variance of the utility scale, is not identifiable along with the ß estimates. However, a researcher can innocuously assume that the μ term equals 1 without consequence to the predictions from the model.

$$P_n(i) = \frac{e^{m\mathbf{X}_{in}\mathbf{ß}_i}}{\sum_{j=1}^{J} e^{m\mathbf{X}_{jn}\mathbf{ß}_j}}, i \in C_n, \forall j \in C_n \qquad (1)$$

While the conditional multinomial logit is a very restrictive model, researchers often use this model because of its simplicity (Louviere et al. 2000). The model is well suited to handle the discrete choices made by individuals for behaviours such as hunting site choice. The estimation of the model provides the weights (i.e., parameters) for the attributes that are necessary to calculate the probability that an individual will choose any alternative (i.e., a choice probability). As with any regression model, one can use the conditional multinomial logit regression model for forecasting. For moose hunting, the forecasts permit individuals to estimate how changes to one or more hunting sites (e.g., a site closure) may affect the choices for all hunting sites.

Choice models were originally estimated from actual choices (i.e., revealed preferences) made by individuals (e.g., past hunting trips). However, Louviere and Woodworth (1983) illustrated how researchers could also estimate these models from hypothetical choices (i.e., stated preferences). One may question the wisdom of conducting a study on what people say they will do rather than what they have done. There are, however, several reasons why a stated preference choice model may provide a better approach than would a revealed preference choice model (Louviere et al. 2000). Most of these reasons exploit the hypothetical nature of the stated preference choice model. For example, since the choice task is hypothetical, one can construct the choice task provided to individuals to follow an experimental design plan that contains good properties for statistical estimation. Furthermore, one can stretch the range of attribute measures beyond existing levels to estimate how these levels may affect choices. In other words, we can use a stated preference choice model to evaluate conditions that do not currently occur on the landscape, but may occur as a result of management actions (e.g., a restriction on the use of all-terrain vehicles for hunting).

Resource economists have almost exclusively driven the application of choice models in outdoor recreation. This popularity among economists exists since choice models provide a convenient method to estimate changes to economic value for non-market goods such as hunting. For hunting, economists can use the forecasting ability of the model to estimate how a scenario (e.g., a site closure) may affect the value that hunters derive from hunting.

The first applications of choice models and hunting were conducted on bighorn sheep (*Ovis canadensis*) in Alberta (Adamowicz et al. 1990, Coyne and Adamowicz 1992). Other efforts on hunting by choice modellers include waterfowl (Creel & Loomis 1992), red deer (*Cervus* *elaphus*) (Bullock et al. 1998), white-tailed deer (*Odocoileus virginianus*) (Schwabe et al. 2001), pronghorn (*Antilocapra americana*) (Boxall 1995), and general hunting (Hausman et al. 1995). However, moose hunting has attracted the most interest among researchers (Boxall et al. 1996, Adamowicz et al. 1997, Akabua et al. 1999, Akabua et al. 2000, Boxall and MacNab 2000, Haener et al. 2000, 2001).

The above studies have uncovered several attributes deemed important by moose hunters when making a site choice, such as travel distance, evidence of moose, and encounter levels with other hunters. While most studies have found that vehicular accessibility was an important determinant of site choice, some studies suggest that poorer accessibility is preferred while others suggest it is not preferred. Finally, a forest disturbance attribute has yielded mixed results in the various studies. In some instances, the authors concluded that the presence of logging reduced the site attractiveness for hunters (Boxall and MacNab 2000, Haener et al. 2000). However, this result seems incongruent with the belief that hunters seek out logged areas to conduct their hunts. We feel that the problem in measuring the impact of forest disturbance on hunting site choice results from the poor descriptions of logged areas that other studies have applied. Even when forest disturbance was measured in detail (Akabua et al. 1999), the unit of analysis focused on a management unit level that was probably too coarse of a scale to model the importance of forest harvesting to moose hunters. In contrast, our study will overcome these previous limitations of research on moose hunting by examining the importance of forest harvest related site characteristics that are relevant to hunters. The inclusion of a description of the height of the regenerating vegetation should be more relevant to moose hunters than would be descriptions about the presence or absence of logged areas. Sarker and Surry (1998) also recommended that future social and economic research in Ontario should concentrate on understanding the effects of forest management practices on the environmental settings preferred by moose hunters.

METHODS

In the fall of 1998, a mail survey of licenced moose hunters from the Ontario Ministry of Natural Resources' Thunder Bay District was undertaken. The initial survey was mailed to 1,000 randomly chosen hunters during the middle of the moose hunting season. This timing allowed for a better recall of hunting experiences by the moose hunters. Survey implementation followed the Total Design Method of Dillman (1978) to maximize response rate. The Total Design Method suggests that after the initial mail-out, a postcard reminder be mailed 1 week later, followed by another survey package to non-respondents 2 weeks after the postcard reminder. The response rate achieved was 63.5%, and we conducted no checks for non-response bias. In comparison, Boxall and MacNab (2000) reported a response rate of 49% for Saskatchewan hunters who were also surveyed by mail. Interested readers are referred to Bottan (1999) and Bottan et al. (2001) for detailed summaries of all survey results from the Thunder Bay respondents.

A key aspect for conducting a stated preference choice modelling study is to determine a list of relevant attributes for the behaviour in question. When combined with an experimental design plan, it is also important to determine appropriate levels that the attributes may take. Our list of hunting site attributes and attribute levels were developed after a careful review of the previously described literature, a focus group with hunters, and discussions with academics, resource management biologists, wildlife specialists, and foresters.

Table 1 describes the 7 attributes and associated levels used for this study. While many other attributes are likely to affect site choices by moose hunters (e.g., tag allocation), we attempted to simplify the choice task for the respondents by holding all regulations constant. To explore the potential demand for new hunting opportunities, one level from 4 attributes represented an environmental or social condition that seldom exists. Based on these formal and informal discussions, we were confident that the choice experiment balanced the presentation of relevant information to hunters while minimizing the burden on the respondents.

The survey task required respondents to choose one alternative from 2 hypothetical hunting alternatives and the option of not hunting (Fig. 1). To properly estimate the attribute weights, the experimental design required us to obtain information from 27 different choice tasks like Figure 1. Each respondent received 1 of 3 survey versions that contained 9 of the 27 different hypothetical choice tasks. Before respondents reached the choice task, each survey booklet contained attribute definitions and an example of how to answer the choice task.

Table 1. Definition of attributes and associated attribute levels.

Attribute	Definition	Level
Distance	The approximate 1-way distance (kms) from the hunter's home to the hunting area	1 = 350km[1] 2 = 250km 3 = 150km
Access	Approximate access conditions by a 2wd vehicle within the hunting area (all areas were assumed to be 4x4 accessible)	1 = 70% of area by 2wd 2 = 50% of area by 2wd 3 = 30% of area by 2wd
Encounters	The number of encounters with other hunting parties during a day's moose hunting within the area	1 = 4 or more other hunting parties 2 = 1-3 other hunting parties 3 = No other hunters[1]
Lakes	Presence of lakes within hunting area	1 = Many lakes 2 = Few lakes 3 = No lakes[1]
Moose	Evidence of moose seen during a day's moose hunting within the area based on seeing or hearing moose or seeing fresh sign such as tracks or droppings	1 = >3 moose per day[1] 2 = 1 - 2 moose per day 3 = <1 moose per day
Height	Height of regeneration growing in cutovers within hunting area (meters)	1 = >2m 2 = 1 - 2m 3 = <1m
Forest type	Predominant type of forest regeneration growing in cutovers within hunting area	1 = Conifer 2 = Hardwood

[1]denotes an atypical level for the attribute.

Fig. 1. An example of a choice task provided to respondents.

24a. If you were to select a new hunting area, and these were the **ONLY** two options available, which one would you choose on your next hunting trip, if either?

Features of Hunting Area	Area A	Area B	1-7
Distance from home to Hunting area (one way)	150 kilometers	150 kilometers	Neither Site A or Site B I will not go moose hunting
Hunting area accessibility by vehicle type: 2wd 4wd (or ATV)	70% by 2wd 100% by 4wd	50% by 2wd 100% by 4wd	
Frequency of encounters with other hunters	NO other hunters	1-3 other hunting parties	
Presence of lakes	many lakes	many lakes	
Moose population: evidence of	one moose every 2 or more days	3 or more moose per day	
Forest characteristics Cutovers: height of new growth Predominant forest regeneration	3-6ft tall (1-2m) conifer	less than 3ft tall (<1m) hardwood	
Check ONE and only one box	☐	☐	☐

For a full discussion of stated preference choice models, experimental design, and attribute coding, the interested reader is referred to Louviere et al. (2000) or Bennett and Blamey (2001), who provide a less technical discussion.

RESULTS

The data were analyzed with a conditional multinomial logit regression model using LIMDEP 7.0 software (Green 1998). Table 2 presents the parameter estimates from this regression model along with asymptotic *t*-test values. The asymptotic *t*-tests are large sample property *t*-tests that assess whether a parameter estimate differs significantly from zero. If all of the parameter estimates associated with the levels of an attribute do not statistically differ from zero, one can conclude that the attribute in question has no effect on site choice. In our model, at least one of the parameter estimates associated with any given attribute was statistically different from zero. One may notice that some attribute levels do not have parameter estimates. In two cases (i.e., distance and access), we estimated one single parameter estimate based on the quantitative values of the attribute levels. For the remaining attributes, which were specified at nominal levels only, parameter estimates could only be obtained for 2 of the 3 attribute levels, with the third level equal to the negative sum of the other two parameter estimates. The quality of the regression model was assessed through an adjusted McFadden's rho statistic. However, this statistic is not at all analogous to the well understood R^2 term from linear ordinary least squares regression and the value of 0.15 for our study is very acceptable.

Table 2 also presents the partworth utility estimates for all attribute levels. The partworth utility represents the weighted contribution to the utility of an alternative that any attribute level provides. The partworth utilities are calculated by multiplying the coding for an attribute level by the relevant parameter estimate(s) (e.g., the partworth utility for the zero encounters level equals the negative sum of the parameter estimates from the 4 or more and 1 to 3 levels for encounters). In this sense, the partworth utilities are somewhat redundant, but we include them since they provide the best summary of the results. High partworth utilities increase the likelihood that a hunter would select a particular hunting site. While it is tempting to use the partworth utilities to pass judgment on the most important attributes, one must remember that the partworth utilities are likely to be affected by the range of levels associated with an attribute. For example, the partworth utilities for travel distance would probably be

Table 2. Statistical model results and partworth utility estimates for attributes and levels.

Attribute	Level	Parameter Estimate	*t*-statistic	Partworth Utility
Intercepts	No Hunting	-0.2718**	-8.27	-0.2718
	Generic	Not Identifiable	Not Identifiable	0.0000
Travel Distance	Linear estimate	-0.0080**	27.47	Not applicable
	350 km	Not applicable	Not applicable	-0.8002
	250 km	Not applicable	Not applicable	0.0000
	150 km	Not applicable	Not applicable	0.8002
Encounters	4 or more	-0.5444**	-16.58	-0.5444
	1-3	-0.0042	-0.13	-0.0042
	0	Not Identifiable	Not Identifiable	0.5486
Accessibility	Linear estimate	0.0028*	2.00	Not applicable
	70% by 2wd	Not applicable	Not applicable	0.0561
	50% by 2wd	Not applicable	Not applicable	0.0000
	30% by 2wd	Not applicable	Not applicable	-0.0561
Lakes	Many Lakes	0.2982**	9.33	0.2982
	Few Lakes	0.1275**	3.99	0.1275
	No lakes	Not Identifiable	Not Identifiable	-0.4257
Moose Evidence	3 or more	0.3475**	11.01	0.3475
	1 - 2 per day	0.1421**	4.51	0.1421
	<1 per day	Not Identifiable	Not Identifiable	-0.4896
Regeneration Height	>2m	-0.2359**	7.25	-0.2359
	1-2m	0.0301	0.97	0.0301
	<1 m	Not Identifiable	Not Identifiable	0.2058
Vegetation	Conifer	-0.0669*	-2.03	-0.0669
	Hardwood	Not Identifiable	Not Identifiable	0.0669

* $P<0.05$; ** $P<0.01$.

much different if we chose levels of 50, 300, and 550km, respectively.

The model appears to provide a good explanation of hunter preferences, as all partworth utilities follow a priori expectations. Distance acts as a strong deterrent to the choice of a hunting site by a resident hunter from the Thunder Bay area. There is a significant positive relationship for a larger proportion of the hunting area being 2-wheel drive accessible, although that relationship is not as strong as the distance effect. As one might expect, the number of expected daily encounters with other hunting parties was negatively related to hunting site choice. Sites in which many lakes were present yielded a positive preference, suggesting that respondents preferred to have an abundance of water present in the area they chose to hunt moose. Intuitively, respondents were more likely to select an area if it had evidence of many moose. It was also revealed that areas with shorter heights of regenerating forest were preferred to areas that had regeneration heights exceeding 2 meters. Lastly, respondents had a positive preference for hardwood as opposed to conifer vegetation that was regenerating in cutovers.

FICTITIOUS FOREST MANAGEMENT SCENARIO

This section will demonstrate two aspects about the managerial usefulness of a choice modelling approach. First, we illustrate how an individual can use the choice model results through a forecasting model to estimate the likely consequences of a change to the hunting environment on the distribution of hunting effort. Second, we demonstrate how an individual can translate a change to a hunting environment into a change in economic value for hunting trips.

Many researchers and managers have proposed restricting access into new cutovers until suitable cover for moose is available to reduce moose vulnerability to hunters (Eason et al. 1981, Tomm et al. 1981, Timmermann and Gollat 1983, Eason 1985, Ferguson et al. 1989, Rempel et al. 1997). While such a policy may achieve certain desirable ecological goals, the implications of such a policy change for moose hunters has never systematically been investigated. Below, we use the results from Table 2 to examine fictitious scenarios whereby one hunting site moves through 3 stages; from undisturbed, to a logged area that is open for hunting, and finally to an area that is closed to hunting. We purposely chose this fictitious scenario to demonstrate the usefulness of the model without becoming engaged in a debate about the assumptions we make regarding the scenarios.

The scenarios we chose involved 6 hypothetical areas available to moose hunters along with the option of not hunting. Table 3 describes these hunting areas by the attributes and attribute levels that we used to estimate our choice model. The bottom 3 rows of the table highlight the expected use of the respective areas by our Thunder Bay resident moose hunters.

The choice probabilities (i.e., the last 3 rows in Table 3) were calculated as follows. First, we replaced the verbal descriptions of each hunting site in Table 3 by the partworth utilities from Table 2. For the distance and accessibility attributes, the partworth utilities were obtained by multiplying the associated linear parameter estimate from Table 2 by the difference between the value in Table 3 and its mean value (i.e., 250 for distance and 50 for accessibility). Second, for each hunting site, the partworth utilities were summed and the sum of the no hunting alternative was set to the partworth utility for the do not hunt alternative. Third, we took the exponent of these summed values and summed all 7 of these values. Finally, we divided the exponent sum for any alternative by the sum

Table 3. Simulation of closing a hunting site in an area with new cutovers.

Attribute	Site #1	Site #2	Site #3	Site #4	Site #5	Site #6	Not hunt
One way travel distance (km)	150	175	190	165	180	160	
Encounters (per day)	4+	4+	4+	4+	4+	4+	
Accessibility (% 2 wheel drive)	70	55	30	60	40	60	
Lakes	few	many	none	few	few	many	
Evidence of moose (per day)	<1	1-2	1-2	<1	3+	1-2	
Regeneration height (m)	>2	1-2	>2	1-2	1-2	>2 to <1	
Vegetation type	conifer	conifer	conifer	conifer	conifer	conifer	
Predicted Hunting Effort (%)							
Before harvest to site #6	9.63	22.02	6.77	10.84	21.00	19.29	10.45
After harvest of site #6	8.70	19.89	6.11	9.79	18.97	27.11	9.44
After closure of site #6	11.94	27.28	8.38	13.43	26.02	Closed	12.95

obtained from all 7 alternatives. The resulting proportions were converted into the percentages shown in Table 3.

In the before harvest scenario, the model predicted that about 19% of hunter effort would have occurred in site #6. After introducing the forest harvest in site #6, which would alter the regeneration height to less than 1 meter, the model predicted that hunter effort in site #6 would increase to around 27%. This predicted increase does not account for the fact that hunters may see more evidence of moose per day as a result of the forest harvest. While we did not consider this change to provide evidence of moose in our scenario, the user of this model is free to make whatever assumptions she/he likes about changes to attributes. It should also be noted that the relative changes to hunting sites in Table 3 are identical among the unaffected hunting sites. This is a direct consequence of the independence of irrelevant alternatives (IIA) property (Luce 1959) of the multinomial logit model. While this rigid substitution pattern appears unrealistic, it is an empirical question whether this property holds for a given data set.

The next scenario involves a closure of hunting in areas with new cutovers (i.e., site #6). The after closure of site #6 row in Table 3 predicts how this closure may impact the use of the remaining 5 hunting areas along with the no hunting alternative. The table demonstrates that individuals can use a choice model to predict the impacts of management changes on the spatial distribution of hunting effort. Furthermore, this forecasting model permits managers to investigate a suite of scenarios without having to implement the scenarios on the landscape.

Besides providing information about the redistribution of hunting effort, one can also use a choice model to determine the change in economic value of hunting associated with the site closure scenario presented above. We restrict our attention to the change in economic value that may arise from the hunting site closure after the forest harvest in site #6. If our model included some monetary attribute such as a fee or cost, we could directly estimate economic values. Without a monetary attribute, we resort to an indirect method of valuation that employs the travel distance attribute weight. In our scenario, we estimate that a hunter would have been willing to drive an additional 39.5km in 1-way travel distance to have avoided the restriction on hunting in site #6. This compensating km value was obtained by: (1) calculating the summed exponent values as described earlier for the scenarios with and without the site closure to site #6; (2) taking the natural logarithm for both of these summed exponent values; (3) subtracting these logarithm values; and (4) dividing this difference by minus one times the travel distance parameter estimate in Table 2.

The 39.5km travel distance is translated into dollars by multiplying this extra round trip distance by a suitable per km cost for operating a vehicle. Even if we choose a reasonable value such as $0.35 per km, the loss per trip to the hunter would have equaled $27.66 for the round trip. We could also add to this amount, costs for the additional travel time associated with each trip multiplied by the value that hunters place on their travel time. Clearly, this economic information would be of great importance to managers who must follow the careful balance of limiting hunting success, yet providing quality hunting opportunities.

DISCUSSION

Lyon (1987: 289) suggested more than a decade ago that "when possible the relationships between participation, experience quality, and those site characteristics that can be managed, such as crowding, hunter success, and access, should be quantified and used to guide management decisions". By adopting a choice modelling approach, we have taken a step in that direction. More importantly, rather than investigating each environmental and social effect on hunting separately, the method permits a more holistic investigation that yields valuable estimates relating to use and to value associated with changes to hunting experiences. As with any modelling approach, the model does require validation with empirical data.

Our study has demonstrated that the behaviours of Thunder Bay area resident moose hunters are likely to be affected by a number of attributes. The model results illustrate that these hunters have preferences for shorter travel distances, fewer encounters with other hunters, greater vehicular accessibility, greater abundance of moose, more water, cutovers with short regenerating vegetation, and areas with hardwood tree species. Besides identifying these preferences, the choice modelling approach provides a unifying method of linking behavioural theory to these preferences. The results of validated choice modelling studies may be used to forecast changes in hunting effort and economic values through a tradeoff approach espoused by the model.

A fictitious forest management scenario was presented in this study to illustrate the ability of a choice model to answer two relevant questions to managers. First, we showed how the model could be used to estimate the expected redistribution of hunting effort arising from changes to the management of the resource. This information is important since managers need to be aware of the likely consequences of shifting hunting effort into other areas when deciding to restrict access or to change other management aspects in one or more hunting areas. Managers could also use the approach to examine the tradeoffs that hunters may make between stricter regulations and better quality hunting experiences. Second, we showed how one could use a choice model to estimate hunters' changes in economic values stemming from management changes. Again this change in economic value provides managers with a better understanding of the costs that the hunting public would likely endure as a result of a specific management direction.

One further positive aspect of the choice modelling approach based on hypothetical behaviours is that we may estimate the consequences of a wide suite of management scenarios without actually implementing these scenarios. Besides the excessive cost of field experiments, many scenarios that managers wish to explore may invoke confrontation with hunters and their stakeholder representatives. Therefore, the choice model permits resource managers to gauge the consequences of many scenarios without invoking a highly politicized response from the hunting public.

In summary, our study provides some new human dimension information to managers. However, some caveats exist that reflect our inability to understand and to model the process that leads to hunting behaviours. For example, we examined hunting site choice in a static environment that does not take into consideration season, habits, or success. As well, we did not examine the relationships between regulations (e.g., tag allocation levels) and other hunting site attributes. Finally, there may be several other attributes that influence hunting effort and the attribute levels specified in this study may not be suitable for every context (e.g., number of encounters on the opening week of the season). However, there is a tradeoff between model complexity and respondent burden, and we opted for data collection that would keep the response task as simple as possible for the hunters.

We feel these caveats need to be understood by readers. However, we do not believe that these caveats take away from the overall positive contribution of our study. No one has the hubris to assume that they know all aspects of any biological or social process. We accept that our ability to understand hunting behaviour is incomplete and we provide much additional information to a growing body of literature. For example, our emphasis on the height of regenerating vegetation in cutovers, which has been ignored by past researchers, was found to be very important to moose hunters. Additionally, the choice modelling perspective embraces researcher uncertainty directly into the model. It is exactly for this reason that the model is probabilistic rather than deterministic in its predictions.

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