Where's the Meat? Exploring Changes in Game Management and Governance of value to British Columbia Resident Hunters

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Abstract

Hunting is an important activity for many BC residents, providing both food and recreational pleasures. It also serves to transfer funds from the more populous to the less populous regions of the province. Many of the most sought game species in BC are in decline, with an increasing share of hunts becoming limited entry (LEH). We use a choice experiment with LEH moose hunt applicants to explore how hunters value increasing the harvestable surplus, changing the probability of being drawn, changing governance, and increasing the share of licence fees dedicated to game management. Using predicted mean willingness to pay estimated for each participating hunter, we find that as described, the changes have on average positive value. Trading between LEH draw probability and odds of harvesting is predicted to leave some participating hunters worse off. Combining changes can generate substantial value for participating hunters, and suggests that increased licence fees would be acceptable if these desired changes can be achieved. Where such changes also result in more hunting trips, it is expected to generate increased economic activity in the less populous parts of the province.

Introduction

Game Management Challenges

Hunting is an important recreational activity in both the United States (White et al., 2016) and Canada, with recent work suggesting that participants in hunting receive among the highest benefit value from engaging in their preferred activity relative to other outdoor recreationists (Lloyd-Smith, 2021). Hunting is an important economic activity for many rural communities, and contributes many benefits to those participating beyond the value of the game they are able to harvest (Reis and Higham, 2009; Arnett and Southwick, 2015). Protecting and enhancing game species population requires monitoring and landscape level management policies that are costly. These costs would include opportunity costs, such as protecting habitats that could be developed for other uses.

British Columbia is the most biodiverse province in Canada, with the most species at risk (Austin et al., 2008). Growing human pressures on wildlife and habitat, together with improved scientific understanding, have led to an increased role for regulation and legislation (Archibald et al., 2014), while public attitudes now demand more accountability and engagement with decision making and governance (Manfredo et al., 2017). Consequently, effective wildlife management has become more complicated and costly, while funding and capacity have simultaneously declined (Archibald et al., 2014).

The North America Model of Wildlife Conservation, which emerged in the 19th century, embodies the wildlife management philosophy guiding policy in Canada and the United States (Mahoney and Geist, 2019). The model was largely created by hunters to halt widespread destruction of wildlife populations due to habitat loss and market hunting (Organ et al., 2012; Heffelfinger et al., 2013; Mahoney and Geist, 2019). Seven core principles guide the management of wildlife under this model (Geist et al., 2001; Geist and Organ, 2004; Duda and Jones, 2008; Organ et al., 2012; Mahoney and Geist, 2019): (1) wildlife is a public trust resource, (2) Game is not harvested for the commercial market, (3) wildlife is allocated by law, (4) wildlife is only killed for legitimate purposes, (5) wildlife is an international resource, (6) science is the tool for the discharge of wildlife policy, and (7) access to hunting is democratic. In brief, wildlife is a resource that is to be available to all, not wasted, and not open to private ownership and commercial exploitation. Rationing access using prices is inconsistent with this philosophy.

For British Columbia, there is limited information on wildlife population sizes. Efforts to accurately count population sizes typically do not occur until sightings and/or harvest numbers indicate a crisis. Before 1987, hunter harvest numbers was not collected for many species, leaving little basis for historic population estimates that rely on these counts (Wolowicz, 2019a). Since harvest counts have been collected, the harvest for many species has shown substantial declines (see for example Janz and Hatter, 1986).

Moose is a particularly poignant example of this decline. In 2016, moose saw the third highest number of licences purchased, after the more abundant mule deer and white-tailed deer (Wolowicz, 2019b). Until the early 1980s, resident hunters were able to purchase a moose species license through General Open Season and hunt annually (Province of British Columbia, 1979). As moose declined, access was rationed through a lottery system, in BC known as the Limited Entry Hunt (Hatter et al., 1990). Resident hunters harvested 10,894 moose in 1976, peaked at 13,045 in 1979, and declined to 4,017 by 2018 (Wolowicz, 2019a).

Enhancing populations of game species and providing more hunting opportunities in British Columbia will require more resources for monitoring and analysis of game species populations and factors affecting their abundance, and further resources to enhance the species through, among other things, habitat protection and enhancement. As a share of the provincial budget, resources dedicated to fish and wildlife management has declined from a peak at 0.628% in 1954 (Smith, 1986) to an estimated 0.080% by 1994 (Archibald et al., 2014). Since 1995, the budget for Fish and Wildlife management has not been reported. There is nothing indicating that the trend has changed.

Wildlife management agencies across North America have struggled with increased costs to administer wildlife management program goals (Jacobson and Decker, 2006; Jacobson et al., 2007). While all jurisdictions in the United States have dedicated income sources for wildlife management (license fees, excise taxes, tax check-offs, license plates, foundations) (Jacobson et al., 2007), British Columbia does not (Ministry of Forests, Lands, Natural Resource Operations and Rural Development, 2018). In BC, approximately 20% of fishing and licence revenues paid by resident hunters are dedicated to the Habitat Conservation Trust Foundation (Habitat Conservation Trust Foundation, 2021). The remainder of the fishing licence revenues are provided to the Freshwater Fisheries Society of BC, whose primary objective is to stock a number of lakes across BC with hatchery-raised fish for anglers to catch (Freshwater Fish Society of BC, 2021). For hunting licences, the remaining 80% of licence revenues become part of general revenue, and are allocated based on a government wide budgeting process.

The objective of this research was to assess the potential for combinations of changes in the governance of wildlife management and in the hunting experience that could induce hunters to accept a higher licence fee. Focussing on the moose LEH, we use a choice experiment with scenarios involving increasing harvestable moose numbers, varying LEH draw and hunting success probabilities, one of two independent management commissions, and increased share of LEH licence fee dedicated to wildlife management, paid for by an increase in the LEH licence fee. In the next section some related research is reviewed. Following this the choice experiment design is described, together with a brief overview of the econometrics applied to the collected data. The results are then presented and discussed, with a brief conclusion wrapping up the paper.

Previous Research

In a choice experiment, participants are asked to choose between two or more scenarios described by changes in the levels of a small set of attributes. One of the scenarios is often a status quo, which would occur if no policy changes are made. In those choice experiments where willingness to pay for the changes in attribute levels is sought, scenarios also include differing levels of a monetary payment vehicle, such as a tax or fee. Choice experiments have been extensively used in environmental economics (Johnston et al., 2017; Hanley and Czajkowski, 2019). In the following, we review some applications to hunting.

Boxall et al. (1996) examined moose hunters' willingness-to-pay (WTP) in the Province of Alberta, using evidence of moose (as a surrogate for abundance), hunter congestion, hunter access, forestry activity, road quality and distance to hunting site as attributes. WTP increased with increased evidence of moose, fewer hunters, and increased access and shorter travel distances. Updating this work in Saskatchewan, Boxall and Macnab (2000) examined moose hunters' WTP using evidence of moose, hunter congestion and forest conditions. Respondents preferred increased evidence of moose, fewer hunters, and less evidence of logging, with rural hunters affected more by the evidence of moose and access. Schroeder et al. (2018) examined turkey hunting season preference in Minnesota, including lottery versus over-the-counter hunting opportunities, one or two turkey permits per hunter, hunter crowding, and season structure. Hunters preferred less crowding, over-the-counter opportunities in low demand areas, and a second hunting permit only if the hunter was unsuccessful in harvesting a turkey with their first permit.

In some jurisdictions, hunters, collectively or individually, rent private land for hunting. For hunting leases in Mississippi, Hussain et al. (2010), hunter WTP was higher for properties with more huntable species, of moderate size (500-1000 acres), closer to hunter residence and of longer duration. The status quo bias was increasing in age, decreasing in income, and unaffected by crowding and hunting avidity. Mingie et al. (2017) examined hunters' WTP for private land big game hunting leases in the State of Georgia. Respondents preferred more acreage and fewer hunting club members, more restrictive regulations with a higher bag limit, and thinned property over clearcut, with respondent age positively correlated with status quo choice.

Discrete choice experiments related to consumptive use activities, particularly hunting, such as those cited above, tend to focus on site and/or species specific activities and the experience, as opposed to broader wildlife management. There are a few exceptions. Fischer et al. (2015), studied trophy hunting in Ethiopia, including an attribute varying the division of the fees between the local communities and the central government. Respondents' WTP depended on the target species, and was increasing with abundant viewable non-target wildlife, no domestic livestock, longer trips, and benefits shared with local communities. Cornicelli et al. (2011) offered a sample of Minnesota deer hunters regulation scenario combinations that were consistent with achieving different ecological objectives, half of which involved a desired reduction in deer populations. Hunters were strongly attached to their home region, limiting the extent to which changing hunt regulations would induce hunters to hunt where population control was needed. Serenari et al. (2019) begin by fixing ecological targets and hunter fees paid by North Carolina hunters, asking hunters to compare various combinations of season length and bag limit. Utility predictions could be used to rank policy scenarios. However, attribute level combinations were not related to any model of hunter success – combinations could include both longer seasons and higher bag limits – and WTP for changes could not be estimated.

The reviewed research suggests that the abundance of the target species is an important attribute. Trading between hunting frequency and hunting success receives limited attention. That hunters are motivated by more than harvesting food is well known (Radder and Bech-Larsen, 2008; Reis, 2010; Larson et al., 2014). By exploring the trade off between frequency and success, we can examine whether current practice is consistent with the balance between motivations preferred by the hunter population. To our knowledge, using WTP as an assessment of these preferences, measured using feasible attribute combinations, has not been previously explored. Likewise, the use of WTP to measure preferences over governance arrangements has been little investigated. Studies of US hunting would not consider these governance aspects, as hunters are involved in governance and substantial fees are dedicated. Canadian provinces do not follow the US management and funding model, while the geographic proximity and historical and cultural similarity of these two countries suggests hunter preferences should be similarities. This fact allows us to use British Columbia as a case to explore whether moving to a management model with some of the US characteristics would be consistent with acceptance of higher licence fees.

Method

Choice Experiment

Subject Population and Case

A draft survey was designed, informed by the hunting expert knowledge of one of the authors. With the cooperation of two fish and game clubs near Kelowna, British Columbia, six resident hunter focus groups were organized (31 total participants) to confirm attribute salience, validate attribute ranges, and ensure appropriate survey wording.

Attributes

An example choice card is shown in Figure 1. Table 1 lists the attribute levels used. Harvestable surplus measures the number of moose available to be harvested at the provincial level. The current (2020) harvestable surplus is approximately 5,000 moose. The harvestable surplus has been as high as 12,500 moose per year. The probability that participants choose the alternative is expected to increase with a larger harvestable surplus.

The trade off between the opportunity to hunt (probability drawn) and the likelihood of a successful hunt (harvest probability) is anchored to the harvestable surplus and the number of applicants as

$$Surplus = Applicants \times Pr\,(Drawn) \times Pr(Harvest)$$

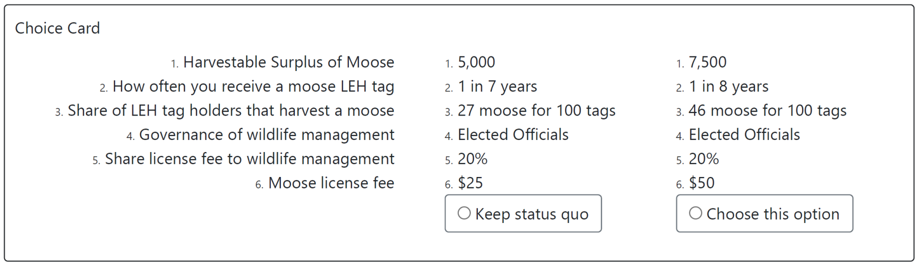

Figure 1: Example choice card.

Table 1: Attribute levels and experimental design priors

Attribute	**Levels**
Harvest Surplus of Moose	**5,000 (current)**, 7,500, 10,000, 12,500 (historic high)
	Priors: [0.00, 015, 0.30, 0.45]
Opportunity vs Success	$Surplus = Applicants \times Pr\,(Drawn) \times Pr(Harvest)$
	1:7 drawn, 27/100 harvest (current)
	Priors: [0.00, 0.00, 0.00, 0.00, 0.00]
Governance	**Elected Officials (current)**, Game Commission,
	Multi-Government, Multi-Stakeholder Commission
	Priors: [0.00, 0.50, 0.30]
Share fee to Management	**20% (current)**, 50%, 100%
	Priors: [0.00, 0.25, 0.50]
Moose Licence Fee	**$25 (current)**, $35, $50, $75, $100, $140, $200, $500
	Priors: [-0.025 (continuous)]

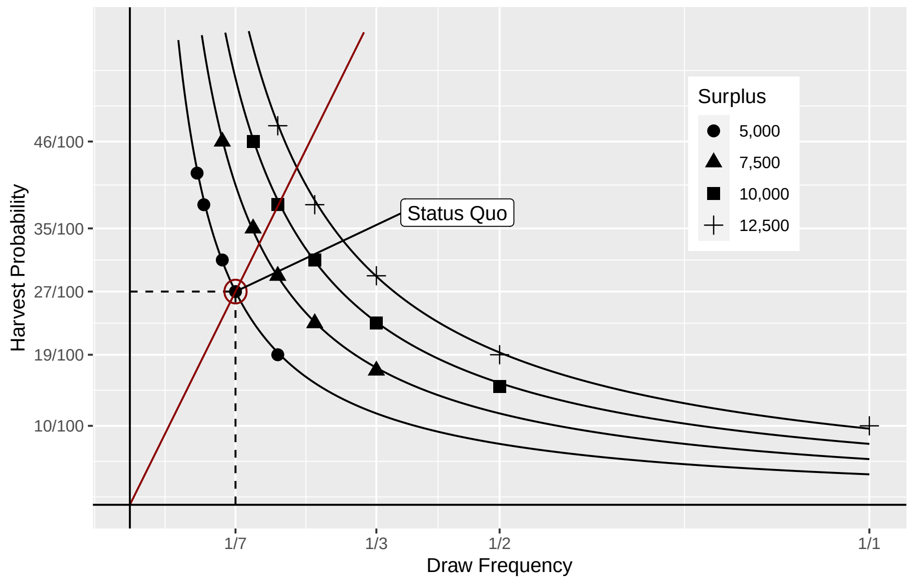

Figure 2: Opportunity vs Success harvest rate isoquants.

Using the current (status quo) values of a 5,000 moose harvestable surplus, probability of being drawn at 1/7 and probability of harvesting a moose at 27/100, the number of applicants solves to 129,630. Assuming the number of applicants is constant, we choose combinations of draw probability and harvest probability that achieve the harvestable surplus attribute levels.

The relationship expressed in the equation is akin to a production function with probability of being drawn and probability of harvesting a moose as the inputs. Figure 2 illustrates these isoquants and identifies all the combinations of harvestable surplus, probability of being drawn, and probability of harvesting that are used in the choice experiment. Combinations above the origin ray correspond to hunting less often with a higher probability of harvesting a moose, while those below correspond to the opposite trade off. In the econometric analysis, we include the ratio of harvest success to odds drawn, the marginal rate of technical substitution, as the regressor. We have no priors on hunter preferences over this attribute.

For ease of understanding by the participants, the probability of being drawn was presented as average number of years between draws, and the probability of harvest as the number of moose harvested per 100 tags drawn. Whole numbers were used for the years, and the implied harvest probability rounded to the nearest ratio to 100.

Harvestable surplus, probability of being drawn and probability of harvesting captures the hunting experience variation explored. Governance and the share of licence fees dedicated reflect different wildlife management arrangements. Participants were presented with one of three possible governance models. Governance was introduced as "a set of policies and laws which determine how decisions are made, implemented and how responsibilities are exercised. Governance can be carried out by elected officials, government representatives, private-public partnerships, or non-government agencies and organizations".

The current situation was labeled "Elected officials," and defined as "Elected officials (Minister and Cabinet) supervise fish and wildlife management; establish regulations; approve budgets and make decisions on wildlife management."

One alternative governance model was labeled "Game Commission," and defined as "An appointed group of representatives knowledgeable and interested in wildlife conservation, residing across the province. This group would supervise fish and wildlife management; establish regulations; approve budgets; conduct public consultation; make decisions on wildlife management."

A third governance model was labeled "Multi-Government, Multi-Stakeholder Commission," and defined as: "A group of representatives from First Nations, provincial government, conservation organizations, and industry which are knowledgeable and interested in wildlife conservation. This group would supervise fish and wildlife management; establish regulations; approve budgets; conduct public consultation; make decisions on wildlife management."

This third model was introduced to reflect the unique Canadian situation, as manifest in British Columbia. Both the provincial and federal governments have committed to the principles of the United Nations Declaration on the Rights of Indigenous Peoples. The federal government has enacted the United Nations Declaration on the Rights of Indigenous Peoples in Canada (Government of Canada) while the province has enacted the Declaration on the Rights of Indigenous Peoples Act (Legislative Assembly of British Columbia). These governmental commitments suggest that major reforms of game management in British Columbia will require enhanced cooperation with First Nations communities. While the focus groups suggest that resident hunters are unsatisfied with the current governance model, we have no strong priors about hunter preference differences between the two alternative attribute levels.

The proportion of license fees dedicated to the resource included the current 20%, 50% and 100% (common in the United States). Increasing the share dedicated is expected to increase the likelihood that the alternative will be chosen.

Licence fees ranged from $25 (no increase) to $500, with the upper limit established based on focus group feedback and levels observed in other jurisdictions. All else equal, increasing the licence fee should reduce the likelihood that the alternative is chosen.

Choice Sets

The attribute levels offer 1,440 unique combinations. We adopt a fractional factorial design that focusses on the main effects. We follow the advice of Johnston et al (2017), to limit the cognitive burden and the opportunities for strategic behavior by limiting the number of choice cards and the number of choices per card. Each respondent is delivered three choice cards with each having one choice between the status quo and one alternative.

We use the idefix package (Traets et al., 2020) developed for R (R Core Team, 2020) to generate a D-efficient design consisting of 72 unique choice cards, using the priors shown in Table 1. These unique choice cards are then organized into 24 choice sets of three cards each using an optimal blocking algorithm in the algDesign package (Wheeler, 2019).

The choice experiment was delivered online, using server end software developed by one of the authors. The system iterates over the choice sets so that an (almost) equal number of participants are delivered each of the choice sets. The final numbers for each choice set depend on completion by the participants.

The choice experiment survey began with a section describing the state of moose in BC, together with information about hunting licence fees and resources devoted to game conservation and enhancement across a variety of jurisdictions in western North America. Following this, the choice experiment attributes were described. For each attribute, participants were asked to indicate their preferred attribute level, all else equal, as a test of understanding. This was followed by the choice cards. For those who always chose the status quo, a set of debriefing questions were delivered, to asses if these choices represent protest votes. Subjects who chose responses suggesting they were not considering the relative utility of the offered scenarios were dropped from the sample. Subsequent to the choice experiment, all participants were asked to describe their perceptions about the three different forms of governance offered. The final sections of the survey collected information about motivations for hunting and demographics.

A BC government partner generated a sample of 5,000 email addresses from applicants to the moose LEH in 2018. BC's Personal Information Protection Act (Legislative Assembly of British Columbia, 2003) precludes the sharing of government lists with others who will use those lists to contact people. Therefore, we prepared a form letter invitation which our government partners then populated and sent. The invitation included a common link to the online survey. Within hours of mailing the invitations the link was being shared through social media. We adapted the system to include personalized URLs for each invitation letter that could only be used once, which our government partner sending the modified invitations to a new sample of 5,000 email address.

Econometrics

We follow the conventional random utility approach first developed by McFadden (Mcfadden, 1981; Ben-Akiva et al., 1999). For each choice task, the individual is assumed to select the option that maximizes their utility. The researcher observes and/or controls aspects of the choice options, while unobserved aspects of the choice and/or individual add variation that is random from the perspective of the researcher.

The utility of individual $i \in \{1, \ldots, N\}$ from option $j \in \{S, A\}$ in choice task $t \in \{1, 2, 3\}$ is modeled as

$$
\begin{aligned}
U_{ijt} &= \alpha_{ij} + \beta_i x_{ijt} + \delta z_i + \epsilon_{ijt} \\
\alpha_{iS} &= 0 \\
\alpha_{iA} &= \alpha_A + \gamma_A z_i + \eta_{iA} \\
\beta_i &= \beta + \Gamma z_i + \eta_i
\end{aligned}
$$

where x_{ijt} is a vector of variables that differ between choices; z_i is a vector of variables that differ across individuals but do not change across choices; α_A, γ_A, β, Γ and δ are fixed parameters, and ϵ_{ijt}, η_{iA} and η_i are unobserved disturbance terms. Defining α_{iA} and β_i as functions of z_i captures individual heterogeneity in the utility contribution of changes in x_i that can be attributed to variations in individual specific characteristics.

The individual is assumed to choose A when $U_{iAt} > U_{iSt}$. Notice that level differences in utility contributed by individual specific characteristics z_i, captured in δ, have no bearing on the choice, and consequently cannot be estimated.

If ϵ_{ijt} is assumed to follow a type I extreme value distribution, then the probability of choosing A will follow a logistic distribution. If η_{iA} and η_i are degenerate random variables, then estimation is as a multinomial logit model. If these random variables are not degenerate, then their influence must be integrated out before the multinomial logit estimation. Excepting some specific distributions where a closed form integral can be derived, integration is typically accomplished through simulation, and the mixed multinomial logit model is estimated using simulated maximum likelihood. For more extensive explanations of these models and their estimation issues, see Train (2009).

Study Population

The target population for this research are resident hunters in British Columbia who purchase a basic resident hunter licence, and applied to the limited entry moose hunt in 2018. Moose is a highly desired game species which has experienced continuing declines in the harvestable surplus. We therefore expect moose to be a highly salient species for resident hunters.

Hunting in BC is divided between First Nations members, resident hunters, and guide-outfitters. First Nations members have rights to hunt and gather that are protected by the Canadian constitution, and therefore do not need a provincial hunting licence. Their willingness to pay a higher licence fee is therefore not relevant. While many guide-outfitters do themselves hunt, the share of the harvestable surplus that they are allocated is used for their business activities. Their WTP for their share of the hunt allocated to guide-outfitters will reflect how the application of those funds affects the profitability of their businesses. For resident hunters, we expect the WTP for changes in choice experiment attribute levels to reflect the resultant utility changes.

Experiment Sample

The survey was started by 2292 people and completed by 2167. Removing protest votes reduced the usable sample to 2038. The raw response rate is at least 22.9%, as we do not know how many email addresses were invalid.

Table 2 summarizes the individual specific characteristics that were examined for their contribution to individual heterogeneity of responses to changes in the attribute levels. Where comparable numbers for the provincial population are available or can be calculated, these are also presented (Statistics Canada, 2021). Results from a 2012 survey of resident hunters provides comparison with the sample for several variables (Responsive Management, 2013).

The sample income profile is similar to equivalent provincial measures, particularly when those who refuse to answer the income question are added to the low income group. Reported educational attainment is somewhat biased towards those with higher education, perhaps reflecting the online nature of the survey. The age profile of resident hunters is quite similar to that of the provincial population as a whole. However, the sample misses younger age hunters and overrepresents middle age hunters, a not uncommon result with survey work. Hunters predominantly identify as male, a fact reflected in the sample.

Hunting occurs in rural areas, and hunters are more likely to live in rural areas than the average for the provincial population. Hunters are almost three times as likely to have a postal code with a rural forward sortation area code than average for the provincial population. When the distribution of hunter residences across the provincial hunting regions is considered, hunters are more likely to live in the less populous regions. The sample distribution across these regions is quite close to the distribution of the 2012 hunter survey.

Answers to *ceterus paribus* attribute level preference questions (pretest questions) were scored, with those whose choice exactly aligned with individual utility maximization rated 'good', and those whose choices were in the direction of utility maximization rated 'fair'. More than half of the sample did not make choices consistent with naive individual utility maximization. This suggests that either respondents didn't understand or accept the *ceterus paribus* condition of the question and/or are not strictly naïve individual utility maximizers. Both alternative framing of the pretest questions and further questions to delve into reasons for the chosen answers should be considered for future survey implementations.

Less than ten percent of the sample considered themselves well informed about the status of moose in the province, how the wildlife resource is managed and funded, and how that compares to other nearby jurisdictions. Almost half of the sample hunts more than twenty days per year, while the provincial average is about 13 days per year (Responsive Management, 2013). This suggests that those who are more active are more likely to complete the survey. Similarly, more than half of survey respondents consider themselves to be advanced hunters. Somewhat surprisingly, the implied correlation, from a Chi-squared test, between days hunting and skill is quite low. The two most common reasons hunters report as the most important reason for hunting are food and time

Table 2: Summary of sample characteristics

Variable	**Group**	**Count**	**Percent**	**Province**	**Hunters**
Income	< 50K	318	14.67	26.94	
	50K - 100K	690	31.84	32.65	
	> 100K	913	42.13	40.42	
	Refuse	246	11.35		
Educ	Elementary	35	1.62	9.60	
	High	742	34.24	26.50	
	Coll/Uni	1390	64.14	63.90	
Age	< 45	589	27.18	43.19	41.97
	45 - 64	1030	47.53	33.22	38.38
	65+	548	25.29	23.58	19.65
Gender	Male	1996	92.11	45.64	92.29
	Female	163	7.52	53.79	7.71
	Other	8	0.37	0.28	
Urban	Rural	607	28.01	10.47	
	Urban	1560	71.99	89.53	
Home	Vancouver Island	353	16.29	16.69	14.64
	Lower Mainland	436	20.12	61.38	23.71
	Thompson	279	12.87	3.65	9.66
	Kootenay	220	10.15	3.29	12.61
	Cariboo	180	8.31	1.36	6.61
	Skeena	125	5.77	1.66	4.66
	Omineca	238	10.98	2.47	9.01
	Peace	85	3.92	1.41	6.01
	Okanagan	251	11.58	8.09	13.09
Days	<= 10	420	19.38		
	11 - 20	722	33.32		
	> 20	1025	47.30		
Skill	Beg	78	3.60		
	Int	907	41.86		
	Adv	1182	54.55		
Reason	Food	978	45.13		
	Family	288	13.29		
	Nature	884	40.79		
	Trophy	17	0.78		
Region	Home	525	24.23		66.34
	Near	1047	48.32		22.89
	Far	595	27.46		10.78
Leaning	Right	508	23.44		
	Neither	1549	71.48		
	Left	110	5.08		
Awareness	Limited	1140	52.61		
	Somewhat	811	37.43		
	Very	216	9.97		
Pretest	Poor	1337	61.70		
	Fair	616	28.43		
	Good	214	9.88		

in nature. A small number, 17 respondents, report their most important reason as collecting a trophy. Note that these are not mutually exclusive categories, as for most hunters, all of these reasons have some importance.

Survey participants were asked to indicate their favorite hunting region. Almost half indicate a favorite region that shares a boundary with their region of residence (near). The hunter population numbers capture where people hunt, not their favorite region. Many people hunt in more than one region, with their home region being one of those. The ratio of near to far locations for hunting and favorite region is similar.

Survey participants were asked to report their political leaning. The direction of leaning was described as:

> It is common to characterize political leaning as left or right. Those who are strongly left see the main role of government as actively promoting equality by using taxes and spending to redistribute income and wealth. Those who are strongly right see the main role of government as providing security and protecting peoples' individual ability to be successful.

In response to this description, almost a quarter of the sample chose leaning right or strongly leaning right. More than a third were weakly leaning one or the other directions or neither.

On a number of measures, the sample is fairly similar either to the provincial resident hunter population or to the provincial average. Younger, less affluent and less educated hunters may be somewhat underrepresented. The strongest concern is with the consistency with naïve individual utility maximizing priors, suggesting that results which seem unusual may reflect participant motivations inconsistent with this assumption.

Results and Discussion

Regressions are estimated in R (R Core Team, 2020), using the package 'logitr' (Helveston, 2022). The alternative specific constant (α_{iA}) and the attribute level parameters are estimated as random parameters. Mean zero normal distributions are used for η_{iA} and η_i. Five models are explored, with diagnostics in Table 3. All models are estimated in willingness to pay space, where the estimation equation includes a scale parameter, the marginal utility of income, multiplied by all parameters (Train and Weeks, 2005; Risa et al., 2011).

Model #1 restricts all interaction parameters to be zero. Model #2 includes interactions only with the alternative specific constant. The variables included are those that may contribute explanatory power to any of the individual attributes. Model #3 includes interactions between attribute levels and individual specific characteristics, without any interactions between individual specific characteristics and the alternative specific constant. Model #4 includes interactions between individual specific characteristics and both the alternative specific constant and the attribute levels. Comparing Model #3 and Model #4

Table 3: Regression model diagnostics.

Measure	Model #1	#2	#3	#4	#5
Log-Likelihood:	-3296	-3234	-3207	-3186	-3205
McFadden R2:	0.222	0.237	0.243	0.248	0.244
Adj McFadden R2:	0.219	0.229	0.226	0.227	0.230
AIC:	6622	6535	6558	6554	6526
BIC:	6722	6764	7042	7166	6916
Observations:	6114	6114	6114	6114	6114
Clusters:	2038	2038	2038	2038	2038
Parameters:	15	34	72	91	58
ASC Interactions	No	Yes	No	Yes	Yes
Attribute Interactions	No	No	Yes	Yes	Yes

identifies those interactions between attribute levels and individual specific characteristics that are not absorbed into the alternative specific constant. These persistent interaction effects are taken to be the strongest explainers of preference heterogeneity. Finally, model #5 is a more parsimonious version of model #4.

As expected, the greatest explanatory power is for the model with the most parameters. When adjusting for parsimony, as for the adjusted McFadden R^2 and the Akaiki Information Criterion (AIC), model #5 is most favoured. The Bayesian Information Criteria (BIC) favours the simplest model.

Alternative Specific Constant

The regression results are presented for each attribute in turn. 4 presents the estimated alternative specific constant (ASC) and interactions. The average respondent has a bias in favour of the alternative that has an equivalent value of \$108.41, with a large variation around this value. The three models with interactions account for this average, with the value of the bias becoming small and insignificant. There is a small decline in the estimated standard deviation of the value of the bias.

Income is a strong and persistent explainer of bias. That the value for those in the top income bin is less than half of that for the middle income bin is consistent with decreasing marginal value, although at a slow rate. That income is such a strong explainer suggests that those with a greater ability to pay are more likely to vote for the alternative, regardless of how the attribute levels change. There is value to those with higher income in simply being able to vote for the alternative. Notice that those who refuse to answer the income question have an estimated bias that is not significantly different from the omitted group, the lowest income category.

Table 4: Regression parameter estimates for alternative specific constant and interactions with individual specific characteristics.

	Model 1		Model 2		Model 4		Model 5	
Variable	**Estimate**	**S.E.**	**Estimate**	**S.E.**	**Estimate**	**S.E.**	**Estimate**	**S.E.**
asc	108.41***	18.48	-17.78	39.75	30.89	59.76	30.37	38.07
	-205.08***	14.71	199.35***	14.81	-190.36***	16.08	-191.72***	14.86
\$50K - \$100K			72.93**	23.57	55.41	35.03	72.05**	23.34
\$100K +			134.27***	25.02	110.15**	36.20	129.37***	24.79
Refuse			10.26	30.06	21.93	43.63	8.36	29.55
Coll/Uni			32.73*	15.72	26.41	23.75	30.82*	15.45
45 - 64			-13.97	18.26	-18.63	27.49	-20.14	18.15
65+			-32.57	22.91	-40.41	34.04	-45.97*	22.51
11 to 20			-19.89	21.40	-32.39	48.46		
> 20			36.69+	21.66	27.93	48.94		
Advanced			14.97	16.02	34.26	32.08	27.93+	15.11
Family			33.06	23.17	26.03	38.36	22.10	38.02
Nature			51.93**	16.41	37.57	26.59	36.17	26.48
Trophy			330.73***	91.21	117.61	125.77	98.08	127.53
Near			-7.10	18.99	-4.83	19.24		
Far			-17.39	20.70	-18.78	21.04		
Right			29.61+	17.59	20.63	35.65		
Somewhat			-20.69	16.15	-17.07	36.58	-32.44	30.03
Very			20.93	27.31	-51.62	62.30	-73.15	49.56
Fair			25.97	17.31	-3.86	40.57	-3.75	39.71
Good			-23.81	24.31	-154.85**	56.88	-132.41*	55.72

Table 5: Regression parameter estimates for harvestable surplus attribute and interactions with individual specific characteristics.

	Model 1		Model 3		Model 4		Model 5	
Variable	**Estimate**	**S.E.**	**Estimate**	**S.E.**	**Estimate**	**S.E.**	**Estimate**	**S.E.**
Surplus	21.55***	2.86	-9.47	7.62	-0.92	9.37	7.71+	4.66
	27.22***	4.29	-28.38***	3.93	-23.08***	5.67	22.79***	4.37
\$50K - \$100K			12.62**	4.50	4.98	6.73		
\$100K +			22.81***	4.76	7.20	6.97		
Refuse			-0.19	5.61	-2.81	8.12		
Coll/Uni			5.49+	3.04	2.08	4.65		
45 - 64			-1.25	3.52	1.55	5.29		
65+			-3.48	4.31	3.07	6.51		
Family			5.97	4.86	1.49	7.99	2.35	7.82
Nature			10.26**	3.45	3.10	5.44	3.66	5.36
Trophy			132.68**	44.92	105.72+	55.72	109.56+	56.20
11 to 20			-0.72	6.39	2.44	7.03		
> 20			6.02	6.24	3.42	6.83		
Somewhat			3.80	4.00	5.01	4.60	5.46	4.57
Very			6.68	7.22	12.28	7.77	13.54+	7.64
Fair			12.82*	5.00	13.38*	5.77	14.82**	4.98
Good			18.69*	8.10	30.43***	8.80	25.98***	7.37

Those with a college education have a somewhat higher bias value, while those in the oldest bin have a smaller bias. Those who spend the most time hunting have a higher bias. However, it is no longer significant when attribute interactions are included. Likewise, primary motivations other than food are strongly significant without interactions, but loose magnitude and significance with attribute interactions. Leaning right has a small effect, which is lost with interactions. Those whose pretest answers were scored ‘good’ have a strong bias toward the status quo when attribute interactions are included, absent when they are not. This suggests that there are attribute interactions working in the opposite direction to the ASC interaction for this characteristic.

Harvestable Surplus

Table 5 shows those results for the harvestable surplus. Including interactions reduces the base mean WTP, and slightly reduces its standard deviation. A larger moose population, all else equal, would be expected to increase the probability of harvesting a moose. To the extent that a moose has value, those with higher income might be expected to pay more. This is the result absent interactions with the alternative specific constant. However, the income effect disappears when income is interacted with the alternative specific constant.

Table 6: Regression parameter estimates for ratio of hunting success probability to LEH draw probability and interactions with individual specific characteristics.

	Model 1		Model 3		Model 4		Model 5	
Variable	**Estimate**	**S.E.**	**Estimate**	**S.E.**	**Estimate**	**S.E.**	**Estimate**	**S.E.**
Succ,/Opp.	-23.26***	5.94	-55.65**	17.34	-51.20**	17.63	-37.84**	12.84
	64.18***	13.31	-69.48***	13.40	68.96***	11.93	-60.43***	15.33
Near			26.78*	11.57	27.57*	11.80	29.22*	11.75
Far			11.16	12.90	14.31	13.08	14.44	13.22
Family			17.58	15.42	7.86	16.21	11.14	16.34
Nature			22.28*	10.98	10.96	11.81	10.07	11.77
Trophy			231.92+	132.50	189.54	144.50	206.43	139.51
11 to 20			6.96	16.35	8.25	16.54		
> 20			30.66+	16.49	24.25	16.61		
Advanced			-27.81**	10.26	-23.00*	10.62	-19.38*	9.56
Fair			-5.97	13.56	-7.97	13.86		
Good			7.35	18.89	11.56	18.83		

Primary motivators beyond meat are significant when ASC interactions are absent, and the interaction with the trophy motivation remains significant throughout. Although small in number, the trophy hunters consistently choose options where the harvestable surplus is larger. Those who have the highest awareness show an increased willingness to pay for a larger harvestable surplus. Being aware of the state of the moose population may incline people to be willing to pay more. Those whose pretest responses were fair or good had higher WTP. These are people who, *ceterus paribus*, preferred more moose, with is consistent with a higher WTP for more moose.

Success / Opportunity

The regressor representing the trade off between success and opportunity is the ratio of the probability of harvesting a moose to the probability of being drawn. Regression results are shown in Table 6. The mean willingness to pay for a change in this ratio is negative and significant for all the models. This suggests that the comparison individual would like to see the probability of being drawn increase, relative to the probability of harvesting an animal. Referring to Figure 2, the comparison individual would like to move along the isoquant towards the lower right. These individuals would prefer to hunt more often, with a lower probability of harvesting.

Hunters whose favorite hunting area is not their home region but a bordering region have a smaller WTP to hunt more often. These hunters would be expected to travel further to hunt, and therefore would hunt less often, and value an increased probability of harvesting an animal more than those who hunt in their home region. The far effect is smaller and not significant. Hunters

Table 7: Regression parameter estimates for governance by game commission and by multi-government, multi-stakeholder commission and interactions with individual specific characteristics.

	Model 1		Model 3		Model 4		Model 5	
Variable	**Estimate**	**S.E.**	**Estimate**	**S.E.**	**Estimate**	**S.E.**	**Estimate**	**S.E.**
Game Comm.	100.11***	19.71	98.54*	40.32	104.10*	43.20	86.60**	26.55
	163.18***	43.14	103.60*	47.95	136.77**	44.43	143.02***	41.40
Right			109.57**	33.95	109.66**	39.20	122.09***	33.73
11 to 20			-26.96	43.99	-16.64	46.94		
> 20			-29.42	44.73	-38.76	48.64		
Advanced			24.56	30.47	2.16	35.10		
Somewhat			-25.24	30.76	-16.15	34.06	-17.26	31.63
Very			73.34	50.64	95.57+	56.20	82.18	51.22
Fair			-45.49	35.80	-43.31	38.19	-49.48	35.60
Good			-75.87	51.05	-26.81	54.05	-23.63	53.46
Multi. Gov.	35.66*	17.64	85.88*	37.07	91.42*	40.85	43.14+	25.68
	209.41***	33.95	-208.55***	31.51	221.20***	30.39	-213.71***	34.27
Right			39.81	32.65	29.62	37.49	36.46	32.77
11 to 20			-42.60	40.29	-29.66	44.41		
> 20			-76.24+	40.79	-91.00*	45.93		
Advanced			28.26	28.75	8.77	33.55		
Somewhat			-16.78	29.11	-10.16	33.30	-8.40	30.93
Very			88.32+	50.57	111.29+	57.50	82.91	51.37
Fair			-32.69	31.40	-29.07	36.07	-30.67	35.87
Good			-119.70*	49.04	-66.98	53.42	-82.51	52.71

who consider their skill level as advanced have an even stronger preference for hunting more often. Perhaps these hunters feel that they are sufficiently skilled that their own probability of harvesting an animal will not be affected.

Governance

Results for both forms of governance are shown in Table 7. The WTP for movement to a game commission (GC) is significant and quite stable in value. Those who indicated that they lean right politically are willing to pay twice as much as the comparison individual who does not lean right. Only one of the included interactions, awareness, shows even weak significance.

The WTP for a move to a multi-government, multi-stakeholder commission (MGMS) is positive, but not as stable across the models. Those who spend more time hunting are less willing to pay for a move to this form of governance. And as for those who are more aware supporting a move to a game commission, they are also willing to pay more to move to the multi-government, multi-stakeholder

Table 8: Regression parameter estimates for dedicating 50% and 100% of licence fees to game management and interactions with individual specific characteristics.

commission. The GC is a form of management by hunters, for hunters, while the MGMS represents a broader range of interests, and therefore may be seen as riskier, particularly by those who are strongly attached to hunting.

Share Dedicated

The final attribute is the share of the licence fee dedicated to wildlife management. Regression results in Table 8. The comparison individual is willing to pay about as much to have 50% of the licence revenue dedicated to game management as they are willing to pay to have 100% dedicated. This individual seems to prefer any increase over the current 20%.

Those who lean right have a willingness to pay for increasing the share dedicated from 20% to 50% that is approximately zero. Somewhat similarly, those whose pretest choices were good are, in models #4 and #5, willing to pay about twice as much for a change to 100% dedicated than they are for 50% dedicated. The remaining individual specific characteristics do not add any explanatory power.

Scenarios

Including interactions between individual specific characteristics and attribute responses enables predictions of the willingness to pay for scenarios for each individual. Figure 3 shows the distribution of the predicted willingness to pay for a set of scenarios. Predictions are based on model #4, the model with the highest McFadden R^2.

The alternative specific constant panel shows the distribution of the bias for or against the status quo. The average predicted value of the bias for the alternative across all the respondents is more than $100, with a median higher than the average. However, just over ten percent of the respondents have a negative predicted bias, favouring the status quo. The bootstrap confidence interval – accounting for both individual unexplained heterogeneity and variance of the parameter estimates (Bliemer and Rose, 2013) – is wide, with a 30.9% share of the bootstrap estimates below zero.

The next four panels show the distribution of individual WTP for scenarios where only one attribute level is changed relative to the status quo. For all changes, the average of the WTP distribution is positive. None of the predicted WTP values are negative if governance is shifted to an appointed game commission and if 100% of licence revenue is dedicated to wildlife management. Increasing the harvestable surplus by 5,000 moose – doubling the number of

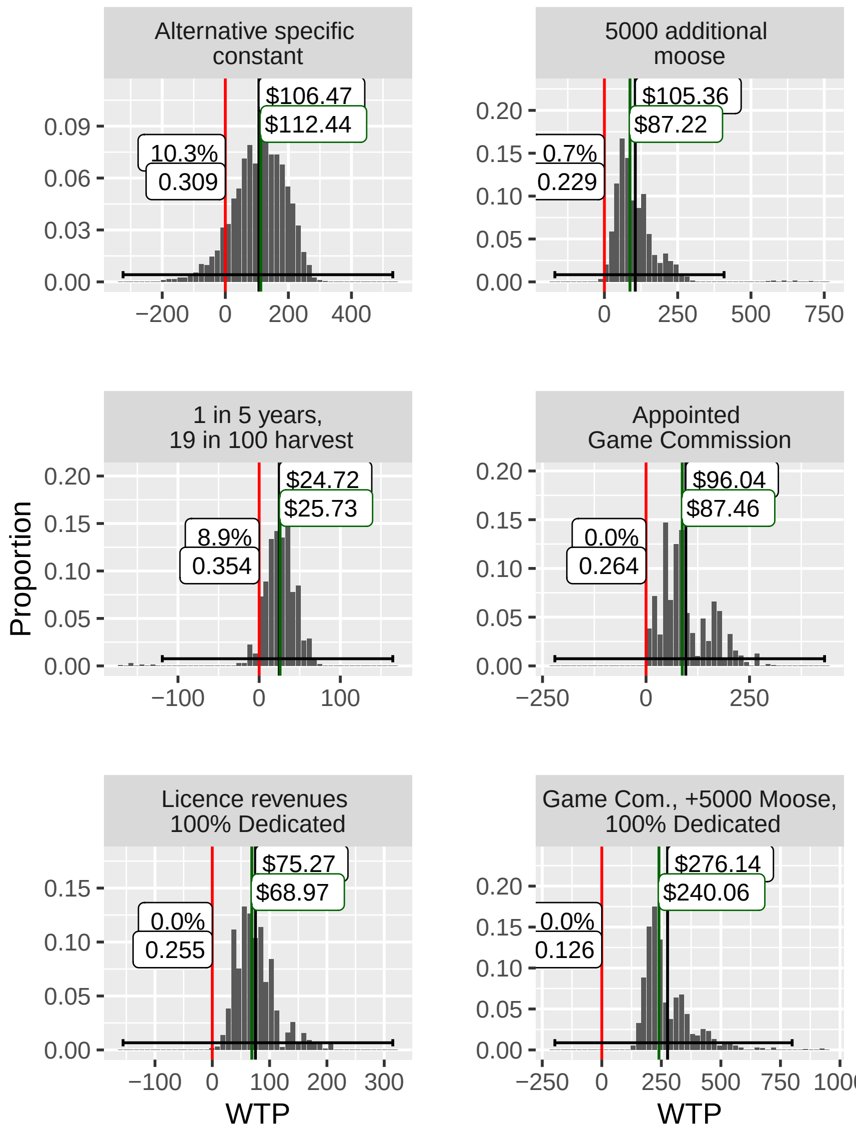

Figure 3: Opportunity vs Success harvest rate isoquants.

harvested moose – has the largest average predicted willingness to pay. However, there are a few people who have a negative predicted willingness to pay. For all but the success/opportunity plot, the median is less than the mean.

Shifting the draw probability from 1/7 to 1/5, with a reduction in harvest probability from 27/100 to 19/100 has a small, positive average WTP. For both the increase in harvestable surplus and the changing of the success to opportunity ratio have a number of extreme values. This would correspond to a large degree to people whose most important hunting reason was harvesting a trophy. These negative outliers pull down the average, so that for this change, the median is larger than the average.

The bottom right panel shows the distribution of predicted values when the scenario includes an appointed game commission, 5,000 increase in harvestable surplus, and 100% of licence fees dedicated to wildlife management. Combining these changes shifts the distribution far enough to the right that the share of the bootstrap confidence interval below zero is reduced to 12.6%. For this scenario, the median is a notable distance below the average. If a majority of hunters had to support an increase in the licence fee, then the largest increase would be the median value of $240.06.

These results suggest that while changing individual features of the moose hunt may on average be beneficial, there is a fairly high probability – based on the bootstrap confidence intervals – that a significant portion of the hunting population will see themselves as being worse off. Combining changes – the example here being doubling the harvestable moose population, shifting governance to an appointed game commission, and dedicating all licence fees to wildlife management, has a smaller probability that the true mean WTP for the change is negative. Hunters are not homogeneous. Each hunter received a unique benefit (or not) from changes in the offered attribute levels, and combining changes appears to have the best chance of leaving a large share of the hunting population better off. For generating funds for management, combining changes and increasing licence fees is more likely to be acceptable to a large share of hunters than asking them to pay for changing only one feature of the hunt.

For our combined scenario, the average predicted WTP for a hunting licence would be more than $250. For the same governance changes but without increasing the harvestable surplus, the average predicted WTP would increase by about $150. British Columbia borders on the US states of Washington, Idaho and Montana. Comparable licence fees in these jurisdictions are $445.71, $268.16 and $167.81 respectively. All three states have a version of an appointed game commission, and US law mandates dedication of a substantial share of hunting related revenues to wildlife management. The average willingness to pay predicted by our analysis for movement to a management system similar to those in these neighbouring jurisdictions falls within the range of the licence fees in these jurisdictions.

Boxall et al. (1996) compared Alberta wildlife management units that could be substitute hunting destinations, finding a willingness to pay for an increase frequency of encountering evidence of moose presence from less than daily to one to two encounters per day of between $88.88 and $134.19 (inflation adjusted from 1995 to 2020). Our estimated average predicted WTP for a doubling of the harvestable surplus of $105.36 falls within this range. Boxall and Macnab (2000) use a similar moose encounter evidence attribute. A scenario that triples encounter evidence while also increasing congestion generates benefits worth $99.31 for urban resident hunters and $45.59 for rural residents (inflation adjusted from 1995 to 2020). Our moose harvest doubling scenario does not include a disamenity, and therefore lying above this range is not surprising.

We do not know of any work that calculates a WTP for changing the success to opportunity ratio. Serenari et al. (2019) do offer hunters changes in season length in their choice experiment, and find that this attribute has the highest importance. This is consistent with our finding that many BC resident hunters would like to hunt more often. However, their experiment does not include a payment vehicle, and therefore WTP is not calculated. Further, attribute levels were randomly combined, consequently there was no connection between hunting success and opportunity and the deer population.

Reported WTP for governance changes in wildlife management are limited. Our result that resident hunter WTP is higher for a game commission than for a commission with broader representation and interests is consistent with results from Manfredo et al. (2017) showing that traditional hunters wish to protect existing wildlife management institutions that emphasize managing wildlife for hunting. Hunt and Davis (2016) ask Ontario resident hunters to rank restrictions that are expected to increase moose numbers. The status quo receives the lowest overall rank, consistent with our strong bias favoring the alternative. The least favored alternative to the status quo is that which most restricts hunting opportunities, suggesting that hunters would rather restrictions on how they hunt than restrictions on how much they hunt, consistent with our result that hunters would prefer to hunt more often, even if the odds of harvesting is reduced.

The predicted WTP can be grouped according to categories like income or region of residence. To the extent that there are correlations between individual specific characteristics, such groupings can reveal magnification or dilution of effects. Predicted WTP was grouped by income, main reason for hunting, and region of residence (see Appendix). As expected, those who chose trophy hunting as their most important reason for hunting were outliers. The difference between groups is otherwise generally small.

In the regressions, and evidenced when WTP is grouped by income, those with higher income gain a larger benefit from the alternative scenarios. Licence fees and application fees are fixed, irrespective of income. Therefore, increasing licence fees in exchange for changing governance and increasing moose numbers may be regressive – higher income people receiving a larger income weighted share of the benefits than low income people. For example, the mean WTP by income group for the combined scenario is $237.91, $245.57, $279.57 and $293.82 for the refuse, low, middle, and upper income categories respectively. A majority of resident hunters would be expected to vote for an increase of $240.06, the median of the predicted WTP. If this increase were implemented, more than

Table 9: Implied financial transfers between hunting regions.

			Median	Net Inflow	
					Per
#	Region	Population	Income	Amount	Capita
1	Vancouver Island	773,788	75,843	-4,599,873	-5.94
2	Lower Mainland	2,846,546	84,451	-13,482,849	-4.74
3	Thompson Nicola	169,484	67,644	5,076,023	29.95
4	Kootenay	152,430	78,156	2,951,548	19.36
5	Cariboo	63,043	67,315	4,193,512	66.52
6	Skeena	77,040	74,193	998,528	12.96
7a	Omineca	114,332	80,811	1,197,011	10.47
7b	Peace	65,444	90,864	3,253,493	49.71
8	Okanagan	375,366	74,274	1,128,797	3.01

$2.4 million in additional revenue could be raised. However, average benefit value would be -$2.15, $5.51, $39.51 and $53.76, for the four income categories. The net benefit to the upper income group is almost ten times the net benefit to the lower income group for this increase in licence fee. If it isn't possible charge different licence fees by income, or otherwise provide more benefit to the lower income group, increasing the licence fee to the level that may be supported by the median hunter will leave low income hunters relatively worse off. Increasing the licence fee to support the proposed changes in governance and the hunting experience could therefore be a regressive policy.

Beyond the value received by hunters from hunting, the fact that hunting occurs in rural areas and many hunters who reside in urban areas travel to rural areas to hunt makes hunting a method of redistributing income from urban to rural areas in British Columbia. Using data collected by the consulting firm Responsive Management (2013), an estimate of the amount of transfers can be made. The report divides expenditures into 15 categories. Some of these categories, such as food and beverages and lodging, primarily occur near where hunting activities take place, while categories such as equipment purchases are more likely to occur where the hunter is resident. An ad hoc division of expenditures by category between home region and the region where hunting occurs suggests that approximately 40% of hunter expenditures occur in the region where those hunters hunt. Allocating this share of expenditures according to where hunters hunt results in the transfer estimates reported in Table 9.

Hunting activities in BC likely transfer about $18 million from the two most populous regions of the province to the less populous regions. This transfer amounts to more than $60 per person for the least populous and lowest median income region. However, it is also a transfer of almost $50 per person to that region of the province with the highest median income. The high median income in a couple of the more rural regions reflects a strong resource sector in those regions generating high paying jobs.

The estimated average willingness to pay for a change in hunting governance to a model closer to that of the bordering US states is quite large. However, those licence fees are not transfers to rural areas, and at present account for less than 4% of hunter expenditures. Raising licence fees could substantially increase this. Using these additional fees to increase the harvestable surplus of moose would lead to more hunting trips, and if those increases in moose populations occur in the more rural areas of the province, would be expected to increase transfer from the urban regions to the rural regions.

Conclusion

The choice experiment reported here offered British Columbia resident hunters scenarios with increased numbers of harvestable moose, harvestable surplus consistent combinations of LEH draw probability and harvest probability, three governance models, and increasing the share of licence revenues dedicated to wildlife management. Hunters prefer more moose, more hunter input into management, and more of their licence fees dedicated to management. Results also suggest that many resident hunters in British Columbia would like to hunt more often, even if that is achieved through a lower probability of harvesting an animal. Hunting is about more than harvesting food, and at present those non-food benefits may not be optimized with the hunt management in place.

The individual heterogeneity explored through the econometric analysis enables prediction of individual WTP under various policy scenarios. The largest net benefit, measured as mean predicted WTP, occurs for combinations of changes. The potential exists to increase revenue from hunting licences by more than $2 million if harvestable surplus can be doubled, wildlife management becomes the responsibility of an arms length game commission, and all licence revenues are dedicated to wildlife management. However, maximizing revenue from a licence fee that is not conditional on income is likely to be regressive, resulting in a larger relative share of the benefit of the improvement being captured by those with higher incomes.

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Appendix: Grouped Predicted WTP

The predicted individual willingness to pay can also be organized around groupings of individuals. The same scenarios are shown in Figure 4, with willingness to pay shown for income categories, most important hunting reason categories, and region of residence.

The income category reflects the regression parameters. The ASC impacts follow the pattern consistent with regression parameter estimates, as does that for increasing the harvestable surplus. The distribution of the other individual specific characteristics is not sufficiently concentrated to offset the effect of income for these two attribute changes, nor is it sufficient to induce much variation for those attributes where income is not included as a regressor. Overall, where scenarios involve changes that show an increasing benefit to those with higher incomes, the outcome of increasing the licence fee can be seen as regressive. The licence fee is a fixed fee, independent of the income of the hunter. However, the benefit, measured as willingness to pay, is greater for those with higher incomes.

When grouping is based on the most important reason for hunting, those who chose trophy are clear outliers. They have the highest value bias for voting for something different, are willing to pay far more than those choosing other most important reasons for hunting, and contrary to the mean for the other shown categories, are substantially worse off if they have to accept a lower probability of harvesting an animal in exchange for hunting more often. This group also shows up as the main beneficiary of the combined change scenario.

Grouping willingness to pay by region of residence does not reveal any outstanding systematic differences, except perhaps for the success to opportunity tradeoff. The boxes around the median substantially overlap for most of the scenarios. Trading success for opportunity seems to be something hunters living in the lower mainland or on Vancouver island are willing to pay more for. The median and surrounding box are noticeably higher, and the 95% range is far tighter. There are only two interactions with the success to opportunity ratio in the model that have a negative sign, the advanced skill level and being fairly well informed. That those hunters residing in the lower mainland or on Vancouver island see more benefit from hunting more often suggests that they are more likely to report that they are advanced hunters than those residing in other hunting regions.

There are only 17 respondents who indicate that collecting a trophy is their most important reason for hunting. Figure 5 plots the distribution age, education, income, and urban vs rural residence for the group who chose trophy as their most important reason for hunting and the rest of the sample. Visually,

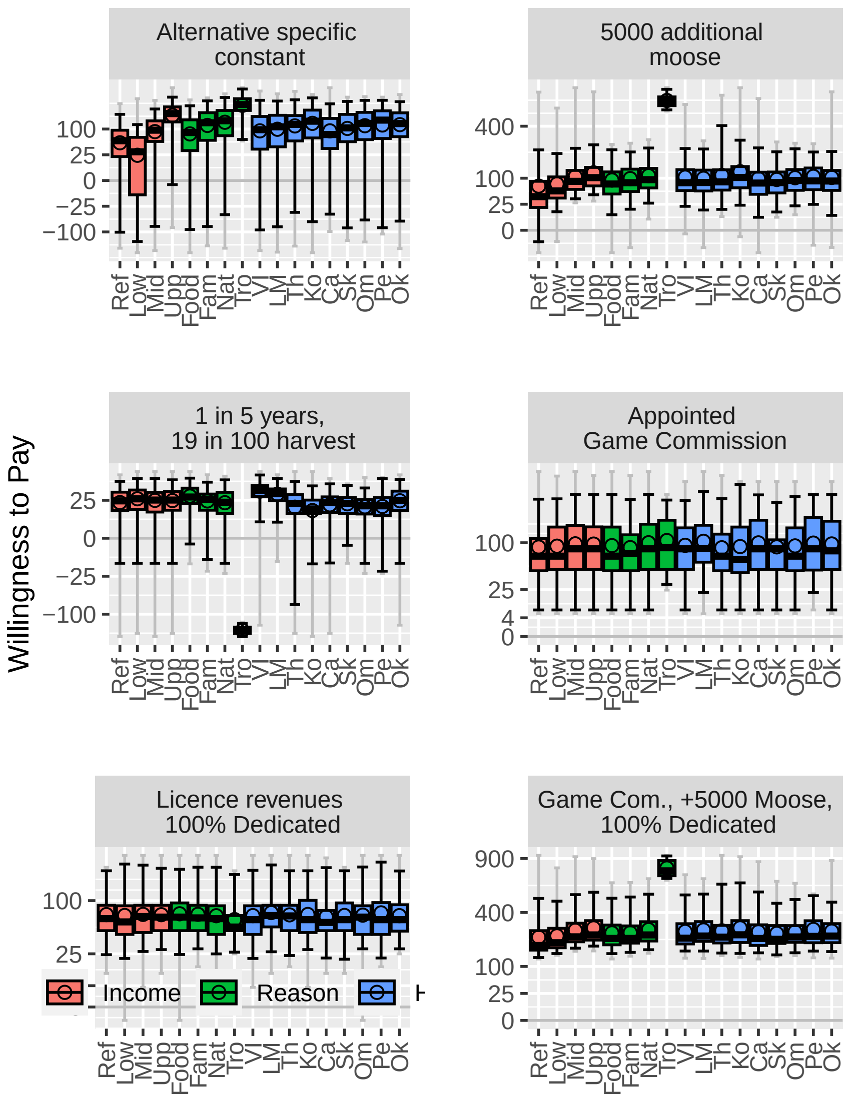

Figure 4: Opportunity vs Success harvest rate isoquants.

Figure 5: Opportunity vs Success harvest rate isoquants.

the trophy group appears to be more concentrated in the middle age group and less in the young group. They are less likely to have a college or university education, are more likely to refuse to answer the income question, and more likely to live in a rural area.

A logistic regression estimating the probability of belonging to the trophy group, as a function of age, education, income and urban or rural residence finds that living in a rural area is the only strongly significant predictor. Refusing to answer the income question is weakly predictive. These correlations are unlikely to be causal. Hunting occurs in rural areas, and those who value hunting more are likely to sort in favour of rural residence locations. Hunters for whom collecting a trophy is the main reason for hunting most likely do not consider this the only reason for hunting. It may be an additional reason, which may make this category an indicator of a stronger than average preference for hunting, suggesting a stronger preference for living in a rural area.