The Economic Benefits of Recreation in Canada

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Abstract

Canadians spend approximately 2.2% of the country's GDP on outdoor recreation, but we do not yet know the economic benefits people receive from participating in these activities. I provide the first ever comprehensive assessment of the economic benefits of outdoor recreation in Canada. I use a nationally representative survey of recreation behaviour on over 24,000 Canadians to estimate a Kuhn-Tucker demand model that accounts for substitution between activities and satiation in demand. The results demonstrate that participation in outdoor recreation provides Canadians with $98 billion in annual economic benefits, which is well over twice as large as reported expenditures. I also reveal substantial heterogeneity in recreation benefits across activities and regions in Canada.

Keywords: Recreation demand, Kuhn-Tucker model, compensating variation, national assessments.

JEL: D12, I31, Q26

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1 Introduction

Outdoor recreation is one of the most tangible ways people experience and benefit from their surrounding natural environment. Almost 85 percent of Canadian adults participate in at least one outdoor recreation activity and recreation is often touted as an important aspect of physical and mental health (Federal, Provincial, and Territorial Governments of Canada 2014). Yet, there is still much to be learned about quantifying the economic value people receive from participating in outdoor recreation. Canadians spent $40.1 billion on outdoor recreation in 2012 representing 2.2% of Gross Domestic Product (GDP) but these expenditures measure the costs of recreation, not economic benefits Canadians receive.[1] While consumer surplus or similar welfare measures are the theoretically correct and more direct measure of economic benefits, these measures are not visible in economic accounts or other commonly collected data. Quantifying these measures has been difficult in practice. This paper provides evidence that Canadians receive substantial economic benefits from participating in recreation activities.

The economic valuation of benefits people receive from non-market activities such as recreation is challenging due to the lack of full market prices. Even when partial market prices exist they often do not capture the full resource costs that individuals incur to participate in these activities. For example, people may pay site and license fees but also incur monetary and time travelling costs associated with participating in recreation. Economists have developed a specialized suite of tools for estimating welfare in these non-market contexts, including both stated and revealed preference methods (Champ et al. 2017). Stated preference methods use surveys to ask structured questions whereas revealed preference methods study choices people have actually made to understand trade-offs involving non-market activities and their values.

[1] Recreation expenditure data is from Federal, Provincial, and Territorial Governments of Canada (2014) and Canada's GDP information is from Statistics Canada Data Table: 36-10-0222-01.

The purpose of this paper is to provide the first ever comprehensive assessment of the economic benefits Canadians receive from participating in outdoor recreation. In doing so, I use a large, nationally representative sample on over 24,000 Canadians' recreation behaviour and expenditures for a comprehensive set of activities. The data is incorporated into a structural Kuhn-Tucker (KT) demand model that behavoiourally and statistically accounts for decisions on both the extensive (i.e. participate in activity or not) and intensive (i.e. how many participation days) decision margins. The other benefits of the KT approach in this context, where people participate in multiple activities, is that the model explicitly accounts for substitution possibilities and satiation in recreation days. The large data set also allows the estimation of provincial and territorial specific demand models to accommodate regional heterogeneity in preferences. The demand models estimation provides the basis for welfare calculation.

The main empirical challenge to estimating the benefits of recreation to Canadians is in measuring the appropriate welfare measure - how much would people need to be compensated if they lose access to recreation opportunities to be as well off as they are with these opportunities? These welfare measures are unobservable in the data and must be estimated using structural econometric models. I combine the estimated demand model parameters and the data to calculate Hicksian compensating surplus measures that are consistent with economic theory.

There are three main results of the paper. First, I estimate that recreation provides Canadians a total of \$98.2 billion in economics benefits per year (95% confidence interval from \$80.4 to \$121.8 billion). These economic benefits are well over twice as large as the reported recreation expenditures of \$40.1 billion. Using recreation expenditures as a proxy for economic benefits would significantly underestimate the value people derive from these activities. Second, out of the 17 activities included in the analysis, I find that the most valuable recreation activities to Canadians are hiking, gardening, and motorized land vehicle activities such as ATVs and snowmobiles. Third, I find significant regional heterogeneity in recreation benefits in the 12 provinces and territories of Canada. Residents of the Yukon and Northwest Territories receive three to five times more economic benefits from recreation compared to people living in Quebec, Prince Edward Island, and New Brunswick.

This work offers several innovations over the existing recreation economics literature. First, this paper provides the first ever national assessment of the economic value of recreation in Canada. In many policy reports, recreation expenditures or economic impacts are used to highlight the economic importance of nature (Conference Board of Canada 2019, The Outspan Group Inc 2011). These studies use expenditures as a measure of economic benefits rather than the theoretically correct measures grounded in welfare economics. There have been several recreation demand studies that have estimated proper welfare measures in Canada, but all of these studies have focused on a single recreation activity, a subset of activities or only in a particular area of Canada. For example, Boxall et al. (1996) estimate moose hunting demand and welfare measures in a region of Saskatchewan and Hailu et al. (2005) examine camping demand in a region of Alberta. Other studies have estimated the benefits of multiple recreation activities but only at a single site such as Dupont (2003) study of swimming, boating, and fishing in Hamilton Harbour and Rollins et al. (2008) study of seven recreation activities at a single park in Ontario. In this paper, I examine almost all outdoor recreation activities people participate in across all provinces and two territories of Canada.

The second innovation of this paper is the data used avoids some of the limitations associated with the typical recreation demand analysis. The CNS sample includes both recreators and non-participants and includes survey weights to allow representative samples to be used in the analysis. The typical recreation economics data comes from sampling people on-site.

The concern with these on-site intercept surveys is that avid recreators are oversampled (i.e. endogenous stratification (Shaw 1988)) and the truncation of the trip distribution at 1 if only recreators are included in the data. The Canadian Nature Survey (CNS) survey avoids these two concerns. The survey also collected recreation information for 17 different activities which allows us to provide a more comprehensive analysis of recreation behaviour, and assess the substitution between activities. Finally, the large representative sample allows us to uncover provincial and territorial level heterogeneity in recreation preferences.

This paper also contributes to the growing literature understanding the economic gains from goods and services that are not traded in markets such as free online services. Allcott et al. (2020) estimate the welfare effects of social media using an experimental approach that paid people to temporarily deactiviate Facebook for four weeks. They elicited mean willingness-to-accept values mean of $180. Brynjolfsson et al. (2019) use stated preference methods to estimate the economic value consumers attach to various internet services such as search engines, email, and streaming services (i.e. YouTube and Netflix). In this paper, I use data on actual behaviour to estimate recreation demand models and calculate the aggregate welfare benefits from recreation in Canada.

Estimates of the welfare benefits of recreation is relevant for a number of current policy issues. The results broaden our understanding of how reliant Canada is on its natural capital wealth by providing a non-market measure that complements market-based measures of the impact of Canada's natural resources on the economy (Olewiler 2017). The results can form the basis for the recreation component of a national ecosystem service assessment as has recently been conducted in the United Kingdom (Bateman et al. 2014). The economic rationale for protecting natural areas often relies on quantifying the economic benefits people receive from nature (Forsyth 2000). This study provides empirical evidence that Canadians benefit substantially from outdoor recreation. As the natural world is threatened from human activity and climate change, the welfare measures estimated in this paper provide baseline results for how much recreational economic value is at risk from these changes.

In the rest of the paper, I first introduce the conceptual framework used to model recreation behaviour and welfare measures. I then describe the CNS data and outline the approach used to estimate participation costs, a key variable in recreation demand models. I then describe the specific empirical model and approach to welfare simulation. The paper concludes with results and a discussion.

2 A Conceptual Model of Recreation Demand and Economic Benefits

I begin with a model of annual recreation demand in Canada using the Kuhn-Tucker framework (Von Haefen & Phaneuf 2005, Bhat 2008). The appeal of adopting the KT framework is that it provides a utility-consistent framework for modeling both extensive (what activities to choose) and intensive (how much of each good) choice margins, which are common in many individual demand problems such as recreation behaviour. Compared to repeated discrete choice models which are typically used in annual recreation demand modeling, the KT framework does not require the number of choice occasions to be specified and substitution patterns are captured through utility parameters rather than relying on unobserved error terms that also characterize unobserved preference heterogeneity. KT models also relax the assumption of constant marginal utility of trips, utilizing choice behaviour to estimate the rate of satiation. The framework is consistent with the random utility maximization model by incorporating unobserved heterogeneity into the utility function.

Each individual i is assumed to maximize utility through the choice of days spent recreating in activity k and a numeraire good, the 'stay at home' option, which captures spending on all other goods subject to a monetary budget constraint. The individual's maximization problem is

$$\max_{x_k, x_1} U(x_k, x_1, Q_k, \theta, \varepsilon) \quad s.t. \;\; y = \sum_{k=2}^{K} p_k x_k + x_1, x_k \geq 0, k = 1, ..., K \tag{1}$$

where x_k is the number of days participating in recreation activity k, x_1 is the numeraire good with the price normalized to one, Q_k is a vector of quality characteristics for the activity k, θ is a vector of structural demand parameters, ε is a vector of unobserved heterogeneity, y is annual income, and p_k is the round-trip price of participating in each activity. The price people pay for recreation includes monetary costs such as transportation, equipment, fees, and supplies as well as non-monetary time costs as detailed in the next section. The resulting first-order KT conditions that implicitly define the solution to the optimal number of trips (x_k) and numeraire goods (x_1) are

$$\frac{U_{x_k}}{U_{x_1}} \leq p_k, \quad k = 2, ...K, \tag{2}$$

$$x_k \left[\frac{U_{x_k}}{U_{x_1}} - p_k \right] = 0, \quad k = 2, ...K. \tag{3}$$

For activities that an individual participates in, the marginal rate of substitution between days and the numeraire good is equal to the price of a recreation day. For activities with non-participation, the marginal rate of substitution between days and the numeraire good is less than the price of a recreation day.

The economic benefits of recreation can be measured using Hicksian compensating surplus (CS^H) which represents the necessary compensation levels that are required to make individuals as well off without these recreation opportunity as they are with recreation.

The CS^H for a change in price and quality from baseline levels p^0 and q^0 to new levels p^1 and q^1 using the expenditure function is

$$CS^H = y - e(p^1, q^1, U^0, \theta, \varepsilon), \tag{4}$$

where θ is a vector of structural demand model parameters and U^0 is the baseline utility level represented as $U^0 = V(p^0, q^0, y, \theta, \varepsilon)$. Taking away the possibility to recreate can be implemented as drastically increasing the price of that recreation activity such that the new price level is above the choke price and the demand is equal to zero.

3 Recreation Data

To estimate the conceptual model, I use detailed data on Canadian's recreation behaviour including number of days spent recreating and participation costs from the 2012 Canadian Nature Survey (CNS) (Federal, Provincial, and Territorial Governments of Canada 2014).[2] This survey is the most recent and comprehensive assessment of recreation behaviour and related expenditures in Canada. The survey employed a stratified probability design to draw a sample of Canadians using mail and web-based administration modes yielding 24,104 responses. The survey targeted Canadians adults (age 18 and older) and does not include recreation activities of children. The overall response rate was 20%. All values are described in 2012 Canadian dollars. The data includes a full set of sampling weights to construct a representative sample of Canadians. Additional information on survey development and administration are provided in Federal, Provincial, and Territorial Governments of Canada (2014).

The CNS provides several advantages for the use in recreation demand modeling. First, the

[2] The full survey can be accessed at https://biodivcanada.chm-cbd.net/documents/canadian-nature-survey.

sample includes both recreators and non-participants and uses a representative sample of Canadians. Compared to a typical on-site intercept survey, there is no concern regarding oversampling avid recreators (i.e. endogenous stratification (Shaw 1988)) or the truncation of the trip distribution at 1 if only recreators are included in the data. Second, the survey collected recreation information for 17 different activities which allows us to provide a more comprehensive analysis of recreation behaviour, and assess the substitution between activities. Third, the data includes expenditures on equipment costs which are important costs for people considering which recreation activity to participate in (e.g. hunting large game animals versus hiking). Fourth, the survey over-sampled less populated provinces aiming for at least 1,000 responses per province or territory. All provinces and territories are included in the analysis except for Nunavut. For Nunavut, a community sample of 57 responses was collected via in-person surveys. These responses were not collected via random sampling and thus are not generalizable to the population of Nunavut. The data for these responses are not available and are not included in this current analysis. The large and diverse sample allows us to uncover provincial and territorial level heterogeneity in recreation preferences.

The specific recreation activities included in the analysis are hiking and walking, cycling and mountain-biking, camping in tents, non-motorized water and beach activities, alpine skiing and snowboarding, cross-country/backcountry skiing and snowshoeing, golfing, photographing or filming nature in general; gardening or landscaping with plants, birding, hunting waterfowl, hunting game birds (other than waterfowl), hunting small game mammals, hunting large game mammals, hunting other wild animals, trapping game animals, and fishing. An example of the activity and expenditure questions is provided in Figure A-1. Table 1 presents the full descriptions of each recreation activity that was presented to respondents in the survey. Table B-1 in the Appendix reports the average number of days spent participating in each recreation activity for each province and territory.

Table 1: Full description of recreation activities presented to respondents

Activity	Full activity description
Alpine skiing/snowboarding	Alpine (downhill) skiing, snowboarding
Beach/non-motorized boating	Non-motorized water and beach activities
Birding	Birding (watching, photographing, filming, feeding)
Camping	Camping in tents
Cross-country skiing	Cross-country skiing, snowshoeing
Cycling	Cycling, mountain-biking
Fishing	Fishing (freshwater or saltwater, fish and shellfish)
Gardening	Gardening or landscaping with plants
Golfing	Golfing
Hiking	Hiking, walking in natural areas, backpacking, climbing, caving, geo-caching, horseback riding
Hunting birds	Hunting game birds other than waterfowl (grouse, partridge, pheasant, etc.)
Hunting large game	Hunting large game mammals (deer, bear, moose, seal, whale, etc.)
Hunting other	Hunting small game mammals (rabbit, squirrel, raccoon, fox, etc.), Hunting other wild animals (frog, snake, lizard, etc.), Trapping game animals (beaver, etc.)
Hunting waterfowl	Hunting waterfowl (ducks, geese, etc.)
Motorized boating	Motorized recreational vehicle use on water (motorboat, etc.)
Motorized land vehicles	Motorized recreational vehicle use on land (ATV, snowmobile, etc.)
Photography/filming	Photographing or filming nature in general

People may participate in these activities for many different reasons. The survey framed the participation around recreation and leisure purposes and did explicitly asked people to not consider commercially motivated participation in these activities. [3] However, there was no effort to disentangle the recreation and leisure motivations from other non-commercial motivations. People may participate in these activities as part of a broader household production function such as gardening to improve the value of their home or hunting, trapping,

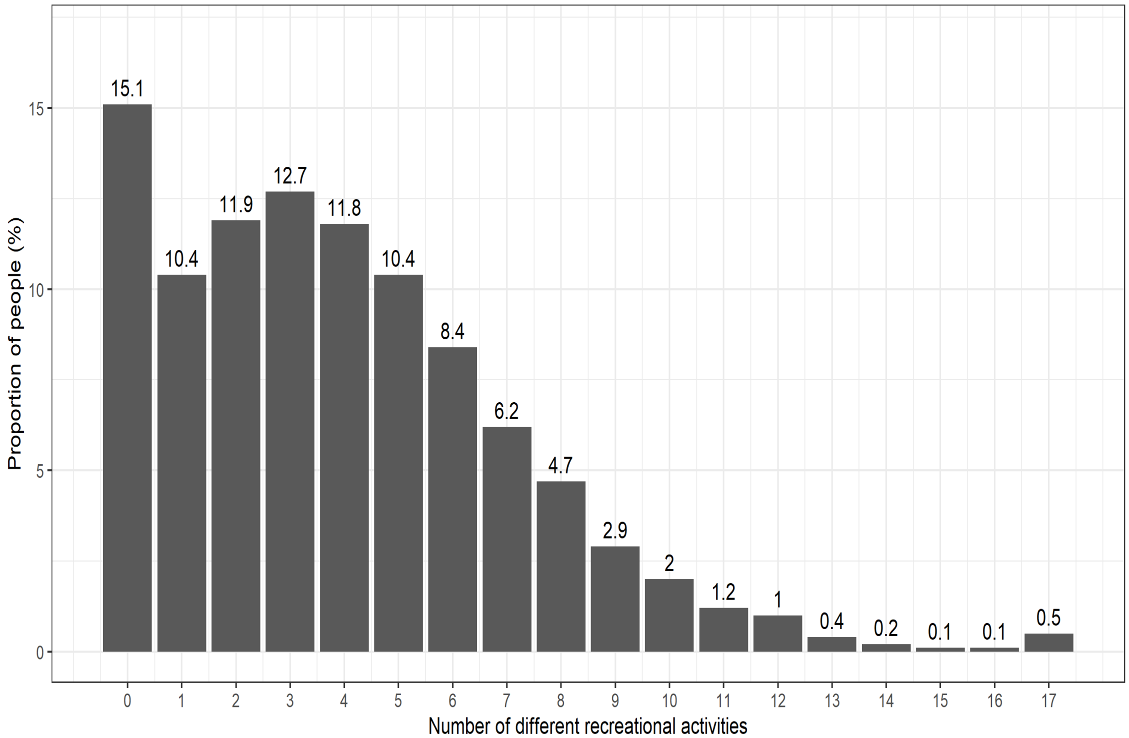
[3]For example, the section asking respondents to report their activities and expenditures was titled "Recreation and Leisure". For activities such as photography and gardening, people were prompted to report only participation for "leisure activities". For the hunting, trapping, and fishing activities section, the survey included a reminder to answer these questions and "only think about your participation in these activities for personal (non-monetary) use or for recreation" (Federal, Provincial, and Territorial Governments of Canada 2014).

and fishing to harvest animals for food or other purposes. Thus this paper uses the term recreation to include all non-commercial motivated participation in these activities.

While the CNS has many benefits for our purposes, there are also some important limitations. One limitation is that no information was collected on the exact location of residence for each respondent nor the spatial location where people participated in each recreation activity. The data only includes the respondent's province or territory of residence and restricts all recreation activity to Canada. In a typical recreation demand study, the distance for each trip is calculated and a per kilometre travel cost is assigned. In the CNS survey, respondents report the amount of money they spent travelling and participating in each recreation activity, but we do not know the distance travelled. Respondents may have difficulty apportioning costs across different activities and there may be concerns that these self-reported amounts are measured with error. However, these self-reported costs may better align with individual-specific travel costs and avoids the issue of a researcher imposed assumption on costs. Furthermore, respondents' perceptions of travel costs can be a better driver of behaviour (Randall 1994). Another limitation is that respondents only report monetary travel costs for activities that they participate in. For an activity that a respondent did not participate in, I need to make assumptions and impute participation costs. To address these potential participation cost measurement errors, I incorporate uncertainty in the calculation in the main analysis as explained in the next section.

Figure 1 shows the distribution of the number of different activities people participate in. Around 85% of people participate in at least one activity and 50% of people participate in more than 3 different activities.

Figure 1: Recreation activity participation distribution



4 Empirical Analysis

In this section, I detail the main steps of our empirical analysis. I estimate the economic benefits of recreation in three steps:

1. First, I use the CNS data to compute participation costs. To account for inherent uncertainty in this calculation, I construct 200 individual-specific participation cost vectors for each activity.

2. Second, I use a weighted bootstrap procedure to estimate the KT demand model using the 200 participation cost vectors and the recreation behaviour data.

3. Third, for each model estimate and cost vector pair, I use a simulation-based approach to calculate welfare changes associated with losing access the recreation activities.

4.1 Participation costs calculation

The full costs of participating in each activity includes the monetary and time costs of travelling to recreation sites as well as any non-travel costs such as activity-specific equipment and supply expenditures, fees, and accommodations. This section details how the data and assumptions are combined to calculate daily participation costs for each individual to participate in each activity.

One challenge with incorporating equipment and supply costs in travel cost models is that some of these costs are spent on durable goods that last more than one year. [4] People may buy a new pair of skis every five years or a canoe once every 20 years. To address this issue, I calculate activity-specific, average daily equipment and supply costs for each province and territory and use these expected costs in the participation cost calculation. In this way, durable good costs are amortized based on average self-reported costs.[5] Avoiding the use of individual-specific equipment costs has the additional benefit of potentially reducing the endogeneity of these types of costs as they are at least partially chosen by the individual.

Another challenge in recreation demand modelling is the treatment of secondary homes such as cabins, cottages, camps, chalets, or bungalows. These are may be purchased to be closer to prime locations to recreate and these costs are excluded from the current analysis. Furthermore, recreation demand models assume that participation costs are exogenous to an individual, but if recreation preferences influence the decision to buy a secondary home, then these costs may be endogenous (see **?**Randall (1994)). A solution to this general concern with recreation demand models is beyond the scope of the current paper but is important to note when interpreting the results.

[4] I thank a reviewer for raising this point.

[5] Taking the canoe example of a purchase once every 20 years, we would expect about 1 in 20 people to purchase a canoe each year and thus the expected annual canoe costs are the average canoe costs in the sample.

While monetary costs are based on self-reported expenditures for each activity, the opportunity cost of travelling time to participate in each activity is unknown and must be valued based on assumptions. There is considerable evidence on the importance of including travel time costs in recreation demand modelling, but less consensus on how exactly it should be valued (Parsons 2017). The most common approach in the recreation demand literature is to use one-third of the wage rate, but there is evidence that people value their time closer to the wage rate (Fezzi et al. 2014, Lloyd-Smith et al. 2019).

Another unknown regards travel costs for non-participants. Because they do not take any trips for a specific recreation activity, they do not report expenditures and thus I need to estimate the expected activity-specific travel costs for these non-participants. Imputing these missing costs for non-participants is challenging because we would expect that higher travel costs are one reason people would not participate and thus the missing cost data are likely missing not at random (MNAR). The typical approach in recreation demand modelling is to use a single assumption, construct participation costs and then test the sensitivity of the resulting behavioural predications or welfare measures to alternative assumptions. This paper takes an alternative approach to explicitly incorporate the participation cost uncertainty into the model estimation and welfare calculation.

To address these uncertainties in participation cost measurement, I adopt a simulation and multiple imputation approach to construct 200 participation costs for each individual-activity pair. For the value of travel time, I consider a range of values from one-third to the full imputed wage rate. For non-participant travel costs, I use the multiple imputation using chained equations (MICE) technique with a multiplicative adjustment factor ranging from 1 (i.e. no adjustment and equivalent to missing at random assumption) to 1.5 (i.e. 150% the expected costs at each imputation) to address the MNAR issue. The 200 participation costs for each individual-activity pair are calculated using 1) the self-reported expenditure data,

2) 200 Halton draws between 1/3 and 1 for the fraction of the imputed wage rate to use as the value of time, and 3) 200 Halton draws between 1 and 1.5 for multiplicative adjustment factor used in the MICE approach for non-participants. The full details on the specific approach used to calculate and impute participation costs is provided in Appendix A as these are more involved than the typical recreation demand application. Table B-2 reports the mean participation costs for each activity in the different provinces and territories of Canada. The next sections describe how these participation cost vectors are used in model estimation and welfare simulation to account for uncertainty in both steps.

4.2 Recreation demand model estimation

I use the first-order conditions in Equation (3) as the estimating equations and use the the random utility specification of the multiple discrete-continuous extreme value (MDCEV) model (Bhat 2008). I assume that the numeraire good acts as the outside good and is always consumed. I use the "γ-profile" utility function specification and estimate α_1 for the numeraire good and activity-specific γ_k parameters (Bhat 2008).[6]

I specify the following translated generalized constant elasticity of substitution (tCES) utility function

$$U(x_k, Q_k, x_1) = \sum_{k=2}^{K} \gamma_k \psi_k \ln\left(\frac{x_k}{\gamma_k} + 1\right) + \frac{\psi_1}{\alpha_1} x_1^{\alpha_1} \tag{5}$$

where $\gamma_k \geq 0$ and $\alpha_1 \leq 1$ are required for this function to be consistent with the properties of a utility function (Bhat 2008). The ψ_k parameter is the marginal utility of a recreation day for activity k when $x_k = 0$. I parameterize ψ to be a function of recreation activity characteristics using a exponential form such that $\psi_k = exp(\beta Q_k + \varepsilon_k)$. I include activity

[6]The tCES form was chosen based on conventional model fit statistics BIC and AIC.

specific constants in the Q_k vector to capture the specific preferences for certain activities and normalize the activity specific constant for one of the activities to zero (i.e. $Q_{birding} = 0$). The ψ_1 parameter for the numeraire is specified as $\psi_1 = exp(\varepsilon_1)$. The error terms, ε, allows for the utility function to be random over the population. I assume an extreme value distribution that is independently distributed across alternatives for ε_k with an associated scale parameter of σ. The α_1 parameter controls the rate of diminishing marginal utility of additional units of the numeraire. The γ_k parameters translate the underlying indifference curves which allows for corner solutions (i.e. zero days for certain activities) and also influences satiation for the recreation activities.

The resulting model probability of the consumption pattern where M goods are chosen can be expressed as (Bhat 2008).

$$P(x_1^*, x_2^* ... x_M^*, 0, ..., 0) = \frac{1}{\sigma^{M-1}} \left(\prod_{k=1}^{M} c_k \right) \left(\sum_{k=1}^{M} \frac{1}{c_k} \right) \left(\frac{\prod_{j=k}^{M} e^{V_k/\sigma}}{\left(\sum_{k=1}^{K} e^{V_k/\sigma} \right)^M} \right) (M-1)! \qquad (6)$$

where σ is a scale parameter, $c_k = \frac{1-\alpha_k}{x_k + \gamma_j p_k}$, $V_k = \beta' Q_k + \ln\left(\frac{x_k}{\gamma_k} + 1 \right) - \ln(p_k) \;\; \forall \; k > 1$, and $V_1 = (\alpha_1 - 1)\ln(x_1)$.

In the empirical application, K=18 as there are a total of 17 different recreation activities represented in the data plus the numeraire good.

I account for participation cost uncertainty and sample representativeness using a unified bootstrap procedure. As detailed in the previous section, participation costs are measured with uncertainty and I estimate separate KT model for each of the 200 vectors of calculated participation costs for each individual. The data included sampling weights and I normalize these weights such that the sum of the weights equals the sample size. I use these normalized sampling weights to define the probability of an individual being sampled. For the bootstrap procedure, I use the sampling weights to draw with replacement a sample of 24,000 individuals from the data set and estimate the KT model. Each bootstrap sample uses a unique participation cost vector and this procedure is repeated 200 times.[7]

4.3 Benefits of recreation simulation

To calculate the benefits of recreation, I estimate the necessary compensation levels that are required to make individuals as well off without these recreation opportunities as they are with recreation. I use the estimated parameters of the KT demand model along with the trip data and participation costs and implement a simulation-based approach to welfare measurement. I use the structural model to simulate Hicksian demand for each activity that can be used to calculate the CS^H associated with losing the ability to participate in each recreation activity. The vector of structural parameters in Equation (4) include $\psi_k, \alpha_1, \gamma_k$, and σ.

Calculating Equation (4) is challenging as it depends on both interior and corner solutions for the k activities and is a random variable due to the presence of the ε term in CS^H (Von Haefen & Phaneuf 2005). To calculate $\mathrm{E}[CS^H]$, I use Monte Carlo simulation techniques and the approach fully described in Lloyd-Smith (2018). I implement the conditional approach to welfare measurement by simulating the unobserved heterogeneity to ensure the model perfectly predicts reported activity levels (Von Haefen & Phaneuf 2005). Thus, the error terms, ε, are drawn to capture individual-specific preferences for each activity and welfare measurement is grounded in the actual behaviour of individuals. I draw 50 conditional errors per individual for each scenario using the Modified Latin Hypercube Sampling algorithm (Hess et al. 2006).

[7] All model estimation and welfare simulation is conducted using the rmdcev R package (Lloyd-Smith 2020).

I simulate the welfare consequences of losing access to each of the 17 recreation activities as separate policy scenarios as well as an additional policy scenario that considers losing access to all recreation activities. For each of these 18 policy scenarios, I incorporate parameter and participation cost uncertainty by calculating the welfare impacts using the 200 unique pairs of model estimates and participation cost vectors. That is to say that for each individual, the same participation cost vector used to estimate the model estimate is used in the welfare calculation.

5 Results

I first present the model parameter and welfare estimates results for the national model. I then present the results for the provincial and territorial-level models that allow for preference heterogeneity at these subnational levels.

5.1 National results

Table 2 presents the estimated parameters for the national recreation demand model using the weighted bootstrap procedure and 200 replications.[8] The β_k parameters affect the marginal utility for the first recreation day (i.e. baseline utility) for each activity. The greater the value of β_k, the more likely an individual will participate in a given activity. All of these baseline utility parameters are relative to birding which has been normalized to zero. Less popular activities such as hunting other animals and cross-country skiing have lower β_k parameter values than more popular activities such as hiking. Because the α_k parameters have been normalized to zero for identification, the γ_k parameters capture satiation in the recreation activities levels with greater values of γ_k implying that individuals satiate less for that particular activity. The α_1 parameter captures satiation for the numeraire good.

[8]The 200 replications was chosen after assessing changes in the standard deviations of the parameter estimates and welfare measures as the number of replications increased.

Table 2: National recreation demand model parameter estimates

Activity-specific parameters	β_k mean	β_k sd	γ_k mean	γ_k sd
Alpine skiing/snowboarding	0.79	(0.09)	3.20	(0.16)
Beach/non-motorized boating	1.48	(0.06)	2.89	(0.13)
Birding	0.00	(fixed)	5.29	(0.38)
Camping in tents	0.79	(0.07)	2.85	(0.11)
Cross-country skiing/snowshoeing	-0.24	(0.09)	3.05	(0.15)
Cycling/mountain biking	0.63	(0.05)	5.19	(0.33)
Fishing	0.81	(0.07)	3.78	(0.21)
Gardening/landscaping	1.44	(0.07)	6.33	(0.45)
Golfing	0.85	(0.08)	3.61	(0.20)
Hiking/climbing/horseback riding	2.18	(0.07)	3.51	(0.20)
Hunting birds	-0.29	(0.12)	4.05	(0.25)
Hunting large game	0.37	(0.10)	4.86	(0.34)
Hunting other	-1.48	(0.12)	10.19	(0.68)
Hunting waterfowl	-0.17	(0.12)	4.23	(0.27)
Motorized boating	1.22	(0.06)	3.34	(0.20)
Motorized land vehicles	1.11	(0.06)	5.32	(0.33)
Photography/filming nature	1.10	(0.05)	3.95	(0.23)
Satiation parameter (α_1)	0.90	(0.01)	-	-
Scale parameter (σ)	1.18	(0.05)	-	-
N observations	24000	-	-	-
Log-likelihood	-585664	(5038)	-	-

Note. This table reports estimates for the structural parameters of the Kuhn-Tucker model using 200 weighted bootstrap iterations.

The parameter estimates in Table 2 along with the data are used in the welfare simulation to calculate the compensating surplus of losing access to each recreational activity. I interpret the compensating surplus as the economic benefits of recreation. Table 3 presents the mean national economic benefits of each recreation activity per person and per participant along with the 95% confidence intervals. All figures are presented in 2012 Canadian dollars. The first three columns present the benefits per person. Hiking is worth \$969 on average and is the most valuable recreation activity for Canadians followed by gardening (\$389), motorized land vehicle activities ($326), and birding ($295).

The last line of Table 3 presents the welfare results for the total loss scenario where Canadians lose access to all recreation activities. In this total loss scenario, there is no substitution possibilities across recreation activities. If we sum up the activity-specific welfare changes in Table 3, the total welfare loss is $3,628 which is less than the welfare change from the last scenario. The reason for this difference is that the activity-specific welfare changes allow substitution to other recreation activities. (i.e. people that lose the opportunity to hunt waterfowl may hunt other birds) whereas people lose access to all recreation activities in the last scenario.

Table 3: National average benefits of recreation activities

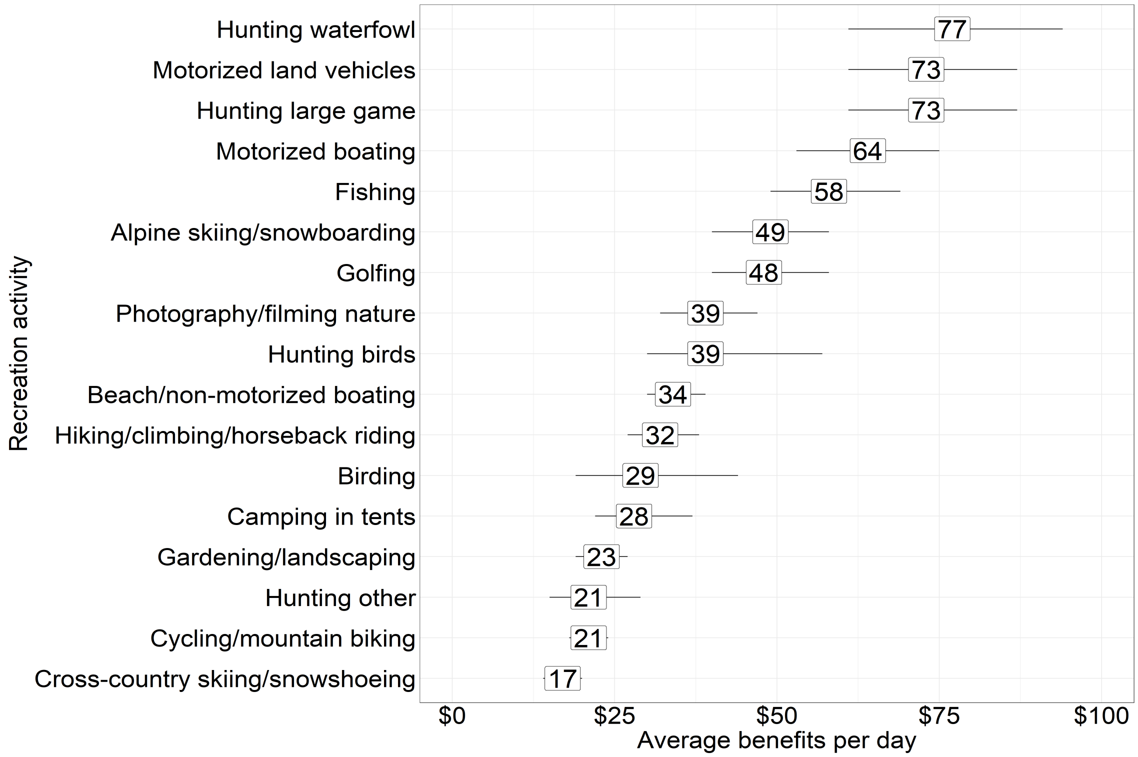
	Per person			Per participant		
Activity	mean	low	high	mean	low	high
Alpine skiing/snowboarding	$116	$96	$135	$874	$709	$1,033
Beach/non-motorized boating	$201	$175	$225	$501	$432	$567
Birding	$295	$208	$425	$1,320	$879	$2,036
Camping in tents	$91	$73	$110	$382	$304	$506
Cross-country skiing/snowshoeing	$34	$29	$40	$196	$163	$231
Cycling/mountain biking	$182	$159	$203	$645	$554	$737
Fishing	$162	$138	$188	$741	$622	$883
Gardening/landscaping	$389	$337	$452	$722	$617	$865
Golfing	$170	$145	$198	$832	$693	$1,000
Hiking/climbing/horseback riding	$969	$830	$1,120	$1,499	$1,271	$1,788
Hunting birds	$39	$31	$47	$786	$608	$1,148
Hunting large game	$106	$91	$124	$1,472	$1,225	$1,754
Hunting other	$40	$30	$54	$1,124	$803	$1,586
Hunting waterfowl	$62	$51	$74	$2,289	$1,821	$2,815
Motorized boating	$185	$155	$214	$909	$754	$1,080
Motorized land vehicles	$326	$281	$378	$1,928	$1,623	$2,296
Photography/filming nature	$261	$218	$307	$858	$706	$1,032
All recreation	$3,704	$3,164	$4,311	-	-	- -

Note. This table reports the national average benefits of different recreation activities per person as well as per participant. All numbers are in 2012 Canadian dollars. Participants are defined as people that report a positive level of days for a particular activity. The low and high estimates report the 95% confidence interval of the mean estimate calculated from the 200 weighted bootstrap samples.

Some recreation activities do not have wide spread participation, but the people that do participate may have high economic values for these opportunities. These average benefit per participant are presented in the last three columns of Table 3. The hunting activities along with motorized land vehicles are the most valuable activities per participant. These differences can be attributed to the fact that activities have different participation rates.

A final way of presenting the national estimates is to compute average daily benefits by

Figure 2: Average national economic benefits per day



This figure reports the average economic benefit per activity in the box and the error bars represent the 95% confidence interval.

dividing the aggregate activity-specific benefits by the average number of participation days reported in Table B-1 of the appendix. The estimates of the average benefits per day for each recreation activity are provided in Figure 2. These are average values rather than marginal values which will be different due to the nonlinear utility function specification used in the modelling. On a daily basis, hunting waterfowl ($77), motorized land vehicles ($73), and hunting large game ($73) are the activities with the highest average benefits while cross-country skiing ($17) and cycling ($21) have the lowest average benefits. Some activities with high benefits per person such as hiking, gardening, and birding have relatively low daily benefits whereas the opposite is true for hunting waterfowl and hunting large game.

6 Provincial and territorial results

The results above using the national recreation model impose the assumption that people have the same preferences for recreation, regardless of which province or territory they reside in. To investigate regional preference heterogeneity, I estimate separate recreation demand models and calculate welfare measures for each province and territory. Due to space constraints, the parameter estimates for these models are presented in Table B-3 in the appendix and I focus the discussion here on the derived welfare measures.

Table 4 shows the annual benefits of recreation per person in each province and territory of Canada. These benefit measures are calculated for the total loss scenario where people lose access to all recreation opportunities. People living in the Yukon and Northwest Territories have the highest benefit estimates at $8,525 and $13,223 while people living in Quebec, Prince Edward Island, and New Brunswick have the lowest values for recreation. The benefits of recreation to people living in the Yukon and Northwest Territories are three to five times higher than for people living in Quebec and Prince Edward Island.

The aggregate benefits of recreation per province and territory are presented in the last three columns of Table 4. The economic benefits of recreation in Ontario, Canada's most populous province, is estimated to be $38.3 billion. Recreation in British Columbia is valued at $15.8 billion followed closely by Quebec ($15.2 billion) and Alberta ($12.2 billion).

Table 4: Benefits of recreation per province/territory

	Per person			Population	Aggregate value ($ millions)		
Province	mean	low	high	millions	mean	low	high
BC	$4,246	$3,527	$5,182	3.72	$15,795	$13,120	$19,277
AB	$4,029	$3,179	$5,553	3.02	$12,168	$9,601	$16,770
SK	$6,670	$5,060	$8,559	0.84	$5,603	$4,250	$7,190
MB	$4,134	$2,975	$6,058	0.96	$3,969	$2,856	$5,816
ON	$3,593	$3,002	$4,298	10.67	$38,337	$32,031	$45,860
QC	$2,318	$1,978	$2,737	6.54	$15,160	$12,936	$17,900
NB	$2,965	$2,450	$3,543	0.62	$1,838	$1,519	$2,197
PE	$2,503	$2,030	$3,112	0.12	$300	$244	$373
NS	$3,421	$2,662	$4,501	0.77	$2,634	$2,050	$3,466
NL	$3,961	$3,090	$4,992	0.43	$1,703	$1,329	$2,147
YT	$8,525	$6,640	$10,278	0.03	$256	$199	$308
NT	$13,223	$8,986	$17,987	0.03	$397	$270	$540
Canada total				27.75	$98,160	$80,405	$121,842

Note. This table reports the average benefits of all recreation activities in each province per person and the aggregate value. All numbers are in 2012 Canadian dollars. The population column reflects the number of people aged 18 and over in 2012. The low and high estimates report the 95% confidence interval calculated from the 200 weighted bootstrap samples.

Aggregating all the provincial and territorial benefit estimates, the overall Canadian benefits of recreation is estimated to be $98.2 billion. The national model result gives a higher value of $103 billion ($3,704 x 27.8 million people aged 18 and over in 2012). Allowing for regional preference heterogeneity results in a lower aggregate welfare estimate.

7 Conclusion

In this work, I provide the first estimates of the economic benefits of recreation in Canada. Canadians participate in numerous recreation activities and receive substantial benefits totalling $98.2 billion (95% confidence interval: $80.4 to $121.8 billion). I also find substantial provincial and territorial heterogeneity in recreation benefit estimates. Another finding of this study is that using expenditures as a proxy for economic benefits can significantly underestimate the value people derive from these activities. For recreation, the economic benefits are well over twice as large as the reported expenditures.

The focus of this paper has been on generating aggregate welfare measures, but the modelling framework implemented can be used for a variety of other policy relevant analyses. For example, instead of losing complete access to a recreational opportunity, the model can be used to simulate the behavioural responses and welfare consequences of moderate changes in activity costs such as increased entrance fees. The average daily benefit measures can be used in an economic analysis of the non-market benefits associated with public investments in outdoor recreational amenities or the protection of natural areas that result in increased activities. Furthermore, the aggregate benefit estimates provide an assessment for the year 2012 and repeating the survey again would allow us to assess how Canadian's recreation behaviour and associated benefits have changed over time.

There are several limitations of the data and modelling analysis. While the data is the most detailed and comprehensive information we have on Canadian's recreation behaviour and expenditure, the data is still coarse and relies on self-reported information. The survey data differentiates between many different types of hunting activities, but lumps beach visits with non-motorized water activities such as canoeing and sailing. Going to the beach and going canoeing are quite different activities and this heterogeneity could be uncovered using even more refined categories. The participation cost data relies on self-reported transportation, accommodation, and equipment, fees and supply costs and these perceived costs may differ from actual expenses. Validating these cost perceptions through comparisons with distance based cost measures would be a useful future research endeavor.

The current analysis only considered activity-specific constants to describe each activity due to the unavailability of more refined, meaningful activity characteristics. Collecting more spatially-explicit recreation data and linking this site-specific data to the environmental quality indicators would permit the assessment of how environmental quality affects behaviour and recreation. Furthermore, assessing the differences in preferences and welfare measures across different socio-demographic groups in Canada can provide information on inequalities in outdoor recreation participation and benefits.

The welfare measures in this paper only include the direct use benefits people receive from participation and not other broader impacts on people and the environment. They do not account for any non-use values people hold for other people's participation. Many people are opposed to recreational hunting and may be willing to pay to prohibit this activity from taking place. On the other hand, the estimated benefits also do not account for the indirect benefits people may receive from other's participation such the provision of food or walking by a pleasant garden. Furthermore, people's recreational behaviour may negatively impact the natural environment such as anglers reducing fish stocks or off-road vehicle users damaging animal habitats and these secondary impacts are not account for. Taken together, including these broader impacts may increase or decrease the total value of recreation in Canada.

We have the tools to broaden our understanding of the economic benefits of nature that go beyond relying on expenditures as proxy measures. While the economic benefits estimated in this paper are subject to measurement uncertainty, these benefits are substantial under a wide range of assumptions. To the extent that public policy is aimed at increasing the welfare of citizens, these results can be used and incorporated into the decision making process of policy-makers.

References

Allcott, H., Braghieri, L., Eichmeyer, S. & Gentzkow, M. (2020), 'The Welfare Effects of Social Media', *American Economic Review* **110**(3), 629–676.

URL: *https://www.aeaweb.org/articles?id=10.1257/aer.20190658*

Bateman, I. J., Harwood, A. R., Abson, D. J., Andrews, B., Crowe, A., Dugdale, S., Fezzi, C., Foden, J., Hadley, D., Haines-Young, R., Hulme, M., Kontoleon, A., Munday, P., Pascual, U., Paterson, J., Perino, G., Sen, A., Siriwardena, G. & Termansen, M. (2014), 'Economic Analysis for the UK National Ecosystem Assessment: Synthesis and Scenario Valuation of Changes in Ecosystem Services', *Environmental and Resource Economics* **57**(2), 273–297.
URL: *https://doi.org/10.1007/s10640-013-9662-y*

Bhat, C. R. (2008), 'The multiple discrete-continuous extreme value (MDCEV) model: Role of utility function parameters, identification considerations, and model extensions', *Transportation Research Part B: Methodological* **42**(3), 274–303.
URL: *http://www.sciencedirect.com/science/article/pii/S0191261507000677*

Boxall, P. C., Adamowicz, W. L., Swait, J., Williams, M. & Louviere, J. (1996), 'A comparison of stated preference methods for environmental valuation', *Ecological Economics* **18**(3), 243–253.
URL: *http://www.sciencedirect.com/science/article/pii/0921800996000390*

Brynjolfsson, E., Collis, A. & Eggers, F. (2019), 'Using massive online choice experiments to measure changes in well-being', *Proceedings of the National Academy of Sciences* **116**(15), 7250–7255.
URL: *https://www.pnas.org/content/116/15/7250*

Champ, P. A., Boyle, K. & Brown, T. C., eds (2017), *A Primer on Nonmarket Valuation*, The Economics of Non-Market Goods and Resources, 2 edn, Springer Netherlands.
URL: *https://www.springer.com/gp/book/9789400771031*

Conference Board of Canada (2019), 'The Economic Footprint of Angling, Hunting, Trapping and Sport Shooting in Canada'.
URL: *https://www.ofah.org/wp-content/uploads/2019/09/Economic-Footprint-Analysis-of-AHTS.pdf*

Dupont, D. P. (2003), 'CVM Embedding Effects When There Are Active, Potentially Active and Passive Users of Environmental Goods', *Environmental and Resource Economics* **25**(3), 319–341.
URL: *https://doi.org/10.1023/A:1024446110640*

Federal, Provincial, and Territorial Governments of Canada (2014), 2012 Canadian Nature Survey: Awareness, participation, and expenditures in nature-based recreation, conservation, and subsistence activities, Technical report, Canadian Councils of Resource Ministers, Ottawa, ON.

Fezzi, C., Bateman, I. J. & Ferrini, S. (2014), 'Using revealed preferences to estimate the Value of Travel Time to recreation sites', *Journal of Environmental Economics and Man-*

agement **67**(1), 58–70.
URL: *http://www.sciencedirect.com/science/article/pii/S0095069613000880*

Forsyth, M. (2000), 'On estimating the option value of preserving a wilderness area', *Canadian Journal of Economics/Revue canadienne d'économique* **33**(2), 413–434.
URL: *https://onlinelibrary.wiley.com/doi/abs/10.1111/0008-4085.00022*

Hailu, G., Boxall, P. C. & McFarlane, B. L. (2005), 'The influence of place attachment on recreation demand', *Journal of Economic Psychology* **26**(4), 581–598.
URL: *http://www.sciencedirect.com/science/article/pii/S016748700400114X*

Heitjan, D. F. & Little, R. J. A. (1991), 'Multiple Imputation for the Fatal Accident Reporting System', *Journal of the Royal Statistical Society. Series C (Applied Statistics)* **40**(1), 13–29.
URL: *https://www.jstor.org/stable/2347902*

Hess, S., Train, K. E. & Polak, J. W. (2006), 'On the use of a Modified Latin Hypercube Sampling (MLHS) method in the estimation of a Mixed Logit Model for vehicle choice', *Transportation Research Part B: Methodological* **40**(2), 147–163.
URL: *http://www.sciencedirect.com/science/article/pii/S0191261505000500*

Lloyd-Smith, P. (2018), 'A new approach to calculating welfare measures in Kuhn-Tucker demand models', *Journal of Choice Modelling* **26**, 19–27.
URL: *http://www.sciencedirect.com/science/article/pii/S1755534517300994*

Lloyd-Smith, P. (2020), *Kuhn-Tucker and Multiple Discrete-Continuous Extreme Value Model Estimation and Simulation in R: The rmdcev Package*. University of Saskatchewan Working Paper.

Lloyd-Smith, P., Abbott, J. K., Adamowicz, W. & Willard, D. (2019), 'Decoupling the Value of Leisure Time from Labor Market Returns in Travel Cost Models', *Journal of the Association of Environmental and Resource Economists* **6**(2), 215–242.
URL: *https://www.journals.uchicago.edu/doi/abs/10.1086/701760*

Olewiler, N. (2017), 'Canada's dependence on natural capital wealth: Was Innis wrong?', *Canadian Journal of Economics/Revue canadienne d'économique* **50**(4), 927–964.
URL: *https://onlinelibrary.wiley.com/doi/abs/10.1111/caje.12295*

Parsons, G. R. (2017), The Travel Cost Model, *in* P. A. Champ, K. J. Boyle & T. C. Brown, eds, 'A Primer on Nonmarket Valuation', number 6 *in* 'The Economics of Non-Market Goods and Resources', Springer Netherlands, pp. 187–233.

Randall, A. (1994), 'Difficulty with the Travel Cost Method', *Land Economics* **70**(1), 88–96.
URL: *https://econpapers.repec.org/article/uwplandec/* $v_3a70_3ay_3a1994_3ai_3a1_3ap_3a88 - 96.htm$

Rollins, K., Dumitras, D. & Castledine, A. (2008), 'An Analysis of Congestion Effects Across and Within Multiple Recreation Activities', *Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie* **56**(1), 95–116.
URL: *https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1744-7976.2007.00119.x*

Schenker, N. & Taylor, J. M. G. (1996), 'Partially parametric techniques for multiple imputation', *Computational Statistics & Data Analysis* **22**(4), 425–446.
URL: *http://www.sciencedirect.com/science/article/pii/0167947395000577*

Shaw, D. (1988), 'On-site samples' regression: Problems of non-negative integers, truncation, and endogenous stratification', *Journal of Econometrics* **37**(2), 211–223.
URL: *https://econpapers.repec.org/article/eeeeconom/*$v_3a37_3ay_3a1988_3ai_3a2_3ap_3a211-223$*.htm*

The Outspan Group Inc (2011), 'The Economic Impact of Canada's National, Provincial & Territorial Parks in 2009'.
URL: *http://www.parks-parcs.ca/english/pdf/*$econ_impact_2009_part1$*.pdf*

Von Haefen, R. & Phaneuf, D. J. (2005), Kuhn-Tucker demand system approaches to non-market valuation, *in* R. Scarpa & A. Alberini, eds, 'Applications of Simulation Methods in Environmental and Resource Economics', number 6 *in* 'The Economics of Non-Market Goods and Resources', Springer Netherlands, pp. 135–157.
URL: *http://link.springer.com/chapter/10.1007/1-4020-3684-*1_8

Appendix A: Participation Cost Calculation Details

This appendix details the approach used to calculate participation costs. Participating in recreation activities consists of three main components: monetary travel costs, travelling time costs, and other non-travel costs such as accommodation, equipment, fees, and supplies costs. The Canadian Nature Survey asked respondents to report their household recreation expenditures for transportation, accommodation, and equipment over the last 12 months to participate in each of the recreation activities. While the CNS asks about recreation related food expenditure, I do not include these as they are unnecessary to make the recreation trip possible (Parsons 2017). An example of the questions collecting trip information is provided in Figure A-1.

The first step is to convert household expenditures for transportation, accommodation, and equipment to expenditures per person. The out of pocket household expenditures are divided by the activity-specific reported number of household members included in the expense to derive per-person expenditures. If respondents did not indicate how many households members are included in the expenses, I impute the value using the provincial average of all completed responses for that particular activity.

The daily costs for individual i to participate in activity j can be specified as

Figure A-1: Canadian Nature Survey example activity question for motorized vehicles

Activity	Days per year in Canada, at home or within 20 km of my home	Days per year in Canada, farther than 20 km from my home	Total money I spent to participate in these activities in Canada ($CDN)
Motorized recreational vehicle use on land (ATV, snowmobile, etc.)			Transportation Accommodation Food Equipment, Fees, & Supplies
Motorized recreational vehicle use on water (motorboat, motorized personal watercraft, etc.)			Transportation Accommodation Food Equipment, Fees, & Supplies

$$costs_{ij} = monetary\_travel_{ij} + travelling\_time_{ij} + nontravel_{ij}. \tag{A-1}$$

Monetary travel costs

Monetary travel costs are obtained from self-reported transportation costs. Survey respondents were prompted to consider all travel costs to participate in the activity including costs to operate private vehicles, vehicle rental, and local and public transportation. For each individual and activity, I divide the per-person expenditures by the number of days an individual participates in that activity to derive an individual cost per activity day.

Travelling time costs

The value of time is one of the most difficult costs of recreation to calculate and has received the most attention in the literature (Parsons 2017). The typical approach is to use self-reported income divided by the annual hours worked per individual (i.e. 2040 hours worked per year) to derive a proxy for hourly wage and then use some fraction of this amount. The most common assumption is one-third of this hourly wage, but there is also evidence that people value their time closer to the hourly wage rate Fezzi et al. (2014), Lloyd-Smith et al. (2019). I use the conventional fraction of the imputed wage rate approach and use a range of values from one-third to the full wage rate.

While the value of time can be readily computed from self-reported income, we do not have reported travel time for each activity and thus we calculate the expected travel time based on reported monetary travel costs. Travel time is calculated as the total monetary travel costs divided by the travel costs per kilometre and the average speed per kilometre. Travel costs per kilometre are $0.57 based on the average costs of driving a sedan in Canada in 2013 (CAA, 2013) and I assume that people drive at 60 kilometres per hour. While our monetary travel costs do not impose any assumptions on expected travel mode, the time travel cost calculations assume the people drive in a sedan.

Non-travel costs

Non-travel costs consist of equipment, fees, and supplies costs as well as accommodation costs. In the Canadian Nature Survey, respondents were asked to consider the following components of equipment, fee, and supply costs:

- Outdoor equipment: camping gear, footwear or clothing, luggage or backpacks, GPS equipment…
- Wildlife viewing, acoustic, or monitoring equipment: cameras, binoculars, recording equipment…
- Sporting equipment and accessories: bicycles, skis, snowshoes, climbing gear…
- Non-motorized water recreation vehicles: canoes, kayaks…
- Hunting, trapping or fishing gear: guns, decoys, traps, rods, reels…
- Licences, entry fees, guide fees, package fees…
- Equipment rental and repairs…
- Expendable supplies for hunting, trapping or fishing: ammunition, bait, tackle…
- Expendable supplies for photography and other nature activities: batteries, memory cards, other data storage…

One of the challenges with including these types of expenditures in travel cost models is that they are partially endogenously chosen by the individual. However, excluding these costs is also problematic as participating in alpine skiing has substantially larger participation costs than birding and these differences can be important drivers of behaviour and substitution across activities. To alleviate the endogeneity concerns of individual-specific equipment costs, I estimate the average daily equipment costs for each activity and province and use these average costs for each individual.

For accommodation costs, survey respondents were explicitly prompted to consider the costs of campgrounds, cabins, lodges, hotels, motels, resorts that are incurred to participate in

Figure A-2: Canadian Nature Survey grouped activity question

19. Please indicate how many days you participated in each of the following outdoor recreation activities, in the last 12 months, at home or away from home but still in Canada, and how much money you spent to participate in these activities. If you did not spend any time or money on an item, please enter "0" in the box.
(One day is defined as all or any part of a calendar day–24 hours or less.)

Activity	Days per year in Canada, at home or within 20 km of my home	Days per year in Canada, farther than 20 km from my home	Total money I spent to participate in these activities in natural areas in Canada ($CDN)
Hiking, walking in natural areas, backpacking, climbing, caving, geo-caching, horseback riding			Transportation
Cycling, mountain-biking			Accommodation
Camping in tents			Food
Non-motorized water and beach activities (e.g. canoeing, kayaking, sailing, swimming, whitewater rafting, surfing)			Equipment, Fees, & Supplies
Alpine (downhill) skiing, snowboarding			On average, how many household members (including yourself) are included in these expenses?
Cross-country/backcountry skiing, snowshoeing			
Golfing			

the recreation activity. We follow a similar approach to equipment costs and use provincial average daily accommodation costs for each activity.

Apportioning grouped activity costs

For seven recreation activities, costs are reported in a combined sum as illustrated in Figure A-2. For individuals only participating in one of these seven activities (i.e. report positive days for one activity), the grouped costs can be interpreted as activity-specific costs. However, for people that participate in more than one of these grouped activities, we need to apportion the total costs across these activities. The method I used to apportion the total costs is to first calculate the mean activity-specific per person daily costs using only individuals that participated in a single activity ($\overline{costs_{jt}}$). This yields an average cost per activity for each cost type t (monetary travel, accommodation, equipment/fees/supplies). These averages reflect the relative daily costs for each activity are taken at the provincial level for hiking and golf and at the national level for the remaining 5 activities due to the smaller sample sizes for these less popular activities. I then multiple these average activity-specific daily costs by the number of participation days ($days_{ij}$) for each individual. These estimated expenditures are aggregated together for each individual to yield an initial estimate of the total expenditures for these seven recreation activities. We calibrate these initial estimates to be equal to the total reported expenditures given in Figure A-2. Specifically, we divide the initial estimates by the reported total costs to calculate the individual-specific adjustment factor for. The adjustment factor is multiplied by the provincial daily average costs to compute the individual-specific costs for each individual-activity pair. For example, if people report spending $200 on the seven activities and the initial estimates are equal to $400, then the adjustment factor would be 0.5. This adjustment process ensures that the total estimated expenditure for each individual is equal to their reported expenditures. Equation A-2 below summarizes the calculation.

$$costs_{ijt} = \frac{\sum (days_{ij} * \overline{costs_j t})}{total\_reported\_costs_{it}} * \overline{costs_j t} \tag{A-2}$$

For accommodation and equipment/fees/supplies costs, I take the average daily activity-specific costs for each province and use that for each individual. For monetary travel costs I use the estimated individual-specific costs.

Non-participant costs

People that do not participate in a particular activity do not report any travel or non-travel costs. Consequently, I need to impute the expected costs these non-participants would face if they participated in each activity. These missing data are likely missing not at random (MNAR) as we'd expect travel costs to be one of the main determinants of non-participation. To address the MNAR issue, I use the multiple imputation using chained equations (MICE) technique with adjustment. Specifically, I use a multiplicative adjustment factor ranging from 1 (i.e. no adjustment and equivalent to missing at random assumption) to 1.5 (i.e. 150% the expected costs at each imputation).

The MICE algorithm uses predictive mean matching (PMM) which is a semi-parametric imputation approach which shares similarities with regression methods. PMM fills in the missing value with a random value from potential observed donor values which have the closest regression-predicted values using a simulated regression model (Heitjan & Little 1991, Schenker & Taylor 1996). I use a large number of variables in the imputation process including 204 province-activity alternative constants, the number of days spent recreating in each activity, and socio-demographic variables such as income, education level, urban, age, gender, whether the individual self-identifies as Indigenous, and whether the individual is an immigrant.

Appendix B

Table B-1: Average number of activity days across provinces and territories

Activity	BC	AB	SK	MB	ON	QC	NB	PE	NS	NL	YT	NT	CA
Alpine skiing/snowboarding	2.6	2.4	0.9	0.8	3.2	1.8	1.6	0.6	1.1	0.6	3.3	0.5	2.4
Beach/non-motorized boating	7.8	4.5	6.2	6.1	6.4	3.9	7.2	7.7	9.5	5.3	7.1	9.0	5.9
Birding	12.1	10.9	14.8	16.0	10.0	6.9	15.9	24.3	16.2	12.2	18.5	7.5	10.4
Camping in tents	2.6	2.7	2.3	5.2	3.7	3.2	3.4	1.4	2.5	1.9	7.4	5.8	3.3
Cross-country skiing/snowshoeing	1.2	1.4	1.8	1.3	2.4	2.2	3.7	2.1	1.4	2.8	12.5	5.0	2.1
Cycling/mountain biking	11.4	8.3	8.0	10.5	8.6	8.8	5.8	5.5	6.7	2.6	14.2	11.0	8.8
Fishing	3.7	1.8	4.4	4.3	2.9	1.9	3.1	3.5	4.0	3.9	6.4	7.9	2.8
Gardening/landscaping	26.3	18.2	25.0	21.2	16.3	11.1	18.3	25.1	19.7	16.4	23.9	22.8	17.3
Golfing	3.4	3.8	4.4	3.5	4.6	1.9	3.2	6.7	3.4	2.2	3.1	3.3	3.6
Hiking/climbing/horseback riding	53.2	29.3	26.0	32.8	24.6	23.5	38.6	44.1	41.3	44.5	79.9	55.0	30.3
Hunting birds	0.3	0.5	1.5	0.3	1.7	0.6	1.8	0.3	0.9	0.6	1.1	0.7	1.0
Hunting large game	0.7	0.8	5.6	1.6	1.5	1.5	1.7	0.1	1.5	1.9	2.2	1.4	1.5
Hunting other	0.1	1.6	1.9	1.5	3.3	1.1	2.8	0.2	1.8	1.5	0.8	0.5	2.0
Hunting waterfowl	0.2	0.7	2.2	0.6	1.3	0.3	1.3	0.5	0.5	0.6	0.1	0.8	0.8
Motorized boating	2.5	2.7	3.8	4.2	3.7	1.7	2.4	2.3	2.5	2.4	4.6	7.8	2.9
Motorized land vehicles	3.1	4.1	8.5	4.6	4.6	4.2	6.8	2.9	4.6	9.3	9.2	10.6	4.5
Photography/filming nature	10.8	6.0	6.8	6.0	7.4	3.4	8.1	7.9	8.5	8.6	17.1	16.5	6.7
Photography/filming	10.0	7.8	5.9	6.4	7.2	4.6	7.2	8.1	8.6	8.6	15.6	15.1	7.9

Note. These numbers represent weighted averages. The last column is the Canadian average.

Table B-2: Average weighted daily activity costs across provinces and territories

Activity	BC	AB	SK	MB	ON	QC	NB	PE	NS	NL	YT	NT	CA
Alpine skiing/snowboarding	79.1	63.3	128.9	95.1	75.5	50.8	71.9	32.6	98.0	159.0	65.1	209.5	72.9
Beach/non-motorized boating	57.0	43.9	49.8	36.4	41.4	33.1	33.6	24.3	37.3	60.2	47.5	66.1	41.8
Birding	23.5	33.9	55.7	65.5	27.6	16.2	24.1	22.3	22.5	17.9	30.2	150.0	26.9
Camping in tents	55.7	44.0	78.3	35.3	34.2	30.1	35.0	34.3	36.0	58.0	59.4	123.2	39.1
Cross-country skiing/snowshoeing	24.6	19.6	28.4	36.1	25.8	18.3	13.9	12.2	21.1	31.3	22.8	35.5	23.3
Cycling/mountain biking	22.2	25.6	23.7	14.4	21.2	13.9	17.1	17.8	23.2	48.7	26.4	33.0	20.3
Fishing	161.3	111.0	97.8	94.1	56.6	71.2	102.8	83.7	101.7	77.8	96.1	86.4	85.4
Gardening/landscaping	20.2	23.8	19.9	23.8	17.1	16.4	21.6	27.5	19.2	27.8	27.5	39.3	18.8
Golfing	76.0	69.2	70.0	60.8	47.9	40.5	57.6	43.8	57.3	59.0	65.3	71.2	54.0
Hiking/climbing/horseback riding	20.4	39.6	45.0	37.5	36.0	37.6	18.1	11.0	18.3	20.8	22.8	48.1	33.8
Hunting birds	139.1	153.6	140.7	106.6	76.1	110.4	81.9	112.4	396.7	80.0	118.1	170.7	113.6
Hunting large game	220.7	127.2	149.9	186.4	81.9	87.3	72.7	204.2	233.9	255.0	192.9	246.1	120.0
Hunting other	55.8	32.3	55.0	140.2	31.1	16.1	39.0	143.7	139.1	30.3	85.0	54.9	39.3
Hunting waterfowl	236.2	113.3	147.5	70.8	47.3	118.7	141.6	170.8	59.3	126.5	189.9	123.2	105.2
Motorized boating	119.6	136.3	121.6	93.9	62.6	63.8	98.5	56.6	67.6	116.3	148.6	148.4	83.3
Motorized land vehicles	184.3	96.6	97.7	53.2	56.1	55.1	89.9	79.7	74.6	71.7	163.8	133.2	80.4
Photography/filming nature	50.7	75.2	95.9	49.8	38.6	36.3	28.8	50.7	40.5	52.4	68.6	102.8	45.9

Note. These numbers represent weighted averages. The last column is the Canadian average.

Table B-3: Provincial and territorial recreation demand models parameter estimates (1/3)

	BC		Alberta		Yukon		NWT	
	mean	sd	mean	sd	mean	sd	mean	sd
Marginal utility parameters (β_k)								
Alpine skiing/snowboarding	1.79	(0.17)	1.13	(0.12)	1.20	(0.12)	-0.17	(0.38)
Beach/non-motorized boating	2.66	(0.15)	1.34	(0.10)	1.93	(0.11)	2.25	(0.30)
Birding	0.00	(fixed)	0.00	(fixed)	0.00	(fixed)	0.00	(fixed)
Camping in tents	1.69	(0.16)	1.08	(0.12)	1.81	(0.12)	1.80	(0.30)
Cross-country skiing/snowshoeing	0.26	(0.20)	-0.33	(0.12)	1.06	(0.12)	0.06	(0.29)
Cycling/mountain biking	1.16	(0.15)	0.88	(0.11)	1.14	(0.12)	0.65	(0.27)
Fishing	2.35	(0.16)	1.16	(0.12)	2.26	(0.13)	1.79	(0.29)
Gardening/landscaping	1.81	(0.17)	1.56	(0.12)	1.64	(0.13)	0.90	(0.32)
Golfing	1.64	(0.17)	1.29	(0.13)	0.64	(0.14)	0.36	(0.30)
Hiking/climbing/horseback riding	2.99	(0.20)	1.88	(0.14)	2.34	(0.20)	2.89	(0.35)
Hunting birds	0.01	(0.26)	0.67	(0.15)	0.85	(0.14)	0.42	(0.30)
Hunting large game	0.80	(0.25)	1.16	(0.13)	1.88	(0.13)	0.53	(0.33)
Hunting other	-2.28	(0.46)	-0.98	(0.16)	-0.46	(0.19)	-1.30	(0.33)
Hunting waterfowl	-0.09	(0.53)	0.81	(0.15)	-0.24	(0.26)	-0.10	(0.34)
Motorized boating	2.19	(0.16)	1.66	(0.11)	2.27	(0.12)	2.45	(0.28)
Motorized land vehicles	1.98	(0.18)	1.32	(0.11)	2.71	(0.11)	2.44	(0.27)
Photography/filming nature	1.97	(0.15)	1.42	(0.11)	1.63	(0.12)	1.92	(0.31)
Translation parameters (γ_k)								
Alpine skiing/snowboarding	4.23	(0.48)	2.48	(0.21)	4.14	(0.38)	2.32	(0.25)
Beach/non-motorized boating	4.33	(0.39)	2.48	(0.19)	3.96	(0.29)	2.34	(0.27)
Birding	15.99	(2.76)	5.80	(0.63)	18.00	(2.67)	9.70	(1.50)
Camping in tents	4.20	(0.33)	2.54	(0.18)	5.08	(0.35)	2.97	(0.30)
Cross-country skiing/snowshoeing	2.74	(0.30)	2.60	(0.20)	7.73	(0.66)	4.65	(0.45)
Cycling/mountain biking	11.74	(1.28)	4.69	(0.46)	10.61	(1.04)	6.22	(0.66)
Fishing	6.08	(0.78)	3.38	(0.27)	4.81	(0.44)	5.28	(0.46)
Gardening/landscaping	16.43	(1.74)	6.82	(0.66)	11.32	(1.04)	12.58	(1.40)
Golfing	5.12	(0.67)	3.17	(0.27)	4.79	(0.55)	3.96	(0.44)
Hiking/climbing/horseback riding	7.06	(0.89)	3.69	(0.37)	10.49	(1.22)	2.97	(0.52)
Hunting birds	4.71	(0.93)	3.52	(0.32)	2.95	(0.27)	2.66	(0.30)
Hunting large game	7.17	(1.44)	2.62	(0.36)	5.46	(0.43)	5.78	(0.63)
Hunting other	5.56	(1.57)	7.28	(0.76)	3.77	(0.59)	2.77	(0.39)
Hunting waterfowl	3.30	(1.08)	3.60	(0.36)	2.79	(0.41)	5.24	(0.72)
Motorized boating	3.96	(0.47)	2.57	(0.31)	5.85	(0.52)	4.45	(0.49)
Motorized land vehicles	8.65	(1.18)	5.25	(0.53)	7.97	(0.89)	7.48	(0.72)
Photography/filming nature	8.40	(1.02)	3.70	(0.31)	11.68	(1.07)	7.44	(0.86)
Satiation parameter (α_1)	0.94	(0.01)	0.88	(0.01)	0.86	(0.01)	0.85	(0.02)
Scale parameter (σ)	1.05	(0.07)	1.09	(0.06)	1.02	(0.06)	1.21	(0.07)
N	1184	-	2328	-	1538	-	966	-
LL	-29649	(498)	-57157	(1041)	-57126	(707)	-32274	(597)

Table B-3: Provincial and territorial recreation demand models parameter estimates (2/3)

	Saskatchewan		Manitoba		Ontario		Quebec	
	mean	sd	mean	sd	mean	sd	mean	sd
Marginal utility parameters (β_k)								
Alpine skiing/snowboarding	-0.60	(0.29)	-0.52	(0.28)	0.63	(0.11)	0.66	(0.12)
Beach/non-motorized boating	0.43	(0.26)	0.70	(0.20)	1.19	(0.08)	1.32	(0.10)
Birding	0.00	(fixed)	0.00	(fixed)	0.00	(fixed)	0.00	(fixed)
Camping in tents	0.42	(0.20)	-0.40	(0.22)	0.49	(0.09)	0.80	(0.11)
Cross-country skiing/snowshoeing	-1.40	(0.25)	-0.93	(0.21)	-0.36	(0.11)	0.01	(0.11)
Cycling/mountain biking	-0.68	(0.23)	0.02	(0.16)	0.41	(0.07)	0.92	(0.09)
Fishing	1.11	(0.18)	1.12	(0.18)	0.05	(0.09)	0.89	(0.12)
Gardening/landscaping	0.55	(0.23)	0.94	(0.19)	1.10	(0.07)	1.66	(0.11)
Golfing	0.30	(0.24)	0.32	(0.20)	0.70	(0.09)	0.46	(0.13)
Hiking/climbing/horseback riding	1.35	(0.21)	1.14	(0.23)	1.79	(0.08)	2.57	(0.11)
Hunting birds	0.16	(0.19)	-0.52	(0.23)	-0.71	(0.14)	-0.28	(0.18)
Hunting large game	1.02	(0.18)	0.58	(0.21)	-0.10	(0.13)	0.26	(0.16)
Hunting other	-0.76	(0.20)	-1.46	(0.32)	-1.43	(0.14)	-2.20	(0.19)
Hunting waterfowl	0.57	(0.21)	-0.45	(0.23)	-0.67	(0.13)	0.27	(0.18)
Motorized boating	1.68	(0.17)	0.94	(0.19)	0.89	(0.08)	0.88	(0.10)
Motorized land vehicles	1.50	(0.17)	0.47	(0.18)	0.65	(0.08)	1.32	(0.10)
Photography/filming nature	1.21	(0.18)	0.44	(0.18)	0.77	(0.07)	0.98	(0.10)
Translation parameters (γ_k)								
Alpine skiing/snowboarding	3.03	(0.37)	3.30	(0.44)	3.23	(0.19)	3.40	(0.27)
Beach/non-motorized boating	4.43	(0.50)	4.34	(0.38)	2.53	(0.14)	2.80	(0.17)
Birding	6.85	(1.03)	8.24	(1.52)	4.03	(0.31)	4.19	(0.39)
Camping in tents	3.56	(0.27)	7.15	(0.77)	2.56	(0.12)	2.89	(0.16)
Cross-country skiing/snowshoeing	4.07	(0.59)	3.40	(0.32)	3.15	(0.17)	3.17	(0.23)
Cycling/mountain biking	10.79	(1.24)	9.32	(0.91)	4.00	(0.26)	4.87	(0.41)
Fishing	4.24	(0.44)	3.77	(0.43)	4.12	(0.28)	3.23	(0.25)
Gardening/landscaping	13.93	(1.62)	9.54	(1.11)	4.90	(0.39)	5.18	(0.48)
Golfing	5.24	(0.63)	5.53	(0.62)	3.27	(0.19)	3.66	(0.29)
Hiking/climbing/horseback riding	5.73	(0.65)	5.74	(0.73)	2.50	(0.18)	3.27	(0.26)
Hunting birds	7.02	(0.68)	2.10	(0.20)	4.38	(0.33)	3.72	(0.36)
Hunting large game	8.94	(1.06)	7.72	(0.97)	4.98	(0.35)	5.68	(0.61)
Hunting other	4.72	(0.47)	11.54	(2.24)	13.00	(0.96)	10.15	(0.97)
Hunting waterfowl	10.20	(1.00)	4.21	(0.42)	4.55	(0.32)	3.36	(0.31)
Motorized boating	2.41	(0.24)	5.77	(0.71)	3.68	(0.24)	3.18	(0.24)
Motorized land vehicles	7.57	(0.75)	7.71	(0.90)	4.77	(0.34)	5.07	(0.47)
Photography/filming nature	5.29	(0.55)	6.32	(0.73)	3.36	(0.22)	3.06	(0.26)
Satiation parameter (α_1)	0.82	(0.02)	0.86	(0.02)	0.85	(0.01)	0.95	(0.01)
Scale parameter (σ)	1.18	(0.08)	1.16	(0.07)	1.11	(0.05)	1.20	(0.06)
N	1456	-	1126	-	5579	-	4011	-
LL	-40524	(790)	-27274	(673)	-145431	(1899)	-79871	(1221)

Table B-3: Provincial and territorial recreation demand models parameter estimates (3/3)

	New Brunswick		PEI		Nova Scotia		NFLD & Labrador	
	mean	sd	mean	sd	mean	sd	mean	sd
Marginal utility parameters (β_k)								
Alpine skiing/snowboarding	0.04	(0.17)	0.19	(0.31)	1.37	(0.24)	0.72	(0.27)
Beach/non-motorized boating	1.16	(0.12)	2.27	(0.23)	2.20	(0.19)	2.15	(0.14)
Birding	0.00	(fixed)	0.00	(fixed)	0.00	(fixed)	0.00	(fixed)
Camping in tents	0.38	(0.14)	1.08	(0.27)	1.05	(0.21)	0.97	(0.18)
Cross-country skiing/snowshoeing	-0.38	(0.12)	0.36	(0.25)	-0.28	(0.24)	0.46	(0.19)
Cycling/mountain biking	-0.25	(0.12)	0.87	(0.25)	0.52	(0.21)	0.40	(0.21)
Fishing	1.37	(0.12)	1.84	(0.27)	1.91	(0.21)	2.11	(0.14)
Gardening/landscaping	1.18	(0.12)	3.09	(0.23)	1.80	(0.19)	2.31	(0.15)
Golfing	0.29	(0.15)	1.77	(0.26)	1.14	(0.21)	0.83	(0.18)
Hiking/climbing/horseback riding	1.01	(0.15)	2.00	(0.24)	1.90	(0.23)	2.42	(0.18)
Hunting birds	0.44	(0.14)	0.59	(0.36)	1.12	(0.26)	-0.13	(0.23)
Hunting large game	0.69	(0.16)	-0.56	(0.55)	1.56	(0.23)	2.06	(0.15)
Hunting other	-1.39	(0.18)	-1.16	(0.45)	1.00	(0.25)	-0.57	(0.20)
Hunting waterfowl	0.88	(0.19)	1.41	(0.37)	-0.16	(0.35)	0.53	(0.26)
Motorized boating	1.04	(0.15)	1.16	(0.30)	1.65	(0.21)	1.87	(0.16)
Motorized land vehicles	1.75	(0.12)	1.61	(0.29)	1.27	(0.21)	1.88	(0.15)
Photography/filming nature	0.21	(0.11)	1.44	(0.25)	1.31	(0.21)	1.75	(0.16)
Translation parameters (γ_k)								
Alpine skiing/snowboarding	6.00	(0.79)	3.02	(0.42)	4.24	(0.45)	3.36	(0.48)
Beach/non-motorized boating	5.00	(0.39)	5.33	(0.54)	4.79	(0.52)	4.95	(0.42)
Birding	20.50	(2.63)	41.28	(5.78)	15.60	(2.58)	12.83	(2.06)
Camping in tents	4.78	(0.43)	3.37	(0.31)	3.87	(0.39)	4.36	(0.44)
Cross-country skiing/snowshoeing	6.46	(0.61)	4.53	(0.47)	4.26	(0.46)	5.97	(0.58)
Cycling/mountain biking	10.14	(1.10)	11.75	(1.38)	9.25	(1.29)	7.89	(0.96)
Fishing	5.12	(0.49)	6.44	(0.86)	5.46	(0.59)	4.25	(0.38)
Gardening/landscaping	11.76	(1.22)	11.76	(1.46)	9.48	(1.11)	8.99	(1.00)
Golfing	5.73	(0.56)	6.45	(1.00)	6.10	(0.75)	5.73	(0.67)
Hiking/climbing/horseback riding	9.32	(0.91)	14.73	(1.58)	9.64	(1.28)	10.77	(1.17)
Hunting birds	7.82	(0.80)	6.99	(1.04)	6.89	(0.81)	6.62	(1.01)
Hunting large game	5.51	(0.59)	4.89	(1.64)	7.88	(0.86)	6.04	(0.63)
Hunting other	20.87	(2.79)	7.21	(2.34)	12.95	(1.98)	9.15	(1.00)
Hunting waterfowl	13.58	(1.80)	10.19	(1.61)	9.23	(0.97)	7.37	(1.27)
Motorized boating	4.32	(0.42)	5.13	(0.86)	4.89	(0.53)	4.75	(0.55)
Motorized land vehicles	12.00	(1.06)	8.78	(1.48)	9.40	(1.10)	10.21	(1.21)
Photography/filming nature	11.34	(1.10)	8.06	(1.00)	6.95	(0.87)	7.34	(0.78)
Satiation parameter (α_1)	0.86	(0.01)	0.98	(0.02)	0.92	(0.02)	0.93	(0.01)
Scale parameter (σ)	0.95	(0.06)	1.03	(0.07)	1.04	(0.07)	1.08	(0.07)
N	1646	-	996	-	1688	-	1502	-
LL	-40839	(894)	-22977	(498)	-41250	(1055)	-36046	(720)