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Analysis of the economic benefits associated with the recovery of threatened marine mammal species in the Canadian St. Lawrence Estuary

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ABSTRACT

This paper examines Canadians' willingness to pay to recover the populations of three marine mammal species found in the St Lawrence Estuary. The valuation approach utilized a stated preference tool that is somewhat a hybrid between contingent valuation and a choice experiment with multiple species recovery program options and choices framed as referenda. Program options involved the use of a marine protected area and restrictions on whale watching and shipping industries. The estimated willingness to pay (WTP) for different levels of marine mammal recovery ranged from $77 to $229 per year per household and varied according to the species affected and the recovery program effort. A series of tests revealed that people would be willing to pay more for programs that contribute to greater increases in marine mammal populations, but the additional value of programs that improve a species status beyond the "at risk" threshold is relatively small.

1. Introduction

The Canadian Species at Risk Act (SARA) includes consideration of the "socioeconomic" costs and benefits of species recovery. In the action planning stage in particular, the act calls for "*an evaluation of the socioeconomic costs of the action plan and the benefits to be derived from its implementation*" [1]. In a practical sense this requires assessment of the economic benefits and costs of actions that might improve the status of species at risk. The costs of such actions may include direct costs of management, as well as opportunity costs (costs of restrictions on current economic activity for example). These types of costs are measurable by examining the impacts on markets and market based activities (fishing, etc.); however, the benefits of improvements in a species' status are more difficult to assess because of the non-market nature of their values.

In this paper we examine the benefits of improving the status of a select group of marine mammals in the St Lawrence Estuary located in the province of Quebec from their current levels (endangered, threatened, or special concern) to levels that include "not at risk". The Estuary is recognized as an area of critical importance for marine mammal species because of large concentrations of prey such as krill and capelin. Some marine mammal species are residents of the Estuary while others migrate there to feed and build energy reserves to prepare for the breeding season elsewhere. Scientists are concerned about the future of resident beluga whales (*Delphinapterus leucas)* and harbor seals (*Phoca vitulina*). Belugas in the estuary are officially listed by SARA as threatened. The eastern Canadian harbor seal population is considered officially not at risk; however, many experts consider it to be threatened in the Estuary due to its increasing rarity and because of the level of anthropogenic threats present in the area. The other marine mammal species found in the Estuary are seasonal visitors (five whale species, two seal species, one dolphin and one porpoise species). One of these species is the blue whale (*Balaenoptera musculus*), which is considered officially endangered by both the Canadian government and international scientific organizations.

The Department of Fisheries and Oceans Canada had identified the need to conduct an economic analysis of marine mammal protection options to help them make informed decisions regarding the management of these marine mammal species at risk and the possible establishment of a marine protected area. Thus, we conduct this analysis by evaluating the economic benefits of three marine protected area (MPA) options, as well as other management actions that could produce improvements in the species' populations. Our analysis describes an approach for conducting such economic assessments and highlights a number of key findings that arise in the economic valuation of species at risk.

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The contribution of this paper is, therefore, empirical (providing estimates of the value of improvements in the status of species at risk), conceptual (identifying key factors that affect values of species at risk) and methodological (providing insights into methods that can be used to evaluate the robustness of measures of value).

2. Passive-use values and their measurement with stated preference methods

There are two sets of reasons why people might value an increase in the number of seals, whales or dolphins: (1) the pleasure of observing them from the shore or via commercial whale watching activities or commercial hunting in some countries, and (2) a desire to bequeath environmental conditions or preserve options for future uses to one's heirs or future generations (bequest value) or a sense of stewardship or responsibility to preserve these species (existence value) [2]. The former category denotes what economists call *use/active-use values* (consumptive and non-consumptive uses), while the latter denotes what is called *passive-use/non-use value*. Because the recovery of marine mammals can only occur over a long period of time, active-use values are expected to occur far into the future, meaning that changes in active-use or use values for consumptive or non-consumptive uses are expected to be relatively small. The values associated with the recovery of marine mammals seem to be primarily of the passive-use type.

There are few studies in the literature that assess the passive-use values associated with threatened and endangered marine mammals [17,18]. Many of these studies were conducted more than 10 years ago and involved valuing the avoidance of the extinction of species such as otters, seals and whales. The economic values (US$2005) reported in those studies ranged from about $13.00/household/year for avoiding the loss of the Hawaiian monk seal (*Monachus schauinslandi*) to $128 for the humpback whale (*Megaptera novaeangliae*) [18]. All of these studies utilized an economic methodology called contingent valuation in determining these values. This method is used because passive-use values are generally unobservable in economic markets and thus their quantification involves the collection of stated preferences rather than observed preferences.

Stated preference methods range from asking respondents a single question about how much they would be willing to pay for a specific program (a basic "contingent valuation" method), to asking respondents multiple choice questions about programs that vary in attributes and costs (i.e., tax increases) to fund them (an attribute based stated preference method or "choice experiment"). Our approach, however, is somewhat of a hybrid that best fits the case of recovery programs for species at risk. We describe programs using attributes then frame each choice of program as a referendum in which respondents are offered two programs—the current situation in which a recovery program does not exist and a proposal for a new program. As such, our methodological approach is somewhere in-between a referendum contingent valuation task and a choice experiment with multiple program options and choices.

3. Methods and data

A stated preference (SP) instrument, usually in the form of a questionnaire, informs respondents about the current level of environmental quality by portraying it as a bundle of attributes, and then describes possible improvements in quality that could result from specific actions. Respondents are then asked to indicate if they support these improvements given various levels of direct costs to their household. Their responses provide information on the monetary tradeoffs they are willing to make for environmental improvements. In this Canadian case, environmental quality was assessed using changes in the level of recovery for each of the marine mammal species currently at risk of extinction in the Estuary. In order to appropriately assess how the various recovery plans might improve the status of marine mammals at risk, we required information on the current trajectories of decline in their populations and potential improvements in these trajectories if recovery programs were implemented.

3.1. Development of the questionnaire

The questionnaire used for this study was developed in several stages. First, a focus group with marine scientists was held to debate the various characteristics of possible recovery schemes and to estimate the potential trajectories of marine mammal populations with and without recovery programs [3]. Threats to the viability of various species were also discussed, as was information on the effects of recovery programs on various sectors of the regional economy. This focus group, in concert with an in-depth literature review and on-going discussions with the scientists, resulted in the development of a series of attributes and levels to describe different recovery program scenarios.

The 2006 SARA status of beluga whales, harbor seals and blue whales were the key factors or attributes that varied across the programs presented to respondents. The various risk categories used by the SARA are shown in Fig. 1. Other characteristics of the programs included the introduction of a marine protected area (MPA) and increases in restrictions to the shipping and whale watching industries. The marine scientists thought such restrictions were an integral program element to improve marine mammal population sizes since these industries can have negative impacts on marine mammals in the Estuary. For the current study, there were levels of hypothetical variation in the SARA status improvement for belugas, harbor seals and blue whales, in the geographic size of the proposed MPA, in the extent of restrictions applied to the shipping and whale watching industries, and finally in the possible cost of the recovery program.

One approach often used in SP studies is to present respondents with all possible combinations of the attributes and levels. In many cases, however, the number of combinations is quite large, burdening respondents with response fatigue from making such a large number of choice decisions. While experimental design procedures are usually employed to reduce this number, in our case, budgetary limitations and a desire to provide realistic choices (i.e., realistic combinations of ecological and regulatory outcomes) led us to develop six plausible program options to improve the status of marine mammals in the Estuary. Table 1 describes the current environmental situation and the six program scenarios created for this study (A through F). Each program affects the recovery of at least one marine mammal species, with

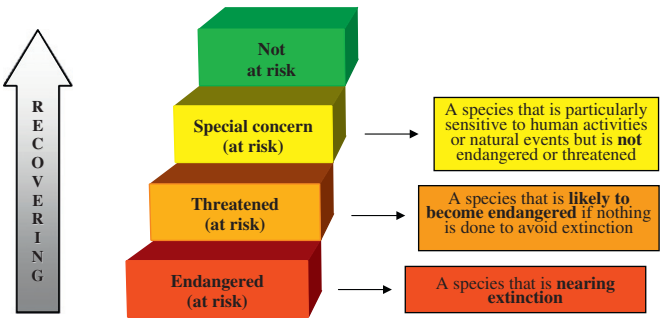

Fig. 1. Explanation used in our survey instrument to explain the different levels of risk identified by the Canadian Species at Risk Act.

Table 1
A summary of the current situation and the six hypothetical programs used in the stated preference survey Instrument[a].

Program	Species status			Size of marine protected area	Shipping and whale watching industry regulations
	Beluga whales	Harbor seals[b]	Blue whales		
Current situation	Threatened	Threatened	Endangered	MPA not present	Current
A	Threatened	Recovery to special concern	Endangered	Small	Minor increase
B	Recovery to special concern	Threatened	Endangered	Small	Minor increase
C	Recovery to special concern	Recovery to special concern	Endangered	Small	Minor increase
D	Recovery to not at risk	Threatened	Endangered	Small	Major increase
E	Recovery to not at risk	Recovery to not at risk.	Endangered	Small	Major increase
F	Recovery to not at risk	Recovery to not at risk	Recovery to threatened	Large	Major increase

[a] Note that for each program, a price attribute was described as an increase in the household's annual taxes. This cost was randomly assigned to each program for each respondent and held one of the following five values: $5, $15, $50, $100, and $350.

[b] The status of the harbor seal used in this study was not an official Species at Risk Act designation but one provided to us from marine scientists based on the low number of individual seals resident in the Estuary.

most programs affecting more than one species. The impacts of the programs on belugas ranged from none (remaining "threatened") to improving to either "special concern" or "not at risk". Effects on harbor seals ranged from none (remaining "threatened") to improvements to "special concern" or "not at risk". According to the marine scientists, only one of the programs could improve blue whale status from "endangered" to "threatened". The size of the MPA was portrayed as being either small or large. Additional restrictions on the shipping and whale watching industries were described as being either major or minor, while focusing on either harbor seals or belugas. These programs were designed in concert with marine scientists in an attempt to represent realistic levels of change required to achieve positive impacts on the recovery of these marine mammal populations.

Fig. 2 illustrates one of the six choice scenarios used in this study. Each SP question required respondents to assess their willingness to move the management of the Estuary from its current situation to a hypothetical state (i.e., implementation of one of the six recovery programs) by paying a fixed annual cost. This was done using a stylized referendum that asked respondents to consider two alternatives, where one was depicted as a future change in the "state-of-the-Estuary" from its current situation due to the introduction of a recovery plan (the program). Respondents then indicated if they would vote for that recovery plan given that it would have a specific negative impact on their household income.

One challenge in the design of SP questions is the definition of the payment mechanism for the cost or price of the proposed environmental change. Implementing the recovery programs in this present study had to be plausibly associated with economic costs. The use of taxes as a payment vehicle has properties that make it a credible mechanism for the collection of public funds.[1] However, for this study we chose two payment vehicles generated by each program. First, an additional annual cost to the household in the form of increased federal income taxes and second, increased prices for goods due to new restrictions on shipping. After extensive focus group and pilot surveys, the payment levels used in the survey were $5, $15, $50, $100 and $350. This range ensured that a large proportion of respondents would choose a lower cost program over the current situation, while the highest cost demand was curtailed with most respondents choosing the current situation. We evaluated this range of payments across all six programs before making the final decision regarding the cost distribution. Thus, each program presented to respondents was associated with one of the five cost levels. In each choice scenario presented to a given respondent the cost for the program was randomly drawn from a uniform distribution of these five levels.

A draft questionnaire was first reviewed and pre-tested in four focus groups (two in Quebec City and two in Edmonton), each involving randomly drawn samples of 12 citizens. Focus group members were asked to complete the questionnaire and then a discussion, led by two of the authors, was held to identify problems of clarity or comprehension. After incorporating suggested improvements, the questionnaire was pre-tested again by a random sample of 88 internet panelists from across Canada to identify any remaining problems of clarity and more importantly, to establish an appropriate range of monetary values to be presented to respondents as the payment required if they voted for each recovery program offered.

The final questionnaire had three parts. The first contained questions about attitudes toward the environment and awareness of the St. Lawrence Estuary. It also provided information about the Estuary and the ecological issues and problems faced by its permanent or seasonal (migrant) marine mammals. Illustrations, figures and diagrams were used to attract the respondent's attention towards the information and facilitate comprehension. For example, Fig. 1 along with suitable text was used in the survey instrument to explain that a species considered "endangered" under the Canadian Species at Risk Act is more likely to become extinct than a species that is "threatened" or of "special concern".

The second part of the questionnaire began by informing respondents about the potential benefits and costs of implementing a marine protected area. More detail on this component of the survey can be found in Olar et al. [3]. Next, five of the six choice scenarios were presented and respondents were asked to vote either for the current situation or for one of the proposed recovery programs (Table 1) with varying levels of restrictions on the shipping and whale watching industries and increased costs for the household. Every respondent was presented with programs A, B, C and F; half of the sample saw program D and the other half program E.[2]

[1] However, there are also drawbacks to the use of taxes as the payment vehicle, such as the risk of "nay-saying" (i.e., voting against the program as a protest against increased taxes because they judge the benefits of the recovery program to be unworthy of the cost).

[2] This distribution of choice scenarios among respondents was the result of budgetary limitations. Focus group testing suggested that answering six choice scenarios was taxing for respondents. Hence we used five and allocated two of the six recovery program scenarios in a split sample manner.

	CURRENT situation Expected levels in 50 years	**PROPOSED program** Expected levels in 50 years
St. Lawrence Belugas	**THREATENED** 1,000 Belugas	**THREATENED** 1,000 Belugas
St. Lawrence Harbour Seals (*No official status yet. Hypothetical status based on the low number of individuals.)	**THREATENED*** 1,000 Harbour Seals	**SPECIAL CONCERN*** At least 2,500 harbour seals
Atlantic Blue Whales	**ENDANGERED** 250 Blue Whales	**ENDANGERED** 250 Blue Whales
MPA size	**NO MPA**	**SMALL MPA**
Regulations on SHIPPING and WHALE WATCHING	**CURRENT REGULATIONS**	**Additional** minor restrictions focused on **harbour seals** that might: • Reduce jobs • Reduce tourism revenues • Increase the cost of goods shipped in the St. Lawrence seaway
ADDITIONAL annual cost to your household in: ♦ **Federal Income Taxes** ♦ **Increased Prices for Goods**	**$0**	**Each respondent randomly received one of the following prices: $5, $15, $50, $100, $350**

Fig. 2. An example of a choice set depicting the current situation in the St. Lawrence Estuary and potential outcomes from introducing one of our hypothetical recovery programs.

The third and final part of the questionnaire gathered the respondent's socio-demographic characteristics, such as age, gender, education, income and participation in environmental organizations and outdoor recreational activities.

3.2. Reduction of hypothetical bias and yea-saying

An important issue in SP surveys is hypothetical bias, which arises in willingness to pay due to the use of a hypothetical valuation format. In the valuation of passive-use, such as endangered species, one cannot avoid the use of hypothetical valuation questions. However, recent research has provided techniques to minimize this bias. The first technique we employed was to include a brief "cheap talk" script. Cheap talk scripts reveal to the respondents the hypothetical nature of the trade-off votes, but remind them to consider these tasks as real votes. Our "cheap talk" text attempted to portray the survey voting exercise as being "consequential" with real policy implications and monetary repercussions. The use of these scripts has been shown to generate responses in hypothetical surveys that more closely reflect actual market or payment transactions (e.g. [4]), thus effectively reducing hypothetical bias [5,6]. The script we used can be found in [3].

A second procedure that helps to adjust for the presence of hypothetical bias was the use of certainty scales. After each vote, respondents were asked to rate how certain they were that the choice they made would be the same as if has been an actual referendum. Respondents could choose: very certain, somewhat certain, somewhat uncertain or very uncertain. The responses were used to transform uncertain votes into votes against the proposed program. Thus, all *very uncertain* and *somewhat uncertain* YES votes were changed to NO votes. Research has shown that the recoded choices are more similar to actual market transactions than the original uncertain choices (see [7,8]). The major implication of this recoding is the reduction of the willingness to pay estimates and thus the generation of more conservative measures of economic values.

Another technique used in SP surveys as a means to reduce hypothetical bias is "yea-saying". This refers to a respondent's tendency to vote "yes" for a recovery program without seriously considering the costs. They may vote for a proposed program because of their desire to fulfill some accepted sense of social obligation or to please the survey administrator. To minimize yea-saying, respondents were requested to seriously take into consideration the additional annual cost to their household implied by these programs. A portion of the script in this section was:

> *"It is very important that you "vote" as if this were a real vote. You need to imagine that you actually have to dig into your household budget and pay the additional costs."*

3.3. Questionnaire administration

The survey was administered to a random sample of an existing Internet panel maintained by Ipsos Reid (a national polling company) because this format allowed us to provide respondents with color maps, graphics and immediate links to other Internet web pages that provide additional information on the species and recovery options. Color maps and graphics were especially important for informing respondents about existing conservation areas and marine mammal population levels in the Estuary. Coding and data entry errors are also eliminated by internet panel surveys. While there are questions about the representative nature of internet panels, the panel maintained by Ipsos Reid has over 100,000 members and the firm actively maintains a membership that closely matches a set of socioeconomic characteristics present in the Canadian general public as well as in certain regions. All panel members must be internet users, which are an increasing proportion of the Canadian public [9]. In 2007, 73% of Canadians accessed the internet; an increase from 68% in 2005. Of this proportion, 94% used the internet from home, which was also a requirement for being an Ipsos Reid panelist.

3.4. Econometric analyses and estimation of economic values

In each SP task respondents chose either a program or the current situation and in so doing revealed their preference for the program attributes. These preferences are determined by estimating parameters which represent "taste or importance weights"

on the various attributes associated with the alternatives. Probabilistic choice models are used to estimate these weights.

Economic theory posits that when people make choices they maximize utility. We modeled this using random utility theory and specified utility as a linear function of the program attributes and the respondents' characteristics and income. For a given respondent j this linear utility function for program i can be written as

$$u_i = \alpha + \beta Z_i + \gamma S_j + \delta(y_j - C_i) + \varepsilon$$

where u indicates the indirect utility for program i, Z is a vector of program attributes, S is a vector of household characteristics of respondent j, y represents j's income and C is the cost of program i. Random utility theory assumes that an individual's utility has elements that are unknown to the researcher and this randomness is captured by the error term ε_i, which appears because the researcher cannot know all of the factors influencing the respondent's utility. The constant, α, represents the level of utility of the "base" program. The term γS reflects the impact of the respondent's characteristics on the utility from choosing a program (relative to choosing no program). The δ coefficient measures the utility respondents derive from one more dollar of income (the marginal utility of income). This coefficient is considered constant across programs because it is unlikely that different programs pose a substantial change in respondents' appreciation of income. The β terms represent the coefficients for the marginal utilities of the programs, relative to the base program.

When a respondent chooses between the current situation and a proposed program she/he compares the two utilities and votes for the proposed program if it provides higher utility; for program $i=1$ and current situation $i=0$ this is expressed as $u_1 - u_0 \geq 0$. Otherwise she/he chooses the current situation; and hence $u_1 - u_0 < 0$. Due to the binary nature of this choice, logit or probit econometric models are typically employed to estimate coefficients and assess their impact on the probability of a vote for the proposed program. The dependent variable holds a value of "1" if the vote is for the proposed program or "0" if it is for the current situation.

To generate estimates of the willingness to pay for a recovery program, let u_{1j} indicate the utility of respondent j when proposed program i is implemented and u_{0j} the level of utility associated with the current situation. To simplify, we suppose that utility depends only on income and a program summarized by θ_i. Willingness to pay is the sum of money that will be taken away from respondent j after program i has been implemented in order to keep her utility at the same level as the current situation. Thus $u_1(y - WTP_j, \theta_1) = u_0(y, \theta_0)$, and substituting the linear indirect utility function form into this expression yields $\alpha_1 + \delta(y_j - WTP_j) + \varepsilon_{1j} = \alpha_0 + \delta y_j + \varepsilon_{0j}$ and thus $WTP_j = (\alpha_1 - \alpha_0)/\delta + (\varepsilon_{1j} - \varepsilon_{0j})/\delta$. Assuming the difference in error means is equal to 0 and normalizing the utility of the current situation to zero ($\alpha_0 = 0$), yields the following expression: $E(WTP) = \alpha_1/\delta$.

4. Results and discussion

4.1. Survey administration and general findings

Data were collected from a sample of Ipsos Reid panel members in April 2006. The percentage of responses from this sample was 52%. The final dataset contained responses from 2006 Canadians; however, in order to examine regional differences, the province of Quebec was over-sampled by 400 respondents. The data were subsequently split into two datasets. The first, comprised of 1606 respondents, including a representative sample of 367 respondents from Quebec, is representative of all Canadians. The second was comprised of 767 respondents from Quebec, including the 367 Quebecers in the Canadian sample plus the additional 400 Quebec respondents. The margin of error was $\pm 2.5\%$ for the Canadian sample and $\pm 3.5\%$ for the Quebec sample with a confidence interval of 95%. Except for tests of regional differences, results reported in this paper come from the first data bank representing all Canadians.

Table 2 shows that the two datasets are representative of the Canadian and Quebec populations in terms of three key characteristics: level of education, gender distribution and household income. The percentage of women in the two samples is almost identical to the percentages in the two populations. Median yearly household income and education levels beyond high school were both slightly higher among respondents in our samples than in the two general populations. In addition, the Canadian sample was representative of the Canadian population in terms of the distribution of provincial residence (see [3]). While our sample appears quite representative in terms of the observable characteristics reported, we cannot guarantee that the responses are representative over all characteristics.

The percentage of respondents claiming to have seen whales, seals or other marine mammals in nature, outside aquariums, is 55% in the Canadian sample (see Table 3). While this percentage seems high, the percentage of respondents in landlocked provinces (e.g. Ontario, Saskatchewan, Manitoba and Alberta), who claimed to have observed marine mammals in nature is substantially lower than in provinces with marine coastal areas (e.g. Quebec, Newfoundland, British Columbia, New Brunswick, Nova Scotia and Prince Edward Island). It is plausible that approximately 45–52% of Canadians living in landlocked provinces traveled to

Table 2
Comparison of several socio-demographic characteristics in our 2006 national and Quebec samples with the 2005 Canadian census data.

Characteristic	Canada		Quebec	
	N	Census	*N*	Census
Number of respondents	1606		767	
Female (%)	49.8	49.0[a]	50.6	50.9[b]
Median household income ($1000)	60–70	58.1	55–60	54.4[c]
Married (%)	52.7	–	40.3	–
Educated beyond high school (%)	58.7	57.6[c]	59.8	58.6
Average household size	2.9	–	2.8	–
Children 17 and under in house (%)	30.6	–	27.2	–
Average age (years)	47	–	45	–
Members of ENGO (%)	3.4	–	2.2	–

[a] Computed with data provided by Statistics Canada, CANSIM, tables 051-0001 and 051-00011.
[b] Computed with data provided by Statistics Canada, CANSIM, table 111-0009.
[c] Computed with data provided by Statistics Canada, CANSIM, tables 282-0003 and 051-00011.

Table 3
Percentage of respondents ($N=1606$) by province that claimed to have observed marine mammals in natural settings.

Province	Percent observed
Newfoundland & Labrador	87
British Columbia	78
Nova Scotia	73
Prince Edward Island	71
New Brunswick	60
Quebec	56
Alberta	52
Manitoba	50
Saskatchewan	49
Ontario	45
Canada	55

observe marine mammals in their natural habitats, but it is also plausible that those that have seen marine mammals in nature may have been more highly motivated to complete the questionnaire. If this were true, there may be a sample selection bias in our data. Unfortunately, we were unable to correct for possible bias because we have no data from the 48% of sampled internet panelists who did not respond to the invitation to participate in the survey.

4.2. Econometric analysis

In order to estimate the willingness to pay for St. Lawrence Estuary marine mammal recovery programs and their attributes, we developed several econometric models based on a linear expression for the underlying utility function explained above. Additional annual costs to the household and age were treated as quantitative (continuous) variables, while the recovery programs, education, participation in environmental organizations, Quebec residency, gender and regulations on shipping and whale watching are modeled as dummy variables. Household income was collected on an ordinal scale, which we converted to a continuous variable using the midpoints of 16 income categories.

Table 4 provides econometric results for three probit models. The first includes data from only the first vote of each respondent. The second model includes information from all five votes and the third introduces some respondent characteristics. The standard binary probit model treats each vote as an independent observation; however, in this case each respondent provided five votes. This can result in biased standard errors of the coefficients [10]. Thus, the econometric approach employed for the latter two models utilized a random effects error component structure. This separates the error term into two independent components. The first represents an unobservable characteristic which is specific to each individual (i.e., it does not vary across the five votes), and the second is a component that varies among individuals and across the five choice observations from each individual.

The majority of independent variables in the models is statistically significant at the 5% or 10% level. Across all models, the coefficient associated with the price variable is negative and statistically significant at the 1% level confirming prior expectations that the probability of voting for a recovery program decreases as the annual household cost for supporting that program increases.

The first and second models analyze the probability of choosing each program relative to program A (i.e., after accounting for the constant, the implied coefficient of program A is 0, such that other programs are assessed relative to this program). The most appreciated program appeared to be program F because it had the highest dummy variable coefficient among all the program dummies. The popularity of program F was followed, in decreasing order of importance, by programs C, E, D, B and A. The levels of significance of the coefficients were generally lower for the first probit model in Table 4 since it only considered the first vote of each respondent.

The third model in Table 4 includes the respondents' socio-demographic characteristics (e.g. age, gender, household income, education and residence in Quebec). Age, college education and household income had positive influences on the probability of voting for the proposed programs, although age was not statistically significant. Membership in an environmental organization also had a positive impact on the willingness to recover marine species at risk. Quebec respondents were less likely to vote favorably toward recovery of the St. Lawrence Estuary marine mammals than respondents from the remaining provinces. Women also had a lower propensity to vote for marine species recovery programs than men, although the parameter was not statistically significant.

4.3. Willingness to pay estimates

Parameters from the first two probit models in Table 4 were used to produce the WTP estimates presented in Table 5. Standard deviations of these estimates were derived using a procedure developed by Krinsky and Robb [11], which involved estimating WTP for 10,000 random draws of parameters from a multivariate normal distribution where the parameter vector represented the mean and the parameter covariance matrix the variances. The resulting estimates for the first vote data were characterized by high variances relative to the pooled votes. This suggests that respondents found it difficult or confusing to respond to their first choice scenario. We therefore find these estimates to be too "noisy" to generate reliable welfare measures. All further discussions will

Table 4
Parameter estimates (SE) for binary probit models assessing the importance of various factors that affect the probability of voting for a marine mammal recovery program.

	Probit	Random effects probit	
	First votes only	All votes pooled	
		Model 1	Model 2
Constant	0.284** (0.086)	0.389** (0.057)	0.048 (0.175)
Tax increase	−0.001** (0.0003)	−0.005** (0.0002)	−0.005** (0.0002)
Program B	0.019 (0.107)	0.171** (0.060)	0.165** (0.061)
Program C	0.258** (0.110)	0.538** (0.058)	0.530** (0.058)
Program D	0.216* (0.122)	0.213** (0.075)	0.215** (0.076)
Program E	0.247** (0.125)	0.656** (0.074)	0.652** (0.075)
Program F	0.329** (0.108)	0.764** (0.056)	0.765** (0.057)
Age	–		0.004 (0.003)
College degree or higher	–		0.223** (0.088)
Member of ENGO	–		0.478* (0.258)
Quebec residence	–		−0.265** (0.099)
Female	–		−0.077 (0.081)
Household income	–		0.002** (0.001)
ρ		0.669** (0.014)	0.659** (0015)
Pseudo R^2	0.023	0.176	0.171
Log likelihood	−1041.29	−4259.43	−4207.19
Number of votes	1606	8030	7965
Number of individuals	1606	1606	

* Significant at 10% or better.
** Significant at 5% or better.

Table 5
Estimates of Canadian households' mean willingness to pay (WTP) for marine mammal recovery programs in the St Lawrence Estuary.

Program	Mean $WTP/Household/yr (SD)[a]		National annual $WTP aggregated over all households[b]
	First vote only	All votes pooled	
Program A: *Harbor seal* recovery from threatened to special concern.	197.85 (61.24)	77.37 (10.94)	962 million
Program B: *Beluga* recovery from threatened to special concern.	211.03 (53.84)	111.46 (11.07)	1386 million
Program C: *Beluga & harbor seal* recovery from threatened to special concern.	379.23 (76.21)	184.21 (11.28)	2291 million
Program D: *Beluga* recovery from threatened to not at risk.	349.10 (80.78)	119.68 (14.50)	1489 million
Program E: *Beluga & harbor seal* recovery from threatened to not at risk.	372.36 (86.30)	207.88 (14.49)	2586 million
Program F: *Beluga & harbor seal* recovery from threatened to not at risk and *blue whale* recovery from endangered to threatened.	429.49 (78.94)	229.17 (11.50)	2850 million

[a] Reported in 2006 Canadian dollars.
[b] National estimates calculated using the "all votes pooled" model and the 2006 Canadian census of 12,437,470 households [14]. Variances of the willingness to pay measures were calculated using 5000 draws of the covariance matrix using the methods proposed by [11].

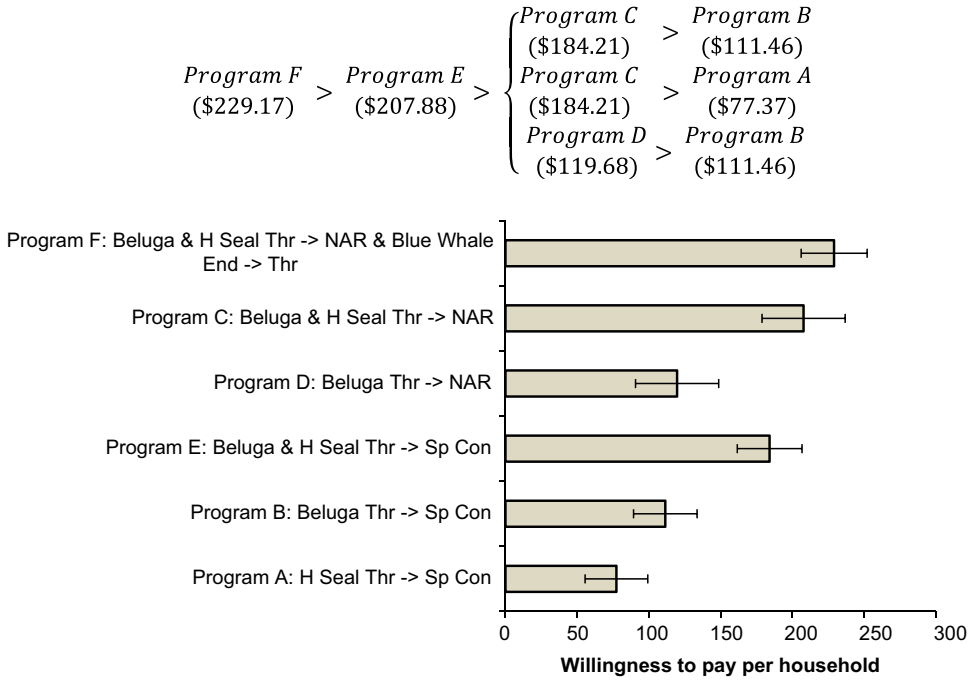

Fig. 3. Ranking of the willingness to pay ($CAN 2006) for recovery programs implied by the level of improvements in marine mammal populations in the St. Lawrence Estuary (top panel) and mean WTP $\pm$ 2 SD from the "all votes pooled" model in Table 5 (bottom panel).

focus on the WTP estimates from the random effects probit model, which used all five votes from each respondent.

The highest valued recovery program was program F ($229.17/household), which had the largest MPA size and major restrictions on whale watching and shipping, but offered the greatest improvement in population numbers for all of the threatened marine mammal species in the estuary. This indicates that our Canadian respondents were willing to incur annual costs of $229 per household to improve the risk status of harbor seals and belugas from "threatened" to "not at risk", and that of blue whales from "endangered" to "threatened" regardless of negative consequences for the industries in the area.

The least preferred program was program A ($77.37/household), which proposed a small MPA with minor restrictions on shipping and whale watching and only offered improvement in the status of harbor seals. Hence, the willingness to pay for marine mammal recovery programs in the St. Lawrence Estuary ranged from about $77/yr to $229/yr per household, and depended on the species affected and the magnitude of restrictions on industry and MPA size.

To assess the validity of these WTP measures, we examined whether respondents were willing to pay more for increasing levels of improvements in the marine mammal populations. The top panel of Fig. 3 displays, in decreasing order, the hypothesized rankings of WTP for programs as implied by the level of environmental improvements each could allegedly achieve if implemented.[3] The bottom panel of Fig. 3, in histogram form, presents the estimated mean WTP values with error bars representing two standard deviations above and below the mean. It is clear that the three programs (F, E and C) purporting to improve the status of multiple species achieved higher mean WTP. Though there was no significant difference between the means for programs F and E and for programs E and C, the mean WTP for these three programs is significantly different from the means for programs D, B and A.

[3] Ideally the WTP for each program should be calculated using only the first vote because this choice would not be affected by information or responses from previous votes. However, as explained above, these estimates are characterized by high variances (see Table 5) and may not be reliable indicators of WTP values for each program.

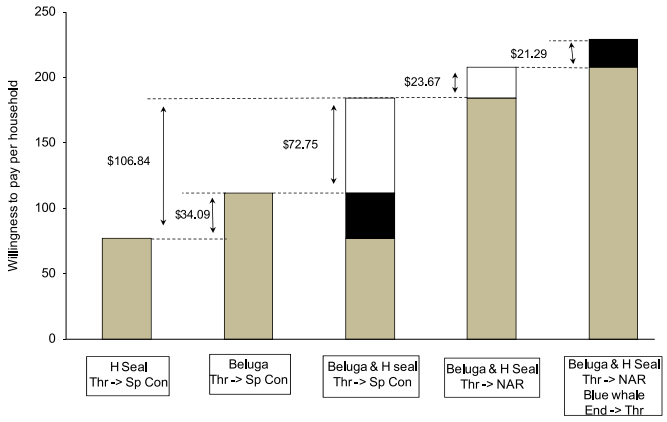

Fig. 4. Marginal increase in the individual household annual willingness to pay ($CAN 2006) for a recovery program expanded to include additional species or recovery measures.

While not all a priori hypotheses were verified, these comparisons do suggest that respondents were sensitive to the scope of environmental improvements in terms of the variety of species affected and, to a lesser extent, the level of status improvement within species.

An important observation arising from this analysis is that the WTP for some initial improvement in the marine mammal populations was quite high, while the WTP additional costs for recovering a given species from an initial improvement on up to the "not at risk" status was lower. Fig. 4 illustrates the decreasing nature of these marginal WTP estimates. It can be seen that our respondents were willing to pay $184.21 for program C, which would improve the status of the beluga and harbor seal populations to "special concern" (only one step better than their current "threatened" status). In contrast, respondents were only willing to pay an additional $23.67 for program E (Fig. 4), which would fully recover these two species up to the "not at risk" status. This suggests a non-linear valuation function over marine mammal species recovery programs. The Canadians we surveyed were committed to ensuring that species are not "threatened", but our results suggest that they are not willing to pay a great deal more for full recovery into the "not at risk" status. This result confirms findings from previous studies regarding the decreasing nature of the marginal WTP for environmental improvements: initial environmental improvements are valued more than subsequent improvements [12,13]. Our respondents appeared to use a cost-minimizing approach to achieve some acceptable threshold level of environmental improvement. This puts considerable weight on the need for accuracy in the scientific assessment of the thresholds and the risk levels associated with those thresholds.

Estimates of the Canadian population's total annual willingness to pay for the various programs were calculated by multiplying the per household mean WTP estimates for the pooled vote model by the most recent estimated number of households in Canada (12,437,470 households) [14]. Aggregate willingness to pay ranged from $962 to $2850 million, depending on the magnitude of the expected recovery (Table 5). Canadians thus appear to place a very high value on the recovery of marine mammals in the St. Lawrence Estuary.

4.4. Regional variations in willingness to pay

Results from the second random effects probit model in Table 4 indicate that Quebec residents were less likely to vote in favor of recovering marine mammals in the St. Lawrence Estuary than those living in the rest of Canada. The parameter associated with Quebec residence is -0.265, which suggests that on average, Quebecers' WTP was $53 less than the WTP among other Canadians for any program ($-0.265/-0.005$). This difference probably arises from province-specific economic, demographic and cultural differences.

A likelihood ratio test of the hypothesis that Quebecers voted differently than Canadians residing in other provinces for marine mammal recovery programs in the St. Lawrence Estuary confirmed that the value provided by residents of Quebec is significantly higher than that from the rest of the country. We then examined if the difference in willingness to pay might be due to protest votes. We hypothesized that Quebec residents rejected the recovery programs not because they do not value the recovery of marine mammals, but because they may think that taxes are too high. Since our questionnaire contained a question asking whether respondents supported reducing Canadian taxes, we were able to test this hypothesis by eliminating all respondents who declared that taxes should be reduced. However, our findings remained unchanged—Quebec residents were still willing to pay less than residents of the rest of Canada.

We were also able to verify if the difference in WTP might be due to another form of nay-saying: voting against all proposed programs because the scenarios were considered unrealistic. Since the questionnaire had specifically asked respondents if they had voted to keep the current situation because they thought the programs could not generate the postulated improvements, we were able to control for this type of nay-saying by removing respondents who selected this answer. Again, the results remained unchanged. Finally, we eliminated respondents who exhibited *both* of these nay-saying characteristics, but the differences between WTP estimates from Quebec and the rest of Canada persisted.

Within the province of Quebec, we used the larger Quebec sample ($N=767$) to test whether respondents' WTP varied as a function of the distance between their place of residence and the St. Lawrence Estuary by grouping Quebec respondents into 3 categories: those living within a 200 km radius of Tadoussac (the most popular site for whale watching in the Estuary), those living between 200 and 400 km from Tadoussac and those living at least 400 km away. The results indicated no differences in WTP estimates among respondents inside Quebec. This is in contrast to other studies (e.g. [15]), which found that passive-use value declines with increasing distance between where one lives and where the environmental improvement would take place.

5. Summary and conclusions

To the best of our knowledge, this paper presents the first estimates of the economic values associated with the recovery of marine mammal populations in Canada. The results are useful inputs into the cost-benefit analysis of species at-risk recovery programs as required by Canadian legislation. In this empirical case, proposed recovery programs involved the establishment of an MPA in Canadian waters with collateral changes in regulations on shipping and whale watching industries.

Tests of scope suggest that the WTP estimates are credible. Respondents appeared to have paid attention to votes, understood the scenarios, and, as a consequence, acted as expected: they voted more often in favor of programs that offered higher protection for marine mammals in the St. Lawrence Estuary. The average individual WTP for different recovery programs ranged from $77 to $229 annually per household with a standard error ranging from $11 to about $14 (in 2006 $). This suggests that Canadians would collectively be willing to fund marine mammal recovery programs that improve the status of their current at-risk populations in the Estuary by $962–$2,850 million annually.

It is important to highlight that while the WTP for protection measures that might recover marine mammals from their present at-risk status to the next level were quite high, the WTP for additional recovery beyond this level (i.e. elimination of the risk of extinction) was quite small. This finding has considerable policy relevance for the appraisal of optimal recovery programs or the assessment of recovery programs that provide the highest net benefits for species at risk. In this case, recovery programs that provided benefits above the threshold of "threatened" were not highly valued, suggesting that approaches that minimize the cost of achieving this threshold are most desirable from an economic efficiency standpoint.

This study also explored regional differences in passive-use value estimates. We found that Canadian respondents living outside the province of Quebec were willing to pay more for the recovery of St. Lawrence marine mammals than residents within the province of Quebec. This difference is most likely explained by province-specific economic, demographic and cultural differences, rather than by distance from the St. Lawrence Estuary. In fact, within the province of Quebec, WTP for marine mammal recovery did not vary significantly with increasing distance between a Quebecer's place of residence and the St. Lawrence Estuary.

Budget and time constraints precluded exploration of additional scenarios, as well as further tests of reliability of the voting data and resulting WTP estimates. In addition, detailed analysis of the cost effectiveness of alternative recovery programs and analysis of the distributional impacts of recovery plan options, would be useful information to policy makers when choosing recovery program options. As with all stated preference valuation exercises, there are concerns about the extent to which the values elicited would correspond to an actual referendum or allocation decision if the marine protected areas and other recovery program elements were implemented. While significant effort was exerted to make the survey *consequential* (as suggested by Carson and Groves [16]) and to check for robustness, these issues remain important areas for further research. This initial investigation of the passive-use values associated with marine protected areas and marine mammal population status does provide significant insights into the economic importance of programs to ensure that the risk of extinction of these species is reduced.

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