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Lyssenko, Nikita and Martinez-Espineira, Roberto

Memorial University of Newfundland

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Nikita Lyssenko
Department of Economics, Memorial University of Newfoundland
St. John's, NL Canada. A1C 5S7
Tel:1-709-737-2149
Fax: 1-709-737-2094
E-mail: nlysenko@mun.ca

and

Roberto Martínez-Espiñeira*
Department of Economics, St. Francis Xavier University
PO Box 5000
Antigonish B2G2W5, Nova Scotia, Canada
Tel: 1-902-867-5433
Fax: 1-902-867-3610
E-mail: rmespi@stfx.ca.

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*Corresponding Author: Economics, St. Francis Xavier University, PO Box 5000, Antigonish B2G2W5, Nova Scotia, Canada. Tel: 1-902-867-5433, Fax: 1-902-867-3610. E-mail: rmespi@stfx.ca.

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Abstract

In this paper we investigate the issue of respondent uncertainty in contingent valuation studies while estimating the willingness to pay for a whale conservation program off the coasts of Newfoundland and Labrador. We use data from a phone survey administered to a sample (N=614) of adult Canadians, proposing a policy consisting of subsidizing and enforcing the use of acoustic devices that would reduce the likelihood that whales become entangled in fishing nets. A follow-up question asked respondents how certain they were about their answer to the main dichotomous-choice question, which allows us to investigate how the treatment of uncertainty affects value measures. A mean willingness to pay of about \$81/year per respondent is estimated when accounting for the degree of certainty with which respondents expressed their willingness to pay. We also analyze payment vehicle effects using a split-sample approach whereby some respondents were asked a dichotomous-choice question about a tax contribution while others were asked about a voluntary donation instead.

Keywords: contingent valuation, whales, preference uncertainty, dichotomous choice, payment vehicle, willingness to pay

JEL CODES: Q21, Q26, Q51, Q57

1 Introduction

Nature-based tourism is a fundamental driver of the viability of many coastal communities and, given the importance of whale-watching, whale conservation is a key ingredient in the policies that promote tourism in the coastal provinces of Canada. However, the economic cost of preserving whales is not negligible. For example, some types of whale conservation efforts consist of restricting the activities of the fishing industry. The efficient management of whales involves a balance of relevant social benefits and social costs, so the benefits from preserving these iconic marine mammals must be somehow estimated. Some benefits are relatively easy to quantify but others require eliciting values which are not or are only imperfectly reflected by market prices. In particular, what environmental economists refer to as the existence value of a resource is not reflected in market prices.

The main objective of this study is to explore the effects of addressing respondent uncertainty in contingent valuation. Our application deals with the estimation of the willingness to pay for a whale conservation program in Newfoundland and Labrador. During a phone survey administered to a sample (N=614) of adult Canadians, respondents were presented with a scenario based on a policy consisting of subsidizing and enforcing the use of acoustic devices aimed at reducing the likelihood of whales becoming entangled in fishing nets. The survey included a follow-up question that asked respondents how sure they were about their answer to the main dichotomous-choice payment question. This allows us to investigate how the treatment of uncertainty affects value measures. Additional follow-up questions allow us to determine which responses were protest responses rather than conventional no-responses.

An estimated mean willingness to pay of $81/year results from accounting for the degree of certainty in the responses to the willingness to pay question. However, we find that the magnitude and precision of this estimate is affected by the degree of certainty with which the valuation question was answered.

In order to analyze payment vehicle effects, a split-sample approach was adopted whereby about half of the respondents were asked a dichotomous-choice question about their willingness to support the policy through a tax contribution while the rest were asked about their willingness to support it through a voluntary donation. We also analyze the effects of previous experience with the good valued (through whale-watching) and of option values.

In the next section, we describe the main issues surrounding whale conservation and offer a brief historical background on whale harvesting in Newfoundland and Labrador. In Section 3, we present a brief outline of the Contingent Valuation Method followed by the methodology of the survey and the data collection procedures in Section 4. The econometric and estimation issues are dealt with in Section 5. The data description and the choice of variables for the estimated model appear in Section 5.3. Section 6 includes the discussion of estimation results, followed by the conclusions.

2 Whale conservation in Newfoundland and Labrador

About seventeen species of cetaceans can be observed in Newfoundland and Labrador waters (Lien et al., 1985; Kinze, 2001). These include both baleen whales (blue, fin, sei, northern right, bowhead, humpback, minke, killer whale) and tooth whales (sperm, narwal, pothead, beluga). The most abundant species in these waters is the humpback whale. In fact, Newfoundland and Labrador has the largest population of humpback whales in the northwest Atlantic.

Whales were already hunted in ancient times, but in small numbers and mostly along the shores. The era of commercial whaling in the North Atlantic began around 1300, when the Basques founded fisheries that used small boats and harpoons to hunt for whales in coastal waters off the Basque Country (Kinze 2001). Coastal hunting developed into whaling out at sea and the Basques began pursuing the whales all the way to North America. In 1530 they founded the first whaling station in North America in Red Bay, Labrador (Kinze, 2001; Ledwell 2005). American, English, and Norwegian whalers came to Newfoundland and Labrador only in late 1800s.

Technological progress allowed whalers to pursue and kill the whales that had previously been either too fast or too large to hunt. Once one species became commercially extinct, whalers turned their attention to the other areas and species (Corbelli, 2006). By 1905 in Newfoundland Labrador there were 18 whaling stations in operation (Lien et al. 1985). During the last fifty years of commercial hunting of blue whales in the western north Atlantic, beginning in 1898, processing stations landed 1,446 blue whales. There were also 1,414 humpback killed Newfoundland and Labrador waters, which represented around seven per-cent of the total catch.

Unrestricted whaling and the overexploitation of populations became a concern at the international level starting in the late 1920s, with the first international agreement that protected whales coming into effect in 1937. In 1946, the International Whaling Commission was set up. The Commission established certain whale hunting limitations and protected areas and in 1982 decided to end commercial whaling operations by the end of 1984-1985 season. Nowadays cetaceans are also protected by means of national regulatory acts, such as Marine Mammal Regulations under the Fishery Act (Canada), the Marine Mammal Protection Act (USA), or the Whale Protection Act (Australia).

Due to these efforts some species have shown signs of recovery from overexploitation by humans. However, there are still species which populations are of great concern, in particular northern right whales, some populations of bowhead whales, western gray whales and many blue whale populations (Clapham et al. 1999). In Canada, species like the northern right whale and the Atlantic blue whale were designated by Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as endangered. The Atlantic population of fin whales have the status of special concern (COSEWIC, 2005). In contrast, humpback whales (Atlantic population) no longer have the status of "special concern" and are considered "not at risk" species, while its north Pacific population still has a status of "threatened".

As commercial hunting over the world was prohibited in 1982, the era of direct exploitation of whales nearly came to its end. However, this form of exploitation was soon replaced by an indirect, non-lethal utilization, such as whale-watching. Humpback whales are the main target for whale-watching in Newfoundland, mainly because this species has a predictable timing of migration. This is because humpbacks come to Newfoundland to feed on capelin and herring (Ledwell, 2005) and they are commonly seen in late Spring, Summer and Fall. Hoyt (2001) and Corbelli (2006) offer an account of the substantial and increasing importance of this form of tourism in Newfoundland

and Labrador.

Whale watching activities provide a non-lethal, alternative way of utilization of cetaceans by humans and thus contributes to conservation efforts. However, as the whale-watching industry expanded and attracted more participants, biologists started to raise concerns about the impacts of whale-watching on the cetaceans. Whale watching usually takes place in the areas where whales breed, nurse, and feed. During these activities, animals become particularly sensitive to disturbance (Garrod and Fennell, 2004).

Other impacts of humans on cetaceans include collision with ships, by-catch (entanglement), habitat loss and degradation, climate change, pollution, noise from industrial activity (Corbelli, 2006, p. 6). Together, these represent a substantial threat to the marine environment. It is difficult to estimate the importance of each of these threats, since situation and threats vary according to the species. However, the agreement is that at the population level entanglements and ship strikes may be the most significant. Recent research demonstrates that the incidental catch of cetaceans in fishing gear and ship strikes are the major sources of non-natural mortality in many species of marine mammals and present a serious threat to the survival of many species around the world (Perrin et al., 1994; Clapham et al. 1999; Hartley et al. 2003; Ledwell, 2005).

Although small cetaceans, such as harbor porpoise and dolphins, are the ones most often involved in entanglements, it is also a common problem for large whales: finback, humpback, and right whales (Volgenau et al., 1995). A study of the North Atlantic population of humpbacks in the Gulf of Maine found that more than half of the humpback whale population had been entangled, whereas the 71.9% of the right whale population had been entangled at least once (Johnson et al., 2005). The authors argue that the registered cases of entanglement of right whales are in fact just a fraction of the total number of entanglements that take place. These estimates are in line with the numbers provided by other researchers. For example, Volgenau et al. (1995) report that around 60% of western North Atlantic right whales have scars and marks as a result of contact with fishing gear. According to Johnson (2005), 88% of all humpbacks have scars due to the same reason and 15% of right whales and humpbacks in the western Atlantic become entrapped each year.

Humpback and minke whales are the two species most often involved in entanglements around Newfoundland, but not the only ones. Between 1978 and 2004, approximately 1,300 humpbacks were reported entrapped (Ledwell, 2005). The number of reported entanglements in fishing gear off Newfoundland from 2000 through 2002 ranged from 11 to 22 each year, with known mortalities ranging from only zero to five per year (Ledwell et al. 2000; Ledwell and Huntington, 2001, 2002). It was found that cod traps were responsible for the most entanglements and mortalities of humpback whales in Newfoundland and Labrador (Volgenau et al., 1995). However, the nature of the Newfoundland fishing industry has changed since the collapse of the groundfish fisheries in the early 1990s. Fishing effort in Newfoundland has recently shifted offshore and it is likely that entanglements in offshore areas are not reported as frequently as entanglements in inshore areas, so the total number of animals entangled (and killed) each year is likely greater than suggested by the above references (COSEWIC, 2003). Based on data from a 2005 phone survey of fishermen in Newfoundland, the estimated number of large whales caught in fishing gear and not reported in Newfoundland waters was 140, while there were only two cases of entanglement of large whales in inshore sector reported (Ledwell and Huntington, 2006).

This threat to whales could be alleviated through a variety of measures including continued disentanglement efforts, gear modifications, seasonal closures for fisheries, and various restrictions on commercial shipping (Knowlton and Kraus, 2001, Johnson et al., 2005). However, regulations aimed at protecting the whales by restricting economic activity can have a substantial economic impact on some communities (Cognetti, 1995; Johnson, 2005). Entanglement has been found to be partially a acoustic problem, since whales cannot detect the fishing nets acoustically (Todd, 1994). Therefore, sound devices (pingers) installed on the nets could be an practical alternative to rigorous regulatory measures. (Kastelein et al., 2007; Johnson et al., 2005). These devices must not be heard by fish, but only whales. Some of these devices were developed by Jon Lien at Memorial University (Kraus, 1999) and have helped to greatly reduced large whale entrapment in fish traps in Canadian waters.

3 The contingent valuation method

The most commonly used stated-preference method to estimate non-consumptive values is the Contingent Valuation Method (CVM). This technique consists of directly asking individuals to state the value they place on a proposed policy involving a change in the quantity or quality of a certain resource (e. g. Freeman, 1993). Cummings et al. (1986) and Mitchell and Carson (1989) provide early descriptions of this method and surveys of empirical results, while Arrow et al. (1993) assessed the CVM and recommended research protocols to improve its performance. Their conclusions became very influential, although the consensus about them is far from complete (e.g., Diamond and Hausman, 1994; Hanemann, 1994).

The dichotomous choice format is also one of the most popular ways to pose contingent valuation questions, due mostly to its purported advantages for avoiding many of the biases affecting other value elicitation formats. In the simplest version of this format, individuals are asked to either accept or reject only one bid as payment for the hypothetical policy. By varying the price (or *bid*) in different subsamples, the researcher can derive the demand curve and estimate the mean willingness to pay (Hanemann, 1984). The hypothetical dichotomous choice question is often presented to the respondent in terms of a vote on a referendum, in order to increase the realism of the payment scenario. In this study we use a dichotomous choice format based on willingness to pay through either a *tax* (for a subsample of respondents) or a *donation* (for the rest) for a conservation program to protect whales from entanglement.

3.1 Previous studies on the valuation of whales

Several works have addressed the valuation of whales, usually in relation with whale-watching activities. One example is Loomis et al. (2000), who restrict their analysis to use values by adopting the travel cost method. In their paper they address the issue of multi-purpose trips and find that the estimated values from whale watching primary-purpose trips using the standard travel cost method and using the simple generalized travel cost method model are identical at $43 per person per day and not significantly different from the value obtained from a generalized model that distinguishes between joint and incidental trips ($50/day). To the extent that non-use values derived from whales can be substantial, these measures of daily benefits from whales would be underestimating the total value of the resource.

Samples et al. (1986) estimated values of Humpback Whales. Their estimates range from $36.33 to $57.06 depending on the assumptions and the model estimated. Another early CVM study estimated the mean annual willingness to pay (WTP) by Californians for eastern Pacific whale conservation to be US$ 26.98 per year (Hageman, 1985). Loomis and Larson (1994) estimated the values of Gray Whale Populations in the same region using stated preference methods too. Using data from Loomis and Larson (1994), Larson and Shaikh (2003) estimated the demand for gray whales and calculated consumer surplus for three whale-watching sites on the California Coast. Willingness to pay estimates ranged from US$ 79 to US$ 360 per person depending on trip type and location. Note, however, that even though these studies used contingent valuation methods, they mainly focused on use values of whales for whale-watchers. Loomis and White (1996) report that the average WTP per year of all studies for gray whales was $26 and the average lump sum WTP for humpback whales was $173. More recently, Bulte and Van Kooten (1999) studied the case of minke whales in the Northeast Atlantic Ocean. We are not aware of any valuation studies of whales in Canadian waters, with the exception of Duffus and Dearden (1993) who examined killer whales on Canadian Pacific Coast.

3.2 Uncertainty in Contingent Valuation Studies

Traditionally, Contingent Valuation (CV) studies implicitly assumed that the respondents were able to come up with responses to the valuation question that reflected their valuation of the good and that they were fully certain about these responses.[1] However, this assumption has been challenged with increasing frequency. A primary concern affecting the CVM is that respondents have little or no previous experience in providing valuation responses about usually unfamiliar goods. Another concern is the single-shot nature of most valuation exercises in hypothetical markets and that individual preferences may be highly uncertain (Crocker et al., 1998; Berrens et al., 2002).

[1] This subsection borrows substantially from the recent surveys of the issue contained in Shaikh et al. (2007) and Akter et al. (2008).

The effect of uncertainty on contingent valuation estimates has been discussed in the literature at both a theoretical and an empirical level. Shaikh et al. (2007), for example, identify several sources of respondent uncertainty. Uncertainty in the responses could be related to uncertainty about the public good or policy valued. Respondents may be uncertain about what they are being asked to value, since they often will have no experience with the good or service proposed. Additionally, the value an individual assigns to the non-market good or service valued is affected by prices of both substitutes and complements, if they even exist, and markets for these goods may behave in ways that are unpredictable to the individual (Wang, 1997). Uncertainty can also originate with the questionnaire used. The CVM contributes to potential measurement error, because it uses hypothetical scenarios (Loomis and Ekstrand, 1998). Apart from the hypothetical nature of the exercise, respondents may simply be unable to make a trade-off between the good or service proposed and their money. Finally, respondents may not understand the policy proposed and the way in which it would be implemented, perhaps being hesitant about the policy instrument, the agency in charge of effecting the policy, etc.

A variety of strategies have been proposed to deal with respondents' uncertainty (see, for example, Shaikh et al., 2007) about their answers to contingent valuation questions. One approach to addressing concerns about the effects of uncertainty behind the responses in CV studies consists of allowing respondents to express the degree of certainty of their valuation responses. In fact, most CVM practitioners address the issue of uncertainty in empirical applications using follow-up questions about the uncertainty itself. Li and Mattson (1995), for example, asked their respondents how certain or confident they were of their previous 'yes'/'no' answer. Similar strategies were employed by Champ et al. (1997); Blumenschein et al. (1998); Johannesson et al. (1998); Loomis and Ekstrand (1998); Ekstrand and Loomis (1998); and van Kooten et al. (2001). However, Ready et al. (1995), Wang (1997), Welsh and Poe (1998), Ready et al. (2001), and Alberini et al. (2003) embedded information about respondent uncertainty directly in the response options offered to the respondents, instead of using a conventional dichotomous question.

Shaikh et al. (2007) compare five econometric methods to the handling of respondent uncertainty within a random utility framework, together with the fuzzy method proposed by van

Kooten et al. (2001). The first of the methods reviewed is the weighted Likelihood Function Model (WLFM). Li and Mattson (1995) used a follow-up question to their valuation question about preservation value of forests in northern Sweden to construct a post-decisional confidence rating. The follow-up question asked about respondent's certainty on a scale ranging from 0% to 100% (in 5% intervals). The resulting certainty percentages were used to weight the individual dichotomous-choice responses directly in the likelihood function, but only after certainty responses were recoded so that, for example, a 'yes' ('no') response with 40% certainty was recoded to a 'no' ('yes') response with 60% certainty. A 'yes' or 'no' with 100% certainty results in the standard dichotomous-choice model with certainty.

Alternatively, Champ et al. (1997) incorporated the information from the certainty follow-up response using what Loomis and Ekstrand (1998) labeled an Asymmetric Uncertainty Model (ASUM). Using a scale ranging from 1 (very uncertain) to 10 (very certain), they elicited responses to the follow-up rating question: "How certain are you that you would donate the requested amount [in the valuation question]?" The asymmetry of the approach has to do with the fact that Champ et al. (1997) recoded all 'yes' responses as a 'no' if the respondent was not completely certain. Similarly, Ready et al. (2001) posed their WTP question with following choices: (1) 'almost certainly yes' (95% sure 'yes'), (2) 'most likely yes', (3) 'equally likely yes and no', (4) 'more likely no', and (5) 'almost certainly no' (95% sure 'no'), and then recoded responses so that only an 'almost certainly yes' (choice 1) was treated as a 'yes'. This ASUM would be most appropriate if respondents answering 'no' are quite certain they would not pay, but those answering 'yes' are more uncertain about their response. Shaikh et al. (2007) found evidence of the validity of this assumption in the case of estimating the willingness to accept a tree planting program data.

Loomis and Ekstrand (1998) proposed instead a Symmetric Uncertainty Model (SUM) that preserves the initial 'yes' or 'no' response to the dichotomous-choice question. They also obtain a certainty scale of 1 to 10 from a follow-up question, but in this case the recoding converts the dichotomous-choice dependent variable into a 'continuous' variable taking on values over the closed interval [0, 1] and then adapt their econometric specification to the continuous nature of this newly constructed variable using a maximum-likelihood procedure. A 'no' response with certainty of 10 takes on the usual value of 0, while a 'yes' with perfect certainty equals 1. If a 'yes' or 'no' answer to the dichotomous-choice valuation question has an associated certainty of 50% or less, it is assigned a value of 0.5. A 'yes' response with certainty level greater than 50% takes the value associated with that certainty level (for example a 'yes' response with a follow-up certainty response of 60% is coded as 0.6). For a 'no' response with certainty level greater than 50%, the dependent variable takes on the value of 100% minus the certainty level (for example, a 'no' response with certainty of 60% is coded as 0.4).

Note that these methods based on a stated degree of certainty in the response or numerical certainty scales (NCS), in the terminology of Akter et al. (2008), rely on two stringent assumptions (Loomis and Ekstrand, 1998). First, it is assumed that the respondents can estimate accurately their own degree of certainty when answering the valuation question. Second, all respondents are assumed to interpret the certainty scale equivalently. The main reason for measuring preference uncertainty in contingent valuation studies is that respondents are uncertain about their valuation of the proposed policy, so assuming that respondents are certain about their levels of confidence on their first response seems contradictory (Akter et al., 2008). A less stringent assumption would be to expect respondents to be able to indicate a certainty range instead of a point estimate (Akter et al., 2008). The second assumption of comparability of the rating scales across individuals is also dubious, as it has been observed that respondents show 'scale preference' in which some individuals tend to be low raters or high raters (Roe et al., 1996).

Yet another way to approach the issue of respondent uncertainty is to assume, as in Wang (1997), that the value the respondent attaches to the valued policy is a random variable with an unspecified probability distribution. Thus each respondent would part from an implicit distribution of values rather than a single true value. Respondents would say 'yes' to a particular bid for a proposed policy only if the latent compensating surplus (CS) is larger enough than the proposed bid, would answer 'no' if the latent CS is smaller enough', and 'don't know' (DK) if their latent CS lies in a 'grey area' in between. It should be noted that in this case, the valuation question permits a DK response, so no follow-up question is needed to elicit the uncertainty of the response.[2] The

[2] In our analysis below, however, we used both DK responses and a follow-up question.

main difference between both approaches is that the multiple-bounded discrete choice (MBDC) approach incorporates the certainty correction directly into the discrete choice question, while the follow-up question method is an *ex post* adjustment to the dichotomous-choice response (Vossler et al., 2003). Wang (1997) econometric approach to handling the three types of response is equivalent to an ordered probit model. Wang also considered treating the DKs as 'no' responses, similar to the approaches of Ready et al. (2001) and Champ et al. (1997) and the one we follow ourselves below, and also by deleting them from the sample. They found that the estimated willingness to pay would be significantly lower when all DKs were recoded as 'no' responses, not surprisingly.

One obvious way to generalize this approach is to use, as in Welsh and Poe (1998), Alberini et al. (2003), and Broberg and Brännlund (2008), a MBDC type of valuation question that directly incorporates certainty levels through a two-dimensional decision matrix: one dimension would measure dollar amounts that individuals would be required to pay for the proposed policy and the second would measure the individuals level of voting certainty via several response options (for example 'definitely no', 'probably no', 'not sure', and 'definitely yes'). Separate willingness to pay functions for each certainty level can be estimated from these data using a random-effects probit model. Vossler et al. (2003) used data from a field validity comparison of hypothetical and actual participation decisions in a green electricity pricing program to compare this MBDC approach with the previously described one based on a follow-up question. They found that both methods estimated hypothetical participation rates that closely corresponded with actual participation rates.

One problem associated with the use of MBDC format is that it might generate higher rates of 'Yes' responses because the respondent (Ready et al., 1995) can give an affirmative response, without making a strong commitment. The MBDC format might also lead to false uncertainty, because it provides respondents with an inducement to leave unresolved their lack of confidence in answering the valuation question (Alberini et al., 2003). Finally, Samnaliev et al. (2006) suggest that adding a 'Not Sure' option to a basic dichotomous-choice question may be used as a tool to identify the 'yea-sayers', since these may tend to select this option rather than a 'yes' answer if given the extra choice. Additionally, this format could be affected by a type of 'framing effect', since the meaning of the terms that are used to elicit respondent uncertainty could be interpreted differently by different respondents (Hanley et al., in press). For example, respondents might not interpret in the same way the distinction between 'Probably Yes' and 'Maybe Yes'. These issues represent an open area of research (Evans et al., 2003; Boman, 2008).

Finally, van Kooten et al. (2001) also assume, like Wang (1997), that respondents do not have a precise value for the policy and that they will never know it with certainty. Instead, they only know the level above which they will certainly reject the proposed payment and the level below which they will certainly accept it. In between these levels, respondent preferences are ambiguous, so respondents' willingness to pay (WTP) and willingness not to pay (WNTP) are regarded as fuzzy sets. In other words, rather than assuming that respondents know the distribution of the true value, but not the precise value itself, Kooten et al. (2001) assumed that consumer surplus can simultaneously belong to both the WTP and WNTP fuzzy sets. Kooten et al. (2001) use follow-up information about how confident or certain the respondent is about her response to the valuation question to estimate both WTP and WNTP fuzzy membership functions. They applied this approach based on fuzzy theory to the same dataset used by Li and Mattson (1995), estimating a much lower willingness to pay than what these authors had estimated using the Weighted Likelihood Function Model described above. Further, Sun and van Kooten (2008) find that measures of willingness to accept and willingness to pay measures they obtain using the fuzzy approach are well below those yielded by standard probability methods.

Loomis and Loureiro (2008) propose using a finite mixture model to deal with response uncertainty in responses, in a recent unpublished work about the Prestige oil spill off the coasts of Spain. Another novel approach has to do with the notion of 'coherent arbitrariness'. For example, Hanley et al. (2008) examine whether respondents would prefer to state a range of values instead of a point estimate, because they are unsure about the value they place on the proposed policy. They focus on a parametric explanation of the determinants of the "value gap" between the most respondents are sure they would pay for a policy, and the smallest amount they are sure they would not pay. They also present a straightforward way to calculate aggregate willingness to pay from data on the range of willingness to pay expressed through a payment ladder. A similar approach was used by Flachaire and Hollard (2007) with their *range* model, who show, using the Exxon

Valdez survey,[3] that, when uncertain, individuals tend to answer "yes".

Only a few authors have attempted to establish a causal relationship between the identified levels of uncertainty in contingent valuation studies and theoretically and intuitively expected independent variables. As Akter et al. (2008) point out, no explicit theoretical model to explain uncertainty has been emerged yet, but there is general agreement about some hypotheses tested by Loomis and Ekstrand (1998). Hypotheses about the causes of uncertainty about values include a lack of knowledge about the good to be valued, insufficient interest, inability to make a quick decision, the presence of substitute and complement goods, the survey instrument and the respondents' lack of understanding about the contingency in question (Shaikh et al., 2007).

Three empirical tests of some of these expected effects are now available. Loomis and Ekstrand (1998) find a quadratic relationship between self-reported preference uncertainty and bid levels, so, as intuition would suggest, as respondents are more certain of their responses about proposed bids that are either very low or very high. Loomis and Ekstrand also find a positive effect on stated uncertainty scores and both respondents' previous knowledge about the particular endangered species and respondents having visited the area proposed for protection in their survey. Champ and Bishop (2001) and Samnaliev et al. (2006) did not find, however, similar empirical evidence. They instead suggest that stated uncertainty scores reflect respondents' attitudes towards the hypothetical market scenario (being a form of protest response). Champ and Bishop (2001) found that those who liked the idea of a wind-generated electricity program and agreed that the policy was worth the extra cost reported higher certainty levels. Similarly, Samnaliev et al. (2006) found that those who in principle objected to imposing user fees on private access to public lands were more certain in rejecting the bid levels. Thus the empirical evidence is not only scarce but also far from conclusive.

Another key aspect of the research on the issue of respondent uncertainty in contingent valuation studies is that there appears to be substantial empirical evidence (Champ et al., 1997; Ethier et al., 2000) to support the claim (Champ and Bishop, 2001) that the information on preference uncertainty obtained from follow-up questions provides a tool against hypothetical bias too (Akter

[3] See Carson et al. (2003) for details about the Exxon Valdez contingent valuation survey.

at al., 2008), since those who express lower levels of certainty about their hypothetical responses tend to be those responsible for most of the hypothetical bias. Other studies considered this issue using the MBDC format instead (Johannesson et al., 1998; Blumenschein et al., 1998 and 2001; Vossler et al., 2003). However, the empirical evidence is not strong enough to allow us to hope that information on certainty will help completely remove hypothetical bias.

4 Data collection

The 29-question survey (whose full text is available upon request) was administered in French and English to adult Canadians by a professional survey research company. It covered 10 Canadian provinces. The number of calls in each province was proportional to the province's population. Pre-testing involved the administration of the questionnaire to a small sample of Anglophone and Francophone subjects in order to determine its plausibility and understandability and to find out whether the range of bids suggested as payments for the dichotomous-choice valuation question were appropriate.[4] The final response rate was about 23% and the final sample consists of 614 useable observations, although some of these contained some missing values. The observations were weighted according to a set of sampling weights, based on age bracket and gender shares, provided by the surveying firm in order to improve the representativeness of the results. In any event, this paper is mainly about comparing the estimation of willingness to pay when correcting for uncertainty with the estimation made with no correction. Therefore, the results do not hinge on the representativeness of the sample and we make no strong claims of whether the sample estimates could be generalized to population levels.

There were two versions of survey, one that used donations to environmental organization as payment vehicle and another that suggested tax increase instead. The final sample includes 311 donation observations and 313 tax ones.

First, the respondents heard a brief explanation about the reason of the call and were asked for their consent to continue with the interview.[5] Next, a series of general questions regarding attitudes

[4] The questionnaires were approved by Interdisciplinary Committee on Ethics in Human Research at Memorial University.

[5] To ensure randomness, only the person in a household who had the nearest birthday was interviewed. A series

to the environment, whale-watching experiences, and travel to or affinity with Newfoundland and Labrador were asked. After that, respondents heard a brief description of a hypothetical whale conservation policy. The conservation policy proposed was simple and plausible, based on imposing and subsidizing the use of acoustic alarms to prevent whales from becoming entangled in fishing gear. Respondents were then asked about their willingness to support the policy through a dichotomous-choice question. More precisely, respondents were asked to agree or disagree with a specified amount of annual donation to environmental fund or annual tax increase, depending on the survey version, to be paid for following five years. The proposed amount value (or *bid*) of donation or tax increase was randomly assigned among respondents. Bid values included $15, $30, $45, $60, $75, and $100. This bid vector was designed using guidance from related contingent valuation literature and refined after analysis of the pretest data.

The final section of the survey included several socio-economic questions (age, income, education, etc.). Following common practice, however, some questions (e.g. age, income), due to their sensitive nature, offered respondents the option to place themselves in a given interval, rather than providing a point estimate.

In the final sample, 46% of the respondents were male and 54% were female. Respondents were asked to volunteer their age or at least their age bracket. In total 45 people refused to provide a point estimate of their age, and among them, six further refused to indicate the corresponding age interval. Sixty percent of respondents were between 35 and 64 years old. The average age of those who provided the point estimate was 47 years. The average age of males was 46.0 years and the average age of females was 47.5 years. As it is usually the case in this type of surveys, a proportion (22% in our case) of respondents refused to provide the income interval. Around 40% of the respondents indicated the income of less than $50,000 CAN in 2007. The income between $50,000 and $70,000 was mentioned by about 20% of participants. Approximately 30% indicated the income above $90,000 per year. When it comes to education, 11% of respondents indicated that they had never completed high school, 21% are high school graduates, 22 % completed college or trade school program. There were 23% university graduates and eight percent indicated that

of age and gender quotas were also pursued.

their education level is higher than bachelor's degree.

The respondents were asked about the number of people in a household under 18 years of age (a variable we labelled *under18*) and the size of the town where they currently resided. Over 30% of respondents lived in towns with population greater than 100,000 people. Another 30% stated that their towns had fewer than 5,000 inhabitants. The provinces of Quebec and Ontario together represent more than 60% of all respondents. For the purpose of the further analysis we distinguish between provinces that have a coastal line with either Atlantic or Pacific Ocean ("coastal" provinces) and other ("non-coastal" provinces). Altogether, the respondents from coastal provinces represent 21% of the sample.

We asked respondents whether they were the members of any environmental organization *such as Greenpeace or the World Wildlife Fund*. Eleven per cent (66 respondents) confirmed the membership, while 9% of all respondents in the sample hunt and 33% fish, seven percent participate in both activities.

We thought it would be useful, in order to evaluate the experience with the resource and the awareness of the policy issue, to ask respondents if they lived in, used to live in Newfoundland and Labrador, ever visited that province, or had never been there. Those who visited at some point or used to live in Newfoundland and Labrador were asked when they visited the province last. Also, those who visited or used to live in the province were asked about the main reason of the most recent visit. In the sample, 75% of respondents had never been to the province 20% visited the province and 2.3% used to live there.

More than a third (38%) of respondents participated in whale-watching activities at some point in time, while 17% of them did in Newfoundland and Labrador in particular. About 90% of those who participated in whale-watching activities either enjoyed more than expected or as much than expected. The respondents were also asked if they were going to participate in whale-watching activities within next five years. Twenty percent of respondents had such plans and 34% answered that there was a possibility of such activity. Among those who had whale-watching experience already, 30% were planning to do it again within next five years and 40% considered the possibility of doing it again. About half of those who had no whale-watching experience stated that they might have plans to participate in such activity within next five years. Almost equal proportions of males and females have definite plans to participate in this activity within the next five years: 47% and 46% respectively.

After a brief explanation of the entrapment problem and the possible way of solving it (by means of installing the net alarms), respondents were asked if they had heard about the problem before. The respondents were also asked (YES or NO) if they thought that something ought to be done to prevent whales from entrapment. About 72% of respondents had heard about the entanglement problem and 99% of those who had heard believed that something had to be done to prevent whales from entrapment. Also 91% of those who had not heard about the issue thought that the problem needed to be addressed.

As mentioned above, the survey had two versions: donation version and tax version. In both versions respondents first heard about the anti-entrapment program that aimed to reduce number of entrapments from 100 to around [10, 20, or 40 randomly assigned] for five years. In the case of the donation version the funds to support such program would come from individual voluntary donations to a private environmental organization. In the case of the tax version the funds to support the program would come from an increase in taxes.

Then the following question was posed:

- Donation version: "Would you be willing to donate $[15, 30, 45, 60, 75, or 100 randomly assigned] per year for the next five years to support the program?"

- Tax version: "Would you be willing to support this program if the extra taxes your household had to pay were $[15, 30, 45, 60, 75, or 100 randomly assigned] per year for the next five years?"

In both cases, the possible answers were: YES, NO, and DON'T KNOW. These answers were coded as variable *agree* with the value one for a YES and the value zero for a NO or a DON'T KNOW.[6] Table 1 provides the distribution of responses.

[INSERT TABLE 1 ABOUT HERE]

[6] As the bulk of the literature suggests (e. g. Bateman et al., 2002).

Whether the answer was 'Yes' or 'No', respondents were asked to rank their confidence in their previous answer on a scale from 1 (not sure at all) to 10 (very sure). This variable was rescaled down into variable *hown*.

If the answer was 'No', the respondent was asked to provide the reasons behind that answer. Overall 119 people provided an explanation to their 'No' response in the tax version. In the donation scenario we received 172 explanations.[7] Table 2 illustrates the distribution of reasons for not paying in both donation and tax versions.

[INSERT TABLE 2 ABOUT HERE]

Under the donation scenario six people have named three reasons for not donating, twenty two people used two reasons and 144 individuals provided one reason. In the tax version one person provided four reasons for not paying extra taxes, five people named three reasons, nineteen people provided two reasons and 94 individuals named one reason.

Contingent valuation studies pay close attention to the treatment of negative responses (e.g. Haab and McConnell, 2002). In particular, for the purpose of finding an unbiased estimate of willingness to pay to preserve a species in question, the literature recommends identifying protest responses. Inclusion of protest responses may threat the validity of the final estimate, since such responses do not indicate the respondents' true values of the good in question. The usual way to distinguish between true zero willingness to pay (a "legitimate" no response) and a protest response is to ask about the reason for such response. Follow-up questions were designed to determine the nature of negative response and assign the relevant category. For instance, respondents who mentioned reasons 1, 3a-6, 8-11 (see Table 2) as their reasons for not paying the specified amount are considered as protesters. In total we received 291 'No' responses in tax and donation scenario. Among these we have identified 100 protest responses. The distribution of protest responses is provided in Table 3. This shows that 43% of the 'no' responses under the tax version were deemed protest responses, while under the donation version the corresponding percent is about 29. This reflects the fact that, as usual, payment vehicles based on taxation face more opposition than those

[7] Two respondents who had refused the offered bid suggested, when asked about their reasons to refuse, that they would have been willing to pay a lower amount. Therefore those respondents information was recoded with a "yes" and an appropriately adjusted bid, based on this additional information.

based on donations.

[INSERT TABLE 3 ABOUT HERE]

5 Econometric Methods

5.1 Treatment of missing data

As it often occurs in CV studies we faced some problems of item non-response in our dataset. Five variables presented missing values: *income, age, age group, education*, and the number of people *under 18* in a household. We decided to use multivariate imputation techniques to handle these missing values, rather than simply discarding the incomplete observations. In order to impute the missing values for the variables we followed the approach developed by Royston (2004, 2005a, 2005b). In particular, we conducted an imputation based on an interchained equations algorithm.

The actual implementation of this approach to imputation of missing values was done using STATA by means of two programs: *uvis* and *ice*.[8] The *uvis* program imputes the values for a single variable only. If more than one variable has missing values then the program has to be called a number of times by the *ice* program to impute the values for all variables. In the *uvis* program all values of a particular variable that are missing are filled randomly. Then the program runs a regression of the variable that has missing values (using the appropriate regression model) on the set variables that do not have missing values (predictors). Using the results of this regression, the missing values are imputed by prediction matching. If there is more than one variable that has missing values, the ice command calls *uvis* again. During this process, as variables have some of their values imputed they become predictors in the following regressions. This completes the first cycle. The cycle is then repeated a specified number of times and the whole process is then repeated m times, creating m datasets. The datasets can then be analyzed separately, leading to a single output for each set. Alternatively, each data set can be analyzed separately and the results are combined into a single output. The results reported below are based on the latter approach.

[8] See Royston (2008).

To impute the values for our dataset we first assume that the missing variables are missing at random. For instance, this assumption implies that we do not expect that respondents of a specific income level systematically refused to place themselves into the corresponding income bracket. The same applies to education and age categories and the question regarding the number of people under 18 years old in the household. We have chosen to make 40 cycles and create ten datasets. As a result of imputation we obtained ten datasets that we can use for the further data analysis. Each dataset includes 614 complete observations.

5.2 Treatment of uncertainty

Following one branch of the literature dealing with the treatment on respondent uncertainty in CV studies (e. g. Li and Mattsson, 1995; Champ et al., 1997; Champ and Bishop, 2001; Ethier et al., 2002; Loomis and Ekstrand, 1998; Ekstrand and Loomis, 1998; Ready et al., 1995, 2001; Welsh and Poe, 1998), our treatment of uncertainty was based on the calibration method that uses information from a follow-up question asked during the survey right after the valuation question to generate a numerical certainty scale (Akter et al., 2008). This question asked respondents to rate their certainty about their previous decision regarding willingness or non-willingness to pay on the scale from 1 to 10:

> *On a scale of 1 to 10, where 1 is "not at all sure" and 10 is "very sure", how would you rank your previous answer?*

Using normalized values (ranging from 0.1 to 1) obtained from this question, we constructed the variable *hown* which provided us with sampling weights to be used in the maximum-likelihood regression analysis. The effect of this weighting procedure is of course to attach more importance (more weight) to those observations associated with those respondents who were more sure about their response to the policy and less importance to the rest. The objective of this weighting procedure was twofold. First, we wanted to obtain a more reliable estimate of willingness to pay, since the literature suggests that those who are more doubtful about their answers in Contingent Valuation studies tend to be behind most of the hypothetical bias in those studies (Champ et al., 1997; Champ and Bishop, 2001). Second, we expected to obtain a more precise estimate of willingness to pay, since we expected to obtain more efficient estimates of willingness to pay and an improvement in the goodness of fit of the overall regression model with the weighting procedure (as in Loomis and Ekstrand, 1998).

5.3 Model specification and variable definitions

Even when the main purpose of a Contingent Valuation study is the estimation of some summary value of the distribution of the willingness to pay variable, which could be achieved through non-parametric methods, regression analysis is usually employed. The purpose of regression analysis in Contingent Valuation is twofold: first, it makes it possible to find relationships between a set of independent variables and the likelihood that the individual is willing to pay to support the whale conservation policy. Some of these results can help establish further confidence on the valuation exercise, to the extent that they permit us to check that the level of willingness to pay varies according to a series of predictors in a manner that agrees with *a priori* theoretical expectations.[9] Additionally, the results of the regressions are used to compute the mean willingness to pay with more precision than by simply estimating a binary regression model of the *agree* variable on the *bid* value. As mentioned above, the imputation process creates ten datasets of 614 complete obsrvations. For the purpose of the main data analysis we used an "average" dataset by calling STATA's *mim* command (Galati et al., 2008) together with the regression commands.

[INSERT TABLE 4 ABOUT HERE]

We begin the data analysis with logistic regressions. This type of regression is probably the most common in contingent valuation studies. The dependent variable in all the logistic regressions used to estimate willingness to pay is a binary variable (*agree*) indicating whether the individual was willing to pay the offered *bid*. This variable takes the value of unity ("YES") or zero ("NO") depending on the answer given by the respondent. Note that for the response "DO NOT KNOW", we assigned zero to the variable *agree*.

Using the logistic regression we estimate the following model:

[9] Apart from helping when it comes to using the results of the study for benefit transfer studies.

$$ln[\frac{\Pr(agree = 1)}{1 - \Pr(agree = 1)}] = \alpha_0 + \alpha_1 bid + \alpha_2 X_2 + ... + \alpha_K X_k + \epsilon \quad (1)$$

The left-hand side of Equation 1 represents the log odds, that is the logarithm of the probability that respondent agrees to pay the offered bid (the variable *agree* takes the value of one) over the probability that respondent does not agree to pay the *bid*.[10] The right-hand side includes the variable *bid* and a series of additional explanatory variables X_2 to X_K, detailed in the next section. The parameters α_i are the coefficients to be estimated by the regression analysis. Table 4 describes the variables used in the regression analysis.

6 Results

6.1 Logit analysis

Table 5 shows the estimated logit regressions of the binary variable *agree* on the *bid* and the additional set of independent variables. The regression results labeled unweighted correspond to the regression for which no correction for uncertainty was used. On the other hand, the weighted results use variable *hown* as sample weights, so that all the observations (both those for which *agree* equaled zero and those for which *agree* equaled one) from those individuals who stated that were more sure about their answer to the valuation question were given a heavier weight. Note that although the regressions reported are based on a weighted average of the results obtained from each of the ten complete datasets artificially generated by the imputation process, only 514 observations were used from each, since protest responses were excluded.

[INSERT TABLE 5 ABOUT HERE]

The coefficient of *bid* is negative as expected and significant at the 1% level. The coefficient of the *income* variable is significant only in the weighted regression, even when a one-sided test is considered, given that its coefficient presents the expected positive sign. Since we also expected to find a positive sign for *heard,* we report the significance level for a one-sided test too.

[10] Or chooses the option "DON"T KNOW".

The signs of the variables *age* and its squared value have also the expected values, so their significance values are measured from one-side tests. The likelihood of agreeing to contribute to the whale conservation program is highest at around 36 years of age according to the unweighted model and about 38 according to the weighted model.

Somewhat surprisingly, *whalewatched* and *remainincidents* did not significantly affect the value of *agree*. We suspect that there may be some problems of endogeneity between whalewatched and agree, which we plan to investigate in a companion paper, while focusing here on the effect of correcting for respondent uncertainty. The variable remaincidents was used to analyze scope effects in the valuation of whales. The coefficient on this variable takes the expected negative sign, which means that, in agreement with economic theory, respondents would be willing to pay less for a policy that protected more whales than for one that protected fewer whales. The fact that this expected effect is not significant is likely explained by the lack of knowledge in the general public about the estimated whale population sizes in the area of study and the numbers needed to be kept for the long term viability of their populations.

Using the usual two-sided tests we observe that the coefficients of the *enviro* and *planatall* variables are significant at the 1% level (and in fact at the 0.1% level too). As expected those who belong to environmental organizations and those who have any plans to use the resource are willing to pay more to preserve it. The latter would suggest that there may be a substantial proportion of the benefit derived from the conservation of whales that is related to an *option value*.

As explained in Section 4, we used a split-sample approach in order to test the potential for payment vehicle effects. One of the samples received a policy scenario that involved the use of a federally funded program that would, during five years, help prevent incidents of entanglement by subsidizing and enforcing the use of acoustic devices in fishing gear. The respondents in this sample were asked about their willingness to pay taxes to support this program. The second sample received a policy scenario based on the use of a program that would, also during five years, help prevent incidents of entanglement by subsidizing and enforcing the use of acoustic devices in fishing gear. However, in this case the proposed program would be funded by voluntary contributions. The respondents in this sample were asked about their willingness to make voluntary donations to support the program.

As shown in Table 5 those who received the *tax* version of the survey were significantly more likely to *agree* to the proposed *bid* value. This probably means that the respondents incorporated in their calculations the potential for free-riding left by the donation format.

The results also show that those respondents who only completed a high-school level of education are willing to pay less for whale conservation. Manitoba and Ontario residents are significantly more likely to pay for whale conservation.

6.2 Welfare calculations

The next step is the computation of the mean/median willingness to pay. In general, in the case of a linear model the mean/median willingness to pay is defined as follows:

$$\overline{WTP} = -\frac{\overline{Z}\alpha'}{\alpha_1} \tag{2}$$

where $\overline{Z}$ is the vector of means of independent variables in a particular regression, $\alpha'$is the vector of coefficients obtained in the regression, and α_1 is coefficient obtained on the bid variable (from Equation 1).

Using the STATA code developed by Wilner Jeanty (2007) we compute the mean willingness to pay, corresponding confidence intervals as well as the achieved significance level. The computer code employed Krinsky and Robb (1986, 1990) procedure to compute the 95% confidence interval. As Park et al. (1991) observe, the presence of confidence intervals for the mean WTP allow to directly compare the estimates of WTP across models and methods. See Haab and McConnell (2002, pp. 110-113) for more details on this procedure.

The estimated mean/median under the unweighted model is substantially lower ($51.69 a year for five years) than the equivalent value estimated from the weighted model ($81 a year for five years) although there is some overlap of the respective 95% confidence intervals. In this case, accounting for the effect of respondent uncertainty leads to an increase in the estimated mean WTP. This is in contrast to the *a priori* expectation one would hold under the assumption that one of the main effects of correcting for uncertainty would be to remove hypothetical bias (Akter et al., 2008). Other studies where the correction for uncertainty led to higher estimates of mean WTP include Chang et al. (2007)

The treatment of uncertainty by weighting the logit regression with the variable *hown* did not in this case increase the precision of the mean WTP estimate. In fact, the relative efficiency measure (Loomis and Ekstrand, 1998) calculated as the ratio (CI_U–CI_L)/mean WTP, where CI_U and CI_L are upper and lower bounds of 95% confidence interval, respectively, is larger in the weighted model. It should be noted that the bulk of the empirical literature finds a similar result (Akter et al., 2008), with the exception of Champ et al. (1997) and in Shaikh et al. (2007) for a subset of their correcting models. The loss of efficiency of 15% we detect in the weighted model compares, however, relatively well to the range of 6% to 150% (in the case of the numerical certainty scale approach) reported in the survey by Akter et al. (2008).

However, it can be shown by comparing the McFadden pseudo-R^2 values obtained from the logit regressions on one of the ten individual datasets generated by the imputation procedure[11] that the goodness of fit of the overall equation improved substantially when the observations were weighted according to response certainty. The McFadden pseudo-R^2 was 0.1834 with weighting, while only 0.1206 without weighting. This contrasts with the majority of results found before , since only Loomis and Ekstrand (1998) and Shaikh et al. (2007) report an improvement in goodness of fit from the application of the ASUM model, as described in Section 3.2.

6.3 Factors behind respondent uncertainty

We decided to investigate whether there would be a set of explanatory variables behind the distribution of the variable hownorm. The distribution of frequencies of this variable is shown in Table 6 and also illustrated by Figure 1. The vast majority of respondents chose to state a value of 10 for *howsure* (equivalent to 1 for *hownorm*, which is just *howsure*/10), or that they were very sure about their answer to the payment question. However, the values of 1, 5, and 8 were also chosen

[11] In general STATA's standard postestimation methods cannot be directly applied to multiply-imputed data. Methods relying on likelihood comparisons (*lrtest*) are not applicable because multiple imputation does not involve calculation of likelihood functions for the data (Galati et al., 2008).

rather frequently. It seems that 5 may have acted as a focal point for those who wanted to express a middle level of certainty and 8 was probably the choice for those who were very sure but still wanted to express some uncertainty. The non-normality of the distribution of values of howsure is further reflected by the very infrequent choice of values 2, 3, and 4, as opposed to a more frequent choice of values 7, 8, and 9.

[INSERT FIGURE 1 ABOUT HERE]

Since *howsure* only takes the discrete values along the scale 1 to 10, we used an ordinal logit model to relate its values to the explanatory variables. The latter included *agree* itself. As shown by the results reported in Table 6, when respondents agree to pay the bid proposed for the hypothetical policy, it seems to be because they are very sure. When they say 'No' to the bid they tend to state a low level of certainty in the follow-up question. This makes sense, since the natural tendency of someone who is not sure about the usual take-it-or-leave-it offer implied by a dichotomous choice payment scenario is to say no now and leave it for some other time.[12] Basically, this is simply reminding us that in most occasions it is easier to buy something later than to resell something we buy if we end up regretting the purchase.

[INSERT TABLE 6 ABOUT HERE]

Loomis and Ekstrand (1998) suggest that the level of certainty should be higher for both really high and really low bids, with the highest uncertainty surrounding questions based on intermediate bids. However, we found that introducing the bid level in a quadratic form did not perform well at all, while the bid value enters the regression with a significantly negative estimate. Although, for example, Champ and Bishop (2001) did not find a significant effect of the size of the bid on the degree of certainty expressed in the follow-up question, we find that the higher the bid value the less certain the responses. Males appear to be less certain about their answers to the valuation question, while the further West the province of residence the more certain respondents are about their answers.

[12] In recognition of this, some authors proposed to ask respondents to assume, in experimental settings, that the good valued could be bought only during the experiment itself and not later nor elsewhere (Blumenschein et al., 1998; Johannesson et al. 1998; Blumenschein et al., 2001).

Although no other variable seems to exert a significant effect, in line with expectations, those with previous experience of the good are more certain about their answers. On the other hand, those people who have ever been to Newfoundland and Labrador appear to be less certain about their answers.

[INSERT TABLE 7 ABOUT HERE]

We ran a logit regression of a simplified version of *howsure* consisting of a binary variable taking the value of 1 if *howsure* was originally equal to 10 and zero otherwise. The results (reported in the second column of Table 7) show that the set of variables considered tend to have a stronger effect on the sorting responses just between completely certain and not than on their sorting along the whole set of values in the original scale (and *age* and *edu* become significant in this simpler model). This confirms that collapsing the number of categories in the scale of certainty might be helpful also at the survey stage, since perhaps respondents fail to meaningfully and consistenly distinguish among several values along the continuum of the scale and consider only focal points, the main ones of course being 1 and 10. We also tried applying an ordered logit to the modelling of several alternative simplified versions of *howsure*,[13] but with little success.

The logit model on the simplified version of *howsure* shows little differences in terms of the direction of the effects with one important exception: the effect of variable *agree* is actually negative in the Logit model. This means that a respondent who answers 'yes' is less likely to state full certainty about her answer than someone who refused the bid proposed, but also less likely to state the lowest levels on certainty. In other words, those who agree to the bid tend to state the higher intermediate values of howsure but are less likely to state full certainty than those who refuse the bid.

[13]For example we built a variable with only 3 values: 1 for 'not sure at all', 3 for 'completely sure' and 2 for anything in between.

7 Conclusions, limitations, and suggestions for further research

The efficient management of whales involves a balance of relevant social benefits and social costs, so the benefits from whales must be somehow estimated. Some benefits are relatively easy to quantify but others require eliciting values which are not or are only imperfectly reflected by market prices. In particular, what environmental economists refer to as the existence value of a resource is not reflected in market prices. We have estimated the willingness of average adult Canadians to pay for a hypothetical program whose objective would be to reduce the likelihood that whales become entangled in fishing gear off the coasts of Newfoundland and Labrador.

Although the scenario we proposed was based on a policy consisting on subsidizing and enforcing the use of acoustic devices in fishing nets, the conclusions can be seen of course as more general. In fact the result obtained (when considering the effect of uncertainty in the response) of a mean willingness to pay of over $81 per year for the next five years for this policy could be understood as the value the average adult Canadian in the sample places on whale conservation in Canada or perhaps even whales in general, since they are such a mobile resource.

Our study considered the effect of respondent uncertainty by including a follow-up question about how certain respondents were about their answer to the main dichotomous-choice question. This information allowed us to calibrate the answers by incorporating the resulting index of certainty as a weight in the maximum likelihood regressions. This correction led to an increase in the estimates of welfare measures and an improvement in the goodness of fit of the overall regression model, while, contrary to expectations, it did not improve the accuracy of the mean willingness to pay estimate itself.

We investigated the factors explaining the value of the numerical certainty index obtained from the follow-up question. We found that those who agreed to the proposed bid were significantly more likely to express higher levels of certainty about that answer. The size of the bid appeared inversely related to the certainty level.

We also found that the magnitude and precision of the willingness to pay estimate was affected by the type of payment vehicle proposed in the questionnaire (*tax* or *donation*). Those respondents who were asked about their willingness to pay through tax for the policy were much more likely to agree. We also considered the effects of previous experience with the good valued (through whale-watching), not finding any significant effect, and of option values, which did appear significant.

We suspect that the effects of some of the variables that failed to enter our reported models will need to be modeled accounting for their potential endogeneity. For example having previous whale-watching experience is something likely to depend on unobserved respondent characteristics that also affect the variable *agree*. Future work should consider these issues of endogeneity.

In this paper we have focused on the treatment of response uncertainty. Further analysis is needed to investigate the effect of treating protest responses, *don't know* responses and zero-respondents in alternative ways.

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Tax			Donation		
Yes	No	Don't know	Yes	No	Don't know
51.8	39.3	8.9	32.5	55.3	12.2

Table 1: Distribution of answers to the WTP question (variable *agree*): Tax and Donation Scenarios.

	Reason	Donation (%)	Tax (%)
1	I don't believe the money would be spent on that	2.43	3.31
2	Too expensive/I cannot afford that	42.23	30.46
3a	It should be financed through taxes/everyone should have to pay to protect the whales from fishing activities	3.88	N/A
3b	It should not be financed through taxes/not everyone should have to pay to protect the whales from fishing activities	N/A	6.62
4	I already donate too much to environmental causes	6.80	N/A
5	I already pay too much tax	N/A	9.93
6	I should not have to pay: it is a provincial matter and the province of NL should pay for that	7.28	5.96
7	I do not care about the whales	0.49	3.31
8	I do not believe that the program would be effective	0.49	1.32
9	The fishermen should pay for that themselves	5.34	10.60
10	The government should fund the program with existing revenues, and not ask for additional taxes	N/A	6.62
11	The government has other higher priorities for spending taxpayers' money	N/A	1.99
12	Other	31.1	19.9

Table 2: Reasons for 'No' Response: Donation and Tax Scenarios.

	Tax	Donation
Protest responses (as % of all 'no' responses)	42.9	28.5
Non-Protest responses (as % of all 'no' responses)	57.1	71.5
Total	100	100

Table 3: Protest Responses (Tax and Donation Scenarios).

variable	description	Mean	Std. Dev.	Min	Max
age	age of respondent in years	47.198	16.114	19	90
agesq	age squared	2487	1597.140	361	8100
agree	response to valuation question: No and Don't Know = 0	0.420	0.494	0	1
been	been to NL at some point	0.204	0.403	0	1
bid	proposed price (tax or donation) in dollars a year	53.298	27.923	15	100
bidsq	bid squared	3619	3276.225	225	10000
ed2	only completed high school	0.212	0.409	0	1
edu	education level	4.306	2.308	1	8
enviro	Member of environmental organization	0.107	0.310	0	1
heard	Aware of entanglement problem	0.723	0.448	0	1
homeless5000	Hometown has less than 5000 inhabitants	0.311	0.463	0	1
hown	howsure/10	0.718	0.318	0.1	1
howsure	How sure about	7.181	3.182	1	10
income[a]	Income brackets	3.199	1.905	1	7
male	gender of respondent	0.464	0.499	0	1
MB	Respondent lives in Manitoba	0.034	0.182	0	1
ON	Respondent lives in Ontario	0.384	0.487	0	1
planatall	plans or definitely plans to do whale watching in the next five years	0.539	0.499	0	1
protest	classified protest response	0.163	0.370	0	1
province	province of residence NL=0 to BC=9	5.456	2.033	0	9
remainincidents[b]	Number of whales entrapped per year after the policy comes into effect	21.303	11.407	10	40
tax	Respondent received tax version of questionnaire	0.493	0.500	0	1
under18	number of people under 18 in household	0.694	1.081	0	7
whalewatched	Whale watching experience	0.378	0.485	0	1

[a] Value of 1 corresponds to "less than \$30,000", value of 2 – "between \$30,000 and \$50,000", 3 –" between \$50,000 and \$70,000", 4 - " between \$70,000 and \$90,000", 5 - "between \$90,000 and \$110,000", 6 - " between \$110,000 and \$130,000", 7 - "over \$130,000"

[b]Values used in split samples were 10 whales, 20 whales and 40 whales

Table 4: Summary and description on variables used in the analyses. N=614. (*howsure*) on *agree* *bid* value and additional. variables

Variable	unweighted	weighted
bid	-0.00894**	-0.0096**
age&	0.05133*	0.06767**
age2&	-0.00069**	-0.00086**
income&	0.07404	0.11171*
ed2&	-0.17467	-0.39974*
heard&	0.53264**	0.43185*
beentoNL	0.10616	0.28652
enviro	0.85443**	1.5084***
tax	0.88591***	1.0444***
planatall	0.65143***	1.0085***
MB	1.5657**	1.8923***
ON	0.42358**	0.59836**
remainincidents	-0.00321	-0.00456
whalewatched	0.05771	0.16647
cons	-1.933**	-2.4425**
Mean = Median WTP/year	$51.69	$80.69
95% Lower Bound	$7.00	$48.69
95% Upper Bound	$81.08	$181.31
ASL[a]	0.0204	0.0118
width of CI/Mean WTP	1.43	1.64
N	514	514

Legend: * p<.1; ** p<.05; *** p<.01. & denotes a one-sided test.

[a]ASL= Achieved Significance Level for testing H0: WTP<=0 vs. H1: WTP>0

Table 5: Results of Logit regressions, unweighted versus weighted according to certainty level (*hown*) on binary variable *agree*

.

		agree = 0				agree = 1	
hownorm	Freq	percent	cumulative	hownorm	Freq	percent	cumulative
0.1	82	23.03	23.03	0.1	6	2.33	2.33
0.2	1	0.28	23.31	0.2	1	0.39	2.71
0.3	6	1.69	25	0.3	3	1.16	3.88
0.4	9	2.53	27.53	0.4	4	1.55	5.43
0.5	33	9.27	36.8	0.5	34	13.18	18.6
0.6	13	3.65	40.45	0.6	17	6.59	25.19
0.7	9	2.53	42.98	0.7	38	14.73	39.92
0.8	24	6.74	49.72	0.8	55	21.32	61.24
0.9	9	2.53	52.25	0.9	19	7.36	68.6
1	170	47.75	100	1	81	31.4	100
Total	356	100%		Total	258	100%	

Table 6: Frequency distribution of the values of *howsure*

	OLOGIT	LOGIT
agree	0.49269***	-0.45289**
bid	-0.00498*	-0.00904**
age	0.0076	0.01496**
edu	-0.04819	-0.10712**
been	-0.04242	0.12482
whalewatched	0.02994	-0.08057
enviro	-0.31076	-0.28744
tax	-0.11149	-0.07843
planatall	-0.24001	-0.0659
male	-0.27863*	-0.38063*
homeless5000	-0.10137	-0.37461*
province	0.07651*	0.06278

Legend: * p<.1; ** p<.05; *** p<.01.

Table 7: Results of Ordered Logit regression of certainty level (*howsure*) on *agree bid* value and additional variables and Logit where the dependent varibale takes the value of 1 if (*howsure*) = 10 and 0 otherwise.

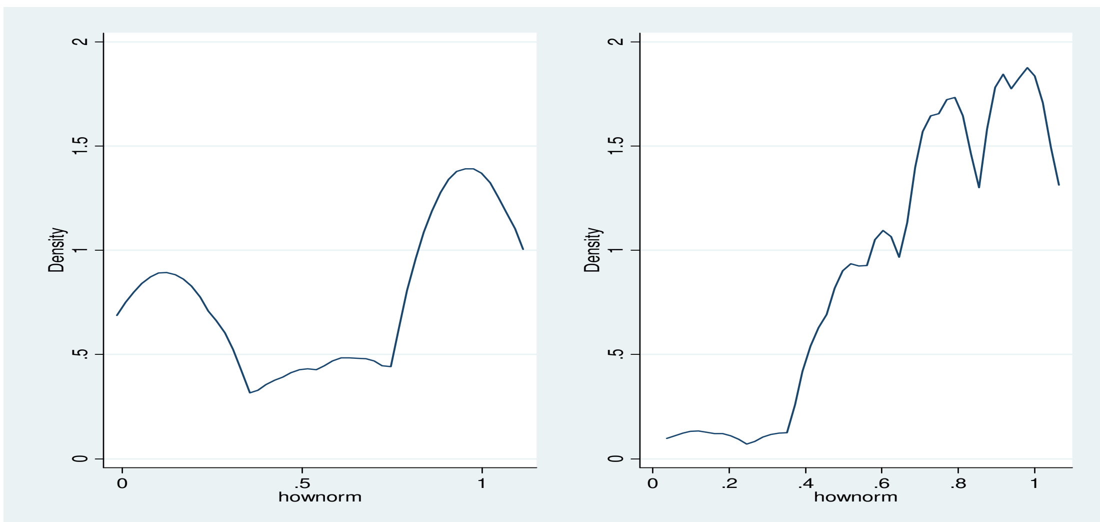

Figure 1: Kernel density estimates based on the Epanechnikov kernel function. The graph on the left hand side corresponds to those respondents for whom *agree* is zero, while on the right hand side *agree* = 1.