Landscape Research

ISSN: 0142-6397 (Print) 1469-9710 (Online) Journal homepage: http://www.tandfonline.com/loi/clar20

Using contingent valuation and choice experiment to value the impacts of agri-environmental practices on landscapes aesthetics

Jérôme Dupras, Jérémy Laurent-Lucchetti, Jean-Pierre Revéret & Laurent DaSilva

To cite this article: Jérôme Dupras, Jérémy Laurent-Lucchetti, Jean-Pierre Revéret & Laurent DaSilva (2017): Using contingent valuation and choice experiment to value the impacts of agri-environmental practices on landscapes aesthetics, Landscape Research, DOI: 10.1080/01426397.2017.1332172

To link to this article: http://dx.doi.org/10.1080/01426397.2017.1332172

Published online: 01 Jun 2017.

LANDSCAPE RESEARCH, 2017
https://doi.org/10.1080/01426397.2017.1332172

Using contingent valuation and choice experiment to value the impacts of agri-environmental practices on landscapes aesthetics

Jérôme Dupras[a,b], Jérémy Laurent-Lucchetti[c], Jean-Pierre Revéret[d] and Laurent DaSilva[e]

[a]Département des sciences naturelles, Institut des sciences de la forêt tempérée, Université du Québec en Outaouais, Gatineau, Canada; [b]Département de géographie, Université de Montréal, Montreal, Canada; [c]Institut d'économie et d'économétrie, Université de Genève, Geneva, Switzerland; [d]École des sciences de la gestion, Université du Québec à Montréal, Montréal, Canada; [e]Ouranos

ABSTRACT
This study explores the willingness to pay (WTP) for an improvement of the environmental situation in agricultural areas with a specific focus on landscape aesthetics. We used the contingent valuation method to measure the discrete value of landscape aesthetics externalities produced by different beneficial management practices implementation scenarios. The choice experiment method was also used to measure the economic value of other ecosystem services in order to situate landscape in consumers' preferences among other non-market benefits produced by agri-environmental practices. We found important WTP for landscape aesthetics improvement, as well as for other ecosystem services, such as water quality and fish diversity.

KEYWORDS
Agri-environmental practices; landscape aesthetics; ecosystem services valuation; contingent valuation method; choice experiment method

1. Introduction

The development and intensification of agricultural activities in past decades have been accompanied by changes in agricultural practice, causing numerous environmental problems, including the deterioration of soil and water quality, habitat fragmentation and loss of biodiversity (Kleijn et al., 2009). The deterioration of agricultural landscapes due to the intensification of agricultural practices is also a well-documented phenomenon that has generally resulted in simplification of landscapes (Ruiz & Domon, 2009). Farming specialisation, abandonment of traditional practices, conversion of grasslands to croplands, increased field sizes and destruction of non-productive agricultural habitats combined with fragmentation and loss of natural habitats also contribute to decreased diversity (Dupras, Parcerisas, & Brenner, 2016b; Dupras et al., 2016a).

Declining numbers of farmers in rural areas owing to the consolidation of farm businesses have culminated in communities where most residents do not practice agriculture, but are still benefiting from the landscapes, since they have made the choice to live in these environments (Paquette & Domon, 2003). This creates a demand for agricultural outputs that are linked not only to food production, but also to attractive living environments, especially in 'everyday' landscapes (Paquette & Domon, 2003). The landscape elements that are valued in rural communities can be very diverse, ranging from visual aspects, like open-views, crop diversity, interesting architectural elements, diversity of land use and topography, to more personal attributes, such as emotional attachment, family heritage, daily experience and intimate knowledge of area (Vouligny, Domon, & Ruiz, 2009). This social demand for

CONTACT Jérôme Dupras jerome.dupras@uqo.ca

landscape aesthetics is closely linked to the loss of diversity in rural communities where intensive agriculture is established (Paquette & Domon, 2003).

In recent years, several countries have encouraged farmers to adopt beneficial management practices (BMPs), that is, agricultural methods designed to reduce potential negative impacts on the environment (Brady, Kellermann, Sahrbacher, & Jelinek, 2009; Grammatikopoulou, Pouta, & Salmiovirta, 2013). Beyond positive effects on the quality of agri-ecosystems, BMP development can have a significant impact on the landscape (Grammatikopoulou et al., 2013). From this perspective, aesthetic improvements in the landscape through BMP implementation can be considered as a positive externality that affects user well-being. The integration of landscape aesthetics in policy-making is observed in several jurisdictions, notably in Europe, under a Common Agricultural Policy (Brady et al., 2009). Indeed, in Québec (Canada), this aspect is rarely taken into account by public institutions and on-farm decisions: the establishment of incentives, programmes or policies favouring BMPs rarely includes landscape dimensions in their planning, design and implementation (Dupras, Alam, & Revéret, 2015).

While environmental considerations are influential factors in BMP development and implementation from the perspective of public or private financing, the design of these interventions and their funding are often based on analysis of the costs and benefits generated. From a market economy viewpoint, the costs of implementing these practices are well-known, and the impact on production of agricultural goods, such as food, fibre and fuel, is generally well-estimated. However, several non-market goods and services that benefit users are also generated by BMPs, such as better water quality, more biodiverse habitats, control of soil erosion and pest management (Dupras & Alam, 2015; Dupras et al., 2016a, 2016b). Cost-benefit analyses, using the total economic value of these practices, are one way of helping in the decision-making process. Consequently, a major challenge is to measure accurately these non-market ecosystem services (ES), and assign economic value to them.

ES refer to the benefits that human societies derive from nature. Recent development of this concept now makes it an important aspect of various strategies regarding protection, enhancement and restoration of natural capital. In the growing volume of literature published on the topic of ES valuation, many experiments focus on ES produced by agricultural ecosystems and agri-environmental practices, such as soil conservation (Pimentel et al., 1995), pollination (Gallai, Salles, Settele, & Vaissière, 2009), water quality (Colombo, Hanley, & Calatrava-Requena, 2005) or recreation (Poder, Dupras, Ndefo, & He, 2016). Similarly, landscape aesthetics have been valued in several studies based on direct and indirect valuation methods, such as hedonic pricing and travel cost methods (Arriaza, Cañas-Ortega, Cañas-Madueño, & Ruiz-Aviles, 2004; Gonzáles & León, 2003), and by stated preference techniques (Arriaza et al., 2004; Campbell, 2007; Gonzáles & León, 2003; Howley, Hynes, & Donoghue, 2012; Poder et al., 2016; Rambonilaza & Dachary-Bernard, 2007).

To establish public policies that promote ES, the ability to measure the economic value of these services is crucial (Dachary-Bernard & Rambonilaza, 2012). In this setting, the present study aims to inform policy-makers and stimulate interest in the issue of agricultural landscapes in Québec and Canada by assessing the economic value of landscape externalities produced by the introduction of BMPs. To do so, a well-known stated preference technique has been employed—the contingent valuation method (CVM). Moreover, to measure the importance of landscape aesthetics compared to other ES produced by BMPs, a choice experiment (CE) valuation was performed.

The present paper adds to the ES valuation literature by performing the first estimation of the value of landscape aesthetics in an agricultural area in Canada through stated preference methods, and by estimating values of other attributes enhanced by BMPs.

2. Methodology

2.1. Analytical framework

Stated preference methods are employed when actual markets—that could allow researchers to extract values for environmental amenities—are absent or to capture both use and non-use values

(Bateman et al., 2002). When consumer behaviour cannot be analysed, stated preference methods propose a simulated market where economic agents can express their preferences. These investigative techniques consist of sampling populations and measuring their willingness to pay (WTP) to improve their environment. Historically, the CVM is the most well-known technique in this group. However, since the second half of the 1990s, choice modelling methods, with CE among them, are growing in popularity to value landscapes (Campbell, 2007; Rambonilaza & Dachary-Bernard, 2007).

The CVM is useful as a global approach to valuating a bundle of environmental goods or services. Environmental characteristics can be detailed by components of the natural asset, but the contingent valuation mechanism is designed to include them in a larger uniform process. Among possible formats, the open-ended CVM allows direct measurement of individual WTP for ES packages by directly asking respondents their maximum WTP to purchase proposed alternatives. The open-ended CVM has been widely used in the stated preferences literature mainly because of its simplicity (Bateman et al., 2002). On the other hand, the simplicity of open-ended CVM comes at a cost. Documented flaws include difficulties in putting a price on hypothetical situations, leading to high non-response rates, protest answers and outliers (Adamowicz, Boxall, Williams, & Louviere, 1998; Bateman et al., 2002; Mccollum & Boyle, 2005).

CE was developed to individually estimate the components of goods, services or bundles of ES (Louviere, Hensher, & Swait, 2000). The method is based on the Lancaster (1966) theory of value. It stipulates that the value of goods can be approximated by the value of their attributes. In this method, respondents evaluate a series of different choice sets in an experimental design. A choice set is composed of numerous hypothetical alternatives and aims to test the reaction of respondents in the face of a choice situation. The alternatives (e.g. car A, B or C) are defined by a series of different attributes (e.g. colour, size and price) presenting various levels (e.g. blue, red and yellow).

The economic background behind CE elicitation builds on an alternative theory of choice derived from McFadden's (1974) work. In brief, CE assumes that the value or benefit that an individual derives from choosing attribute A over attribute B is a function of the frequency with which he or she chooses attribute A over attribute B in repeated choices. CE survey design, therefore, creates a simulated market where respondents are asked to choose repeatedly between a number of alternatives with different levels of attributes and different prices. It is assumed that respondents are able to discriminate between different levels of attributes, providing information on how they value each of these attributes and allowing the marginal value of incremental changes in attributes to be evaluated.

This assumption also implies that the benefits derived from BMPs are additive across attributes, that is, the marginal value associated with incremental variation in fish diversity is independent of and additive to the current level and to the marginal value accorded to incremental variation in water quality or any other attributes for that matter.

That being said, using traditional statistical analysis of repeated choices made by respondents, the marginal value of an attribute can be estimated. This is done by isolating the sensitivity of choices made to variations in the levels of attributes and to the monetary constraints imposed by price attributes. Marginal values for each attribute are estimated by a traditional conditional logistic model and by controlling for other parameters that could influence the choices made (e.g. socio-economic parameters).

Like CVM elicitation, CE methods have been subject to criticism by experimental economists and psychologists who have proved that individuals can only handle a limited amount of information when making a decision (Hanley, Mourato, & Wright, 2001). CE can therefore impose a cognitive burden that leads to biased utility elicitation. Additive separability has also been an area of criticism, with numerous articles proving that this assumption does not hold (Foster & Mourato, 1997).

One distinct feature that differentiates the CVM and CE is that, generally, practitioners obtain average values when applying the CVM and marginal values when applying CE (He, Dupras, & Poder, 2016). Typically, the mean WTP obtained from a CVM corresponds to distinct change in the scenario, while statistical models related to CE yield values corresponding to mean WTP for marginal change in each attribute. If the marginal values estimated from CE application are constant for all units, they can be used for discrete change value estimation in linear form (Hanley, Wright, & Adamowicz, 1998). These limitations have led to the hypothesis that the CVM is more suitable to estimate discrete values, while

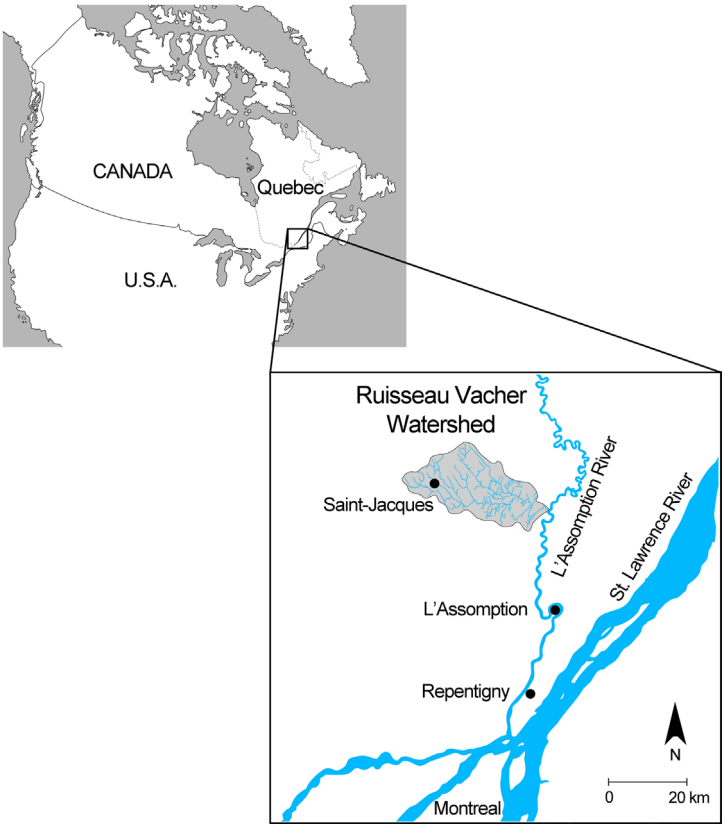

Figure 1. Location of the study site.

CE is best for marginal values or relatively small discrete changes (Bateman et al., 2002; Hanley et al., 1998). It should also be noted that the CVM can be formulated as a discrete choice response, and the underlying utility maximisation problem is then identical to the CE presented.

In compliance with the literature, this study uses the CVM to measure the discrete values of landscape aesthetic externalities produced by different BMP implementation scenarios through picture-based valuation questions. If CE also measures the economic value of target ES, it is also employed to situate landscapes in consumer preferences among other ES produced by BMPs.

2.2. Study site and BMP implementation

From 2005 to 2010, the Fauna Foundation of Québec and the Québec Farmers' Union (*Union des producteurs agricoles*) tested a programme to improve the quality of water and wildlife habitats in 10 agricultural sites in the Province of Québec (Canada). The programme explored different models of BMP combinations based on three main types of interventions: agro-environmental farming practices, water control and wildlife habitat (Fondation de la Faune du Québec & Union des Producteurs Agricoles, 2011).

Among the 10 sites where BMPs were implemented, analysis focused on the upper section of the Ruisseau Vacher watershed (RVW), a tributary of the l'Assomption River in the Lanaudière region 65 km north of Montréal, Québec (Canada) (Figure 1). This watershed of 3035 hectares, covered by 77% of agricultural land and 17% of woodlands, is part of the Greater Montréal Greenbelt (Dupras et al., 2015). An urbanised sector, the Municipality of Saint-Jacques and some gravel roads complete the big picture of this territory. The environmental issue is water-quality degradation due to the presence of phosphorus,

coliforms and suspended solids (Fondation de la Faune du Québec & Union des Producteurs Agricoles, 2011). Several septic systems in the residential sector, in the centre of the basin, are still inadequate, with riparian zones being poorly diversified and often very narrow (Fondation de la Faune du Québec & Union des Producteurs Agricoles, 2011).

The Ruisseau Vacher Programme (RVP) was designed to mobilise agricultural and wildlife stakeholders in the watershed to improve the water quality of the streams. It also aimed to provide amenities in the riparian zone, re-creating rich and diverse biodiversity habitats. The following BMP interventions were undertaken:

- Erosion control through bioengineering
- Output protection of drains, ditches and furrows
- Drain installations combined with sedimentation basins
- Characterisation and monitoring of avian and fish species

2.3. Survey design

Before drawing up the questionnaire, two focus groups were held with residents from Saint-Jacques, one comprised farmers, and the other, citizens at large. Their understanding and opinions regarding environmental issues related to agriculture and the changes occurring in terms of beneficial practices were probed. How various goods and services linked to biodiversity could best be formulated were examined.

2.3.1. Contingent valuation method

Study participants were asked to consider and evaluate landscape variations through modified images representing different evolution scenarios. Simulated landscapes served as supports for respondents to reply to individual preference elicitation questions. The site chosen as base for the generation of future evolving scenarios consisted of a typical view from a farmland road representative of the area: intensive agriculture, open landscape, limited crop diversity. The specific location was selected because no interesting landscape element had been recorded on this 8-km stretch of road in regional planning documents or in any local tourism development strategy (Vouligny et al., 2009). The agricultural landscape was mainly associated with maize and soya production, the main activity in the area (Vouligny et al., 2009).

Realistic photo simulations of landscape evolution of the study site were generated with Adobe Photoshop software and based on analysis of landscape patterns between 1983 and 2000 related to forested areas, vegetation cover and the physical variables associated with these landscape variables (Ruiz, Domon, Lucas, & Côté, 2008). This analysis helped to identify major territorial agricultural development features in the region, particularly parcel expansion and decreases in woodland. Four scenarios over a 20-year period were developed on the basis of aerial photo interpretation and analysis of laws, programmes and agricultural policies (Figure 2). After examining the current situation, respondents were asked to evaluate four levels of agricultural landscape evolution, including a status quo scenario.

Each of these scenarios was represented by an image based on an actual photograph of the current situation, modified with the photo-editing software to create the other scenarios. Care was taken not to insert any sensational effects but, on the contrary, to remain as close as possible to various realities that could occur in these scenarios (Ruiz et al., 2008). In the questionnaire, three neutrally phrased sentences accompanied each picture, qualifying the key changes.

In comparison to the current situation, the status quo scenario established what the landscape could become if current development trends continued (Figure 2(a)). The second scenario was based on laws, regulations and programmes that could affect landscape dynamics (Figure 2(b)). The main landscape impact derived from legislation in Québec regarding riparian zones. For example, in all agricultural areas of the province, these regulations require farmers to maintain a vegetated riparian buffer. Due

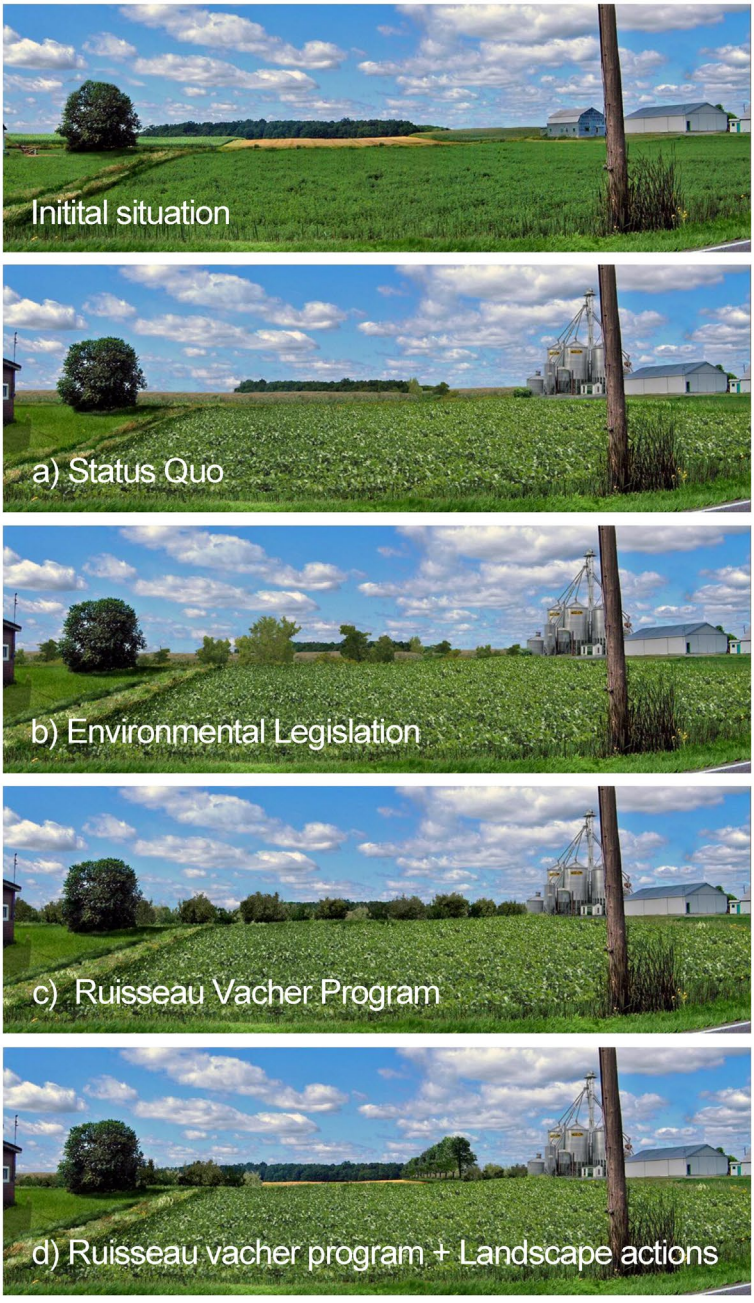

Figure 2. Scenarios of changing landscapes based on photo-realistic simulations used in the CVM (partially adapted from Ruiz et al., 2008).

to lack of monitoring and control, this rule is rarely upheld. The third scenario represented impacts on landscape aesthetics arising from integration of BMPs in the RVP (Figure 2(c)). The fourth scenario, a fictive programme called 'Environment Plus', included the RVP's BMPs, but with more specific landscape aesthetic actions (Figure 2(d)). In the study site, these actions took the form of woodland protection, modulation of parcel sizes, crop diversity and elements valued by the population, such as open views of the woodlands (Ruiz et al., 2008).

Table 1. Attributes and levels used in the CE.

Attributes	Definition	Levels
Water Quality	Depending on its quality, water can be used for different activities: boating (a), fishing (b), swimming (c)	High: a, b, c Medium: a, b Low: no activities
Fish Diversity	The number of fish species present in the brook that can be fished	High: 13 species Medium: 7 species Low: 4 species
Bird Diversity	The possibility to observe birds of high or exceptional ornithological interest in the watershed area (0%: no interest birds can be seen; 100%, an interest bird is seen at each observation)	High: 70% Medium: 50% Low: 30%
Landscape Diversity	Diversification of landscapes within the parameters of riparian zones (a), windbreaks (b), crops diversification (c), open-sight on the landscape (d)	High: a, b, c, d Medium: a, b Low: -
Cost	Amount paid on the municipal taxes account each year during five years	25$, 75$, 125$

Table 2. Example of scenarios proposed in the CE.

	If the four options below were the only possibility, which one would you choose?			
	Status quo	Option A	Option B	Option C
Water quality	Low	Medium	High	Low
Depending on its quality, water can be used for different activities: boating (a), fishing (b), swimming (c)	No Activities	a, b	a, b, c	No Activities
Fish diversity	Low	High	Low	Medium
The number of fish species present in the brook that can be fished	4 Species	13 Species	4 Species	7 Species
Bird diversity	Low	Low	High	Medium
The possibility to observe birds of high or exceptional ornithological interest in the watershed area	30%	30%	70%	50%
Landscape diversity	Low	Low	Medium	High
Diversification of landscapes within the parameters of riparian zones (a), windbreaks (b), crops diversification (c), open-sight on the landscape (d)	No Diversity	No Diversity	a, b	a, b, c, d
Cost				
Amount paid on the municipal taxes account each year during five years	0$	25$	75$	125$

Once the different scenarios were displayed, respondents were asked if they would pay for such changes in the short/mid-term. Those who answered affirmatively were asked in an open-ended CVM form how much they would be willing to pay for the three scenarios over a five-year period as an additional component of municipal water taxes, with no additional cost for the status quo.[1] Open-ended elicitation can lead to protest answers.[2] To identify these protest answers and to understand the reasons for them, a follow-up question was added.

2.3.2. Choice experiment method

The first step in survey design was to choose attributes reflecting specific ecological goods or services. According to Bateman et al. (2002), the number of attributes should vary from 4 to 6. The attributes were based on analysis of the literature and focus group results. The selected attributes had to meet 3 conditions: (1) they had to be ES and not another element of agricultural multifunctionality (e.g. employment and vitality of the rural community); (2) they had to be directly affected either positively or negatively by the BMPs implemented; and (3) they could not have existing values in a specific market (e.g. food, fibre and fuel). Water quality as well as landscape, fish and bird diversity were selected and added to the cost attribute.

The manipulations of each attribute as a representation of increasing environmental quality was based on the scientific literature and expert knowledge, validated by academics and experts from

specific fields (Table 1). This validation exercise permitted the development of realistic alternatives related to the specific ecosystem context of the RVW. To compare the results on landscape aesthetics with both valuation methods, the 3 landscape diversity levels attributed to CE represented the same characteristics as the status quo, the RVP and Environment Plus in CVM scenarios.

Scenarios were created according to a statistical design respecting orthogonality conditions for separate and independent analysis of each attribute (Louviere et al., 2000). For all possible combinations, SAS software produced a factorial design respecting D-efficiency criteria to generate 18 orthogonal scenarios (Bateman et al., 2002). These 18 scenarios were organised in 6 choice sets with 3 alternatives and the status quo, each following the recommendation of Rolfe and Bennett (2009). At the end, respondents were asked to choose between four alternatives, a status quo scenario where all attribute levels were lower but combined with zero cost, and three scenarios where attributes varied randomly. Table 2 gives examples of choice scenarios presented to respondents.

The web-based questionnaire was divided into three main sections. The first section probed respondents for their opinions, awareness and individual actions regarding the environment. The second, the valuation section, contained both the CVM and CE as well as an opportunity for them to indicate the reasoning behind their choices. The third section of the questionnaire dealt with socio-economic and demographic dimensions.

2.4. Populations and sampling approach

Initial background populations consisted of all residents and farm operators in the Saint-Jacques region, but to capture the effect of distance from the site under study and to represent both rural and urban populations, the background population was enlarged with 2 other sampling strata: residents of Repentigny and l'Assomption (20–35 km downstream of the RVW in the same larger watershed) and residents of Montreal (65 km away, with no connection to the RVW).

A letter was mailed to all residents and farm operators in the Saint-Jacques area. The Repentigny and l'Assomption samples were randomly selected by postal code in November 2008. Montréal participants were selected from various university mailing lists. The study was presented at initial contact, and recipients were invited to answer the questionnaire on an identified website. Since Internet service is provided in the totality of the rural area studied, the sampling approach was not considered to exclude any rural respondents. However, for those interested in participating yet not willing or unable to use the Internet, a toll-free phone number was made available to request a hard copy of the questionnaire.

3. Results

3.1. Descriptive statistics

Of the 4400 survey invitations mailed, 250 questionnaires were filled out on the website and useable, while 5 respondents asked for a paper version. Mailing surveys can have a number of advantages over direct interviews (no interviewer bias, easier to answer sensitive questions), but these generally come at the cost of a low response rate: 6% in this case. While the response rate was low, geographic distribution of the respondents was representative of the study sites. Sending out the mail-in survey directly would have probably produced a higher response rate, but this was impossible, because existing mailing lists were lacking, even from survey companies.

The final sample consisted of respondents from 3 distinct regions: Saint-Jacques ($n = 79$), Repentigny ($n = 75$) and Montréal ($n = 96$). The sampling technique was not random and therefore could not, and should not, be considered as representative of any geographic scale except in the local context of the RVW. This lack of full-scale and probabilistic sampling has to be kept in mind when assessing the results.

Self-selection bias resulted in a sample with higher education than the regional average (Table 3), a common issue in internet-based surveys. It is particularly striking in the present survey (Table 3). However, other socio-demographic characteristics are relatively representative of regional figures.

Table 3. Descriptive WTP statistics for the open-ended CVM.

	Saint-Jacques		Repentigny		Montreal	
	Sample	Population*	Sample	Population*	Sample	Population*
Median age	50	43	40	41	40	39
Sex (% female)	42%	51%	51%	51%	48%	52%
Median income	50 000$	52 561	70 000$	72 793$	60 000%	49 969$
Proportion university degree	28%	10%	56%	18%	78%	30%

*Date gathered from the 2006 Census (Statistics Canada, 2006).

Looking at socio-demographic characteristics across the subsamples, significant heterogeneity between the three regions was found in both the sample and background populations. In terms of income distribution, Saint-Jacques respondents had significantly lower gross household incomes than their Repentigny and Montréal counterparts (median income of $50 000 in Saint-Jacques and $60 000 and $70 000 in Montréal and Repentigny, respectively)

Age distribution presented a similar pattern, with Saint-Jacques respondents being typically older than those from Repentigny and Montréal. However, the biggest difference in the subsamples lay in the level of education attained by respondents. In Repentigny and Montréal, the majority of respondents possessed a university degree (close to 80% in Montréal) while the proportion reached only 28% in Saint-Jacques. Even if these figures seemed to be boosted by the sampling strategy, background populations appeared to have similar patterns across the three regions. Finally, the sample showed balanced sex distribution, with slightly more males than females.

The questionnaire also investigated respondents' environmental actions. Respondents were considered as pursuing environmental actions on a regular basis if they often practiced three of the following: recycling, using public transportation, composting or donating to environmental organisations. The Saint-Jacques subsample performed environmentally better than Repentigny and Montréal respondents.

3.2. WTP estimates

3.2.1. Contingent valuation method

In the CVM, the only difference between the status quo and evolution scenarios was landscape aesthetics resulting from BMP integration. Respondents were first asked whether they were 'willing to pay for the implementation of BMPs'. Those agreeing to pay were invited to state the amount they were willing to pay annually for a period of 5 years to finance a BMP programme. Following Bateman et al.'s (2002) recommendations, the sample was screened for outliers and any WTP presenting any of the following irregularities were dropped:

- WTP was more than $1000 for any of the 3 programmes
- WTP was at least $500 for all 3 scenarios when respondent households had revenues lower than $60 000

This screening procedure forced 7 observations from the CVM database to be left out, as they were considered to be outliers.

Slightly more than half the respondents (51%) declared that they were ready to pay for the adoption of practices that would improve landscape aesthetics. Table 4 reports average annual WTP for BMPs impacting landscape aesthetics for the three suggested scenarios and for each of the three subsamples. Considering only respondents' willing to pay (including 'implicit' zero responses), average WTP was $32.89 in respect of the regulation scenario, $46.66 for the RVP and $80.13 for the Environment Plus programme. While the Montréal and Saint-Jacques subsample results were comparable, the values associated with WTP for BMPs in all three scenarios from Repentigny respondents were about twice as

Table 4. Descriptive WTP statistics for the open-ended CVM.

	Saint-Jacques			Repentigny			Montréal			Total		
Programme	Mean ($)	SD ($)	Median ($)	Mean ($)	SD ($)	Median ($)	Mean ($)	SD ($)	Median ($)	Mean ($)	SD ($)	Median ($)
Regulation	25.70	63.36	.00	52.00	135.38	5.00	23.88	45.81	.00	32.89	87.53	.00
Ruisseau Vacher	32.47	69.53	.00	67.01	143.00	5.00	42.45	83.48	.00	46.66	102.62	.00
Env. Plus	69.87	176.27	.00	103.49	198.11	20.00	70.31	126.61	3.50	80.13	166.58	.00
N		79			75			96			250	

Table 5. Regression estimates for the CVM.

	Logit		Heckman two-step	
Decision to pay	Coefficient	Standard errors	Coefficient	Standard errors
Age	−.216**	.099	−.142**	.061
Sex	.021	.279	.055	.170
Medium Income ($40 000–$80 000)	.002	.320	.040	.200
Higher Income (>$80 000)	.287	.361	.242	.224
High school/college	−1.051*	.631	−.570	.406
University Degree	−.041	.621	.013	.400
Resident of Saint-Jacques	−.032	.422	−.051	.257
Resident of Repentigny	.618*	.337	.372*	.212
Env. Actions	.593**	.288	.370**	.178
Rec. Activities in Saint-Jacques	.653**	.330	.373*	.214
Constant	.598	.796	.303	.508
Willingness to pay				
Age			.175	.419
Sex			.148	.282
Medium Income ($40 000 to $80 000)			.302	.300
Higher Income (> $80 000)			.086	.738
High school/college			.643	1.734
University Degree			.461	.555
Resident of Saint-Jacques			.256	.429
Resident of Repentigny			−.127	1.050
Env. Actions			−.144	1.118
Rec. Activities in Saint-Jacques			−.537	1.089
Constant			4.190	2.965
N	250		245	
Log likelihood	−160.50583		–	

*Significant at 10% confidence level; **Significant at 5% confidence level; ***Significant at 1% confidence level.

high. However, when WTP was tested statistically according to residential area of the respondents, no significant differences were evident.

In addition to direct observation of WTP, we present the results of a logistic regression model on the choice of giving money for the project or not, depending on observable characteristics. These estimates allowed the investigation of observable characteristics that could influence individual decisions. A Heckman two-step model of WTP was also used to estimate observable characteristics that could explain the decision to pay or not to pay, and the amount respondents were willing to pay. With the Heckman two-step model, the WTP data were normalised through log-transformation. Table 5, which summarises the results of both these regressions, shows a high level of consistency between the two tests.

Age appeared to be a negative and significant determinant of the decision to pay, as indicated by Logit analysis. Level of education and commitment to environmental actions were positively correlated with the decision to pay for BMPs. Living in Repentigny was also correlated with positive decision to pay. The Heckman two-step model showed that no observable characteristics could provide guidance in inferring WTP. This result could have been caused by the small sample size.

3.2.2. Choice experiment valuation

Valuation of landscape aesthetics was then compared to other ES associated with BMPs. To do so, CE helped to elicit the preferences for agents with each specific environmental attribute of the project. Besides price, 4 different attributes (water quality, fish, bird and landscape diversity), each with 3 levels of quality, served to create 18 orthogonal scenarios. In six choice sets, respondents were presented three different scenarios in addition to the status quo. As illustrated in Table 2, alternatives were offered but no visual support was provided. CE elicitation aimed to isolate the value of BMP impacts other than on landscape aesthetics.

Twenty-four observations were collected for each respondent (6 choice sets × 4 scenarios) producing a total of 6000 observations.

Table 6. Estimation of WTP for the CE using conditional logistic regression.

	Coefficients				Std. Err.			
ASC	.409				.340			
Price	−.005***				.001			
	Water		Fish diversity		Bird diversity		Landscape aesthetics	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Attribute	1.311***	.284	.126	.085	−.147***	.056	.645***	.165
Attribute × Age	−.011***	.003	−.001	.001	.000	.001	−.007***	.002
Attribute × Sex	.141	.103	.037	.029	.025	.021	−.016	.060
Attribute × Education	−.018	.014	.003	.005	.007***	.003	.010	.009
Attribute × Income	.000	.000	.000	.000	.000**	.000	.000	.000
Attribute × Env. Actions	.108	.096	−.021	.029	.010	.019	.140**	.056
Attribute × Rural	−.384***	.129	−.093**	.043	−.018	.030	−.081	.086
Attribute × Saint-Jacques Activity	.105	.117	.062*	.034	.003	.019	.122	.078
Attribute × Residing in Saint-Jacques	−.115	.142	−.004	.043	.061**	.025	−.177**	.087
Attribute × Residing in Repentigny	−.120	.122	−.035	.033	.018	.023	−.125*	.074
N	5304							
Log pseudolikelihood	−1160.57							

Note: Confidence intervals were calculated using the Krinsky–Robb procedure with 2000 repetitions.
*Significant at 10% confidence level; **Significant at 5% confidence level; ***Significant at 1% confidence level.

Statistical analysis estimated the influence of socio-economic parameters on the decision to pay for a proposed scenario. Table 6 reports the results of conditional Logit analysis. As expected, price negatively impacted the choice of scenarios: the higher the price, the lower the probability that an agent would select a scenario, everything else being equal.

Higher levels of an attribute (except for bird diversity) increased the probability of respondents choosing that scenario. As with the CVM results, the probability of a scenario being chosen diminished with increasing age of respondents but only for landscape and water-quality attributes. The results also indicated that respondents engaged in recreational activities in the Saint-Jacques region were more likely to select an alternative if it generated higher fish diversity, which could be seen as producing new opportunities for recreational fishing in the region. Obviously, these new opportunities were much more interesting for users than for non-users.

WTP values were then computed by the marginal rate of substitution at mean values. Marginal WTP was calculated by dividing the total coefficient of each attribute by the price coefficient. More precisely:

$$\mathrm{WTP}_{\mathrm{marginal}} = -\left(\beta_{\mathrm{attribute}}/\beta_{\mathrm{price}}\right)$$

The results indicate the average WTP for an increase in the quality of a given attribute by 1 unit. The implicit prices derived varied from just under $9.00 for bird diversity to $128.00 for water quality.

Table 7 summarises WTP according to the CE method using conditional logistic estimation. Also provided are estimates from alternative estimation models, namely, a basic conditional logistic model with no interaction terms and a random parameter logistic model to relax the assumption of independence of irrelevant alternatives (IIA).[3] Total WTP was calculated for all four attributes according to the improvement scenarios proposed in the survey. Respondents were willing to pay larger amounts for the water quality attribute, followed by landscape and fish diversity, and were only marginally motivated to pay for bird diversity.

Table 7. Total WTP from CE.

	Basic conditional Logit	Cond. Logit W. Multiplicative terms	Random Parameter Logit (simple)
Water quality	385.09 $	399.28 $	402.46 $
95% CI	(245.88–782.69)	(256.58–910.06)	(288.97–608.01)
Fish biodiversity	242.30 $	262.65 $	200.63 $
95% CI	(149.51–511.90)	(159.59–593.30)	(144.28–303.51)
Bird biodiversity	94.27 $	84.26 $	85.45 $
95% CI	(49.21–208.07)	(42.48–222.05)	(50.47–138.98)
Landscape aesthetics	354.25 $	363.71 $	332.88 $
95% CI	(228.40–709.98)	(233.08–811.36)	(236.81–506.58)

4. Discussion

The results corroborate several studies of agricultural areas where the non-market economic value of aesthetic agricultural landscape quality has been recognised. For example, in studying rural landscape features on farms in Ireland, Campbell (2007) found WTP CAN$101-236/year for improvement of agri-environmental practices (cultural heritage, stone walls, farmyard tidiness and mountain land). In the southern part of Finland, Grammatikopoulou et al. (2013) recorded average WTP US$136/household for crop diversity, grazing animals, water buffer zones and renovated production buildings. Similarly, Hanley et al. (1998) reported WTP US$140/household/year for policy that preserved traditional Scottish agriculture, while Marangon and Visintin (2007) calculated WTP of US$269 for residents and 43/household/year for non-residents to protect the diversity of traditional agricultural landscapes in Slovenia and US$81-445/household/year to protect hill viticulture in Italy.

In addition to valuation studies, several analyses based on non-economic methodologies conclude with significant and positive appreciation of landscape and other benefits of agri-environmental practices (see review by Hall, McVittie, & Moran, 2004). The hierarchy of valued elements is consistent with the literature in that water quality usually generates higher WTP than landscape diversity or aesthetics (Hall et al., 2004; Poder et al., 2016), especially for the population concerned.

The main concern in generalising the results of this study to a background population is the high questionnaire non-response rate and the lack of full-scale surveying and probabilistic sampling. Even though the questionnaire sampling strategy tried to randomly select respondents across the populations of each of the three sub-regions to which the questionnaire was sent, sample characteristics may have been biased by the low response rate. Indeed, respondents could share common socio-economic characteristics that are not representative of the rest of the population (or non-respondents). This is especially true for the Montréal subsample. For example, 80% of Montréal participants had a university degree. This could lead to inflated WTP estimates, since more educated individuals tend to prefer more natural landscapes, such as those proposed in environmental programmes (Howley et al., 2012). This shortcoming is the main reason why aggregating estimated WTP to any of the background populations was avoided.

Moreover, protest bias may occur when individuals who oppose or do not approve the survey fail to respond, give invalid but positive bids (outliers) or place a zero value on goods that they actually value. The first two biases were accounted for, but no control could be established for the latter. Thus, the present study estimates may include 'too many' 0's.

When comparing WTP with the CVM and CE for the landscape aesthetics attribute, estimations of the latter were found to be four times higher than estimates of the former ($360 vs. $80). This is coherent with the literature, in which open-ended WTP has been found to give underestimated values in comparison with choice-based CE (Adamowicz et al., 1998; Jin, Wang, & Ran, 2006). While numerous studies have compared the CVM and CE (e.g. Adamowicz et al., 1998; Colombo et al., 2005; Hanley et al., 1998; He et al., 2016; Jin et al., 2006), they have not been compared in the results reported here.

At least 3 reasons suggest why we should avoid comparing the results of the 2 methods used in this study. Firstly, both methods had very different elicitation formats. As an example of these differences,

CVM elicitation used an open-ended question, while CE used closed questions to elicit respondents' preferences. Secondly, respondents were systematically asked to first answer CE and then the CVM, which could have led to bias. Thirdly, besides difficulties arising from the incompatibility of both methods, it could be assumed that rather large differences between these results could arise from the fact that the benefits generated by BMPs do not respect the additive separability assumption used to evaluate total WTP in CE elicitation. In other words, individuals might find it difficult to value attributes independently, considering that the benefits of an increment in one attribute (e.g. water quality) will necessarily affect other attributes (e.g. fish diversity).

However, use of an open-ended CVM in this study could be questioned, since preference revelation is known to differ according to question formats. While the open-ended format could help to avoid yea-saying biases and to define equally valid bid level vectors through different valuation sites, many recommendations support the use of close-ended questions (Adamowicz et al., 1998; Jin et al., 2006; Mccollum & Boyle, 2005). The free-riding effect, starting point bias and strategic overstatement attributed to open-ended questions can be avoided by the close-ended format and, consequently, furnish more reliable estimates (Mccollum & Boyle,2005).[4]

Many authors consider that CE also has the ability to avoid certain biases associated with the CVM (Adamowicz et al., 1998; Bateman et al., 2002). This is explained by the fact that the respondents in CE surveys are asked to decide on their preferences for different alternatives from a set of scenarios associated with different payments, more closely reflecting realistic everyday consumption decisions. However, with repetition of the exercise, it may be difficult for respondents to maintain consistent strategic thinking (Bateman et al., 2002).

While comparison between the CVM and CE techniques is still an area of abundant research in the literature on economics, a broader debate on stated preferences elicitation should not be ignored in this discussion. Since they are both based on simulated markets, they suffer from their hypothetical nature. This hypothetical bias has been studied by many authors, and meta-analyses by Little and Berrens (2004) and Murphy, Allen, Stevens, and Weatherhead (2005) show overestimation, compared to real-life WTP, by factors of 3 and 1.35, respectively. Moreover, stated preference techniques struggle to integrate the confounding effect of symbolic values for anything that refers to environmental improvement and cannot deal with physical effects that are closely linked to the experience of landscape appreciation (Price, 2014).

In the end, the definition and valuation of landscape aesthetics are complex processes and cannot be fully assessed through econometric welfare estimates. Landscape aesthetics are interconnected and dependent on other ES provided by the agro-environment. Economic valuation techniques and environmental economists tend to neglect these interdependencies, simplifying both ecosystem functions and how respondents might evaluate them (Kumar & Kumar, 2008). The results should be interpreted in this sense, and these limits should be kept in mind when presenting the data based on such methods in the case of agri-environmental BMPs.

5. Conclusion

Although agricultural landscapes are quite commonplace in the visual environment of populations, particularly in intensive agricultural regions, the results of this study have shown that they are still subject to significant social demand. Consequently it is relevant to ask: what kinds of policies optimise positive landscape externalities?

Current Québec and Canadian policies that aim to implement BMPs consider landscape aesthetics as externalities and do not manage them specifically. Paradoxically, although BMPs aim to generate greater social benefits, one of the most valued (i.e. landscape) is not included in the design, planning and management of these policies. It is a reminder that traditional agri-environmental policies on a national scale are not fully adapted and efficient enough to provide ES that are consistent with population preferences.

Under these circumstances, new tools, which are more spatially differentiated and context-specific, need to be considered. The results provided by this study give interesting insights into further agri-environmental policies aiming in that direction. They show that landscape aesthetics are one of the most preferred benefits arising from BMPs. This highlights the need for inclusion of landscape planning in the management of agriculture towards the implementation of BMPs. Our economic valuation of different landscape evolution scenarios and of ES generated in agricultural systems, could also be useful for policy-makers to create locally designed payment schemes for agricultural landscape services.

Notes

1. Note that deviations from the status quo, all occurring at the same point in time, were considered. Thus, taking into consideration that discounting would not change different relative values, alternatives would be discounted at the same rate.
2. Formulation may lead to 'protest bids' of 0 instead of (true) positive WTP: consequently, there may be more '0's' than in reality, and estimates should be considered as lower bounds in that respect.
3. The IIA assumption was subjected to Hausman-McFadden testing of the conditional Logit model. This was done by removing 1 alternative at a time (18 alternatives + status quo), re-estimating the model and comparing the estimates with the full model. Ten out of 19 tests rejected the null hypothesis of IIA. However, readers should keep in mind that the Hausman-McFadden test has been contested by a number of authors and, most notably, by McFadden himself. Instead of such ex-post investigation, he suggested that the conditional Logit model should be used only in cases where the alternatives 'can plausibly be assumed to be distinct and weighted independently in the eyes of each decision maker' (McFadden, 1974). The random Logit parameter is also presented to relax rigid IIA assumptions.
4. The fact that the scenarios are presented one after another can also lead to 'anchoring bias': respondents may rely too heavily on the first scenario offered when making decisions.

Acknowledgements

We gratefully acknowledge the financial support of Agriculture and Agri-Food Canada and the Social Sciences and Humanities Research Council of Canada under the J.A. Bombardier's grant. This project was conducted in the context of a project under the responsibility of Groupe AGECO and we would specially like to thank Isabelle Charron for her help in conducting this study. We also would like to thank the experts who helped to design the scenarios: Gerald Domon, Pierre Dumont, Steve Garceau, Claude Grondin, Louis Ménard, Sébastien Rioux and Julie Ruiz. Finally, we are indebted to Pierre André, Jean-François Bissonnette, Ovid DaSilva and Thomas Poder for their valuable inputs and revisions.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

This work was supported by Agriculture and Agri-Food Canada; and Social Sciences and Humanities Research Council of Canada, under the Joseph-Armand-Bombardier grant.

References

Adamowicz, W., Boxall, P., Williams, M., & Louviere, J. (1998). Stated preference approaches for measuring passive use values: Choice experiments and contingent valuation. *American Journal of Agricultural Economics, 80*, 64–75.

Arriaza, M., Cañas-Ortega, J. F., Cañas-Madueño, J. A., & Ruiz-Aviles, P. (2004). Assessing the visual quality of rural landscapes. *Landscape Urban Planning, 69*, 115–125.

Bateman, I. J., Carson, R. T., Day, B., Hanemann, M., Hanley, N., Hett, T., … Swanson, J. (2002). *Economic valuation with stated preference techniques: A manual*. Cheltenham: Edward Elgar Publishing.

Brady, M., Kellermann, K., Sahrbacher, C., & Jelinek, L. (2009). Impacts of decoupled agricultural support on farm structure, biodiversity and landscape mosaic: Some EU results. *Journal of Agricultural Economics, 60*, 563–585.

Campbell, D. (2007). Willingness to pay for rural landscape improvements: Combining mixed logit and random-effects models. *Journal of Agricultural Economics, 58*, 467–483.

Colombo, S., Hanley, N., & Calatrava-Requena, J. (2005). Designing policy for reducing the off-farm effects of soil erosion using choice experiments. *Journal of Agricultural Economics, 56*, 81–95.

Dachary-Bernard, J., & Rambonilaza, T. (2012). Choice experiment, multiple programmes contingent valuation and landscape preferences: How can we support the land use decision making process? *Land Use Policy, 29*, 846–854.

Dupras, J., & Alam, M. (2015). Urban Sprawling and ecosystem services: A half-century perspective in the montreal region (Quebec, Canada). *Journal of Environmental Policy and Planning, 17*, 180–200.

Dupras, J., Alam, M., & Revéret, J. (2015). Economic value of greater montreal's non-market ecosystem services in a land use management and planning perspective. *Canadian Geographer, 59*, 93–106.

Dupras, J., Marull, J., Parcerisas, L., Coll, L., Gonzalez, A., Girard, M., & Tello, E. (2016a). The impacts of urban sprawl on ecological connectivity in the montreal metropolitan region. *Environmental Science & Policy, 58*, 61–73.

Dupras, J., Parcerisas, L., & Brenner, J. (2016b). Using ecosystem services valuation to measure the economic impacts of land-use changes on the Spanish Mediterranean coast (El Maresme, 1850–2010). *Regional Environmental Change, 58*, 61–73.

Fondation de la Faune du Québec & Union des Producteurs Agricoles. (2011). *Manuel d'accompagnement pour la mise en valeur de la biodiversité des cours d'eau en milieu agricole* [Water biodiversity conservation guide for farmers of Quebec]. Québec: Fondation de la Faune du Québec.

Foster, V., & Mourato, S. (1997). *Behavioural consistency, statistical specification and validity in the contingent ranking method: Evidence from a survey on the impacts of pesticide use in the UK* (CSERGE Working Paper 97-09). Norwich: Centre for Social and Economic Research on the Global Environment.

Gallai, N., Salles, J. M., Settele, J., & Vaissière, B. E. (2009). Economic valuation of the vulnerability of world agriculture confronted with pollinator decline. *Ecological Economics, 68*, 810–821.

Gonzáles, M., & León, C. J. (2003). Consumption process and multiple valuation of landscape attributes. *Ecological Economics, 45*, 159–169.

Grammatikopoulou, I., Pouta, E., & Salmiovirta, M. (2013). A locally designed payment scheme for agricultural landscape services. *Land Use Policy, 32*, 175–185.

Hall, C., McVittie, A., & Moran, D. (2004). What does the public want from agriculture and the countryside? A review of evidence and methods. *Journal of Rural Studies, 20*, 211–225.

Hanley, N., Wright, R., & Adamowicz, V. (1998). Using choice experiments to value the environment: design issues, current experience and future prospects. *Environmental and Resource Economics, 11*, 413–428.

Hanley, N., Mourato, S., & Wright, R. E. (2001). Choice modelling approaches: A superior alternative for environmental valuatioin? *Journal of Economic Surveys, 15*, 435–462.

He, J., Dupras, J., & Poder, T. (2016). The value of Wetlands in Quebec: A comparison between contingent valuation and choice experiment. *Journal of Environmental Economics and Policy, 6*, 51–78. doi:10.1080/21606544.2016.1199976.

Howley, P., Hynes, S., & Donoghue, C. O. (2012). Countryside preferences: Exploring individuals' willingness to pay for the conservation of the traditional farm landscape. *Landscape Research, 37*, 703–719.

Jin, J., Wang, Z., & Ran, S. (2006). Comparison of contingent valuation and choice experiment in solid waste management in Macao. *Ecological Economics, 57*, 430–441.

Kleijn, D., Kohler, F., Baldi, A., Batary, P., Concepcion, E. D., Clough, Y., … Verhulst, J. (2009). On the relationship between farmland biodiversity and land-use intensity in Europe. *Proceedings of the Royal Society B: Biological Sciences, 276*, 903–909.

Kumar, M., & Kumar, P. (2008). Valuation of the ecosystem services: A psycho-cultural perspective. *Ecological Economics, 64*, 808–819.

Lancaster, K. (1966). A new approach to consumer theory. *Journal of Political Economy, 74*, 132–157.

Little, J., & Berrens, R. (2004). Explaining disparities between actual and hypothetical stated values: Further investigation using meta-analysis. *Economics Bulletin, 3*(6), 1–13.

Louviere, J. J., Hensher, D. A., & Swait, J. D. (2000). *Stated choice methods: Analysis and application*. Cambridge: Cambridge University Press.

Marangon, F., & Visintin, F. (2007). Rural landscape valuation in a cross-border region. *Cahiers d'économie et sociologie rurales, 84–85*, 114–132.

Mccollum, D., & Boyle, K. (2005). The effect of respondent experience/knowledge in the elicitation of contingent values: An investigation of convergent validity, procedural invariance and reliability. *Environmental & Resource Economics, 30*, 23–33.

McFadden, D. (1974). Conditional logit analysis of qualitative choice behavior. In P. Zarembka (Ed.), *Frontiers in Econometrics* (pp. 105–142). New York, NY: Academic Press.

Murphy, J. J., Allen, P. G., Stevens, T. H., & Weatherhead, D. (2005). A meta-analysis of hypothetical bias in stated preference valuation. *Environmental and Resource Economics, 30*, 313–325.

Paquette, S., & Domon, G. (2003). Changing ruralities, changing landscapes: Exploring social recomposition using a multi-scale approach. *Journal of Rural Studies, 19*, 425–444.

Pimentel, D., Harvey, C., Resosudarmo, P., Sinclair, K., Kurz, D., McNair, M., … Blair, R.. (1995). Environmental and economic costs of soil erosion and conservation benefits. *Science, 267*, 1117–1123.

Poder, T., Dupras, J., Ndefo, F., & He, J. (2016). The economic value of the greater montreal blue network (Quebec, Canada): A contingent ranking study to estimate non market-aquatic ecosystem services benefits. *PLoS One, 11*, e0158901. doi: 10.1371/journal.pone.0158901.

Price, C. (2014). Regulating and supporting services and disservices: Customary approaches to valuation, and a few surprising case-study results. *New Zealand Journal of Forestry Science, 44*(Suppl 1), S5.

Rambonilaza, M., & Dachary-Bernard, J. (2007). Land-use planning and public preferences: What can we learn from choice experiment methods? *Landscape and Urban Planning, 83*, 318–326.

Rolfe, J., & Bennett, J. (2009). The impact of offering two versus three alternatives in choice modeling experiments. *Ecological Economics, 68*, 1140–1148.

Ruiz, J., & Domon, G. (2009). Analysis of landscape pattern change trajectories within areas of intensive agricultural use: Case study in a watershed of southern Québec, Canada. *Landscape Ecology, 24*, 419–432.

Ruiz, J., Domon, G., Lucas, E., & Côté, M. J. (2008). Vers des paysages multifonctionnels en zone d'intensification agricole au Québec (Canada) [Towards multifunctional landscapes in agricultural intensification zone in Quebec (Canada)]. *Revue forestière française, 60*, 589–602.

Statistics Canada. (2006). *2006 Census of population*. Retrieved from http://www12.statcan.gc.ca/census-recensement/2006/index-eng.cfm

Vouligny, E., Domon, G., & Ruiz, J. (2009). An assessment of ordinary landscapes by an expert and by its residents: Landscape values in areas of intensive agricultural use. *Land Use Policy, 26*, 890–900.