Linking agricultural land conservation and provision of ecosystem services: A choice experiment approach

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Abstract

This paper evaluates agricultural land conservation programs and bridges the linkage between agricultural land conservation and provision of ecosystem services. A choice experiment is used to estimate the values of conservation programs that preserve land in different types of agricultural use with different locations to residents of a peri-urban area, the Alberta Capital Region in Canada. We employ the multinomial logit model to estimate willingness to pay for the proposed conservation strategies and the latent class model to relax residents' heterogeneous preferences. The values of ecosystem services conveyed by type of agricultural use are further estimated. The results show that residents in the study area ascribe positive values to farmland conservation, ranging from CAD$20,000 to CAD$129,000 per acre depending on different agricultural practices and land locations. In specific, willingness to pay for conservation programs is highest for land used for commercial vegetable farm, adjacent to primary highways, and outside of city limits. We also find that among a myriad of ecosystem services residents are most concerned with local food production while recreation has the lowest interest across all types of agricultural use.

Keywords: agricultural land conservation, ecosystem services, choice experiment, nonmarket valuation, latent class model, peri-urban, Canada

JEL Classification: Q15, Q24, Q57, R52

1. Introduction

Characterized as a wide range of natural processes and products that support human existence and enhance human wellbeing, the term ecosystem services (ES) has been popularized by both ecologists and economists over the decades (Costanz et al., 1997; Daily, 1997; Limburg and Folke, 1999). de Groot (1992) explicitly defined ecosystem services as the direct and indirect benefits that human beings can obtain from the capacity of natural processes and components. Following this broad concept, the Millennium Ecosystem Assessment (2005) further grouped ES into four categories that include supporting, provisioning, regulating, and cultural purposes.

To design policies that can guide landowners to provide ES at levels that are desirable to the whole society, the assessment of economic values on ES is pivotal. However, ecosystem services are not always measurable in the marketplace. To overcome this issue, nonmarket valuation methods (i.e., the estimation of monetary values of goods and services that are not typically exchanged in a market setting) have been applied to evaluate ecosystem services (Swinton et al., 2007). However, values of ES may differ from landowners to consumers (or the general public). In specific, landowners would often lose income by changing production practices to generate more ES. In such cases, the value of ES to them can be estimated from their willingness to supply those ES in exchange for minimal compensation, referred to as willingness to accept (WTA). On the other hand, consumers would gain satisfaction from the availability of more ES, so values to them can be estimated from their willingness to pay (WTP) for additional ES. In the nonmarket valuation literature, choice experiment has widely been used to measure farmers' WTA through payments for ecosystem services schemes (Beharry-Borg et al., 2013; Kaczan et al., 2013) and public's WTP for the provision of ecosystem services (Baskaran et al. 2009; Dias and Belcher, 2015).

Over the century, the clearing of native ecosystems such as forest or wetland constitutes a major disturbance of existing ecosystems (FAO, 2010). Meanwhile, it has been increasingly recognized that the agricultural sector also delivers substantial ecosystem services flows (de Groot et al., 2002; Nainggolan et al., 2013). Although the production of food, fiber, and fuel is considered the primary goal of agriculture, agriculture has been found to supply all other three categories of ecosystem services (i.e., supporting, regulating, and cultural services) that are outlined in the Millennium Ecosystem Assessment. For example, agricultural practices have a variety of environmental impacts that affect a wide range of ecosystem services, including water quality, pollination, nutrient cycling, soil retention, carbon sequestration, and biodiversity conservation (Dale and Polasky, 2007; Verburg et al. 2009).

In this paper, we explore the linkage between agricultural land conservation and the provision of ecosystem services. We first elicit residents' preferences for agricultural land conservation using a choice experiment approach and estimate economic values that residents place on various agricultural land conservation programs through multinomial logit model. Latent class model is further employed to relax the heterogeneous preferences. In addition, we link different types of agricultural use and residents' affinity with different ecosystem services upon which we estimate the values of ecosystem services that are conveyed by differentiated agricultural practices. The application is to the Alberta Capital region (ACR), Canada, where there contains some of the highest soil quality land in the province. The ACR has experienced substantial agricultural land conversions in the past decades, and rapid land-use changes, as well as fast-growing population, have brought great concerns to the provincial government and local authorities. Meanwhile, lack of concrete policy guidelines in Alberta for preserving prime farmland and the threat of urban sprawl to the future local food production continue to arouse debate on the conservation of agricultural land.

Our analysis highlights several key findings and contributions to the literature. First, to our best knowledge, this is one of the very few studies in Canada (see Bower and Didychuk, 1994; Androkovich et al., 2008; Wang and Swallow, 2016) that estimates the values of agricultural land conservation using nonmarket valuation method. Although such valuation research has been extensively conducted in the United States (see Bergstrom and Ready, 2009), prior studies in a Canadian context are still limited, especially in a peri-urban setting. Second, while there exists a growing body of valuation studies on agricultural land conservation programs and provision of ecosystem services, they tend to investigate these two streams separately. Few of the current literature bridges the linkage between agricultural land conservation and provision of ecosystem services, and little is known about the economic values of ecosystem services conveyed by agricultural land conservation. Using a rigorously designed survey instrument, we reveal the values of different types of ecosystem services and their relationship with different agricultural land uses and different locations. The results from this study can provide the local government with valuable information on how the residents evaluate the agricultural land conservation programs. In addition, the nonmarket values of ecosystem services associated with different types of agricultural use can also be compared to the financial costs of future projects that aim to provide ecosystem services at the optimal level that are desirable to the entire society.

2. Study Area

Located in the center of the prairie province Alberta in Canada, the Alberta Capital Region (ACR) is a conglomerate of 24 municipalities (i.e., five cities, 11 towns, and three villages in five counties) that surround the provincial capital, Edmonton (Figure 1). Covering approximately three million acres, the ACR accounts for 1.9% of Alberta's land base but accommodates 31.8% of Alberta's population (CRB, 2016). In the past decade, increasing population growth and development have been observed in the region. By the year 2016, the ACR had a population of about 1.2 million, making it the sixth-largest Census Metropolitan Area in Canada (CRB, 2016). During the period 2008-2013, the population in the ACR increased about 0.1 million with a growth rate of 8.6%. Such a rising trend is likely to continue over the forecast period and the ACR is expected to have about two million residents by 2044 (CRB, 2016). The rapid population growth in the ACR has caused evident agricultural land conversions. A report by the Alberta Land Institute indicated that of all agricultural land conversions, approximately 7.1% was converted to development during 2000-2012 and that about 61% of these agricultural lands had soils with the highest suitability for agricultural uses in the province (Haarsma et al., 2014).

[Figure 1 is about here]

Increasing population growth and resulting agricultural land conversions have brought substantial concerns to the provincial government and local authorities. In 2008, the Government of Alberta created the *Land-Use Framework* (LUF) as a blueprint to align provincial and local initiatives for land-use policies and to support a healthy environment, diverse communities, and a thriving economy (Government of Alberta, 2008). One of the key strategies was the call to identify ecosystems as main desired outcomes in the outlined seven regions within the province and to develop a regional plan for each of these regions. Specifically, the use and enjoyment of land and natural resources as well as the protection of land, air, water, and biodiversity were highlighted. At the regional level, the Capital Region Board further implemented the *Capital Region Land Use Plan* in 2009 to improve land-use planning and coordination among municipalities in the region (CRB, 2009). The Plan also has a strong focus on the preservation and protection of environmentally sensitive areas (e.g., open space, natural reserves) and agricultural lands for environmental and ecological features.

Despite these policy efforts, unlike other provinces such as British Columbia, Quebec, and Ontario, there still lacks provincial-level legislative framework in Alberta for preserving prime farmland (Beckie et al., 2013). However, rapid urban sprawl has caused the loss of high soil quality agricultural land in the Edmonton area. The power of developers' interest, both new industrial and residential development, continues to threaten the preservation of farmland. Both the development interests and the planning process itself have resulted in a land-use plan that preserve little agricultural land and threaten the future of local food production in the area (Smythe, 2013). Therefore, an investigation of how residents perceive agricultural land conservation and what motivate them to protect farmland shall provide policy makers with valuable evidence to design more effective policy interventions.

3. Materials and Methods

3.1 Choice experiment approach

Choice experiments (CEs), also referred to as conjoint analyses or attribute-based methods, are typically applied to goods or services that have multiple attributes, particularly those related to the environment and ecosystem. CEs define the goods or services in the form of specific bundles of various attributes, cost/price included, and thus evaluate respondents' WTP/WTA for different levels of individual attributes (Grafton et al., 2003). Typically, respondents are given a choice of several different bundles, including a bundle that is the status quo option wherein there is no change and no associated cost.

CEs have widely been used to evaluate a variety of environmental and ecological programs worldwide, for example, the preservation of farmland (Inge et al., 2013; Duke et al., 2014), wetland retention (Carlsson et al., 2003; Dias and Belcher, 2015), forest conservation

(Horne et al., 2005; Kaczan et al., 2013), and coastal and marine ecosystem (McVittie and Moran, 2010; Remoundou et al., 2015).

3.2 Experimental design and data collection

The economic values of agricultural land preservation programs have been extensively explored in North America on multiple aspects (see a review by Bergstrom and Ready, 2009). In general, the typical types of agricultural land practice in the literature include grain crops, livestock grazing, hay, and vegetable farming (e.g., Johnston and Bergstrom, 2011; Johnston et al., 2007; Volinskiy and Bergstrom, 2007). Recent studies have also considered spatial elements that contain the size of land parcel, land proximity, and adjacent land uses, to more realistically describe land preservation programs (e.g., Hanley et al., 2003; Inge et al., 2013; Johnston and Bergstrom, 2011). Other studies focused on multifunctional amenities of preservation programs such as preservation policies (Johnston and Duke, 2009), public access (Duke and Johnston, 2010), and some specific management practices (Duke et al., 2012).

Following the previous studies, the attributes in the CE design in this study include type of agricultural use (four levels), acres conserved (four levels), adjacent area (two levels), location proximity (two levels), and the cost in the form of a one-time increase in property tax or rent for the next year only (five levels), as shown in Table 1. In the CE survey, each respondent was provided with two alternatives in each choice set, with one alternative named the “conservation strategy” that would conserve land in a specific agricultural land use and a specific type of area through a conservation easement with a certain cost, and the other alternative as the “status quo” that would result in no policy change and no cost. Figure 2 illustrates an example of a choice experiment question. We adopted a two-alternative choice experiment primarily based on prior literature (Johnston et al., 1999; Johnston et al., 2002) and higher incentive compatibility to respondents as opposed to the three-alternative approach (Adamowicz et al., 2011; Carson and Groves, 2011). To achieve a D-efficiency design of the experimental design, we generated 32 different choice sets from the econometric software *Ngene*. These 32 choice sets were grouped into four blocks, and each respondent randomly received one block with eight different choice sets, which were also in randomized orders.

[Table 1 is about here]

[Figure 2 is about here]

The survey was developed by the authors of this article and was finalized after three focus groups with experts, one focus group with a random sample of the general public, and a soft launch as the pilot study. Three expert focus groups were held to define the context, scope, and objectives of the study. One focus group of study area residents was randomly selected to pre-test the survey. *Qualtrics*© (a market research company) conducted the final internet-based survey with a panel of study area residents. Besides the attribute-based choice experiment questions, the survey instrument also asked other questions such as background information on respondents' attitudes toward agricultural land conservation, follow-up questions, and respondents' demographics. A total of 320 respondents completed the survey, which was used in the empirical analyses.

3.3 Choice experiment conceptual model

The conceptual model is derived from the standard random utility theory (Ben-Akiva and Lerman, 1985; McFadden, 1974). First, it is assumed that residents face a gain of utility from agricultural land conservation programs through a conservation strategy but a loss of utility from the associated cost. Second, residents are assumed to choose a conservation strategy if the net utility from that choice is higher than no strategy. Third, the probability of residents making a particular choice is assumed to increase as the utility of that choice increases. The overall utility obtained from a conservation strategy is expressed as the following utility function:

$$U_i(P_j) = U(\boldsymbol{X_j}; \boldsymbol{Z_i}) \tag{1}$$

where P_j is the j^{th} conservation strategy, $U_i(P_j)$ is the utility obtained from that conservation strategy, $\boldsymbol{X_j}$ is a vector of attributes (cost included) of conservation strategy j, $\boldsymbol{Z_i}$ is a vector of individual-specific characteristics of respondent i. Utility is assumed to be a function of the nature of the conservation strategy, P_j, which corresponds to an indirect utility function, $V_i(P_j)$. The indirect utility function is comprised of a systematically observable component $v_i(P_j)$ and a randomly unobservable component ε_{ij}:

$$V_i(P_j) = v_i(P_j) + \varepsilon_{ij} \tag{2}$$

The probability, π_{ij}, that a conservation strategy j would be chosen from a set of conservation strategies N is:

$$\pi_{ij} = \Pr\left[v_i(P_j) + \varepsilon_{ij} \geq v_i(P_k) + \varepsilon_{ik}; \forall j \neq k \in N\right] \tag{3}$$

Equation (3) can be rearranged as:

$$\pi_{ij} = \Pr\left[\varepsilon_{ik} - \varepsilon_{ij} \leq v_i(P_j) - v_i(P_k); \forall j \neq k \in N\right] \tag{4}$$

The standard assumption in using random utility model is that errors are independently and identically distributed (IID) following a type 1 extreme value (Gumbel) distribution. The difference between two Gumbel distributions results in a logistic distribution, yielding a conditional or multinomial logit (MNL) model (McFadden, 1974). Suppose that each choice set consists of N conservation strategies. If errors are distributed as type 1 extreme value, the MNL model applies and the probability of respondent i choosing conservation strategy j is:

$$\pi_i(P_j) = \frac{e^{\mu v_i(P_j)}}{\sum_{j=1}^{N} e^{\mu v_i(P_j)}} \tag{5}$$

where μ is a scale parameter which reflects the variance of the unobserved part of utility (Ben-Akiva and Lerman, 1985). In basic models, the scale parameter is typically set equal to one. We further assume a linear specification of the observable utility function as follows:

$$v_i(P_j) = \boldsymbol{\beta X_j} \tag{6}$$

where $\boldsymbol{\beta}$ is a vector of marginal utilities for each attribute $\boldsymbol{X_j}$.

A major limiting property of the MNL model is the assumption of homogenous preferences across respondents, which restricts the preference parameters estimated from Equation (6), $\boldsymbol{\beta}$, to be the same for all respondents. One popular approach to relaxing the heterogeneity assumption is the use of a latent class (LC) model in which it is assumed that respondents belong to different preference classes that are defined by a small number of segments (Swait, 1994). Suppose there are S segments that represent different preferences. If respondent i belongs to segment s ($s = 1, \ldots, S$), the probability of choosing conservation strategy j for respondent i depends on the segment that one belongs to and it can be expressed as follows:

$$\pi_{i|s}(P_j) = \frac{e^{\mu_s \boldsymbol{\beta_s X_j}}}{\sum_{j=1}^{N} e^{\mu_s \boldsymbol{\beta_s X_j}}} \tag{7}$$

where μ_s and $\boldsymbol{\beta_s}$ are segment-specific scale parameters and utility estimates, respectively.

3.4 Empirical model

Based on the CE design in this study, the observable utility function in a linear specification for empirical analysis can be expressed as follows:

$$v_i(P_j) = \beta_0(ASC) + \beta_1(Grain * Acres) + \beta_2(Live * Acres) + \beta_3(Hay * Acres) + \beta_4(Highway * Acres) + \beta_5(City * Acres) + \beta_6(Acres) + \beta_7(Cost) \quad (8)$$

where *ASC* (alternative specific constant) is a binary variable indicating the choice of no conservation strategy; *Grain*, *Live*, and *Hay* are all binary variables indicating whether the land is conserved for grain/oilseed farming, livestock grazing on native farming, and hay land, respectively, against the default of commercial vegetable farm; *Highway* is a binary variable indicating the conserved land is adjacent to a primary highway, against the default of adjacent to a conservation buffer; *City* is a binary variable indicating whether the conserved land is within city limits, against the default of within a 10-km buffer from currently developed land; *Acres* is the number of acres conserved; and *Cost* is the property tax or rent increase for the next year only. Note that the variable "*Grain**Acres*" denotes "*Grain*" multiplied by "*Acres*," and so on for other variables in the model as applicable. This model specification follows a prior study (Wang and Swallow, 2016), which is primarily based on previous literature (e.g., Duke and Johnston, 2010; Johnston and Duke, 2009; Johnston et al., 2007).

Based on the linear utility function as shown in Equation (8), WTP for a marginal change in the i^{th} attribute can be simply calculated as the ratio of the coefficient of that attribute and the coefficient of the money cost as follows:

$$WTP_i = -\frac{\beta_i}{\beta_7} \quad (9)$$

Following Johnston et al. (2007) and Wang and Swallow (2016), WTP for changes in more than one attribute (e.g., conservation strategies) can be calculated as follows:

$$WTP = -\frac{\sum_i \beta_i \Delta X_i}{\beta_7} \quad (10)$$

where ΔX_i indicates the change in the i^{th} attribute, relative to the baseline case.

4. Results

4.1 Descriptive statistics

Table 2 shows some basic socio-demographic statistics about the respondents. Gender percentage was equal, and the average age of the sample was about 51 with a minimum of 18 and maximum of 86 years old. Approximately 75% of the respondents lived in the City of Edmonton, with the rest living in surrounding cities and counties. The median household income (before tax) for the sample was between $89,999 and $119,999. Almost 43% of the respondents have completed a university degree (e.g., undergraduate, Master or Ph.D.). In comparison with the demographics at the ACR level, the survey sample was fairly well represented in terms of the gender and residence.

4.2 Agricultural land conservation preferences and WTP

There are two problems need to be addressed before we can use the choice experiment data for analysis. First, hypothetical bias may exist due to “yea-saying.” Yea-saying is closely related to social desirability, the influence of social norms, and the immediate social context on the resulting responses (Mitchell and Carson, 1989). In general, yea-sayers are deemed as those who vote “yes” to the program regardless of the cost. However, respondents who voted “yes” to all eight valuation questions in our study may not necessarily be yea-sayers. Other criteria need to be taken into account to identify this group, such as respondents’ attitude toward the cost (Olar et al., 2007; Sverrison et al., 2007). We asked a debriefing question about how important was each attribute to respondents when voting. Those that chose the answer “not at all important” or “unimportant” for the cost of the conservation strategy (i.e., property tax or rent increase for the next year only) were termed “yea-sayers” and if they voted “yes” to all eight valuation questions. As a result, we identified seven respondents as “yea-sayers” across the sample. Second, uncertain responses were also identified. Responses with “somewhat uncertain” or “very uncertain” to the vote questions were considered votes with uncertainty in this study. Previous studies suggested that if respondents indicate a high level of uncertainty in their response, that particular vote could effectively be considered a vote of “no” (Blumenschein et al., 2008). We followed this practice and recoded the uncertain votes for the conservation strategy to the status quo (i.e., no strategy).

Table 3 presents the coefficient estimates and corresponding per-acre per-household WTPs using the data when uncertain votes were recoded and yea-sayers were removed. First, it is expected that the coefficient for *Cost* has a negative relationship with the probability of voting “yes” for the conservation strategy, as respondents’ marginal utility of money is assumed to be decreasing. Second, a significantly negative estimate of *ASC* indicates that respondents have a strong tendency to vote for conservation strategies that conserve land in agricultural uses, relative to the status quo in which no such program would be implemented. This finding is in accordance with other answers to the warm-up questions in which most respondents expressed their great concern with the agricultural land loss in the ACR and their preference to maintain land in agricultural uses. Third, in terms of the type of agricultural use, commercial vegetable farm is most preferred, with grain/oilseed farming and hay land least favored. Forth, with respect to the spatial attributes of conserved land, residents prioritize land adjacent to primary highways over land adjacent to existing conservation buffers, and prefer land within a 10-km buffer from currently developed land over land within city limits.

[Table 3 is about here]

Based on the WTP estimates for each attribute from Table 3, we calculated the values of conservation strategies as a whole at the household level in Table 4. As policy makers may be particularly interested in the aggregate welfare measures, we further estimated the WTP per acre for the whole study area for all sixteen different types of conservation strategies that can be generated from the survey. Table 4 shows that the WTPs for conservation strategies range from CAD$0.04 to CAD$0.28 per acre per household. If we consider the whole population of the ACR, these values vary from CAD$20,000 to CAD$129,000 per acre. In specific, a conservation strategy that consists of commercial vegetable farm, adjacent to primary highway, and within 10-km buffer from currently developed land is most preferred and would generate about CAD$129,000 per acre. Meanwhile, grain/oilseed farming and hay land that are adjacent to conservation buffer, and within city limits are given the lowest priority and respondents' WTPs for these two conservation strategies are CAD$20,000 per acre.

[Table 4 is about here]

4.3 Heterogeneity of preferences

To investigate what potential factors contribute to heterogeneous preferences, we adopted the latent class model by including respondents' socio-demographic characteristics as well as attitudinal indicators into the model. Besides the attribute-based choice experiment questions, the survey instrument asked respondents' socio-demographics and their attitudes toward agricultural land conversion rate, need for agricultural land conservation, and infill development. As for the selection of the number of classes, no standard criteria have yet been proposed in literature. Rather, previous studies (Boxall and Adamowicz, 2002; Scarpa and Thiene, 2005) suggested class selection based on log-likelihood statistics and information criteria such as AIC (Akaike Information Criterion). Generally, smaller values of such information criteria are preferred (Cameron and Trivedi, 2005). Additionally, some judgement is required with regard to the plausibility of results given the size of membership classes. For example, Scarpa and Thiene (2005) indicated that as the number of classes increases, the significance of parameter estimates gradually decreases, especially in classes with low probability of membership. Therefore, the selected number of classes must also account for the significance of parameter estimates and be tempered by researchers' own judgment on the meaningfulness of the parameter signs. We selected a two-class model primarily based on both AIC criterion and the meaningfulness of parameter estimates (i.e., both sign and significance).

Table 5 presents the results from the latent class model. First, the average of these two classes, weighted by the class probabilities, are 0.70 and 0.30, respectively, for Class 1 and Class 2. In general, results from Class 1 are similar to those reported in the MNL model as shown in Table 3. Specifically, *ASC* and the *Cost* are significantly negative. Among four types of agricultural use, the commercial vegetable farm is most preferred, with grain/oilseed and hay land given the least priority. While for Class 2, respondents seem to support the status quo as the estimate of *ASC* is positively significant. In addition, respondents in this class do not appear to have significantly different preferences among four types of agricultural use, although land adjacent to primary highways is preferred to land adjacent to conservation buffers. Second, in terms of the socio-demographics in the class analysis, males and residents living in Edmonton are less likely to fall into Class 1. However, respondents' age and household income do not appear to explain grouping. For all three attitudinal indicators (i.e., attitudes toward agricultural land conversion rate, need for agricultural land conservation, and infill development), the coefficients are significantly positive. Such results indicate that holding these opinions respondents are more likely to be in Class 1 with strong support of the proposed conservation strategies.

[Table 5 is about here]

4.4 Linkage between agricultural land conservation and provision of ecosystem services

Another contribution of this study is to explore the links between values of land in agricultural uses and residents' affinity with different ecosystem services. After each valuation question, respondents were asked to choose the ecosystem services (primarily based on the Millennium Ecosystem Assessment, 2005) provided by the chosen agricultural uses, upon which they voted for the proposed conservation strategy. Figure 3 demonstrates the percentages of seven ecosystem services that respondents chose regarding the specific type of agricultural use. Respondents were found to be most concerned with food for local market among all ecosystem services with an average of 84% across four types of agricultural use, while recreation has the lowest percentage of about 36%. In addition, the orders of percentage are generally similar across the type of agricultural use, with food for local market having the highest percentage and recreation the lowest. One noteworthy point is for commercial vegetable farms that more than 90% of residents chose the proposed conservation strategies because of food for local consumption. Intuitively, more respondents think water purification and air quality regulation are more important to hay land than livestock grazing on native pasture since livestock may raise problems such as manure which is considered to be detrimental to the environment.

Combining the percentage statistics from Figure 3 and WTP estimates from Table 4, we further calculate the estimated aggregate WTP for ecosystem services by type of agricultural use, as shown in Table 6. A range of estimates is given due to the embedded spatial elements of the proposed conservation strategies in the choice experiment. For example, residents would pay about CAD$118,000 per acre for local food production through a conservation strategy that consists of commercial vegetable farm, adjacent to primary highway, and within 10-km buffer from currently developed land. Approximately CAD$6,800 per acre for recreational values can be generated for a conservation strategy that conserves land in grain/oilseed farming, adjacent to conservation buffer, and within city limits. A noteworthy finding from Table 6 is that although residents are generally willing to pay more for conservation strategies involving commercial vegetable farm, the values may not necessarily be higher when it comes to ecosystem services. For example, WTP is higher for local food production when land is conserved for livestock grazing relative to the case in which land is conserved for commercial vegetable farm for the global food production purpose.

[Figure 3 is about here]

[Table 6 is about here]

5. Discussion and Policy Implications

Several findings from this study need to be discussed in more detail. From multinomial logit model we find that commercial vegetable farm is most preferred among four types of agricultural use. Such a result can be closely related to residents' interests in local food production and consumption. In 2012, the City of Edmonton launched a food and urban agriculture strategy called *Fresh* (City of Edmonton, 2012) to build a resilient food system that contributes to the local economy and environmental sustainability. Several steps have been taken in growing local food supply and demand including the identification of existing locations that could be used for local food production. Meanwhile, the rapid urban sprawl surrounding Edmonton continues to be a hot debate among the public. Since farming practices in areas on the urban edge are predominantly tailored for serving urban markets and that peri-urban areas are iteratively shaped by how cities grow and expand, particular policy attention needs to be focused on farmland protection in city fringes. Indeed, most of land suitable for fresh vegetable production is located in northeast Edmonton near the North Saskatchewan River (Smythe, 2015). But development plans for that region continue to threaten the future food production and have triggered the public's strong support of local food and preservation of farmland (Beckie et al., 2013).

Residents are found to prioritize land adjacent to primary highways over land adjacent to existing conservation buffers. There are primarily two reasons accounting for this result. First, for nonuse values such as scenic beauty, residents would attach higher values to the conserved agricultural land if the land is more accessible to them (e.g., more visible from roads and highways). This argument can be supported by prior studies (Hanley et al., 2003; Inge et al., 2013) that WTP decreases when the conserved areas are located further away from respondents' residence, referred to as the distance decay effect. Second, there may exist the crowding-out effect (Andreoni, 1993; Parker and Thurman, 2011) between newly conserved land and existing conservation areas. Given that the CRB has already designated environmentally sensitive areas to protect natural features in the ACR (CRB, 2009), our analysis provides policy makers with some useful information on the location selection of future agricultural land conservation if they plan to establish specific designations such as agricultural land reserves to accommodate peri-urban farmland.

Another important policy implication from this study lies in the knowledge of the values of ecosystem services and their relationship with different agricultural practices. Our analysis provides solid evidence that residents value the local food production the most among all ecosystem services across four types of agricultural use. Together with the results from MNL model, one effective policy intervention is to encourage small local food business and communitywide facilities such as U-pick farms and community gardens within and/or surrounding the urban fringes. Although residents are generally willing to pay more for conservation strategies involving commercial vegetable farm, the values of ecosystem services may not necessarily be higher (Table 6). For example, when it comes to air quality improvement and water purification, residents may place higher values on gran/oilseed farming and hay land relative to commercial vegetable farm. Such an outcome suggests that more tailored program design need to be considered that incorporate not only the targeted type of agricultural use but also the potential ecosystem services the agricultural practice can deliver to the public.

6. Conclusion

In this paper, we conduct the nonmarket valuation of agricultural land conservation programs using a choice experiment approach in the Alberta Capital Region, Canada. We extend the literature to a Canadian and peri-urban setting that has been less explored in prior studies. Both multinomial logit and latent class models are applied in the empirical analysis.

Our results show residents' strong support of conservation strategies to conserve agricultural land. The choice experiment specifically reveals that commercial vegetable farm is the most preferred type of agricultural use, with grain/oilseed farming and hay land least favored. Residents also prioritize land adjacent to primary highways against land adjacent to conservation buffers and prefer land within 10-km buffer from currently developed land over land within city limits. In terms of monetary values, residents would be willing to pay for the proposed conservation strategies ranging from CAD$20,000 to CAD$129,000 per acre, depending on the type of agricultural use and land locations. From the latent class model, residents are more likely to be in the group that advocate agricultural land conservation if they are more concerned with agricultural land conversions in the study area.

We further explore the linkage between agricultural land conservation and provision of ecosystem services. We find that residents are most concerned with local food production among all ecosystem services across four types of agricultural use, while showing the lowest interest in recreational values from agricultural land conservation programs. The aggregate WTP for ecosystem services vary from CAD$6,800 to CAD$118,000 per acre by type of agricultural use. Although residents impose higher values on conservation strategies involving commercial vegetable farm in general, the values may be lower when it comes to ecosystem services when compared to other agricultural practices. Such variations suggest heterogeneous demand for ecosystem services that can be obtained from different agricultural practices, which shall offer more insights of future conservation programs to be implemented.

References:

Adamowicz, V., Dupont, D., Krupnick, A., Zhang, J., 2011. Valuation of cancer and microbial disease risk reductions in municipal drinking water: An analysis of risk context using multiple valuation methods. Journal of Environmental Economics and Management 61(2), 213-226.

Allen, K.E., Moore, R., 2016. Moving beyond the exchange value in the nonmarket valuation of ecosystem services. Ecosystem Services 18, 78-86.

Andreoni, J., 1993. An experimental test of the public-goods crowding-out hypothesis. American Economic Review 83(5), 1317-1327.

Androkovich, R., Desjardins, I., Tarzwell, G., Tsigaris, P., 2008. Land preservation in British Columbia: An empirical analysis of the factors underlying public support and willingness to pay. Journal of Agricultural and Applied Economics 40(3), 999-1013.

Baskaran, R., Cullen, R., Takatsuka, Y., 2009. Estimating the value of agricultural ecosystem services: A case study of New Zealand pastoral farming. Australasian Journal of Environmental Management 16(2), 103-112.

Beckie, M.A., Hanson, L.L., Schrader, D., 2013. Farms or freeways? Citizen engagement and municipal governance in Edmonton's food and agriculture strategy development. Journal of Agriculture, Food Systems, and Community Development 4(1), 15-31

Beharry-Borg, N., Smart, J.C.R., Termansen, M., Hubacek, K., 2013. Evaluating farmers' likely participation in a payment programme for water quality protection in the UK uplands. Regional Environmental Change 13, 633-647.

Ben-Akiva, M., Lerman, S., 1985. Discrete choice analysis: Theory and application to travel demand. MIT Press, Cambridge, Massachusetts.

Bergstrom, J.C., Ready, R.C., 2009. What have we learned from over 20 years of farmland amenity valuation research in North America? Review of Agricultural Economics 31(1), 21-49.

Blumenschein, K., Blomquist, G.C., Johannesson, M., Horn, N., Freeman, P., 2008. Eliciting willingness to pay without bias: Evidence from a field experiment. The Economic Journal 118: 114-137.

Bowker, J.M., Didychuk, D.D., 1994. estimation of nonmarket benefits of agricultural land retention in eastern Canada. Agricultural and Resource Economics Review 23, 218-225.

Boxall, P., Adamowicz, W.L., 2002. Understanding heterogeneous preferences in random utility models: A latent class approach. Environmental and Resource Economics 23(4), 421-446.

Cameron, A.C., Trivedi, P.K., 2005. Microeconometrics: Methods and applications. Cambridge University Press, New York.

Capital Region Board (CRB), 2009. Capital Region Land Use Plan. Available at http://www.assembly.ab.ca/lao/library/egovdocs/2009/alma/172916_02.pdf.

Capital Region Board (CRB), 2016. About the CRB. Available at http://capitalregionboard.ab.ca/about-us/.

Carlsson, F., Frykblom, P., Liljenstolpe, C., 2003. Valuing wetland attributes: An application of choice experiments. Ecological Economics 47, 95-103.

Carson, R.T., Groves, T., 2011. Incentive and information properties of preference questions: Commentary and extension. In: Bennett, J. (Ed.), International Handbook of Non-Market Environmental Valuation. Edward Elgar, Northampton, MA.

City of Edmonton, 2012. Fresh, Edmonton's food and urban agriculture strategy. Available at http://www.edmonton.ca/city_government/documents/FRESH_October_2012.pdf/.

Costanza, R., d'Arge, R., de Groot, R.S., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R.V., Paruelo, J., Raskin, R.G., Sutton, P., van den Belt, M., 1997. The value of the world's ecosystem services and natural capital. Nature 387, 253–260.

Daily, G.C., 1997. Nature's services: Societal dependence on natural ecosystems. Island Press, Washington, DC. 392 pp.

Dale, V.H., Polasky, S., 2007. Measures of the effects of agricultural practices on ecosystem services. Ecological Economics 64, 286–296.

de Groot, R.S., 1992. Functions of nature: Evaluation of nature in environmental planning, management and decision making. Wolters-Noordhoff, Groningen.

Dias, V., Belcher, K., 2015. Value and provision of ecosystem services from prairie wetlands: A choice experiment approach. Ecosystem Services 15, 35-44.

Duke, J.M., Dundas, S.J., Johnston, R.J., Messer, K.D., 2014. Prioritizing payment for environmental services: using nonmarket benefits and costs for optimal selection.

Ecological Economics 105, 319-329.

Duke, J.M., Johnston, R.J., 2010. Nonmarket valuation of multifunctional farm and forest preservation. New perspectives on agri-environmental policies: A multidisciplinary and transatlantic approach. Routledge, New York, pp.124-142.

Duke, J.M., Borchers, A.M., Johnston, R.J., Absetz, S., 2012. Sustainable agricultural management contracts: Using choice experiments to estimate the benefits of land preservation and conservation practices. Ecological Economics 74, 95-103.

Food and Agriculture Organization of the United Nations (FAO), 2010. Global forest resources assessment 2010: Main report. FAO Forestry Paper no. 163.

Government of Alberta, 2008. Land-use Framework. Available at https://www.landuse.alberta.ca/PlanforAlberta/LanduseFramework/Pages/default.aspx.

Grafton, R.Q., Adamowicz, W., Dupont, D., Nelson, H., Hill, R.J. Renzetti, S., 2003. The economics of the environment and natural resources. Blackwell Publishing: United Kingdom.

Haarsma, D., Doll, C., Bentley, A., Qiu, F., Jeffrey,S., 2014. Agricultural land conversion and fragmentation in Alberta: A review of land cover patterns 2000-2012 and land use policy. Available at http://www.albertalandinstitute.ca/public/download/documents/10440.

Hanley, N., Schlapfer, F., Spurgeon, J., 2003. Aggregating the benefits of environmental improvements: Distance-decay functions for use and non-use values. Journal of Environmental Management 68(3), 297-304.

Horne, P., Boxall, P.C., Adamowicz, W.L., 2005. Multiple-use management of forest recreation sites: A spatially explicit choice experiment. Forest Ecology and Management 207(1-2), 189-199.

Inge, L., Marije, S., Leo, D.N., Steven, B., Jan, S., Joris, A., Roy, B., 2013. Developing a value function for nature development and land use policy in Flanders, Belgium. Land Use Policy 30, 549-559.

Johnston, R.J., Bergstrom, J.C., 2011. Valuing farmland protection: Do empirical results and policy guidance depend on the econometric fine print? Applied Economic Perspectives and Policy 33(4), 639-660.

Johnston, R.J., Duke, J.M., 2009. Willingness to pay for land preservation across states and jurisdictional scale: Implications for benefit transfer. Land Economics 85(2), 217-237.

Johnston, R.J., Duke, J.M., Kukielka, J., 2007. Public preferences and willingness to pay for farmland preservation in four Connecticut communities: Case studies of Brooklyn, Pomfret, Thompson, and Woodstock. Available at http://www.ctrcd.org/pdf/WTPforFarmlandPreservation2007%282%29.pdf.

Johnston, R.J., Swallow, S.K., Weaver, T.F., 1999. Estimating willingness to pay and resource tradeoffs with different payment mechanisms: An evaluation of a funding guarantee for watershed management. Journal of Environmental Economics and Management 38, 97-120.

Johnston, R.J., Swallow, S.K., Bauer, D.M., 2002. Spatial factors and stated preference values for public goods: Considerations for rural land use. Land Economics 78(4), 481-500.

Kaczan, D., Swallow, B.M., Adamowicz, W.L., 2013. Designing a payments for ecosystem services (PES) program to reduce deforestation in Tanzania: An assessment of payment approaches. Ecological Economics 95, 20-30.

Limburg, K.E., Folke, C., 1999. The ecology of ecosystem services: Introduction to the special issue. Ecological Economics 29, 179–182.

McFadden, D., 1974. Conditional logit analysis of qualitative choice behavior. In: Zarembka, P.E. (Ed.), Frontiers of econometrics. Academic press, New York.

McVittie, A., Moran, D., 2010. Valuing the non-use benefits of marine conservation zones: An application to the UK Marine Bill. Ecological Economics 70(2), 413-424.

Millennium Ecosystem Assessment, 2005. Ecosystems and Human Well-Being: A Framework for Assessment. Island Press, Washington, D.C.

Mitchell, R.C., Carson, R.T., 1989. Using surveys to value public goods: The contingent valuation method. Washington, DC: Resources for the Future.

Nainggolan, D., Termansen, M., Reed, M.S., Cebollero, E.D., Hubacek, K., 2013. Farmer typology, future scenarios and the implications for ecosystem service provision: A case study from south-eastern Spain. Regional Environmental Change 13, 601-614.

Olar, M., Adamowicz, W.L., Boxall, P.C., West, G.E., 2007. Estimation of the economic benefits of marine mammal recovery in the St. Lawrence Estuary. Published by: Policy and Economics Branch, Fisheries and Oceans Canada, Quebec, QC. 62pp.

Remoundou, K., Diaz-Simal, P., Koundouri, P., Rulleau, B., 2015. Valuing climate change mitigation: A choice experiment on a coastal and marine ecosystem. Ecosystem Services 11, 87-94.

Scarpa, R., Thiene, M., 2005. Destination choice models for rock climbing in the Northeastern Alps: A latent-class approach based on intensity of preferences. Land Economics 81(3), 426-444.

Smyth, E.A., 2015. Local food, farmland, and urban development: A case of land grabbing North American style. Canadian Food Studies 2(1), 48-74.

Sverrisson, D., Boxall, P.C., Adamowicz, W.L., 2007. Estimation of the passive use values associated with future expansion of provincial parks and protected areas in Southern Ontario. Final Report to the Ontario Ministry of Natural Resources, Peterborough, Ontario. 120pp.

Swait, J., 1994. A structural equation model of latent segmentation and product choice for cross-sectional revealed preference data. Journal of Retailing and Consumer Services 1, 77-89.

Swinton, S.M., Lupi, F., Robertson, G.P., Hamilton, S.K., 2007. Ecosystem services and agriculture: Cultivating agricultural ecosystems for diverse benefits. Ecological Economics 64, 245-252.

Verburg, P.H., van de Steeg, J., Veldkamp, A., Willemen, L., 2009. From land cover change to land function dynamics: a major challenge to improve land characterization. Journal of Environmental Management 90(3), 1327-1335.

Volinskiy, D., Bergstrom, J.C., 2007. Valuation of farmland conservation easement programs when preferences vary. Department of Agricultural and Applied Economics, the University of Georgia, Faculty Series Working Paper.

Wang, H., Swallow, B.M., 2016. Optimizing expenditures for agricultural land conservation: Spatially-explicit estimation of benefits, budgets, costs and targets. Land Use Policy 59, 272-283.

Table 1. Attributes and attribute levels in the choice experiment

Attribute	Level	Explanation
Type of agricultural use	• Grain/oilseed farming • Livestock grazing on native pasture • Hay land • Commercial vegetable farm	Major types of agriculture in the Alberta Capital Region.
Acres conserved	• 200 • 500 • 1000 • 2000	A range of farm sizes from small to large. The average farm size in the Capital Region is 515 acres.
Adjacent area	• Adjacent to primary highway • Adjacent to conservation buffer	Land area to distinguish the adjacent landscape
Location proximity	• Within city limits • Within 10-km buffer from currently developed land	Land location to distinguish the proximity to the city
Property tax or rent increase for next year only ($)	• 25 • 50 • 100 • 300 • 600	Property tax or rent increase next year only as the cost to implement conservation strategies

Table 2. Socio-demographic statistics for the sample and the ACR

Demographic	Description	Sample Percentage (%)	The ACR Percentage (%)[a]
Gender	Male	50.00	49.54
	Female	50.00	50.46
Residence	City of Edmonton	74.38	69.77
	Lamont County	0.00	0.33
	Leduc County	5.31	3.34
	Parkland County	2.81	2.60
	Strathcona County	6.88	7.56
	Sturgeon County	5.31	7.14
	Others	5.31	9.26
Household Income	Less than $30,000	13.44	N/A
	$30,000 - $59,999	18.75	N/A
	$60,000 - $89,999	22.81	N/A
	$90,000 - $119,999	21.88	N/A
	$1200,000 - $149,999	10.31	N/A
	Greater than $150,000	12.81	N/A
Education	Lower than High School	0.94	N/A
	Completed High School	22.19	N/A
	Completed Post-secondary Technical School	34.06	N/A
	Completed University Undergraduate Degree	32.81	N/A
	Completed Post-graduate Degree (e.g., Master or Ph.D.)	10.00	N/A

[a]: Gender statistics are from Statistics Canada (2011) and residence statistics (2013) are from Capital Region Land Use Plan, Capital Region Board. N/A indicates not applicable from the current datasets.

Table 3. Coefficient estimates and WTP from multinomial logit model

Attribute	Coefficient (Std. Err)	WTP Estimate (CAD$ per acre per household)
Grain*Acres	-0.00025**	-0.09058**
	(0.00013)	(0.04710)
Live*Acres	-0.00015	-0.05435
	(0.00013)	(0.04710)
Hay*Acres	-0.00025**	-0.09058**
	(0.00011)	(0.03986)
Highway*Acres	0.00021**	0.07609**
	(0.00009)	(0.03261)
City*Acres	-0.00018*	-0.06522*
	(0.00010)	(0.03623)
Acres	0.00055***	0.19928***
	(0.00012)	(0.04348)
Cost	-0.00276***	-
	(0.00023)	
ASC	-0.67179***	-
	(0.10270)	
Observations	2504	
Log-likelihood	-1520.54	
AIC	3057.1	

***, **, and * indicate significance at 1%, 5%, and 10% level

(Standard errors in parentheses)

Table 4. Estimated aggregate WTP for different conservation strategies in the ACR

Conservation Strategy	WTP Estimate	
	CAD$ per acre per household	million CAD$ per acre[a]
Grain/Oilseed Farming; Adjacent to Primary Highway; Within City Limits	0.1196	0.0560
Grain/Oilseed Farming; Adjacent to Primary Highway; Within 10-km Buffer from Currently Developed Land	0.1848	0.0865
Grain/Oilseed Farming; Adjacent to Conservation Buffer; Within City Limits	0.0435	0.0204
Grain/Oilseed Farming; Adjacent to Conservation Buffer; Within 10-km Buffer from Currently Developed Land	0.1087	0.0509
Livestock Grazing on Native Pasture; Adjacent to Primary Highway; Within City Limits	0.1558	0.0729
Livestock Grazing on Native Pasture; Adjacent to Primary Highway; Within 10-km Buffer from Currently Developed Land	0.2210	0.1035
Livestock Grazing on Native Pasture; Adjacent to Conservation Buffer; Within City Limits	0.0797	0.0373
Livestock Grazing on Native Pasture; Adjacent to Conservation Buffer; Within 10-km Buffer from Currently Developed Land	0.1449	0.0679
Hay Land; Adjacent to Primary Highway; Within City Limits	0.1196	0.0560
Hay Land; Adjacent to Primary Highway; Within 10-km Buffer from Currently Developed Land	0.1848	0.0865
Hay Land; Adjacent to Conservation Buffer; Within City Limits	0.0435	0.0204
Hay Land; Adjacent to Conservation Buffer; Within 10-km Buffer from Currently Developed Land	0.1087	0.0509
Commercial Vegetable Farm; Adjacent to Primary Highway; Within City Limits	0.2101	0.0984
Commercial Vegetable Farm; Adjacent to Primary Highway; Within 10-km Buffer from Currently Developed Land	0.2754	0.1289
Commercial Vegetable Farm; Adjacent to Conservation Buffer; Within City Limits	0.1341	0.0628
Commercial Vegetable Farm; Adjacent to Conservation Buffer; Within 10-km Buffer from Currently Developed Land	0.1993	0.0933

[a]: Since the cost through either property tax or rent is collected mostly at the household level, we thus chose the household as the appropriate unit to calculate the aggregate WTP. Based on Census 2011, there were about 1,170,525 residents in the ACR in 2012, which was comprised of approximately 468,210 households in the region.

Table 5. Coefficient estimates from latent class model

Attribute	Class 1	Class 2
	Coefficient (Std. Err)	Coefficient (Std. Err)
Grain*Acres	-0.00045**	-0.00015
	(0.00020)	(0.00020)
Live*Acres	-0.00036*	0.00003
	(0.00021)	(0.00022)
Hay*Acres	-0.00046**	-0.00010
	(0.00018)	(0.00018)
Highway*Acres	0.00010	0.00043***
	(0.00014)	(0.00014)
City*Acres	-0.00027*	-0.00009
	(0.00014)	(0.00015)
Acres	0.00090***	0.00038**
	(0.00020)	(0.00018)
Cost	-0.00337***	-0.00176***
	(0.00029)	(0.00047)
ASC	-1.18115***	0.49779**
	(0.13696)	(0.20171)
Average Class Probability	0.696	0.304
Class Probability Model (Class 1)		
Constant	20.4400	-
	(13.0188)	
Age	-0.21267	-
	(0.14048)	
Gender (male=1)	-10.9480*	-
	(6.45165)	
Residence (Edmonton=1)	-16.5839*	-
	(9.34497)	
Household income (in 1,000 CAD)	-0.07524	-
	(0.04935)	
Agricultural land conversion rate (%)	0.16109*	-
	(0.09165)	
Not enough land reserved for agricultural uses (=1)	11.6009*	-
	(6.19657)	
More intensive (infill) development (=1)	18.5554*	-
	(10.6501)	
Observations	2504	
Log-likelihood	-1417.06	
AIC	2882.1	

***, **, and * indicate significance at 1%, 5%, and 10% level

(Standard errors in parentheses)

Table 6. Estimated aggregate WTP for ecosystem services by type of agricultural use

Ecosystem Services	WTP Estimate (million CAD$ per acre)			
	Grain/Oilseed Farming	Livestock Grazing	Hay Land	Commercial Vegetable Farm
Local Food	0.0164 - 0.0697	0.0332 - 0.0919	0.0154 - 0.0653	0.0575 - 0.1181
Air Quality	0.0140 - 0.0595	0.0225 - 0.0623	0.0137 - 0.0583	0.0402 - 0.0826
Water Purification	0.0136 - 0.0577	0.0217 - 0.0601	0.0136 - 0.0578	0.0398 - 0.0818
Scenic Beauty	0.0109 - 0.0463	0.0206 - 0.0572	0.0115 - 0.0491	0.0335 - 0.0687
Global Food	0.0106 - 0.0452	0.0192 - 0.0533	0.0083 - 0.0355	0.0274 - 0.0562
Climate Regulation	0.0091 - 0.0388	0.0164 - 0.0454	0.0097 - 0.0412	0.0299 - 0.0613
Recreation	0.0068 - 0.0290	0.0145 - 0.0403	0.0077 - 0.0329	0.0221 - 0.0454

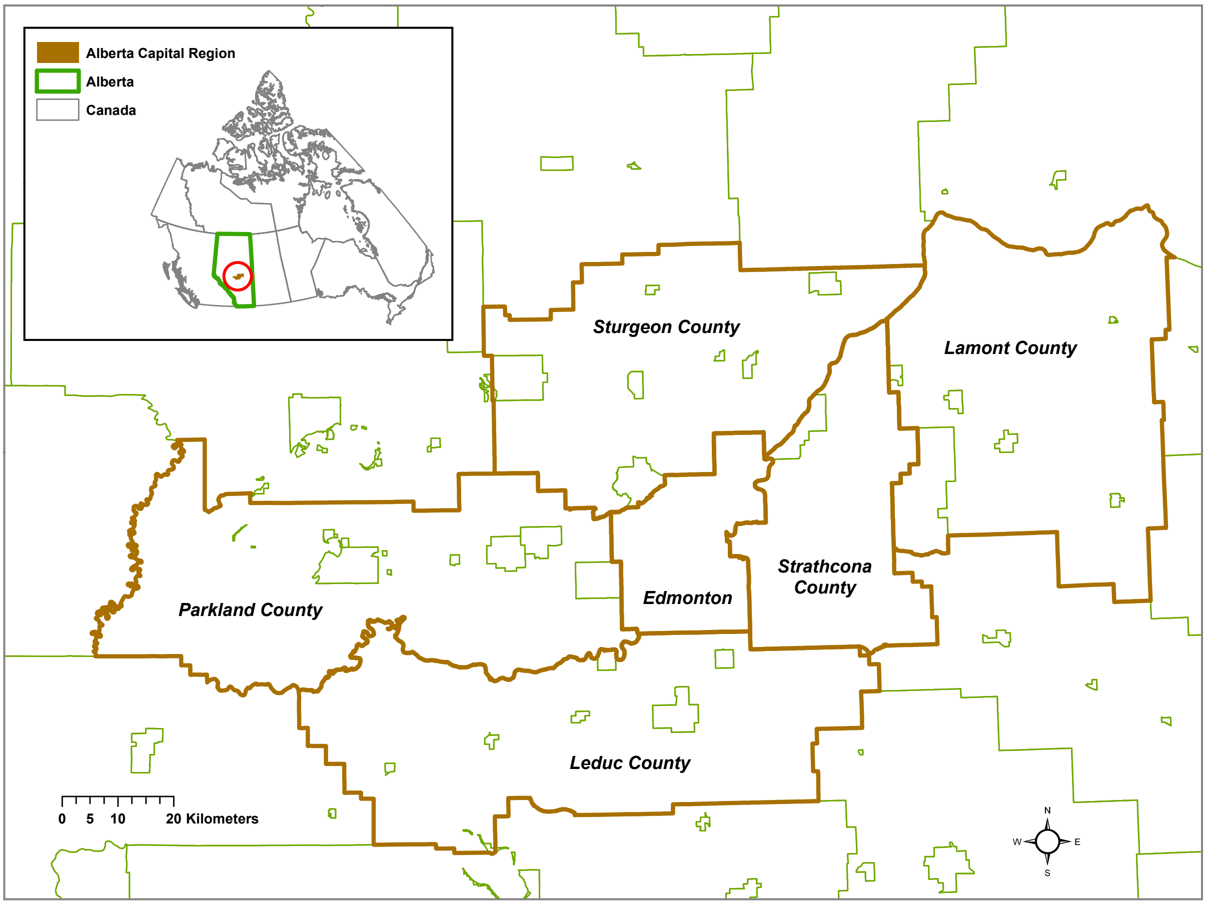


Figure 1. Geographical location of the Alberta Capital Region

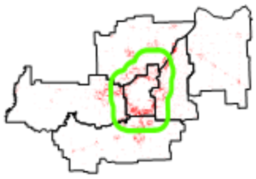
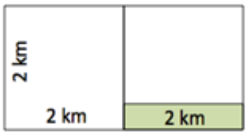
	Conservation Strategy	Status Quo
Type of Agricultural Use	Hay Land 	No Public Conservation Strategy for Land in Agricultural Uses
Location Proximity	Within 10-km Buffer from Currently Developed Land 	
Acres Conserved	200 acres (2 km x 0.4 km) 	
Adjacent Area	Adjacent to Primary Highway 	
Property Tax or Rent Increase Next Year Only	$ 300	$ 0

Figure 2. Example of choice experiment question in the survey

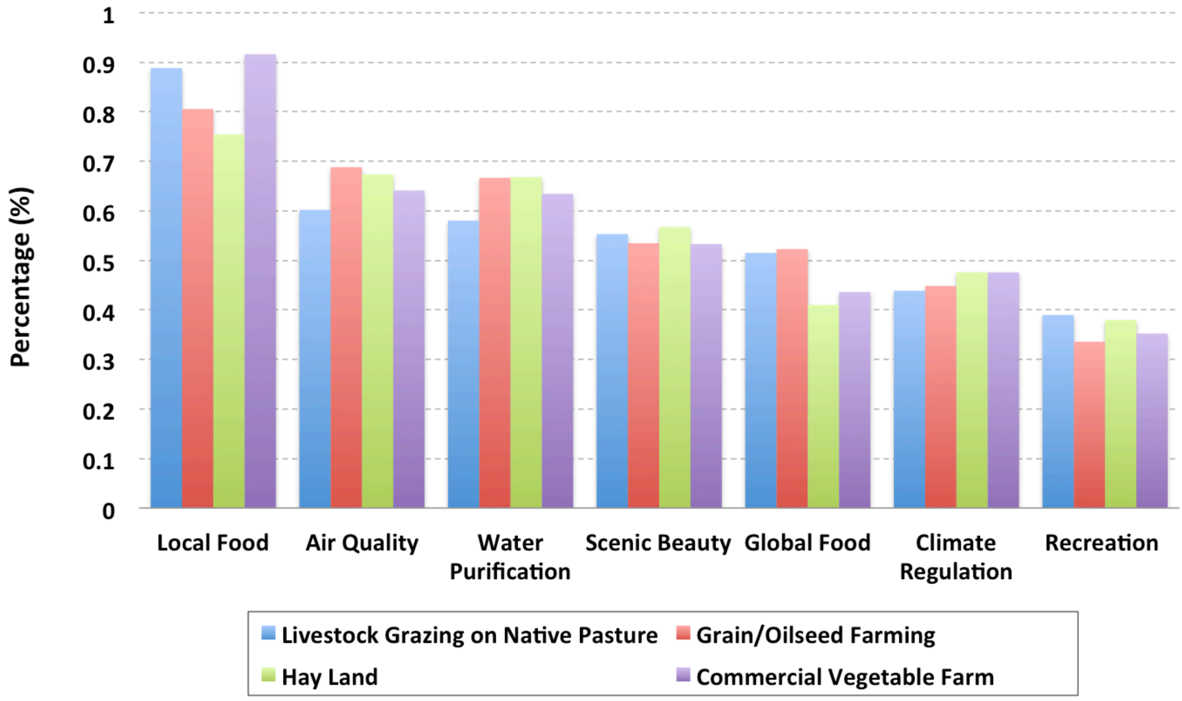


Figure 3. Comparison of types of agricultural use by ecosystem services