Examination of Agricultural Land Conservation in the Alberta Capital Region, Canada

by

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Abstract

The Alberta Capital Region is experiencing rapid population growth, economic development, and conversion of agricultural land into alternative land uses. As a result, some of the province's most productive agricultural land has been converted. However, little is known about what values are being gained and lost as a result of agricultural land conversion. This three-part thesis seeks to examine the agricultural land conservation in the study area.

Using remote sensing data, the first part assesses the extent of land use and land cover changes in the Alberta Capital Region from 2000 and 2012, with a focus on agricultural land conversion. To provide the context of the implementation of agricultural land conservation programs, associated land use policies and land management tools are also reviewed. The second part involves a choice experiment survey that was developed to estimate the nonmarket values (i.e., willingness to pay) for agricultural land conservation in the region. Data were collected through a rigorous design procedure that included expert and public focus groups, pre-tests, pilot study, and full launch. Several model specifications were adopted to allow for heterogeneity, and benefit estimates were calculated accordingly. The third part of this thesis presents an analysis of the optimal use of financial resources for agricultural land conservation, using nonmarket benefits and market costs in the Alberta Capital Region. The performance and efficiency of four targeting tools that have been widely used for various conservation programs are compared. Applications are to both urban and rural settings in the Alberta Capital Region. Results from this section provided empirical support for future policymaking regarding agricultural land conservation.

Dedication

To what I have received and to what I am still receiving.

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Chapter I - Introduction

1 General Background

Over the last 30 years, the Alberta Capital Region (the City of Edmonton and 23 surrounding cities, towns, villages and municipal districts) has experienced rapid population growth, economic development, and conversion of agricultural land into alternative land uses. As a result, some of the province's most productive agricultural land has been converted into residential and industrial development. For example, growth rates for population and developed areas in the Alberta Capital Region between 2000 and 2012 were approximately 30% and 50%, respectively. For all newly added developed areas, almost 90% were converted from agricultural land (Haarsma, 2014). Concerns about the pace and pattern of development and agricultural land conversion led the provincial government to create the *Land-Use Framework* in 2008 (Government of Alberta, 2008), the Alberta Capital Region Board to create the *Capital Region Land Use Plan* in 2009 (Capital Region Board, 2009), and the City of Edmonton to create a food and urban agriculture strategy *Fresh* in 2012 (City of Edmonton, 2012).

Despite the historical rates of agricultural land conversion and the policy attention it has prompted, little is known about what values are being gained and lost as a result of agricultural land conversion. Some values (e.g., the market value of agricultural commodities) accrue mainly to private individuals and firms, while others (e.g., biodiversity conservation values) accrue to society in general. Values of some agricultural land uses, such as those associated with the production of "local food", regulation of water and air quality, or maintenance of peri-urban green space, may be weighed very differently by different interest groups. Such environmental amenities are often non-tradable in the real market. Despite the difficulty in valuation, these nonmarket values play a substantial role in the implementation of conservation reserve programs, especially when such programs are financially supported by public funds. How to best utilize public funds to trade for environmental amenities is frequently at the hub of recent economics and public policy studies.

In terms of programs that aim to conserve agricultural land, mandatory agricultural land reserves through land use zoning have been introduced. The merits of such programs include the protection of large tracts of land and the avoidance of conflicts by segregating agricultural lands from non-agricultural land uses (Kruft, 2001). However, these programs have become problematic with public concern focused on issues such as the loss of private property rights and the challenge of accommodating new development within current urban areas. Relative to mandatory zoning approaches, there are many possible alternatives. These include voluntary contracting programs such as Environment Canada's Ecological Gifts Program (Environment Canada, 2015), voluntary conservation-related programs such as the US Conservation Reserve Program (USDA, 2015), and market-based programs such as conservation easements (Chiasson et al., 2012; Ontario Farmland Trust, 2015) and transfer of development credits (Greenaway and Good, 2008). These programs provide advantages over traditional zoning policies by mitigating inefficiencies arising from rent-seeking and avoiding arbitrary rationing of gains from development associated with direct controls (Greenaway and Good, 2008). Also, agricultural land can be protected in perpetuity through such programs.

Although market-based programs provide some advantages over mandatory approaches, they have been challenged due to the failure to efficiently allocate land in the presence of nonmarket amenities or benefits. This is particularly important when it comes to the use of public funds in implementation of such land conservation programs. Given the involvement of either tax and/or direct public expenditures, the selection of land to be conserved should maximize public benefits as much as possible given budget constraints. This leads to at least two questions that need to be answered. First, how would one estimate the nonmarket benefits of agricultural land conservation? Second, how would one optimally select agricultural land to be conserved so as to improve the efficiency of such agricultural land conservation programs?

2 Research Objectives

This research has three main objectives. The first objective is to summarize information that frames the context of land use change and policy in the Alberta Capital Region. Data on the extent of land use and land cover changes from 2000 to 2012 in the Alberta Capital Region are explored, with a focus on agricultural land conversion. Relevant government policies and land management tools that may be of particular use for future implementation in the study area are reviewed. The second objective is to elicit the values that residents in the Alberta Capital Region have for land conserved in agricultural uses. To that end, a choice experiment survey is designed to gather insights of conservation programs specifically for agricultural land uses. Targeting the residents in the Alberta Capital Region, the survey instrument aims to identify areas of agricultural lands with outstanding conservation values so they can be protected against future land conversion. This two part multi-methods study involves qualitative approaches incorporating focus groups and quantitative analyses of survey data. The third objective is to illustrate how information on values and costs can be used to select particular plots of land for conservation. Results from the choice experiment are combined with two sets of farmland costs in alternative models of optimal selection of agricultural land to be conserved. This analysis aims to inform valuable empirical results for future policy making regarding agricultural land conservation.

More specifically, the analyses in this thesis address the objectives as follows:

i. Use recent advances in remote sensing data to assess land use and land cover changes in the Alberta Capital Region from 2000 to 2012;
ii. Review relevant land use policies and land management tools for the implementation of agricultural land conservation programs;
iii. Estimate nonmarket values, in terms of the willingness to pay (WTP), that residents of the Alberta Capital Region place on conserving land in different locations in the region and in different types of agricultural use;
iv. Explore the links between those values and residents' affinity with different ecosystem goods and services;
v. Identify areas and strategies that are of outstanding values for conservation;

vi. Optimize use of resources for agricultural land conservation using both nonmarket benefits and markets costs;

vii. Consolidate a variety of results from this study to determine relevant policy implications and provide future research directions.

3 Thesis Structure

There are five chapters in this thesis. Chapter I introduces the general background and research objectives. The following three chapters analyze different research questions, with each chapter building upon previous analyses. Specifically, Chapter II is a review of land use and land cover changes and associated land use policies in the Alberta Capital Region from 2000 to 2012, with a focus on agricultural land conversion. This chapter provides the background information to prepare for the design and development of the survey instrument in Chapter III. Chapter III reports on a choice experiment undertaken to assess the multiple values of land in agricultural uses in a peri-urban setting. Nonmarket benefits resulting from the survey are used in the next chapter. Chapter IV reports an analysis of the optimal selection of agricultural land to be conserved using nonmarket benefits and market costs. Results from four targeting tools to conserve agricultural lands are compared. Chapter V concludes the thesis by summarizing the policy implications of the combined chapters, as well as a discussion of future research directions.

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Chapter II - A Review of Land Use and Land Cover Changes and Associated Land Use Policies in the Alberta Capital Region from 2000 to 2012

1 Introduction

Alberta's landscape is experiencing substantial changes due to fast growth in its economy and population. As a result, agricultural land, which comprises approximately one third of the provincial land base, is undergoing significant conversion to non-agricultural uses. Only a few previous studies have touched on agricultural land use changes in Alberta. These include a report by Alberta Agriculture and Rural Development that assessed the loss of agricultural lands using an agricultural land base monitoring from 1977-2002 (AARD, 2002), and an article from Young et al. (2006) that analyzed an area to the east of Edmonton using satellite imagery from 1977-1998. Results from the first study showed the conversion of agricultural land to development for residential, commercial, and industrial purposes in general, and the second paper found out shifts from perennial forage crops to annual commodity crops as the major land cover changes within the study area. Overall, there were limited data and results about agricultural land conversion in history. As a result, a research project named *Economic Evaluation of Farmland Conversion and Fragmentation in Alberta* is being undertaken to assess and quantify the economic impacts and implications of farmland conversion for policy and planning.

One report of this project reviewed the land cover patterns 2000-2012 in Alberta and land use policy with a focus on agricultural land conversion and fragmentation (Alberta Land Institute, 2014). Some key results of this report include: (1) Between 2000 and 2012, there was a net loss of 2,088,535 acres (-5.63%) agricultural land in Alberta mainly due to pasture land transitioning to shrubland or grassland; (2) In the same period, approximately 306,157 acres (0.82%) of the agricultural land base was converted for developed uses. While the provincial level represents a minor loss, about 94,517 acres (4.3%) of agricultural land was converted in the Edmonton-Calgary Corridor which demonstrates a more concentrated development occurrence; (3) Agricultural land conversion is happening at a significant rate on the highest land suitability class of agricultural land within the province - 68.4% of the

agricultural land converted within the province was from the two highest land suitability classes of land.

A more in-depth study was conducted by Haarsma (2014) using spatial techniques to analyze agricultural land conversion and its associated drivers in Alberta. The determinants of agricultural land conversion to developed uses were investigated with a focus on the neighboring impacts of land uses as well as population growth. The analyses showed the strong spillover effects resulting from both neighboring agricultural land conversion activities as well as population growth. Additionally, using the geographically weighted regression approach, the author suggested that environmental and socio-economic factors influencing agricultural land conversion patterns were spatially heterogeneous in both magnitude and sign throughout the province. Large spatial variation in parameters indicating differences in agricultural land conversion between rural and urban areas, as well as between the two main cities of Edmonton and Calgary were revealed. For example, lower population density and large negative distance estimates surrounding Edmonton inferred a more extensive suburban growth relative to Calgary, and the large negative household income effect around Edmonton reaffirmed the larger footprint of Edmonton (Haarsma, 2014).

Another piece of research regarding agricultural land conversion in Alberta is a case study of the Edmonton-Calgary Corridor that investigates the impacts of neighboring influence on farmland conversion (Qiu et al., 2015). Incorporating fragmentation and neighboring impacts into the farmland conversion analysis, the results indicated that land-use activities and decisions have strong spillover effects on neighboring areas. Additionally, fragmentation has positive effects on farmland conversion. Increases in fragmentation further encourage farmland conversion to urban uses.

Although the agricultural land conversion has been investigated at the provincial level, the Alberta Capital Region, as the geographical center of the province, has not yet been comprehensively explored in terms of broader topics such as land use and land cover

changes and land use policies. As rural and urban development have caused permanent conversion of some of the province's most productive agricultural lands in the Alberta Capital Region, an investigation using more recent data in this region will provide more insights for municipalities to make relevant land use policies. Therefore, the primary goal of this chapter is to report quantitative analyses of land use and land cover changes in the Alberta Capital Region during the period of 2000-2012, with a focus on agricultural land conversion to developed uses. In order to provide more background information in preparation for the survey instrument to be designed in the second phase of this study, existing government policies, land management tools and practices about agricultural land conservation in Canada are reviewed so as to explore the possibility of conserving agricultural land under current legislation in the region. Information about population growth and public finances in the Alberta Capital Region is also provided. This chapter concludes with a discussion on the methods for nonmarket valuation of the public benefits of agricultural land.

2 Land use and land cover change

The Alberta Capital Region is a conglomerate of municipalities that surround Alberta's provincial Capital, the City of Edmonton (Figure 1-1). The region covers approximately twelve thousand km^2, accounts for 1.9% of Alberta's land mass and is home to 31.8% of Alberta's population (Capital Region Board, 2015). According to the 2011 Census, the Alberta Capital Region had a population of about 1.15 million, making it the sixth largest Census Metropolitan Area in Canada by population. There are 24 municipalities in the region identified as follows:

- 5 cities: Edmonton, Fort Saskatchewan, Leduc, Spruce Grove, and St. Albert
- 5 counties: Lamont, Leduc, Parkland, Strathcona, and Sturgeon
- 11 towns: Beaumont, Bon Accord, Bruderheim, Calmar, Devon, Gibbons, Lamont, Legal, Morinville, Redwater, and Stony Plain
- 3 villages: Thorsby, Wabamun, and Warburg

Planning across the 24 municipalities is coordinated by the Capital Region Board, which was established by provincial legislation in 2008. The Capital Region Board was created to prepare and implement an integrated growth plan with the initial priorities covering land use, inter-municipal transit services, nonmarket and market-affordable housing and geographic information services in the region.

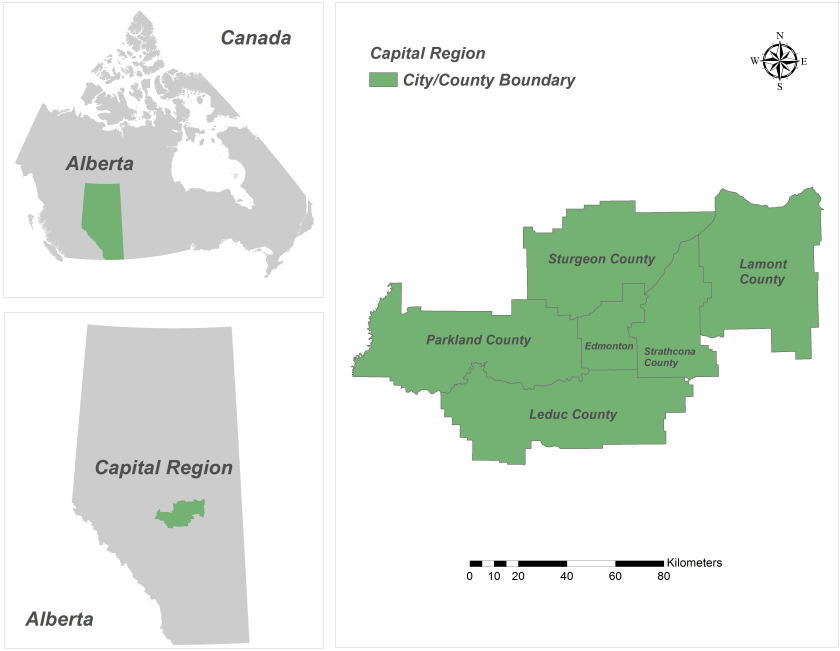

Figure 1-1: Reference Map of the Alberta Capital Region

In the past decade, the Alberta Capital Region has experienced significant land use and land cover changes. We examined the transitions over the period 2000 to 2012. The spatial data for these two years are based on 30-meter resolution land-use raster images, which are provided by Agriculture Agri-Food Canada (AAFC)[1]. The 2000 image contains 11 different land use classes including Cropland, Pasture, Developed (or Built-Up), Water, Barren, Shrubland, Wetland, Grassland, Coniferous Trees, Deciduous Trees and Mixed Trees. The 2012 image has nearly 40 land use types comprising the last 10 classes in 2000 and detailed cropland type classifications (e.g., wheat, canola, corn). To better compare across data sets, we processed the data sets into 9 land use and land cover classes as follows: Cropland, Developed (or Built-Up), Exposed Land, Forests, Grassland, Pasture, Shrubland, Water, and

[1] The land use and land cover raster data is available at ftp://ftp.agr.gc.ca/pub/outgoing/aesb-eos-gg/Crop_Inventory/ (accessed June 12, 2014).

Wetland. Figure 1-2 presents the land use and land cover changes in the Alberta Capital Region from 2000 to 2012. In general, we can see the evident trend of urban sprawl surrounding the cities in this area. Specifically, developed uses increased by about 90 thousand acres between 2000 and 2012, with an increase of 47.65%.

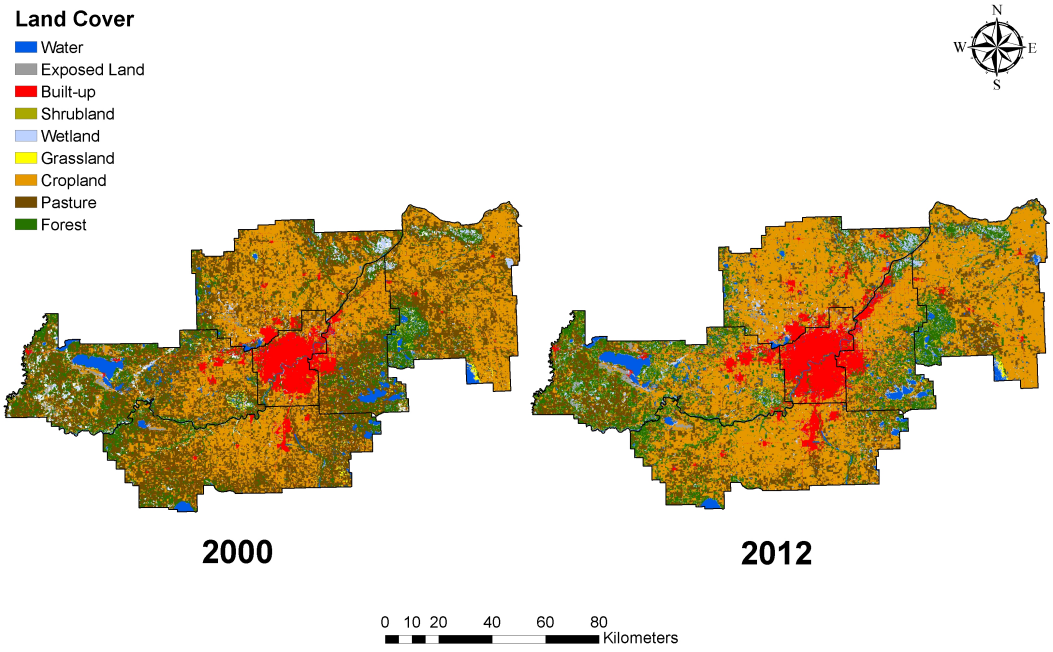

Figure 1-2: Land Use and Land Cover Changes in the Alberta Capital Region 2000-2012 (AAFC, 2000 and 2012)

2.1 Agricultural land use

Agriculture has a long history in Alberta, and the province is the third largest producer and exporter of agri-food products in Canada (Government of Alberta, 2014a). In the Alberta Capital Region, according to the census 2011, there were 4,344 farms with a total acreage of 2.2 million acres which represents 4.4% of Alberta's total farm acreage (Government of Alberta, 2012a). The agricultural land base in the Alberta Capital Region constituted almost 71% of the total area in 2000, but decreased to 64% in 2012 (Table 1-1). In using the term agricultural land in this study, we mainly refer to cropland and hay/pasture land. The primary activities that take place on agricultural land in the region include intensive cropping (e.g., grain and oilseeds), livestock production (e.g., pasture) and forage production (e.g., hay land). There are also small areas dedicated to seed potato and vegetable production.

Between 2000 and 2012, the changes of land use types in the Alberta Capital Region varied due to different possible causes. For example, the area of water and wetlands increased by about 35% and 40%, respectively, likely due to the fact that there was exceptionally low rainfall in the region from September 2000 to August 2001 as a result of its driest 12-month period on record in the past 50 years (Environment Canada, 2001). The decrease of land use types was mainly from pasture because of the decline of the cattle industry associated with the outbreak of mad cow disease (BSE) in 2003 and the high relative prices of grains and oilseeds between 2007 and 2012.

Table 1-1: Land Use and Land Cover Changes for the Alberta Capital Region between 2000 and 2012 (AAFC, 2000 and 2012)

	LULCC_2000 (1,000 acres)	LULCCC_2000 (%)	LULCC_2012 (1,000 acres)	LULCC_2012 (%)	Net Change (1,000 acres)	Change as % of Total Land	Change as % of Own Class
Water	99.73	2.47	134.65	2.54	34.92	1.13	35.01
Exposed	14.74	0.29	21.82	0.65	7.08	0.23	48.05
Developed	189.93	4.01	280.43	5.59	90.50	2.92	47.65
Shrubland	34.48	1.95	134.33	5.42	99.85	3.22	289.60
Wetland	67.37	2.59	95.34	3.59	27.96	0.90	41.51
Grassland	14.05	5.35	5.90	3.26	-8.14	-0.26	-57.97
Cropland	1081.88	34.26	1498.30	46.19	416.42	13.43	38.49
Pasture	1131.75	32.99	475.41	16.55	-656.34	-21.16	-57.99
Forest	467.45	16.08	455.19	16.20	-12.26	-0.40	-2.62
Total Land	3101.37	100.00	3101.37	100.00	0.00	0.00	0.00

Over the same period, the total loss of agricultural land in the Alberta Capital Region amounted to almost 240 thousand acres. Within agricultural land, a total of 656 thousand acres of pasture were converted which leads to an approximately one-fifth change as the percentage of total land (Table 1-1). For these pasture losses, about 72% was converted to

cropland[2]. Meanwhile, cropland had a newly added acreage of approximately 416 thousand acres that represents a 40% rise over the study period. The gains were primarily from Leduc and Sturgeon County that are to the south and north, respectively, of the City of Edmonton (Figure 1-2). This may be due to increases in cereal and oilseed prices starting in 2008.

2.2 Agricultural land conversion

One specific type of land use and land cover changes is the conversion from agricultural land to developed uses. The encroachment of urban areas onto agricultural land has many ramifications, with one direct impact being the potential loss of agricultural production. Other important impacts include reduction of positive externalities provided by agricultural land such as rural amenities and ecological values (Fleisher and Tsur, 2009; Plottu and Plottu, 2012). However, agricultural lands near urban areas also have some negative externalities such as the odor and manure from livestock (Fleisher and Tsur, 2009).

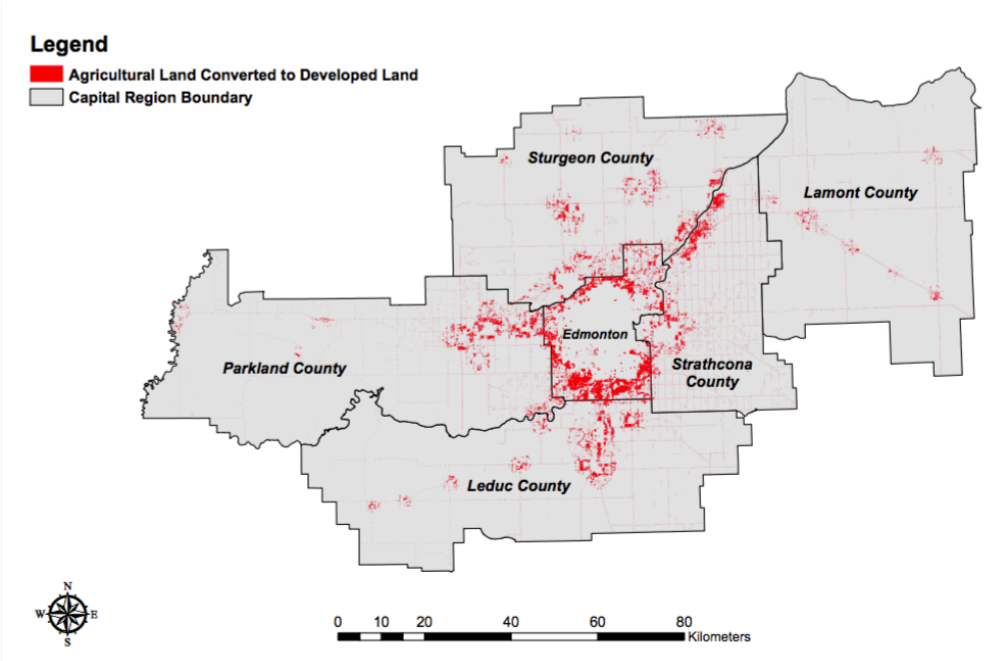

Figure 1-3: Agricultural Land Conversion in the Alberta Capital Region 2000-2012 (AAFC, 2000 and 2012)

[2] The number was calculated from a complete set of statistics that reveal the detailed number of land use and land cover changes from each category to another over the study period. The table (and associated underlying data) is available from the research team upon request. The data source is from AAFC.

Figure 1-3 displays the agricultural land conversion in the Alberta Capital Region from 2000 to 2012. In this period, about 94,517 acres of agricultural land was converted to developed uses, which represents a 4.3% loss of the agricultural land base in the region. This leads to an average annual loss rate of about 0.36% over the period. Based on this figure we can further see that the conversion has primarily taken the form of suburban development on the periphery of the cities, with the southern part of the City of Edmonton most evident. Over this period, however, only about one-tenth as much land was converted from developed uses to agriculture.

Table 1-2: Agricultural Land Conversion by Land Suitability Rating System (LSRS) for the Alberta Capital Region from 2000 to 2012 (AAFC, 2000 and 2012)

Land Suitability Class	Converted (1,000 acres)	Percent of Total Conversion (%)	Total in Capital Region Area (1,000 acre)	Percent of Conversion per Class (%)
2	47.65	50.40	1460.81	3.26
3	10.45	11.06	429.90	2.43
4	3.45	3.65	137.54	2.51
5	0.63	0.67	49.58	1.27
6	1.09	1.16	27.74	3.94
7	0.39	0.41	32.83	1.17
9*	30.87	32.66	75.23	41.03
Total	94.53	100.00	2213.65	4.27

*Note: LSRS Class 9 is land that is considered urban or water. Urban classification is based on urban boundaries, which has resulted in agricultural land within the boundary of Edmonton being improperly classified as Class 9 instead of its actual suitability level. In Alberta, there is no Class 1 type based on this rating system.

In addition to the spatial pattern, another aspect that requires consideration is the quality of agricultural land. The Land Suitability Rating System (LSRS) was introduced by AAFC to characterize the suitability of land for crop production based on measurable qualities of soil, climate, and landform (AAFC, 2011). As a basis for developing specific ratings for various

factors, the relationship between suitability class and limitations for crop production was established. In short, lower suitability class indicates that the land has fewer limitations for crops. Table 1-2 presents the agricultural land conversion by LSRS for the Alberta Capital Region from 2000 to 2012.

Agricultural land conversion is happening at a significant level on the highest quality agricultural land within the region. Haarsma (2014) found that of the agricultural land converted, about 69% of the total conversion was from the two highest quality categories (Class 2 and 3) across the province. Results showed that in the Alberta Capital Region, the proportion of agricultural land with higher suitability ratings (Class 2 and 3) being converted is approximately 61%, slightly lower than the provincial level. Additionally, of all the converted agricultural land in the region, more than 50% is Class 2.

2.3 Conservation buffer

The Alberta Capital Region is home to numerous significant natural areas and varying land uses. It is therefore of great importance to develop an accommodating regional plan for buffer areas (Capital Region Board, 2009b). In 2009, the Capital Region Board proposed an addendum called the *Capital Region Growth Plan* for the purpose of identifying Regional Buffer Areas. One noticeable element of the Regional Buffer Areas is the conservation buffer.

In general, a conservation buffer is a designation for an agricultural area that needs special protection due to its landscape, wildlife or historical values. Conservation buffers can add variety to the landscape and foster a healthy environment for communities with fresh water and air. In addition, local biodiversity can be protected. Figure 1-4 shows that conservation buffers in the Alberta Capital Region are mainly located along the North Saskatchewan River and around some major lakes. There is also a large conservation buffer in the southeast part of Strathcona County, which is located to the east of the City of Edmonton.

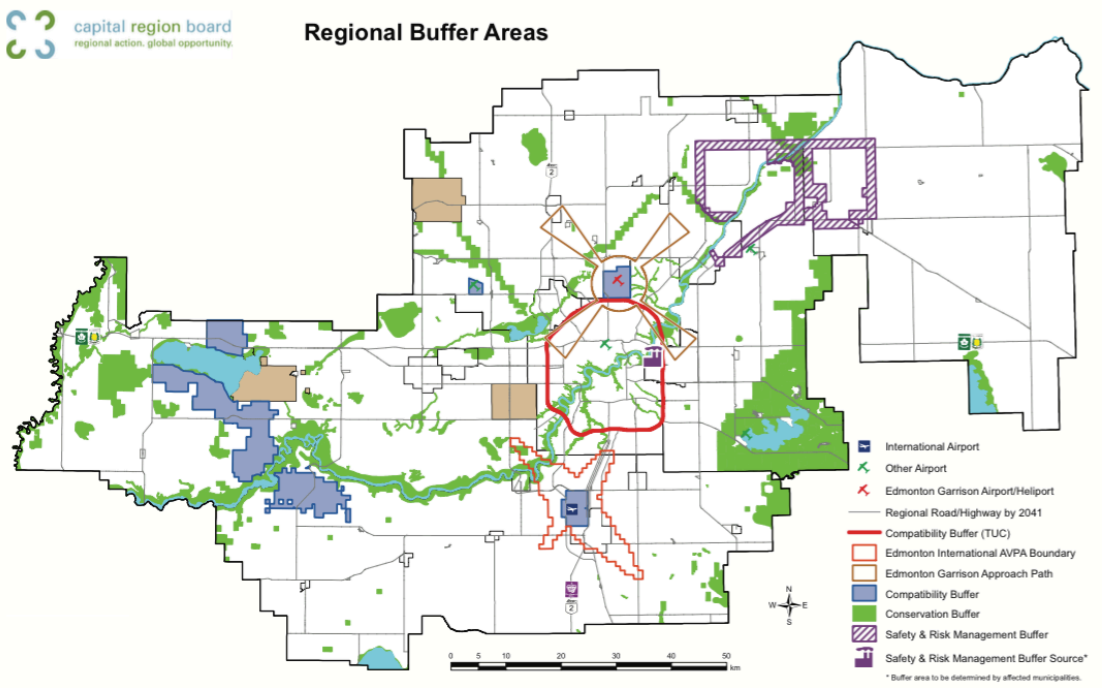

Figure 1-4: Conservation Buffer Map in the Alberta Capital Region (Capital Region Board, 2009b)

If we overlap the land use and land cover data in 2012 from AAFC (Figure 1-2) and the designated conservation buffers (Figure 1-4) in the Alberta Capital Region, we find that about 17% and 12% of conservation buffers were used as cropland and pasture, respectively. In addition, forests comprised approximately 42% of conservation buffers, and water and wetlands made up for around 13%. For grassland and vegetable farms, they only possessed 0.5% and 0.3%, respectively, of the land that were designated as conservation buffers.

3 Urban development and sprawl

Urban development and sprawl are common worldwide, and predominant in North America. While 81% of Canadians now live in urban areas, half of metropolitan residents live in suburbs, and suburbs are growing 160% faster than city centers (Thompson, 2013). Often characterized by development on previously agricultural or natural "greenfield" sites, urban sprawl has a number of characteristics that include low density of development per acre, rigorously separated uses (e.g., long distances between housing and retail), "leapfrogging" past existing areas of build-up, leaving undeveloped gaps, and/or dependency on the

automobile for personal transport. Notable evidence of urban sprawl can be seen in the Alberta Capital Region. The agricultural land base is under pressure from rural and urban development, particularly around cities such as Edmonton (Figure 1-3). Furthermore, the land base is being fragmented into smaller parcels (e.g., for acreages, transportation routes) which also challenges the maintenance of agricultural land.

3.1 Population pressure

Agricultural land conversion is often a consequence of urbanization and population growth. In the City of Edmonton as well as the Alberta Capital Region, conversion of land from agricultural uses to development reflects population growth. Figure 1-5 shows that the population of Edmonton and the Alberta Capital Region increased by about 26 % and 30%, respectively, during the 2000-2012 period. It is projected that the population of the Alberta Capital Region will grow by an additional 12% between 2012 and 2018, and 28% between 2012 and 2028 (Capital Region Board, 2009a). Although relatively small in total population, the other four cities in the region are also experiencing rapid population growth (Figure 1-6). For example, the population increased by more than 50% in Fort Saskatchewan, Leduc and Spruce Grove between 2000 and 2012. The projection shows an additional 20% growth in the next decade in Fort Saskatchewan and Leduc (Capital Region Board, 2009a).

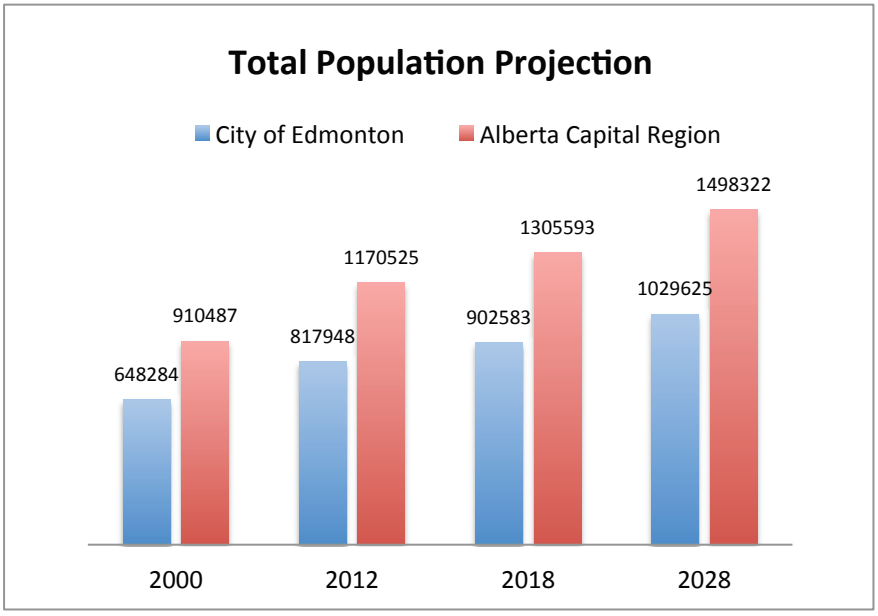

Figure 1-5: Total Population Projection in the City of Edmonton and the Alberta Capital Region from 2000 to 2028 (Capital Region Board, 2009a)

Increasing population imposes pressure on land use and expedites the process of agricultural land conversion. Mostly for the new residential development, those converted lands tend to be clustered and are often close to existing urban areas (Figure 1-3). In addition, with the growing population there comes rising demand for city services that need to be built and maintained. For example, such infrastructure includes construction of roads, growth of markets and schools, extension of water and sewer lines, and provision of parks and recreational facilities. These resulting demands may further cause the fragmentation and conversion of agricultural land.

If we compare the growth, however, we find that the speed of urban sprawl exceeded the population growth over the period of 2000-2012 in the Alberta Capital Region. In specific, the population growth rate was about 29% while the developed land increased by around 48%. If we focus on the population density in the region, it actually decreased from 4.8 people per acre in 2000 to 4.2 in 2012.

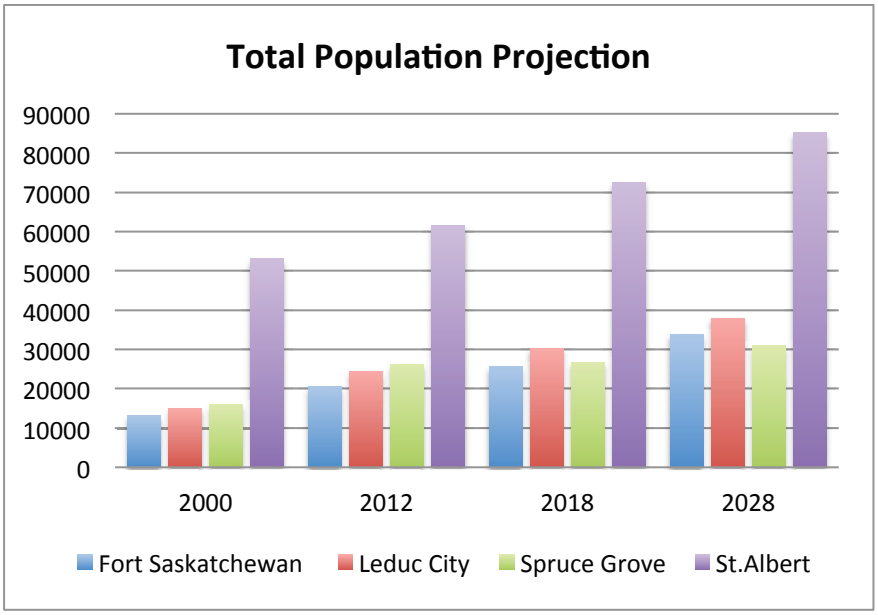

Figure 1-6: Total Population Projection in Other Four Cities in the Alberta Capital Region from 2000 to 2028 (Capital Region Board, 2009a)

3.2 City annexation

To better understand the historic growth patterns as it relates to agricultural land, land development and annexation information is to be analyzed along with the city growth. As

the hub of the Alberta Capital Region, the City of Edmonton has experienced challenges from both population growth and land development. To meet with these demands, the City of Edmonton is competing and/or collaborating with its regional partners (i.e., surrounding municipalities) to adjust boundaries through the process of annexation. Figure 1-7 demonstrates the history of annexations by era in the City of Edmonton.

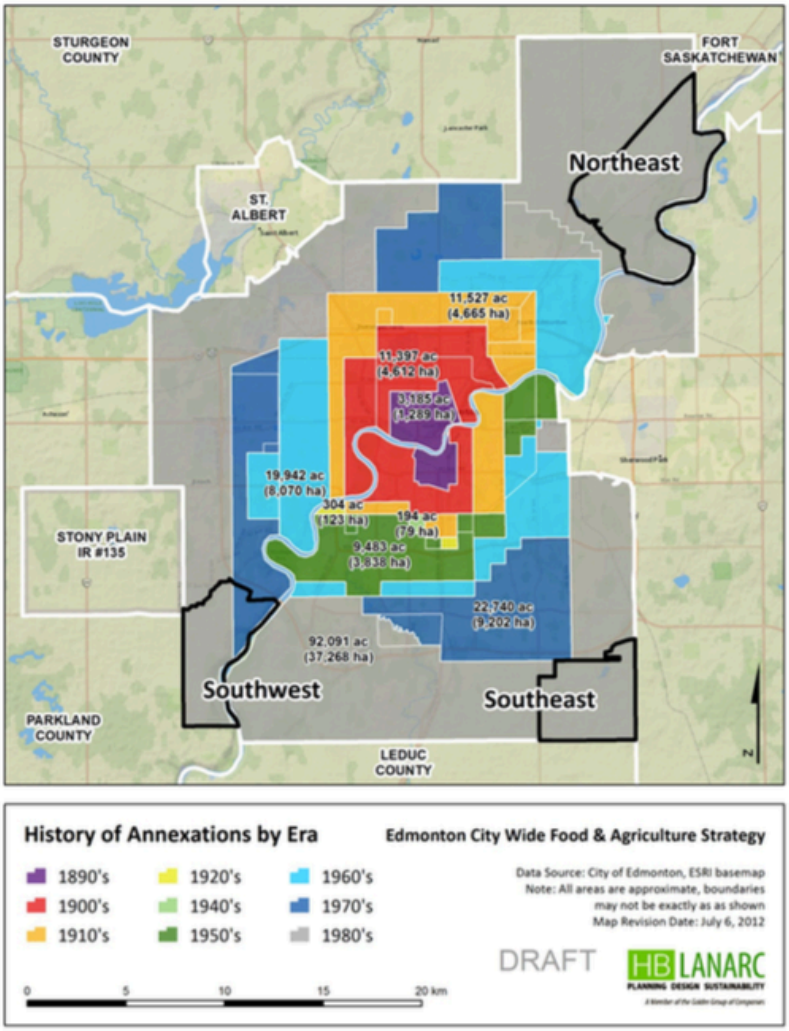

Figure 1-7: History of Annexations by Era in the City of Edmonton (City of Edmonton, 2012a)

Annexation of rural areas and in the City of Edmonton began at the turn of the 20th century as the city established itself. The early 20th century (1905s) saw a big increase that made the city almost four times larger. The speed of annexation slowed down slightly during the interwar period (1920s-1940s), and then resumed again in the late 1950s/early 1960s when

Edmonton again annexed a significant amount of rural land (approximately ten thousand acres) from neighboring municipalities, to establish the parts of the city known as Beverly, Jasper Place, and Mill Woods. Annexation continued in the 1970s and 1980s, and the latest one almost doubled the size of the city. For the 1980's annexation, one particular note is the amount of remaining vacant land. According to City of Edmonton (2012a), about 43,544 acres, or 47% of the annexed land of that era, remained in agricultural or undeveloped uses by the end of 2011. However, at least 37% of the 1980's annexation was built-up in the 2007-2011 period.

The current growth plan for the City of Edmonton mainly involves two parts (City of Edmonton, 2015). One plan that was first proposed in 2013 extends south of the city into Leduc County. The proposed annexation comprises 15,600 acres of land, which would result in a 23% increase of the land base of the city and a 6% decrease in the area of Leduc County. The second plan is to pursue a boundary adjustment (annexation) that includes about 40 acres of land from Sturgeon County. For the second plan, Sturgeon County already consented the City of Edmonton's efforts in 2014 (City of Edmonton, 2015). While for the annexation involving the City of Edmonton and Leduc County, negotiations are still going on. Recent updates include the finalization of annexation negotiation protocols between both Council representatives in November 2014, and further annexation negotiations in February and March 2015 (Leduc County, 2015).

3.3 Taxation and revenue

City planners emphasize that decisions about development and resource allocations have implications for public finances. Meanwhile, revenue and expense also have impacts on land use decisions. It is therefore important to be aware of the sources of public finances and how these resources are utilized.

In Alberta, property taxes are a primary source of revenue for municipalities, and they are used to finance programs and services that mainly include the construction and maintenance of public facilities (Government of Alberta, 2010). Property taxation is assessed

based on the value of land, and is further calculated according to different formulas and rates. Besides the different tax rates for different land uses, the assessment valuation standards are not the same for different land uses in Alberta. For example, all land is assessed at market value, except that farmland is assessed on the basis of productive value (Government of Alberta, 2010).

From Figure 1-8 we can see that there was a steady increase in both taxation and operating revenue in the City of Edmonton between 2009 and 2013. The operating revenue is mainly comprised of taxation, user fees and the sale of goods and services, subsidiary operations etc., with approximately half coming from taxation. In particular, the taxation in the city has reached a billion dollars since 2012 (City of Edmonton, 2009-2013) and it is mainly collected from property and business taxes.

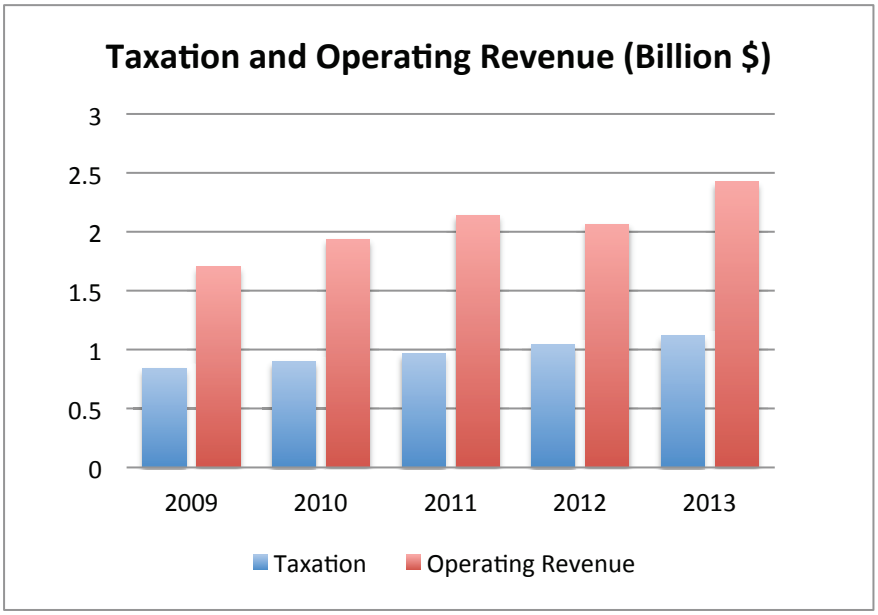

Figure 1-8: Taxation and Operating Revenues in the City of Edmonton from 2009 to 2013 (City of Edmonton, 2009-2013)

While the total taxation and operating revenue reflect the sources of finance, it is also noteworthy to look at is the distribution of expenses. Based on the distribution of expenses reported in the *Financial Annual Report* (City of Edmonton, 2009-2013), we calculated the return of taxation per dollar for three primary tax-supported programs across the city from 2009 to 2013 as shown in Figure 1-9. The money amount of three primary tax-supported

programs was respectively divided by the total taxation to generate the return of taxation, in the unit of per dollar. In general, transportation services rank first among all these services with approximately 0.7 per dollar return. Transportation services mainly include bus, light rail transit (LRT), roadway and parking services. Protective services come second and the return of taxation per dollar is quite steady around 0.5 dollars. For the protective services, they are mainly referred to police, traffic safety, bylaw enforcement and emergency responses. The return of taxation per dollar of community services is less than 0.4 dollars, which ranks third among all the programs. Community services incorporate a wide range of provisions and the expenses mainly go to parks and recreation, community and family services and other education related programs.

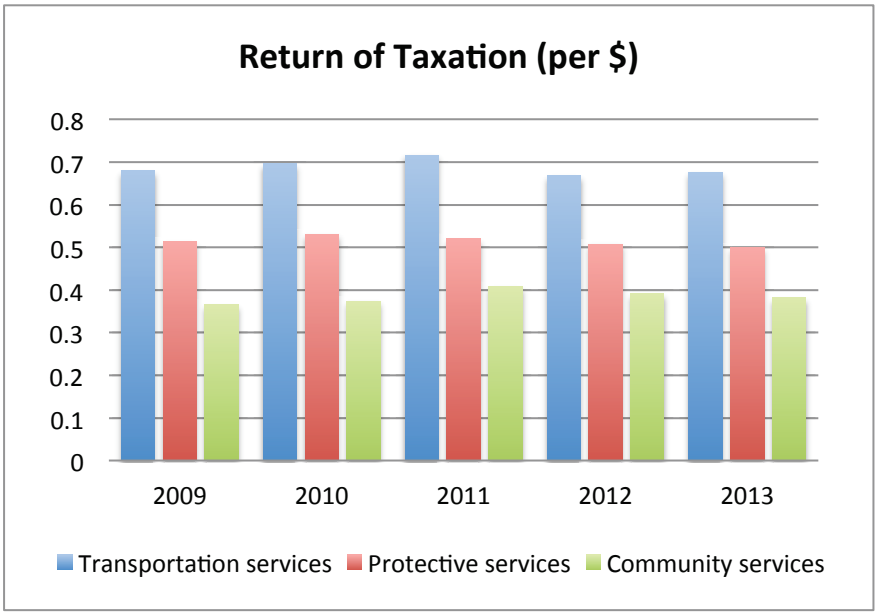

Figure 1-9: Return of Taxation in the City of Edmonton from 2009 to 2013 (City of Edmonton, 2009-2013)

4 Agricultural land conservation

The increasing rate of agricultural land conversion arouses attention from government, stakeholders and the public. Strong desires are expressed to conserve agricultural land or land in agricultural uses. Extensive discussions about the establishment of a healthy landscape environment to conserve agricultural land source from current government policies and possible land management tools. This section provides a review of relevant land use policies implemented in Alberta regarding agricultural land uses, and associated land use

planning tools that advance specific goals.

4.1 Government policies

Documents of particular relevance regarding agricultural land uses include the *Municipal Government Act* (MGA) and *Alberta Land Stewardship Act* (ALSA). These documents shape the land planning and development processes in which the standing of agricultural land protection is underlined. *MGA* specifically pointed out the protection of agricultural operations. That is, in preparing a land use bylaw, a municipality must consider the protection of agricultural operations unless an *ALSA* regional plan requires agricultural operations to be protected or requires agricultural land or land for agricultural purposes to be protected, conserved or enhanced (Government of Alberta, 2002). *ALSA* further discussed the conservation and stewardship tools as the funding to support conservation and environmental values of agricultural land uses. In detail, the Lieutenant Governor in Council is responsible for establishing, supporting or facilitating funding and cost-sharing initiatives, mechanisms and instruments to support the protection, conservation and enhancement of agricultural land or land for agricultural purposes, which highlighted the introduction of conservation easements (Government of Alberta, 2009).

Additionally, concerns about the pace and pattern of development and agricultural land conversion led the provincial government to create the *Land-Use Framework* (LUF) in 2008, the Capital Region Board to create the *Capital Region Land Use Plan* in 2009, and the City of Edmonton to launch the food and agriculture strategy *Fresh* in 2012. The LUF mainly outlines strategies to improve land use and resource management in Alberta. One of the key strategies designed to improve land use decisions is to define seven watershed regions across the province and develop a regional plan for each region. Specifically, the Alberta Capital Region is included in the North Saskatchewan Regional Plan (Government of Alberta, 2008). In response to the land use principles and policies, the *Capital Region Land Use Plan* specifically listed preserving agricultural lands to protect the environment and resources (Capital Region Board, 2009a). *Fresh* highlights the importance of local food production and focuses on identifying mechanisms to protect and maintain the ecosystems that are

connected to peri-urban agricultural lands. Another strategic direction of *Fresh* is to integrate agricultural land in the city's Urban Growth Areas that are embedded in the context of Edmonton's growth and ecological footprint (City of Edmonton, 2012b).

4.2 Land management tools

In North America, a number of policy and market-based instruments can be used to preserve agricultural land, including conservation easements, transfer of development rights/credits, direct agricultural support payments, voluntary agricultural districts or preserves, and regulatory zoning approaches (Bengston et al, 2004). To help promote the efficient use of land and achieve the goals detailed in *LUF*, the Government of Alberta completed a review of tools and best practices in *Efficient Use of Land Implementation Tools Compendium* in 2014 (Government of Alberta, 2014b). Most of the 29 potential tools listed are suitable for conservation on private lands under individual and/or municipal management/planning. Additionally, a further 16 tools that are more appropriate for public lands are described in the document of *Integrated Land Management Tools Compendium* (Government of Alberta, 2012b). The purpose of both compendia is to present and describe a set of potential tools and practices for municipalities to achieve the outcome of strategies for efficient use of land, with examples of how each tool has been applied within Alberta. Generally, all these tools were assessed for their applicability to the Alberta context as well as their legal ability to be used as a result of laws and tax structures. Though not all of the tools have been used in Alberta, they may have the potential for use in the province.

Among the tools and practices described in the compendia, conservation easements have been comparatively more discussed as possible options to preserve agricultural land. In 2009, with the proclamation of the *ALSA*, the Government of Alberta took the step of expanding Alberta's 13-year-old conservation easement provisions to include agriculture (Government of Alberta, 2009). A document named *Conservation Easements for Agriculture in Alberta* analyzed the existing practice of conservation easements for agriculture in Alberta, with a review of legislation, policy, and delivery mechanisms (Chiasson et al., 2012). Even though only two Canadian provinces (i.e., Nova Scotia and Ontario) specifically use conservation

easements to conserve agricultural land, some provinces without agricultural purposes in their conservation easements legislation have farms with conservation easements or land trusts with “agricultural conservation” as a mandate purpose.

4.3 Practices in Canada

Public concerns about agricultural land conversion appear strongest in the Canadian provinces of British Columbia, Nova Scotia and Ontario, and evidence can be traced in these provinces with regard to agricultural land preservation programs through provincial legislation.

In British Columbia, there is a land preservation program called the *Agricultural Land Reserve* (ALR), in which agriculture is recognized as the priority use. Within this provincial-wide zone, farming is encouraged and non-agricultural uses are restricted. The ALR protects approximately 11.6 million acres of agriculturally suitable land across British Columbia (Agricultural Land Commission, 2014). In Ontario, there is a registered Canadian charity named the *Ontario Farmland Trust* (OFT) that has the mission to protect and preserve farmlands through conservation easements and land donations. The OFT has recently launched a project of agricultural easements to support broader acceptance and use of farm easements throughout the province (Ontario Farmland Trust, 2014). In addition, the Greenbelt has become popular in Ontario. At almost 2 million acres as the world’s largest permanently protected land, the Greenbelt in Ontario protects environmentally sensitive areas and productive farmlands from urban development and sprawl (The Friends of the Greenbelt Foundation, 2015). The Greenbelt also keeps farmlands, forests, wetlands safe and sustainable, and continues to provide fresh air, clean water and healthy local food. Relevant practices can also be seen in Nova Scotia. As part of the Ecology Action Centre, Heliotrust has conserved two farms on the Hants Shore of Nova Scotia through Conservation Easements (HelioTrust, 2014). Meanwhile, the trust has set up an Endowment Fund for potential future farmland conservation and legal challenges.

5 Nonmarket valuation

One key question has to be addressed when it comes to agricultural land conversion. What values are being gained and lost as a result of such land use changes? The values of agricultural land uses may be weighed quite differently by different interest groups. For example, some of these values (e.g., the market value of agricultural commodities) accrue mainly to private individuals and firms, while others (e.g., water filtration and biodiversity conservation values) accrue to the society in general. Possible values of preserving or conserving agricultural land include, but are not limited to, values for environmental management, values as a source of local food, values for community development, and values for maintenance of peri-urban green space.

However, the economic benefits of some values (especially those associated with environment and ecosystem) cannot be easily determined as there is no conventional market for such values (Grafton et al. 2003). In other words, these kinds of values are commonly referred to as either existence, nonuse or passive use values as people may consider these values if they expect to see the associated goods or services or for the option to see them in the future (Freeman 2003). This type of value can be elicited through nonmarket valuation methods; in this case the use of stated preference techniques wherein individuals are asked through a specially-designed survey instrument to reveal their willingness to pay (WTP) for alternative programs that result in specific policy changes. More details about these methods are presented in Chapter III.

6 Conclusions

In conclusion, agricultural land conversion in the Alberta Capital Region is increasing mainly due to urban development and sprawl over the past decade, and this trend is expected to continue. The municipalities and provincial government have already expressed great concerns about the need to conserve agricultural land. Corresponding programs and policies are being established to balance the allocation of land between development, agriculture and ecological uses. Yet, not much research has been done to empirically determine values of agricultural land in the context of Alberta. One goal of this study is to identify and

estimate the values that residents in the Alberta Capital Region place on conserving agricultural land.

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Chapter III - Using a Choice Experiment to Assess the Multiple Values of Land in Agricultural Uses in a Peri-urban Area: An Application to Edmonton, Canada

1 Background Literature

1.1 Introduction

This chapter outlines the methods of nonmarket valuation research and discusses previous studies regarding agricultural land conservation that have been conducted both in Canada and other countries. Choice experiments that are used in this study to elicit values of land in agricultural uses are discussed in detail. In addition, studies of the linkages between ecosystem goods and services and agricultural uses are reviewed.

1.2 Valuation methods

For decades, economists have struggled with the challenge of valuing public goods that cannot be easily observed in the real market. Many valuation methods have been proposed to tackle this puzzle, including contingent valuation and choice experiments. Both methods have been used extensively, especially for environmental goods and services valuation.

1.2.1 Contingent valuation

The contingent valuation (CV) method uses survey questions to find out respondents' preferences for public goods or services by eliciting what they would be willing to pay for specific improvements in them (Mitchell and Carson, 1989). This concept emerged from a couple of early studies (e.g., Ciriacy-Wantrup, 1947; Davis, 1963) since the elicited monetary values (i.e., WTP) are contingent upon the particular hypothetical market described in the survey instrument.

Mitchell and Carson (1989) indicated that in a contingent valuation study, respondents are usually presented with quesntionaires that often consist of three components: (1) A detailed description of the goods or services being valued and the hypothetical circumstance under which it is provided to the respondent; (2) Questions which elicit the respondents' WTP for the goods or services; and (3) Questions about respondents' characteristics (e.g., gender,

age, and income), and their preferences relevant to the goods or services being valued.

There are two types of CV questioning: discrete choice questions and opened-ended questions (Freeman, 2003). As the name suggests, open-ended questions simply ask respondents how much they would be willing to pay for a specific change in a specific scenario. This is a direct reflection of the stated value by respondents. However, Freeman (2003) argued that this approach provides respondents with a rather unfamiliar task of identifying their own price for a good or service. Respondents are more often presented with levels of goods or services as well as an associated price that they can either accept or not accept. In contrast, discrete choice questions ask respondents to answer "yes" or "no" to the cost/price that is pre-determined by the researcher. The difficulty of this format is the cost levels chosen in the study should adequately represent the upper and lower bounds of valuation for the goods or services. Nowadays, discrete choice questions are more commonly used than open-ended questions in CV research. For one reason, the choice is comparatively simple as respondents are only asked to respond with either a "yes" or "no". For another, the discrete choice format is generally considered to be more "incentive compatible" if a referendum is used, because respondents are less likely to behave strategically in answering WTP questions.

1.2.2 Choice experiment

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

Similar to contingent valuation, the choice experiment method can also be used to estimate economic values, especially nonmarket ones. Tradeoffs can be made through statistical

techniques between the characteristics of the good or the service, and WTP can thus be computed as long as cost/price is one of the attributes. Compared to the CV method, CEs have gained popularity because of several advantages (Holmes et al., 2014). First of all, CEs cannot only elicit the monetary values of an action or a new policy, but also allow researchers to specifically evaluate the various characteristics or attributes that result in the corresponding changes, at both single and multiple levels. Second, characteristics (or attributes) are experimentally manipulated and presented to respondents. They are typically regarded as exogenous, non-collinear, and can reflect characteristic levels. The statistical efficiency of the estimated parameters can thus be increased even if the samples remain the same. However, challenges also exist with the use of CEs. For one thing, CEs are typically more complex than the CV method and the cognitive difficulty in considering alternatives with multiple attributes may become high for respondents. For another, concerns about hypothetical bias as well as strategic behavior also arise since CE responses are stated-preferences as in the CV method.

1.2.3 Challenges of valuation

Although contingent valuation (CV) and choice experiment (CE) are commonly used to elicit nonmarket valuation, much literature shows that there remain challenges in applying these valuation techniques.

One shortcoming is the nature of the information provided in CV or CE surveys, which is also referred as “information bias” (Cummings et al., 1986). It has been suggested that if respondents have little prior experience with the proposed programs or scenarios and lack monetary values for unfamiliar public goods, they must construct a value at the time of the survey (Ajzen et al., 1996; Schkade and Payne, 1994). Partly to alleviate this problem, investigators have been providing respondents with a detailed and accurate description of the proposed transaction, so that respondents know what they are being asked to evaluate and can make informed decisions accordingly (Fischhoff and Furby, 1988; Mitchell and Carson, 1989). Although an accurate and balanced description of the proposed program is needed, giving respondents overwhelming information about the goods or services as well

as the relevant context can lead to unintended and unanticipated distortions (Cummings et al., 1986). In addition, persuasive communications should be avoided when the information is provided, and it is also advisable to obtain valuations for more than one information scenario (Ajzen et al., 1996).

Another issue with CV and CE methods is hypothetical bias that occurs when participants respond differently to questions depending on whether they perceive scenarios to be real or hypothetical (Cummings and Taylor, 1999). Hypothetical bias can be considered as the divergence between the preferences expressed in a hypothetical survey and those expressed in a real market (see Murphy et al., 2004 for a well summarized evidence from many studies). It is inferred that hypothetical bias could be due to either social desirability or strategic behavior. However, several approaches have been proposed to mitigate such biases. One suggested method is to present respondents with a short script prior to the valuation questions with descriptions of what hypothetical bias is and what the consequences are for research. This script is called “cheap talk” and was first introduced by Cummings and Taylor (1999). Another approach to alleviating hypothetical bias is to design debriefing questions (Blumenschein et al., 1998; Grafton et al., 2003). There are several types of debriefing questions (Krupnick and Adamowicz, 2007). One commonly utilized one is to ask how certain participants are in their responses to the valuation questions. Other debriefing questions include asking the reasons why respondents were “for” or “against” the particular programs, and asking them to indicate their affecting factors regarding particular choices.

Along with the problem of hypothetical bias is the existence of “yea-saying” and “warm glow”. In collecting CV and CE data, there might be a group of individuals who can bias the measure of economic values by ignoring budget constraints and without recognizing the tradeoffs inherent between environmental improvements and income loss (Blamey et al., 1999). 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 addition, a phenomenon called “warm glow” arises when respondents tend to vote for an

improvement in a public program. Hypothetically, respondents will say they will pay a few dollars for any type of public goods or services just to appear public spirited (Andreoni, 1989). It is also indicated that respondents are purchasing moral satisfaction rather than the program itself when there exits “warm glow” (Grafton et al., 2003). To identify and potentially mitigate these problems, debriefing questions can again be used.

Incentive compatibility is another challenging aspect in CV and CE valuation. Carson and Groves (2011) indicated that a single binary discrete choice question for a pure public good is incentive compatible in the sense that truthful preference revelation is a respondent’s dominant strategy. To be incentive compatible, if a referendum on a pure public good is adopted, it needs to be a take-it-or-leave-it offer, where the vote does not influence any other offers that may be made to agents and where the payment mechanism is coercive in the sense that each agent can be required to pay independently of how the individual agent voted (Carson and Czajkowski, 2012). The referendum method has been widely used in the United States regarding land conservation for biodiversity. A recent study by Kroetz et al. (2014) suggested that referenda in the form of ballot box occur in counties with significantly greater biodiversity than counties chosen at random. Their results also demonstrated that large potential gains for conservation are possible if ballot box measures are directly incorporated into national-scale conservation programs.

1.3 Review of previous studies

Both CV and CE have been widely used to value a variety of programs of agricultural land preservation worldwide, especially in the context of North America (see a systematic review by Bergstrom and Ready, 2009). Different aspects of such preservation programs have been investigated, including types of agricultural land use, preservation contracts and public accessibility etc. Also, recent literature has started to focus on spatial characteristics, for example, size of the area, land proximity and adjacent land uses, to better and more realistically depict the scenarios. Meanwhile, ecosystem goods and services that are related to agricultural land uses are gaining attention as well.

1.3.1 Agricultural land preservation

Early studies regarding agricultural land amenities valuation started in the 1980s using the CV method to estimate WTP for agricultural land protection. These CV studies span major geographic regions across the U.S. (e.g., Beasley et al., 1986; Bergstrom et al., 1985; Halstead, 1984; Krieger, 1999; McLeod et al., 2002; Rosenberger and Walsh, 1997; Waddington, 1990). Starting in the early 2000s, scholars using contingent valuation methods to evaluate agricultural land amenities switched their focus toward the CE approach to analyzing the WTP for agricultural land protection and specific attributes in such programs. Most of the previous CE studies were conducted in the U.S., and the majority of these studies were conducted in the northeastern region (e.g., Duke and Ilvento, 2004; Johnston and Duke, 2007; Johnston et al., 2007a; Johnston et al., 2007b; Ozdemir, 2003; Volinskiy and Bergstrom, 2007). More recently, a few CE studies have been undertaken in countries other than North America such as Finland (Grammatikopoulou et al., 2012).

Type of agricultural land use has been one of the attributes of agricultural land preservation programs. Though agricultural land uses may vary across regions, the common types include grain crops (or field crops), hay, vegetables, and pasture (primarily for livestock). Previous CE studies show that people place more value on protecting the agrarian landscape and access to fresh, local food supplies. For example, previous studies have found that WTP is higher for agricultural land used to produce human food crops (e.g., cropland, vegetables) than for timberland, hayland or pastureland (e.g., Nickerson and Hellerstein, 2004; Roe et al., 2004; Swallow, 2002; Volinskiy and Bergstrom, 2007). In contrast, results from Johnston and Bergstrom (2011) and Ozdemir (2003) indicated that estimates of grain crops and pasture are insignificant which means they do not significantly affect people's preferences. Residents in four Connecticut communities tend to value the preservation of livestock (or dairy farms) somewhat more than other farm types including field crops (Johnston et al., 2007a). Similar results were found by Grammatikopoulou et al. (2012) that grazing animals has a significant positive effect on the choice of landscape management alternatives relative to no animals in Finland. Based on the above mixed results, it is therefore difficult to draw firm generalizations about the effects of different agricultural land use types on WTP for

agricultural land protection.

Different agricultural land preservation programs have been evaluated in history and Colyer (1998) systematically reviewed the various policy tools for preserving farmland. A growing number of studies have included preservation contracts, primarily conservations easements or purchase of development rights as opposed to outright purchase by the government, in the survey instruments that use CV and CE methods. As policy process attributes, Johnston and Duke (2007) found that marginal utilities associated with conservation easements differ from those associated with simple fee purchase of farmland parcels. For instance, the WTP for state-implemented conservation easements is higher than simple fee purchase by either the state or the land trusts. Similarly, Johnston et al. (2007a) indicated that residents in Connecticut communities place higher WTP for preservation contracts that permanently prohibit development relative to outright purchase. More recent literature directly adopts conservation easements to frame the farmland preservation programs in the choice experiment survey. For example, both Volinskiy and Bergstrom (2007) and Johnston and Bergstrom (2011) used agricultural conservation easements for the case of Georgia, and Duke et al. (2012) conducted choice experiments in Delaware with the choice scenario of land preservation and conservation practices.

1.3.2 Spatial characteristics

Empirical evidence has shown that values of public goods, such as ecosystem goods and services, are often strongly related with their spatial characteristics (Johnston et al., 2002; Horne et a., 2005). As a result, spatial variables such as size, location, adjacent area, and proximity to the population of beneficiaries have gradually been taken into consideration in CV and CE methods.

Various types of adjacent land uses have been used in previous studies, including urban areas, natural buffer zones, and residential areas. Farmland preservation is typically given priority to areas near urban areas (Ozdemir, 2003; Volinskiy and Bergstrom, 2007). Specifically, Johnston and Bergstrom (2011) found that relative to no farmland location

priority, residents are willing to pay higher WTP for agricultural uses near urban areas. Grammatikopoulou et al. (2012) suggested that natural buffer zones (i.e., 15 meters width) are preferred for agricultural landscape improvements. Compared to other management and condition of buffer zones, natural buffers increase the choice probability. Inge et al. (2013) included nature and residential areas as the surrounding land uses for nature development. Their results showed that developing a natural area adjacent to an existing nature area or adjacent to residential area increases WTP compared to an area located adjacent to other agricultural areas.

In the theory of contingent valuation, people prefer more over less of a good or a service but the marginal utility is generally expected to decrease as the provision level rises (Arrow et al., 1993). A number of studies using CV or CE methods have included the size of area as an attribute in the survey. Bower and Didychuk (1994) found a strong positive relationship between WTP and acreage of farmland to be preserved, though the agricultural types were not differentiated in their study. Ozdemir (2003) generally showed the support for protection of relatively larger acres of farmland. Inge et al. (2013) also found that the size of the natural area has a positive linear effect on choices. Specifically, households are willing to pay more for every extra hectare that is added to the nature area, irrespective of the additional attributes. However, some researchers indicated that size was not the main criterion for the choice between natural areas. Volinskiy and Bergstrom (2007) implied that the program size, alone, was not a significant factor for respondents, while farmland qualitative attributes such as farmland type and location had more decisive effects on conservation preferences.

Distance/proximity is another important spatial characteristic in terms of use and non-use values associated with environmental changes. Mainly related to recreation sites, longer distance reflects a higher cost of visiting, both in time and transportation. It is therefore expected that respondents' interest decreases as the distance from the site to their residence increases. This phenomenon is generally known as distance-decay (Hanley et al., 2003). Inge et al. (2013) used distance from residence to natural area in the survey and

clearly observed a distance decay effect. Willingness to pay reduces when nature areas are situated further away from the place of residence of respondents.

1.3.3 Ecosystem goods and services

Different combinations of services are provided to human populations from various types of ecosystem. The Millennium Ecosystem Assessment (2005) summarized four categories of ecosystem services, namely supporting services, provisioning services, regulating services and cultural services. In each category, detailed services and descriptions are presented. Taking provisioning services for example, food and fresh water are the most common items to humans. Climate regulation and water purification are listed as regulating services, and cultural services include aesthetic and recreational activities etc.

Among all the services, food production, especially from a local perspective, might be the most notable to the general public. Aubry et al. (2012) designed an interdisciplinary research program to test the concept of "multi-functionality" in agriculture. They found that food production, especially production of fresh produce, is regarded to be one of the main functions of urban agriculture. Similar results were demonstrated by Ives and Kendal (2013) that peri-urban agricultural landscapes are perceived as multifunctional systems by the urban public, and their findings showed that the public considers other landscape functions as important but ancillary to the primary function of food production in peri-urban agricultural lands. In the case of farmland conservation easement programs, Ozdemir (2003) implied that one of the primary motivations for farmland preservation is the concern about food security based on the focus group discussions they have conducted.

Environmental attributes have been theoretically investigated in the literature with regard to agricultural land preservation. Duke and Aull-Hyde (2002) used analytic hierarchy process (AHP) to identify public preferences for farmland preservation programs. Their results showed that public preference is strongest for the environmental and agricultural attributes. In addition, within the environmental attributes, water quality was listed to have the highest weight. Duke and Ilvento (2004) also conducted a conjoint analysis of public preferences for

agricultural land preservation and found that environmental and nonmarket-agricultural services are the most important preserved-land attributes. In accordance with the findings reported in Duke and Aull-Hyde (2002) which represented a nonutility-theoretic framework, both approaches found that agricultural and environmental attributes were the most important. Kline and Wichelns (1996) implemented a factor analysis of the ratings to a set of reasons for preserving farmland, and outcomes revealed protecting groundwater as most important.

Another noticeable aspect of ecosystem goods and services is scenic beauty, which may be incorporated in rural amenities that are frequently mentioned when it comes to farmland preservation. Lynch and Duke (2007) suggested that the public clearly express a willingness to pay for rural amenities such as scenic beauty when they vote for farmland preservation programs. Similarly, Duke and Aull-Hyde (2002) found that respondents ranked scenic quality protection highly when compared to rankings for other purposes such as providing wildlife habitat and preserving natural places. Bastian et al. (2002) indicated that people would be willing to pay more for agricultural land that provides scenic views in addition to agricultural production. Nickerson and Hellerstein (2003) explored the importance of protecting different rural amenities in farmland preservation programs. Based on the ranking criteria, they suggested the importance of road frontage, which could be indicative of a desire to protect scenic views, were significantly correlated with such programs aiming for protection of rural amenities.

1.3.4 Study cases in Canada

Though widely studied in the U.S., only a few Canadian cases have been observed regarding the nonmarket valuation of agricultural land preservation. To our knowledge, no study has used the choice experiment method.

Bowker and Didychuk (1994) estimated the nonmarket benefits of agricultural land retention in the Moncton area in the province of New Brunswick. In their study, they employed the contingent valuation method with a payment card. Their results reported that

households were willing to pay an average of CAD$86.20 per year (1991) to preserve 95,000 acres of farmland. Their findings also indicated that at the margin, regional extra-market benefits of retaining farmland were about CAD$97 per acre or about 6%-16% of the 1991 land price in the Moncton area. Marginal extra-market benefits of farmland retention thus appeared small compared to land prices and the potential costs of establishing a preservation program in the region. In this light, a general farmland preservation program did not appear to be socially warranted for that case.

In British Columbia, there is an actual land preservation program called the Agricultural Land Reserve (ALR) program that was advocated by British Columbia's Agricultural Land Commission (ALC) in 1973. ALC is an independent administrative tribunal dedicated to preserving agricultural land and encouraging farming in British Columbia (Province of British Columbia, 2015). There are at least two pieces of study that investigated farmland protections and agricultural land values based on this program. One is Androkovich et al. (2008) that explored the motives the people of British Columbia to support an Agricultural Land Reserve (ALR) program, and how much they would be willing to pay each year to ensure that development does not occur on land in the ALR. They launched a survey based on the contingent valuation method to respondents across the province. The results suggested that ensuring local food production, maintaining economic importance of agricultural sector, and protecting the environment were regarded by residents as being of equal importance. This study further estimated the aggregate WTP with the most conservative estimate being CAD$91.18 million per year (2008). Another study by Eagle et al. (2014) used a multilevel hedonic pricing model to estimate the impact of land use, geographic, and zoning characteristics on farmland value near the capital city of Victoria on Vancouver Island. Their results suggested a changing ALR impact over time that varies substantially by improved and unimproved land types. In 2008, landowners paid 19% less for the typical improved farmland parcel within the ALR versus that outside it. However, ALR land that is unimproved has a premium of 55%, suggesting that this land is more valuable for agriculture than for development.

1.4 Conclusions

Many of the existing agricultural land preservation studies use the contingent valuation and choice experiment methods to implement nonmarket valuation of agricultural land uses, spatial characteristics and associated ecosystem goods and services. However, the majority of the research has been conducted outside Canada and the few Canadian cases have only applied the contingent valuation method. This study uses a choice experiment approach to eliciting the nonmarket values of land in agricultural uses to residents in the Alberta Capital Region. Conservation easements, as alternative conservation strategies relative to the status quo that would result in no policy change, are chosen to be the framework to conserve land in a specific agricultural use, in a specific type of area, with a specific cost. In addition, links between those nonmarket values and residents' affinity with different ecosystem goods and services are explored. As one of the few studies of agricultural land values conducted in Canada, this study aims to contribute to the literature and case studies through the development of nonmarket valuation measures in the context of current land use policies and legislations.

2 Methodology

2.1 Introduction

The first part of this chapter focuses on the procedures used to design the survey and collect the data. Expert and public focus groups were organized to review the overall design of the study and prepare for the final survey instrument. Pre-tests were then used to review and edit the internet-based version of the survey. In addition, the procedures used to conduct the survey and collect the data are also described. The second part of the chapter provides an overview of the survey instrument, which includes the attributes and the experimental design. The last part presents the conceptual and econometric models that are used to analyze the choice experiment data.

2.2 Survey design

According to Carson (2000), the scenario under which the good or service would be provided should be described accurately and clearly. The tradeoff or the decision that a respondent is

asked to make should be reasonable. In addition, respondents should be provided with enough, but not overwhelming, information so that they can make informed decisions. A good contingent valuation survey should contain seven basic elements as follows:

(1) An introduction, including the general context in which the good or the service will be provided.
(2) A detailed description of the good or the service, including the proposed changes in quantity or quality relative to the current state.
(3) The institutional framework in which the proposed changes will be credibly implemented.
(4) The coercive payment vehicle that will be used to finance the provision of the good or service.
(5) Valuation scenarios that elicit the respondent's preferences or willingness to pay for the proposed changes.
(6) A set of follow-up questions that explore why the respondent answered the questions as the way they did in the valuation scenarios.
(7) A set of debriefing questions regarding the respondent's characteristics and demographic information.

2.2.1 Expert focus groups

Nonmarket valuation using stated preference or choice experiment data requires that great care be taken in designing the survey instrument. Before it was launched to the general public, drafts of the survey were presented to small focus groups. Focus groups are an essential element of the development of contingent valuation studies (Carson and Hanemann, 2005). Two types of focus groups were convened in this study: expert groups and general public groups.

The aim of expert focus groups was to determine if the information provided both in the presentation and the draft survey was accurate, logical and would be understandable to the general public. Specifically, experts helped organize the background information and develop the key elements of the choice experiment.

The first expert group was held in Department of Resource Economics and Environmental Sociology at the University of Alberta on 22nd July 2014. It involved seven experts (Appendix A) from academia, government as well as owners of land in the Alberta Capital Region. This expert group mainly focused on the most important information to be provided in the survey. The gist of the discussion was as follows: there was a need to clarify differences between several pairs of concepts (e.g., land use versus land cover, land use versus land management, conservation versus preservation); the terminology should be clarified to be understandable to the public without causing confusion; additional background information should be provided; information about current taxation and future population projections should be presented in a more accessible manner; conservation easements should be identified as one of several possible tools to protect land in agricultural uses; and the potential study areas under Alberta's current land use framework.

The second expert group was held in the same location on 28th July 2014. Four experts (Appendix A) were drawn from municipal governments and non-governmental organizations. The purpose of this expert group was to improve the quality of the survey as modified after the first expert group. The whole survey was separated into two parts, Background Information and Choice Experiment Questions. The experts reviewed the survey page by page and provided following consensus comments: the sub-headings should be added to make it easier for respondents to understand the background information; the sequence and structure of the background sections should be changed to make the survey more readable; and there should be transitions between warm-up questions, choice experiment questions, and debriefing questions.

The third expert group was held in the same location on 16th September 2014. The six experts (Appendix A) were from academia, municipal government and non-governmental organizations. The discussion covered topics such as the sequence of warm-up questions, the proper way to present background information in the internet-based survey, the ideal scenario to frame the conservation strategy based on existing land-use practices in the study

area, and the conservation instrument (e.g., conservation easements) to be used in the survey. This expert group further suggested that the survey instrument was on the right track, and should be ready for moving to the public focus groups.

2.2.2 Public focus groups

The main goal of the public focus groups was to ensure the key concepts and structure of the survey instrument were clearly understood.

A Canadian market and social research firm, *Advanis*, was contracted to assist in the recruitment of the public focus group. *Advanis* randomly sampled members of the Edmonton public to participate in a single focus group to be organized on 22nd October 2014. *Advanis* contacted potential survey respondents by phone and invited them to attend the focus group, with the understanding that the meeting would run on 22nd for approximately 90 minutes, that they would be discussing a survey and issues related to conservation of land in agricultural uses, and that they would receive an honorarium of $50 if they participated. The recruitment screener is shown in Appendix B, and a confirmation letter (Appendix C) was sent if the participant agreed to attend the focus group. For the focus group, we intended to get an equal gender split and to involve people of different ages, excluding anyone under 18 years old. In order to ensure the turnout of at least 10 participants, *Advanis* recruited 13 participants. One participant cancelled before the focus group and two participants did not show up, thus making a final turnout of 10 participants.

The focus group was convened on 22nd October 2014 in the Department of Resource Economics and Environmental Sociology at the University of Alberta. Participants were given a package of Information Sheet (Appendix D), Consent Form (Appendix E) and Consent Form Checklist (Appendix F), which summarized the main points such as research background and objectives. The draft survey was divided into two booklets, one with all the questions (i.e., warm-up questions, choice experiment questions, associated debriefing questions, and demographic questions) and the other with all of the background information that aimed to help participants get familiar with the scenarios covered in the survey. After participants

completed the survey, they were encouraged to raise questions and discuss any concerns or difficulties that they encountered. We went through the survey page by page so as to make sure we captured all the contents. Participants were paid $50 for attending the public focus group.

The public focus group was particularly helpful in finalizing the survey instrument. Issues such as length of the survey, clarity of scenarios, and question order were addressed. In order to make respondents feel less overwhelmed with the survey, we considered separating the questions from the background information and making the background information optional to be seen. We tested this approach with the public focus group. They were satisfied with the approach and offered useful suggestions for minor modifications. For instance, they suggested that we modify some specific terms so that a layperson in the public could more easily understand. In addition, some warm-up and debriefing questions were slightly modified to be more consistent with the scenarios in the choice experiment. Overall, the comments from the public focus group were quite positive, and indicated that the survey was very close to being ready.

2.2.3 Pre-tests

Before we launched the final survey, pre-tests were implemented from 17th November to 21st November 2014 among students at the University of Alberta. The pre-tests served two purposes. First of all, it was the first time we tested the internet version of the survey, and experiences of completing the online version were considered. Second, participants in pre-tests were able to proofread and correct editorial mistakes, which helped to make sure the survey was complete before being sent out.

Fourteen students from different disciplines, including both undergraduates and graduates, participated in the pre-tests. An honorarium of $20 was given for their participation of approximately 60 minutes. Two or three students were organized as a group for each pre-test. They were required to complete the online survey separately for approximately 20-30 minutes, and for the rest of time, they were involved in the discussion regarding their

opinions of the survey. The survey used in the pre-tests was quite close to the final version, and the general comments from pre-tests were rather satisfactory. For example, the length of the survey was appropriate, and participants found it very useful and informative to have background information optional for them to make informed choices. The approach we used to present different scenarios did not seem to place a higher priority for one option versus any other. Though some questions may require a certain amount of thought, most participants felt the survey questions were clear and easy to answer. There were no sections that participants thought should be removed, though suggestions about re-wording and re-framing some questions were generated.

2.3 Survey administration

One of the key issues associated with survey design is the population of respondents to be represented. Choice about the population has significant impacts on the outcome, and also on the policy implications that are drawn. Since this study mainly involves questions of land in agricultural uses in the Alberta Capital Region (i.e., the City of Edmonton and surrounding areas), we chose to target residents who are over 18 years old and are actual or potential tax payers in the region.

A contract was established with a market research company called *Qualtrics* for the administration of the internet-based survey instrument. *Qualtrics* works with its partners to keep active panels for contact and response. The partners regularly manage their panelists and can provide data on demographic characteristics such as residence, which we used to screen the survey responses. The panelists receive compensation, such as Merchant Points, as an incentive to complete various surveys. An email invitation (Appendix G), which included the link of the online survey, was sent to panelists by their corresponding partners.

Internet-based surveys offer a number of advantages as opposed to other forms such as mail, telephone or personal interviews (Dillman, 1999). Online surveys are able to provide respondents with plenty of information in the form of tables, figures and other functions that can assist in understanding the issues covered in the survey. This is especially helpful for

complex experimental designs such as choice experiments. Furthermore, using a computer interface boosts completion rates through forced responses. Respondents are required to complete each question before moving on to subsequent questions. In addition, skipping logic was adopted so that we were able to make it optional for respondents to read background information. Another advantage of the online survey was to randomize the order of choice sets to reduce sequencing effects in the choice experiment. Each respondent was expected to receive a different order of choice sets.

2.3.1 Soft launch

Soft launch, or the pilot study, is typically used to detect any remaining ambiguities in the survey before it is sent out to a wider group of respondents. Specifically, the results obtained from the soft launch were used to determine the final range of the tax payment distribution, and the optimal experimental design of choice sets. In addition, minor adjustment of question answers was anticipated.

The draft survey was provided to the project manager at *Qualtrics* on 1st December 2014. The *Qualtrics* team made several formatting such as setting forced responses, and added screening questions at the beginning of the survey to screen out any respondent who is under 18 years old and not a resident in the Alberta Capital Region. In addition, attention filters were highly recommended to be added into the survey by the *Qualtrics* team. Attention filters are questions that ask survey participants to respond in a particular way. If respondents do not follow the question instructions, they will be screened out. This approach ensures that respondents are actually reading the questions. The soft launch was activated by *Qualtrics* to their internet panelists on 2nd December 2014. A total of 63 complete responses were gathered on 3rd December 2014.

The results from the soft launch were mainly used to get priors for the further experimental design in the full launch afterwards, and the process was detailed in Section 2.4.3. Besides the preliminary outcomes, several modifications were made as follows to improve the survey quality. First, we adjusted the range of tax payment. The initial distribution ranged

from $10 to $300. We anticipated there would be few respondents voting for the conservation strategy regardless of the combination of attributes at the $300 level and that most would vote for the program at the $10 level (note that the $300 level was higher than the $100 level we used in the focus groups). The upper-end tax payment of $300 was chosen to "choke" off the demand for the proposed program. However, we found the percentage of respondents voting "yes" at the $300 level was as high as 60% in the soft launch. Meanwhile, the percentages of "yes" responses at the $10 and $25 levels seemed to be the same. As a result, we eliminated the $10 level and added the upper-end price of $600, thus making the adjusted range of tax payments from $25 to $600. Second, we decreased the intervals of household income from $50,000 to $30,000 so that the results would be better distributed.

2.3.2 Full launch

Once we were done with the modifications arising from the soft launch, we sent the adjusted survey instrument to *Qualtics* for final review. There were two full launches involved in this study. The first experiment was activated by *Qualtrics* on 10th December 2014, and a total of 520 complete responses were collected by 15th December 2014. The second experiment was launched on 9th March 2015, and a total of 320 complete responses were collected by 12th March 2015. The reason to draw a second sample was to obtain a wider range of choice set scenarios to respondents relative to the first one. Details about the range of scenarios were presented in Section 2.4.3 (Experimental design).

The partners *Qualtrics* works with sent out email invites (Appendix G) to their panelists. As long as we got 320 complete responses, they stopped the flow. In total, 2667 invites were sent out. This leads to a response rate of about 12% for the second experiment. Data collected from the second experiment were used for all following analyses, though coding of question answers were anticipated.

2.4 Overview of survey instrument

The Choice Experiment (CE) is one of stated-preference methods commonly used for eliciting values of environmental goods and services, where the environmental goods or

services are comprised of several attributes. The overall objective of a CE is to estimate economic values for attributes that are not traded in the marketplace. In a choice experiment survey, respondents will face different possible scenarios and they are asked to state their preferences concerning those options. Economic values are derived from choices observed in these hypothetical scenarios. Including price as an attribute permits a multi-dimensional, preference-based valuation surface to be estimated for use in benefit-cost analysis (Holmes et al., 2014).

2.4.1 Attributes and attribute levels

The choice experiment presents five attributes for respondents to consider when voting for different conservation strategies in the survey. These attributes are: type of agricultural use, acres conserved, land proximity, adjacent area, and the associated cost through a one-time increase in property tax or rental. The detailed levels and explanations of attributes are given in Table 2-1. Both type of agricultural use and acres conserved have four levels, and land proximity and adjacent area have two levels, with five levels of cost.

Major types of agricultural use in the Alberta Capital Region (City of Edmonton, 2012; Government of Alberta, 2011) were chosen on the basis of available land use data for the year 2012 provided by Agriculture and Agri-Food Canada. These land types were discussed with both the expert and public focus groups. This led to the following four types of agricultural use: grain/oilseed farming, livestock grazing on native pasture, hay land, and commercial vegetable farm. The number of acres conserved ranged from 200 to 2000 acres, which was gauged by Census of Agriculture (2011) data that showed the average farm size in the Alberta Capital Region in 2011 was 515 acres[3].

For the adjacent area, we chose land adjacent to primary highways or conservation buffers to distinguish the adjacent landscape of land to be conserved. Primary highways serve to help farmers transport agricultural products, and also provide the public with the access to

[3] Government of Alberta. 2012. http://www.albertacanada.com/business/statistics/capital-agriculture.aspx (accessed June 12, 2014).

the land for multiple uses. There are approximately 57 primary highways and 48 main roads (e.g., trails and lanes) in the Alberta Capital Region, as shown in Figure 2-1 (CanMap Route Logistics, V2012.3). A conservation buffer is a designation for an agricultural area that needs special protection due to its landscape, wildlife or historical values. Conservation buffers can add variety to the landscape and foster a healthy environment for communities. In addition, local biodiversity can be protected. The Capital Region Board has designated areas for conservation buffers within the region, and Figure 2-2 shows the locations[4]. Conservation buffers are mainly located along the North Saskatchewan River and around some major water bodies. There is also a large conservation buffer in the southeast part of Strathcona County.

Table 2-1: Attributes and Attribute Levels

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

[4] The spatial data of conservation buffers in Alberta Capital Region was kindly provided by Brandt Denham (GIS Coordinator) and Neal Sarnecki (Manager of Regional Projects) from Capital Region Board.

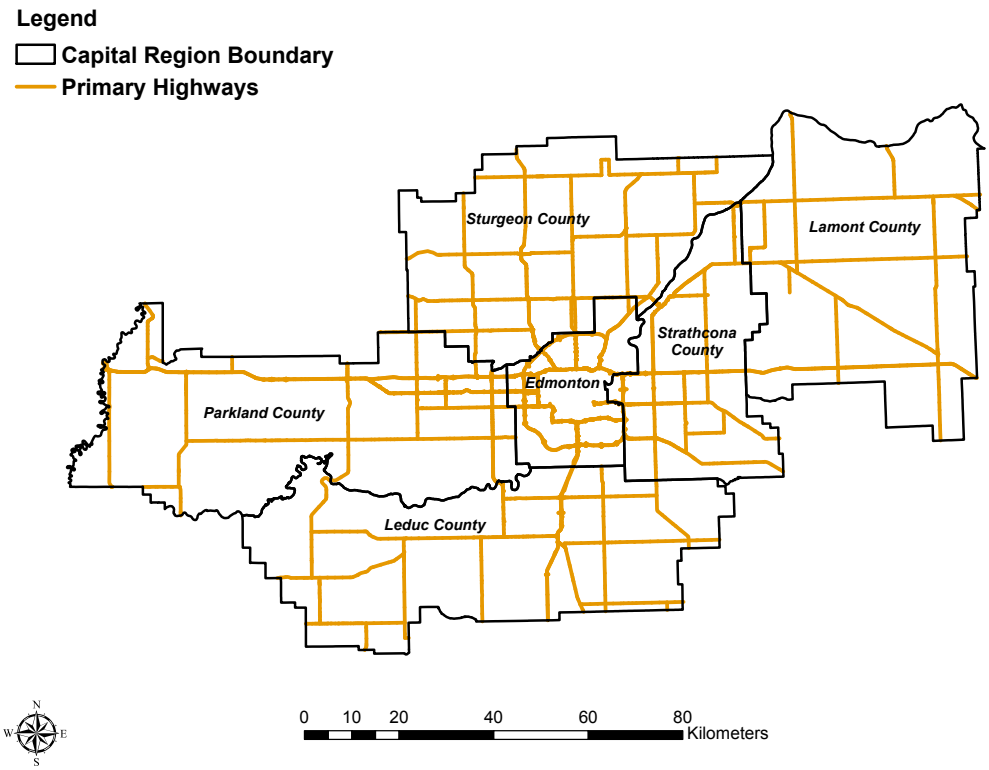


Figure 2-1: Primary Highways in the Alberta Capital Region (CanMap Route Logistics, V2012.3)

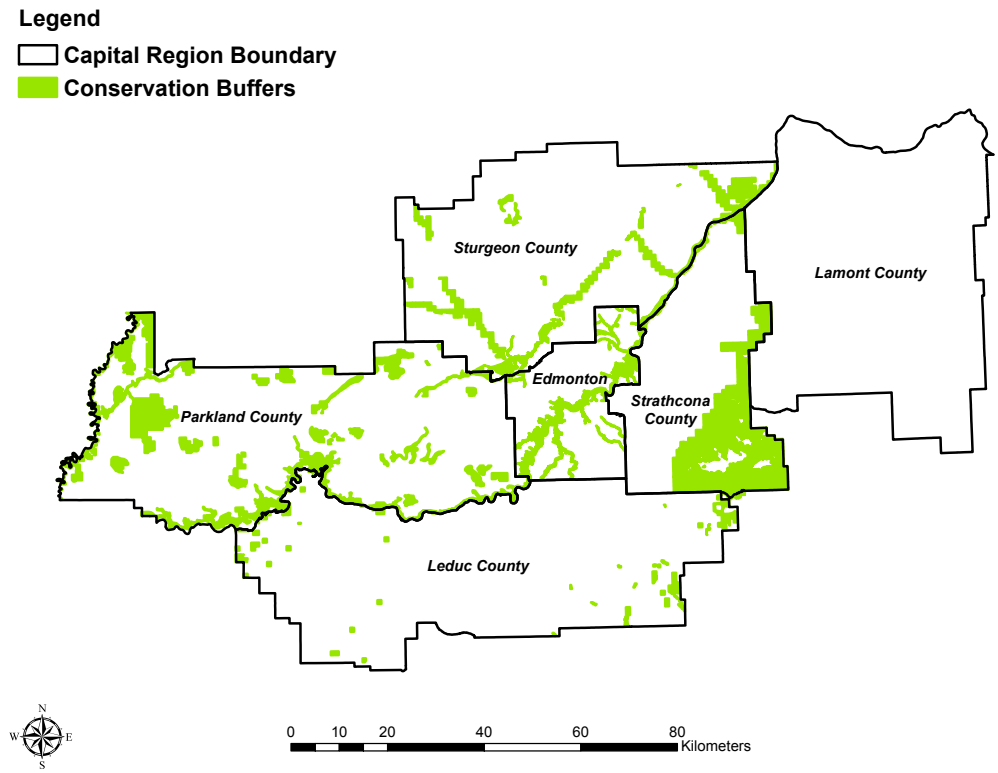


Figure 2-2: Conservation Buffers in the Alberta Capital Region (Capital Region Board, 2009)

With regard to land proximity, we are interested in respondents' preferences regarding how far away land in agricultural uses is from current non-farm developments. Haarsma (2014) found that the conversion of agricultural land into development during the years from 2000 to 2012 has primarily taken the form of suburban development on the periphery of the cities. Therefore, we chose within city limits (Figure 2-3) as one land location, and within a 10-km buffer from currently developed land (Figure 2-4) as the other, so as to distinguish the proximity to the existing city boundaries and newly added developed uses.

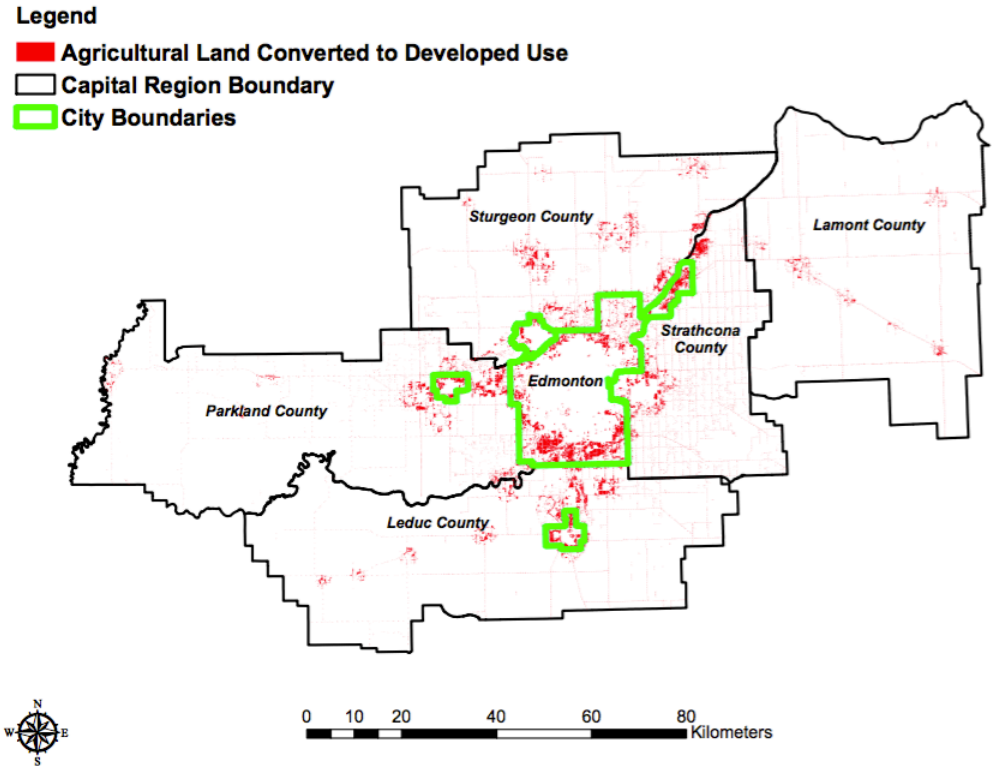


Figure 2-3: Within City Limits

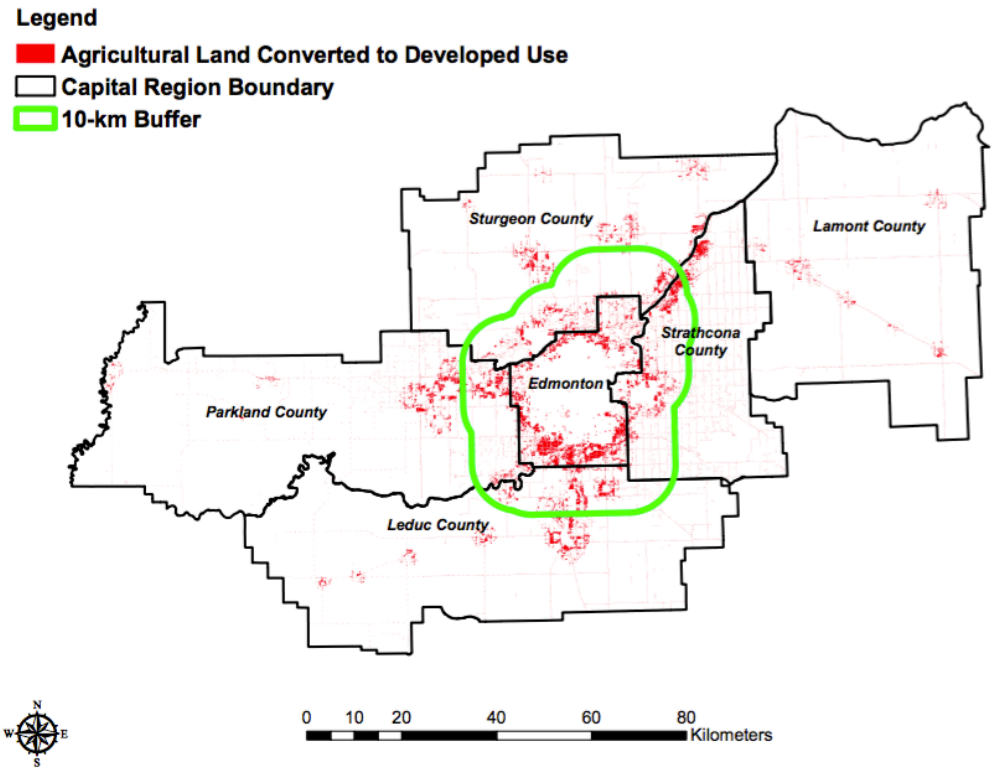


Figure 2-4: Within 10-km Buffer from Currently Developed Land

The payment vehicle to be used in a choice experiment is supposed to be incentive compatible and needs to be consequential, so that the associated cost with the provided goods or services can be credibly imposed on the entire sample of interest (Carson and Hanneman, 2005). An increase in household tax fulfills the requirement for such a payment mechanism and would most likely avoid voluntary contributions. Regarding the household tax, however, debates exist on whether to present this as a provincial income tax or municipal property tax. Generally, the provincial income tax has wider application as opposed to the municipal property tax, but the implementation of land management is more practical at the municipal level. Also, Alberta does not currently have a provincial sales tax, so some other form of provincial tax would need to be identified. On the other hand, some members of our focus groups preferred the provincial tax, as they did not think the burden should just be put just on homeowners in the Alberta Capital Region. Also, not all the residents in the Alberta Capital Region own properties, especially those who rent apartments inside the cities (e.g., downtown areas). Taking all suggestions from focus groups into account, especially those from the public focus group, we thus chose “property tax or

rent increase" as the payment vehicle as to incorporate as many tax payers as possible. The cost is for the next year only since purchasing the conservation easements for land in agricultural uses is a one-time decision. There are five levels of cost in the form of property tax or rent increase, namely, $25, $50, $100, $300 and $600. The tax increase levels were approximately calculated through the estimated number of households in the City of Edmonton and Alberta Capital Region, agricultural land prices[5], and the acres to be conserved in this study.

2.4.2 Alternative identification

An alternative, which combines different attributes at different levels, is a scenario that the respondent could choose over another possible scenario (e.g., the status quo). We have a universe of 320 (4*4*2*2*5) alternatives in our case.

One important decision to make when presenting alternatives is whether to use labeled or unlabeled alternatives (Hensher et al., 2005; Louviere et al., 2000). An unlabeled alternative is by definition an alternative in which the title is generic or uninformative to the respondents, as opposed to labeled alternatives in which the title conveys a specific meaning. One of the main benefits of using unlabeled alternatives is that it does not require the identification and use of all alternatives within the whole alternative set. Another benefit of using unlabeled alternatives is the IID (independently and identically distributed) assumption that restricts the alternatives used in the modeling process to be uncorrelated. We set each of the alternatives to be unlabeled (i.e., Conservation Strategy) in the choice experiment.

In addition to the title of alternatives, another design element is the number of alternatives in a choice set. The impact of having two versus three alternatives in a choice experiment has been extensively documented. Rolfe and Bennett (2009) indicated that the three-alternative split induce more robust models compared to the two-alternative one. However, Adamowicz et al. (2011) used both two-alternative and three-alternative formats

[5] Roy Kelley Land. http://roykelleyland.com/land-for-sale (accessed June 12, 2014).

and found that respondents in the three-alternative version were more likely to choose the status quo as opposed to the two-alternative version. In addition, two-alternative choice experiments are reported to be more incentive compatible and familiar to respondents, especially in a binary discrete choice question (Carson and Groves, 2011). Therefore, we used a two-alternative version, the status quo included, in our choice experiment. For one reason, adding the status quo into the choice experiment can avoid forced options that result in polarized responses in contingent valuation experiments (Rolfe and Bennett, 2009). Dhar and Simpson (2003) also proposed that the status quo option can provide an alternative way of resolving difficult choices that is not available when respondents are forced to make decisions.

2.4.3 Experimental design

How to generate the choice sets, given the selected attributes and levels, is a basic question needs to be addressed in the experimental design of choice experiments. An experimental design should include sufficient independent variation among attribute levels so that each preference parameter can be identified. Several approaches have been proposed to estimate preference parameters. Traditional experimental designs, such as orthogonal designs, were popular because correlation between attributes can be eliminated. However, this does not allow optimal statistical efficiency, especially when nonlinear-in-parameters models are used to analyze the choice experiment data. Therefore, efficient designs (e.g., *D-efficient* design), where the elements of the variance-covariance matrix for the linear model are minimized, have been proposed (Rose and Bliemer, 2009).

The most complete experimental design is a full factorial design that contains every level of each attribute (Hensher et al, 2005). It is evident that the major advantage of a full factorial design is that all main and interaction effects are statistically independent (orthogonal). However, the primary downside is it requires a very significant number of alternatives when the numbers of attributes and levels are large. In our case, there are 320 different combinations of attributes for each alternative, which were calculated by multiplying attribute levels (4*4*2*2*5). Therefore, we started with a fractional factorial design that

reduces the design size. We chose 8 different alternatives from the fractional factorial design for the soft launch, and the design was balanced and orthogonal for the main effects.

Ngene software (Choice Metrics, 2014) was used to determine a *D-efficiency* design using prior parameters from the soft launch. The efficient design for the first experiment consisted of a set of 8 different alternatives, and each respondent was given the same set but with different orders. In order to allow for more variation in the alternatives, the second experiment design was comprised of a total of 32 different alternatives which were blocked into 4 sets of eight, as each respondent was still given eight choice questions. The syntax for the *D-efficiency* design in Ngene can be seen in Appendix H.

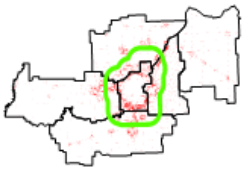
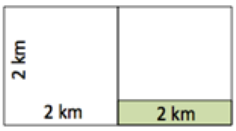
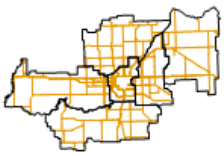
	Conservation Strategy	Status Quo
Type of Agricultural Use	Hay Land 	No Public Conservation Strategy for Land in Agricultural Uses
Location Proximity	Within 10-km Buffer from Currently Developed Land 	
Acres Conserved	200 acres (2 km x 0.4 km) 	
Adjacent Area	Adjacent to Primary Highway 	
Property Tax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

Figure 2-5: Example of Choice Set Used in Survey Instrument

An example of choice set is shown in Figure 2-5. Each choice set includes two alternatives, Conservation Strategy and Status Quo (i.e., No Pubic Conservation Strategy). In the second experiment, each respondent was first assigned with one block and then asked 8 choice sets with random orders.

We would like your thoughts on the "**tradeoffs**" between conservation for land in agricultural uses and economic costs.

The following questions will ask you to compare different **Conservation Strategies** with the **Status Quo** for land in agricultural uses in the City of Edmonton and surrounding areas. Conservation Easements could be used to maintain land in agricultural uses rather than being converted to other uses.

We are asking you to state whether or not you feel that the proposed strategy, for the cost of money, should be implemented.

PLEASE NOTE:

We know that how people make a choice in a survey is often not a reliable reflection of how people would actually behave at the polls. In surveys, some people ignore the monetary and other sacrifices they would really have to make if their vote won a majority and became law. Researchers call this phenomenon "hypothetical bias". In surveys that ask respondents if they would pay more for certain goods/services, research has found that people may say that they would pay as much as 50% more than they actually will in real transactions.

It is of great importance that you "choose" as if this were a real vote. You need to imagine that you actually have to dig into your budget and pay the additional costs associated with the proposed conservation strategies.

Suppose you were asked to consider the following strategies. In each set presented below, imagine that these are the ONLY OPTIONS available for you to choose from. For each set, please choose INDEPENDENTLY from other questions - please do not compare options from different sets.

Figure 2-6: Cheap Talk Script Used in Survey Instrument

The "cheap talk" script (Figure 2-6) was also used in the survey to minimize hypothetical bias which occurs when a respondent responds differently to questions depending on whether they consider them to be real or hypothetical (Cummings and Taylor, 1999). The concept of the "cheap talk" script was first proposed by Cummings and Taylor (1999) and is now used in

most valuation studies, such as caribou conservation (Harper, 2012) and wetland restoration and retention (Pattison, 2009). This script involves discussing what hypothetical bias is and what the consequences of it are. The full survey instrument can be seen in Appendix I.

2.5 Conceptual model

This subsection reviews the theory and conceptual models used for the analysis of the choice experiment data. Discussions are provided on the random utility theory, the Multinomial Logit model which is used to estimate willingness to pay and measure welfare. In addition, more advanced models such as Random Parameter Logit and Latent Class models are introduced to relax preferences.

2.5.1 Random utility theory

The analysis of responses to a choice experiment is based on an extension of the random utility maximization (RUM) model that underlies discrete choice contingent valuation responses. The RUM model is based on the assumption that respondents know their utility with certainty, but analysts are unable to perfectly observe respondents' utility so the unobservable elements are part of the random error (Holmes et al., 2014). This assumption is formalized in a model where utility is the sum of systematic (v) and random (ε) components for individual *k*:

$$U_{ik}(\cdot) = U_{ik}(\boldsymbol{Z_i}, y_k - p_i) = v_{ik}(\boldsymbol{Z_i}, y_k - p_i) + \varepsilon_{ik} \quad (1)$$

where v_{ik} is the true but unobservable indirect utility associated with alternative *i*, $\boldsymbol{Z_i}$ is a vector of attributes associated with alternative *i*, p_i is the cost of alternative *i*, y_k is income of individual *k* and ε_{ik} is a random error term with zero mean.

In reality, a respondent will face a choice between *N* mutually exclusive alternatives, where each alternative is comprised of a vector of different attributes, $\boldsymbol{Z_i}$. We assume that respondents maximize their utility when making a choice. Therefore, the respondent will choose alternative *i* if and only if:

$$v_{ik}(\boldsymbol{Z_i}, y_k - p_i) \geq v_{jk}(\boldsymbol{Z_j}, y_k - p_j); \forall j \in C \quad (2)$$

where *C* is a universe of all alternatives in the choice set. If we further consider the random

error term, respondent *k* will choose alternative *i* if and only if:

$$v_{ik}(\boldsymbol{Z_i}, y_k - p_i) + \varepsilon_{ik} \geq v_{jk}(\boldsymbol{Z_j}, y_k - p_j) + \varepsilon_{jk}; \forall j \in C \quad (3)$$

The stochastic term in the random utility function allows probabilistic statements to be made about choice behavior. The probability that a respondent will choose alternative *i* from a choice set containing mutually exclusive alternatives can be expressed as follows:

$$P_{ik} = P[v_{ik}(\boldsymbol{Z_i}, y_k - p_i) + \varepsilon_{ik} \geq v_{jk}(\boldsymbol{Z_j}, y_k - p_j) + \varepsilon_{jk}; \forall j \in C] \quad (4)$$

Equation (4) is a general form, and further assumptions about the specification of the utility function and the probability distribution of the error terms should be made so as to empirically estimate the model.

A typical assumption of the utility function is that the utility is a linear function of the attributes included in the choice experiment, so that the utility of choosing alternative *i* is captured as:

$$v_{ik} = \alpha + \boldsymbol{\beta Z_i} + \lambda(y_k - p_i) + \varepsilon_{ik} \quad (5)$$

where α is a constant that represents the baseline utility experienced by all respondents regardless of the proposed program or respondent characteristics, $\boldsymbol{\beta}$ is the vector of preference parameters that represent the marginal utilities associated with non-monetary attributes, and λ is the marginal utility of money. In our case, we have choice experiments with five attributes, including a monetary attribute. A utility function that is a linear function of the attributes can thus be written as:

$$v_{ik} = \alpha + \beta_1 Z_{i1} + \beta_2 Z_{i2} + \beta_3 Z_{i3} + \beta_4 Z_{i4} + \lambda(y_k - p_i) + \varepsilon_{ik} \quad (6)$$

One important property of discrete choice models is that only the differences in utility between alternatives affect the choice probabilities, not the absolute levels of utility. This leads to the following equation by rearranging the terms in Equation (4):

$$P_{ik} = P[\varepsilon_{ik} - \varepsilon_{jk} \geq v_{jk}(\boldsymbol{Z_j}, y_k - p_j) - v_{ik}(\boldsymbol{Z_i}, y_k - p_i); \forall j \in C] \quad (7)$$

2.5.2 Multinomial logit model

Alternative probabilistic choice models can be derived depending on the specific assumptions that are made about the distribution of the random error term in Equation (7).

The standard assumption in using RUM has been 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 of the choice experiments consist of *N* alternatives (*i* = 1, ..., N). If errors are distributed as type 1 extreme value, the MNL model applies and the probability of respondent *k* choosing alternative *i* is:

$$P_{ik} = \frac{\exp(\mu v_{ik})}{\sum_{j=1}^{N} \exp(\mu v_{ik})} \quad (8)$$

where μ is the 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.

2.5.3 Random parameters logit model

A major limiting property of the MNL model is the assumption of homogenous preferences across respondents, which restricts the preference parameters estimated from Equation (5), $\boldsymbol{\beta}$, to be the same for all respondents. However, heterogeneity in the sample can be captured by estimating the mean and variance of the random parameter distributions. This approach is referred to as a Random Parameters Logit (RPL) or Mixed Logit model (Train, 1998). The RPL model can be illustrated as follows based on Equation (5):

$$v_{ik} = \boldsymbol{\beta} \boldsymbol{Z_i} + \varepsilon_{ik} = \overline{\boldsymbol{\beta}} \boldsymbol{Z_i} + \widetilde{\beta_k} \boldsymbol{Z_i} + \varepsilon_{ik} \quad (9)$$

where each respondent's coefficient vector $\boldsymbol{\beta}$, is the sum of the population mean $\overline{\boldsymbol{\beta}}$ and an individual deviation $\widetilde{\beta_k}$.

If we assume that the coefficients $\boldsymbol{\beta}$ vary in the sample with a density distribution $f(\beta|\theta)$, where θ is a vector of the underlying parameters of the preference distribution, then the conditional probability of choosing alternative *i* is:

$$P_{ik|\beta} = \frac{\exp(\beta Z_i)}{\sum_{j=1}^{N} \exp(\beta Z_k)} \quad (10)$$

The RPL model also requires assumptions about the distributions of the coefficients. However, not all parameters need to follow the same assumed distribution or to be randomly distributed. The most common distribution has been the normal distribution, but in principle other distributions such as the uniform distribution can also be applied.

2.5.4 Latent class model

Another approach to relaxing the heterogeneity assumption is to use a Latent Class model in which it is assumed that respondents belong to different preference classes that are defined by a small number of segments (Holmes et al., 2014). Suppose there are *S* segments that represent different preferences. If an individual *k* belongs to segment *s* (s = 1, …, S), the conditional indirect utility function can be expressed as:

$$V_{ik|s} = \boldsymbol{\beta Z_i} + \varepsilon_{ik|s} \tag{11}$$

Therefore the probability of choosing alternative *i* for respondent *k* depends on the segment that one belongs to and it can be expressed as follows:

$$P_{ik|s} = \frac{\exp\left(\beta_s Z_i\right)}{\sum_{j=1}^{N} \exp\left(\beta_s Z_k\right)} \tag{12}$$

where β_s represents the segment-specific utility estimates.

2.5.5 Welfare measures

In the case of a state-of-the-world choice experiment, there is only one single alternative to be chosen which consists of multiple attributes. We follow Equation (5) as a linear utility function for alternative *i* to represent a certain state of the world. If we are to calculate a respondent's willingness-to-pay (WTP) in the attribute vector from initial conditions ($\boldsymbol{Z^0}$) to altered conditions ($\boldsymbol{Z^1}$) due to a policy change, the compensating variation (CV) associated with this change is therefore formalized as:

$$CV = \frac{1}{\lambda}\{V^1 - V^0\} \tag{13}$$

where V^1 and V^0 are expressions of indirect utility for the new and base case states of the world. In the base case state (Equation 14), no program would be implemented with zero cost. For the new case state (Equation 15), a specific program would be implemented with the associated cost.

$$V^0 = (y_k, 0) \tag{14}$$

$$V^1 = (y_k - p_i, 1) \tag{15}$$

In the Equation (15), the number 1 represents a specific program that consists of several attributes. In our study, we conduct a choice experiment with five attributes, including the cost, and we estimate the utility function as shown in Equation (6). Based on the estimated model, the WTP calculation for a change in the proposed program relative to the status quo (i.e., no conservation program) would then be:

$$WTP = -\frac{\alpha+\beta_1\Delta Z_{i1}+\beta_2\Delta Z_{i2}+\beta_3\Delta Z_{i3}+\beta_4\Delta Z_{i4}}{\lambda} \tag{16}$$

This expression shows, in specific, the maximum amount of money a respondent is willing to pay in order to obtain the improvement in the four attributes: ΔZ_{i1}, ΔZ_{i2}, ΔZ_{i3} and ΔZ_{i4}. In our case, ΔZ_{i1} represents type of agricultural use, ΔZ_{i2} represents location proximity, ΔZ_{i3} represents acres conserved, and ΔZ_{i4} represents adjacent area. α is a constant that represents the baseline utility of the status quo, regardless of the proposed program or respondent characteristics.

However, what is often reported from generic choice experiments is the marginal WTP (MWTP). Using a simple linear utility function (Equation 6), the marginal rate of substitution between any of the attributes and money is simply the ratio of the coefficient of that attribute and the marginal utility of money:

$$MRS_i = -\frac{\partial v_{ik}/\partial z_i}{\partial v_{ik}/\partial y_k} = -\frac{\beta_i}{\lambda} = MWTP_i \tag{17}$$

$MWTP_i$ (also known as the implicit price) shows how much money an individual is willing to sacrifice for a marginal change in the specific attribute *i* (Holmes et al., 2014).

2.6 Econometric model

Based on the choice experiment design in our study, the observable utility function $v_{ik}(\boldsymbol{Z_i}, y_k - p_i)$ for the empirical analysis is specified as follows:

$$v_{ik}(\boldsymbol{Z_i}, y_k - p_i) =$$

$$\beta_0(sq) + \beta_1(grain * acres) + \beta_2(live * acres) + \beta_3(hay * acres) + \beta_4(highway * acres) + \beta_5(city * acres) + \beta_6(acres) + \beta_7(cost) \quad (18)$$

where variables are defined as follows*:

sq	binary (0,1) variable indicating the Status Quo (no conservation strategy)
grain	binary (0,1) variable indicating whether conserved land is for grain/oilseed farming (default is commercial vegetable farm)
live	binary (0,1) variable indicating whether conserved land is for livestock grazing on native pasture (default is commercial vegetable farm)
hay	binary (0,1) variable indicating whether conserved land is for hay land (default is commercial vegetable farm)
highway	binary (0,1) variable indicating whether conserved land is adjacent to primary highway (default is adjacent to conservation buffer)
city	binary (0,1) variable indicating whether conserved land is within city limits (default is within 10-km buffer from currently developed land)
acres	number of acres conserved
cost	property tax or rent increase for the next year only

* Note that the variable "grain*acres" indicates "grain" multiplied by "acres", and so on for other variables in the model if applicable.

We chose this model specification mainly according to previous studies (e.g., Johnston, 2007b) and also after tests of other model specifications. This model specification provides the best statistical fit of the collected survey data, and attributes to the ease of WTP calculation of conservation strategies generated from the survey design. The betas (β_0, …, β_7) represent coefficients to be estimated by the model.

For the three attributes (i.e., type of agricultural land, location proximity and adjacent area), one variable is set as default in each category to avoid multicollinearity as these variables

are all binary. As a result, the variable "acres" indicates a conservation strategy that is comprised of "commercial vegetable farm, adjacent to conservation buffer, and within 10-km buffer from currently developed land", which is set as the baseline of all conservation strategies to be chosen. Any change of the conservation strategies in terms of the attribute result from adding other coefficients (β_1, …, β_5). For example, the estimate of β_1 represents a conservation strategy changing from "commercial vegetable farm" to "grain/oilseed farming", other attributes kept constant; the estimate of β_4 represents a conservation strategy changing from "adjacent to primary conservation buffer" to "adjacent to primary highway", other attributes kept constant; the estimate of β_5 represents a conservation strategy changing from "within 10-km buffer from currently developed land" to "within city limits", other attributes kept constant. The estimate of β_0 represents the alternative specific constant for the status quo (i.e., no public conservation strategy). All betas indicate the main effects of attributes based on the experimental design.

2.7 Conclusions

In conclusion, this chapter provides a detailed description of the study methodologies that were used in this research. The first phase involved qualitative methods that incorporated focus groups of both selected experts and the public. The feedback from the focus groups informed the development of the survey instrument for the second phrase of the study and increased the questionnaire quality. The survey instrument and implementation of the survey are also discussed. The second part of this chapter reviews the theories in contingent valuation and choice experiment methods, on which we build conceptual and empirical models.

3 Results

3.1 Introduction

This chapter provides descriptive statistics for the sample, and summarizes responses regarding background information. For econometric analysis, we first start with a basic multinomial logit model. Heterogeneities are investigated through model comparisons, and more advanced empirical models such as random parameter and latent class models. The

resulting willingness to pay estimates are also calculated. Finally, different conservation strategies are evaluated and aggregate benefits of agricultural land conservation are estimated.

The data used for all following analyses were from the second experiment that was collected in March 2015, which consists of 320 respondents from the Alberta Capital Region. Results from the first experiment that were collected in December 2014 are attached in Appendix J.

3.2 Demographic and socio-economic statistics

Table 2-2 shows some basic demographic and socio-economic statistics about the respondents. Gender percentage is equal, and the average age of the sample is about 51 with a minimum of 18 and maximum of 86 years old. Approximately 75% of the respondents live in the City of Edmonton, with the rest living in surrounding cities and counties. The median household income (before tax) for the sample is 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 Alberta Capital Region level, the survey sample is fairly well represented in terms of the gender and residence.

In the last portion of the survey instrument, respondents were also asked about their employment status and corresponding employment sector. Table 2-3 provides the results. Almost half of the respondents work full time, either self-employed or employed by others. The most common employment sectors are accommodation and food services, finance insurance real estate and leasing, and health care and social assistance. About 23% of the sample are retired residents.

Table 2-2: Demographic and Socio-economic Statistics for the Sample (N=320)

Demographic	Description	Frequency	Sample Percentage (%)	Capital Region Percentage (%)[6]
Gender	Male	160	50.00	49.54
	Female	160	50.00	50.46
Residence	City of Edmonton	238	74.38	69.77
	Lamont County	0	0.00	0.33
	Leduc County	17	5.31	3.34
	Parkland County	9	2.81	2.60
	Strathcona County	22	6.88	7.56
	Sturgeon County	17	5.31	7.14
	Others	17	5.31	9.26
Household Income	Less than $30,000	43	13.44	N/A
	$30,000 - $59,999	60	18.75	N/A
	$60,000 - $89,999	73	22.81	N/A
	$90,000 - $119,999	70	21.88	N/A
	$1200,000 - $149,999	33	10.31	N/A
	Greater than $150,000	41	12.81	N/A
Education	Lower than High School	3	0.94	N/A
	Completed High School	71	22.19	N/A
	Completed Post-secondary Technical School	109	34.06	N/A
	Completed University Undergraduate Degree	105	32.81	N/A
	Completed Post-graduate Degree (e.g., Master or Ph.D.)	32	10.00	N/A

[6] Gender statistics are from Statistics Canada (2011). http://www12.statcan.gc.ca/census-recensement/2011/dp-pd/hlt-fst/as-sa/Pages/highlight.cfm?TabID=1&Lang=E&Asc=1&PRCode=01&OrderBy=1&Sex=3&View=1&tableID=21&queryID=2 (accessed July 31, 2015). Residence statistics (2013) are from Capital Region Land Use Plan, Capital Region Board. http://capitalregionboard.ab.ca/-/reports/crlanduseplan031209.pdf (accessed June 12, 2014).

Table 2-3: Employment Statistics for the Sample (N=320)

Demographic	Description	Frequency	Percentage (%)
Employment Status	Working Part-time (Self-employed or Employed by others)	48	15.00
	Working Full-time (Self-employed or Employed by others)	154	48.13
	Retired	74	23.12
	Student	5	1.56
	Unemployed	22	6.88
	Others	17	5.31
Employment Sector	Agriculture	0	0.00
	Accommodation and Food Services	30	9.37
	Educational Services	24	7.50
	Finance, Insurance, Real estate and Leasing	35	10.93
	Forestry, Fishing, Mining, Oil and Gas	16	5.00
	Health Care and Social Assistance	29	9.06
	Information, Culture and Recreation	23	7.19
	Public Administration	18	5.63
	Retired	80	25.00
	Transportation and Warehousing	18	5.63
	Utilities, Construction and Manufacturing	20	6.25
	Others	27	8.44

3.3 Background information response

At the beginning of the survey, participants were asked several warm-up questions. Respondents were asked about their sources for food consumed at home and the results are presented in Table 2-4. Almost all residents purchased food from chain grocery stores, with a third of them visiting specialty stores for groceries. One noteworthy point is the popularity of farmers' market in the study area. More than half of the respondents get food from farmers' markets to consume at home.

Table 2-4: Food Sources that Respondents Get to Consume at Home (N=320)

Food Source	Frequency	Percentage (%)
Chain Grocery Store	315	98.44
Specialty Grocery Store	111	34.69
Convenience Store	40	12.50
Farmers' Market	172	53.75
Personal or Community Garden	57	17.81
Directly from a Farm (e.g., U-pick Farm)	26	8.13
Donation or Gift	5	1.56
Others	0	0.00

Another aspect of the survey is to understand respondents' attitude towards land uses in the Alberta Capital Region, with a focus on agricultural land uses. By asking respondents whether the area has enough of certain types of land use, we can see from Figure 2-7 that about half of them think there is not enough land reserved for agricultural uses and a similar proportion think that enough land has been currently set aside for urban growth. The results also show that almost 60% of them think there are not enough natural area systems and conservation buffers in the Alberta Capital Region. For the future type of urban development, residents are more positive about more intensive (infill) development, with about 60% of them supporting this development path. 29% of respondents supported the previous trend of urban development, with several participants thinking that a balanced form between infill

and expansionary development should be considered (Figure 2-8).

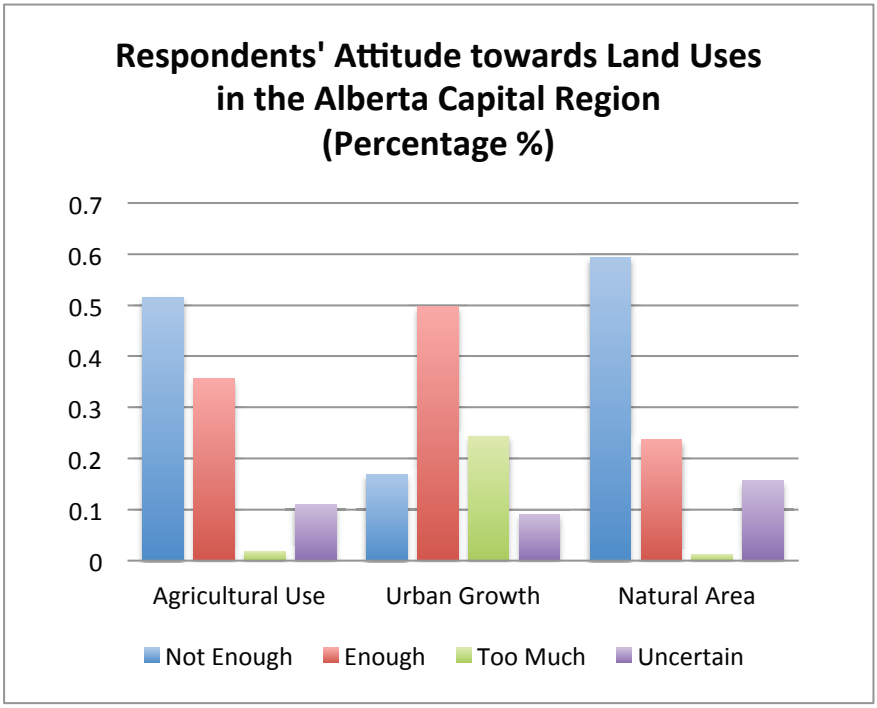


Figure 2-7: Respondents' Attitude towards Land Uses in the Alberta Capital Region

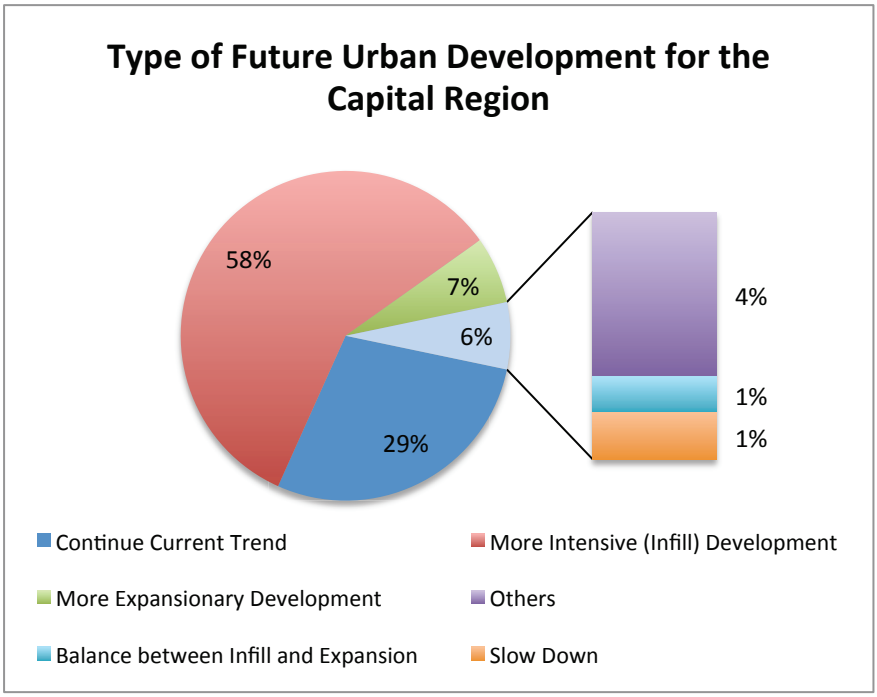


Figure 2-8: Respondents' Favored Type of Future Urban Development for the Alberta Capital Region

Table 2-5: Respondents' Attitude towards Land in Agricultural Uses (N=320)

Statement	Percentage (%)				
	Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree
It is important to maintain land in agricultural uses for future generations	0.00	0.94	5.94	37.81	55.31
The primary function of land in agricultural uses is to produce food	0.00	4.38	13.13	55.62	26.87
Land in agricultural uses acts as a natural water filter	0.00	2.50	17.50	48.75	31.25
Land in agricultural uses conserves diversity of natural systems	0.63	2.19	19.69	45.62	31.87
The economic benefits from land in agricultural uses outweigh the benefits that other land uses provide	0.00	8.13	32.19	35.31	24.37
Land in agricultural uses provides social benefits such as recreational opportunities	0.00	6.56	30.94	45.00	17.50
Land in agricultural uses can be improved through human management	0.31	1.89	15.00	54.68	28.12
It is desirable to live near land in agricultural uses	0.00	6.88	36.88	39.06	17.18

In response to questions about their attitude towards land in agricultural uses, the majority of residents (93%) agree that it is important to maintain land in agricultural uses. More than 80% of them agree that food production is the primary function of land in agricultural uses. But when it comes to other services that land in agricultural uses can perform (e.g., social benefits such as recreational opportunities, acting as a natural water filter), uncertainty arises and respondents' perceptions vary (Table 2-5). In addition, a third of the respondents neither agree nor disagree that whether or not living proximate to land in agricultural uses is desirable, despite their general preference for keeping land in agricultural uses.

3.4 Valuation results

This subsection deals with estimation of willingness to pay based on preferences associated with different agricultural land conservation strategies in the Alberta Capital Region. Heterogeneities are relaxed among certain groups of residents. Welfare measures are also evaluated as the aggregate values over the entire population in the region.

3.4.1 Non-parametric analysis

We first calculate the percentage of respondents who voted "yes" to all valuation questions. A "yes" response indicates residents' support for the proposed conservation strategies to conserve specific areas of land in agricultural uses, and a "no" response means they would prefer the status quo where there is no such public conservation strategy.

As addressed in the Background Literature section, hypothetical bias may exist due to the existence of "yea-saying" and "warm glow". 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; Pattison, 2009; 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 proposed strategy (i.e., property tax or rent increase for the next year only) are termed "yea-sayers", and if they voted "yes" to all eight valuation questions. As a result, we identified 7 respondents out of 320 as "yea-sayers" across the sample.

In addition, responses with uncertainty are also identified. Responses with "somewhat uncertain" or "very uncertain" to the vote questions are considered votes with uncertainty in this study. Previous studies suggested that if a respondent indicates a high level of uncertainty in their response, that particular vote could effectively be considered a vote of "no" (Blumenschein et al., 2008; Harper, 2013; Pattison, 2009). We followed this practice and recoded the uncertain votes for the proposed strategy to the status quo (no strategy).

Figure 2-9 demonstrates the percentage of respondents who voted “yes” to the valuation questions at each cost level. Four groups that include all sample, uncertainty recoded, yea-sayers removed, uncertainty recoded and yea-sayers removed are listed for comparison. In general, the percentage of “yes” votes decreases as the cost rises. Approximately 80% of respondents voted “yes” to the lowest cost level of $25, and between 30% and 40% of them voted “yes” to the highest cost level of $600. A comparison of the full sample and the sample with yea-sayers removed shows similar percentages of “yes” votes, with the latter group having a slightly lower percentage. When uncertainty votes are recoded, a comparatively lower yes rate can be observed. The group with uncertainty recoded and yea-sayers removed has the lowest yes rate among four groups.

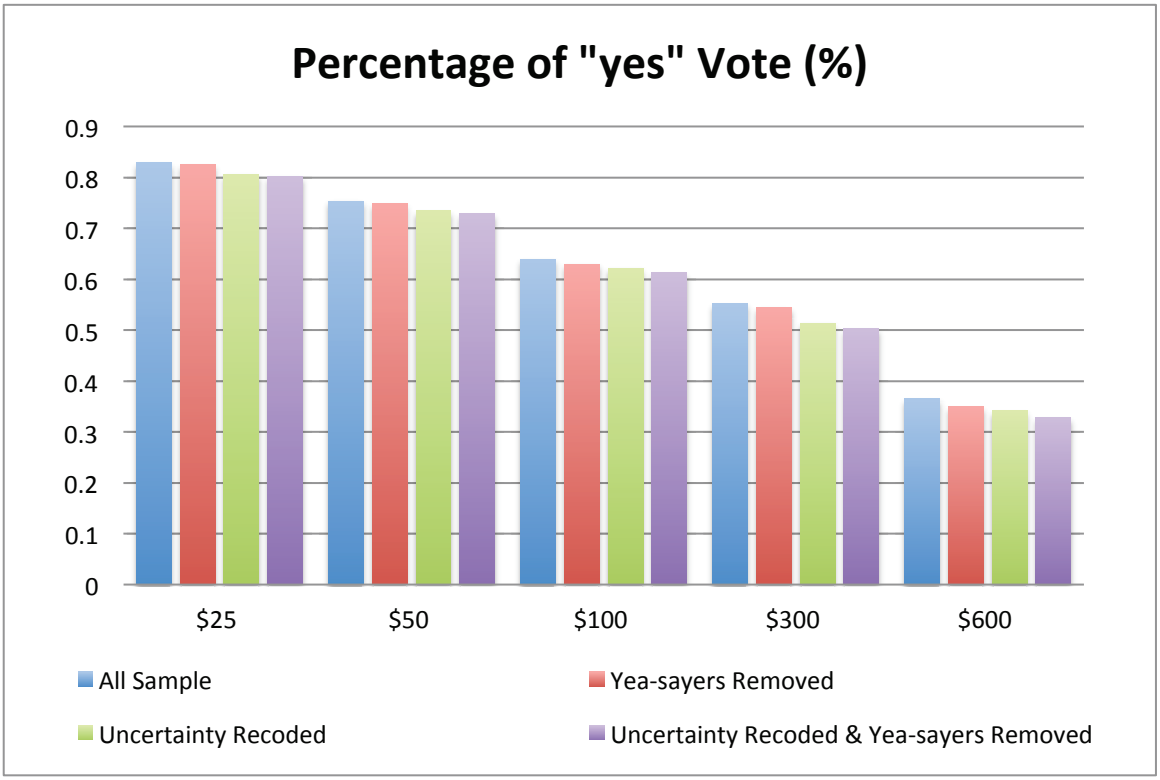


Figure 2-9: Percentage of Respondents Who Voted “yes” to the Valuation Questions at Each Cost Level

3.4.2 Basic model

All the econometric models were estimated using *NLOGIT* software (Econometric Software, 2011). In the multinomial logit model, respondents are asked to vote between two alternatives: conservation strategy or the status quo, where the conservation strategy

consists of attributes such as land in a specific agricultural use, in a specific type of area, with a specific cost. A linear functional form was adopted for all models in this study as this is the most commonly used functional specification in the literature (Johnston et al., 2009b; Ozdemir, 2003). As both uncertainty responses and yea-sayers are identified in Section 3.4.1, we therefore use the "uncertainty recoded and yea-sayers removed" data set for all following modeling and empirical analyses.

It is expected that the coefficient for cost (or price) 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. In all models, the estimate of cost is negative and significant at the 1% level. As for the status quo, all the parameters are also negative and significant at the 1% level, which indicates that respondents have a strong tendency to vote for conservation strategies that aim to conserve land in agricultural uses. 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 Alberta Capital Region and their preference to maintain land in agricultural uses. For land's adjacent area, residents prefer primary highways to conservation buffers. With regard to location proximity, land within a 10-km buffer from currently developed land is given priority over land within city limits. In general, commercial vegetable farm is the most preferred type of agricultural use, with livestock grazing on native pasture second, and preferences for grain/oilseed farming and hay land vary slightly across the sample.

Table 2-6 compares results from the whole Alberta Capital Region and the City of Edmonton. Despite the similar preferences over the types of agricultural use, disparities exist between these two groups regarding the spatial characteristics of the land to be conserved. For example, residents from the City of Edmonton do not seem to give priority to land within a 10-km buffer from currently developed land as opposed to within city limits as the coefficient of *city_acres* is insignificant. In addition, respondents from Edmonton place a higher value on land adjacent to primary highways, when everything else kept constant.

Table 2-6: MNL Coefficient Estimates and MWTP (per acre, per household) Comparison between the Alberta Capital Region and the City of Edmonton

Attribute	Alberta Capital Region[a]		City of Edmonton[b]	
	Coefficient (Std. Err)	MWTP Estimate (CAD $)	Coefficient (Std. Err)	MWTP Estimate (CAD $)
grain*acres	-0.00025**	-0.09058**	-0.00025*	-0.09058*
	(0.00013)	(0.04710)	(0.00014)	(0.05072)
live*acres	-0.00015	-0.05435	-0.00003	-0.01087
	(0.00013)	(0.04710)	(0.00016)	(0.05797)
hay*acres	-0.00025**	-0.09058**	-0.00026**	-0.09420**
	(0.00011)	(0.03986)	(0.00013)	(0.04710)
highway*acres	0.00021**	0.07609**	0.00026**	0.09420**
	(0.00009)	(0.03261)	(0.00010)	(0.03623)
city*acres	-0.00018*	-0.06522*	-0.00007	-0.02536
	(0.00010)	(0.03623)	(0.00011)	(0.03986)
acres	0.00055***	0.19928***	0.00046***	0.16667***
	(0.00012)	(0.04348)	(0.00013)	(0.04710)
cost	-0.00276***	-	-0.00276***	-
	(0.00023)		(0.00027)	
sq	-0.67179***	-	-0.60698***	-
	(0.10270)		(0.11770)	
Observations	2504[c]		1864[c]	
Log-likelihood	-1520.54		-1144.27	
AIC	3057.1		2304.5	

*** Significant at 1% level, ** Significant at 5% level, * Significant at 10% level

(Standard Errors in Parentheses)

[a]: Using the data from respondents who reside in the Alberta Capital Region

[b]: Only using the data from respondents who reside in the City of Edmonton

[c]: Using the data when uncertain votes are recoded and yea-sayers are removed

3.4.3 Heterogeneity

In order to explore heterogeneity in preferences, we first start with two models, an endogenous model and an exogenous model, by introducing various variables to understand the factors that may reflect respondents' votes and associated attitudes. For the exogenous model, variables indicating respondents' demographic and socio-economic characteristics such as age, gender, residence and household income are introduced. For the endogenous model, the answers to the attitudinal questions that could possibly determine respondents' voting behaviors regarding agricultural land conservation are added into the basic model. A model combing both streams of variables is also tested for comparison purpose.

Table 2-7 shows all the results from these three models. Generally, the inclusion of these variables does not change the preferences of attributes in the conservation strategies and the estimated coefficients remain quite similar. However, heterogeneity is reflected in terms of the status quo. For example, the introduction of exogenous variables turns the parameter of the status quo into positive. *Gender* is negative and statistically significant, which means that males are less likely to vote for the conservation strategies. *Household income* is also found to be significantly negative, but this outcome is surprising as intuition would suggest that wealthy residents would be likely to contribute money to support agricultural land conservation programs. *Age* is insignificant, indicating that being older or younger does not statistically affect a respondent's voting behavior. Compared to the basic model, the model including three possibly endogenous variables has a significantly lower estimate of the status quo. This finding suggests that respondents' attitudes could potentially cause an endogeneity problem when it comes to voting. All these three variables are positive and significant, which can somewhat account for the strong dislike in the status quo when only the basic model is considered. Specifically, the higher agricultural land conversion rate a respondent thinks of, the more likely a respondent would vote for the conservation strategy. Additionally, residents who feel there is not enough land reserved for agricultural land uses are more willing to support programs that aim to conserve land in agricultural uses.

Table 2-7: MNL Coefficient Estimates with Exogenous and Endogenous Variables

Attribute	Exogenous Model	Endogenous Model	Both Models
	Coefficient (Std. Err)	Coefficient (Std. Err)	Coefficient (Std. Err)
grain*acres	-0.00027**	-0.00027**	-0.00028**
	(0.00013)	(0.00013)	(0.00013)
live*acres	-0.00015	-0.00015	-0.00016
	(0.00014)	(0.00014)	(0.00014)
hay*acres	-0.00024**	-0.00026**	-0.00025**
	(0.00011)	(0.00012)	(0.00012)
highway*acres	0.00021**	0.00023***	0.00023***
	(0.00009)	(0.00009)	(0.00009)
city*acres	-0.00019**	-0.00018*	-0.0020**
	(0.00009)	(0.00010)	(0.00010)
acres	0.00056***	0.00057***	0.00058***
	(0.00012)	(0.00012)	(0.00012)
cost	-0.00279***	-0.00292***	-0.00294***
	(0.00023)	(0.00024)	(0.00024)
sq	1.29350***	-0.35476**	0.22571
	(0.24846)	(0.15144)	(0.28736)
age	-0.00145	-	-0.00206
	(0.00328)		(0.00344)
gender	-0.31683***	-	-0.22570**
(male=1)	(0.09113)		(0.09492)
residence	-0.20508**	-	-0.11718
(Edmonton=1)	(0.10241)		(0.10630)
household income	-0.00272**	-	-0.00295**
(in 1,000 CAD)	(0.00111)		(0.00115)
agricultural land	-	0.01036***	0.00959***
conversion rate (%)		(0.00216)	(0.00225)
not enough land	-	0.72111***	0.68262***
reserved for agricultural uses (=1)		(0.09401)	(0.09595)
more intensive (infill)	-	0.42118***	0.47696***
development (=1)		(0.09207)	(0.09365)
Observations	2488	2504	2488
Log-likelihood	-1499.71	-1452.67	-1436.21
AIC	3023.4	2927.3	2902.4

*** Significant at 1% level, ** Significant at 5% level, * Significant at 10% level

(Standard Errors in Parentheses)

[a]: Using the data when uncertain votes are recoded and yea-sayers are removed

We further investigate the heterogeneity between two types of sample group based on other questions asked in the survey (Table 2-8). One is only using the data from respondents who read the background information. In the online survey, we provided five separate pieces of background information as optional for respondents to read[7]. Approximately 15% of them skipped all five pieces, and we remove these respondents from the sample, thus making it the "No Background Removed" group. A comparison between the full sample group and "No Background Removed" group shows that respondents who did not read any background information have slightly higher WTP values in terms of all types of agricultural use, and spatial characteristics such as adjacent area and land proximity. The other one is only using the data from respondents who thought the proposed programs are likely to be implemented. One of the follow-up questions we asked after the valuation questions is how respondents feel the strategies presented in the survey could be actually implemented. About 48% of them responded to the question with either "very likely" or "somewhat likely", and we thus grouped those respondents into a "Likely to be Implemented" group. Results in Table 2-8 indicate that the WTP estimates for each attribute are substantially higher in the "Likely to be Implemented" group relative to the full sample group. This is consistent with the intuition that respondents who hold positive perceptions of proposed programs are willing to pay more.

[7] These five pieces of background information are: background information about the Alberta Capital Region, information about land in agricultural uses and associated services, information about agricultural land conversion in the Alberta Capital Region, information about population growth in the City of Edmonton and the Alberta Capital Region, and information about conservation buffers in the Alberta Capital Region.

Table 2-8: MNL Coefficient Estimates and MWTP (per acre, per household) Comparison between All Sample, No Background Removed, and Likely to be Implemented

Attribute	All Sample		No Background Removed[a]		Likely to be Implemented[b]	
	Coefficient (Std. Err.)	MWTP Estimate (CAD $)	Coefficient (Std. Err.)	MWTP Estimate (CAD $)	Coefficient (Std. Err.)	MWTP Estimate (CAD $)
grain*acres	-0.00025**	-0.09058**	-0.00033**	-0.10855**	-0.00054**	-0.17308**
	(0.00013)	(0.04710)	(0.00015)	(0.04934)	(0.00025)	(0.08013)
live*acres	-0.00015	-0.05435	-0.00021	-0.06908	-0.00050**	-0.16026**
	(0.00013)	(0.04710)	(0.00015)	(0.04934)	(0.00024)	(0.07692)
hay*acres	-0.00025**	-0.09058**	-0.00028**	-0.09211**	-0.00029	-0.09295
	(0.00011)	(0.03986)	(0.00013)	(0.04276)	(0.00023)	(0.07372)
highway*acres	0.00021**	0.07609**	0.00026**	0.08553**	0.00040**	0.12821**
	(0.00009)	(0.03261)	(0.00010)	(0.03289)	(0.00017)	(0.05449)
city*acres	-0.00018*	-0.06522*	-0.00021*	-0.06908*	-0.00039**	-0.12500**
	(0.00010)	(0.03623)	(0.00011)	(0.03618)	(0.00018)	(0.05769)
acres	0.00055***	0.19928***	0.00067***	0.22039***	0.00092***	0.29487***
	(0.00012)	(0.04348)	(0.00014)	(0.04605)	(0.00023)	(0.07372)
cost	-0.00276***	-	-0.00304***	-	-0.00312***	-
	(0.00023)		(0.00025)		(0.00035)	
sq	-0.67179***	-	-0.76495***	-	-1.26631***	-
	(0.10270)		(0.11293)		(0.16661	
Observations	2504[c]		2136[c]		1200[c]	
Log-likelihood	-1520.54		-1246.23		-609.66	
AIC	3057.1		2508.5		1235.3	

*** Significant at 1% level, ** Significant at 5% level, * Significant at 10% level

(Standard Errors in Parentheses)

[a]: Only using the data from respondents who read background information

[b]: Only using the data in which the proposed programs are likely to be implemented

[c]: Using the data when uncertain votes are recoded and yea-sayers are removed

In addition to partitioning the sample into groups, another popular approach to relaxing the assumption of homogenous preferences across respondents is to adopt Random Parameter Logit model and Latent Class model. Initially, a Random Parameter Logit model is estimated to develop a general sense of heterogeneity within the sample, and then the Latent Class model is employed to determine specific drivers that result in heterogeneity.

In the Random Parameter Logit model, variables that are specified as random are allowed to vary in a specific distribution across individuals with fixed means. Table 2-9 shows results for two Random Parameter Logit models. For the first RPL model, only the status quo is specified as the random variable with a normal distribution. For the second RPL model, besides the status quo as a normally distributed, we also specify all the attributes in the proposed program as uniformly distributed since these variables are set as dummies in the model. The coefficients estimates from both RPL models are quite similar to the results from the basic multinomial model. The results further show that in terms of types of agricultural use, adjacent area, location proximity and the status quo, there is evidence of variation but the parameters of these standard deviations are not statistically significant.

Table 2-9: Random Parameters Logit Model (RPL) Coefficient Estimates

Attribute	RPL 1		RPL 2	
	Coefficient[a]	Coefficient (Std. Dev.)	Coefficient[a]	Coefficient (Std. Dev.)
grain*acres	-0.00026**	-	***-0.00029****	0.00019
	(0.00013)		***(0.00015)***	(0.00070)
live*acres	-0.00015	-	***-0.00019***	0.00035
	(0.00014)		***(0.00016)***	(0.00059)
hay*acres	-0.00025**	-	***-0.00028****	0.00001
	(0.00012)		***(0.00013)***	(0.00062)
highway*acres	0.00022**	-	***0.00022****	0.00019
	(0.00009)		***(0.00010)***	(0.00049)
city*acres	-0.00018*	-	***-0.00019***	0.00050
	(0.00010)		***(0.00012)***	(0.00061)
acres	0.00056***	-	**0.00066*** **	0.00035
	(0.00012)		**(0.00018)**	(0.00025)
cost	-0.00287***	-	-0.00287***	-
	(0.00032)		(0.00026)	
sq	**-0.69831*** **	0.41360	**-0.66611*** **	0.15826
	(0.11960)	(0.43160)	**(0.10842)**	(0.33318)
Observations	2504[b]		2504[b]	
Log-likelihood	-1520.02		-1518.72	
AIC	3058.0		3067.4	

*** Significant at 1% level, ** Significant at 5% level, * Significant at 10% level

(Standard Errors in Parentheses)

[a]: Results in **bold** represent random parameters. Results in *italic* mean the parameters are uniformly distributed, otherwise normally distributed.

[b]: Using the data when uncertain votes are recoded and yea-sayers are removed

As we can observe the existence of heterogeneity in the sample, we further adopt the Latent Class model to investigate what potential factors contribute to this variation. Based on previous findings from endogenous and exogenous models, we thus include these demographic and socio-economic characteristics as well as attitudinal indicators into the model. As for the selection of the number of classes, no standard criteria have been proposed yet. Rather, previous studies (e.g., 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) and BIC (Bayesian 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 select a two-class model primarily based on both AIC criterion and the meaningfulness of parameter estimates (i.e., both sign and significance). Table 2-10 presents the results from the Latent Class model that include both endogenous and exogenous variables.

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 all sample model and other selected models. Specifically, the status quo 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 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.

In terms of the demographic and socio-economic variables in the class analysis, males and residents living in the city are less likely to fall into Class 1, which is in accordance with the outcomes in the endogenous model (Table 2-7) that males and respondents from Edmonton are less likely to vote for the conservation strategies. 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 positive and significant, which indicates that holding these opinions respondents are more likely to be in Class 1 with strong support of the proposed programs. Such outcomes can also be verified with results from the exogenous model as shown in Table 2-7.

Table 2-10: Latent Class Model (LC) Coefficient Estimates

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)
sq	-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[a]	
Log-likelihood	-1417.06	
AIC	2882.1	

***, ** and * indicate significance at 1%, 5% and 10% level (Standard Errors in Parentheses)

[a]: Using the data when uncertain votes are recoded and yea-sayers are removed

3.4.4 Debriefing

Respondents were asked some debriefing questions to elicit their motivations for valuation question responses. One commonly adopted question is to ask their attitude towards each attribute and its importance in making their voting decisions. In general, more than half of respondents said it was either important or very important of each attribute regarding their voting behaviors (Table 2-11). The table further illustrates that more than 75% of respondents who voted for the proposed programs considered the type of agricultural use as either important or very important, while only approximately 63% of them said the adjacent area was either important or very important in making their valuation decisions. Almost 85% of them (which is the highest) thought the cost was either important or very important in making their valuation decisions, and about 45% chose very important which also makes it the highest percentage in this category compared to other attributes.

Table 2-11: Respondents' Attitude towards Each Attribute (N=320)

Attribute	Percentage (%)				
	Not At All Important	Unimportant	Neither Unimportant Nor Important	Important	Very Important
Type of Agricultural Use	1.56	4.38	17.71	57.50	18.75
Land Proximity	0.94	7.50	29.06	49.06	13.44
Acres Conserved	1.56	3.44	19.69	57.19	18.12
Adjacent Area	0.94	6.25	30.31	49.38	13.12
Property Tax or Rent Increase Next Year	0.62	3.75	11.25	39.38	45.00

After the valuation questions, we also asked debriefing questions about reasons why respondents voted to choose the proposed conservation programs or to keep the status quo. The percentages shown in Table 2-12 and Table 2-13 do not add to 100% as respondents were allowed to check all reasons that applied. From Table 2-12 we can see that "the proposed strategies would be better than no conservation" and "the proposed strategies are

worth the money" are the two most popular reasons for voting conservation strategies. Table 2-13 contains the percentages of reasons about why respondents voted to keep the status quo. Among all reasons, respondents were most concerned with the cost as about 65% of them voted against the proposed strategies because the cost is too much. In comparison between these two tables and associated reasons, cost is decisive in voting for the status quo while in voting for the proposed strategies, the programs play a more substantial role.

Table 2-12: Reasons Why Respondents Voted to Choose the Proposed Conservation Strategies (N=284)[a]

Reason	Percentage (%)
I believe the proposed strategies would be better than no conservation	71.48
I believe that the proposed strategies are worth the money	61.97
This is a better use of money compared to other things that the money should be spent on	48.94
We should pay more to conserve/expand land in agricultural uses	41.20
Other reason	6.69

[a]: 284 respondents voted for the proposed conservation strategies at least once.

Table 2-13 Reasons Why Respondents Voted to Choose the Status Quo (N=223)[a]

Reason	Percentage (%)
I believe that the cost is too much for the proposed strategies	64.57
I do not have enough information to make this decision	29.60
There are other land uses that should be considered	17.94
I do not believe the proposed strategies would be better than no conservation	16.14
Other reason	5.38

[a]: 223 respondents voted for the status quo at least once.

Another contribution of this study is to explore the links between values of land in agricultural uses and residents' affinity with different ecosystem goods and services. After each valuation question, respondents were asked to indicate aspect(s) that were important to them with respect to the chosen agricultural uses. Figure 2-10 demonstrates the percentages of seven ecosystem goods and services that are important regarding specific agricultural uses. Respondents were found to be most concerned with food for local market among all options with an average of 84% across four agricultural uses, while the importance of recreation has the lowest percentage of about 36%. For each specific agricultural use, the orders of importance are generally similar with food for local market having the highest percentage and recreation the lowest, although preferences may vary slightly for the order of other ecosystem goods and services. One noteworthy point is for commercial vegetable farms, more than 90% of residents chose the proposed program as they thought food for local consumption was an important aspect.

In order to examine whether there exist statistically significant differences between the agricultural uses regarding different ecosystem goods and services, we adopt the Mann-Whitney two sample test and the results are shown in Table 2-14. There are statistically significant differences between hay land and livestock grazing on native pasture for food for local market, food for national/global market, water purification and air quality regulation. In accordance with the intuition, more respondents feel food production (for both local and national/global) is important to livestock grazing on native pasture relative to hay land. While more of them think water purification and air quality regulation are important to hay land than livestock grazing on native pasture, and possible reasons include that livestock may raise problems such as manure which is considered to be detrimental to the environment. However, there are no statistically significant differences between any agricultural use with respect to climate regulation, recreation and scenic beauty.

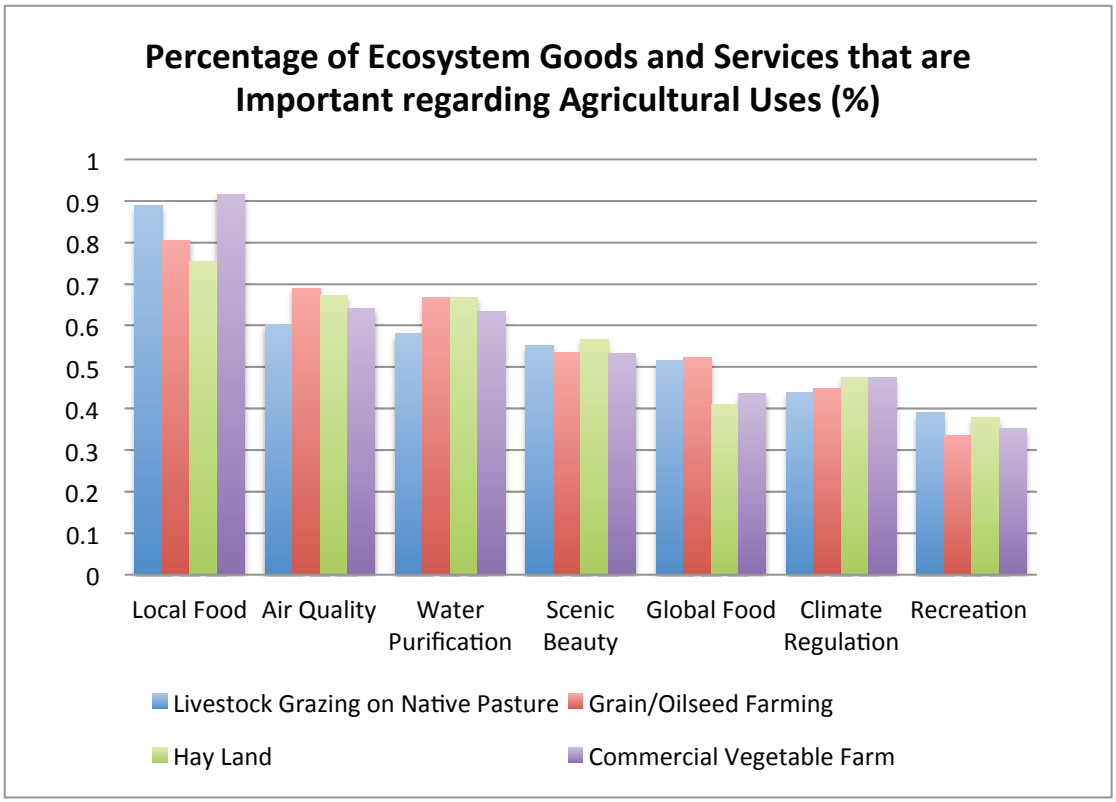


Figure 2-10: Percentage of Ecosystem Goods and Services that are Important regarding Agricultural Uses

Table 2-14: Mann-Whitney Test Results for Ecosystem Goods and Services between Different Types of Agricultural Uses (N=320)

	Local Food	Global Food	Water Purification	Air Quality	Climate Regulation	Recreation	Scenic Beauty
Grain/Oilseed	80.56%*	52.28%***	66.67%	68.82%	44.84%	33.57%	53.48%
	(0.36)	(0.50)	(0.47)	(0.46)	(0.50)	(0.47)	(0.50)
Hay Land	75.44%*	41.01%***	66.84%	67.34%	47.59%	37.97%	56.71%
	(0.44)	(0.49)	(0.47)	(0.47)	(0.50)	(0.49)	(0.50)
Grain/Oilseed	80.56%***	52.28%	66.67%**	68.82%**	44.84%	33.57%	53.48%
	(0.36)	(0.50)	(0.47)	(0.46)	(0.50)	(0.47)	(0.50)
Livestock	88.83%***	51.50%	58.04%**	60.22%**	43.87%	38.96%	55.31%
	(0.32)	(0.50)	(0.49)	(0.49)	(0.50)	(0.49)	(0.50)
Grain/Oilseed	80.56%***	52.28%**	66.67%	68.82%	44.84%	33.57%	53.48%
	(0.36)	(0.50)	(0.47)	(0.46)	(0.50)	(0.47)	(0.50)
Vegetable	91.63%***	43.61%**	63.44%	64.10%	47.58%	35.24%	53.30%
	(0.28)	(0.50)	(0.48)	(0.48)	(0.50)	(0.48)	(0.50)
Hay Land	75.44%***	41.01%***	66.84%**	67.34%**	47.59%	37.97%	56.71%
	(0.44)	(0.49)	(0.47)	(0.47)	(0.50)	(0.49)	(0.50)
Livestock	88.83%***	51.50%***	58.04%**	60.22%**	43.87%	38.96%	55.31%
	(0.32)	(0.50)	(0.49)	(0.49)	(0.50)	(0.49)	(0.50)
Hay Land	75.44%***	41.01%	66.84%	67.34%	47.59%	37.97%	56.71%
	(0.44)	(0.49)	(0.47)	(0.47)	(0.50)	(0.49)	(0.50)
Vegetable	91.63%***	43.61%	63.44%	64.10%	47.58%	35.24%	53.30%
	(0.28)	(0.50)	(0.48)	(0.48)	(0.50)	(0.48)	(0.50)
Livestock	88.83%	51.50%**	58.04%	60.22%	43.87%	38.96%	55.31%
	(0.32)	(0.50)	(0.49)	(0.49)	(0.50)	(0.49)	(0.50)
Vegetable	91.63%	43.61%**	63.44%	64.10%	47.58%	35.24%	53.30%
	(0.28)	(0.50)	(0.48)	(0.48)	(0.50)	(0.48)	(0.50)

*** $p<0.01$, ** $p<0.05$, * $p<0.1$ (Standard Errors in Parentheses)

3.4.5 Welfare measures

The choice experiment elicits residents' WTP for a change in each attribute level. According to Table 2-6 if we consider the Alberta Capital region sample, respondents are willing to pay around CAD$0.20 per acre for the base case of the conservation strategy (i.e., land used in commercial vegetable farm, adjacent to conservation buffer and within 10-km buffer from currently developed land) relative to the status quo that no public conservation strategy would be implemented. Respondents are willing to pay approximately an extra CAD$0.08 per acre if land is conserved adjacent to primary highways as opposed to land adjacent to conservation buffers. Residents are willing to pay about CAD$0.07 more per acre if there is a change for land conserved from within city limits to within a 10-km buffer from currently developed land. Regarding the type of agricultural use, residents are willing to pay about CAD$0.09 less per acre for either grain/oilseed farming or hay land relative to commercial vegetable farms. The WTP for livestock grazing on native pasture is around CAD$0.05 less than land in the use of commercial vegetable farm.

Based on WTP for each attribute, we thus estimate the values of conservation strategies as a whole. Table 2-15 reports the WTP (per acre, per household, next year only) for each of the sixteen different types of conservation strategies that can be generated from the survey instrument, for both all sample group and group with yea-sayers removed. Among all the conservation strategies, a program that consists of commercial vegetable farm, adjacent to primary highway and within 10-km buffer from currently developed land is most preferred and residents would be willing to pay about CAD$0.28 per acre per household next year for all sample group. 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$0.04 per acre per household next year for all sample group.

Since the cost through either property tax or rent is collected mostly at the household level, we thus choose the household as the appropriate unit to calculate the resulting aggregate welfare measures. There were about 1,170,525 residents in the Alberta Capital Region in

2012, which is comprised by approximately 468,210 households in the region[8]. Shown in Table 2-16, the estimated aggregate WTP for each conservation strategy per acre for next year only in the Alberta Capital Region ranges from CAD$20,000 to CAD$129,000 for all sample group, depending on different types of agricultural use, adjacent area and location proximity. These results can be further used to conduct a benefit-cost analysis that examines whether a specific conservation strategy is socially warranted compared to its associated cost for the implementation of such strategy.

In order to spatially visualize different conservation strategies, we first identify the four types of agricultural use based on current agricultural landscape data in the Alberta Capital Region in the year 2012 from AAFC (see Figure 1-2), and then overlap with the spatial information (i.e., adjacent area and land proximity) used in the choice experiment to characterize conservation strategies. Figure 2-11 shows the spatial visualization of sixteen conservation strategies that can be generated from the choice experiment, and meanwhile are in current practice in the Alberta Capital Region.

[8] Based on Census 2011, the average number of persons in household was 2.5 in the Edmonton metropolitan area. http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/famil124f-eng.htm (accessed March 24, 2015).

Table 2-15: Estimated MWTP for Conservation Strategy in Alberta Capital Region (per acre, per household, next year only)

Conservation Strategy	WTP Estimate (CAD $)
	All Sample[a]
Grain/Oilseed Farming; Adjacent to Primary Highway; Within City Limits	0.1196
Grain/Oilseed Farming; Adjacent to Primary Highway; Within 10-km Buffer from Currently Developed Land	0.1848
Grain/Oilseed Farming; Adjacent to Conservation Buffer; Within City Limits	0.0435
Grain/Oilseed Farming; Adjacent to Conservation Buffer; Within 10-km Buffer from Currently Developed Land	0.1087
Livestock Grazing on Native Pasture; Adjacent to Primary Highway; Within City Limits	0.1558
Livestock Grazing on Native Pasture; Adjacent to Primary Highway; Within 10-km Buffer from Currently Developed Land	0.2210
Livestock Grazing on Native Pasture; Adjacent to Conservation Buffer; Within City Limits	0.0797
Livestock Grazing on Native Pasture; Adjacent to Conservation Buffer; Within 10-km Buffer from Currently Developed Land	0.1449
Hay Land; Adjacent to Primary Highway; Within City Limits	0.1196
Hay Land; Adjacent to Primary Highway; Within 10-km Buffer from Currently Developed Land	0.1848
Hay Land; Adjacent to Conservation Buffer; Within City Limits	0.0435
Hay Land; Adjacent to Conservation Buffer; Within 10-km Buffer from Currently Developed Land	0.1087
Commercial Vegetable Farm; Adjacent to Primary Highway; Within City Limits	0.2101
Commercial Vegetable Farm; Adjacent to Primary Highway; Within 10-km Buffer from Currently Developed Land	0.2754
Commercial Vegetable Farm; Adjacent to Conservation Buffer; Within City Limits	0.1341
Commercial Vegetable Farm; Adjacent to Conservation Buffer; Within 10-km Buffer from Currently Developed Land	0.1993

[a]: Using all the data in the sample when uncertain votes are recoded and yea-sayers are removed

Table 2-16: Estimated Aggregate WTP for Conservation Strategy in Alberta Capital Region (per acre, next year only)

Conservation Strategy	WTP Estimate (million CAD $)
	All Sample[a]
Grain/Oilseed Farming; Adjacent to Primary Highway; Within City Limits	0.0560
Grain/Oilseed Farming; Adjacent to Primary Highway; Within 10-km Buffer from Currently Developed Land	0.0865
Grain/Oilseed Farming; Adjacent to Conservation Buffer; Within City Limits	0.0204
Grain/Oilseed Farming; Adjacent to Conservation Buffer; Within 10-km Buffer from Currently Developed Land	0.0509
Livestock Grazing on Native Pasture; Adjacent to Primary Highway; Within City Limits	0.0729
Livestock Grazing on Native Pasture; Adjacent to Primary Highway; Within 10-km Buffer from Currently Developed Land	0.1035
Livestock Grazing on Native Pasture; Adjacent to Conservation Buffer; Within City Limits	0.0373
Livestock Grazing on Native Pasture; Adjacent to Conservation Buffer; Within 10-km Buffer from Currently Developed Land	0.0679
Hay Land; Adjacent to Primary Highway; Within City Limits	0.0560
Hay Land; Adjacent to Primary Highway; Within 10-km Buffer from Currently Developed Land	0.0865
Hay Land; Adjacent to Conservation Buffer; Within City Limits	0.0204
Hay Land; Adjacent to Conservation Buffer; Within 10-km Buffer from Currently Developed Land	0.0509
Commercial Vegetable Farm; Adjacent to Primary Highway; Within City Limits	0.0984
Commercial Vegetable Farm; Adjacent to Primary Highway; Within 10-km Buffer from Currently Developed Land	0.1289
Commercial Vegetable Farm; Adjacent to Conservation Buffer; Within City Limits	0.0628
Commercial Vegetable Farm; Adjacent to Conservation Buffer; Within 10-km Buffer from Currently Developed Land	0.0933

[a]: Using all the data in the sample when uncertain votes are recoded and yea-sayers are removed

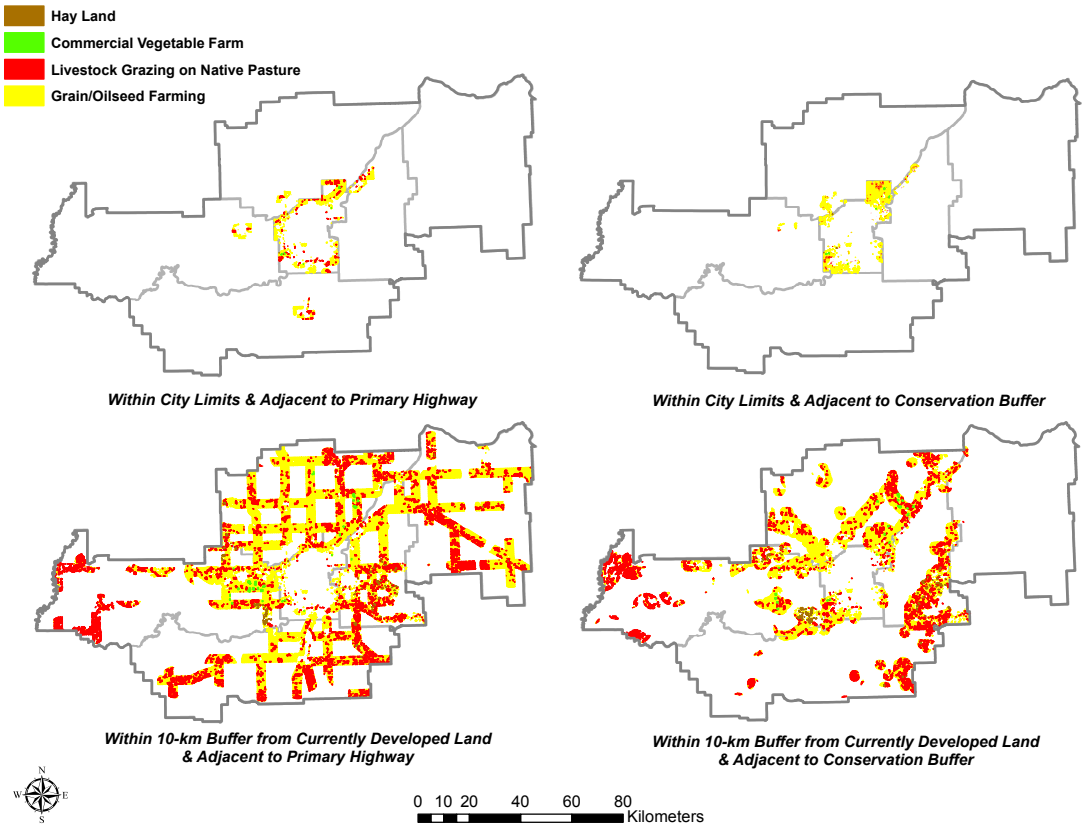


Figure 2-11: Spatial Visualization of Conservation Strategies

3.5 Conclusions

This chapter provides both descriptive and empirical results from the survey. Descriptive statistics and responses from background information indicate residents' high concern for agricultural land loss in the study area as well as their strong propensity to conserve land in agricultural uses. Non-parametric analysis also supports the proposed conservation strategies that aim to conserve specific areas of land in specific agricultural uses in a general sense, relative to the status quo in which no such programs would be implemented. The parametric analysis of the choice experiment data reports that commercial vegetable farm is the most preferred type of agricultural use, and meanwhile respondents give priority to land adjacent to primary highways and land within 10-km buffer from currently developed land.

Preference heterogeneity was examined through use of several modeling techniques, including the inclusion of endogenous and exogenous variables, Random Parameters Logit model and Latent Class model. Variations are evident in terms of the status quo rather than

attribute levels in the proposed programs. Respondents' attitudinal responses about agricultural land loss and conservation for agricultural land uses are found to be positively associated with their voting for the proposed programs. Yea-sayers are identified, uncertainty votes are recoded, and other approaches to addressing potential hypothetical bias are also employed.

Aggregate welfare measures are performed based on the WTP estimates for each conservation strategy and household number in the Alberta Capital Region. Results show that residents in the study area are willing to pay, approximately CAD$129,000 per acre for the next year only, for land in commercial vegetable farm that is adjacent to primary highway and within a 10-km buffer from currently developed land, which is the highest among all strategies. While land in either grain/oilseed farming or hay land that is adjacent to the conservation buffer and within city limits is least preferred with about $20,000 per acre for the next year only.

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Chapter IV - Optimizing Use of Financial Resources for Agricultural Land Conservation: Nonmarket Benefits and Market Costs in the Alberta Capital Region

1 Introduction

How to best utilize public funds to conserve environmental amenities is an issue which has received increasing attention in recent economics and public policy studies (Ando et al., 1998; Babcock et al., 1996). One example of this problem is how to allocate scarce conservation resources in the selection of sites for biological reserves (Polasky et al., 2001; Wilson et al., 2006). Another stream of research focuses on the conservation for agricultural lands, particularly through the purchase of agricultural conservation easements (ACEs). Literature shows that the public has substantial willingness to pay (WTP) for ACEs and recognizes many environmental and other services resulting from these programs, such as water quality, scenic beauty and rural amenities (Duke and Aull-Hyde, 2002; Lynch and Duke, 2007; Nickerson and Hellerstein, 2003). Prompted by public concern, tools such as conservation easements, which are widely used for conserving wildlife and ecological purposes, have been applied to agricultural land protection (Johnston and Bergstrom, 2011).

Gardner (1977) clarified the economic rationale for public investment in land preservation in the presence of nonmarket amenities or benefits so as to potentially improve efficiency. This concept is especially applicable when it comes to agricultural conservation easements as an approach to conserving agricultural land parcels (Duane, 2010). However, such public programs often involve the allocation of public funds collected through either specific taxes or general public funds (Land Trust Alliance 2004; Pidot, 2005). The selection of agricultural land parcels for the expenditure of such public funds should, therefore, maximize net public benefits (Kline and Wichelns, 1996; Poe, 1999) to the maximum possible extent subject to budget constraints. As a result, researchers have begun to find possible solutions to the problem of optimal selection of land for conservation.

Several targeting methods have been discussed. Initially, researchers put emphasis on maximizing the pure benefits of conservation programs, such as environmental amenities

(Fooks and Messer, 2013; Messer, 2006). However, this approach does not always lead to efficient resource allocation due to the ignorance of the associated costs. Techniques that integrate cost measures into priority assessment have thus been developed. This branch of literature demonstrates that the incorporation of costs into conservation decisions can significantly improve efficiency and enhance net public benefits (Balmford et al., 2000; Naidoo et al., 2006). More recently, a growing trend within this literature is to inform an optimal conservation using linear programming such as the branch-and-bound optimization algorithm by taking both benefits and costs into account (Kaiser and Messer, 2011; Messer, 2006).

Although many studies have used various targeting tools to quantify the efficiency of conservation programs, there are relatively few such studies regarding agricultural land (see Duane, 2010; Duke et al., 2014). We thus make a contribution to the current literature by conducting our analysis on conservation easements specifically for land in agricultural uses. We further take advantage of a rigidly-designed survey to generate empirical measures of nonmarket benefits, rather than those drawn from scoring or analytical hierarchy processes as in many other studies (e.g., Messer, 2006; Messer and Allen, 2010). Additionally, most previous studies are generic and do not explicitly include spatial information. Using a choice experiment that spatially depicts nonmarket values across the study area, together with agricultural land sales data from the real market in two scenarios (i.e., urban and rural settings), this paper aims to depict a more realistic picture of optimal selection of conservation strategies so as to conserve land in agricultural uses.

Additionally, previous studies used single budget constraints for optimal selection (Duke at el., 2014), we explore multiple levels of budget that are simultaneously generated through the choice experiment. While most of previous studies in this field have been conducted in the United States, few results are available for Canada, especially in a peri-urban setting in the prairie region. Our study also contributes to the current literature by applying both streams of methods, nonmarket valuation for benefits and market estimation for costs, to the Alberta Capital Region in Canada.

2 Study Area and Background

Located in the center of the Canadian prairie province, the Alberta Capital Region is a conglomerate of municipalities that surround Alberta's provincial Capital, Edmonton. The region covers approximately 3 million acres, which accounts for 1.9% of Alberta's land mass but holds 31.8% of Alberta's population (Capital Region Board, 2015). According to the 2011 Census, the Alberta Capital Region had a population of about 1.15 million, making it the sixth largest Census Metropolitan Area in Canada by population. Active agricultural activities can be observed in this area. For example, there were a total of 2.2 million acres of farms or 4.4% of Alberta's total farm acreage in the region, which accounted for 4.6% of the province's total value of on-farm livestock and poultry in 2011 (Government of Alberta, 2012a).

Increasing population growth and the need for residential services have imposed great pressure on land uses in the area by converting agricultural land to developed uses. Between 2000 and 2012, about 94,517 acres of agricultural land was developed, which represents a 4.3% loss of agricultural land base in the region[9]. The conversion has primarily taken the form of suburban development on the periphery of the cities. Such conversions have brought substantial concerns to the provincial government and the Capital Region Board, and further led to the creation of the *Land-Use Framework* (LUF) in 2008 and the *Capital Region Land Use Plan* in 2009 to improve the land planning and development processes.

Meanwhile, to help facilitate the efficient use of land and obtain the goals depicted in the *LUF*, the Government of Alberta completed a review of tools in *Efficient Use of Land Implementation Tools Compendium* in 2014 (Government of Alberta, 2014b). The 29 proposed tools are mostly for private lands under individual and/or municipal management/planning. Another 16 tools that are more appropriate for conservation of public lands are described in the document of *Integrated Land Management Tools Compendium* (Government of Alberta, 2012b). The purpose of both compendiums is to present and describe a set of potential tools and practices for municipalities to achieve the

[9] The land use and land cover raster data is available at ftp://ftp.agr.gc.ca/pub/outgoing/aesb-eos-gg/Crop_Inventory/ (accessed June 12, 2014). The statistics were from authors' analysis.

outcome of efficient use of land strategies. Though not all of the tools have been implemented in Alberta, they have potential for use in the province.

Among all the tools and practices described in the compendiums, conservation easements have been discussed comparatively more as possible options to preserve agricultural land. In 2009, with the proclamation of the *ALSA*, the Government of Alberta took the step of expanding Alberta's 13-year-old conservation easement provisions to include agriculture (Government of Alberta, 2009). A document named *Conservation Easements for Agriculture in Alberta* analyzed the existing practice of conservation easements for agriculture in Alberta, with a review of legislation, policy, and delivery mechanisms (Chiasson et al., 2012). Even though only two provinces (i.e., Nova Scotia and Ontario) have specifically named conservation of agricultural land as a purpose and used conservation easements within an agricultural context in Canada, some provinces without agricultural purposes in their conservation easements legislation have farms with conservation easements or land trusts with "agricultural conservation" as a mandate purpose.

3 Methods

Prior studies have shown that targeting instruments can play a substantial role in optimally allocating a given budget for conservation programs (Babcock et al., 1996; Babcock et al., 1997). Several approaches have been proposed to evaluate the relative efficiency of potential conservation programs in the literature (Duke et al., 2014). The majority of them included one or several of the following: Benefit Targeting (BT), Cost Targeting (CT), Benefit-Cost Ratio Targeting (BCRT), and Optimization (OPT). In this paper, we used all four targeting tools to comprehensively investigate the efficiency of different targeting adoptions.

3.1 Benefit targeting (BT)

BT, as the name suggests, prioritizes the lands that possess higher conservation benefits. This metric has been used in multiple studies regarding conservation efforts (Fooks and Messer, 2013; Messer, 2006). One advantage of this technique is obvious, as conservation

agencies can easily target the lands they plan to acquire without having to collect cost information until the purchase stage. However, this advantage comes with the downside that such a selection outcome is likely to be cost-ineffective as it neglects the cost as an important criterion (Duke et al., 2013).

BT's portfolio is solely determined by ranking all available land parcels from highest to lowest, based on the conservation benefits and selecting as many of the highest-ranked parcels as possible given a certain budget. Formally, BT's selection algorithm can be written as follows. Given an index for each land parcel, i = 1, 2,..., I, V_i, is the i^{th} parcel's conservation benefit. V_i is then ranked from highest to lowest. Let R(•) denote the rank operator and let R_i = $R(V_1,...,V_I)$ represent the rank of the i^{th} parcel, where the land parcel with the highest benefit V_i receives a rank of 1. The decision of whether a parcel is selected can be represented by a binary variable, X_i = {0,1}, where X_i = 0 means that the i^{th} parcel is not selected and X_i = 1 indicates that this parcel is selected. This leads to the vector X as a set of choices among all land parcels, where X = $[X_1, X_2,..., X_I]$. After ranking all parcels, they can be arrayed in the following format as shown in Table 3-1.

Table 3-1 Selection Algorithm

Rank	Parcel Selection	Cost
1	X_i, X_j	C_i, C_j
2	X_I	C_I
.	.	.
R	X_r	C_r

In cases where conservation benefits are equal among several parcels, conservation costs are considered to break the tie. For example, if parcels i and j have the same rank in terms of the conservation benefits with the costs $C_i < C_j$, then:

$$X_i = 1 \quad if \quad C_i \leq B$$

$$X_i = 0 \quad if \quad C_i > B$$

$$X_j = 1 \quad if \quad C_j \leq B - X_i C_i$$

$$X_j = 0 \quad if \quad C_j > B - X_i C_i$$

where B is the given budget. Through the above iterative process, land parcels are selected until the financial resources are exhausted.

3.2 Cost targeting (CT)

A parallel idea applies when a conservation agency merely considers conservation costs while ignoring the associated benefits. This approach is called the Cost Targeting (CT). Specifically, it ranks programs solely by acquisition cost and selects the least expensive ones until a given budget is fully spent (Ferraro, 2003). Like the BT method described above, CT is commonly used for the prioritization of parcels for conservation by public and private entities. In practice, CT tends to maximize acreage rather than net benefits (Babcock et al., 1997).

Let S(•) denote the rank operator over all parcel costs, and let $S_i = S(C_1, ..., C_I)$ be the rank of the i^{th} parcel, such that the parcel with the lowest cost receives a rank of 1. After ranking all parcels, CT selects the lowest cost parcels until the budget is exhausted. In situations where multiple parcels have the same costs, CT would select the parcel with the highest benefit. Given three parcels, d, e and f, for the illustration purpose (see Duke et al., 2014), where $C_d < C_e < C_f$. Therefore, CT would select

$$X_d = 1 \quad if \quad C_d \leq B$$

$$X_d = 0 \quad if \quad C_d > B$$

$$X_e = 1 \quad if \quad C_e \leq B - X_d C_d$$

$$X_e = 0 \quad if \quad C_e > B - X_d C_d$$

$$X_f = 1 \quad if \quad C_f \leq B - (X_d C_d + X_e C_e)$$

$$X_f = 0 \quad if \quad C_f > B - (X_d C_d + X_e C_e)$$

3.3 Benefit-cost ratio targeting (BCRT)

Benefit-cost Ratio Targeting (BCRT) selects programs with the highest benefit-cost ratios until the budget is overspent. This technique ensures selection of programs with the highest benefit per dollar spent, which typically generates greater cost-effectiveness than simply BT or CT (Babcock et al., 1996). Economists advocate BCRT because of its cost-effectiveness (Ferraro, 2003; Wu et al., 2001). However, true cost-effectiveness might not be achieved for several reasons and small inefficiencies can arise especially when the selection process approaches the budget constraint. First, cost is embedded as a benefit index in this measurement (Duke et al., 2013). Second, like BT, BCRT will continue to seek a parcel with the best available benefit-cost ratio that the remaining budget can still accommodate (Messer, 2006). This sequenced targeting can result in a non-optimal set of parcels when the budget is relatively small and the acquisition costs are discrete and comparatively large (Duke et al., 2014).

The BCRT algorithm basically follows the method of the BT approach, and the rank operator, $T(\bullet)$, is based on the ratio of benefits and costs. That is, $T_i = T(V_1/C_1,..., V_I/C_I)$ is the rank of the i^{th} parcel, where the parcel with the highest benefit-cost ratio receives a rank of 1.

3.4 Optimization (OPT)

Optimization (OPT) aims to achieve true cost-effectiveness by involving a set of mathematical programming algorithms such as binary linear programming. OPT systematically addresses complexities, such as a need to enroll a minimum number of acres or to maximize conservation benefits (Fooks and Messer, 2012; Kaiser and Messer, 2011). Relative to BCRT, OPT offers slight advantages over iterative selection techniques by better accounting for budget remainders that are left unspent from the period budget after the last program has been selected (Messer, 2006).

The decision variable X is similar to the previous selection algorithms in that $X_i = 1$ means that the program is selected and $X_i = 0$ means that the program is not selected. Using the branch-and-bound algorithm (*GAMS* software was used for this analysis in this paper), OPT

considers all of the possible selection combinations given the budget restriction and identifies the set of parcels that would yield the highest possible aggregate conservation benefits (Kaiser and Messer, 2011). The optimization problem can be written as follows, where V(X) is the total conservation benefits:

$$Max\ V(X) = \sum_{i=1}^{I} X_i V_i$$

$$st.\ \sum_{i=1}^{I} X_i C_i \leq B, V_i > C_i$$

4 Data

The data sets used for this study are from four sources. The land use and land cover raster data in the Alberta Capital Region is from Agriculture and Agri-Food Canada (AAFC)[10]. Nonmarket benefits for conservation programs regarding agricultural uses were estimated through choice experiment data that were collected by researchers associated with the Alberta Land Institute in 2014-2015. The budget data were also generated from the choice experiment study. More details regarding the proposed budgets are discussed in section 4.3. For the costs data, there are two sources that are used in two different scenarios. One is the Agricultural Real Estate Transfer data from the Government of Alberta (Agriculture and Forestry)[11] that mostly represent the most rural settings in the Alberta Capital Region, and the other one is from agricultural land sales data from Roy Kelly Land[12] that shows agricultural land for sale in the real market around Edmonton and the other cities in the Alberta Capital Region. The following sub-sections provide the details of data descriptions.

4.1 Land use and land cover data

The 30-meter resolution land use and land cover raster image for 2012 is provided by Agriculture Agri-Food Canada (AAFC). The 2012 image has nearly 40 land use classes comprising annual crops, pasture, developed (or built-up), water, barren, shrubland, wetland, grassland, coniferous trees, deciduous trees, mixed trees, and detailed crop type

[10] The land use and land cover raster data is available at ftp://ftp.agr.gc.ca/pub/outgoing/aesb-eos-gg/Crop_Inventory/ (accessed June 12, 2014).

[11] Agricultural Real Estate Transfers by Municipality and C.L.I. Class: 1995-2014. http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/sdd1504 (access July 8, 2015). The Government of Alberta (Department of Agriculture and Forestry) only provides summarized statistics online. We thank to staff in AARD and the Government of Alberta for providing part of the transfer data at the individual level.

[12] Roy Kelly Land. http://roykelleyland.com/land-for-sale (accessed July 8, 2015).

classifications (e.g., wheat, canola, corn). To better demonstrate the images, we processed the data into nine land use and land cover classes as follows: Annual Crops, Developed (or Built-Up), Exposed, Forests, Grassland, Pasture, Shrubland, Water, and Wetland. Figure 3-1 presents the land use and land cover changes for the Alberta Capital Region in 2012. Specific land uses to be used in this study (e.g., hay land and vegetables) were also identified within the data set, and authors aggregated the data manually based on *AAFC Annual Crop Inventory - Data Product Specifications* (Government of Canada, 2015).

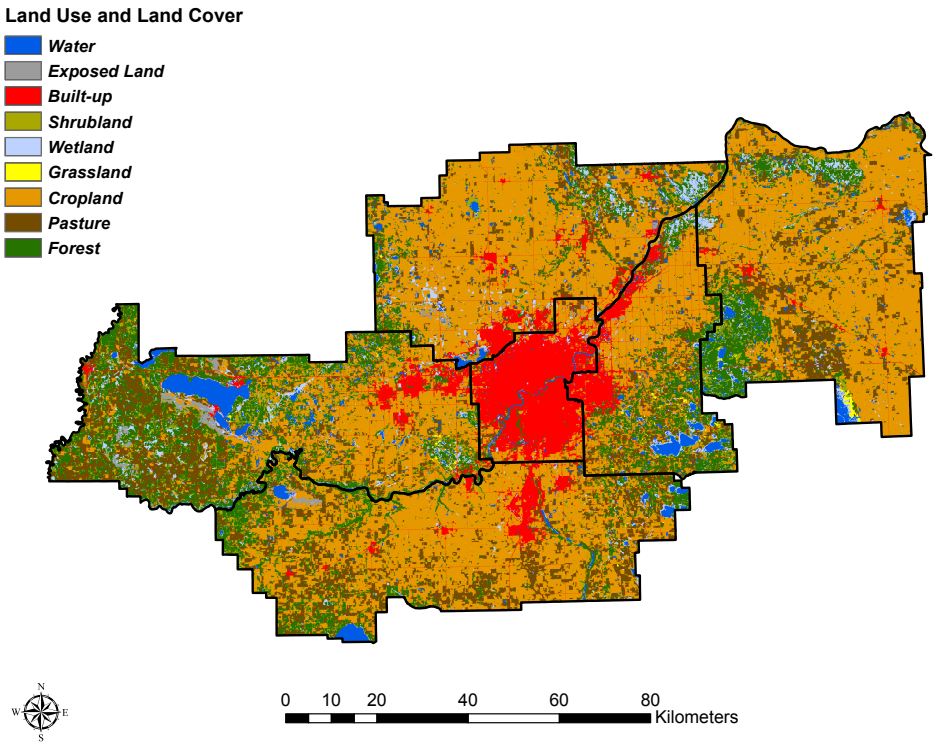


Figure 3-1 Land Use and Land Cover in the Alberta Capital Region (AAFC, 2012)

4.2 Nonmarket benefits for conservation

Choice experiment (CE) data were used to estimate nonmarket values accruing to residents of the Alberta Capital Region for conserving specific parcels of land in agricultural uses. Willingness to Pay (WTP) was thus calculated for different conservation strategies that explicitly indicate specific agricultural uses and specific types of area. The internet-based survey instrument was developed by the authors of this paper and implemented conducted by *Qualtrics* (a market research company) in March 2015, and a total of 320 respondents completed the survey. We used this data set for all following empirical analyses. The

internet-based survey was conducted 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 (see Chapter III for more details).

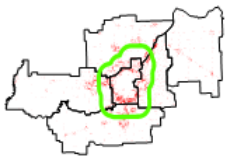
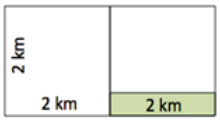
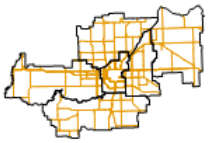
	Conservation Strategy	Status Quo
Type of Agricultural Use	Hay Land 	No Public Conservation Strategy for Land in Agricultural Uses
Location Proximity	Within 10-km Buffer from Currently Developed Land 	
Acres Conserved	200 acres (2 km x 0.4 km) 	
Adjacent Area	Adjacent to Primary Highway 	
Property Tax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

Figure 3-2 Example of Choice Set Used in Survey Instrument

The CE survey provided respondents with two alternatives in each choice set, with one alternative, the "conservation strategy", that would conserve land in a specific agricultural use and a specific type of area and the other alternative as the "status quo" that would result in no policy change. Figure 3-2 displays an example of a choice set question. We generated 32 different choice sets from an econometric software called *Ngene* to achieve a *D-efficiency* design of the experimental design. 32 choice sets were grouped into 4 blocks, and each respondent randomly received one block with 8 different choice sets. In terms of the attributes and attribute levels, these were mainly the results of consultation from focus

groups. The varied attributes in the CE were type of agricultural use (4 levels), acres conserved (4 levels), adjacent area (2 levels), location proximity (2 levels) and the cost in the form of property tax or rent increase for the next year only (5 levels). Table 3-2 shows the details and corresponding explanations. One noteworthy point in CE is the spatial visualization of the proposed conservation strategies by explicitly incorporating spatial components in the choice set. This approach contributes to mapping out the conservation strategies with specific locations in the study area. CE data was then conceptualized by the random utility theory and empirically estimated through multinomial logit model (*NLOGIT* software was used for econometric modeling). Table 3-3 shows the WTP estimates for sixteen different conservation strategies that were generated from CE.

Table 3-2 Attributes and Attribute Levels

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 3-3 Estimated WTP for Conservation Strategies in the Alberta Capital Region

Conservation Strategy	MWTP Estimate	
	(CAD $)	(million CAD $)
	per acre, per household	per acre, whole population[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]: There were about 1,170,525 residents in the Alberta Capital Region in 2012, which makes approximately 468,210 households in the region, given that the average number of persons in household was 2.5 in the Edmonton metropolitan area based on Census 2011.

Since the CE examined trade-offs involved in conserving land in agricultural uses in the study area, we first identified the four types of agricultural uses in the Alberta Capital Region based on the current agricultural landscape data in the year 2012 from Agriculture and Agri-food Canada (AAFC) as shown in Figure 3-2. Secondly, we mapped out the locations of conservation strategies in the region according to the spatial information embedded in CE. Combining these two data sources led to Figure 3-3 that demonstrates the spatial visualization of sixteen conservation strategies from the choice experiment that are in current practice in the Alberta Capital Region, together with the nonmarket benefits as shown in Table 3-3. The results were then used in the benefit-cost optimization analysis in section 5.

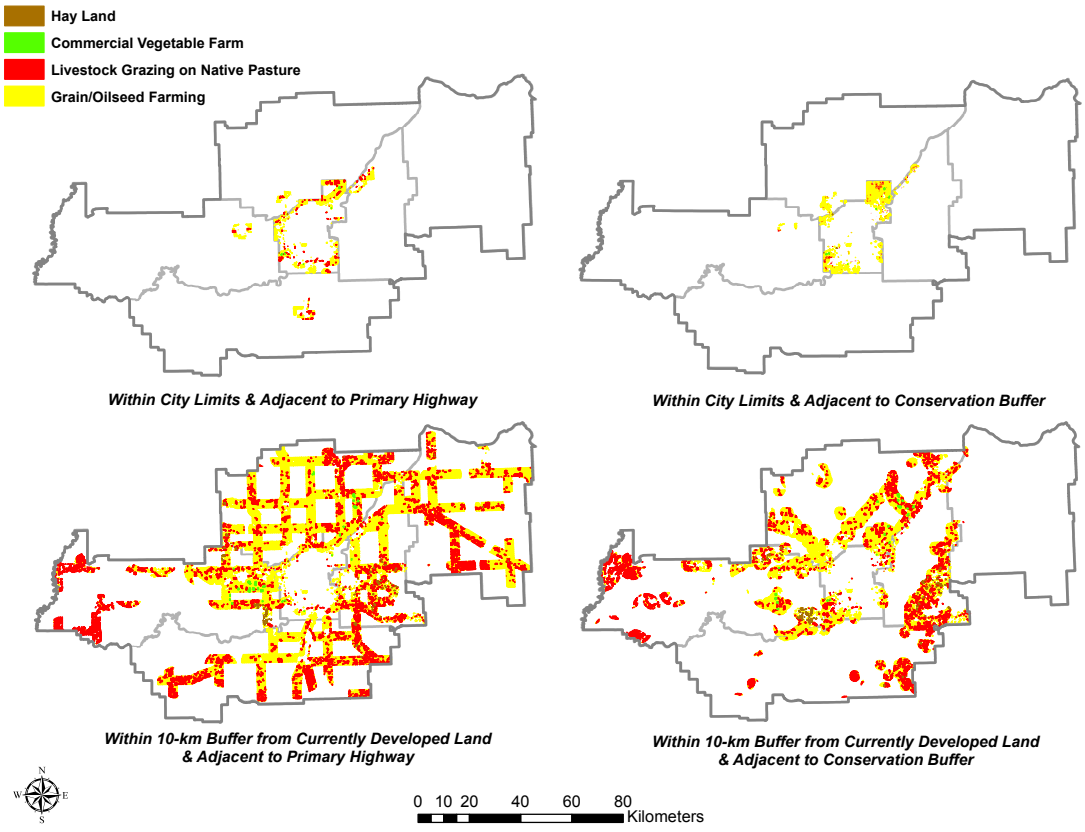


Figure 3-3 Locations of Conservation Strategies for Land in Agricultural Uses

4.3 Budget assumption

One data source needed in this study is the budget level to implement conservation strategies. If a government entity has no budget constraint, there would be no optimal selection strategy as the government can simply purchase all available land parcels with

positive net values (i.e., benefits minus costs). Different budgets may lead to quite divergent selection strategies as well as future policy implications. In this study, we assume that costs would be met through the imposition of an increase in the property tax or rent for the next year only from the choice experiment study, which applies to the residents in the study area (Table 3-4). This approach has two merits. First, the budget is closely tied with the public funds that would be collected from the residents. Second, the nature of these costs was used in the choice experiment study of the nonmarket benefits of conservation.

Table 3-4 Calculation of Budget Levels through Cost Levels

Cost Level (CAD $)	Yes Percentage (%)	Total Budget (CAD $)[a]
25	82.86	9,698,636
50	75.36	17,641,484
100	63.96	29,945,931
300	55.21	77,547,281
600	36.46	102,420,938

[a]: Total budget = cost level * yes percentage * number of household. There were about 1,170,525 residents in the Alberta Capital Region in 2012, which makes approximately 468,210 households in the region, given that the average number of persons in household was 2.5 in the Edmonton metropolitan area based on Census 2011.

4.4 Market costs for conservation

One simple way to implement such conservation strategies is to purchase the agricultural land parcels and put it into some type of conservation reserve programs, such as conservation easements, to permanently conserve the land in agricultural uses (Babcock et al., 1996; Babcock et al., 1997). With the conservation easements in place, the land could then be rented or sold to farmers. Therefore, agricultural land prices that indicate market values can roughly reflect the costs for such conservation strategies. However, agricultural land prices can vary quite differently depending on their location. For example, land closer to urban areas is considered to have higher price due to development pressure and the probability of re-zoning for development. We thus take the advantage of two data sources that demonstrate both rural and urban scenarios for comparison.

We used the Agricultural Real Estate Transfer data from the Government of Alberta (Department of Agriculture and Forestry) as the cost data for the rural setting. A number of details about each agricultural land transfer were provided for that data: the size of the parcel (in acres); the location descriptions including the city or county, as well as the legal land description (i.e., meridian, range, township, section, and quarter section); the transaction year and total transaction value; and the Canada Land Inventory (C.L.I.) Class of the land parcel. We had an initial number of 360 observations from 2012 to 2014 in the Alberta Capital Region. By reviewing all the observations, we deleted 28 duplicates. We also identified 33 land parcels that have been transferred multiple times with different values between 2012 and 2014. We chose the value of the latest year and deleted the previous records. As a result, we had a final list of 299 observations for our analysis. Price per acre was calculated by dividing the transaction value by the land acreage. Though the size of agricultural land parcels might not be exactly a full quarter section (i.e., 160 acres), most of these parcels were within a quarter section with an average of about 137 acres across the sample (Table 3-5). We therefore used the calculated price to approximate the average agricultural land price for a whole quarter section where the listing parcel is located. All the price information was processed at the quarter section level as the unit of analysis, which is the smallest unit according to Alberta Township Survey (ATS). Figure 3-4 depicts the agricultural land transfer price in the Alberta Capital Region from 2012 to 2014.

Table 3-5 Summary of Agricultural Real Estate Transfer Data (2012-2014)

Year	Number of Parcels	Average Acres	Total Acres	Average Price (CAD$ per acre)
2012	98	139.97	13716.78	1873.85
2013	102	136.97	13971.26	2048.24
2014	99	133.07	13173.96	1967.84
Total	299	136.66	40862.00	1964.46

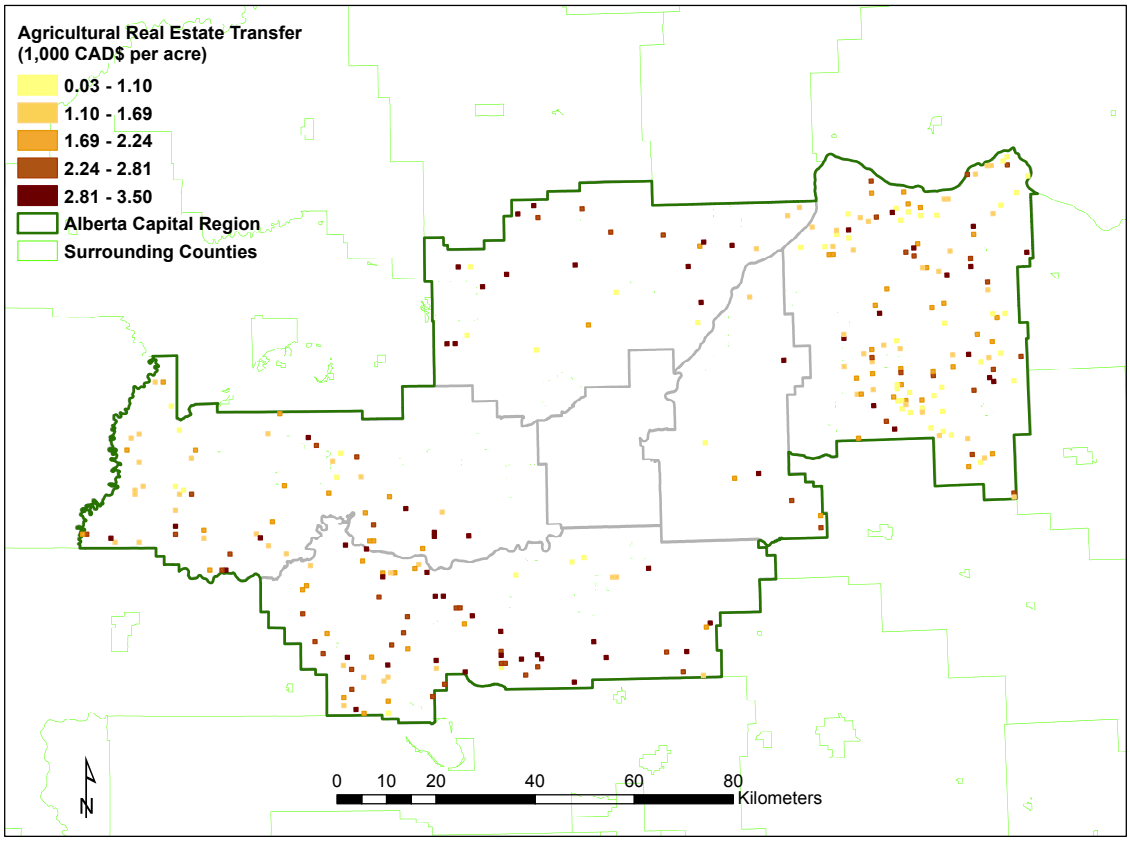


Figure 3-4 Locations of Agricultural Real Estate Transfer Data (2012-2014)

Additionally, we used the agricultural land sales data from Roy Kelly Land to estimate land costs for the urban setting. The following information about agricultural land sales was collected from the Roy Kelley website (accessed June 2015): the size of the parcel (in acres); the location (i.e., longitude and latitude); and the asking price. As a result, we had a list of 37 observations from Roy Kelly Land. The processed the data in the same way that we did for the Agricultural Real Estate Transfer data. Price per acre was calculated by dividing the sales price by the land acreage. Though the size of agricultural land parcels might not be exactly a full quarter section (i.e., 160 acres), most of these parcels were within a quarter section with an average of about 111 acres across the sample (Table 3-6). We thus used the calculated price to approximate the average agricultural land price for the whole quarter section where the parcel for sale is located. Figure 3-5 depicts the agricultural land transfer price in the Alberta Capital Region from 2012 to 2014.

Table 3-6 Summary of Roy Kelly Land Data

Year	Number of Parcels	Average Acres	Total Acres	Average Price (CAD$ per acre)
To date	37	111.05	4108.90	54133.45

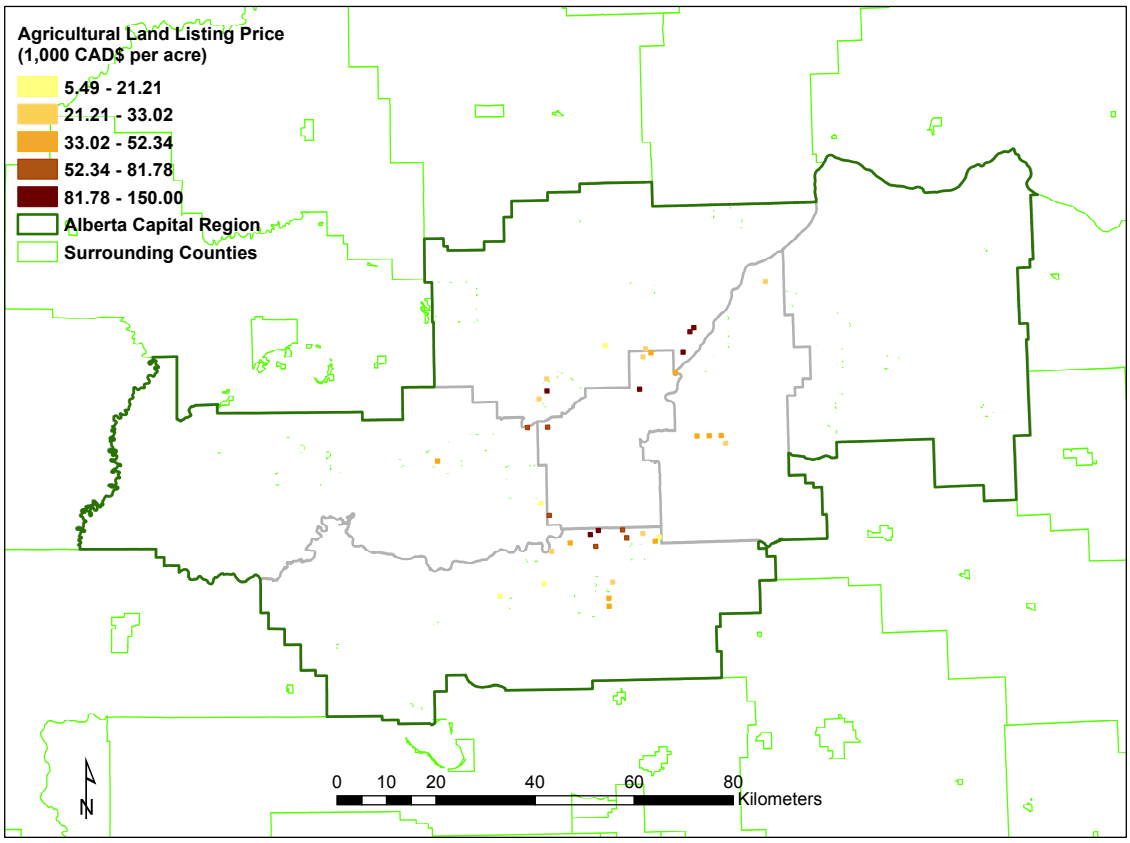


Figure 3-5 Locations of Roy Kelly Land Data

5 Optimization Results and Discussions

We had 11,658 agricultural land parcels from benefits data. While for costs data, we had 299 observations for the rural setting and 37 for the urban setting. By overlapping benefits and costs data, we ended up with a total of 160 agricultural land parcels for the rural scenario and 80 for the urban scenario, for the analysis of optimization. Note that not all units were at the quarter section level, as there could be more than one type of agricultural uses for some quarter sections. That said, the purchase of the agricultural land parcels would not exactly be a quarter section as well. In terms of the type of agricultural use, there were only three types (i.e., hay land, pasture and grain/oilseed) in the optimization results. The costs

data from both sources did not include any observation for commercial vegetable farm.

Four targeting strategies (BT, CT, BCRT, and OPT) were applied to all 80 eligible agricultural land parcels for the urban setting and 160 for the rural setting in the Alberta Capital Region with different budget levels (i.e., $10 million, $18 million, $30 million, $78 million, and $102 million) that were generated from CE survey. As the total cost of all land parcels in Agricultural Real Estate Transfer data is around $20 million. Any budget higher than that can buy out all land parcels, which results in no difference among four targeting tools. Therefore, only two budget levels (i.e., $10 million and $18 million) were applied in the rural setting.

As a result, the budget levels outlined in section 4.3 result in 0 to 64 of the eligible set of 80 agricultural land parcels in the urban setting, and 33 to 155 of the eligible set of 160 in the rural setting, being selected in the study area, depending on different budget levels to be collected. The results are presented numerically in Table 3-7 to Table 3-11 and spatially in Figure 3-6 to Figure 3-10 for the urban setting, and numerically in Table 3-12 to Table 3-13 and spatially in Figure 3-11 to Figure 3-12 for the rural setting.

5.1 Efficiency results

Generally, BT tends to conserve the least number of agricultural land parcels given a certain budget while CT tends to maximize the number of parcels conserved. This outcome is intuitive and in accordance with previous studies (Babcock et al., 1997; Duke et al., 2014). Although BCRT and OPT might not select the highest number of land parcels for conservation, the total net benefits they can generate and the acreage they can conserve outnumber those from BT and CT, especially when it comes to the comparison with BT. For example, the possible net benefits of BT can only account for approximately 30% of benefits obtained from OPT for the urban scenario (except the case that no land parcel is conserved which leads to zero net benefits), depending on different budget levels (Figure 3-13). Although the possible net benefits of BT increase to more than 80% of benefits obtained from OPT in the rural scenario (Figure 3-14), the efficiencies of BT are still the lowest compared to those from other three targeting tools. Being lower than both BCRT and OPT in

general, however, CT presents a higher efficiency as opposed to BT. In the urban setting, CT outperforms about 50% of potential maximum benefits from OPT than BT, except the case that CT is less efficient than BT at the $30 million budget level.

The relative inefficiency of BT and CT (especially for BT) is not surprising, given the selection settings of targeting. Specifically, as BT tends to focus on a few high-benefit parcels (those typically with high-cost), it sacrifices the higher net benefits that could otherwise be gained through the selection of a larger number of slightly lower net benefit parcels that can be acquired at substantially lower cost. One specific example in our study is that no land parcel is conserved at the $10 million budget level when BT is adopted in the urban setting. Another example indicates the inefficiency of BT is that the total net benefits turns to negative at the $18 million budget level in the urban setting, which would not be selected in practice. The cost of the land parcel exceeds the budget, which leads to the case that no land parcel can be selected. The reason that CT underperforms BCRT and OPT, though not significantly in our study for some scenarios, is due to its inability to identify high-benefit parcels, relative to the associated cost. Though the largest amount of land parcels is conserved through CT, much of this land has low conservation benefits as parcels are chosen exclusively based on cost, and the average acreage of land parcel is comparatively small as well. For example, CT even generates lower net benefits than BT at the $30 budget level in the urban setting since the total benefits of conserving parcels is much lower.

In addition, results from BCRT are almost identical to those from OPT in terms of the number of parcels, acres, and associated benefits and costs, though OPT slightly outperforms BCRT. The intuition for this outcome is that the sequenced process of BCRT directs it to conserve an additional parcel based on the ranking of benefit-cost ratio, relative to OPT. This would possibly tease out some otherwise affordable land parcels when the acquisition costs are discrete and relatively high, especially when the budget is comparatively small. While OPT is flexible enough to forego the final few affordable parcels on the margin of BCRT, and is able to identify the optimal set of parcels when the expenditure nears the budget constraint. However, our study shows that OPT only obtains quite a small portion (e.g., less than 2% as

shown in Figure 3-13 and Figure 3-14) of extra net benefits relative to BCRT in both urban and rural settings, since our approach to identifying plots for OPT is essentially the same as BCRT method. This finding was also indicated by Duke et al. (2014). One noteworthy point in our study is the identical results from BCRT and OPT at the budget level of $102 million in the urban scenario. The highest budget in our study can buy out the majority of all land parcels available. This finding somewhat indicates that as the conserved land parcels get close to the upper bound, BCRT and OPT approaches tend to obtain identical results.

The spatial pattern of parcel selection also varies across different targeting methods (Figure 3-6 to Figure 3-12). In general, all four targeting approaches rarely select the same set of agricultural land parcels. For instance, CT tends to include quite a number of parcels that would not be selected by any of BT, BCRT, or OPT, most of which are at low costs. An example for this is the selection of the only land parcel for hay land in our study. It emerges when the budget level reaches $18 million in the urban setting when CT is adopted, while no other targeting tools tend to select that land parcel until the budget level reaches $78 million. Similar to the near-identical selection results, the pattern of BCRT and OPT is quite alike in terms of the spatial distribution, especially when the budget constraint increases. Additionally, BCRT and OPT matches CT more closely than BT. Besides the differences in total net benefits, the spatial distribution of selected land parcels also vary across the targeting tools. These differing spatial patterns may arouse relevant implications for future policy guides as well.

Table 3-7 Comparison of Selection Results with a Budget of $10 Million (Urban)

	Benefit Targeting (BT)	Cost Targeting (CT)	Benefit-Cost Ratio Targeting (BCRT)	Optimization (OPT)
Parcels Conserved	0	34	7	11
Pasture	0	20	2	5
Grain/Oilseed	0	14	5	6
Acres Conserved	0	259	501	502
Pasture	0	111	161	162
Grain/Oilseed	0	148	340	440
Total Benefits ($)	0	16,831,804	46,039,316	46,136,932
Total Cost ($)	0	8,674,682	9,948,282	9,998,028
Total Net Benefits (NB) ($)[a]	0	8,157,122	36,091,034	36,138,904
Benefit-Cost Ratio[b]	N/A[d]	1.94	4.63	4.61
% of Possible NB[c]	0	22.57%	99.87%	100%

[a]: Total Net Benefits (NB) = Total Benefits – Total Cost.
[b]: Benefit-Cost Ratio = Total Benefits/Total Cost.
[c]: % of Possible NB = NB/the largest NB of four targeting tools.
[d]: N/A means not applicable in this case since no land parcel could be purchased at the $10 million budget level for BT.

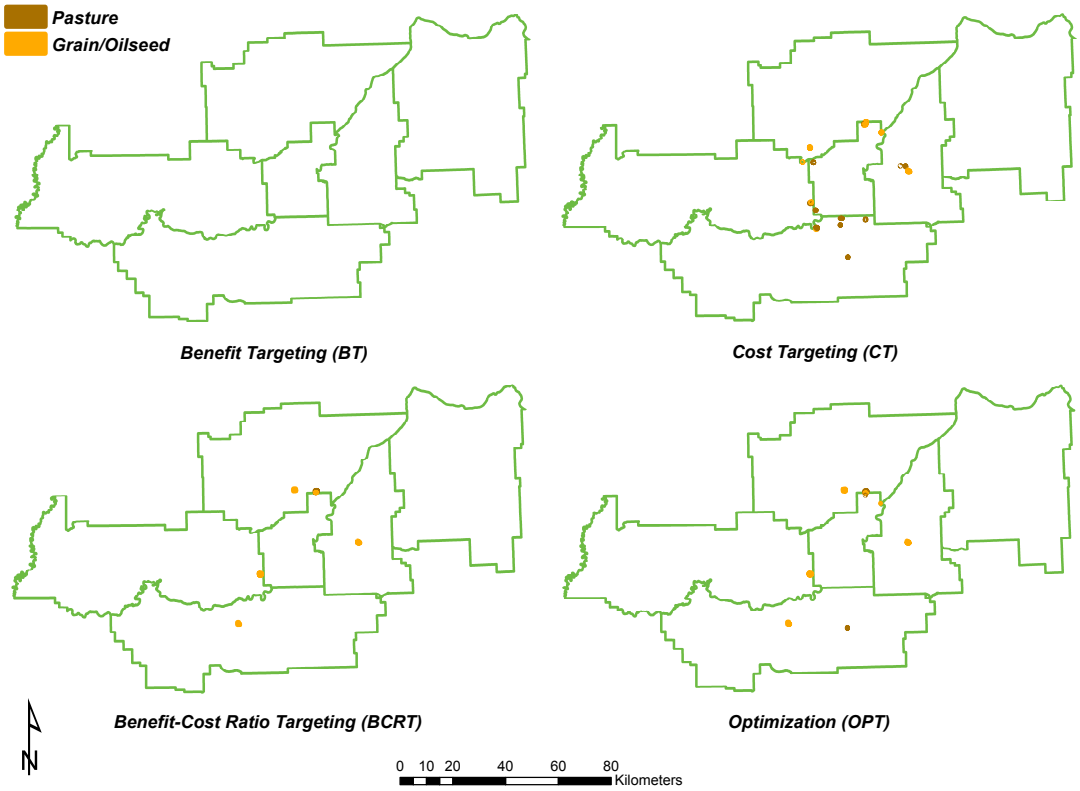


Figure 3-6 Comparison of Selection Results with a Budget of $10 Million (Urban)

Table 3-8 Comparison of Selection Results with a Budget of $18 Million (Urban)

	Benefit Targeting (BT)	Cost Targeting (CT)	Benefit-Cost Ratio Targeting (BCRT)	Optimization (OPT)
Parcels Conserved	1	38	12	19
Pasture	0	20	4	8
Grain/Oilseed	1	17	8	11
Hay Land	0	1	0	0
Acres Conserved	160	507	819	856
Pasture	0	111	174	184
Grain/Oilseed	160	352	645	672
Hay Land	0	44	0	0
Total Benefits ($)	13,813,307	36,083,508	68,420,420	70,711,531
Total Cost ($)	16,985,563	16,199,783	16,675,714	17,999,592
Total Net Benefits (NB) ($)	-3,172,256[a]	19,883,725	51,744,706	52,711,939
Benefit-Cost Ratio	0.81	2.23	4.10	3.93
% of Possible NB	-6.02%	37.72%	98.17%	100%

[a]: Negative Total Net Benefits indicate that BT would not be selected in practice.

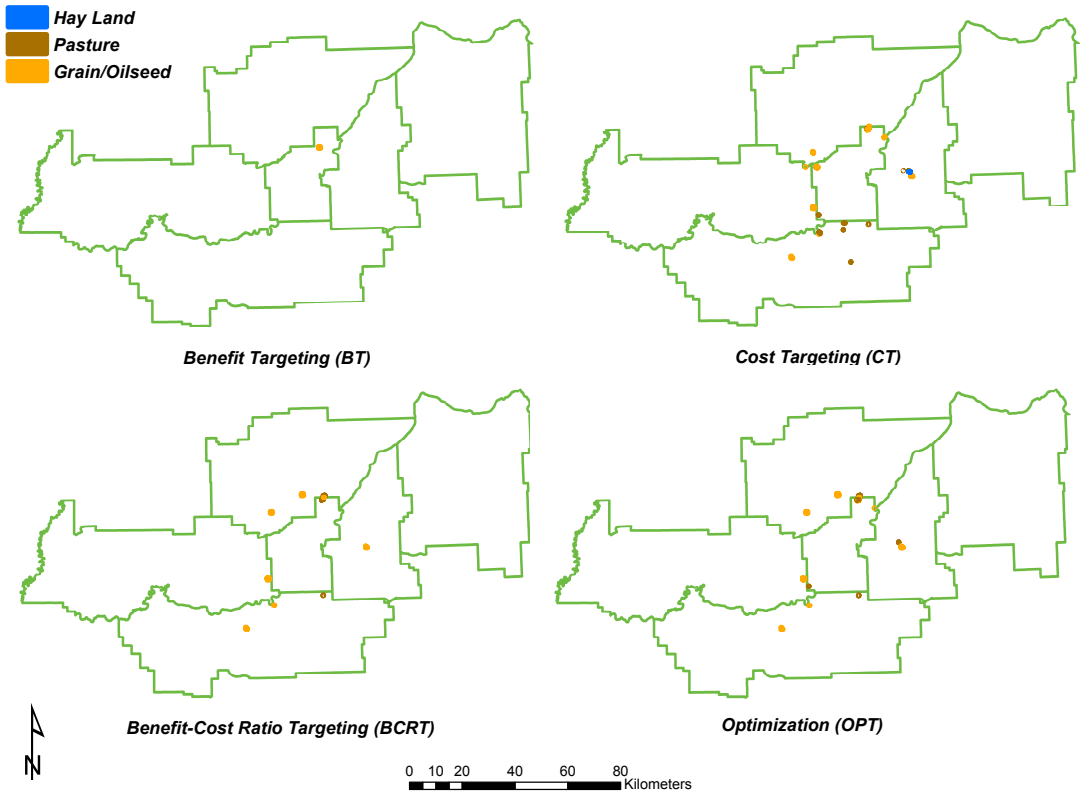


Figure 3-7 Comparison of Selection Results with a Budget of $18 Million (Urban)

Table 3-9 Comparison of Selection Results with a Budget of $30 Million (Urban)

	Benefit Targeting (BT)	Cost Targeting (CT)	Benefit-Cost Ratio Targeting (BCRT)	Optimization (OPT)
Parcels Conserved	4	44	21	32
Pasture	0	20	10	17
Grain/Oilseed	4	23	11	15
Hay Land	0	1	0	0
Acres Conserved	605	657	1,203	1,240
Pasture	0	111	355	364
Grain/Oilseed	605	502	848	876
Hay Land	0	44	0	0
Total Benefits ($)	52,356,614	45,278,469	100,136,034	102,398,345
Total Cost ($)	28,651,658	29,429,692	28,560,655	29,995,905
Total Net Benefits (NB) ($)	23,704,956	15,848,777	71,575,379	72,402,440
Benefit-Cost Ratio	1.83	1.54	3.51	3.41
% of Possible NB	32.74%	21.89%	98.86%	100%

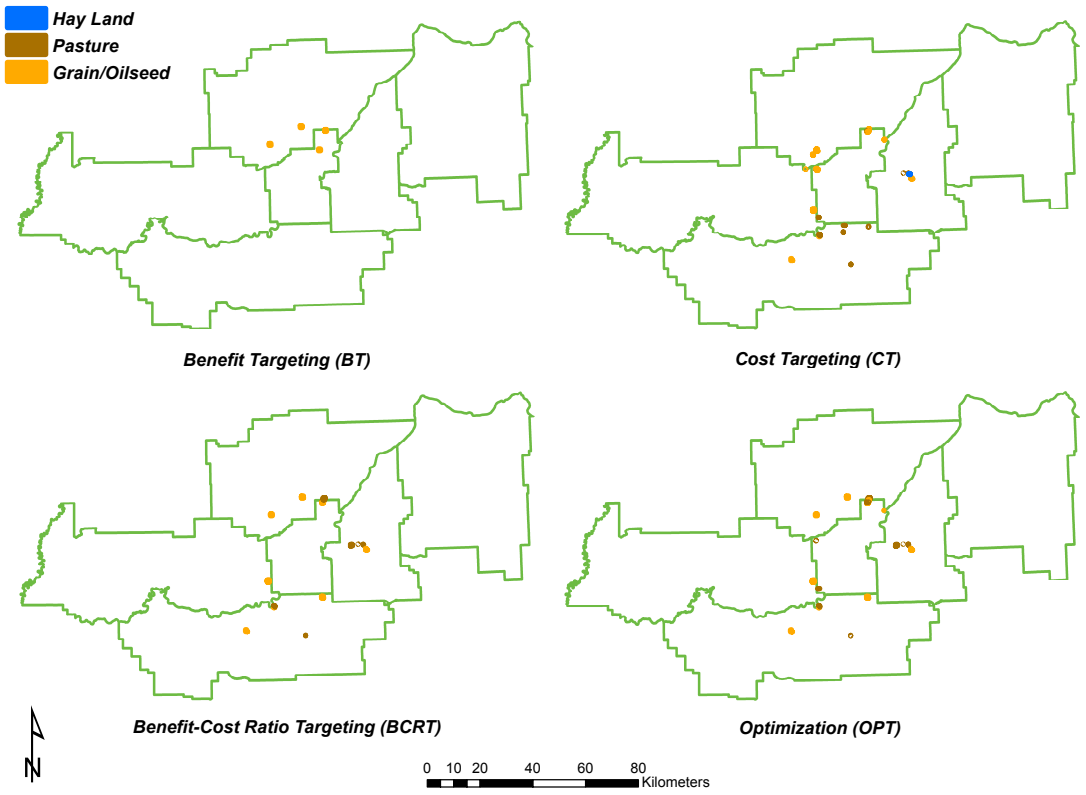


Figure 3-8 Comparison of Selection Results with a Budget of $30 Million (Urban)

Table 3-10 Comparison of Selection Results with a Budget of $78 Million (Urban)

	Benefit Targeting (BT)	Cost Targeting (CT)	Benefit-Cost Ratio Targeting (BCRT)	Optimization (OPT)
Parcels Conserved	9	60	41	41
Pasture	1	23	15	15
Grain/Oilseed	8	36	25	25
Hay Land	0	1	1	1
Acres Conserved	1,246	2,302	2,553	2,554
Pasture	107	384	365	366
Grain/Oilseed	1,139	1,874	2,144	2,144
Hay Land	0	44	44	44
Total Benefits ($)	109,633,356	165,942,669	195,059,101	195,212,695
Total Cost ($)	77,255,944	77,718,010	77,845,368	77,995,878
Total Net Benefits (NB) ($)	32,377,412	88,224,659	117,213,733	117,216,817
Benefit-Cost Ratio	1.42	2.14	2.51	2.50
% of Possible NB	27.62%	75.27%	99.99%	100%

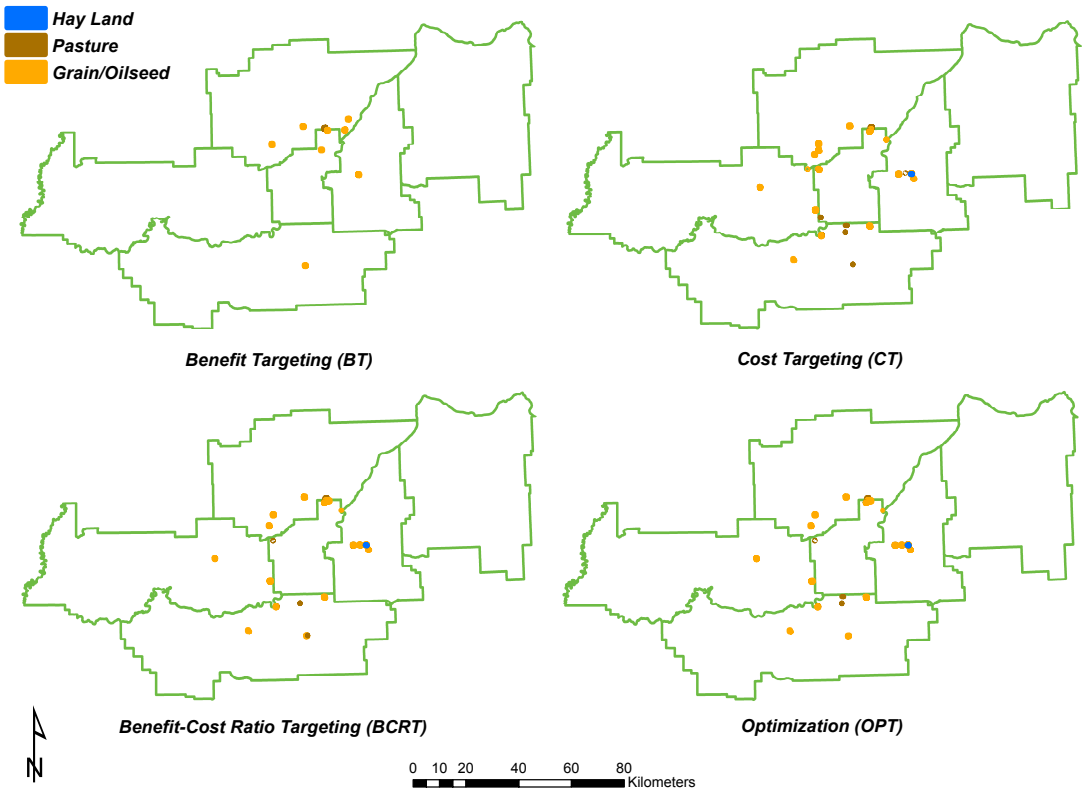


Figure 3-9 Comparison of Selection Results with a Budget of $78 Million (Urban)

Table 3-11 Comparison of Selection Results with a Budget of $102 Million (Urban)

	Benefit Targeting (BT)	Cost Targeting (CT)	Benefit-Cost Ratio Targeting (BCRT)	Optimization (OPT)
Parcels Conserved	11	64	53	53
Pasture	1	23	20	20
Grain/Oilseed	10	40	32	32
Hay Land	0	1	1	1
Acres Conserved	1,483	2,862	2,970	2,970
Pasture	107	384	378	378
Grain/Oilseed	1,376	2,434	2,548	2,548
Hay Land	0	44	44	44
Total Benefits ($)	130,148,165	200,817,163	221,613,563	221,613,563
Total Cost ($)	94,283,958	99,287,766	98,209,096	98,209,096
Total Net Benefits (NB) ($)	35,864,207	101,529,397	123,404,467	123,404,467
Benefit-Cost Ratio	1.38	2.02	2.26	2.26
% of Possible NB	29.06%	82.27%	100%	100%

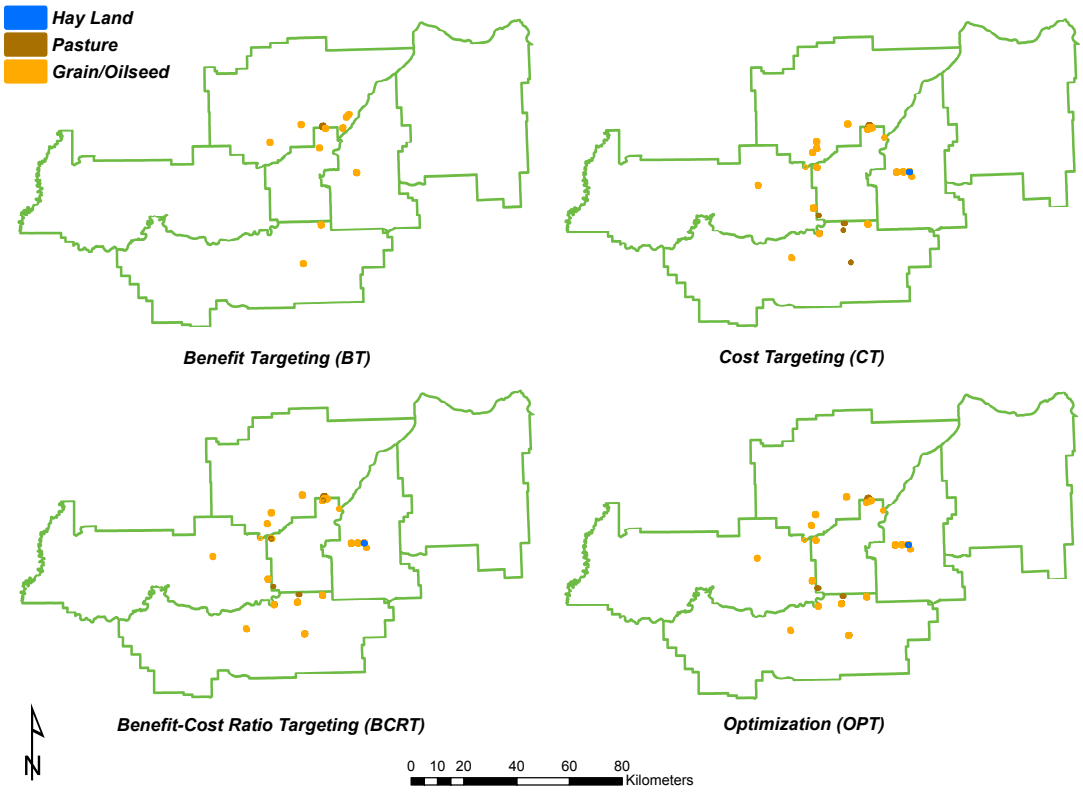


Figure 3-10 Comparison of Selection Results with a Budget of $102 Million (Urban)

Table 3-12 Comparison of Selection Results with a Budget of $10 Million (Rural)

	Benefit Targeting (BT)	Cost Targeting (CT)	Benefit-Cost Ratio Targeting (BCRT)	Optimization (OPT)
Parcels Conserved	33	133	104	113
Pasture	7	67	52	59
Grain/Oilseed	26	66	52	54
Acres Conserved	4,817	6,083	6,264	6,290
Pasture	994	2,732	2,585	2,621
Grain/Oilseed	3,823	3,351	3,679	3,669
Total Benefits ($)	433,641,765	516,947,796	550,219,968	554,316,357
Total Cost ($)	9,878,268	9,977,071	9,874,175	9,999,228
Total Net Benefits (NB) ($)	423,763,497	506,970,725	540,345,793	544,317,129
Benefit-Cost Ratio	43.90	51.81	55.72	55.44
% of Possible NB	77.85%	93.14%	99.27%	100%

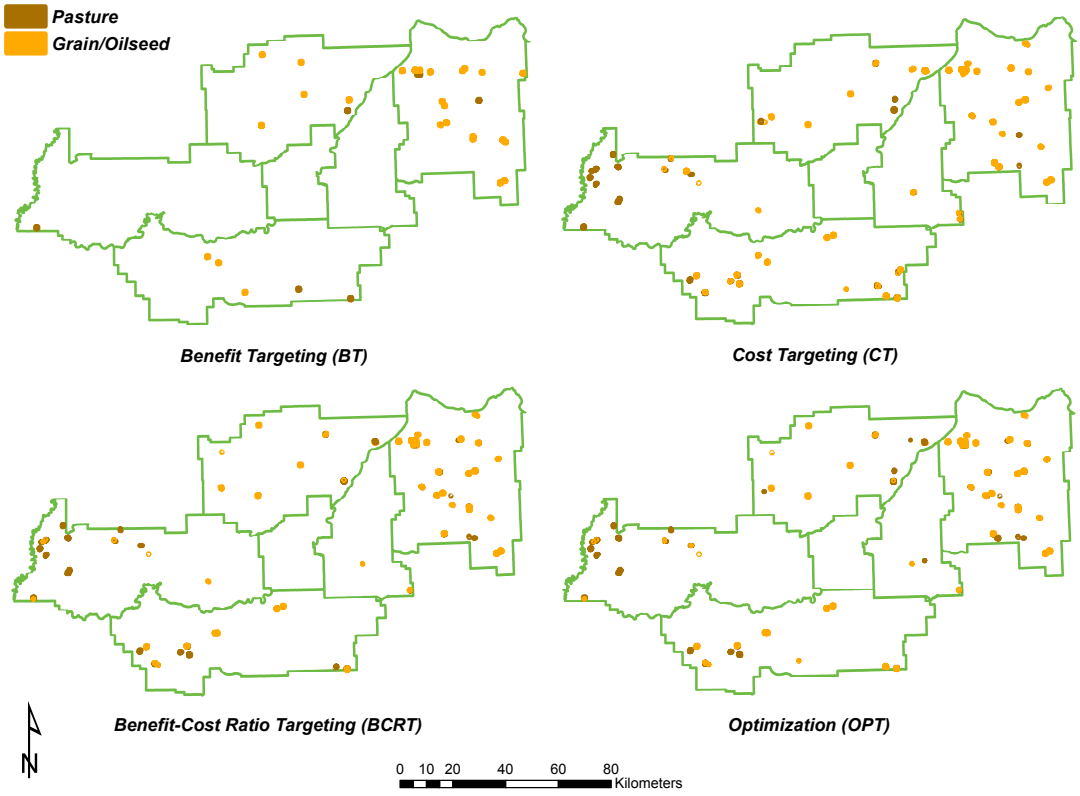


Figure 3-11 Comparison of Selection Results with a Budget of $10 Million (Rural)

Table 3-13 Comparison of Selection Results with a Budget of $18 Million (Rural)

	Benefit Targeting (BT)	Cost Targeting (CT)	Benefit-Cost Ratio Targeting (BCRT)	Optimization (OPT)
Parcels Conserved	77	155	149	151
Pasture	30	71	68	70
Grain/Oilseed	47	84	81	81
Acres Conserved	8,526	9,070	9,021	9,035
Pasture	2,658	3,268	3,211	3,213
Grain/Oilseed	5,868	5,802	5,810	5,822
Total Benefits ($)	725,182,682	771,566,291	784,955,832	785,694,593
Total Cost ($)	17,951,625	17,955,367	17,937,616	17,992,498
Total Net Benefits (NB) ($)	707,231,057	753,610,924	767,018,216	767,702,095
Benefit-Cost Ratio	40.40	42.97	43.76	43.67
% of Possible NB	92.12%	98.16%	99.91%	100%

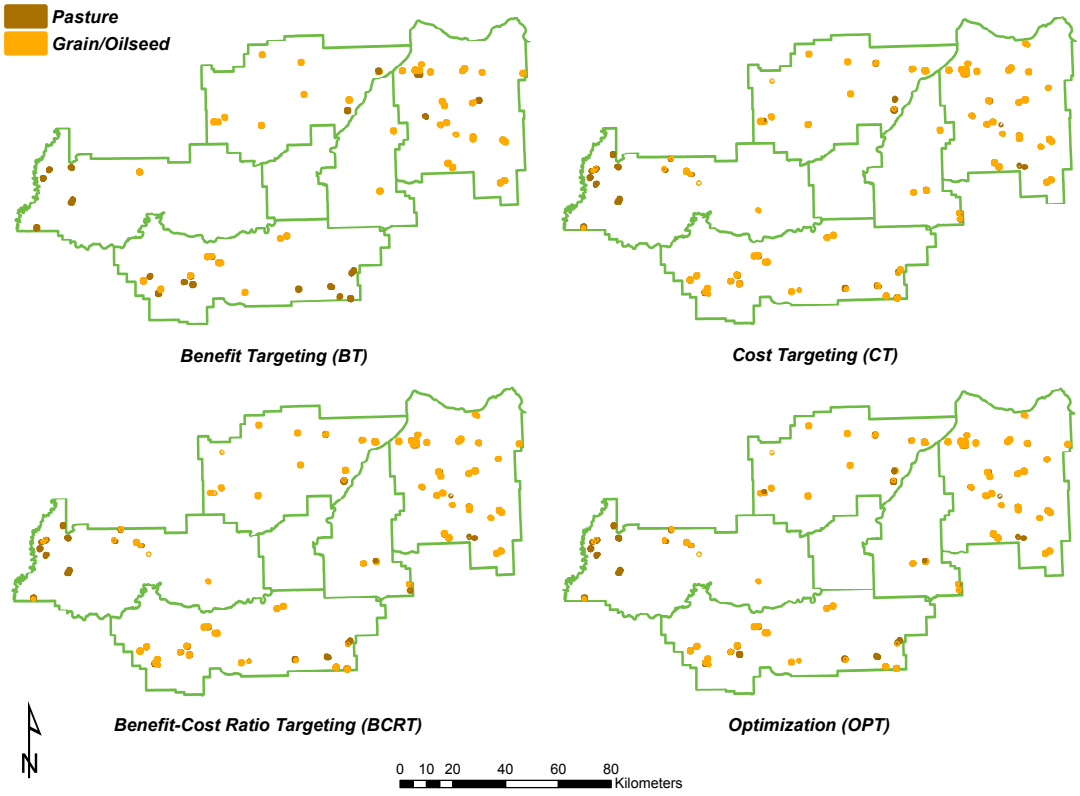


Figure 3-12 Comparison of Selection Results with a Budget of $18 Million (Rural)

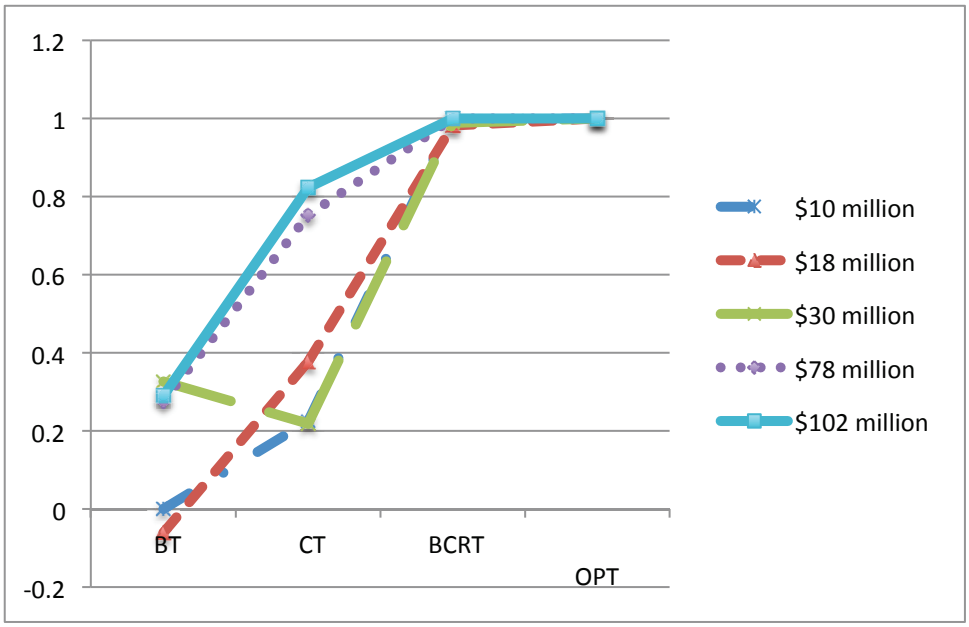


Figure 3-13 Comparison of Targeting Efficiencies at Different Budget Levels (Urban)

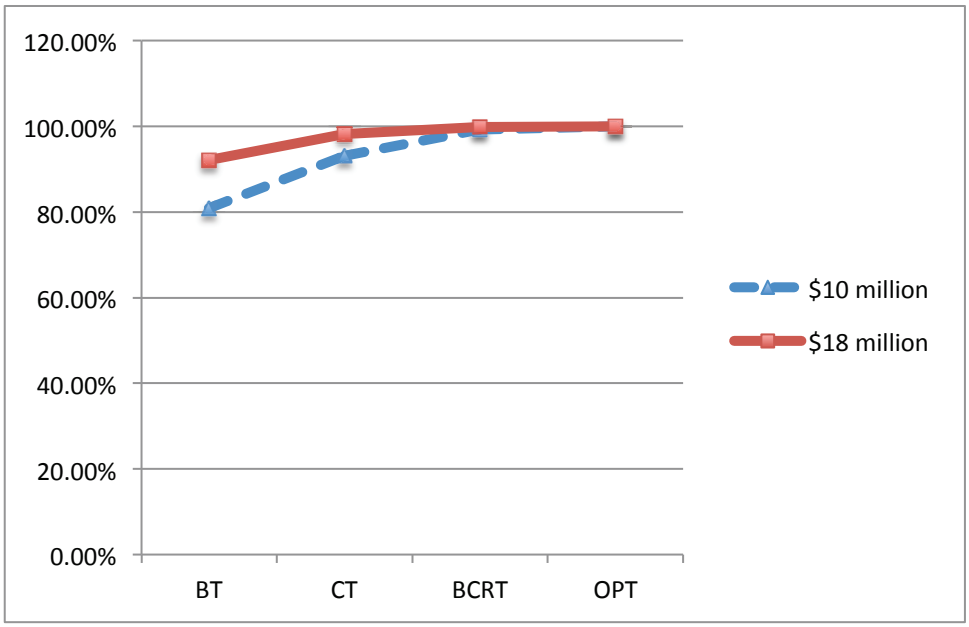


Figure 3-14 Comparison of Targeting Efficiencies at Different Budget Levels (Rural)

5.2 Implications

There are several implications of these results. First, by combining nonmarket benefits and market costs data in a realistic setting, a government or conservation agency can learn that the use of BCRT and OPT is able to produce substantially higher net benefits than BT and slightly greater net values than CT. This further indicates that conservation efforts that merely focus on benefits or costs might be ineffective from a policy perspective. This finding

shows that BT and CT methods might have significant opportunity costs for the implementation of agricultural land conservation programs. These not-always-observed costs are far from negligible. The sacrificed net benefits could be as high as 72.38% (under BT) and 78.11% (under CT) of the maximum possible net benefits under OPT. In some cases, the adoption of BT even turns to negative net benefits (i.e., at the $18 million budget level in the urban setting). Therefore, the administration of BT and CT approaches should be re-considered in terms of the conservation benefits that might be lost through non-optimal selection.

Second, based on the results that BCRT and OPT generate almost-identical results in terms of the number of land parcels, acres and associated benefits and costs, OPT might not always be the first option in making the real policy decisions. As agencies and government entities can achieve quite similar net conservation benefits and sometimes even identical results, using the much simpler BCRT method is superior given the mathematical complexity of OPT. Despite the reasonable advocacy of BCRT as an "optimal" targeting tool, such setting might be inappropriate in situations where a relatively small budget constraint and large discreet acquisition costs are involved. Under such circumstances, the adoption of OPT might outperform BCRT by a greater margin (Duke et al., 2014).

In addition, the magnitude of the benefits that can be generated by agricultural land conservation programs that could be financed through an increase in property tax or rent for residents of the Alberta Capital Region is quite different to the application of urban and rural settings. Generally, the benefit-cost ratios generated from the rural scenario are much higher than those from the urban setting. For instance, a benefit-cost ratio of 40.4 can be generated for the $18 million investment using BT in rural land, compared to a ratio of less than 1 for the same investment using BT to urban land. This finding implies that conserving agricultural land in rural regions might be more socially warranted for the same amount of investment than implementing such conservation programs near urban areas, though agricultural land within city limits is under more pressure from being developed. The result could also shed some light on policies that aim to optimize land use allocations for the local

government, especially in the case of collaboration among municipalities.

Lastly, some implications can also be drawn from the mix of agricultural land uses and how the mix changes with the different budget levels and targeting approaches. For example in the urban area, CT emphasizes the selection of hay land, BT prioritizes grain/oilseed, and BCRT and OPT tend to produce a mixture of all types of agricultural use available. While in the rural scenario, grain/oilseed is generally prioritized over pasture for all four targeting tools. A further note is the highest WTP for vegetable production among all types of agricultural use that is generated from CE study. However, we did not find any examples of vegetable land being sold during this period in both data sets.

5.3 Study Limitations

Despite contributions to the current literature, however, there are several limitations in this article that might be addressed in the future study.

First, although using market sales or transfer data as costs represents a more realistic setting for the implementation of agricultural land conservation programs, there exist caveats in the current data sets we used for this study. One of the key limitations relates to the reliability of the agricultural land transfer data, which seems to be quite low. In addition, the Roy Kelly Land data might not include all agricultural land for sale around major cities in the study area. A more comprehensive data set would therefore be desired to conduct a more complete study in the future.

Second, we implicitly assume that the program would purchase land at either a market price indicated by a commercial real estate agency or at a transfer price listed on a government database. The market price would not consider the motivations that land owners in the area may want to sell and/or conserve land in agriculture. The transfer price may not reflect full market values if it is done between family members. An extended study regarding the motivation of agricultural land conservation from the landowner's perspective may also be required. Another aspect to consider is the increased price of land when a government

entity purchases the program for agricultural land conservation.

Third, we implicitly assumed zero costs for placing a conservation easement on agricultural land, but currently there is no simple or low cost way to implement agricultural conservation easements. To better create a simulated market for such conservation programs, other costs associated with the implementation might also have to be taken into account, which include management costs, transaction costs, damage costs and opportunity costs as suggested in Naidoo et al. (2006).

6 Conclusions

This study aims to empirically investigate the optimization of use of financial resources for agricultural land conservation, comparing the performance and efficiency of four alternative targeting tools that have been widely used for various conservation programs. Both nonmarket benefits and market costs are incorporated to conduct cost-benefit analysis in the Alberta Capital Region in Canada. We take the advantage of a rigorously-designed choice experiment to estimate the conservation benefits instead of simplified benefit indices (e.g., number of endangered species conserved). Additionally, two sources cost data (i.e., sales price and transfer price) of agricultural land are utilized as conservation costs so as to represent a realistic setting to both rural and urban scenarios.

Similar to a prior study conducted by Duke et al. (2014), our results also support that both benefit-cost ratio targeting (BCRT) and branch-and-bound optimization (OPT) outperform benefit targeting (BT) and cost targeting (CT) in terms of the potential net benefits and the efficiency. Though theoretically more superior, OPT does not achieve substantially higher net benefits given that the implementation of BCRT approach is relatively simpler. The possible net benefits under BT is significantly lower as opposed to either BCRT or OPT, which indicates that government entities or conservation agencies might suffer from serious ineffectiveness if they solely focus on conservation benefits when considering conservation programs. Regarding the spatial pattern of selected parcels under different targeting tools, BCRT and OPT matches CT more closely than BT, though CT tends to include a few land

parcels that would not be selected by any of others.

A comparison between urban and rural settings also nicely reflects the differences with multiple budget levels and targeting tools. In general, conserving agricultural land in rural regions can generate more net benefits than implementing such conservation programs near urban areas, with the same amount of investment. While in the urban setting, a more mix of agricultural land uses can be demonstrated through the adoption of different targeting approaches.

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Chapter V - Conclusions

This thesis aims to examine the agricultural land conservation in the Alberta Capital Region, Canada. Choice experiments that explicitly incorporate spatial information are adopted to conduct nonmarket valuation, in terms of the willingness to pay (WTP), for agricultural land conservation. In order to provide plenty of background for the implementation of the survey instrument, quantitative analyses of land use and land cover changes from 2000 to 2012 in the region are conducted, and relevant government policies as well as land management tools are reviewed. A further utilization of the nonmarket valuation results is to optimize use of financial resources for agricultural land conservation, together with the costs data (i.e., sales price and transfer price) of agricultural land on real market. The following sections summarize the major findings of each chapter, discuss policy implications, and provide possible research extensions.

1 Policy Implications

Results from Chapter II indicate that agricultural land conversion in the Alberta Capital Region is increasing mainly due to urban development and sprawl over the past decade. From 2000 to 2012, about 94,517 acres of agricultural land was developed, which represents a 4.3% loss of the agricultural land base in the region. This number was much higher than the provincial level of 0.8%, and the agricultural land conversion mainly took the form of suburban development in the periphery of the cities. As Thompson (2013) points out, there are many hidden costs that need to be considered when suburban areas sprawl. For example, sprawling suburban development requires the maintenance, repair and renewal of the infrastructure such as fire and police stations, pipes and roads, and recreation facilities. Less quantifiable costs when residents move to suburbs include long commutes and increased emissions. Policymakers wishing to contain agricultural land conversion may have to consider possible infill development so as to more efficiently use existing land allocation.

Chapter III provides both descriptive and empirical results from the choice experiment survey. Descriptive statistics and responses indicate residents' strong concern of the

agricultural land loss in the study area as well as their highly inclination to conserve land in agricultural uses. Non-parametric analysis also supports the proposed conservation strategies that aim to conserve specific areas of land in specific agricultural uses in a general sense, relative to the status quo that no such programs are to be implemented. The parametric analysis further shows that commercial vegetable farm is the most preferred type of agricultural use, and meanwhile respondents give priority to land adjacent to primary highways and land within 10-km buffer from currently developed land. Aggregate welfare measures are calculated based on the WTP estimates for each conservation strategy and household number in the Alberta Capital Region. Results show that residents in the study area are willing to pay, approximately $20,000-$129,000 per acre for the next year only, for land in a specific agricultural use and in a specific area. Given that the municipalities and provincial government have already expressed great concerns to conserve agricultural land through the establishment of several programs and policies, the results from this chapter can provide empirical support for future policymaking. In addition, choice experiment results indicate that residents are more interested in conserving agricultural land outside city boundaries. This may imply that they see annexation as a clear precursor to development. Plus the outcomes from Latent Class model, residents' behavior somewhat conforms to the NIMBY (Not In My Back Yard) concept that they generally advocate some proposal (e.g., tax increase to improve some programs) but oppose to implement it in a way that would require sacrifice on their part. This finding has further implications for policy makers in the Alberta Capital Region. The importance of farmland conservation should be given, while there may actually be more interest in coordination across jurisdictions to implement agricultural land conservation programs, as well as more interest in effective use of public funds to actualize such programs.

Chapter IV uses a combination of nonmarket benefits and market costs data to optimize use of financial resources for agricultural land conservation. The performance and efficiency of four targeting tools that have been widely used for various conservation programs are compared. Results support that both benefit-cost ratio targeting (BCRT) and branch-and-bound optimization (OPT) outperform benefit targeting (BT) and cost targeting

(CT) in terms of the potential net benefits, benefit-cost ratio, and the efficiency. Though theoretically more superior, OPT does not achieve substantially higher net benefits given that the implementation of BCRT approach is relatively simple. This implies that policy makers wishing to maximize the potential net benefits while minimize the complexity of the program implementation may want to consider BCRT rather than OPT. The possible net benefits under BT is significantly lower as opposed to either BCRT or OPT, which indicates that government entities or conservation agencies might suffer from serious ineffectiveness if they solely focus on conservation benefits when considering conservation programs. Also, a comparison between urban and rural settings nicely reflects the differences regarding the implementation of conservation programs. First, conserving agricultural land in rural regions can generate more net benefits than implementing such conservation programs near urban areas, with the same amount of investment. Second, the range of benefit-cost ratio (more than 40) of the rural setting is much higher than that of the urban scenario (less than 5) depending on different budget levels. These findings again imply that coordination across jurisdictions in the Alberta Capital Region to actualize agricultural land conservation programs would be advocated.

2 Future Research

One potential shortcoming in this research is the concern of the representativeness of the survey sample. Although the sample distribution, in terms of the demographic and socio-economic characteristics, is quite consistent across two experiments, plus that the proportion of residents in the City of Edmonton to the Alberta Capital Region (which makes up more than 70%) is close to the statistics reported in Capital Region Board (2009), we were unfortunately unable to get any response from the Lamont County. The lack of small portion of the population in the study area[13] may lead to a potential bias in the WTP estimation.

Another potential limitation of this study is the inherent complexity in the choice experiment valuation questions. Fully understanding the background information so as to make

[13] According to the 2011 Census, Lamont County had a population of 3,872, which comprised 0.33% of the total population in the Alberta Capital Region.

informed decisions about different conservation scenarios is challenging for respondents. In addition, as can be observed from the focus groups, some participants (especially landowners) felt uncomfortable with choice questions and the vote mechanism that decide the conservation of land in agricultural uses. Efforts were made through the focus groups and pre-tests to ensure that respondents would understand the valuation questions and that they feel free to ask any questions or express any concerns. However, there still exists some possibility that some respondents did not understand the choice experiment questions and thus were unable to make informed decisions.

Due to the limitations in market sales data as costs for the implementation of agricultural land conservation programs, there could have some improvements for this study. First, the reliability of the agricultural land transfer data needs to be further verified as the prices seem to be rather low. Second, besides the pure purchase price of the agricultural land to be conserved, other costs associated with the implementation of conservation programs shall also be taken into consideration such as management costs, transaction costs, damage costs and opportunity costs.

Future research can be explored based on the results from this study, and there are at least four facets to conduct such extension. First, it is needed to know how much value the landowners place on conserving their land in agricultural uses in the Alberta Capital Region, in terms of the willingness to accept as compensation. An investigation of such study can be combined with the empirical results from this study to further test the supply-demand mechanism of agricultural land conservation. Second, other alternative tools other than conservation easements can be potentially assessed as approaches to encouraging agricultural land conservation. The Agricultural Land Reserve (ALR) program in British Columbia could be an approach for future policy in the Alberta Capital Region. As Eagle et al. (2014) suggested, zoning by itself is insufficient to protect farmland, and other policies need to be implemented in conjunction with zoning for agricultural land preservation. Furthermore, the intensives and motivations, including both extrinsic and intrinsic motivations (de Snoo et al., 2013; Kits et al., 2014), that are associated with alternative

instruments could also be explored to evaluate behavioral responses. Third, displacement effects of purchasing land for agricultural conservation programs could be further explored. This can take into account the risk of agricultural land to be developed in the future. Given the context of study area, agricultural land in counties near the City of Edmonton (e.g., Leduc and Sturgeon County) are more likely to be converted to developed uses than those in Lamont County. An examination of displacement effects of implementing agricultural land conservation programs would shed some light on the optimal use of public finances. Last but not the least, the links between nonmarket benefits of agricultural land conservation and their affinity with different ecosystem goods and services have been investigated in this study. However, monetary values with respect to specific ecosystem goods and services could be explored in more details.

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Appendix A: Expert Focus Group List

Date	Name	Affiliation
July 22, 2014	Bill Bocock	Land Owner
	Candace Vanin	Agricultural and Agri-Food Canada
	Feng Qiu	University of Alberta
	Jason Cathcart	Alberta Agriculture and Rural Development
	John Bocock	Land Owner
	Kevin Jones	University of Alberta
	Scott Jeffrey	University of Alberta
July 28, 2014	Lisa Larson	The City of Edmonton
	Rachel Bocock	Alberta Urban Municipalities Association
	Stacey O'Malley	Alberta Land Institute
	Tasha Blumenthal	Alberta Association of Municipal Districts & Counties
September 16, 2014	Allan Bolstad	Edmonton Federation of Community Leagues
	Hani Quan	The City of Edmonton
	Jim Visser	Farmer
	Mary Beckie	University of Alberta
	Melisa Zapisocky	Alberta Agriculture and Rural Development
	Robert Summers	University of Alberta

Appendix B: Public Focus Group Recruit Screener

Int1
Hello, my name is _____ and I'm calling from Advanis, a professional public opinion research company, on behalf of the Department of Resource Economics and Environmental Sociology at the University of Alberta. Today we're calling a random sample of Edmonton residents to invite them to attend a discussion group at the University of Alberta, sponsored by the Alberta Land Institute, to discuss values associated with agricultural uses of land in Edmonton and surrounding areas.

The discussion group will be about 90 minutes in length and those who participate will receive a $50 honorarium to cover costs like childcare, transportation and parking.

May I speak to a person living in your household who is 18 or older and is a Canadian citizen. Would that be you?

(IF RESPONDENT HAS QUESTIONS SAY: If you have any questions you may contact the Research Ethics Office at the University of Alberta at 780-492-2615.

IF ASKED: The group will be held on Wednesday October 22, 2014 from 6:30 p.m. to 8:00 p.m.

- ❑ Yes
- ❑ No, not a Canadian citizen / not over 18 years of age
- ❑ No, do not live in Edmonton
- ❑ Call back
- ❑ Refused

CB1 *Show If int1_callback*
Arrange a call back.

Ref1 *Show If int1_refusal Refusal.*

T1 *Show If int1_not_in_Edmonton*
Unfortunately we are looking for people who live in Edmonton. Thank you for your time. We hope you would consider participating in other surveys in the future. Goodbye.

Page Show If int1_not_Canadian_or_18

Int2
May I please speak to a person in the household who is a Canadian citizen over the age of 18?

- ❑ *Yes, getting person*
- ❑ *No, no one in household qualifies*
- ❑ *Call back*

- ❑ *Refusal*

CB2 *Show If int2_callback*
Arrange a call back.

Ref2 *Show If int2_refusal*
Refusal.

T2 *Show If int2_no_one_qualifies*
Unfortunately we are looking for people who are Canadian and over 18 years of age. Thank you for your time. We hope you would consider participating in other surveys in the future. Good bye.

Int3
Hello, my name is _____ and I'm calling from Advanis, a professional public opinion research company, on behalf of the Department of Resource Economics and Environmental Sociology at the University of Alberta. Today we're calling a random sample of Edmonton residents to invite them to attend a discussion group at the University of Alberta, sponsored by the Alberta Land Institute, to discuss values associated with agricultural uses of land in Edmonton and surrounding areas.

The discussion group will be about 90 minutes in length and those who participate will receive a $50 honorarium to cover costs like childcare, transportation and parking.

(IF RESPONDENT HAS QUESTIONS SAY: If you have any questions you may contact the Research Ethics Office at the University of Alberta at 780-492-2615.

IF ASKED: The group will be held on Wednesday October 22, 2014 from 6:30 p.m. to 8:00 p.m.

Int4
Would you be interested in attending a group like this?
(IF ASKED: The group will be held on Wednesday October 22, 2014 from 6:30 p.m. to 8:00 p.m.)

- ❑ *Yes*
- ❑ *No*

T3 *Show If int4_not_interested*
Thank you for your time. Good bye.

Pretext
Now I'd like to ask you just a couple of questions to see if you qualify for this particular group.

Before we begin I'd like to inform you that this call may be recorded for quality assurance.

Q1
What age category are you in?
(READ LIST)

- ❑ 18 to 24
- ❑ 25 to 34
- ❑ 35 to 49
- ❑ 50 to 64
- ❑ 65 or over
- ❑ Don't know
- ❑ Refused

Q2
In total, how many years have you lived in the Edmonton area?
(READ LIST)

- ❑ Less than 1 year
- ❑ 1 to 2 years
- ❑ 3 to 5 years
- ❑ 6 to 10 years
- ❑ 11 to 20 years
- ❑ 21 years or more
- ❑ [DO NOT READ] Do not live in the Edmonton area
- ❑ Don't know
- ❑ Refused

T4 *Show If q2_not_live_in_Edmonton*
Unfortunately we are looking for people who live in Edmonton. Thank you for your time. We hope you would consider participating in other surveys in the future. Goodbye.

Q3
RECORD GENDER - DO NOT READ

- ❑ *Male*
- ❑ *Female*

T5age *Show If quota_block_age*
Unfortunately we already have enough responses from people like yourself and we are looking for a different profile. Thank you for your time. We hope you would consider participating in other surveys in the future. Good bye.

T5gender *Show If quota_block_gender*
Unfortunately we already have enough responses from people like yourself and we are looking for a different profile. Thank you for your time. We hope you would consider

participating in other surveys in the future. Good bye.

R1
There will be a group held with Edmonton residents to discuss values associated with agricultural uses of land in Edmonton and surrounding areas on Wednesday October 22, 2014 from 6:30 p.m. to 8:00 p.m.

Would you be interested in attending this group?
((Select one.))

- ❑ *Yes*
- ❑ *No*
- ❑ *Don't know*
- ❑ *Refused*

T6 *Show If r1_not_interested*
Thank you for your time. Good bye.

X1
Thank you for agreeing to participate in this discussion group. The group will be approximately about 90 minutes in length and participants will be paid $50 to attend.

We will be sending you out a confirmation letter, but due to the short time lines we'd like to give you some information over the phone. Do you have a pen and paper handy?

The group will be held in Conference Room 550, General Services Building (GSB), North Campus, University of Alberta.

Please arrive 10 to 15 minutes early if you can and bring photo ID. Light refreshments will be served.

If for any reason you are unable to attend the group please call Sue Day at 866-820-5163 and mention project 3358 to let us know. It is very important to us that as many people as possible attend the group.

Please bring your reading glasses to the group if you need them. We will be calling you the night before to confirm your attendance.

For the purposes of mailing out this information, could I please have your name and email address?
Name: _____
Email address: _____

Send
PAGE DOWN TO SEND AUTOMATIC EMAIL.

AltPh

Is there an alternate (cell phone or work) number that we can reach you at in case we need to reach you the day of the groups for any reason?

(PLEASE ENTER PHONE NUMBER AS 222-333-4444 FORMAT)

_____
_____
_____
_____
_____

- ❑ No alternate number provided

End

Thank you for your time. We look forward to seeing you at the group.

Appendix C: Confirmation Letter

Thank you for choosing to participate in our discussion group Your input is very valuable to us. Below is some information pertaining to the day of the discussion group. Your discussion date and time is:

Wednesday October 22nd, 2014 at 6:30 pm

You will receive a $50 cash compensation for your time and attendance at the discussion group.

Substitutes are not allowed so please remember to bring a driver's license or other form of identification with your photograph and your name. We would like to begin and finish on time so that people can get on with their evening, so please arrive up to 10 minutes before the start time. Latecomers will not be able to take part in the session and will not be eligible for the incentive. Please avoid bringing children to the session as we will need your full attention.

Please see the next page for directions to the discussion group on the University of Alberta (North Campus).

If you have any questions about the study, please contact Haoluan from the Department of Resource Economics and Environmental Sociology at 587-938-0604.

If you cannot make it to the discussion group, please contact Sue Day at 866-820-5163 so that we can find a replacement.

Location and directions are outlined below.

Again, thank you for your participation and we will see you on Wednesday, October 22nd!

UNIVERSITY OF ALBERTA
DEPARTMENT OF RESOURCE ECONOMICS
AND ENVIRONMENTAL SOCIOLOGY

The discussion group will be held in **Conference room 550 in the General Services Building (GSB)** which is boxed in **red**.

Arriving by Car

The closest parking is available in Stadium car park located just south of GSB. It is the building boxed in **purple**. Charge for parking will be $5.00 (GST inclusive). Please pay the parking fees yourself first and do not forget to bring the receipt with you. After participation in the discussion group, we will reimburse the parking fees and take your receipt.

Directions: From Stadium car park, exit north and enter into the white and brown building straight ahead. The doors are located right by the loading docks. There will be signs to guide you once inside. Proceed through another set of doors to the north of the building where the elevators are located. The room is on the 5th floor, Conference Room 550.

Arriving by Bus

The closest bus stop and route to the GSB building is marked out in **green**.

Directions: From the bus stop, proceed around the Students Union Building into the Agriculture-Forestry Center. There will be signs to guide you once inside. Please proceed through the building onto the pedway to GSB. Turn right, then your next left to the elevators. The room is on the 5th floor, Conference Room 550.

Arriving by LRT

The route to meet up with the bus directions are in **pink**.

Get off at the University station and proceed to street level from any exit. Proceed west until you reach the Students Union Building. Please follow the bus directions from this point.

Appendix D: Information Sheet

UNIVERSITY OF ALBERTA

Resource Economics and Environmental Sociology
Faculty of Agricultural, Life and Environmental Sciences
Brent Swallow, Department Chair and Professor
515A General Services Building http://www.rees.ualberta.ca Tel: 780.492.6656
Edmonton, Alberta, Canada T6G 2H1 brent.swallow@ualberta.ca Fax: 780.492.0268

INFORMATION SHEET

Title of Study: Assessing the Multiple Values of Alternative Land Uses in Edmonton and the Capital Region

Investigators:

Brent Swallow, Professor and Chair,
515A General Services Building
Tel: (780) 492-6656
brent.swallow@ualberta.ca

Scott Jeffrey, Professor
531 General Services Building
Tel: (780) 492-5470
scott.jeffrey@ualberta.ca

Background:

You have been asked to participate in a research study involving the valuation of alternative land uses in the City of Edmonton and the wider Capital Region. We will be developing a formalized survey, and ask for your input with questions, concerns, or ideas that arise from discussion topics.

About 10 participants are being recruited for each of two focus groups in the City of Edmonton. You have been selected based on your residence in this region.

Purpose:

The purpose of this project is to collect feedback on the public's view of alternative land uses. The information collected in this sub-project, through this focus group and the resulting survey, will be used to develop a deeper understanding of the multiple values associated with alternative uses of land in different parts of the Capital Region. This research aims to identify farmland areas that are particularly valuable to the public interest and the potential for different policy options to maintain those lands in agriculture. Data collected will be used for academic reports, papers and graduate theses.

Study Procedures:
The focus groups will be held in classrooms at the University of Alberta's North Campus and Enterprise Square. It will be a 90-minute session comprising of a 20-30 minute PowerPoint

presentation and a 30-50 minute discussion.

Benefits:

To compensate for your time and any other expenses incurred as the result of participation, a payment of $50 will be issued. You will collect this payment at the end of the session.

Risks:

There are no foreseeable risks involved with participation in this focus group beyond those encountered in everyday life.

Confidentiality:

You will be administered an identification number when you attend the focus group which will be associated with your discussion input. Your name will not be used in any publications; any comments or notes taken will be anonymous. Your name will appear on the consent form, payment receipt, and master list linking participant names with de-identified data. These documents will be kept locked in a cabinet in a locked room. At the University of Alberta, we keep data stored for 5 years after the end of the study.

Because of the nature of the focus group, others will be hearing your ideas. Confidentiality from others cannot be guaranteed, but we ask that all participants keep the conversations from the workshop confidential, and not identify specific individuals and the workshop discussions outside the session.

Voluntary Participation:

Participation in this focus group is by choice.

Freedom to Withdraw:

You are free to leave the focus group at any time, even if you have agreed to participate, and the information you provide will not be used in analysis.

Additional Contacts:

If you have concerns about this study, you may contact the Research Ethics Office, at (780) 492-2615. This office has no direct involvement with this project.

Appendix E: Consent Form

UNIVERSITY OF ALBERTA

Resource Economics and Environmental Sociology
Faculty of Agricultural, Life and Environmental Sciences
Brent Swallow, Department Chair and Professor
515A General Services Building http://www.rees.ualberta.ca Tel: 780.492.6656
Edmonton, Alberta, Canada T6G 2H1 brent.swallow@ualberta.ca Fax: 780.492.0268

CONSENT FORM

Title of Study: Assessing the Multiple Values of Alternative Land Uses in Edmonton and the Capital Region

Investigators:

Brent Swallow, Professor and Chair,
515A General Services Building
Tel: (780) 492-6656
brent.swallow@ualberta.ca

Scott Jeffrey, Professor
531 General Services Building
Tel: (780) 492-5470
scott.jeffrey@ualberta.ca

Why am I being asked to take part in this research study?

The market research firm Advanis has selected you to participate in this study based on your residence in Edmonton. You are being asked to participate in this study so that we can gather public opinions on land use in the city and wider Capital Region.

Before you make a decision one of the researchers will go over this form with you. You are encouraged to ask questions if you feel anything needs to be made clearer. You will be given a copy of this form for your records.

What is the reason for doing the study?

This research is being done so we can better understand how the public values different aspects of alternative land uses. The reactions and preferences expressed by you and other members of the focus group today will be applied to the development of a questionnaire for future use.

What will I be asked to do?

We will be asking questions and initiating discussions on various topics regarding land use. This focus group will run once for 90 minutes. We will begin with a brief presentation on patterns of agricultural land fragmentation and conversion in the capital region (20-30 minutes), and proceed with a discussion for 30-50 minutes. As we are interested in your opinions and experiences, we ask for your participation in this discussion.

What are the risks and discomforts?
There are no known risks beyond those you encounter in everyday life.

What are the benefits to me?
The only direct benefit you will receive is the cash payment of $50 to compensate you for your time and any other costs to participation. Indirect benefits might arise if governments in Edmonton or elsewhere in the region change policies or regulatory practices on the basis of this research.

Do I have to take part in the study?
Participation in this study is by choice. If you decide to be in the study, you can change your mind and stop being in the study at any time, and it will not affect the payment you receive for participating.

Can my participation in the study end early?
If, for any reason, you decide you no longer wish to participate in the focus group, you may leave at any time. This will not affect the payment you receive for participating.

Will I be paid to be in the research?
We are offering a payment of $50 for your participation. You can collect you payment following the session.

Will my information be kept private?
During this focus group we will be collecting information from the discussions that take place. You will be assigned an identification number to be referenced in analysis, and publications will include only summarized group findings. Your name will appear on the consent form, payment receipt, and master list linking participant names with de-identified data. These documents will be kept locked in a cabinet in a locked room. Because of the nature of the focus group, others will be hearing your ideas. Confidentiality from others cannot be guaranteed, but we ask that all participants keep the conversations from the workshop confidential, and not identify specific individuals and the workshop discussions outside the session. At the University of Alberta, we keep data stored for 5 years after the end of the study.

What if I have questions?
If you have any questions about the research now or later, please contact one of the principal investigators**:**
Brent Swallow: (780) 492-6656
Scott Jeffrey: (780) 492-5470

If you have any questions regarding your rights as a research participant, you may contact Charmaine Kabatoff of the Research Ethics Board 1 at (780) 492-0302. This office has no affiliation with the study investigators.

Appendix F: Consent Form Checklist

UNIVERSITY OF ALBERTA

Resource Economics and Environmental Sociology
Faculty of Agricultural, Life and Environmental Sciences
Brent Swallow, Department Chair and Professor
515A General Services Building http://www.rees.ualberta.ca Tel: 780.492.6656
Edmonton, Alberta, Canada T6G 2H1 brent.swallow@ualberta.ca Fax: 780.492.0268

CONSENT FORM CHECKLIST

Title of Study: Assessing the Multiple Values of Alternative Land Uses in Edmonton and the Capital Region

Investigators:

Brent Swallow, Professor and Chair,
515A General Services Building
Tel: (780) 492-6656
brent.swallow@ualberta.ca

Scott Jeffrey, Professor
531 General Services Building
Tel: (780) 492-5470
scott.jeffrey@ualberta.ca

	Yes	No
Do you understand that you have been asked to be in a research study?	☐	☐
Have you read and received a copy of the attached Information Sheet?	☐	☐
Do you understand the benefits and risks involved in taking part in this research study?	☐	☐
Have you had an opportunity to ask questions and discuss this study?	☐	☐
Do you understand that you are free to leave the study at any time, without having to give a reason and without affecting any payments you receive for participating?	☐	☐
Has the issue of confidentiality been explained to you?	☐	☐
Do you understand that audio-recording will be used?	☐	☐
Do you understand who will have access to what you say or write?	☐	☐

Who explained this study to you? _____

I agree to take part in this study:

Signature of Research Participant _____

(Printed Name) _____ Date _____

Signature of Investigator or Designee _____ Date _____

THE INFORMATION SHEET MUST BE ATTACHED TO THIS CONSENT FORM AND A COPY GIVEN TO THE RESEARCH PARTICIPANT

Appendix G: Email Invitation

Dear XXX (potential participant),

Based on your Qualtrics profile as a panelist, you are invited to earn Merchant Points for participating in a research survey. If you qualify and complete the survey:

Full reward amount: Merchant Points

Full survey length: approximately 20 minutes

To complete the survey and earn Merchant Points, simply click the link below, or copy the URL into your browser:

http://<%website%>/pro.do?FT=<%uniqueid%
(a real link for the online survey will be provided)

Important: This survey is NOT available through the Mobile App and may or may not be compatible in the Web browsers of smartphones or other mobile devices; so please use your desktop or laptop computer to complete this survey.

We encourage you to respond quickly -- this invitation will be available only until a predetermined number of responses have been received. Please Note: you will only receive Merchant Points for taking the survey once.

Sincerely,
The Qualtrics Team

Appendix H: Ngene Choice Design Syntax

Syntax:

```
Design
;alts = alt1, alt2
;rows = 32
;block = 4
;eff = (mnl,d)
;model:
U(alt1) = b2 * A[0,1] + b3 * B[0,1] + b4 * C[0,1] + b5 * D[0,1] + b6 * E[0,1] + b7 *
F[200,500,1000,2000] + b8 * G[25,50,100,300,600]        /
U(alt2) = b1
;reject:
alt1.A + alt1.B + alt1.C > 1
$
```

Note:

A: Grain/Oilseed Farming
B: Hay Land
C: Commercial Vegetable Farm
(Default: Livestock Grazing on Native Pasture)

D: Adjacent to Primary Highway
(Default: Adjacent to Conservation Buffer)

E: Within City Limits
(Default: Within 10-km Buffer from Currently Developed Land)

F: Acres conserved
G: Cost

Appendix I: The Survey Instrument

A Survey about

Conservation for Land in Agricultural Uses

in the City of Edmonton and Surrounding Areas

UNIVERSITY OF ALBERTA
DEPARTMENT OF RESOURCE ECONOMICS
AND ENVIRONMENTAL SOCIOLOGY

Alberta Land Institute

PARTICIPANT CONSENT FORM

Title of Study: Assessing the Multiple Values of Alternative Land Uses in Edmonton and the Capital Region

Principal Investigators:

Brent Swallow , Professor
567 General Services Building
Tel: (780) 492-6656
brent.swallow@ualberta.ca

Scott Jeffrey, Professor
531 General Services Building
Tel: (780) 492-5470
scott.jeffrey@ualberta.ca

Why am I being asked to take part in this research study?

The market research firm Qualtrics has selected you to participate in this study based on your residence in the City of Edmonton or the Alberta Capital Region, and your status as a panelist. You are being asked to participate in this study so that we can gather public opinions on land use in the city and surrounding areas.

What is the purpose for doing the study?

The purpose of this project is to collect feedback on the views of Edmonton area residents regarding conservation for land in agricultural uses. This research aims to identify agricultural uses that are particularly valuable to the public interest and the potential for using different policy options to conserve lands in agriculture. This study is funded by the *Alberta Land Institute*, which is an independent, non-partisan research institute based at the University of Alberta.

Please note that this study is not focusing on the market value of land, but on the non-market values that are associated with different agricultural uses.

The answers and preferences expressed by you and other respondents will be analyzed. Data and results will be used for academic reports, papers and graduate theses.

What will I be asked to do?

We will be asking questions on various topics regarding land use. This internet-based survey should take approximately 20 minutes.

What are the risks and discomforts?

There are no known risks beyond those you encounter in everyday life.

What are the benefits to me?

As a panelist, you will receive Merchant Points in your account as the compensation for your time and any other costs to participation. Indirect benefits might arise if governments in Edmonton or elsewhere in the region change policies or regulatory practices on the basis of this research.

Do I have to take part in the study?

Participation in this study is voluntary. If you decide not to complete the survey, you can change your mind and stop at any time.

Will I be paid to be in the research?

There will not be direct payment for your participation. You will be compensated by your panel company once you have completed the survey.

Will my information be kept private?

Your name and contact information will not be collected and your individual responses will not be shared with anyone. Your comments and ideas will not be related back to you in any way. Once submitted, data cannot be withdrawn. All data uses will be in compliance with the University of Alberta Standards. Results will not in any way be associated with personal information. At the University of Alberta, we keep data stored for 5 years after the end of the study.

What if I have questions?

The plan for this study has been reviewed for its adherence to ethical guidelines by a Research Ethics Board at the University of Alberta.

For questions regarding participant rights and ethical conduct of research, contact the Research Ethics Office at (780) 492-2615.

If you have any questions about the research now or later, please contact one of the principal investigators**:**

Brent Swallow: (780) 492-6656 Scott Jeffrey: (780) 492-5470

Consent

If you consent to participating in the experiment, please click on the ">>" symbol to start the survey.

Section A	To begin with the survey, we ask a few questions about food and land use around Edmonton

➔ ***Question 1***

Where do you get the food that you consume at home?

(PLEASE CHECK ALL THAT APPLY)

- ❑ Chain Grocery Store
- ❑ Specialty Grocery Store
- ❑ Convenience Store
- ❑ Farmers' Market
- ❑ Personal or Community Garden
- ❑ Directly from a Farm (e.g., U-pick Farm)
- ❑ Donation or Gift
- ❑ Other (Please Specify) _____

➔ ***Question 2***

In your opinion, how important are the following aspects of food produced in the City of Edmonton and surrounding areas?

		Not At All Important	Unimportant	Neither Unimportant Nor Important	Important	Very Important
1	There should be enough food to supply the local market	O	O	O	O	O
2	The food should be of good quality	O	O	O	O	O
3	Consumers should be able to access local food all the year around	O	O	O	O	O
4	The price of local food should be no higher than imported food	O	O	O	O	O
5	Consumers should know where the food is produced	O	O	O	O	O

➔ ***Question 3***

One aspect of our study is to understand how people feel about land in agricultural uses around Edmonton. Please indicate what you think of the following statements by clicking the button that best describes your level of agreement or disagreement.

		Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree
1	It is important to maintain land in agricultural uses for future generations	O	O	O	O	O
2	The primary function of land in agricultural uses is to produce food	O	O	O	O	O
3	Land in agricultural uses can be improved through human management	O	O	O	O	O
4	Land in agricultural uses acts as a natural water filter	O	O	O	O	O
5	Land in agricultural uses conserves diversity of natural systems	O	O	O	O	O
6	The economic benefits from land in agricultural uses outweigh the benefits that other land uses provide	O	O	O	O	O
7	Land in agricultural uses provides social benefits such as recreational opportunities	O	O	O	O	O
8	It is desirable to live near land in agricultural uses	O	O	O	O	O

Section B	The next set of questions is concerned with the Alberta Capital Region as a planning unit

➔ ***Question 4***

Before this survey, have you ever heard of the Alberta Capital Region?

- ❑ Yes
- ❑ No

We provide some background information about the Alberta Capital Region for your reference.

- ❑ Yes, I would like to see it
- ❑ No, I would like to skip it

[Participants who click "Yes" will be presented the following information. Participants who click "No" will move on to the next section]

The Alberta Capital Region, also commonly referred to as the Edmonton Capital Region, is a conglomeration of municipalities centred on Alberta's provincial capital of Edmonton (Figure 1). It covers 11,993 square kilometers, and accounts for 1.9% of Alberta's landmass and for 31.8% of Alberta's population.

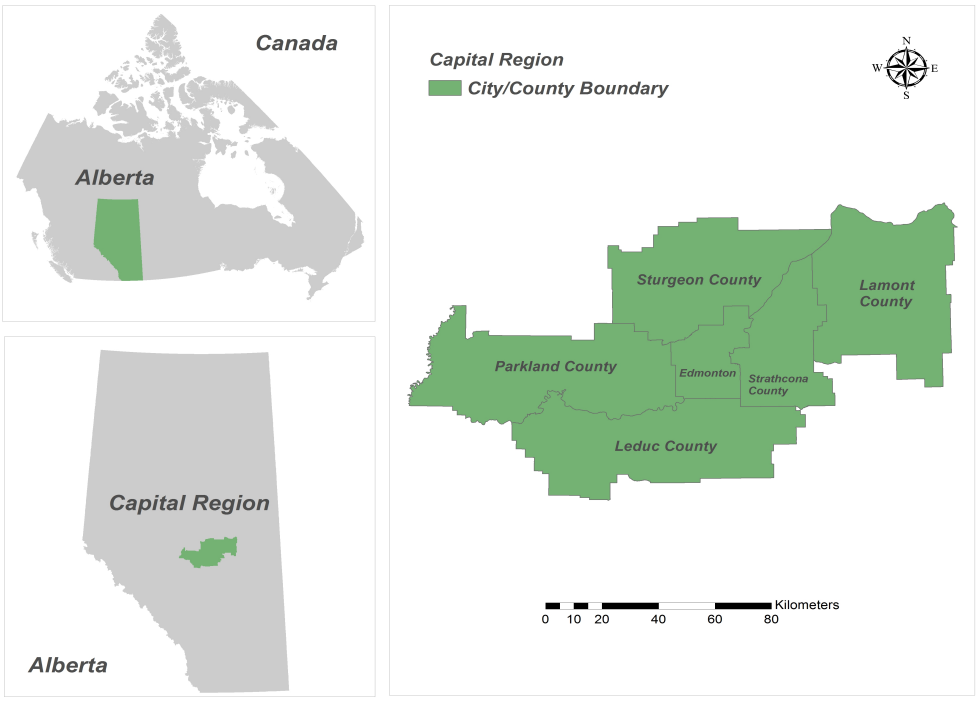


Figure 1 Alberta Capital Region Reference Map

There are 24 municipalities in the region as follows:

- 5 cities: Edmonton, Fort Saskatchewan, Leduc, Spruce Grove, St. Albert
- 5 counties: Lamont, Leduc, Parkland, Strathcona, and Sturgeon
- 11 towns: Beaumont, Bon Accord, Bruderheim, Calmar, Devon, Gibbons, Lamont, Legal, Morinville, Redwater, and Stony Plain
- 3 villages: Thorsby, Wabamun, and Warburg

Planning across the 24 municipalities is coordinated by the Capital Region Board, which was established by provincial legislation in 2008.

Section C	The next set of questions deals with the values of land in agricultural uses and conversion of land from agriculture to developed land uses in the Capital Region

➔ ***Question 5***

For the Alberta Capital Region, what do you think are the most important values of land in agricultural uses?

Please specify in order of importance (up to three):

_____

_____

_____

We provide some information about land in agricultural uses and associated services for your reference.

- ❑ Yes, I would like to see it
- ❑ No, I would like to skip it

[Participants who click "Yes" will be presented the following information. Participants who click "No" will move on to the next question]

Agricultural land can be used for several extensive (e.g. field crops, pastures for cow-calf operations) and intensive (e.g. confined feeding operations, greenhouse, market gardens, agricultural processing facilities) agricultural uses that produce food for human or animal consumption. Land in agricultural uses can also provide values in terms of green space, aesthetics, community character, lifestyle, air quality, and wildlife habitat.

In general, land in agricultural uses can provide four categories of ecosystem goods and services as follows:

- Provisioning Services, such as food, fresh water and minerals
- Regulating Services, such as water purification, flood control and pollination
- Cultural Services, such as aesthetic, recreation and education
- Supporting Services, such as soil formation and biodiversity conservation

➔ ***Question 6***

Based on your previous knowledge, what do you think is the percentage of agricultural land in the Alberta Capital Region that has been converted to development use in the past decade?

Please specify _____%

We provide some information about agricultural land conversion in the Alberta Capital Region for your reference.

- ❑ Yes, I would like to see it
- ❑ No, I would like to skip it

[Participants who click "Yes" will be presented the following information. Participants who click "No" will move on to the next question]

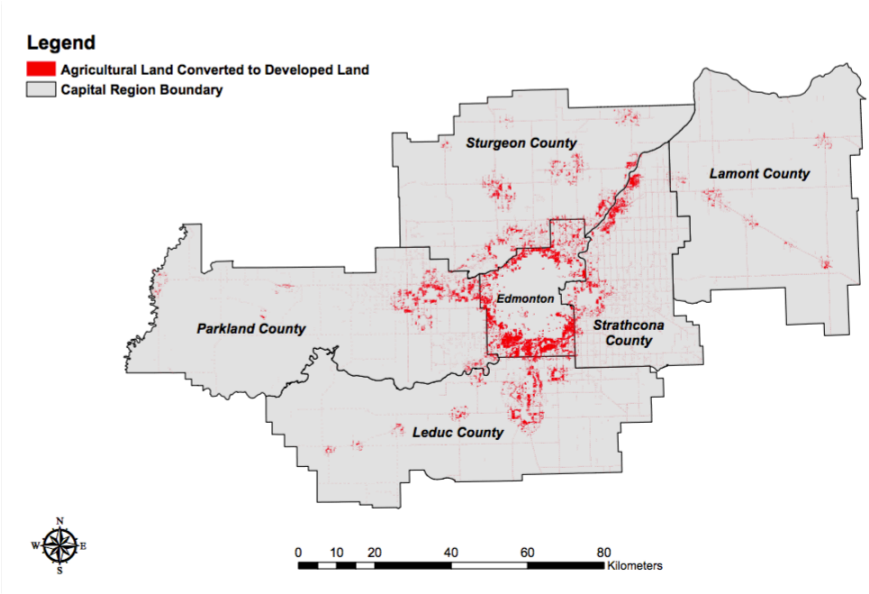


Figure 2 Agricultural Land Conversion in the Alberta Capital Region (2000-2012)

Figure 2 displays the agricultural land conversion in the Alberta Capital Region from 2000 to 2012. In this region, 94,517 acres of agricultural land was developed, which represents a 4.3% loss of agricultural land in the region. The conversion has primarily taken the form of suburban development on the periphery of the cities.

Over this period, about one-tenth as much land was converted from developed uses to agriculture.

Section D	The next set of questions focuses on development planning and conservation of natural area systems in the Alberta Capital Region

➔ ***Question 7***

For the Alberta Capital Region, what do you think are the most important factors influencing development that occurred between 2000 and 2012?

Please specify in order of importance (up to three):

We provide some information about population growth in the City of Edmonton and the Alberta Capital Region for your reference.

- ❑ Yes, I would like to see it
- ❑ No, I would like to skip it

[Participants who click "Yes" will be presented the following information. Participants who click "No" will move on to the next question]

Conversion of land from agricultural uses to developed reflected growth in the population of Edmonton and the Capital Region. Figure 3 shows that the population of the Capital Region increased by about 30% during the 2000-2012 period. It is projected that the population of the region will grow by an additional 12% between 2012 and 2018, and an additional 28% between 2012 and 2028.

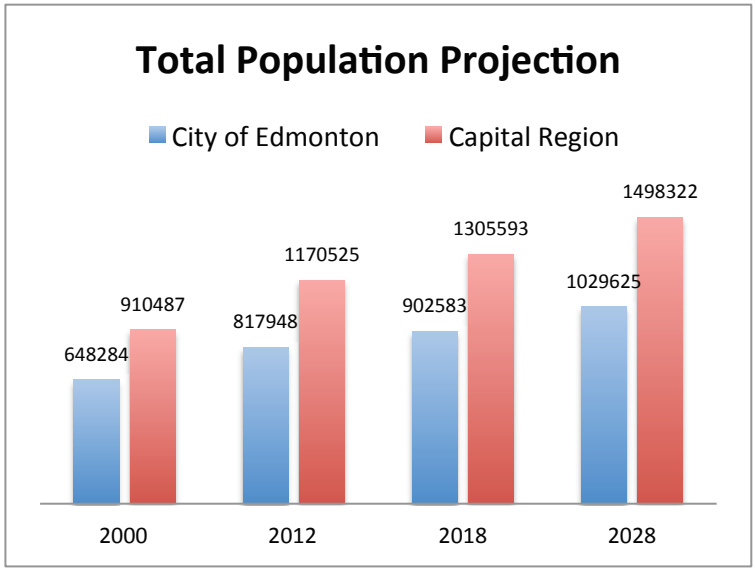


Figure 3 Total Population Projection in Edmonton and the Capital Region (2000-2028)

Planners in the Alberta Capital Region face challenges of balancing growth at the margins of the developed areas, more intensive (infill) development within the existing developed areas, conservation of natural area systems, and conservation of land in agricultural uses.

➔ ***Question 8***

Do you think we have enough of the following land uses in the Capital Region?

		Not Enough	Enough	Too Much	Uncertain
1	Land reserved for agricultural uses	O	O	O	O
2	Land currently set aside for urban growth	O	O	O	O
3	Natural area systems and conservation buffers	O	O	O	O

We provide some information about conservation buffers in the Alberta Capital Region for your reference.

- ❑ Yes, I would like to see it
- ❑ No, I would like to skip it

[Participants who click "Yes" will be presented the following information. Participants who click "No" will move on to the next section]

A conservation buffer is a designation for an agricultural area that needs special protection due to its landscape, wildlife or historical values.

Conservation buffers can add variety to the landscape and foster a healthy environment for communities with fresh water and air. In addition, local biodiversity can be protected.

Figure 4 shows that conservation buffers in the Capital Region are mainly located along the North Saskatchewan River and around some major lakes. There is also a large conservation buffer in the southeast part of Strathcona County.

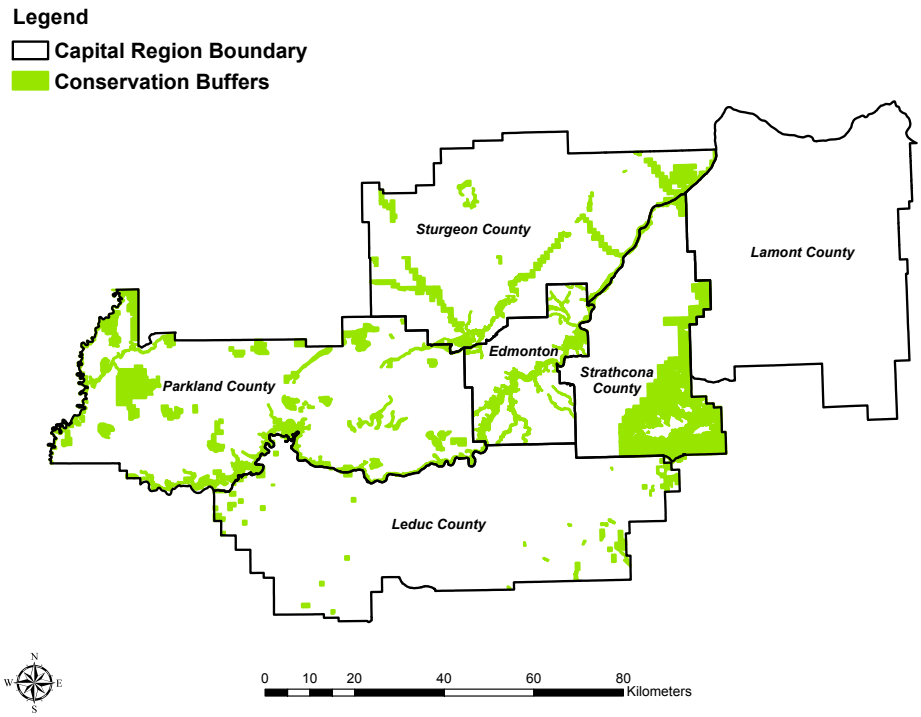


Figure 4 Conservation Buffer Map in the Alberta Capital Region

Section F	The next set of questions focuses on public finances and one possible tool for conserving specific areas of land in agriculture

Planners emphasize that decisions about development and conservation have implications for public finances. Relative to the current situation, conserving specific areas of land for natural area systems or agriculture could involve public costs. On the other hand, the same conservation effect could be achieved through planning that emphasizes infill development over expansion at the margins of existing developed areas. Public costs for infill development may be higher or lower than costs for expansionary development.

➔ ***Question 9***

What type of future urban development do you most favour for the Alberta Capital Region?

- ❑ Continue current trend
- ❑ More intensive (infill) development
- ❑ More expansionary development
- ❑ Other: (Please specify)

  _____

Different tools could be used to conserve specific areas of land for agriculture. One of these tools is a conservation easement. A conservation easement is a legal contract between a qualified private land conservation organization (or government agency) and a private landowner, whereby certain rights or opportunities are granted away by the landowner in order to protect the identified conservation values.

Conservation easements have been legislatively enabled in Alberta since 1996. In 2009, with the proclamation of the Alberta Land Stewardship Act, the Government of Alberta took the step of expanding Alberta's 13-year-old conservation easement provisions to include agriculture. More specifically, it added the purpose of protection, conservation or enhancement of agricultural land. Conservation easements for agriculture have been applied widely in Canada.

Section G	The next set of questions asks you to make choices about conservation strategies for specific areas of land in agricultural uses

We would like your thoughts on the "**tradeoffs**" between conservation for land in agricultural uses and economic costs.

The following questions will ask you to compare different **Conservation Strategies** with the **Status Quo** for land in agricultural uses in the City of Edmonton and surrounding areas. Conservation Easements could be used to maintain land in agricultural uses rather than being converted to other uses.

We are asking you to state whether or not you feel that the proposed strategy, for the cost of money, should be implemented.

These strategies will differ in terms of the following attributes:

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 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

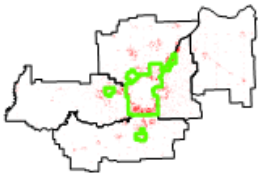
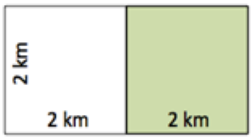
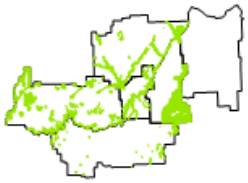
PLEASE NOTE:

We know that how people make a choice in a survey is often not a reliable reflection of how people would actually behave at the polls. In surveys, some people ignore the monetary and other sacrifices they would really have to make if their vote won a majority and became law. Researchers call this phenomenon “hypothetical bias”. In surveys that ask respondents if they would pay more for certain goods/services, research has found that people may say that they would pay as much as 50% more than they actually will in real transactions.

It is of great importance that you “choose” as if this were a real vote. You need to imagine that you actually have to dig into your budget and pay the additional costs associated with the proposed conservation strategies.

Suppose you were asked to consider the following strategies. In each set presented below, imagine that these are the ONLY OPTIONS available for you to choose from. For each set, please choose INDEPENDENTLY from other questions - please do not compare options from different sets.

V1. Suppose you were asked to consider a program that would use conservation easements to conserve specific areas of land in agricultural uses **(Conservation Strategy),** compared to the situation without such a program (**Status Quo)**. The conservation strategy contains the attributes how land would be conserved for agricultural uses, and the resulting cost to you.

	Conservation Strategy	Status Quo
Type of Agricultural Use	Hay Land 	No Public Conservation Strategy for Land in Agricultural Uses
Location Proximity	Within City Limits 	
Acres Conserved	1000 acres (2 km x 2 km) 	
Adjacent Area	Adjacent to Conservation Buffer 	
Property Tax or Rent Increase Next Year Only	$ 50	$ 0

1a. Suppose you have to vote between the proposed **Conservation Strategy** and **Status Quo**. Which one would you vote for?

(PLEASE CHECK ONE RESPONSE ONLY)

- ❑ Conservation Strategy
- ❑ Status Quo

1b. How certain are you that this is the choice you would make in an actual referendum?

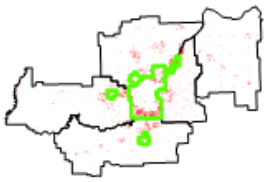
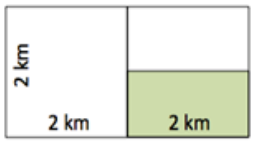
- ❑ Very Certain
- ❑ Somewhat Certain
- ❑ Neither Certain nor Uncertain
- ❑ Somewhat Uncertain
- ❑ Very Uncertain

1c. If you voted for the proposed **Conservation Strategy**, please indicate which aspect(s) you think is important to you with respect to agricultural uses.

(PLEASE CHECK ALL THAT APPLY)

- ❑ Food for Local Market
- ❑ Food for National/Global Market
- ❑ Water Purification
- ❑ Air Quality Regulation
- ❑ Climate Regulation
- ❑ Recreation
- ❑ Scenic Beauty
- ❑ I did not vote for the proposed Conservation Strategy

V2. Suppose you were asked to consider a program that would use conservation easements to conserve specific areas of land in agricultural uses **(Conservation Strategy),** compared to the situation without such a program (**Status Quo)**. The conservation strategy contains the attributes how land would be conserved for agricultural uses, and the resulting cost to you.

	Conservation Strategy	Status Quo
Type of Agricultural Use	Grain/Oilseed Farming 	No Public Conservation Strategy for Land in Agricultural Uses
Location Proximity	Within City Limits 	
Acres Conserved	500 acres (2 km x 1 km) 	
Adjacent Area	Adjacent to Primary Highway 	
Property Tax or Rent Increase Next Year Only	$ 600	$ 0

2a. Suppose you have to vote between the proposed **Conservation Strategy** and **Status Quo**. Which one would you vote for?

(PLEASE CHECK ONE RESPONSE ONLY)

- ❑ Conservation Strategy
- ❑ Status Quo

2b. How certain are you that this is the choice you would make in an actual referendum?

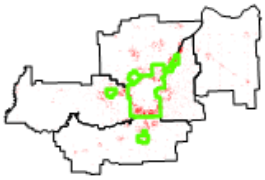
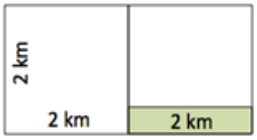
- ❑ Very Certain
- ❑ Somewhat Certain
- ❑ Neither Certain nor Uncertain
- ❑ Somewhat Uncertain
- ❑ Very Uncertain

2c. If you voted for the proposed **Conservation Strategy**, please indicate which aspect(s) you think is important to you with respect to agricultural uses.

(PLEASE CHECK ALL THAT APPLY)

- ❑ Food for Local Market
- ❑ Food for National/Global Market
- ❑ Water Purification
- ❑ Air Quality Regulation
- ❑ Climate Regulation
- ❑ Recreation
- ❑ Scenic Beauty
- ❑ I did not vote for the proposed Conservation Strategy

V3. Suppose you were asked to consider a program that would use conservation easements to conserve specific areas of land in agricultural uses **(Conservation Strategy),** compared to the situation without such a program (**Status Quo)**. The conservation strategy contains the attributes how land would be conserved for agricultural uses, and the resulting cost to you.

	Conservation Strategy	Status Quo
Type of Agricultural Use	Livestock Grazing on Native Pasture 	No Public Conservation Strategy for Land in Agricultural Uses
Location Proximity	Within City Limits 	
Acres Conserved	200 acres (2 km x 0.4 km) 	
Adjacent Area	Adjacent to Primary Highway 	
Property Tax or Rent Increase Next Year Only	$ 100	$ 0

3a. Suppose you have to vote between the proposed **Conservation Strategy** and **Status Quo**. Which one would you vote for?

(PLEASE CHECK ONE RESPONSE ONLY)

- ❑ Conservation Strategy
- ❑ Status Quo

3b. How certain are you that this is the choice you would make in an actual referendum?

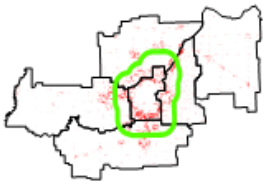
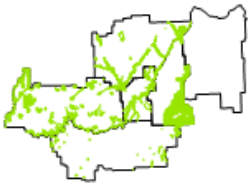
- ❑ Very Certain
- ❑ Somewhat Certain
- ❑ Neither Certain nor Uncertain
- ❑ Somewhat Uncertain
- ❑ Very Uncertain

3c. If you voted for the proposed **Conservation Strategy**, please indicate which aspect(s) you think is important to you with respect to agricultural uses.

(PLEASE CHECK ALL THAT APPLY)

- ❑ Food for Local Market
- ❑ Food for National/Global Market
- ❑ Water Purification
- ❑ Air Quality Regulation
- ❑ Climate Regulation
- ❑ Recreation
- ❑ Scenic Beauty
- ❑ I did not vote for the proposed Conservation Strategy

V4. Suppose you were asked to consider a program that would use conservation easements to conserve specific areas of land in agricultural uses **(Conservation Strategy),** compared to the situation without such a program (**Status Quo)**. The conservation strategy contains the attributes how land would be conserved for agricultural uses, and the resulting cost to you.

	Conservation Strategy	Status Quo
Type of Agricultural Use	Commercial Vegetable Farm 	No Public Conservation Strategy for Land in Agricultural Uses
Location Proximity	Within 10-km Buffer from Currently Developed Land 	
Acres Conserved	2000 acres (2 km x 4 km) 	
Adjacent Area	Adjacent to Conservation Buffer 	
Property Tax or Rent Increase Next Year Only	$ 25	$ 0

4a. Suppose you have to vote between the proposed **Conservation Strategy** and **Status Quo**. Which one would you vote for?

(PLEASE CHECK ONE RESPONSE ONLY)

- ❑ Conservation Strategy
- ❑ Status Quo

4b. How certain are you that this is the choice you would make in an actual referendum?

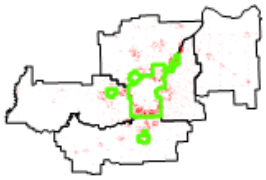
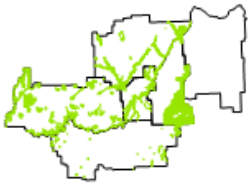
- ❑ Very Certain
- ❑ Somewhat Certain
- ❑ Neither Certain nor Uncertain
- ❑ Somewhat Uncertain
- ❑ Very Uncertain

4c. If you voted for the proposed **Conservation Strategy**, please indicate which aspect(s) you think is important to you with respect to agricultural uses.

(PLEASE CHECK ALL THAT APPLY)

- ❑ Food for Local Market
- ❑ Food for National/Global Market
- ❑ Water Purification
- ❑ Air Quality Regulation
- ❑ Climate Regulation
- ❑ Recreation
- ❑ Scenic Beauty
- ❑ I did not vote for the proposed Conservation Strategy

V5. Suppose you were asked to consider a program that would use conservation easements to conserve specific areas of land in agricultural uses **(Conservation Strategy),** compared to the situation without such a program (**Status Quo)**. The conservation strategy contains the attributes how land would be conserved for agricultural uses, and the resulting cost to you.

	Conservation Strategy	Status Quo
Type of Agricultural Use	Hay Land 	No Public Conservation Strategy for Land in Agricultural Uses
Location Proximity	Within City Limits 	
Acres Conserved	2000 acres (2 km x 4 km) 	
Adjacent Area	Adjacent to Conservation Buffer 	
Property Tax or Rent Increase Next Year Only	$ 25	$ 0

5a. Suppose you have to vote between the proposed **Conservation Strategy** and **Status Quo**. Which one would you vote for?

(PLEASE CHECK ONE RESPONSE ONLY)

- ❑ Conservation Strategy
- ❑ Status Quo

5b. How certain are you that this is the choice you would make in an actual referendum?

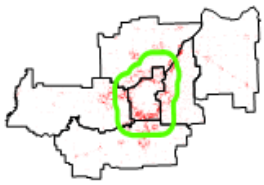
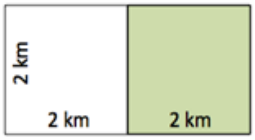
- ❑ Very Certain
- ❑ Somewhat Certain
- ❑ Neither Certain nor Uncertain
- ❑ Somewhat Uncertain
- ❑ Very Uncertain

5c. If you voted for the proposed **Conservation Strategy**, please indicate which aspect(s) you think is important to you with respect to agricultural uses.

(PLEASE CHECK ALL THAT APPLY)

- ❑ Food for Local Market
- ❑ Food for National/Global Market
- ❑ Water Purification
- ❑ Air Quality Regulation
- ❑ Climate Regulation
- ❑ Recreation
- ❑ Scenic Beauty
- ❑ I did not vote for the proposed Conservation Strategy

V6. Suppose you were asked to consider a program that would use conservation easements to conserve specific areas of land in agricultural uses **(Conservation Strategy),** compared to the situation without such a program (**Status Quo)**. The conservation strategy contains the attributes how land would be conserved for agricultural uses, and the resulting cost to you.

	Conservation Strategy	Status Quo
Type of Agricultural Use	Grain/Oilseed Farming 	No Public Conservation Strategy for Land in Agricultural Uses
Location Proximity	Within 10-km Buffer from Currently Developed Land 	
Acres Conserved	1000 acres (2 km x 2 km) 	
Adjacent Area	Adjacent to Primary Highway 	
Property Tax or Rent Increase Next Year Only	$ 50	$ 0

6a. Suppose you have to vote between the proposed **Conservation Strategy** and **Status Quo**. Which one would you vote for?

(PLEASE CHECK ONE RESPONSE ONLY)

- ❑ Conservation Strategy
- ❑ Status Quo

6b. How certain are you that this is the choice you would make in an actual referendum?

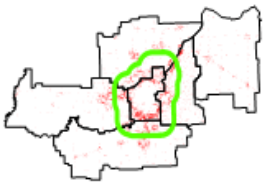
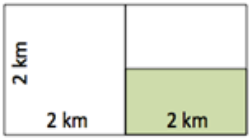
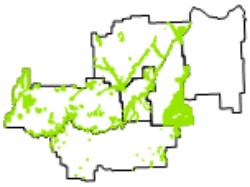
- ❑ Very Certain
- ❑ Somewhat Certain
- ❑ Neither Certain nor Uncertain
- ❑ Somewhat Uncertain
- ❑ Very Uncertain

6c. If you voted for the proposed **Conservation Strategy**, please indicate which aspect(s) you think is important to you with respect to agricultural uses.

(PLEASE CHECK ALL THAT APPLY)

- ❑ Food for Local Market
- ❑ Food for National/Global Market
- ❑ Water Purification
- ❑ Air Quality Regulation
- ❑ Climate Regulation
- ❑ Recreation
- ❑ Scenic Beauty
- ❑ I did not vote for the proposed Conservation Strategy

V7. Suppose you were asked to consider a program that would use conservation easements to conserve specific areas of land in agricultural uses **(Conservation Strategy),** compared to the situation without such a program (**Status Quo)**. The conservation strategy contains the attributes how land would be conserved for agricultural uses, and the resulting cost to you.

	Conservation Strategy	Status Quo
Type of Agricultural Use	Livestock Grazing on Native Pasture 	No Public Conservation Strategy for Land in Agricultural Uses
Location Proximity	Within 10-km Buffer from Currently Developed Land 	
Acres Conserved	500 acres (2 km x 1 km) 	
Adjacent Area	Adjacent to Conservation Buffer 	
Property Tax or Rent Increase Next Year Only	$ 600	$ 0

7a. Suppose you have to vote between the proposed **Conservation Strategy** and **Status Quo**. Which one would you vote for?

(PLEASE CHECK ONE RESPONSE ONLY)

- ❑ Conservation Strategy
- ❑ Status Quo

7b. How certain are you that this is the choice you would make in an actual referendum?

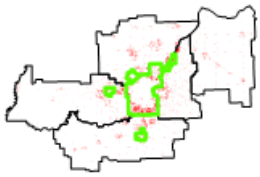
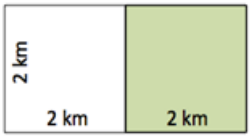
- ❑ Very Certain
- ❑ Somewhat Certain
- ❑ Neither Certain nor Uncertain
- ❑ Somewhat Uncertain
- ❑ Very Uncertain

7c. If you voted for the proposed **Conservation Strategy**, please indicate which aspect(s) you think is important to you with respect to agricultural uses.

(PLEASE CHECK ALL THAT APPLY)

- ❑ Food for Local Market
- ❑ Food for National/Global Market
- ❑ Water Purification
- ❑ Air Quality Regulation
- ❑ Climate Regulation
- ❑ Recreation
- ❑ Scenic Beauty
- ❑ I did not vote for the proposed Conservation Strategy

V8. Suppose you were asked to consider a program that would use conservation easements to conserve specific areas of land in agricultural uses **(Conservation Strategy),** compared to the situation without such a program (**Status Quo)**. The conservation strategy contains the attributes how land would be conserved for agricultural uses, and the resulting cost to you.

	Conservation Strategy	Status Quo
Type of Agricultural Use	Commercial Vegetable Farm 	No Public Conservation Strategy for Land in Agricultural Uses
Location Proximity	Within City Limits 	
Acres Conserved	1000 acres (2 km x 2 km) 	
Adjacent Area	Adjacent to Primary Highway 	
Property Tax or Rent Increase Next Year Only	$ 50	$ 0

8a. Suppose you have to vote between the proposed **Conservation Strategy** and **Status Quo**. Which one would you vote for?

(PLEASE CHECK ONE RESPONSE ONLY)

- ❑ Conservation Strategy
- ❑ Status Quo

8b. How certain are you that this is the choice you would make in an actual referendum?

- ❑ Very Certain
- ❑ Somewhat Certain
- ❑ Neither Certain nor Uncertain
- ❑ Somewhat Uncertain
- ❑ Very Uncertain

8c. If you voted for the proposed **Conservation Strategy**, please indicate which aspect(s) you think is important to you with respect to agricultural uses.

(PLEASE CHECK ALL THAT APPLY)

- ❑ Food for Local Market
- ❑ Food for National/Global Market
- ❑ Water Purification
- ❑ Air Quality Regulation
- ❑ Climate Regulation
- ❑ Recreation
- ❑ Scenic Beauty
- ❑ I did not vote for the proposed Conservation Strategy

Section H This section asks you some follow-up questions

➔ ***Question 1***

When voting, how important was each of the following attributes to you?

	Not At All Important	Unimportant	Neither Unimportant Nor Important	Important	Very Important
Type of Agricultural Use	O	O	O	O	O
Land Proximity	O	O	O	O	O
Acres Conserved	O	O	O	O	O
Land Location	O	O	O	O	O
Property Tax or Rent Increase for Next Year	O	O	O	O	O

➔ ***Question 2***

How do you feel the strategies presented in the survey could be really implemented?

- ❑ Very Likely
- ❑ Somewhat Likely
- ❑ Uncertain
- ❑ Somewhat Unlikely
- ❑ Very Unlikely

➔ ***Question 3***

If you voted to choose any of the proposed **Conservation Strategies** when considering the scenarios presented above, it was because…

(PLEASE CHECK ALL THAT APPLY)

- ❑ I believe that the proposed strategies are worth the money
- ❑ We should pay more to conserve/expand land in agricultural uses
- ❑ I believe the proposed strategies would be better than no conservation
- ❑ This is a better use of money compared to other things that the money should be spent on
- ❑ I did not vote to choose the proposed Conservation Strategies
- ❑ Other reason: (Please specify)

_____

➔ ***Question 4***

If you voted to keep the **Status Quo** considering the scenarios presented above, it was because…

(PLEASE CHECK ALL THAT APPLY)

- ❑ I believe that the cost is too much for the proposed strategies
- ❑ There are other land uses that should be considered
- ❑ I do not believe the proposed strategies would be better than no conservation
- ❑ I do not have enough information to make this decision
- ❑ I did not vote to keep the Status Quo
- ❑ Other reason: (Please specify)

_____

Section I The next set of questions is about you

Q1: What is your gender?

- ❑ Male
- ❑ Female

Q2: What is your age? Please specify _____

Q3: Which city or county do you live in?

- ❑ City of Edmonton
- ❑ Lamont County
- ❑ Leduc County
- ❑ Parkland County
- ❑ Strathcona County
- ❑ Sturgeon County
- ❑ Others, please specify _____

Q4: Which neighborhood do you live in? Please specify _____

Q5: What is your postal code? Please specify 6 digits _____

Q6: Which of the following is the highest level of education you have completed?

(PLEASE CHECK ONE RESPONSE ONLY)

- ❑ Lower than high school
- ❑ Completed high school
- ❑ Completed post-secondary technical school
- ❑ Completed university undergraduate degree
- ❑ Completed post-graduate degree (e.g., Master or Ph.D.)

Q7: What is your current employment status?

(PLEASE CHECK ONE RESPONSE ONLY)

- ❑ Working part-time (self-employed or employed by others)
- ❑ Working full-time (self-employed or employed by others)
- ❑ Retired
- ❑ Student
- ❑ Unemployed
- ❑ Others, please specify _____

Q8: Which sector are you currently employed in?

(PLEASE CHECK ONE RESPONSE ONLY)

- ❑ Agriculture
- ❑ Accommodation and food services
- ❑ Educational services
- ❑ Finance, insurance, real estate and leasing
- ❑ Forestry, fishing, mining, oil and gas
- ❑ Health care and social assistance
- ❑ Information, culture and recreation
- ❑ Public administration
- ❑ Transportation and warehousing
- ❑ Utilities, construction and manufacturing
- ❑ Retired
- ❑ Others, please specify _____

Q9: Which listed category best describes your total household income (before tax)?

- ❑ Less than $30,000
- ❑ $30,000 - $59,999
- ❑ $60,000 - $89,999
- ❑ $90,000 - $119,999
- ❑ $120,000 - $149,999
- ❑ Greater than $150,000

THANK YOU VERY MUCH FOR YOUR KIND PARTICIPATION

Appendix J: Descriptive Results from First Experiment

Table J-1: Demographic and Socio-economic Statistics for the Sample (N=520)

Demographic	Description	Frequency	Percentage (%)
Gender	Male	260	50.00
	Female	260	50.00
Residence	City of Edmonton	384	73.85
	Lamont County	0	0.00
	Leduc County	21	4.04
	Parkland County	21	4.04
	Strathcona County	46	8.85
	Sturgeon County	25	4.80
	Others	23	4.42
Household Income	Less than $30,000	36	6.92
	$30,000 - $59,000	104	20.00
	$60,000 - $89,000	110	21.16
	$90,000 - $119,000	118	22.69
	$1200,000 - $149,000	70	13.46
	Greater than $150,000	82	15.77
Education	Lower than High School	9	1.73
	Completed High School	93	17.88
	Completed Post-secondary Technical School	190	36.54
	Completed University Undergraduate Degree	152	29.23
	Completed Post-graduate Degree (e.g., Master or Ph.D.)	76	14.62

Table J-2: Employment Statistics for the Sample (N=520)

Demographic	Description	Frequency	Percentage (%)
Employment Status	Working Part-time (Self-employed or Employed by others)	73	14.04
	Working Full-time (Self-employed or Employed by others)	254	48.85
	Retired	145	27.88
	Student	9	1.73
	Unemployed	21	4.04
	Others	18	3.46
Employment Sector	Agriculture	4	0.77
	Accommodation and Food Services	6	1.15
	Educational Services	51	9.81
	Finance, Insurance, Real estate and Leasing	32	6.15
	Forestry, Fishing, Mining, Oil and Gas	30	5.77
	Health Care and Social Assistance	86	16.54
	Information, Culture and Recreation	27	5.19
	Public Administration	40	7.69
	Retired	147	28.27
	Transportation and Warehousing	17	3.27
	Utilities, Construction and Manufacturing	47	9.04
	Others	33	6.35

Table J-3: Food Sources that Respondents Get to Consume at Home (N=520)

Food Source	Frequency	Percentage (%)
Chain Grocery Store	516	99.23
Specialty Grocery Store	172	33.08
Convenience Store	47	9.04
Farmers' Market	246	47.31
Personal or Community Garden	96	18.46
Directly from a Farm (e.g., U-pick Farm)	37	7.12
Donation or Gift	11	2.12
Others	22	4.23

Table J-4: Respondents' Attitude towards Land in Agricultural Uses (N=520)

Statement	Percentage (%)				
	Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree
It is important to maintain land in agricultural uses for future generations	0.19	1.15	2.88	35.77	60.00
The primary function of land in agricultural uses is to produce food	0.19	2.31	7.50	53.65	36.35
Land in agricultural uses acts as a natural water filter	0.58	2.69	20.96	45.48	30.39
Land in agricultural uses conserves diversity of natural systems	0.58	5.58	19.23	46.92	27.69
The economic benefits from land in agricultural uses outweigh the benefits that other land uses provide	0.96	7.31	30.77	35.96	25.00
Land in agricultural uses provides social benefits such as recreational opportunities	0.77	9.42	33.85	40.00	15.96
Land in agricultural uses can be improved through human management	0.19	0.96	14.42	54.62	29.81
It is desirable to live near land in agricultural uses	0.58	5.96	33.85	38.85	20.77

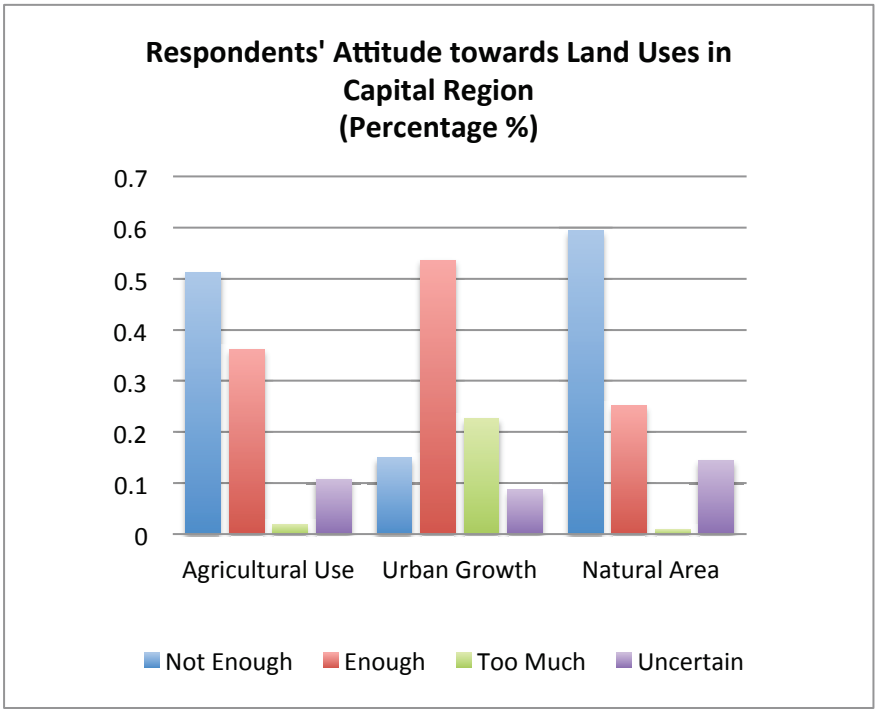


Figure J-1: Respondents' Attitude towards Land Uses in the Alberta Capital Region

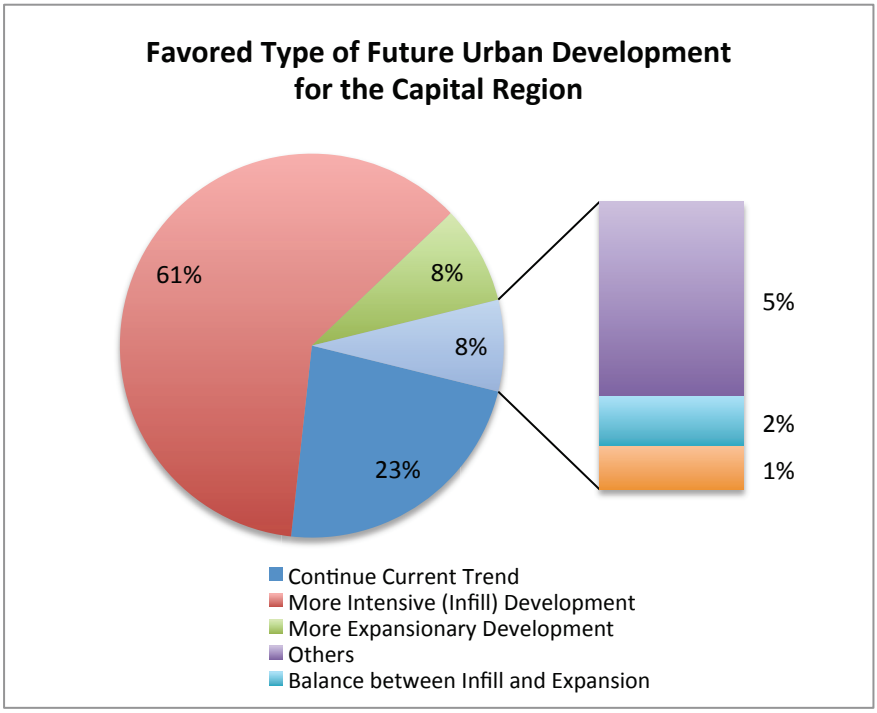


Figure J-2: Respondents' Favored Type of Future Urban Development for the Alberta Capital Region