University of Alberta

The Non-Market Valuation of Wetland Restoration and Retention in Manitoba

by

John Karl Pattison

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Examining Committee

Peter C. Boxall, Rural Economy

Wiktor Adamowicz, Rural Economy

Lee Foote, Renewable Resources

Dedication Page

I would like to dedicate this thesis to the many individuals from Rural Economy that made this experience so memorable.

Abstract

Wetland loss is a concern in Canada, with significant loss in urban and agricultural areas. Due to their provision of ecological goods and services - water quality improvement, carbon sequestration, flood and erosion control and biodiversity - wetlands are an important natural resource to conserve. A stated preference CVM survey was designed to estimate the non-market values of wetland in the prairie pothole region of Manitoba. This included information on benefits and costs associated with wetland restoration, a referendum portion and a debriefing section. A rigorous design procedure was followed that included several public focus groups and pre-tests. Results from 1,980 individuals indicate that respondents are willing to pay to retain and restore wetlands. Conservative willingness to pay estimates placed between $290 (retention) and $360 (full restoration) per household per year. Aggregated to the entire province over a five year period, this increases to approximately $600 and $730 million, respectively.

Acknowledgements

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Chapter 1 Introduction

1.1 Introduction

Canada contains a significant portion of the world's wetland resources. Considered to be productive ecosystems, wetlands are defined as *land where the water table is at, near or above the surface or which is saturated for a long enough period to promote such features as wet-altered soils and water tolerant vegetation. Wetlands include organic wetlands or "peatlands," and mineral wetlands or mineral soil areas that are influenced by excess water but produce little or no peat* (Environment Canada 2009). Associated through much of human history with unpleasant images of swamps, mosquitoes and unknown creatures harbouring disease, wetlands have existed at the margin of productive agricultural land for centuries, slowly being converted and drained for other purposes. The agricultural revolution and development of large earth moving machinery further accelerated the loss of wetlands in urban and agricultural areas. Indeed many provincial governments in Canada established wetland drainage policies that promoted the benefits of converted wetlands for agricultural purposes (Cortus *et al*. 2005). It is only in recent years that a greater understanding of wetland ecosystems caused reversal of these drainage policies and the promotion of wetland protection.

Wetland conservation is an important issue in Canada, with approximately 20 million hectares drained or lost since 1800 (Environment Canada 2009). Concern for this loss of habitat was confirmed when Canada signed the Ramsar Convention in 1971 and the federal government enacted a wetland policy in 1991. The goal of these initiatives was to promote the conservation of Canada's wetlands and to sustain their ecological and socio-economic functions, now and in the future. Although the benefits of wetlands - such as water quality improvement, carbon sequestration, flood control, and biodiversity - are well known, actual evaluation of those

benefits is limited. Measurement of marginal benefits and costs is important for both recommendation and implementation of conservation policies.

1.2 Thesis Objectives

The primary objective of this thesis is to determine the value the Manitoba population places on increasing wetland conservation activities in the prairie pothole region of the province. Specifically the research deals with the restoration of wetlands that have been lost historically. Many government and non-government organizations, such as Ducks Unlimited Canada, have introduced wetland restoration programs. These programs include wetland rehabilitation projects with landowners, and securing remaining wetlands through conservation easements and land purchase.

Environmental goods and services (EGS) provided by ecosystems such as wetlands are not actively traded in markets and consequently have no clearly defined market value. Economists employ a number of tools to assess the values of these non-market goods and services. The stated preference (SP) method is one approach. This method involves the presentation of a survey instrument containing a series of questions to individuals comprising a sample of the population of interest. Some of these questions involve one or more hypothetical situations in which a respondent is required to make simulated market transactions (Haab and McConnell 2002). The information is used by researchers to estimate the respondents' willingness to pay (WTP) for the goods. Since these survey methods include the presentation of information to respondents, determination of the scope of the program in which ecological goods are supplied (i.e. different levels of wetland restoration provide different increases in EGSs), proper identification and reminders of substitutes, and the reduction of biases such as hypothetical bias and strategic behaviour form critical components of the exercise.

Finally, the overall objectives of this study will not be limited to providing public welfare measures for wetland restoration in Manitoba. In addition, there will be contribution to the field of wetland non-market valuation. The rigorous survey design procedure employs the most recent SP techniques. Innovations in measuring marginal values of restoration will contribute to current literature of both wetland valuation and the non-market valuation field in general. It is also reasonable to assume that this study will generate interest on behalf of conservation organizations and government for similar studies in other regions, such as Alberta and Saskatchewan. Moreover, perhaps the most significant applied aspect of this research may be its impact on government policy towards wetlands in the province on Manitoba. Establishing the recognition and acceptance of the non-market valuation field and the inclusion of government officials in the survey design were therefore essential components of this exercise. It is our hope that sound policy decisions that consider the non-market benefits provided by wetlands will result from this research.

1.3 Study Plan

This thesis outlines the past and current status of wetlands in the prairie pothole region of Manitoba. Attempts are then made to quantify the benefits of these wetland ecosystems in terms of ecological goods and services (EGS) provision, such as nutrient removal rates from water, carbon capture, soil stabilization, flood control and biodiversity. Relevant literature on the development of non-market valuation of environmental goods and services is described, and then wetlands valuation scenarios are developed and assessed. Since the economic value estimates are likely to have considerable program and policy relevance, a significant portion of the thesis is devoted to summarizing the design of the survey instrument employed in order to provide evidence of rigour in the design. Finally, results from the survey are outlined - in particular

willingness to pay for levels of wetland restoration programming – and recommendations made for further study and limitations of the research.

Chapter 2 Wetland Status and Restoration

2.1 Introduction

This chapter defines and outlines the current status of wetlands in Canada generally and Manitoba specifically. Detailed analysis of the benefits of wetlands in the Manitoba prairie pothole region is described, followed by a description of the current state of wetlands in that portion of the province. The entire chapter provides a basis of understanding wetlands and their status in the province of Manitoba.

2.2 Current Status and History

2.2.1 Canada

Approximately one quarter of the world's wetlands are located within Canada and cover 14% of the country (Environment Canada 2009). They exist in all regions and in various types, from marine deltas to muskeg swamps to marshes in the prairie pothole regions. The majority of wetlands are found in Ontario, the Northwest Territories, Nunavut and Manitoba. The Canadian government's definition of wetlands encompasses a broad spectrum of habitats that have been classified by the National Wetland Working Group (1997) into the categories included in Table 2.1.

Climate, hydrology, soil and water chemistry and seasonality gradient of a region are factors that contribute to the development and evolution of wetlands (Environment Canada 2009). It is not uncommon for a particular wetland to evolve, moving through a number of these classifications over time. Moreover, *wetlands* should not be confused with *wet lands,* or areas that simply have high levels of moisture in the soil but do not exhibit any change in vegetation characteristics.

Table 2.1. Wetland classification categories according to the National Wetlands Working Group (2007).

Wetland Class	Characteristics
Bogs	Dense layer of peat; acidic; low nutrient content; water table at or near the surface; usually covered with mosses, shrubs and sedges; trees possibly present.
Fens	Covered with peat; water table at or near the surface; higher nutrient content than bogs; vegetation usually characterized by sedges and grasses; trees and shrubs may or may not be present.
Swamps	Stagnant or slow-flowing pool; high nutrient content; usually covered with trees or shrubbery.
Marshes	Periodically or permanently flooded; absence of trees; emergent vegetation; usually high nutrient content.
Shallow waters	Include basins, pools and ponds, as well as wetlands found beside rivers, coastlines and shorelines; submerged vegetation; floating leaved plants.

While wetlands may seem abundant, they are decreasing. As human populations have increased and technology has allowed development of marginal agricultural lands, large wetland areas have been drained. Since European settlement, it is estimated that approximately 20 million hectares of wetlands in Canada have been drained for agricultural purposes alone (Environment Canada 2009). This realization prompted Canada to become a signatory to the Ramsar Convention of Wetlands in 1971 and to become the first national government to enact a wetland policy in 1991. Provincial governments have followed suit to a degree, but most have been slow to implement wetland policies or have allowed them to remain in draft form for over a decade (Delaporte *et al.* 2009).

2.2.2 Manitoba

Manitoba is well known for its wetlands. The southern portion of the province has been labelled in geological terms the "prairie pothole region" due to its history of glaciations and the remnant depressions in the topography. Most of this region is what used to be Lake Agassiz – a great glacial lake that dried up as the Laurentide Ice Sheet retreated. This flat, low lying land is ideal for wetland ecosystems and is often a floodplain in the spring season. The most common types of wetlands in this region are small marshes and seasonally flooded lowlands.

Manitoba is also well known for its agriculture. Most wetlands are embedded in land that is suitable for agricultural production (relatively flat, treeless and high nutrient content), and as a result, Manitoba has seen high levels of wetland conversion to agriculture. Due to the topography, agriculture in the area does not suffer from seasonal drought as other regions in the Prairie Provinces, but rather must deal with flooding and excess water. This abundance of water and suitability for agriculture has led Environment Canada to estimate that up to 70% of wetlands that existed in Manitoba prior to human settlement have been drained.

2.3 Wetland Benefits

Wetlands provide a number of benefits to people and the environment. They filter water, removing nutrients such as phosphorous and nitrogen from spring runoff. They act as sponges, capturing and reducing the volume of spring runoff while controlling erosion. They remove carbon from the atmosphere via photosynthetic plants. They enhance biodiversity, acting as nesting, breeding and wintering habitat for many species of waterfowl and a great number of other bird and mammal species.

While there is considerable literature on wetlands and their benefits, "Wetlands" the book by Mitsch and Gosselink (2007) is considered to be an authority on the subject. Including issues from science to management, this text provides extensive information on the ecological benefits of wetlands. For the purposes of this study, all forms of "use" values[1] associated with wetlands are not considered, nor is groundwater recharge due to controversy between hydrologists on the matter (Mitsch and Gosselink 2007).

As temperate wetlands are often situated in intensive agriculture areas, water purification is a major benefit. Runoff from livestock operations and crop fertilizers enter wetlands and act as a fertilizer for aquatic plant life which bind these nutrients. Subsequently, water flowing from the wetland often contains much lower levels of contaminants such as nitrogen and phosphorous. Fisher and Acreman (2004) conducted a review of the evidence for water purification by examining fifty-seven wetlands world-wide. They found that in the majority of cases wetlands significantly decreased nutrient loads in water[2].

In times of high rainfall and spring snow melt, wetlands play an important role in flood mitigation. Intercepting high water flows, wetlands slow the discharge over longer periods (Mitsch and Gosselink 2007) thereby reducing flood damage that is often most severe during these times. Ogawa and Male (1983) used hydrologic modelling to simulate the relationship between upstream wetland removal and downstream flooding. They conclude that the ability of wetlands to reduce downstream flooding increases in relation to area of wetlands, the flow of water, the distance the wetland is downstream from the source of the flow, and the existence of upstream reservoirs. In the same manner, erosion of sediments is limited by wetlands. Slower

[1] "Use" values are those for which a private market exists, such as hunting and fishing.
[2] Nutrient reduction did not occur in several cases due to an increase in N and P soluble species that enhanced eutrophication (Fisher and Acreman 2004).

discharge of water allows time for suspended sediments to settle and remain rather than being swept downstream (Mitsch and Gosselink 2007).

Prompted by global concerns of climate change, wetlands are being examined for their abilities to capture and store atmospheric carbon. The rich vegetation found in wetlands requires carbon for the photosynthetic process, rendering wetlands a sink of greenhouse gases (Mitsch and Gosselink 2007; Euliss *et al.* 2006). While efforts are continuing to increase the scientific understanding of net greenhouse gas removal rates and differences between various classifications of wetlands (Mitsch and Gosselink 2007), all levels of government have an interest in this particular issue. At the federal level there is interest in terms of the Canada's overall greenhouse gas output for meeting international agreements such as the Kyoto Protocol. Provincial governments consider how federal legislation will affect their economy, and local governments consider the interests of local constituents in the context of landowner compensation for maintenance of natural wetland areas and nuisance value[3] of wetlands to agriculture and urban development.

Biodiversity enhancement has long been a very evident contribution of wetlands to the environment. From swarms of mosquitoes to migrating waterfowl it is clear that wetland ecosystems play an important role in the life cycle of many organisms. Shutler *et al*. 2000 documents the habitat use of bird communities in Saskatchewan and found that wetlands are preferred; Seabloom and van der Valk (2003) analyzed the high level of vegetative richness of prairie pothole wetlands in the Midwestern United States; and conservation organizations such as Ducks Unlimited Canada and the World Wildlife Fund have devoted considerable research towards wetlands and their contribution to biodiversity. In terms of flora and fauna, wetlands are considered one of the most productive ecosystems on earth (DUC 2009).

[3] Time taken to drive around wetlands, etc.

Research collaboration between the University of Guelph and Ducks Unlimited Canada conducted in the Broughton Creek Watershed (Yang *et al*. 2008) and elsewhere in the prairie pothole region yields useful information and quantifies some of the ecological goods and services provided by wetlands. This research found that a wetland acre in the Manitoba prairie pothole region can filter approximately 0.043 tons/N/yr, 0.009 tons/P/yr., and have the capacity for approximately 6 tons of soil and 1200m^3 of water (Yang *et al*. 2008)[4]. Research into greenhouse gas emissions found that a wetland acre can store approximately 3.9 net tons of CO2 equivalents per year (DUC 2009). In terms of biodiversity the great variation between wetland types naturally leads to varying degrees of carrying capacity for different organisms. However, Cowardin *et al*. (1995) found that a typical prairie pothole wetland acre can provide habitat for approximately two breeding pairs of ducks per year, and this can be considered an indicator for other living things.

In general, the benefits provided by wetlands are relatively well known. Most organizations dedicated to wetland conservation will articulate what these benefits are, but do not typically provide rigorous quantitative estimates of them. Thus, what are less understood are the quantified values of these EGS both in ecological and economic terms that allow the public to make informed decisions about trade-offs. Unfortunately, the actual level or quantity of service provided by some resource to human society is critical to determining the value society places on that service (Mullarkey and Bishop 1999).

2.4 Wetland Policy and Restoration in Manitoba

Increasing awareness of wetland loss and information on wetland benefits has resulted in reactionary response from both government and conservation organizations. The federal

[4] These are rough estimates taken from an early stage in the report development and thus differ slightly from the final document.

government wetland policy (1991), Manitoba Water Rights Acts (1988) and the North American Waterfowl Management Plan (1986) are all initiatives that include goals for wetland habitat retention and restoration. A general awareness of the history, goals and achievements of these programs is beneficial to provide context for this study.

The Federal Policy on Wetland Conservation (Environment Canada 1991) set the stage for wetland conservation in Canada. With the stated objective to "sustain the ecological and socio-economic functions of wetlands, now and in the future" this program includes maintenance of the functions and values of wetlands, no-net-loss of wetland area on all federal lands and waters, and enhancement and rehabilitation of wetlands in areas where continuing loss and degradation is occurring. However, this legislation applies only to federally owned lands and no fixed restoration goals exist.

Provincially, Manitoba is in the process of watershed and wetland policy development (Delaporte *et al.* 2009). Policy development for wetlands exists under the Manitoba Water Strategy (2003) and the Water Protection Act (2004), but until then provincial wetland conservation remains in the purview of the Water Rights Act (1988). However, this legislation provides only guidelines for restoration.

While formal wetland policies do not exist, awareness of wetland loss and retention and restoration efforts in Manitoba have been promoted. In 1986 the North American Waterfowl Plan (NAWMP), an international agreement between conservation groups and government departments in Canada and the United States[5], was created to address decreasing waterfowl populations. Divided into regional "joint ventures", Manitoba lies in the Prairie Habitat Joint Venture (PHJV). With the stated objective to "restore waterfowl to levels enjoyed in the 1970's" (MIP 2008), a major thrust of this initiative was to address habitat loss and degradation. The

[5] Mexico joined NAWMP in 1988.

goal of the Manitoba Implementation Plan (MIP 2008) is to retain existing wetlands and restore lost wetlands, in particular small basins. Priority areas are regions with high levels of historic loss and areas with a low percentage of cropland. Total wetland objectives for the current NAWMP MIP are retaining 575,000 wetland acres and restoring 10,800 wetlands[6]. These objectives are expected to met be with a combination of direct land purchase of sensitive land and affecting other areas with use of conservation easements and land use policy initiatives such as the federal Agriculture Policy Framework (MIP 2008). While DUC has extensive experience in these efforts through various land purchases and partnerships with landowners, they have recognized that greater effort is needed and the Manitoba government is needed to join them in these efforts.

In summary, limited policies exist both federally and provincially to prevent further wetland loss and promote wetland restoration. However, it is evident that the most proactive efforts are coming from organizations such as Ducks Unlimited Canada and initiatives between government and non-government organizations such as the PHJV. While the mechanism under which wetland retention and restoration will occur is unclear, it will likely be a combination of direct program delivery and land use policy initiatives between the various levels of government and conservation organizations.

2.5 How Many Wetlands?

In order to accurately determine historical and future wetland loss, I attempted to determine how many wetlands remain in the Manitoba prairie pothole region. The following section records this process in detail and culminates in what I consider reasonable, unbiased estimates of the current status of wetlands in Manitoba and the historical loss that has occurred. I admit, however, that the figures employed (explained below) contain a wide margin of error.

[6] Acreage not specified.

The difficulty associated with this task can be considered one of the reasons little information exists on wetland values in Canada.

A number of issues arise in determining the historic and current levels of wetlands. These are: seasonal variation, the influence of climate change, and wetland degradation. Seasonal variation is particularly problematic because wetland acreage is much higher in the spring than in the fall. Drained *wetlands* usually become *wet lands* in the spring due to the large influx of spring snow melt.

Climate change may also impact the number and size of wetlands, influencing assessments of rates of wetland loss. Consideration must be given to how much of historic wetland loss is due to expansion of agricultural areas, urban and infrastructure development and how much is due to climate change.

The establishment of the Federal Policy of Wetland Conservation (Environment Canada 1991) that required a "No-Net-Loss" of wetlands in the 1990's allowed many individuals to offset the drainage of a wetland with the construction of another one elsewhere. While theoretically, the number of wetland acres remained the same, the actual environmental benefits that new constructed wetlands provide is not necessarily as high as what a natural wetland contributes (Elifritz and Fennessy 2005; Mitsch and Gosselink 2007; Seabloom and van der Valk 2003). While no-net-loss is implemented in various Canadian provinces, the Manitoba government does not endorse this policy approach, recognizing that it does not address losses in the provision of EGS from natural wetlands. This is an issue in assessing the status of wetlands in Manitoba, however, because in calculating the number of wetlands remaining in Manitoba, some researchers include degraded wetlands while others do not, as shall be discussed in following sections.

A final issue regarding the status of wetlands in Manitoba is whether to use historical or present data as the baseline. For this study, I wanted to quantify the area of wetlands that existed before human settlement. We used the term "historical" wetlands. There are a wide array of estimates of wetland loss in Canada and the prairie pothole region. Environment Canada tends to use 70% (Environment Canada 2009). That is, an estimated 70% of wetlands in the prairie pothole region have been lost since settlement. While this is an estimate indicating a level of loss, it is very general and little data is provided as to the way this number was calculated or how many acres this figure corresponds to. Some studies provide estimates of the number of wetlands existing in Manitoba during pre-settlement times[7] as this was one of the earliest agricultural settlements in western Canada (see Hanuta 2006). The other option was to build backward from today using annual estimates of loss rates. In consultation with wetland experts it was decided that since accurate data have only been collected and recorded for the past 40 years in this region, we would work from around a 1970 baseline. Thus began a search for how many wetlands actually existed today and how many had existed around 1970.

2.6 Current Wetland Status

Environment Canada and the Canadian Wildlife Service have recently published a number of reports on the current status of wetlands in Manitoba and the entire Prairie Pothole Region. Dahl and Watmough (2007) estimate that the rate of loss in the Canadian Prairie Pothole Region is 0.53% and the Alberta Water Council (AWC 2007) states an annual loss rate of 0.50%. In particular, the work of Watmough and Schmoll (2007) on the state of Prairie wetlands outlines the methods and challenges of measuring wetland levels. This report indicates

[7] Mid-1800's

wetland loss in Manitoba has been 0.36% per year since 1986, but does not include *degraded* wetlands and thus may underestimate the loss of ecological goods and services.

Ducks Unlimited Canada (DUC) employs research scientists and collaborates with universities to increase awareness and understanding of the issues of wetland loss. This organization has recognized that there is a serious lack of information surrounding wetland status and has embarked upon a rigorous project to provide accurate numbers of wetlands currently in the province of Manitoba and rates of loss over time. DUC, in collaboration with Dr. Wanhong Yang and his team of researchers from the University of Guelph provided data from GIS and hydrologic models on the status of wetlands in certain regions of Manitoba, in particular, the South Tobacco Creek Watershed and the Broughton Creek Watershed. Upon consultation with Manitoba experts[8] it was determined that the Broughton Creek data could be used to represent the status of wetlands in the entire prairie pothole region of the province.

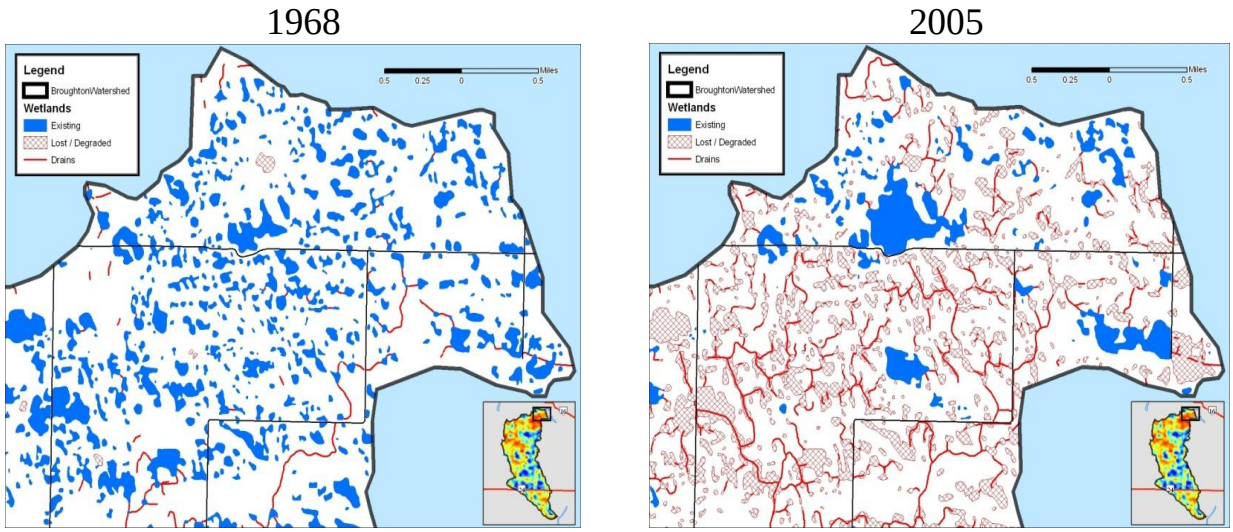

Figure 2.1. An illustration of changes in existing wetlands in the Broughton Creek watershed in the prairie pothole region of Manitoba between 1968 and 2005 (DUC 2009).

[8] Principally staff from Manitoba Agriculture and Food, Manitoba Environment, DUC, etc.

Broughton Creek, a watershed just north of Brandon, is considered a representative watershed of the prairie pothole region (Yang *et al*. 2008). This area contains many small pothole wetlands and high levels of agriculture and wetland drainage. In addition, accurate measurements of wetland levels in this watershed existed for 1968 and 2005 (Yang *et al.* 2008) and thus, provide an estimate of the annual rate of wetland loss in the watershed. Since this information does not exist for the entire pothole region in Manitoba, for the purposes of this present research the annual rate of loss was assumed to represent the loss rate in the entire pothole region of the province[9]. Thus, given that information exists for baseline acreage in the well-studied Broughton watershed, and that an annual rate of loss between 1968 and 2005 could be determined, the Broughton Creek information was expanded to the pothole region of Manitoba to determine a trend for wetland loss. Based on this information, a wetland restoration program would consider 1968 wetland acreage as a goal for "full" or 100% restoration.

Satellite imagery and GIS modelling indicated that approximately 7,406 acres of undisturbed wetlands existed in the Broughton Creek watershed in 1968. By 2005, only 5,874 wetland acres remained. These two acreage estimates (1968 and 2005) suggest an overall total wetland loss of 1,530 acres, or an average annual loss rate of 0.57% per year (Yang *et al.* 2008). When this information was expanded to the entire Manitoba prairie pothole region (Euliss *et al.* 2006; DUC 2009), an estimated 1,355,977 wetland acres existed in 1968 and by 2005 only 1,044,102 acres of wetlands would have remained. This assumes an annual loss rate of approximately 7,700 acres per year which was determined by applying the 0.57% annual loss rate to the total acres of wetland in southern Manitoba in 1968 (see Figure 2.2 below).

[9] I acknowledge that this assumption is large. However, detailed information on wetland acreage in this region of the province is limited, and this assumption was deemed acceptable by Manitoba experts in conservation and water quality.

Extending this loss rate to the year 2020 - assuming a linear rate of loss[10] - would result in a decrease of wetland acres from 1,355,977 acres in 1968 to approximately 950,000 acres in 2020.

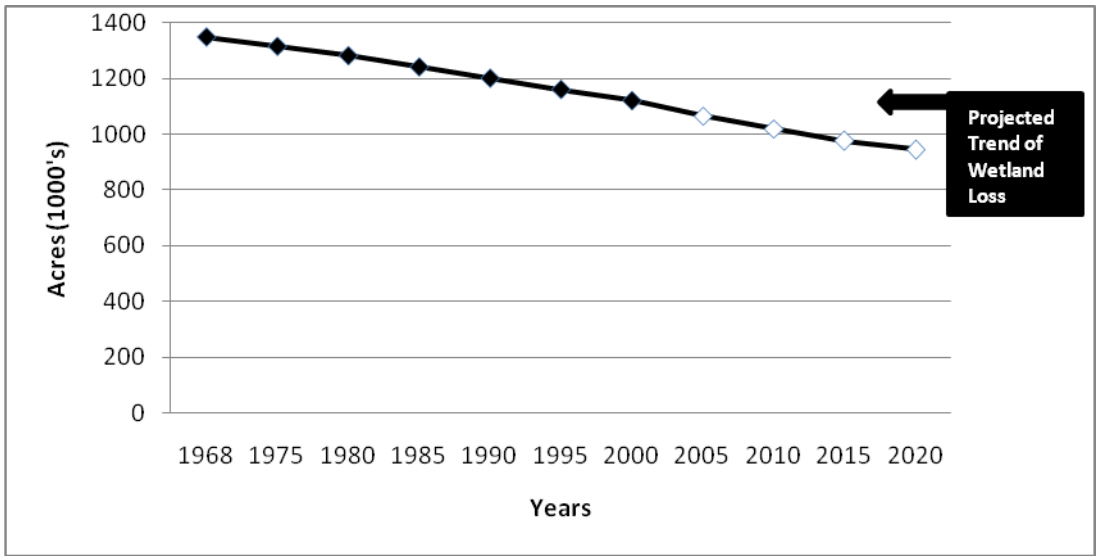

Figure 2.2. An estimated trend of wetland loss in the prairie pothole region of Manitoba based upon 1968 and 2005 levels in the Broughton Creek Watershed.

An appreciable area of wetlands was obviously lost to agricultural development prior to 1968 (Watmough and Schmoll 2007). However, in discussion with Manitoba experts it was determined that a reasonable goal for present restoration efforts would be to restore wetland area to 1968 levels since this is a relatively recent quantity that may be achievable. Despite this somewhat conservative restoration goal, there would still be significant conversion of agricultural land to wetlands. Considering that areas of wetlands existing in periods prior to 1968 were probably quite large, the costs of wetland restoration to historical levels would be significantly higher than restoration to the 1968 level. We suspect that these higher restoration levels would be significant enough to impact the agricultural sector and related rural economies in the province and would be strongly opposed by the agricultural industry, a significant

[10] Wetland loss did not likely occur at a linear rate over this time. However, given only two data points (1968 and 2005) I decided to portray it in this manner for the presentation of the survey instrument.

contributor to the Manitoba economy. Therefore a reasonable goal for present restoration efforts in southern Manitoba would be to restore wetlands to their 1968 levels.

Such a restoration program would still be somewhat ambitious since 100% restoration of previously drained areas would require affecting approximately 311,875 acres of mostly agricultural land. Realizing the difficulty of 100% restoration to 1968 levels, four restoration scenarios of 12.5%, 25% 50% and 100% of the wetlands that had been lost since 1968 were modelled in the Broughton Creek watershed[11] and derived estimates of the EGS provided by restoration activities in that watershed. Table 2.2 summarizes the increase in EGS provision from what currently exists to what would be provided by 100% restoration scenario.

Table 2.2. Estimates of the increase in ecological goods and services provision from the current levels to full restoration (1968 levels) of wetlands in the prairie pothole region of Manitoba (from Yang *et al*. 2008 and Cowardin 1995).

	Nutrient reduction (tonnes)		Erosion control (1000 tonnes)	Flood control (1000 m^3)	Carbon capture (1000 tonnes)	Biodiversity (number of breeding duck pairs)
	Nitrogen	Phosphorus				
100% restoration (311,875 wetland acres)	13,411	2,806	2,027	378,616	1,216	623,750

We took these estimates along with the approach in Figure 2.2 and developed six wetland restoration scenarios for the southern region of Manitoba (Table 2.3). First a "current situation" or baseline scenario was developed. This scenario involved applying the 0.57% rate of wetland loss in Broughton Creek to the pothole region to the year 2020 as shown in Figure 2.2 and involved no restoration activity. This scenario suggests a further decrease of wetland acres from

[11] The scenarios were chosen as convenient ways to capture the entire scope of wetland restoration – each scenario is double the restoration level of the previous scenario.

1,044,102 to 949,184 acres in southern Manitoba. Thus, a further loss of 94,918 acres would be experienced and at this rate of loss by 2020, only 70% of the wetland areas that existed in 1968 would remain. Table 2.3 identifies the levels of EGS that would result from this further wetland loss.

The next scenario involved retaining the wetlands that currently exist in southern Manitoba to the year 2020. This would require cessation of all drainage activity and maintaining the current acreage of wetlands at 1,044,102 acres. Thus, no restoration would take place and the current levels of EGS provided by these wetlands would be maintained into 2020 (Table 2.3).

The remaining four scenarios involve restoration activities of various intensities ranging from 12.5% to 100% of 1968 wetland areas. The most intensive involves 100% restoration in which all of the wetlands lost since 1968 would be restored by 2020. Thus, wetland acreage in southern Manitoba would increase from 1,044,102 to 1,355,977 acres for a total increase of 311,875 acres by the end of the program in 2020. Using the estimates of EGS from Table 2.2 resulting nutrient reduction, flood and erosion control, carbon capture and biodiversity levels would increase in the province.

The least intensive scenario involves increasing wetlands by about 12.5% of 1968 levels resulting in an additional 38,985 acres for a total of 1,083,087 acres. This acreage is about 80% of 1968 wetland levels. In a similar fashion to the scenarios discussed above levels of EGS were developed (Table 2.3). The remaining scenarios involved restoration levels of 25% and 50% of 1968 wetland levels.

Table 2.3. Attributes of various wetland management scenarios including estimates of associated ecological goods and services associated with hypothetical wetland retention and restoration programs in the prairie pothole region of Manitoba*.

Wetland scenario	% 1968 wetland area restored by 2020	% 1968 wetland area	Total wetland acres by 2020	Change in wetland acres	Estimates of ecological goods and services					
					Nutrient reduction (tonnes)		Flood Control (1000 m^3)	Erosion control (1000 tonnes)	Biodiversity (1000 breeding duck pairs)	Carbon capture (1000 tonnes)
					N	P				
Current situation	-30	70	949,184	-94,918	40,815	8,543	1,152,309	6,169	1,898	3,701
Retention	0	77	1,044,102	0	44,896	9,397	1,267,539	6,786	2,088	4,071
12.5% restoration	12.5	80	1,083,087	38,985	46,573	9,748	1,314,867	7,040	2,166	4,224
25% restoration	25	83	1,122,071	77,969	48,249	10,099	1,362,194	7,293	2,244	4,376
50% restoration	50	89	1,200,040	155,938	51,602	10,800	1,456,848	7,800	2,400	4,680
100% restoration	100	100	1,355,977	311,875	58,307	12,204	1,646,156	8,813	2,711	5,288

*estimates provided are based upon total wetland acreage, rather than the number of acres restored.

Chapter 3 Wetland Valuation

3.1 Introduction

This chapter outlines the establishment and growth of non-market valuation research and discusses various wetland valuation studies that have been conducted internationally and in Canada. Furthermore, various issues associated with the contingent valuation method and alternative stated preference methods are discussed. The combination of a history of non-market valuation, a review of wetland valuation studies and a discussion of design issues surrounding stated preference (SP) research will provide for context this study.

3.2 A Brief History

In 1967 the *American Economic Review* published an article by John Krutilla entitled "Conservation Reconsidered." This article described problems with traditional measures of valuing the natural environment, pointing out that missing markets for many environmental goods and services inevitably led to their degradation. He argued that while technology may push back the constraints to growth imposed by scarce natural resources, increasing degradation of the natural world would nevertheless cause people to attach value to the very existence of unspoiled natural environments. Formalizing the writings of naturalists such as Aldo Leopold and John Muir in the realm of economics and public policy, the work by Krutilla has been described by many as an intellectual cornerstone for assessing and protecting the natural environment (RFF 2007). Since the publication of Krutilla's 1967 article, environmental valuation in economics has become more common. Faced with increasing human consumption and detrimental impacts on the environment, decision-makers realized that traditional methods of measuring "value" were not adequately capturing various public goods where there was no private market. In situations where there is no easily observed benefit, or none that is easily

identified by consumer behaviour, the value individuals derive from resources such as wetlands has come to be known as *existence value* (Grafton *et al*. 2004).

The literature has evolved over the years in terms of defining and measuring non-use values. An extension of existence value is *passive use value*. An individual may obtain utility from the knowledge that an environmental good or ecosystem will be maintained in the future in the event they would like to visit it, or that their children would have the opportunity to visit it. In other words, there are potential future use values in addition to existence values. Any public good provision issue where there is no market transaction can generally be considered as a non-use value issue (Grafton *et al*. 2004). As described previously, SP methods have been used to measure these non-use values, typically through the use of a survey instrument administered in a variety of ways (i.e. mail, in person, internet, etc). While a wide range of stated preference techniques have been used, the most commonly employed SP approach has been the *contingent valuation method* (CVM).

S.V. Ciriacy-Wantrup (1947) first employed the CVM in valuing soil erosion prevention. While this study did not attempt any empirical valuation, research in the decades that followed built upon these early design techniques, and survey design and welfare measures were progressively refined. Several significant events led to the prominence of the CVM and its establishment in the public arena outside academia. One of these events was the publication from Krutilla described earlier. A second was the 1981 Regan Executive Order in the United States requiring the use of cost-benefit analysis for environmental projects and the subsequent monetization of social values. A third major event was the 1989 reinterpretation of the US Comprehensive Environmental Response, Compensation and Liability Act of 1980 that allowed

equal weight to be placed on revealed and stated preference data. The CVM was now firmly in the public arena and recognized as a credible method to determine the economic value of EGS.

The final event, often attributed as the most significant in establishing valuation approaches, was the Exxon Valdez oil spill in Alaska in 1989. In assessing the economic damages of the spill, non-use values were considered. A comprehensive CVM study was conducted by Richard Carson, a prominent resource economist from California (Carson *et al.* 1992). As the inclusion of non-use values had the potential to dramatically increase the costs of the spill, Exxon fought this study by hiring a group of researchers to challenge the credibility of the CVM as a means to accurately determine non-use values. This confrontation led to the establishment of the National Oceanic and Atmospheric Administration (NOAA) panel recommendations to increase the credibility of the CVM and to establish certain guidelines in the survey design stage (Arrow *et al.* 1993). The resulting discussions provided a foundation for CVM and addressed concerns expressed by a number of individuals over its use (see Diamond and Hausman 1994).

The CVM, as outlined by the NOAA panel recommendations, is essentially a survey where a hypothetical market is described for an environmental good that elicits the economic welfare change associated with the change in the good (Grafton *et al.* 2004). The structure is generally set up as a hypothetical referendum where respondents vote on accepting or rejecting an environmental improvement in exchange for an increase in taxes. That is, the provision of the environmental good is contingent upon the respondent voting yes. Information regarding the particular good is provided to the respondent prior to voting, and certain demographic information is elicited after the voting. Willingness-to-pay estimates are based upon random utility theory, where the individual will choose the alternative that provides him/her with the

greatest level of utility. For the present study the CVM was employed, and respondents were asked to vote five times, allowing researchers to determine the value associated with marginal increases in restoration levels and associated benefits.

Validity of data yielded by stated preference surveys must be assessed on two levels. First the data must be relevant and useful in the design of policies and programs (Krupnick and Adamowicz 2006). To that end, involvement of scientific experts in the development of the survey is essential. Second, respondents to the survey – typically members of the public – must be given a clear understanding of the information provided and the questions asked (Krupnick and Adamowicz 2006).

3.3 Wetland Valuation

In 1997 the Ramsar Convention Bureau published a book entitled *Economic Valuation of Wetlands: A guide for policy makers and planners* (Barbier *et al*. 1997) because an increasing number of decisions made by public policy makers today are based upon market-based incentives. Quantitative valuation of wetlands must be attempted. In addition, the authors realized that context was important. The diversity of wetlands found in the world required slight variations in valuation techniques, and so provided case studies of valuations of six different wetlands types and locations. Publication of this book is evidence of international recognition of the value of wetlands and the role that environmental economics can play in the conservation of these ecosystems.

3.3.1 International Wetland Valuation

A wide range of wetland valuation studies have been conducted internationally (EVRI 2009). The majority of these studies have taken place in developed countries, where issues such as property rights, resources for funding, and modes of administration allow for more rigorous

and complex survey designs. Due to differences in the classification of wetlands – coastal, prairie, boreal, etc. - direct comparisons of willingness-to-pay estimates found in the literature is difficult. Unless circumstances are very similar between the wetlands, benefit transfers - relating the value estimates from one place to another - are not appropriate (Leitch and Fridgen 1998). According to Leitch and Fridgen (1998), benefit transfers have been a common practice in wetland valuation that have often led to misleading value estimates. This review of the literature will include information from a variety of wetland studies, providing a baseline for our willingness-to-pay estimates and valuable insight into the complexities of wetland valuation and innovative approaches to survey design. However, the degree that WTP estimates from these studies will be compared to the value of prairie pothole wetlands in Manitoba must be limited to that which is deemed reasonable.

A recent study using SP survey design methods was conducted in Sweden to obtain an economic value of wetland attributes. The study revealed that individuals in the populated regions of southern Sweden ranked the nutrient removal capabilities (water filtration) and recreational benefits of wetlands over other ecological benefits in an application of stated preference modelling (Carlsson *et al.* 2003). The study was informative both in the manner in which the survey was conducted, but also in its identification of the attributes the general population found most important. Information on preferred wetland attributes is essential to establish policies that increase wetland protection in populated regions of the world.

Sweden was also the study area for Gren (1995), who analysed the value of nitrogen abatement functions of wetlands in Gotland. This research found that investments in wetlands as an abatement mechanism may be more effective than investments in sewage treatment plants and agriculture. The production of environmental services that wetlands provide such as buffering of

water and biodiversity enhancement resulted in WTP estimates of $349 per hectare per year. This number is based upon the capacity for annual nitrogen abatement and the assumption that nitrogen abatement from wetlands will increase over time. This information is valuable for policy development and the application of scientific knowledge.

In studies of two prairie potholes in North Dakota, one seasonal and one semi-permanent, Hovde (1993) reported WTP estimates of $16 per acre per year for the seasonal wetland and $12 per acre per year for the semi-permanent wetland. Roberts and Leitch (1997) determined the value of wetland services in Mud Lake, South Dakota to be $375 per acre per year. This value includes flood control (based on dollar damages prevented), water supply (based upon public utility revenues), and CVM results for aesthetics, recreation and fish/wildlife habitat. These two studies illustrate the wide range of benefit estimates depending on the definition of benefits and the methods of measurement.

Leitch and Hovde (1996) analyzed five prairie pothole wetlands in North Dakota, and found that WTP estimates varied from $10 to $921 per hectare per year, depending upon the stakeholder perspectives and the wetland being considered. They argue that the reason for such variation in the wetland valuation estimates is a lack of scientific understanding of the wetlands in question. They cite estimates from a number of wetland valuation studies: $299 per hectare per year for South Dakota wetlands (Hubbard 1989); $6,669 per hectare per year for coastal wetlands in Louisiana (Gosselink *et al*. 1974); $23,465 per hectare per year for the Charles River wetlands (Ostro and Thibodeau 1981); and another estimate of $766 per hectare per year for the coastal Louisiana wetlands (Grigalunas *et al*. 1992).

A study conducted by Blomquist and Whitehead (1998) used contingent valuation to examine values and the effects of information on the value of related environmental goods. In

terms of wetland valuation, the lack of scientific understanding of the actual benefits wetlands provide draws into question the validity of many results. This study looks at how this lack of information affects WTP estimates, though it does not address or incorporate more recent design issues inherent in contingent valuation.

Mullarkey and Bishop (1999) argue that the failure of many wetland valuation studies to pass the scope test for construct validity[12] is due to lack of information. In their Wisconsin study they found that if respondents were provided with a significant amount of information, they would pass the scope test. In the area surrounding a secondary highway, small wetlands were valued between $10 and $60 per acre, depending on the level of information provided. It must also be noted that while this WTP estimate can provide a certain level of comparison for estimates derived from the present Manitoba study, the regions are very different and the wetlands likely provide different benefits. Thus WTP levels between studies may vary widely.

Wetland valuation studies are typically costly and difficult to implement due to the complex survey design procedures employed. There have been several attempts to complete a meta-analysis of a number of wetland valuation studies already conducted (Brouwer *et al*. 1997; Woodward and Wui 2001; and Brander *et al.* 2006). Essentially a regression of the regressions, results from meta-analyses could save time and money and become a useful guide for policy regarding wetland conservation. Borisova-Kidder (2006) also conducted a meta-analysis of these meta-analyses. With a significant database of values, these authors deemed that the time was appropriate to conduct meta-analyses in order to understand common factors that can affect economic value estimates, and potentially decrease the need for detailed and costly contingent valuation studies for location specific wetlands.

[12] Higher WTP estimates for greater provision of the good (Grafton *et al*. 2004).

The problem with these analyses is again the large heterogeneity in the wetlands studied and the variations of valuations conducted. Some studies focussed on recreational values of prairie wetlands (Hammack and Brown 1974; Johnson 1984) while others analyzed marine wetlands (Gosselinck *et al*. 1974; Breaux *et al*. 1995). Other economic research studies focussed on testing and developing new valuation approaches or novel experimental design methods (Ledoux 2003; Campbell *et al*. 2002). This diversity of empirical approaches and geographical locales studied makes the merging of the various wetland valuation data into one large valuation model ineffective, and the resulting estimates may not yield useful results to policy and program managers. Moreover, it renders benefit transfers inadequate, as the wetlands in many of the studies included in the meta-analysis have very different functions are not comparable with each other.

3.3.2 Wetland Valuation in Canada

There has been few wetland valuation studies conducted in Canada. While the federal government enacted a wetland conservation policy in 1991 that recognized the value wetlands provide, most provinces have been slow to introduce any form of wetland policy or rigorous attempts to value these resources (Delaporte *et al*. 2009). Valuation studies have been piecemeal at best. What research exists is largely contained in the Great Lakes Region of Ontario, a region with high population density and human development. Bardecki (1998) conducted a review of wetland literature in the Great Lakes region, the Canadian Wildlife Service published *Wetlands are not Wastelands* (CWS 1988) and the Canadian Wildlife Service Ontario Region provide an overview of wetland economic valuation on their website (Environment Canada 2009).

The body of literature is both small and diverse. Several authors analysed use values associated with wetlands, such as birdwatching and other forms of recreation (Kreutzwiser 1981;

Hvenegaard *et al*. 1989). Bardecki (1988) and Elliot & Mulamoottil (1992) researched issues of land use comparisons and cost benefit analysis, while Schaefer *et al.* (1996) considered the benefits of wetlands as a nutrient buffer zone near the Eramosa River watershed in Ontario. Ferguson *et al.* 1989 conducted a contingent valuation study on the Cowichan estuary on Vancouver Island, British Columbia. This work used three different wetland evaluation methods for describing the characteristics of the wetlands in the estuary, and then looked at the impacts of two hypothetical development projects. WTP estimates were placed around $9,139 per hectare per year.

DUC has contributed to the knowledge of non-market valuation of wetlands significantly in various research initiatives such as the Institute for Wetland and Waterfowl Research - promoting scientific knowledge - and many of their reports to the public, such as Natural Values (Gabor *et al.* 2004) and The Value of Natural Capital in Settled Areas of Canada (Olewiler 2004). These two documents provided comprehensive overview of ecological goods and services, their value to society and the inability of the market to capture these values. Olewiler (2004) discussed EGS provided by wetlands in the Assinaboia watershed in Manitoba, and determined the net benefit of a wetland to be as high as $106.89 per hectare per year. This estimate does not employ a rigorous SP method and includes use values, but nevertheless is an important move towards valuing the EGS provided by wetlands. Without these initiatives wetlands in Canada would be far less understood. Yet while all of the above efforts have contributed to increasing the general public's knowledge on ecological goods and services, there have been no comprehensive CVM studies conducted on wetlands in Canada. Little knowledge exists regarding Canadian's willingness-to-pay to retain and restore wetlands.

3.4 Design Issues

There are a number of design issues inherent in contingent valuation surveys that, unless addressed, can seriously influence results and credibility of a study. As environmental economic literature has grown, debates have emerged within the academic community and beyond (see Diamond and Hausman 1994; Hanemann 1994; Portney 1994; Ludwig 2000) over the use of economic value estimates using the CVM for policy recommendations. Concerns expressed in this literature are valid. Contingent valuation designers must have a clear understanding of these issues in order to make attempts to correctly deal with them (Grafton *et al.* 2004). This section describes these problems and explains how they were addressed in this study.

3.4.1. Hypothetical Bias

Critics of non-market valuation techniques doubt that the creation of hypothetical scenarios can convincingly replace the absence of real market transactions. How effective are calibration techniques in correcting this bias? Cheap talk has been proposed as the means to mitigate hypothetical bias by convincing respondents that the survey has policy implications and reminding them of the consequential trade-offs they are making in the valuation scenarios. Cheap talk is a carefully worded explanation and conditioning narrative presented to survey respondents immediately prior to their assignment of values for goods. It is designed to influence them into a more realistic response. This typically involves telling them that research suggests that respondents will often say they will pay much more than they actually would if they had to pay immediately. The cheap talk script also makes respondents aware of how biased answers can skew willingness to pay results upward. Studies by Cummings and Taylor (1999), List (2001) and Lusk (2003) confirmed the effectiveness of cheap talk in mitigating hypothetical bias.

Participants may also be probed for their level of certainty following each of their choices in voting scenarios. If a respondent indicates a high level of uncertainty in their response that particular vote can effectively be considered a vote of "no". Statistical studies have shown that hypothetical values are not significantly different from real values when respondents are certain of their responses (Champ *et al*. 1997; Blumenschein *et al*. 1998). Furthermore, "uncertain" responses are not as meaningful for policy guiding purposes as "certain" responses (Champ *et al*. 2003).

3.4.2 The Payment Vehicle

The payment vehicle describes the method of payment for a public good and provides respondents with incentives to report their true willingness to pay (WTP). For the payment vehicle to be incentive-compatible it needs to be consequential and credibly impose costs on the entire sample of interest while avoiding voluntary contributions (Arrow *et al*. 1993; Carson and Hanneman 2005).

An increase in household taxes fulfills the requirements for such a payment mechanism and will credibly impose equal cost on all agents if the project is implemented. The "take-it-or-leave-it" approach is considered incentive compatible for respondents to reveal their true WTP for public goods. On the other hand, payment vehicles based on voluntary contributions (such as donations) invite strategic behaviour and inflate WTP measures as respondents do not expect to be charged for the public good (Freeman III 2003; Carson and Hanneman 2005). However, tax-based payment vehicles run the risk of protest votes or "nay-saying" which is a form of rejection of the scenarios, thus decreasing respondents' WTP even though they may approve of the proposed program. The final range of "bid values" or tax levels for the payment vehicle can only

be determined by the use of focus groups and pre-tests as passive use values and their corresponding bid distributions are commonly not known beforehand (Champ *et al*. 2003).

3.4.3 Identification of Yea Sayers

Some respondents will vote for a proposed environmental improvement regardless of the personal cost to them. This can be a legitimate response as long as they actually will pay the amount presented if the situation was "real", and that they have the income available to do so. However, research has shown that individuals who are sympathetic to causes such as environmental degradation simply feel good about allocating money to what they deem to be a worthy cause. In collecting stated preference data these individuals can bias measures of economic values upward as they ignore budget constraints and do not recognize the tradeoffs inherent between environmental improvements and income loss (Blamey *et al.* 1999). These people have the tendency to agree with questions regardless of content, and hence are termed "yea-sayers". Their presence may indicate the unique nature of the environmental good being presented in the survey, or an indication that perhaps the survey scenarios are not sufficiently incentive compatible to yield truthful answers (Freeman III 2003). Researchers must determine that the responses accurately reflect willingness to pay and not the purchase of moral satisfaction. Due to the potential for inflated measures of economic values these individuals must be identified and in some cases removed from the sample (Blamey *et al.* 1999).

This problem may be mitigated through the incorporation of several techniques. First, the use of incentive compatible payment vehicles such as taxation reduces the potential for free-riding in that if the majority of individuals vote for a proposal, then all must pay. Second, avoidance of emotionally capturing images in the survey that may overemphasize the benefits of wetlands and rather simply outline the tradeoffs and reasons for draining can assist in reducing

yea-saying. Finally, research has shown that the inclusion of the cheap talk script prior to presenting the voting scenario(s) can reduce these biases (Cummings and Taylor 1999).

3.5 Quantification and Presentation of Benefits

According to Mullarkey and Bishop (1999) there are several major problems with previous wetland valuation literature dealing with the provision of EGS. First, the diverse benefits provided by wetlands are unfamiliar to most members of the general public. Second, there is a high degree of scientific uncertainty regarding the quantitative estimates of these ecological functions. The responsibility therefore lies with the researchers conducting the survey to provide evaluations of the ecological services provided and to convey that information in a way easily understood by the public. Survey respondents must be able to articulate their willingness to pay for the wetlands in question rather than some value of wetlands in general.

Initially, there must be understanding and scientific agreement on the actual quantities of the ecological services provided in the geographic region of the study – in this case the prairie pothole region of southern Manitoba. Many government and conservation websites dedicated to wetland conservation articulate the values that wetlands provide: water filtration, carbon sequestration, flood and erosion control, etc., however, there are rarely any references to the quantities associated with these qualifications or to the specific location or classification of the wetland in question. It is only after quantities are determined that it is possible to relate these numbers to the general public in an understandable manner. It should be noted that this omission is not out of any desire of wetland advocates to confuse members of the general public by exaggerating the benefits of wetlands or painting the situation as more dire than it actually is. Rather, there is a lack of scientific research and understanding into the actual level of benefits provided.

3.6 Summary

Existing wetland valuation studies are diverse in terms of size, geographic location and provision of EGS. The majority of the research has been conducted outside Canada. With the exception of some studies in the Great Lakes region there has been little or no economic valuation of the vast wetland ecosystems of the coastal, prairie pothole and northern regions of Canada. In addition, much of the research was conducted with a limited understanding of the quantified benefits of wetlands in the study area and used outdated CVM designs.

Chapter 4 Methodology

4.1 Introduction

Stated preference methods involve the presentation of a survey instrument containing a series of questions to individuals comprising some sample of the population of interest. Rigour and attention to detail in the development of these survey instruments is necessary in order to capture the passive use value of wetland retention and restoration and to address inherent design issues. This chapter describes the development of the survey instrument employed, the administration of the survey, and the econometric modelling technique used to estimate willingness to pay for wetland programs.

4.2 Survey Design

The contingent valuation method (CVM) is the most commonly used stated preference method and typically involves the structuring of a single hypothetical scenario where the respondent is offered an environmental improvement in return for increased taxes. Many researchers have developed CVM instruments and generated values, some of which have been used in assessing the economic magnitude of environmental damages caused by human activity. According to Carson (2000) a credible contingent valuation survey should include seven basic sections:

(1) an introduction, including an overview of the general context in which the public good will be provided

(2) a detailed description of the current state of the public good and the proposed changes in its quality

(3) the institutional framework which will credibly ensure the quality change will be provided

(4) a credible and coercive payment mechanism for the public good

(5) valuation scenarios that extract respondent's preferences or willingness to pay for the public good

(6) a set of debriefing questions that help explain the respondent's choices in the valuation scenarios

(7) further debriefing questions to elicit respondent's characteristics and demographic information.

In developing the survey instrument and its component parts, focus groups with experts involved in providing the public good, as well as focus groups with representatives from the region from which the sample of respondents is drawn should be employed. Involving experts should ensure that the information in the survey is accurate and that the results will assist in policy development. Focus groups with potential respondents provide qualitative information on whether the instrument is understandable and consequential. Finally, it is critical that pre-tests of the survey instrument be conducted to provide some quantitative checks on the resulting data.

The initial steps followed in the design of the survey instrument employed in the present study are described below.

4.2.1 Preliminary Activity

Research was initiated for the survey in May 2008 in Winnipeg with the formation of an advisory group of experts to provide input into the content of the survey. DUC staff in Manitoba was asked to gather a group of experts on wetland policy and ecology to serve as a steering committee to provide information and advice on wetland issues and policy in Manitoba. The

final advisory group of experts was established in May 2008 and the membership is provided in Appendix A.

The first meeting was held in Winnipeg and involved discussions on procedure and methods. It also set the stage for the collection of information on wetland issues in Manitoba, availability of existing data, and a rough outline of a survey was presented by Boxall along with principles of administration. This meeting was followed by numerous conference calls and emails as the information was developed, and as the survey instrument was constructed. This group of experts served as the initial scoping exercise for the development of the non-market valuation survey and discussions on potential uptake of wetland restoration activities.

Further to suggestions received from the steering committee, thorough research into wetland literature was conducted that allowed for a first draft of the survey to be completed, (summarized above.) Much information and correspondence occurred between wetland researchers at the University of Guelph and the steering committee to gain accurate and current information regarding the costs and benefits of wetlands. I travelled to Manitoba in August 2008 to see the prairie pothole region of interest, meet with members of DUC at Oak Hammock Marsh, conduct a focus group with wetland experts and have a second meeting with the expert advisory group. A series of public focus groups were conducted in early October to finalise the draft survey before administration. Finally, pilot tests involving 446 respondents were administered by Ipsos Reid[13] to clarify any remaining ambiguities.

4.2.2 Focus Groups

The effective development of economic valuation models using SP data requires sound data which arises from a high level of understanding on the part of respondents to the survey instrument. Before starting the survey, clarity was ensured by presenting it to small focus groups

[13] A national market Research firm hired for the administration of the survey instrument.

drawn from the public at large. Focus groups are an essential component of the development of contingent valuation studies (Carson and Hanneman 2005), in that they ensure the key concepts and framework of the survey instrument are understood. When conducting these focus groups, the moderator must not bias participants must be aware of interviewing techniques (Johnston *et al.* 1995). For this survey, seven focus groups were conducted in total – one with graduate students, one with wetland experts, three focus groups in Manitoba with randomly drawn members of the public, and one of agricultural producers in rural Alberta. Descriptions of these focus groups are presented in Appendix A.

Participants in the graduate student focus group largely proofread and corrected editorial mistakes, as well as provided formatting suggestions. There were eight students involved who had backgrounds in economics, agriculture and renewable resource management. The expert focus group was held in Winnipeg in late summer and consisted of members of Manitoba Environment, Manitoba Agriculture and DUC.

A market survey research company was contracted to assist in the development of the public focus groups. The Leger Marketing Group randomly sampled members of the Manitoba public to participate in three focus groups over the course of a week in October 2008. Each focus group met for approximately 90 minutes to discuss administration of the draft survey, followed by a discussion of the survey and issues related to wetland conservation in Manitoba. Compensation for their participation involved an honorarium of $60.

Overall the focus groups were invaluable in providing critical feedback regarding the survey procedure. The expert focus group identified areas of questionable value, corrected any erroneous scientific points and highlighted issues that would be of particular importance to Manitobans. The public focus groups were especially helpful in the completion of survey

design. Issues such as length, interest, clarity and bias were addressed. Care was taken in the instrument to not "push" the respondents to support proposed wetland programs. Members of all three groups were virtually unanimous in finding the survey informative, interesting, clear and easy to understand, although some felt the questions were "deep", requiring a considerable amount of thought. Length was acceptable and "allowed them to make informed decisions". There were no sections that the participants felt should be removed, although several editorial corrections and suggestions were made following the discussion.

Some concern was expressed that perhaps the survey was biased towards conserving wetlands[14]. Suggestions were provided to address this potential bias, but others felt it would naturally occur for two reasons: the public is under-informed as to the full benefits of wetlands and historical rates of loss, and the use of quantitative means to describe the benefits would naturally push towards conservation. Most felt with some minor adjustments that the survey instrument would be suitable in the form provided in the focus group examination.

Due to concern over "pushing" respondents to support wetlands and possible misrepresentation of agricultural producers, it was decided that the survey should be discussed with producers. While Alberta may be different in many ways than Manitoba, producers still deal with the same issues surrounding wetlands. The survey instrument was tried with five different Alberta farm families. None of these families felt the survey was unfairly biased towards agriculture and all felt the trade-offs articulated were reasonable. They did not feel pushed towards supporting wetland restoration scenarios. They felt that they should not be penalized for draining wetlands - if society derived benefit from the wetlands, then the government should be compensating landowners for their protection.

[14] This is unsurprising, as very little information provided today is "anti-wetland".

In conclusion, the focus groups proved to be an essential component of the survey design process. Editorial errors were corrected and clarification of several portions was addressed. Suggestions were made regarding the presentation of the wetland loss trend, and the use of percentage rather than acreage was recommended due to a feeling that public knowledge was lacking in terms of units of land measurement. All of this assisted in making the survey instrument more effective in conveying information and increased the credibility of welfare estimates ultimately derived from the responses.

4.2.3 An Overview of the Final Survey Instrument

The final version of the survey instrument (see Appendix B) consisted of three parts. First, respondents were asked to rate the level of effort the provincial government should be applying to a broad list of current issues, including health, education, and the environment. Respondents were provided with a base level of information consistent with the methodology outlined by Carson (2000). The opening pages provided a description of environmental issues in Manitoba, followed by questions regarding the respondents' familiarity with these issues. Finally, information on the benefits of wetlands, the rate and reasons for wetland loss, the current state of loss and the trade-offs associated with wetlands conservation were provided. Respondents were asked to rate their levels of concern with the issues enumerated and to indicate who should be responsible for addressing wetland loss. This procedure was utilized to keep the respondents interested in reading further. In addition, we elicited opinions on who should be financially responsible for addressing wetland loss.

In the valuation section the scenarios described in Table 2.3 were presented to the respondents in a referendum CVM approach. Since many of the wetland valuation studies

conducted historically operated without a complete understanding of the EGS benefits provided by wetlands, we utilized the EGS estimates in Table 2.3 in the survey instrument. First, the "no" vote was considered a choice of the Current Situation, with the concomitant further reduction of wetland area and reduction of EGS from wetlands in southern Manitoba. The programs entailed one of either the retention scenario or one of the four restoration scenarios. Associated with these options was an estimate of the changes in EGS from the current situation. Thus, we attempted to provide respondents with knowledge of *what* they were voting for and not some vague qualitative statements on the benefits of wetland conservation. We hoped that this approach enabled them to make informed decisions about their trade-offs between personal income and wetland conservation.

In order to facilitate the comprehension of wetland retention and expansion, the estimated levels of EGS provided by wetlands were converted into units we thought the average citizen could relate to. These conversions are shown in Table 4.1. Nutrient reduction of nitrogen and phosphorous were combined and converted to an equivalent number of semi-truckloads of fertilizer with an average capacity of 11 tonnes per truck[15]. Flood and erosion control estimates were simply converted to billions and millions of cubic meters respectively, as there was no clear comparison for such large volumes of water and earth[16]. Biodiversity was indicated by the number of nesting pairs of ducks. Carbon sequestration was related to the number of cars on Manitoba roads. For example, by 2020[17] the total wetlands in the Manitoba prairie pothole region would sequester a net carbon equivalent of 740,000 cars; 1 million cars at full 100%

[15] Based upon an average tandem axle truck capacity of 11,000kg (Alberta Infrastructure and Transportation 2006).
[16] Other conversions were considered and presented to the public focus groups, such as annual river flow, etc, but were considered to be less clear than simple volume measures.
[17] At the current rate of wetland decline.

restoration[18]. Total EGS provision was communicated based upon the full acreage of the restoration scenario in question rather than an increase or decrease from the base case.

Detailed estimates incorporating the complexities of estimating benefits of wetlands at a large scale, such as those found in Yang *et al.* (2008), were not provided in the voting scenarios due to the need for clarity and simplicity. These are rough numbers based upon per acre estimates of wetland EGS provision and the number of acres in each restoration scenario. While some precision may have been lost in this conversion, the target audience is the general public, and in the time respondents have to vote they must be able to weigh and consider their options without becoming overwhelmed in the analytic details of how the benefits were calculated.

Table 4.1 Estimates of the ecological goods and services provided by all wetlands in the Manitoba prairie pothole region in units considered more understandable to the general public for the various restoration scenarios.

Wetland scenario	Estimates of ecological goods and services				
	Nutrient reduction (semi-truck loads of fertilizer)	Flood Control (billion m^3)	Erosion control (million tonnes)	Biodiversity (1000 breeding duck pairs)	Carbon capture (cars on road)
Current situation	4,500	1.1	6	1,898	740,000
Retention	5,000	1.2	6.8	2,088	800,000
12.5% restoration	5,100	1.3	7	2,166	840,000
25% restoration	5,300	1.4	7.3	2,244	875,000
50% restoration	5,600	1.5	7.8	2,400	940,000
100% restoration	6,400	1.6	8.8	2,711	1,000,000

[18] Based upon an average car emitting 5 tonnes carbon per year (Natural Resources Canada 2008).

Associated with each proposed program was a randomly assigned, increased tax level that respondents would be required to pay annually for the next 5 years. The initial tax level distribution employed ranged from $25 to $500. We anticipated there would be few respondents voting for the restoration program regardless of the level of restoration at the $500 level and that many would vote for the program at the $25 level. Note that the $500 level is higher than the $400 level used in the focus groups. This decision was made in response to the fear that there may be potential for respondents to vote for the proposed program in each restoration scenario posed regardless of the associated increase in taxes. A tax of $500 was chosen to "choke" off demand for the program. This highest tax level is considerably higher than those used in recent Canadian valuation studies (see Olar *et al*. 2007).

The choice framework employed a referendum approach to address the issue of incentive compatibility. Referenda in a democratic government require a majority, and if a majority is reached, the entire collective must live up to the terms of the proposal successfully chosen by the majority. The referendum approach addresses free-riding in which an individual may prefer improved environmental conditions, but relies on others to fund the actual improvement (Adamowicz *et al*. 1997). Participants were also probed for their level of certainty following each of their choices in the wetland voting scenarios. If a respondent indicated a high degree of uncertainty their response to that particular vote was effectively considered a vote of "no" to the proposed wetland program (see Section 3.4.1).

The presentation used in the survey instrument addressed the concerns raised by CVM experts. However, a number of innovations were also employed. The use of five voting scenarios per respondent was utilized instead of the typical CVM case of only one.[19] The

[19] In some CVM application multiple votes are employed but the level of the environmental quality change is held constant and the tax level is varied depending on whether the respondent agreed to pay some original level or not.

presentation of these voting scenarios and associated tax levels was randomized in the final administration of the instrument to enable to assessment of responses to the first vote as well as the series of votes provided by the sample of respondents. This is important for tests of scope of the environmental quality changes implied by the various wetland programs (Carson and Mitchell 1993).

The third section of the survey contained a series of debriefing questions and elicited individual-specific information such as demographics and environmental attitudes. For the latter, membership in an environmental organization and visitation to parks was employed.

4.2.4 Survey Versions

Two versions of the survey were administered in the pre-test. The versions differed in the graphical presentation of the restoration levels in relation to the 1968 baseline in the voting scenarios (see Figure 4.1 below).

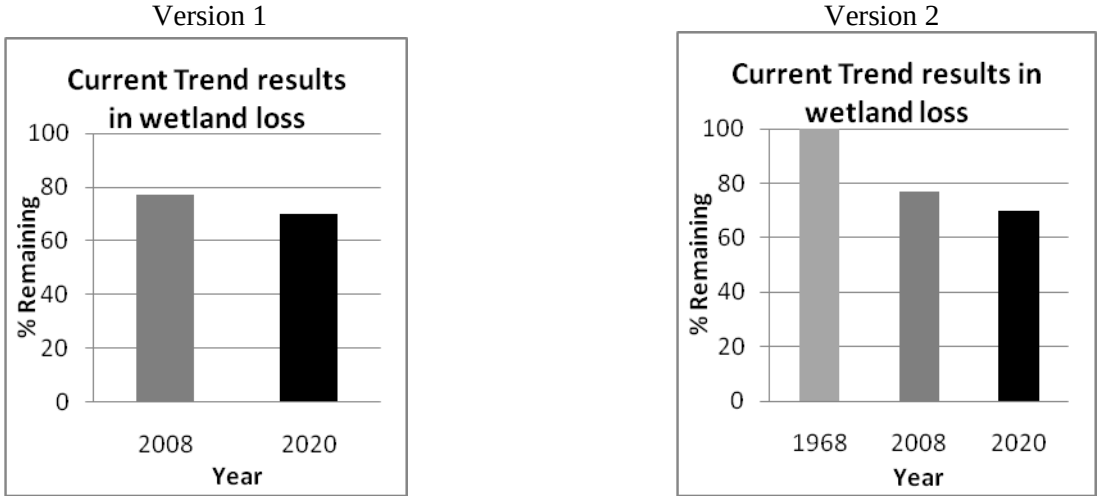

Figure 4.1. An illustration of the presentation of wetland area loss in two versions of the wetland restoration survey.

This is called double bounded CVM. This approach provides a great level of detail on the marginal utility of income. However, in this present study we varied the wetland level which provides more detail on preferences over the environmental quality change of interest.

Version 1 contained a histogram of the current area of wetlands in southern Manitoba as a percentage of wetlands remaining from the 1968 base area, as well as a second histogram comparing the projected future area in 2020 based on a linear trajectory of loss based in the period 1968-2008 in an absence of restoration. Version 2 had the above information as well as a third histogram showing the 1968 base level as a 100% wetland area. The construction of two versions arose from the focus group comment that Version 2 better illustrated the wetland decline that had occurred historically in the province[20]. There was concern about the possiblility of anchoring effects in this second version - respondents could anchor on the 1968 level rather than the current level in order to develop preferences for wetland restoration (a common design issue in contingent valuation studies). This could also relate to loss aversion bias, where the respondent's may vote for the proposed program to avoid further wetland loss rather than acquiring the benefits of wetlands. We hypothesized *a priori* that the willingness to pay estimates developed from Version 1 data would be lower than those developed from Version 2 data. It was deemed appropriate to obtain responses from both versions because of the responses received from public focus groups.

4.2.5 Yea-Sayers and Cheap Talk

In order to address concerns over hypothetical bias, the following information was provided to respondents in the survey prior to the valuation questions:

"*PLEASE NOTE: Research has shown that how people vote on a survey is often not a reliable indication of how people would actually vote 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. We call this hypothetical bias. In surveys that ask people if they would pay more for certain services, research has found that people may say that they would pay 50% more than they actually will in real transactions. It is very important that you "vote" as if this were a*

[20] When presented with the two options, most participants in the focus groups preferred the graph with 3 histograms because they could "see what the earlier level had been". This was an indication that participants may be anchoring on the earlier level and not basing the decisions soley on the information provided.

real vote. You need to imagine that you actually have to dig into your household budget and pay the additional costs."

Further to this narrative in the instrument, techniques employed by Olar *et al*. (2007) and Sverrison *et al*. (2007) were used to identify yea-sayers in the data. A debriefing question followed the voting scenarios, described in Table 4.2 below. Those that chose the answer "I think we should protect wetlands regardless of the cost" as the most important reason were termed "yea-sayers" and their survey data was not considered in developing estimates of economic values.

Table 4.2. The question employed in the Manitoba wetland restoration survey used to identify "yea-sayers".

If you voted yes for any of the PROPOSED PROGRAMS it was because:
In the first column, please check all the reasons that apply. In the second column, of those selected, please check the MOST IMPORTANT REASON by marking one box only.

REASON	Please check all that apply	Of those selected, please check the most important reason
I think that this is a small amount to pay for the benefits received		
I think we should protect wetlands regardless of the cost		
I feel it is the "right" thing to do		
It is important to invest in protecting wetlands for future generations		
The program is important but I don't really think it will cost me directly		
I might be affected by the loss of wetlands directly		
I think that our government does not do enough to protect our water and wetland resources		

4.3 Administration of the Survey and Pre-tests

Upon completion of focus group discussions and adjustments to the survey instrument, the questionnaire was pre-tested with a larger sample of respondents. Use of a large pre-test sample permits researchers to assess in a statistical manner the relevance and accuracy of the

research approach and the results. This pilot or pre-test stage of survey design is typically used to detect any remaining ambiguities and specifically in the case of CVM studies, to determine the final range of the bid or tax payment distribution.

A contract was established with the research marketing company Ipsos Reid for presentation and administration of the instrument to a sample representing the population of Manitoba. This firm used an internet panel for contact and response. Internet panels offer a number of advantages over mail, telephone or personal interviews (Dillman1999). Internet surveys are able to provide the respondent with a large amount of information in the form of pictures, graphs and other figures which can assist in understanding a variety of issues. Using computers reduces respondent error through programming that forces respondents to complete each question before moving on to subsequent questions, thus effectively removing data entry and recoding errors in the analysis stage. Finally, programming allows for complex experimental designs that would be difficult to implement with a paper based survey. Randomizing questions and ordering of valuation scenarios to reduce sequencing effects, and presenting the respondents relevant debriefing questions that relate to their specific answers. The approach also permits randomizing the presentation of information among respondents – particularly important for the tax payment levels used in the present study. This form of survey precludes the participation of households without access to the internet. However statistics show a high percentage of Manitoban households have internet access in their home, and many others have internet access at work (Statistics Canada 2007).

Ipsos Reid maintains a panel of about 10,000 Manitobans for survey purposes. Ipsos Reid staff regularly keep in touch with their panel members (called “managing” their panel) and can provide data on panel member’s demographic characteristics (e.g. city/town of residence, gender,

age, income, children in household, household size, education, own or operate a business, employment status, occupation, marital status, medical conditions, home ownership, internet experience and usage as well as information on financial products, technology products, alcohol and tobacco use, etc.). This information does not need to be obtained for each respondent, thus reducing response burden. Panel members are selected through a screening process with the intent to ensure representation of all demographic and market segments, and panel members receive various coupons and perks as an incentive to respond to various surveys that are sent to them. The Ipsos Reid panel is frequently "refreshed" (new members added and old ones excused) to ensure accurate representation of the changing demographics of the current population of interest.

The draft instrument was provided to survey design experts at Ipsos Reid on November 3 2008. The Ipsos Reid team made several formatting and question flow suggestions to which the research team agreed. Staff at Ipsos Reid coded the questionnaire for on-line presentation and administration. The research team requested Ipsos Reid to 1) randomly select a tax payment level from the following tax payment vector – {$25, $50, $100, $200, $350, $500}; and 2) randomly order the presentation of the 5 voting scenarios for each respondent. Each respondent therefore received a different order of wetland restoration levels and associated tax payments, thus enabling the comparison of the first vote results separately from the "panel" of vote responses across the respondents. This technique was used in the studies by Olar *et al*. (2007) and Sverrison *et al*. (2007) and permits a test of scope (see Carson and Mitchell 1993) as well as providing "statistical richness" in voting responses as each respondent provides information on 5 votes presented in a different order.

The pilot or pre-test was launched by Ipsos Reid to their internet panel of Manitobans on November 21 2008. A total of 353 individuals were surveyed, 84 of which only partially completed the survey. Of the 269 completed surveys, 134 completed Version 1 (2 histograms) and 135 of which completed Version 2 (3 histograms). Thus, complete survey data from 269 respondents was provided to the research team. Unfortunately through an error in administration the vote order was not randomized among the respondents. Hence Ipsos Reid administered a second pilot survey to a different sample from the Manitoba panel. The second pre-test was conducted online by Ipsos Reid between December 14 and 20, 2008. Restoration levels were randomized and recorded correctly by Ipsos Reid, and bid levels had been adjusted to $25, $100, $200, $350 and $600 – removing the previous $50 level and increasing the highest bid to $600. A total of 446 individuals completed this second pilot survey, and due to time constraints, detailed information on respondents who did not fully complete the questionnaire were not provided. This resulted in a total of 446 completed surveys, 271 of which completed Version 1 and 175 of which completed Version 2. This larger sample size was helpful in determining true preferences. As in the first pre-test, while a number of demographic and environmental attitudinal characteristics were captured by the survey pre-test, analysis was only conducted on the bid level distribution as this was the portion of the survey that captured the willingness to pay levels.

4.4 Econometric Model

The following section reviews the theory and statistical techniques used for the analysis of the respondent voting data. Discussion will be provided on the theory of random utility, economic valuation of the environment using willingness to pay and the conditional logit model used to estimate model parameters.

4.4.1 Random Utility Theory

Random utility models assess the utility or satisfaction associated with choosing the current state or a proposed program. Consumers are assumed to maximize their own welfare and always choose the alternative that gives them greater utility. The higher the utility associated with an alternative, the greater the likelihood of that particular alternative being selected. Utility is assumed to be a linear combination of proposed program and respondent characteristics (Verbeek 2004). The following utility function in equation [1] shows this relationship:

$$U_j = \alpha + \beta Z_j + \gamma D + \mu(Y - C_j) + \varepsilon_j \qquad [1]$$

where U_j represents the utility of program j, α is a constant, β is a vector of parameters associated with program characteristics (Z_j), γ is a vector of parameters associated with vector D of individual specific characteristics (such as income, age, gender etc.), μ represents the marginal utility of income which is obtainable from the difference between an individual's income and the price of proposed program C_j and ε_j is a random error term. No econometric model can fully predict or account for all the factors that influence consumer preferences (Verbeek 2004). The theory of random utility assumes that certain elements of respondent's preferences are random and therefore cannot be predicted by the model. The error term, ε, is meant to account for this random element of consumer behaviour that cannot be explained by other means (Adamowicz *et al.* 1997).

The constant, α, represents the baseline utility level experienced by all respondents independent of the proposed program or respondent characteristics. The β *and* γ parameters represent the marginal utilities associated with a unit increase in relevant proposed program attributes and respondent characteristics, respectively. The μ term represents the marginal utility of income and is assumed constant over different proposed program characteristics.

Respondents' perceptions of money are assumed constant over the range of available choices. These parameter estimates combined with respondent and program characteristics are then used to estimate a willingness to pay function for the environmental improvements (Haab and McConnell 2002).

4.4.2 Estimation of Economic Values

The value individuals place on improving wetland services is measured as a quality change in the state of wetland areas. This monetary measure assists policy makers in assessing and comparing the impacts different programs would have on public welfare. The welfare measure that equalizes a respondent's utility between states of the world implied by the current trend and a proposed wetland program is known as the compensating variation (CV) or more commonly an individual's willingness to pay (WTP) to see the quality change take place. After the proposed wetland program has been implemented, the CV would be equal to the decrease in income necessary to move a respondent's utility back to the level it was under the current trend (Freeman III 2003).

The equation below shows how WTP for a program k is calculated. Let V_0 represent respondent j´s utility associated with the current situation and V_1 the same individual's utility if a proposed wetland program is implemented. To simplify let X represent the vector of all right hand side variables (as seen in the previous section) apart from income and its relevant parameter vector δ (a combination of the β and γ vectors). Following the previous section, let Y_j represent income of individual j and μ the marginal utility of income. Note that the indirect utilities V_1 and V_0 are equal because WTP_k has been deducted from individual j's income after the proposed program is implemented.

$$V_1(Y_j - WTP_k, X_1) = V_0(Y_j, X_0)$$
$$\therefore \delta X_1 + \mu(Y_j - WTP_k) + \varepsilon_{1j} = \delta X_0 + \mu(Y_j) + \varepsilon_{0j}$$
$$\therefore\ WTP_k = \frac{\delta[X_1 - X_0]}{\mu} + \frac{\varepsilon_{1j} - \varepsilon_{0j}}{\mu}$$

Replacing ε_{1j} - ε_{0j} with ε and assuming that the differences in the error terms are distributed with a zero mean, the expected value of the willingness to pay for program *k* simplifies to:

$$E(WTP_k) = E\left[\frac{\delta X_1}{\mu}\right] - E\left[\frac{\delta X_0}{\mu}\right] + E\left[\frac{\varepsilon}{\mu}\right] = E\left[\frac{\delta X}{\mu}\right] + 0$$
$$\rightarrow E[WTP_k] = \frac{\delta[X_1 - X_0]}{\mu}$$

After all parameters have been estimated, this equation allows for the possibility of calculating participant WTP for the implementation of any proposed wetland program. The equation also shows the importance of the price variable parameter (μ) for without it welfare changes cannot be estimated (Haab and McConnell 2002).

4.4.4 Addressing Heterogeneity

A common issue in state of the world choice models like the one used in the present study is the limited ability to examine preference heterogeneity (Carlsson *et al*. 2003). As estimation is based upon the difference in utility between alternatives, socioeconomic variables that do not vary between alternatives cannot be included directly in the estimation (Grafton *et al.* 2004). Two methods to address this problem are the random parameters logit and the latent class approach.

Random parameters logit models allow for estimation of individual parameters to address parameter heterogeneity (Grafton *et al.* 2004). Selected explanatory variables are distributed randomly across individuals with fixed means, allowing for estimates of levels of heterogeneity.

A latent class approach is similar to the random parameters model, but parameter heterogeneity across individuals is modeled with a set of classes. The underlying assumption is that individuals are members of unknown or latent classes that can range from 2-5, specified in the model via the minimum Bayesian Information Criterion and/or Akaike Information Criterion (Boxall and Adamowicz 2002). Determination of class membership can be based upon attributes and socioeconomic variables such as age, income, etc. Welfare measures from individual classes are calculated in the same manner as the conditional logit model.

Chapter 5 Results and Discussion

5.1 Introduction

The final data were collected in January 2008 via an internet panel from approximately 10,000 individuals, representative of the general Manitoba population. In total information was collected from 1,980 individuals that completed the survey and 154 individuals that partially completed the survey.

The following section describes respondent impressions, summarizes results of the survey, and provides willingness to pay estimates from several econometric models. Finally, aggregate benefits of wetland restoration are compared with cost estimates in a discussion of the socially efficient level of wetland restoration.

5.2 General Results

5.2.1 Impressions

Individuals that agree to be Ipsos Reid panel members regularly complete surveys for the company. It is routine at the completion of a survey for respondents to be questioned regarding their impressions of the survey compared to other surveys they have completed for the company. Table 5.1 below shows the respondent impressions of this survey: in terms of learning something new, how meaningful it was and how fun it was to answer the survey ranked in the 90^{th} percentile. The respondents' rating of the length of this present survey represented the median response when compared to other surveys the respondents had answered from Ipsos. As CVM surveys must present a considerable amount of information in a short period of time, respondents may feel tired and stop providing accurate responses. The median ranking for length is indication that the survey was well within the average length.

Table 5.1. Feedback from respondents on their impressions of the Manitoba wetland restoration survey.

Rank percentile*			
Learned something new	Survey was meaningful	Fun to answer	Length
90	90	90	50

*100 indicates that the sample of panellists fell in the 100th percentile of all surveys conducted by Ipsos in which these panellists participated.

Data from 154 respondents who partially completed the survey yielded insight into their reasons for not completing it. Major reasons for partial completion were interruption and survey length, as individuals were interested and seemed to understand the issue, not feeling their responses would be worthless (Table 5.2). As this is feedback from individuals who did not even complete the survey, this is good indication of the effectiveness of the survey in conveying information in a clear and interesting manner.

Table 5.2. The percent distribution of the reasons respondents who partially completed the Manitoba wetland restoration survey listed for their partial completion. (N=154).

Reason	Percent of total			
	Very Important	Somewhat Important	Not very Important	Not at all important
Interrupted when completing	31.6	27.1	16.1	25.2
Too long	25.5	26.1	22.9	25.5
Too complicated	12.3	25.3	30.5	31.8
Not interested in the issue	7.8	29.9	33.1	29.2
Response would NOT make a difference	6.5	19.0	35.9	38.6
Did not understand the issues	5.2	26.6	34.4	33.8

Table 5.3 compares socio-demographic characteristics of the sample of respondents versus the population of Manitoba recorded in the 2006 census by Statistics Canada. The comparison shows that the sample simulates the population characteristics well, with income, gender ratio, household size and percentage married close to that of census data of the Manitoba

population. Median age from the sample is higher than the Manitoba population because data were collected only from individuals over 18 years of age. As Statistics Canada provides median age from the entire population, including those less than 18 years old, it is reasonable to consider the sample age representative.

Table 5.3. Socio-demographic characteristics of the sample vs. Manitoba population.

Characteristic	Full sample (N=1980)	Manitoba population
% male	48.0	49.8
Median household income ($)*	57,500	58,700
% married	49.6	46.0
Average household size	2.62	2.5
Median age*	51.0	38.1

*Statistics Canada provides median age of entire population, while this sample only includes those 18 and over.

5.2.2 Environmental Sentiments and Location Information

Environmental characteristics and location information of respondents was collected in order to further understand voting behaviour. A large majority of Manitoba residents (90%) are not members of any form of environmental organization such as the Nature Conservancy or Ducks Unlimited Canada, or members of any hunting and fishing organization (Table 5.4).

Table 5.4. Information on membership in environmental organizations, residence, and location where raised by respondents to Manitoba wetland restoration survey (N=1980).

	Percentage of total sample
Membership in Conservation Groups	
Hunting or fishing organization	4.1
Environmental or conservation organization	6.0
Neither	91.2
Visitation to Manitoba Parks	
Yes	70.5
No	29.5
Location Raised	
Rural Area	23.3
Small Town	22.1
City	53.9
Declined Response	0.7
Region Raised	
Manitoba	80.1
Elsewhere in Canada	14.9
United States of America	0.9
Outside of Canada and USA	3.7
Declined Response	0.4

Visitation to Manitoba parks is popular among Manitoba residents - 70% of respondents indicated that they had visited a park in the last year. Provincial and National Parks were not distinguished, so visitation could involve an afternoon visit to an urban park or an extended trip in a National Park. Manitoba has a large network of provincial parks and Riding Mountain National Park in quite close to a number of major urban centers, allowing ease of access and exposure to natural areas. Such exposure to natural areas could contribute to increased environmental awareness and concern.

The majority of respondents were raised in the province of Manitoba (Table 5.4). The remainder were mainly from other parts of Canada, while only a very small percentage were from the United States or elsewhere. Approximately half of the people were raised in a city,

while the rest were from either a small town or rural area. This longstanding residency and rural connection in the province may provide insight into voting behaviour.

5.2.3 Information Section Response

The following tables present the responses of the full sample of individuals to various questions within the information sections of the survey. These questions were included in the survey to maintain interest and attention, but can provide insight into respondents' opinions and preferences.

In order to start the respondents thinking about tradeoffs and other government services that require funding, a series of questions regarding general attitudes towards public goods were asked. Improving roads and highways, reducing crime and improving health care rank high as areas where government should be expending more effort (Table 5.5). To a lesser degree, supporting the arts, improving education, encouraging economic growth, increasing jobs in rural communities and lowering taxes were also all considered to be worthy of more government attention. Protecting the natural environment ranked fourth in terms of emphasis on more action. Even when faced with tradeoffs between other programs requiring government funding, environmental conservation still ranked high.

Table 5.5. Respondents' attitude towards the level of government spending on several public services gathered in the Manitoba wetland restoration survey (N=1,980).

Public service	Percent total respondents					
	A lot More	A little more	Same	A little less	A lot less	Total
Reducing Crime	56.5	27.9	13.4	1.3	0.9	100
Improving Health Care	53.3	33.2	12.0	0.9	0.6	100
Improving Roads and Highways	52.5	33.0	12.7	1.0	0.9	100
Protecting the Natural Environment	36.2	36.5	24.2	1.9	1.1	100
Encouraging Economic Growth	35.4	42.9	20.1	0.9	0.8	100
Lowering Taxes	34.0	32.5	28.3	3.5	1.7	100
Improving Education	32.5	39.3	25.8	1.7	0.7	100
Increasing Job Opportunities in Rural Communities	30.3	39.2	27.3	2.0	1.2	100
Supporting the Arts	8.8	17.5	47.2	16.9	9.6	100

Familiarity with environmental issues in the province was also gauged. Table 5.6 shows that before completing the survey respondents were less familiar with wetland loss than with other environmental issues such as nutrient overflow into Lake Winnipeg and climate change.

Table 5.6. Respondent familiarity towards several environmental issues in the province of Manitoba from the Manitoba wetland restoration survey (N=1980).

Environmental Issue	Percent total respondents				
	Familiar	Somewhat Familiar	Somewhat unfamiliar	Unfamiliar	Total
Climate Change	25.3	59.7	11.5	3.5	100
Nutrient Overload in Lake Winnipeg	22.5	46.4	18.3	12.7	100
Cross Border Pollution	20.9	52.4	17.7	9.0	100
Hydroelectric developments in the boreal forest	12.8	47.4	23.7	16.2	100
Intensification of Agriculture	12.5	46.7	27.1	13.6	100
Loss of Wetlands in the South	12.4	43.0	30.6	14.0	100

When provided with information regarding wetland benefits and loss rates, almost 90% percent of individuals suggested some level of concern about the issue (Fig. 5.1). A majority of sample respondents seemed to be concerned, even if not completely familiar with the wetland loss issue.

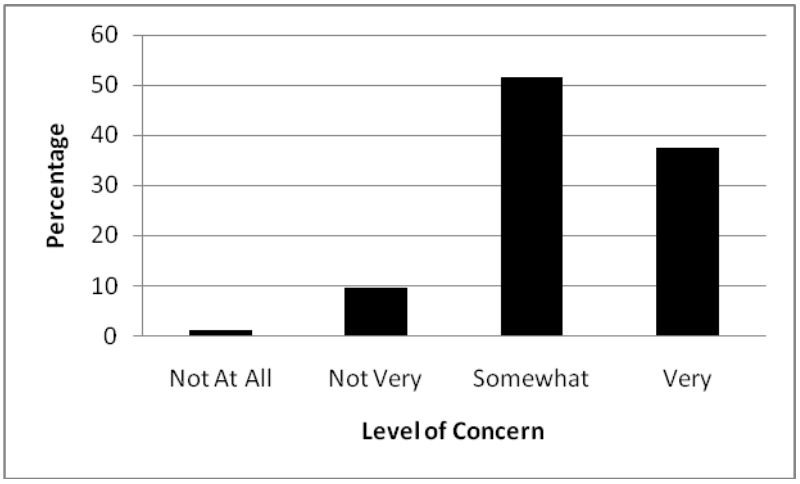

Figure 5.1. Levels of concern expressed by respondents to the Manitoba wetland restoration survey over wetland loss in southern Manitoba (N=1980).

Concern was expressed in focus groups, particularly among agricultural producers, that urban people would likely expect the farmers to bear the burden of wetland restoration costs. Survey data indicate otherwise. While most people felt that landowners bore some level of responsibility for wetlands restoration (Figure 5.2), very few felt they should bear this financial cost alone.

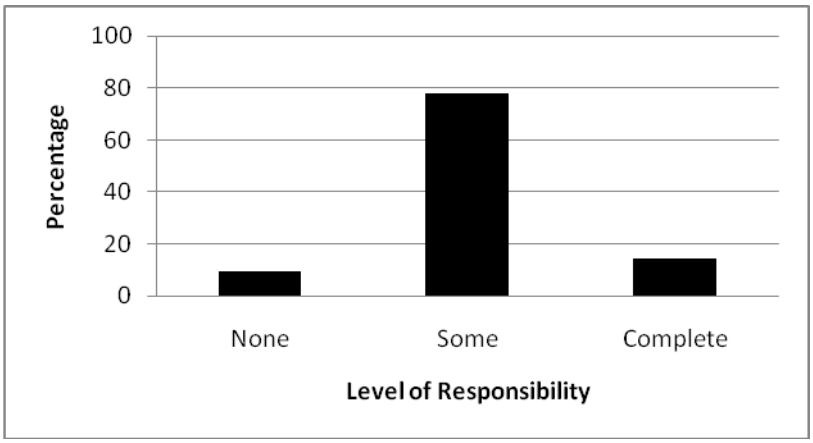

Figure 5.2. Levels of financial responsibility of landowners for wetland conservation in Manitoba expressed by respondents to the Manitoba wetland restoration survey (N=1980).

When further probed on financial responsibility, respondents felt landowners had some financial responsibility for wetland restoration, but that government should pay the larger share of restoration costs (Figure 5.3). Respondents also supported the involvement of non-governmental conservation groups (e.g. Ducks Unlimited Canada) in sharing the financial costs of wetland restoration. This information can be considered as supportive of policies that do not expect landowners to bear the full costs of wetland conservation, and suggests that public opinion supports some level of compensation for their conservation practices.

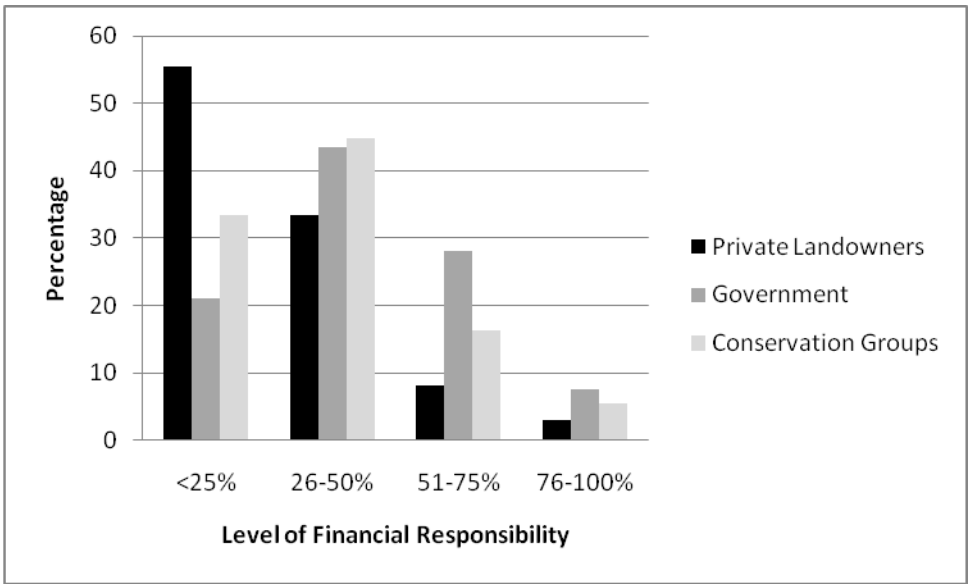

Figure 5.3. The percent distribution of the level of financial responsibility for wetland conservation in Manitoba from respondents to a survey on wetland restoration in Manitoba (N=1980).

5.3 Voting Responses

Preferences associated with wetland retention and restoration in southern Manitoba were estimated using logit model parameters estimated on pooled Version 1 and Version 2 data[21]. This section outlines how hypothetical bias was addressed in the study, describes variables used in the analysis, the willingness to pay function per proposed program, the validity of the willingness to pay estimates using the scope test and willingness to pay estimates aggregated over the entire population of Manitoba.

5.3.1 Addressing Hypothetical Bias

Yea-sayers were identified using the debriefing question described in the Methodology section. Figure 5.4 shows these individuals were not sensitive to increased tax levels and would have inflated WTP estimates if included in the final analyses. A total of 132 individuals from the

[21] Preliminary econometric estimates using the pooled data with a dummy variable for version suggested that data from Versions 1 and 2 were not statistically significantly different and could be legitimately pooled.

dataset of 1,980 were not included for econometric estimations. This number of yea-sayers as a proportion of the total sample was smaller than what was observed in the Sverrisson *et al*. (2007) and Olar *et al.* (2007) studies. While these individuals may in fact have a very high WTP for wetland conservation, the literature suggests they may not be taking the voting scenarios seriously and should be removed from the sample (Blamey *et al.* 1999).

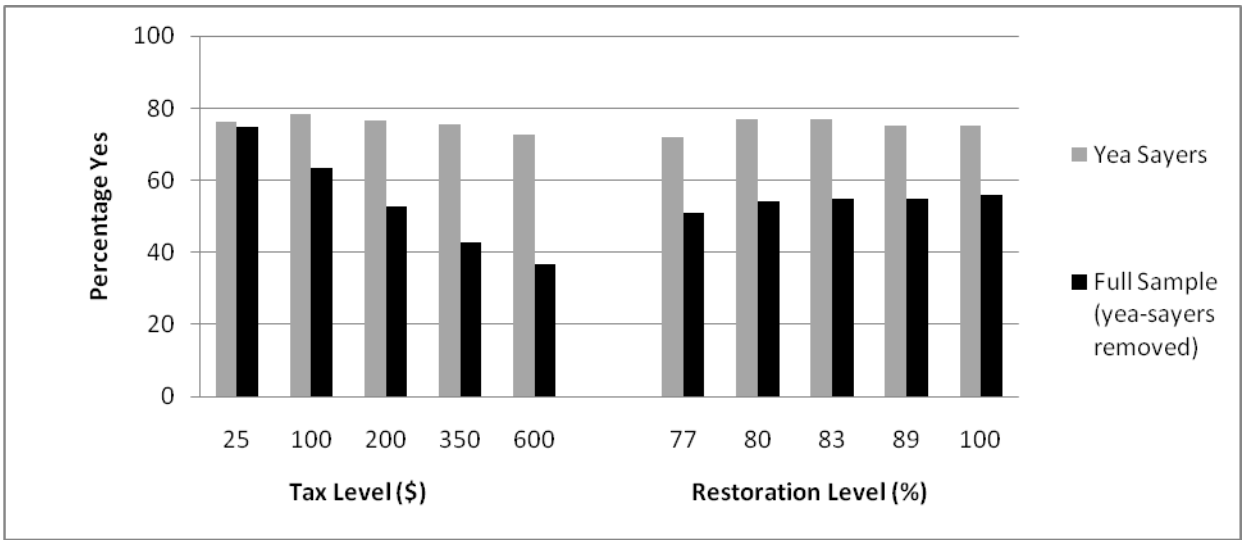

Figure 5.4. Comparison in terms of tax and restoration levels of "yes" votes between yea-sayers and the full sample with yea-sayers removed for wetland restoration in Manitoba.

Votes for the proposed program that were uncertain were coded to "no". The figure below identifies uncertainty levels in voting responses among tax levels. A total of 615 responses from 358 individuals were recoded to "no" in the entire dataset. As tax levels increase, respondents became more uncertain regarding their voting decisions. However, uncertainty did not seem to vary between levels of restoration. This figure does not distinguish between those that voted for or against wetland programs.

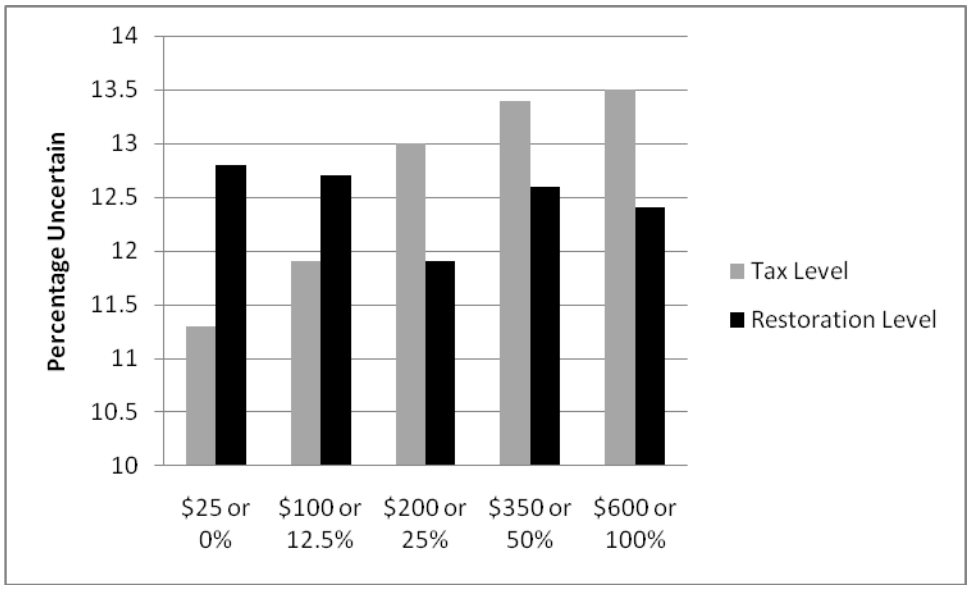

Figure 5.5. Percentage of "uncertain" votes for wetland restoration programs in Manitoba compared with the levels of tax and restoration (N=1,848; yea-sayers were removed).

5.3.2 Variables in the Models

Several logit model specifications were used to estimate the parameters shown in equation [1]. In all cases the dependent variable was the respondent's vote indicating either a "yes" response to supporting the proposed wetland restoration or retention program at the stated tax level or a vote of "no" indicating choice of the current situation which was a continued decline of wetland area at the current rate of 0.57% per year. The set of explanatory variables were divided into four categories: design variables, demographic variables, endogenous variables reflecting their environmental sentiments and financial attitudes, and location variables.

The design variables represent the levels of restoration and taxes and were the main factors used to describe the proposed programs. The restoration parameter was input as wetland acres relative to the total 1968 level. While all four ways of describing the restoration scenarios (Table 2.3) could have been used, it was decided to that using the relative number of 1968 wetland acres would ease interpretation. Demographic variables involved individual

characteristics such as income, gender, age, number of people in the household. Endogenous variables describing environmental sentiments were based on responses to attitudinal survey questions such as the membership in environmental organizations and visitation to Manitoba parks. Financial attitudes distinguish between those that feel government bears the majority of responsibility for restoration and those that feel private landowners and environmental organisations are responsible. These are endogenous in that it is unclear if they determine valuation sentiments, or are determined by valuation sentiments. Finally, dummy variables indicating the region of respondent's residence was added to the final model to determine if respondents from certain locations in Manitoba voted in a particular way. Explanatory variables were divided into the four categories in order to allow a more careful look at the individual variables and their effects.

Table 5.7. Descriptions of variables and associated descriptive statistics used in the econometric analyses of preferences for wetland restoration programs in Manitoba (N= 9,240 votes from 1,848 respondents*).

Variable	Type	Mean	SD	Min	Max	Description
Design variables						
Tax	Continuous	126.01	191.03	0	600	Five tax levels ($25,$100,$200,$350, and $600)
Restoration level (in 1000's of 1968 acres)	Continuous	1055.12	131.54	949.18	1355.98	Six options relating to current situation, retention and four levels of restoration.
Demographic variables						
Income ($)	Continuous	64.87	35.99	2.50	160	Thousands of dollars annually
Male	Dummy	0.48	0.49	0	1	Gender=1 if male
Age (years)	Continuous	48.39	15.02	18	89	Age of respondent
Household size	Continuous	2.64	1.31	1	10	Number of people in respondent's household
Environmental and Financial attitude variables						
Membership in an ENGO	Dummy	0.06	0.23	0	1	Member of an environmental organization 1=member
Park visitation	Dummy	0.71	0.46	0	1	Visited a Manitoba Park within the last year 1=visited
Government share of restoration costs	Dummy	0.35	0.48	0	1	1=gov should pay >50%
Landowner share of restoration costs	Dummy	0.11	0.31	0	1	1= landowner should pay >50%
Location variables						
Brandon	Dummy	0.04	0.19	0	1	1= residence in Brandon
Thompson	Dummy	0.01	0.09	0	1	1= residence in Thompson
Rural	Dummy	0.22	0.41	0	1	1= residence in a rural area

* Yea-sayers removed

5.3.3. The Basic Model

The econometric software LIMDEP (Greene 2006) was used to estimate the parameters in the logit model framework. The data reflects two states of the world – conserving wetlands or not conserving wetlands.

In the conditional logit framework, individual respondents are asked to vote between two alternatives: conserving wetlands or allowing them to decline at their current rate. A vote of "yes" to the proposed program is also a vote of "no" to the current situation, and vice versa. Restoration units used in the models were acres relative to 1968 rather than restored acres or related percentages (Table 2.3). Using these units allowed for ease of interpretation and transformation to various functional forms. WTP estimates were then calculated for each level of restoration based upon the econometric theory provided in Section 4.4. The basic model in Table 5.8 includes only the design variables.

Several specifications for the restoration parameter were examined to determine which was the most appropriate to use for aggregate WTP calculations. The results from three specifications are provided in Table 5.8 (see below), though reciprocal and square root forms were also tested. The squared term in the quadratic functional form was insignificant and therefore not deemed appropriate to use for aggregate willingness to pay calculations. The linear and logarithmic functional form specifications are quite similar in terms of the McFadden R^2 value (0.0565 vs. 0.0566 respectively). Either model could be used to calculate aggregate willingness to pay, as the R2 values are smaller than 0.01 (Ben Akiva and Lerman 1985). The logarithmic specification with a slightly larger R^2 value was selected.

Table 5.8 Parameter estimates (*t*-statistics*)* from conditional logit models using three specifications for the level of wetland restoration variable (N=9,240 observations from 1,848 individuals*).

	Linear specification	Quadratic specification	Logarithmic specification I	Logarithmic specification II
Dependent Variable: Probability of willing to pay a specified price level				
CurrSit	-0.78868*** (-14.515)	-0.64056*** (-5.03)	-0.77306*** (-13.314)	-0.80298 (12.859)
Tax Level	-0.00283*** (-25.755)	-0.00286*** (-25.761)	-0.00283*** (-25.756)	-0.00278 (-24.061)
Restoration	0.00055** (2.794)	0.00753 (1.385)		
Restoration*Restoration		-2.90E-06 (-1.285)		
Ln(Restoration)			0.67299** (2.842)	0.52243 (1.986)
RetTax				-0.00025 (-1.302)
N	9240	9240	9240	
Log-likelihood	-6004	-6003	-6004	
P-value chi-square	0.0000	0.0000	0.0000	
McFadden R^2	0.05628	0.05631	0.05630	

*Yea-sayers removed

In the fourth column of Table 5.8 are parameter estimates for an additional model with the logarithmic specification of wetland retention. This model includes an interaction term where the tax variable is multiplied by a dummy variable for those scenarios that focused on retention of existing wetland levels rather than restoration. The parameter on this variable is negative but statistically insignificant. This model was estimated to examine the potential for loss aversion that many economists have uncovered in empirical work (Kahneman *et al*. 1991). While the negative parameter estimate supports the potential for loss aversion, its insignificance suggest that this effect is not strong. Hence the first logarithmic specification will be used for further analysis in this thesis.

5.3.4 Validity Testing: The scope test

The scope test has been suggested as a means to test the validity of welfare estimates in CVM studies. If respondents are sensitive to the scope of the proposed environmental change it could imply that they took the hypothetical scenarios seriously and considered the relevant trade-offs posed to them in the referendum. When respondents are sensitive to scope they should be willing to pay more for greater levels of provision of the public good (Champ *et al*. 2003). The scope test results presented in Table 4.6 arose from WTP estimates using design parameters from the basic model shown above. First vote responses were selected in order to perform the test without any sequencing or anchoring effects. Both scope tests had yea-sayers removed and uncertain votes treated as "no´s".

Table 5.9. Results of scope tests: Estimates of household WTP ($) for wetland restoration in Manitoba for retention and high levels of restoration by vote sequence (N=9,240 observations from 1,848 individuals*).

	Willingness to pay ($/household) by vote sequence						
	1st Vote	2nd Vote	3rd Vote	4th Vote	5th Vote	All votes pooled	Votes 2-5
Retention	463.87	318.88	225.28	272.51	175.42	271.67	250.79
S.D	951.00	45.67	39.72	29.83	44.44	17.60	17.23
Restoration100%	519.39	380.75	405.55	396.45	259.96	359.48	340.57
S.D.	390.00	40.02	35.65	28.06	20.85	21.17	20.98

*Yea-sayers removed

When all votes are combined the willingness to pay estimates pass the scope test – that is, respondents are willing to pay more for the 100% level of restoration than simply retaining the current level. This suggests that they are distinguishing between restoration levels and are making their decisions based upon tradeoffs among the differing levels of goods and services that these wetlands provide. However, while the mean WTP estimates in the first vote are higher

for full restoration than full retention as expected, the differences in these means are not statistically significant and so do not pass the scope test. This is the only "pure" vote where respondents have not been influenced by other votes, and it is this vote that would truly validate the model. As can be seen, the standard deviations are very high[22], inferring that the responses in the first vote are highly variable. When the first vote is removed, the pooled results from observations 2-5 are less variable, and the welfare measures from using all of the votes pooled are not statistically different than those when the first vote is removed. Possibly respondents had some difficulty choosing a vote the first time they saw these voting scenarios and had to "learn" how to consider the trade-offs. Further research is required to fully understand this potential.

Bishop and Mullarkey (1999) found that wetlands may be a particular case of valuation that will not pass the scope test due to unclear understanding of the benefits provided at the various levels of wetland service provision. However, this Manitoba study employed clear quantification of the benefits and in terms understandable to the layman (Table 4.1), so we expected that it would pass the first vote scope test. There may be some undefined characteristics of wetlands that cause people to respond differently. While it is clear that as respondents are presented with more scenarios they are more sensitive to scope – and perhaps anchoring on the levels we are providing them – evidence from focus groups and pre-tests suggested that we are in the correct region of bid levels, making the results more reliable than the single vote scope test might suggest.

5.3.5 Four Models

The various variable categories described in Table 5.7 were then combined to generate models in order to understand more fully the determinants of the observed votes in the

[22] Standard deviations were calculated in the econometric software using the Krinsky and Robb procedure (see Haab and McConnell 2003).

referendum questions. Logit regression results and descriptions for each of the four models are provided below in Table 5.10.

Model 1 contained the design variables of tax and level of wetland restoration. The parameter estimates show the alternative specific constant for the current situation (Currsit) is negative and significant, indicating that respondents do not like the current rate of wetland loss. The tax coefficient was negative and highly significant. That is, as tax levels increased for wetland programs respondents were less willing to vote for the proposed programs. The level of wetland restoration was positive and significant, indicating that respondents preferred restoring more wetlands to less and value increased provision of ecological goods and services. The restoration parameter was not as highly significant as the tax level.

Model 2 was similar to model 1 in the inclusion of the design variables (signs and significance remained the same) but added several exogenous demographic variables to the regression. Household income was found to be positive and statistically significant. This is intuitive in that wealthy individuals may have more money to contribute to causes such as wetland conservation programs. Age was positive and significant, indicating that older individuals were more likely to vote yes to the proposed wetland program. Male gender was negative and statistically significant – men are less likely to pay for wetland restoration. The number of people in a respondent's household had a negative and statistically significant effect on voting for the proposed programs. This result probably indicates that larger households have less disposable income available for spending on the environment. However, this variable was not highly correlated with the income variable.

Model 3 included the same variables as model 2 but added possibly endogenous variables such as respondents' environmental sentiments and financial responsibility. Environmental

sentiments were measured by membership in an environmental organization and visitation to parks in Manitoba in the previous year. Both of these variables were positive and significant. Those individuals that joined environmental organizations and visited national or provincial parks could place more value on the natural environment and may be willing to pay more to preserve it. The design variables were also included in this model and with the exception of the ASC becoming insignificant, their signs and significance did not change with the addition of the new variables. Financial responsibility for wetland conservation in general was indicated by respondent opinions regarding landowner and government financial responsibility. Individuals felt that government should bear more of the costs while landowners should not have to bear the financial burden of restoration. Both of these variables are statistically significant.

The final model added some location dummy variables in order to determine if region played a role in voting behaviour. Residents of Thompson, a northern town far from the prairie pothole region, were found to be less likely to vote for the proposed program; while residents of Brandon were more likely to vote for the program (positive and significant). The dummy variable for rural residents was included in the model as these may be the individuals that will be most directly affected by actions to increase wetland areas. This variable is negative and statistically significant, indicating that rural residents do not typically prefer wetland restoration. One possible explanation for this voting result is that they may feel the majority of the financial burden of restoration would fall to them. All previous variables retained their signs and significance.

Table 5.10. Parameter estimates (t-statistics) from four logit models explaining determinants of respondents' voting behaviour for wetland restoration programs in Manitoba **(**9,240 observations from 1,848 respondents*)**.**

	Model 1	Model 2	Model 3	Model 4
Currsit (ASC)	-0.77306*** (-14.515)	-0.38242*** (-3.200)	-0.12670 (-0.551)	-0.08459 (-0.660)
Tax level ($)	-0.00283*** (-25.756)	-0.00287 (-25.415)	-0.00293*** (-25.677)	-0.00294*** (-25.703)
Ln (Restoration level) (in 1000's of total 1968 acres)	0.67299** (2.842)	0.67612** (2.776)	0.68474** (2.789)	0.68768** (2.798)
Household income (in 1000's of dollars)		0.00142** (2.219)	0.000912 (1.399)	0.00087 (1.316)
Male Gender		-0.16055*** (-3.539)	-0.18643*** (-4.064)	-0.21394*** (-4.533)
Age		0.01102*** (7.052)	0.01187*** (7.504)	0.01222*** (7.693)
Number of people in the household		0.05004** (-2.742)	-0.04783** (-2.601)	-0.04878** (-2.646)
Member of an environmental organization			0.34143** (3.464)	0.35079** (3.552)
Visited a park			0.29403*** (5.842)	0.30135*** (5.951)
Government Share (over 50% of restoration costs)			0.35736*** (7.482)	0.36052*** (7.539)
Landowner Share (over 50% of restoration costs)			-0.24807** (-3.473)	-0.25627** (-3.583)
Resident of Brandon				0.36328** (3.083)
Resident of Thompson				-0.16909 (-0.728)
Rural resident				-0.13080* (-2.350)
N	9240	9240	9240	9240
Log-likelihood	-6004	-5696	-5633	-5624
Log-likelihood P-value chi-square	-6364 0.0000	-6087 0.0000	-6087 0.0000	-6087 0.0000
McFadden R^2	0.0563	0.0634	0.0733	0.0744

*yea-sayers removed

Parametric WTP estimates[23] from the various models were virtually the same, and results are provided below (Table 5.11). Individuals were WTP approximately $294 per household per year for a five year period to retain the current level of wetlands. As restoration levels increased, so did the WTP, but at a decreasing rate. In order to restore all of the wetlands lost since 1968, individuals will pay up to $356 per household per year for five years. The marginal values[24] are constant throughout the levels of restoration. These results are an affirmation that people in Manitoba want more wetlands restored, and place greater value on higher levels.

Table 5.11. Estimates of willingness to pay from four logit models explaining determinants of respondents' voting behaviour for wetland restoration programs in Manitoba (9,240 observations from 1,848 respondents*).

	$/household/year
Retention at current level (77% of 1968 level or 1,044,102 acres)	294.54
SD	12.07
Restoration to 80% of 1968 levels (to 1,083,087 acres)	302.47
SD	10.42
Restoration to 83% of 1968 levels (to 1,122,071 acres)	310.71
SD	9.30
Restoration to 89% of 1968 levels (to 1,200,040 acres)	326.77
SD	9.74
Restoration to 100% of 1968 levels (to 1,355,977 acres)	356.07
SD	16.71

*Yea-sayers removed

[23] Non-parametric welfare estimates were also calculated using Turnbull Estimates with pooling (Haab and McConnell 2002) and were found to range from $290 (retention) to $325 (full restoration) – consistent with the parametric values.

[24] Percent change in WTP/Percent change in acres.

5.3.7 Heterogeneity

In order to examine heterogeneity in preferences for wetland conservation both random parameter and latent class models were estimated. Initially the random parameter logit model was used to develop a general sense of heterogeneity within the sample, and then the latent class model was employed to determine specific factors contributing to heterogeneity.

In the random parameters model (Table 5.12) both the current situation alternative specific constant and the restoration level were specified as random. That is, these variables were allowed to vary in a normally distributed manner across individuals with fixed means. Standard deviation of the current situation is highly significant, indicating that there is great variation in preferences for choice of the current situation. Some respondents were supportive of wetland retention and restoration programs while others would be quite content remaining with the current trend. In terms of the restoration level there is evidence of heterogeneity, but it is not statistically significant.

Once the existence of heterogeneity in the sample was established, the latent class model was employed to understand what socio-demographic characteristics contribute to this variation. The latent class model sorts respondents into classes based on their choices in the referendum CVM questions as well as the explanatory variables income, gender, environmental membership and financial responsibility (Table 4.8). These variables were selected as defining features of class membership as they are all significant in earlier regressions and have been used in other wetland valuation latent class model studies (e.g. Milon and Scrogin 2006). Three classes were selected based upon minimum Bayesian Information Criterion (BIC) and Akaike Information Criterion (AIC) results (Boxall and Adamowicz 2002).

Class one, comprising about 40% of the sample, can be considered the "pro wetland conservation group". The current situation ASC is negative and statistically significant. This group dislikes the current situation and appear to support greater levels of restoration. However, as expected they dislike increased taxes. These individuals tend to be higher income, members of environmental organizations and less likely to be male. They also feel landowners should not bear major financial responsibilities for wetland restoration.

Class two is considered the "strongly pro wetland conservation group" and constitutes about 34% of the sample (Table 5.12). This group is characterized by a large negative and statistically significant ASC for the current situation. This ASC parameter is more than twice the magnitude of the ASC in class one suggesting that the preferences for action in this second class are stronger than those for members of class one. Membership tends to include individuals that are members of environmental organizations and feel that government should pay for wetland restoration. Income and gender are not significant factors in explaining membership in this class.

Class three is the base that the other two classes are compared with, and includes the remaining 25.7% of individuals. This is the "ambivalent group", who neither dislike nor like the current situation as evidenced by the statistical insignificance of the associated ASC. These individuals clearly dislike higher taxes and do not particularly care about wetland restoration (Table 5.12). These people are unlikely to support any form of wetland restoration policy.

Table 5.12. Regression results from a random parameters and latent class model to examine heterogeneity in voting behaviour for wetland retention and restoration in Manitoba (N=9,240 observations from 1,848 individuals*).

	Random Parameters Model		Latent Class Model			
Variables	Coefficient	SD parameter	MNL	Class 1	Class 2	Class 3
CurrSit (ASC)	-1.735***	2.892***	-0.773***	-1.442***	-3.166***	-0.169***
	(-16.262)	(30.777)	(-13.314)	(-11.274)	(-21.655)	(-1.041)
Tax	-0.00627***	-----	-0.003***	-0.007***	-0.003***	-0.003***
	(-29.952)		(-25.756)	(-20.928)	(-12.401)	(-15.169)
Ln(Restoration (in 1000's of 1968 acres)	1.331**	0.427	0.673**	1.620**	1.0790*	0.748
	(3.950)	(1.464)	(2.842)	(3.182)	(1.907)	(1.111)
Income (1000's of dollars)	----	----	----	0.46D-05*	0.29D-05	Fixed Parameter
				(2.033)	(1.365)	
Male	----	----	----	-0.00044*	-0.00034	Fixed Parameter
				(-1.903)	(-1.566)	
EnvOrg	----	----	----	0.8680*	1.024*	Fixed Parameter
				(2.090)	(2.709)	
DGovernment	----	----	----	2.061	0.649**	Fixed Parameter
				(1.158)	(4.581)	
Latent Class Probability	----	----	----	0.399	0.344	0.257
Log Likelihood			-4643.213			
Restricted LL			-6404.680			
Adj R2			0.27353			

*Yea-sayers removed

While there is support for wetland conservation among most of the individuals in the sample, some respondents would clearly not be supportive of significant actions to restore lost wetlands - at least using taxes as an instrument to fund this restoration. Knowledge of the existence of differences between individuals and what demographic characteristics contributed to these differences is useful for policy recommendation and implementation.

5.4 Debriefing

In order to determine reasons for respondent voting behaviour several debriefing questions were asked. For those that voted for both the current situation and proposed programs, this was beneficial in understanding their voting behaviour and public perceptions surrounding the various services those wetlands provide.

Respondents identified water quality benefits provided by wetlands as the most important[25] reason for voting for restoration programs. This is an intuitive result considering the increased awareness of the contamination and eutrophication of Lake Winnipeg. Two other major contributors affecting voting decisions were increased household taxes and wildlife habitat. Flood water and sediment control were also contributors, likely due to the flooding problems that Manitoba faces every spring. Carbon sequestration and size of wetland expansion were also factors, but to a lesser degree.

Table 5.13. Reason for voting on the proposed program of wetland restoration in Manitoba in terms of information provided in the voting scenarios (N=1,752*).

Reason	Percent total respondents				
	Extremely Important	Very important	Somewhat important	Not at all important	Total
Water Quality	39.5	44.3	14.8	1.4	100
Increased household taxes	39.0	33.7	24.1	3.1	100
Wildlife Habitat	25.1	31.3	30.3	3.4	100
Flood Control	20.0	42.7	34.2	2.31	100
Soil Erosion	17.0	40.4	39.7	2.9	100
Carbon capture and storage	15.8	35.8	40.9	7.5	100
Size of Wetland Expansion	15.0	33.6	45.4	6.0	100

*228 respondents never voted for the proposed program.

[25] "very important" and "extremely important" categories were pooled

The major factor causing respondents to vote against wetland improvements was the increase in taxes (Table 5.14). Other issues were relatively small by comparison; very few people felt the program would not be of benefit or that the issue was not important. Some individuals felt that taxes could be better spent on other public needs; and some respondents felt that they did not have enough information to make an informed decision. In terms of reaching targets, some felt that targets would be reached too soon, and there was no real sense of urgency. Very few respondents felt that the targets would be reached too late. Of particular interest was the effect of restoration size on the voting behaviour. The number of individuals that felt the expansion was too large was similar to the number of individuals who felt the expansion was too small – so the restoration level did appear to play a role in determining why people voted against the proposed programs, but it was very heterogeneous between respondents.

Table 5.14. Most important reason respondents voted for the current trend of wetland loss in Manitoba (N=1,327*).

Reason	Percentage
Tax increase too high	57.1
Taxes better spent on other issues	12.0
Not enough information to make the decision	11.8
Total size of expansion was too small	4.4
Don't believe programs will actually benefit	4.1
Feel wetland targets will be reached too late	3.8
Feel wetland targets will be reached too soon	2.6
Feel proposed expansion is too large	2.3
Wetland loss is not an important issue	1.7
Total	100

*633 respondents never voted for the current situation.

The majority of people voting for the proposed program felt it was a small price to pay for the benefits received and it was important to invest for the future. This finding is consistent with the economic valuation literature and the definition of passive use values. Some voted for the program for moral reasons – "it is the right thing to do", while others felt that the government does not do enough to protect the natural environment. The number of respondents who felt that

they would be directly impacted was similar to the number who felt they would not be directly impacted by the project. Note that this question was also used to identify the yea-sayers – those who are willing to protect wetlands regardless of the cost.

Table 5.15. Most important reason respondents voted for the proposed restoration or retention wetland program in southern Manitoba (N=1,752*).

Reason	Percentage
Investment for the future	30.4
Small amount to pay for the benefits received	27.0
It is the "right" thing to do	15.9
Government does not do enough	10.6
Wetlands should be protected regardless of the cost	7.5
Important but no direct impact	4.4
Directly impacted	4.2
Total	100

*228 respondents never voted for the proposed program.

5.5 Estimates of Aggregate WTP

In order to be a more effective mechanism in the guidance of public policy, levels of household willingness to pay were expanded to assess the aggregate levels of willingness to pay at the provincial level.

Aggregate WTP = household WTP * 5 years * total # Manitoba households

Mean annual household willingness to pay estimates were discounted to the present using the net present value (NPV) formula below:

$$NPV = \sum_{t=1}^{5} \frac{WTP_i^t}{(1+r)^t}, \qquad [2]$$

where WTP_i^t is the willingness to pay estimate for wetland program *i* in time *t*, and r is the discount rate. For this aggregate calculation we employed a discount rate of 5%[26]. Aggregate

WTP was estimated by multiplying the total WTP of each of the restorations levels by the current number of households in the province: 448,765 (Statistics Canada 2006). Table 5.16 shows the aggregate willingness to pay estimates from full retention to full restoration of 1968 wetland acreage.

Table 5.16. Logit model estimates of aggregate WTP and per acre WTP levels for wetland restoration in Manitoba using the logarithmic specification for restoration and three discount rates (9,240 observations from 1,848 respondents*).

	WTP ($)		
	Discount Rates		
	2.5%	5%	10%
Retention at current level (77% of 1968 level or 1,044,102 acres)	630,883,691	602,264,084	552,438,966
Per Acre	604.23	576.83	529.10
Restoration to 80% of 1968 levels (or 38,985 acres restored)	650,409,016	620,903,656	569,536,491
Per Acre	500.84	478.12	438.57
Restoration to 83% of 1968 levels (or 77, 969 acres restored)	669,215,452	638,856,950	586,004,515
Per Acre	491.63	469.33	430.50
Restoration to 89% of 1968 levels (or 155,938 acres restored)	704,870,650	672,894,675	617,226,310
Per Acre	474.46	452.94	415.47
Restoration to 100% of 1968 levels (or 311,875 acres restored)	764,402,005	729,725,431	669,355,475
Per Acre	428.11	408.69	374.88

*Yea-sayers removed

The estimated aggregate willingness to pay using a logarithmic specification of restoration ranges from $552 million for retention to $764 million for full restoration, depending on the discount rate used. On a per acre level this corresponds to an average of $604 per acre for

retention to $374 per acre for full restoration[27]. This essentially is a demand curve for wetland restoration. Total WTP is higher, but to capture the larger number of acres there is less money for restoration on a per acre basis. That is, as restoration levels increase there will be consecutively less money for each additional acre. A WTP estimate per acre is convenient for comparative purposes between other wetland valuation studies that often use dollars per acre as a measurement unit[28].

5.6 Discussion

In the previous section the benefits of wetland restoration to the Manitoba population were determined. Economic valuation of these benefits is important in the development of any wetland policy. The value of these benefits is clear, but restoration also comes at a cost. Wetland conservation must be balanced by an awareness of actual restoration costs and the demands of other social issues such as education and health care. These costs must be understood and merged with the benefits in order to determine a socially efficient level of wetland restoration. The next logical step is to consider these benefit estimates with cost estimates to determine the feasibility of adopting a policy of wetland retention and restoration. Unfortunately there has been little research to date on estimating these costs in the pothole region of the Canadian Prairie Provinces.

However, research in the South Tobacco Creek watershed in south-western Manitoba by Boxall *et al*. (2009) has attempted to develop economic information on the costs of wetland restoration to agricultural producers. This watershed is located on the Manitoba escarpment (former shore of Lake Aggasiz) with almost all of the past wetlands existing in this watershed

[27] Calculated by dividing the aggregate WTP by total acres in the retention scenario and aggregate WTP divided by restored acres (minus retention WTP) in the restoration scenarios.
[28] While dollars per acre may not be the best measure of value due to wetland heterogeneity, it is the standard measure for land values and therefore employed by most studies.

drained. Thus, given its location, topography and wetland loss trajectory, it is not representative of the prairie pothole region.

Considering these caveats, according to preliminary results by Boxall *et al*. (2009) the average cost of wetland restoration in South Tobacco Creek is much higher than the estimate of benefits. That is, at the current level of approximately 1 million acres of wetlands the costs of restoration are greater than the value society places on their restoration. The public clearly does want wetlands protected and restored, but have not indicated a full willingness to pay for the full price of restoration. However, there will be a number of wetlands that could be restored for less than $400 per acre (Boxall *et al.* 2009), and it is these wetlands that any restoration program should target. The conclusion is therefore to restore these less expensive wetlands while retaining as many wetlands possible, because once they are converted to agricultural production it becomes prohibitively expensive or impossible to restore them to their natural state.

Wetland retention is a policy that is already being implemented among conservation organizations. Ducks Unlimited Canada has a well established program of land acquisition to retain wetlands. This could be expanded to protect more wetland areas. Marginal lands that include wetlands are estimated by the Farm Credit office in Brandon at approximately $100 per acre in Broughton's Creek. At this cost, all of the wetlands could be retained. Contrast this with productive farm land that may be marketable at up to $1000 per acre. At this price none of the wetlands would be retained. More realistic is that land prices vary, and opportunities exist to purchase land that is less expensive. Wetlands in regions with low land prices could be retained first, and those found on more expensive land could be selectively chosen based upon estimates of EGS provision.

Information on the public value of wetlands should encourage provincial and federal governments to support programs compensating landowners for retaining wetlands in their natural state, while implementing policy to restore wetlands in sensitive regions.

Chapter 6 Summary and Conclusion

6.1 Introduction

Wetlands are natural resources that provide a variety of ecological goods and services. The issue of wetland loss in Canada has gained importance in recent years as vast tracts of wetland ecosystems have been drained and degraded by human development. While the federal and some provincial governments have wetland policies, they are often in draft form or not fully implemented (Delaporte *et al.* 2009) and loss continues to occur at a substantial rate - largely due to the economic value landowners receive from transforming wetlands to cultivated agricultural land (Cortus *et al.* 2005). Research into the social benefits of wetlands in terms of EGS provision, such as water filtration, carbon sequestration, and flood control is particularly timely in light of increased social environmental awareness and government environmental initiatives. In order to influence policy decisions to retain and restore these sensitive ecosystems estimates of the general Manitoba population's WTP are required.

This study employed the CVM in estimating the non-market values Manitobans place on wetlands. A rigorous survey instrument was designed and conducted through 2008-09. This section will summarize the major findings of this survey, discuss policy implications, outline limitations of the study and provide suggestions for future research. We hope the information provided in this survey will be of assistance in the social understanding and preservation of wetland ecosystems in Manitoba and stimulate further work in the economic valuation of wetlands.

6.2 Major Findings and Policy Implications

The basic structure of this thesis - researching the status of wetlands in the province of Manitoba, a brief history of environmental non-market valuation and literature review of wetland valuation studies, and the CVM survey design outline – provided a foundation for understanding wetlands in Manitoba and the need for a rigorous non-market valuation of these ecosystems.

The CVM survey instrument designed in the summer of 2008 and implemented in early 2009 followed the NOAA panel recommendations for SP survey design, such as a referendum format, taxation as a payment vehicle, focus group input and pre-tests of the instrument. Various levels of restoration were provided, allowing for value estimates at the margin. From this survey I determined that when informed of the benefits wetlands provide and the tradeoffs associated with restoring them, Manitobans *do* value their wetlands resources beyond what the market indicates. WTP estimates ranged from $294 per household per year for five years for full retention to $357 for full restoration to 1968 levels, indicating relatively constant marginal WTP between restoration levels. Aggregated to the provincial level, this corresponds to $603 million for full retention or up to $729 million for retention and full restoration. The flat marginal WTP for wetland restoration is of particular benefit in terms of policy recommendation.

There is an expectation that government and tax dollars will play a significant role in their conservation. Respondents to the survey are clearly of the opinion that because society benefits from wetlands, government rather than landowners should pay a major portion of the costs of wetland conservation. This finding has significant policy implications. To date, environmental organizations such as DUC have been the largest player in retention and restoration of these ecosystems. Results from this survey show that the Manitoba taxpayer values wetlands and is willing to pay to retain and restore them. It is a clear mandate to

governments that programs in the conservation of wetlands are economically and politically sound, and that non-use values from EGS are important.

6.3 Limitations of the Study

Several factors affect conclusions drawn from this study: 1) Failure to pass the scope test on the first vote, 2) regional analysis of voting behaviour, and 3) lack of cost data representative of the prairie pothole region are the three major limitations considered.

Critics of the CVM question whether information provided from these surveys is an accurate representation of what people would really pay if faced with the option of paying to protect wetlands. There are a number of ways to address this hypothetical bias (see Section 3.4.5), and one of these is the scope test. That is, results must indicate that respondents are WTP more for larger programs. While the pooled WTP estimates passed scope test at each level of restoration, an analysis of the first vote does not. Passing the test on the first vote would have rendered the benefit estimates even more significant.

Heterogeneity in both regional voting behaviour and wetlands remains an issue. The data were collected on a provincial basis and only enabled basic regional and rural/urban comparisons. Location variables from respondents was captured, but not at a detailed level. As this issue is heterogeneous between individuals and regions, this detail would have been beneficial in policy decisions, regions of highest impact, etc. In addition, wetlands heterogeneity will always be an issue, as not all wetlands are equal in terms of biophysical attributes. The size of the wetland, history of flooding within the watershed and surrounding land topography will all influence the provision of EGS. While this study did obtain data from a representative watershed, expanding this projecting the findings to the entire prairie pothole region may be less appropriate.

Determination of the socially efficient level of wetland restoration would be a valuable extension of this thesis. Such determination requires both benefit and cost estimates. While this study provides benefit estimates from the representative Broughton Creek watershed, comparable cost data were not available from this watershed. Rather, for the purposes of discussion, cost data were obtained for the South Tobacco Creek watershed, where significant research has been ongoing into producer adoption of beneficial management practices. Even with the inclusion of non-market values it was deemed to be socially inefficient to restore wetlands. The conclusion: retain what wetlands already exist as once they are gone they are difficult to get restore. Yet there are inherent problems in the direct comparison of the STC and Broughton Creek watersheds that may overemphasize the costs of wetlands restoration. Restoration projects may be socially efficient in the prairie pothole region if costs estimates were available from a representative watershed such as Broughton's Creek.

6.3 Areas for Future Research

There are a number of areas for future study. Ongoing research is necessary into the quantified benefits of ecological goods and services provided by wetlands. These may change significantly between wetlands and regions, and clear understanding of the provision of EGS is necessary for rigorous economic valuation. It is possible that prairie pothole wetlands in Alberta and Saskatchewan have different EGS values and the public of these provinces place different values on them.

Further information and research is needed to determine agricultural producers' willingness to accept compensation for wetland compliance programs in Manitoba. The cost of restoration must be clearly understood for any wetland restoration policy to be implemented and adopted.

Economic valuation of wetland services is a growing field of research. Lack of research efforts in Canada may be attributed to a number of factors - prohibitive costs of SP data collection, heterogeneity between wetlands, lack of quantified biophysical information, and a persistent belief that this country has an unending supply of wetland resources. Efforts must be made to arrest and reverse the loss of these ecosystems. The market fails to capture the true value of wetlands to society. The science of environmental economics can play a pivotal role in further needed research and in the development of public policy.

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APPENDIX A – Advisory and Focus Group Membership

Table A.1 Members of the Expert Advisory Group in Manitoba that contributed to survey design.

Individual	Association
Rhonda McDougal	MB Water Stewardship
Lonnie Scott	MB Agriculture Food and Rural Initiatives
Esther Salvano	MB Agriculture Food and Rural Initiatives
Ian Campbell/Matthew Straub	Agriculture and Agri-Food Canada
Gordon Goldsborough	University of Manitoba
Cynthia Edwards	Ducks Unlimited Canada
Shane Gabor	Ducks Unlimited Canada
Greg Bruce	Ducks Unlimited Canada
Rick Andrews	Ducks Unlimited Canada
Stacey Hay	Ducks Unlimited Canada

Table A.2 Summary of focus groups conducted during the design stage of the wetland valuation survey in Manitoba.

Focus Group Description	**Location**	**Date**	**Recruitment**
Graduate students	U of A, Edmonton	July 24, 2009	John Pattison
Experts	Winnipeg	August 21, 2008	Ducks Unlimited Canada
Advisory group	Winnipeg	August 22, 2008	Peter Boxall
Public	Winnipeg	October 07, 2008	Leger Marketing
Public	Brandon	October 08, 2008	Leger Marketing
Public	Winnipeg	October 09, 2008	Leger Marketing
Agricultural	Kingman, Alberta	October 20, 2008	Kingman Crop Marketing Club

APPENDIX B – The Survey Instrument

Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

A Survey about Environmental Issues in Manitoba

Ducks Unlimited Canada
Conserving Canada's Wetlands

University of Alberta – Quaecumque Vera

The Manitoba government, Ducks Unlimited Canada and the Federal Government are seeking information regarding wetlands in Manitoba. We are seeking your opinion on investing public funds for the retention and restoration of wetlands in the prairie pothole region in southern Manitoba. Your feedback is important for the management of wetlands in accordance with the will of the public of Manitoba.

Thank you for spending your time to complete this survey. Please try to answer all the questions. It should take no longer than 20-25 minutes.

All information you provide is strictly confidential. Your name or any personal information will never appear with your answers. Only a summary of the results will be made public.

Your feedback is important and we appreciate your help with this project.

To contact the researchers:

John Pattison (Graduate Student)
E-mail: johnp@ualberta.ca
(780) 492-4603

Dr. Peter Boxall
Peter.boxall@ualberta.ca
(780) 492-4603

Dr. Vic Adamowicz
Vic.adamowicz@ualberta.ca
(780) 492-4603

Department of Rural Economy
515 GSB
University of Alberta
Edmonton, Alberta T6G 2H1

Question 1. Listed below are statements about the relationship between humans and the environment. For each one, please indicate whether you STRONGLY AGREE, MILDLY AGREE, are UNSURE, MILDLY DISAGREE, or STRONGLY DISAGREE with it.

Possible Concerns	**Strongly Agree**	**Mildly Agree**	**Unsure**	**Mildly Disagree**	**Strongly Disagree**
1. We are approaching the limit of the number of people the earth can support					
2. Humans have the right to modify the natural environment to suit their needs					
3. When humans interfere with nature it often produces disastrous consequences.					
4. Human ingenuity will insure that we do NOT make the earth unliveable					
5. Humans are severely abusing the environment					
6. The earth has plenty of natural resources if we just learn how to develop them					
7. Plants and animals have as much right as humans to exist					
8. The balance of nature is strong enough to cope with the impacts of modern industrial nations					
9. Despite our special abilities humans are still subject to the laws of nature					
10. The so-called "ecological crisis" facing humankind has been greatly exaggerated					
11. The earth is like a spaceship with very limited room and resources					
12. Humans were meant to rule over the rest of nature					
13. The balance of nature is very delicate and easily upset					
14. Humans will eventually learn enough about how nature works to be able to control it					
15. If things continue on their present course, we will soon experience a major ecological catastrophe					

Question 2. Consider the following list of current issues facing Manitobans today. Please rate the level of effort government should be allocating to each issue compared to what is currently done in Manitoba.

Government Program in Manitoba	Do a lot less	Do less	Do about the same	Do more	Do a lot more
Improving roads and highways					
Supporting the arts					
Improving education					
Encouraging economic growth					
Reducing crime					
Increasing job opportunities in rural communities					
Protecting the natural environment					
Lowering taxes					
Improving health care					

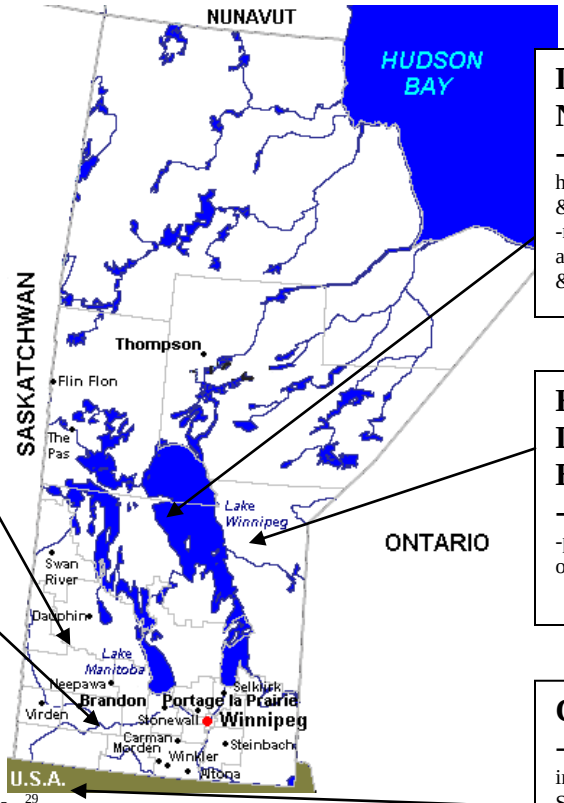
Environmental Issues in Manitoba

Manitoba is Canada's 6th largest province and has some of the most pristine wilderness areas in the country. The southern portion of the province contains most of the provincial population and agricultural land, leaving the northern portions of the province relatively untouched. Manitoba has large freshwater lakes, some relatively untouched watersheds, the most southern herd of woodland caribou, wild rivers, the Hudson Bay coastline with associated Arctic wildlife, and is on the migratory pathway for thousands of waterfowl. Despite these assets, however, there are a variety of environmental issues facing residents of Manitoba that will need to be addressed in the near future:

Climate Change
-increased drought frequency and expansion of arid regions
- more flooding problems due to extreme weather

Loss of wetlands in the south
-up to 70% loss due to agricultural and urban expansion

Intensification of Agriculture
-runoff from high levels of fertilizer application
-negative impacts on local wildlife



Lake Winnipeg Nutrient Overload
-poorer water quality as a result of human activity (industrial, municipal, & agricultural runoff)
-negatively affects water consumption and recreation safety, wildlife levels, & aesthetic appeal

Hydro-Electric Developments in the Boreal Forest
-flooding of wilderness lands
-poorer water quality and destruction of habitat for transmission lines

Cross-Border Pollution
-water pollution from upstream industry and agriculture in the United States

Major environmental issues in Manitoba. [29]

Question 2. *How familiar were you with these current environmental issues in Manitoba prior to participating in this survey?*

Environmental Issue	Not Familiar	Slightly Familiar	Familiar	Quite Familiar	Very familiar
Nutrient Overload in Lake Winnipeg					
Climate Change					
Hydroelectric Dams					
Intensification of Agriculture					
Wetland Loss					
Cross-Border Pollution					

The remainder of this survey will deal with the conservation of wetlands in Manitoba

[29] Map of Manitoba created by Earl Andrew. Obtained from the internet site http://en.wikipedia.org/wiki/Image:Manmap.PNG

What are wetlands?

Wetlands are areas that hold water for short or long durations, where a close relationship exists between water and land organisms. Intact natural wetlands have many types of plants that can only live on the unique aquatic soils. Wetlands contain a large diversity of living things.

Examples of wetlands

Wetland Benefits

Wetlands are important ecosystems that provide an array of environmental benefits to humans. Some of these benefits are:

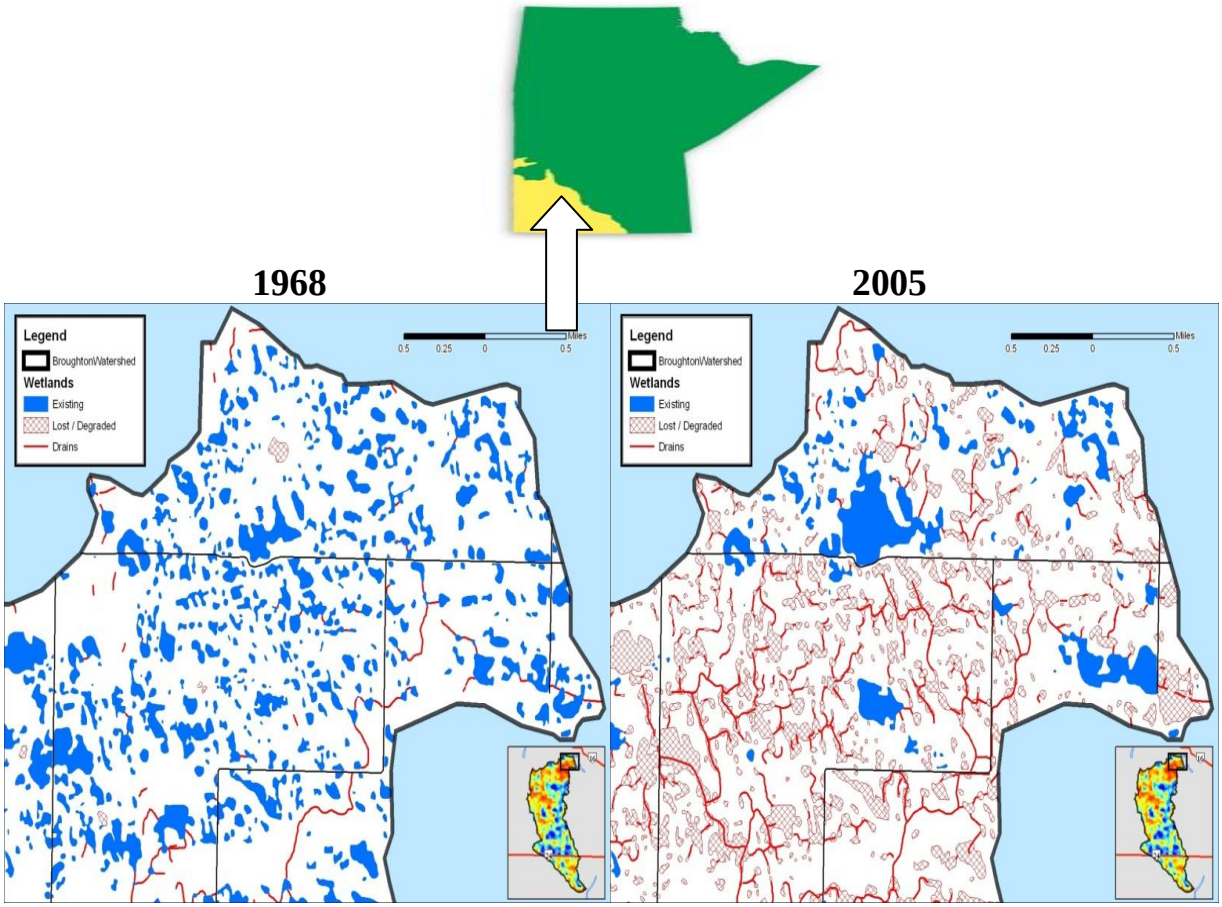
- Wetlands are **natural filters that improve water quality**. Wetlands remove nutrients and contaminants such as phosphorus and nitrogen from water that flows into lakes, streams and rivers, and groundwater.
- Wetlands can **recharge levels of groundwater** in rural areas that some residents rely on for household water uses.
- Wetlands help **control floods** by storing large amounts of water. When wetlands are destroyed, the probability of rainfall causing flooding and floodwater damage increases.
- Wetlands **control soil erosion** by slowing movement of water
- Wetlands **remove and store** carbon from the Earth's atmosphere and can slow climate change.
- Wetlands also **provide habitat for over 600 species of wildlife** – including more than one-third of the species Canada currently assesses at risk of loss (extinction).

Thus, losing wetlands increases contaminants entering lakes in Manitoba, such as Lake Winnipeg, and would significantly increase costs for drinking water treatment. Wetland loss would also mean less recreational use, diminished levels of wildlife, higher levels of soil erosion, and reduced flood control.

Wetland areas are declining

A significant loss in wetland area has occurred since the late 1800's. Most of this loss is directly attributed to human activity such as expansion of urban areas, agriculture, and various industries. It is estimated that up to 70% of wetlands in the southern prairie pothole region of Manitoba have been lost or degraded.

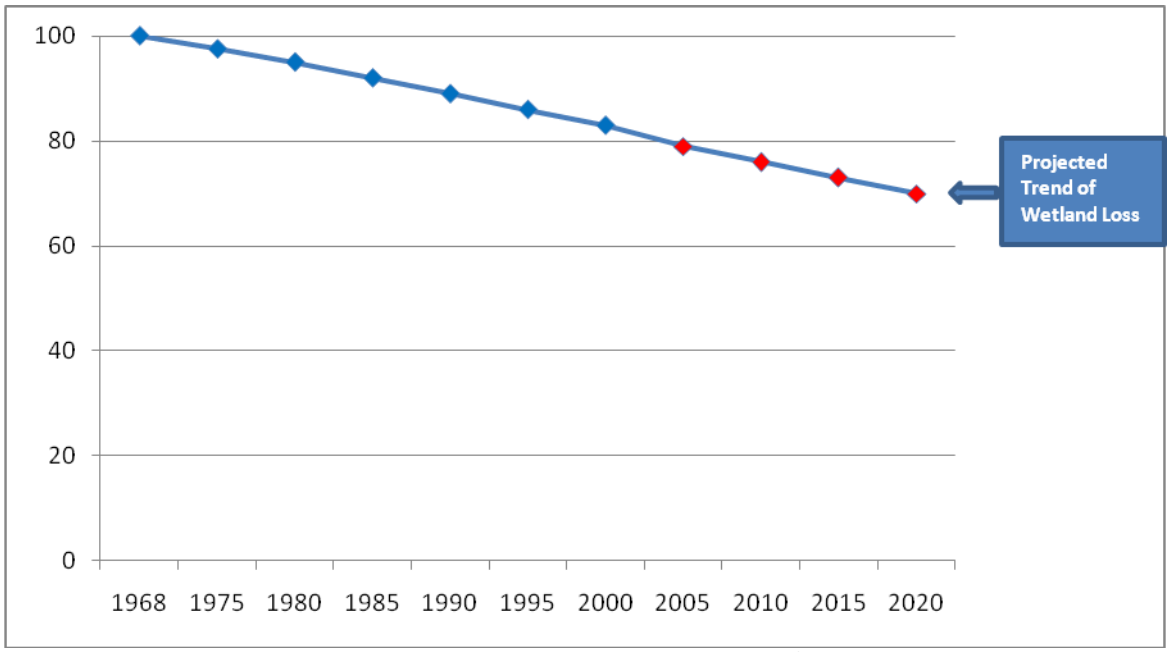
While much has been lost or degraded, accurate information on wetlands area has only been available in recent years. Accurate air photos and measurements of wetland loss became available in the 1960s. In 1968 approximately 1,350,000 acres of the southern prairie pothole region in Manitoba were considered wetlands. By 2005 wetland area had dropped to about 1,070,000 acres, or about 79% of what existed in 1968.



An illustration of changes in existing wetlands in a **representative watershed** of the southern Prairie Pothole Region of Manitoba between 1968 and 2005[30]

Scientists estimate the loss of wetlands in this region is continuing at a rate of 0.57% annually. If this trend continues, there could be as little as 70% of the wetland areas in southern Manitoba that existed in 1968 remaining by 2020.

[30] Ducks Unlimited Canada, 2005



Actual and projected wetland loss trend in the Prairie Pothole Region of Manitoba since 1968

Why wetlands are declining

There are various factors contributing to the loss and degradation of wetlands, such as growing cities and the construction of highways. A major contributor, however, is agricultural expansion.

As the fourth largest sector in the Manitoban economy, agriculture has contributed to approximately 85% of the loss and degradation of wetlands in Manitoba's prairie pothole region. The expansion of agriculture occurred in response to expanding human populations which demand more food. At the same time, real incomes for farmers remained basically the same or even declined. These issues resulted in government response with policies and programs that promoted drainage of wetlands to **increase cultivated land areas, food production and farm incomes**.

An illustration of the drainage of wetlands an agricultural watershed in the prairie pothole region of Manitoba [31]

[31] Ducks Unlimited Canada, 2005

Question 3. *How concerned are you about the loss of wetlands in Manitoba?*

Very concerned	*Somewhat concerned*	*Not concerned*

Reasons to Drain Wetlands

Currently policies that promote wetland drainage are being withdrawn. A major issue, however, is that the prices farmers are paid to produce agricultural products do not cover the costs that farmers must bear to maintain wetlands on their farms. Thus, even though farmers may be good stewards of the land, they may choose to drain wetlands for financial reasons. Some of these reasons are:

- Wetlands can be costly for farmers to maintain in terms of **increased fuel** and time taken to manoeuvre machinery around them during seeding and harvesting. The presence of wetlands can also lead to **double application** of seeds or fertilisers in some areas of their fields, leading to higher costs to the farmer.
- Price increases for agricultural products have increased the value of agricultural land. Draining wetlands **increases cultivated acreage** allowing for increases in the production of crops and increased profits for the farmer.
- Wetlands attract waterfowl that often eat young plants or un-harvested grain, decreasing yields.

In addition, many other businesses and industries rely on agriculture. Restoring wetlands and decreasing cultivated acres could indirectly affect businesses such as equipment dealerships, hardwear stores and fertilizer dealerships.

Question 4*. How much financial responsibility should private landowners, such as farmers, have to preserve wetlands on their property?*

No Responsibility ☐ Some Responsibility ☐ All Responsibility ☐

Results of Decline in Wetlands

Current research efforts estimate that the annual 0.57% decline in wetlands that has been experienced in the southern prairie pothole region of Manitoba has resulted in:

- an *additional* 330 tonnes of nitrogen and 70 tons of phosphorous added to the southern regions watersheds annually (equivalent to 45 semi-truck loads of fertilizer)
- an increase of 9 million cubic meters of flood water annually
- 50,000 tonnes of soil lost due to erosion annually
- loss of 500 breeding pairs of ducks annually, an indicator for other living species
- release of an *additional* 30,000 tonnes of carbon annually - equivalent to carbon emissions from 6,000 cars on provincial roads[32]

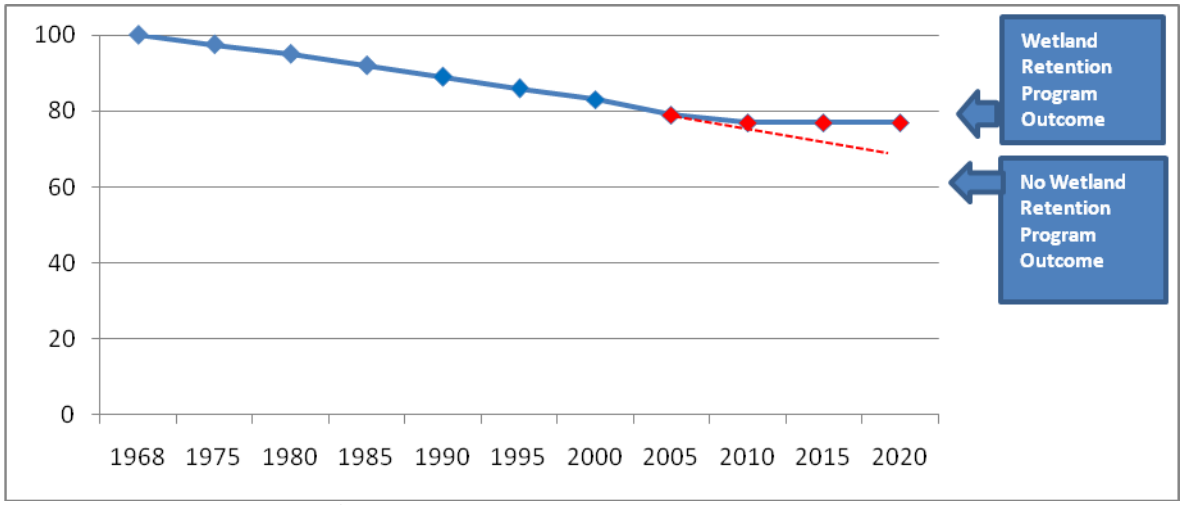
[32] Based upon a mid-sized vehicle emitting 5 tonnes/year

Stopping the Loss of Wetlands in Manitoba

Farmers and other landowners maintain wetlands at a personal cost, while society at large benefits from having wetlands on the landscape. In response to this issue governments and nongovernmental organizations have included wetland retention and restoration in a number of programs to assist private landowners in maintaining wetlands.

Wetland Retention

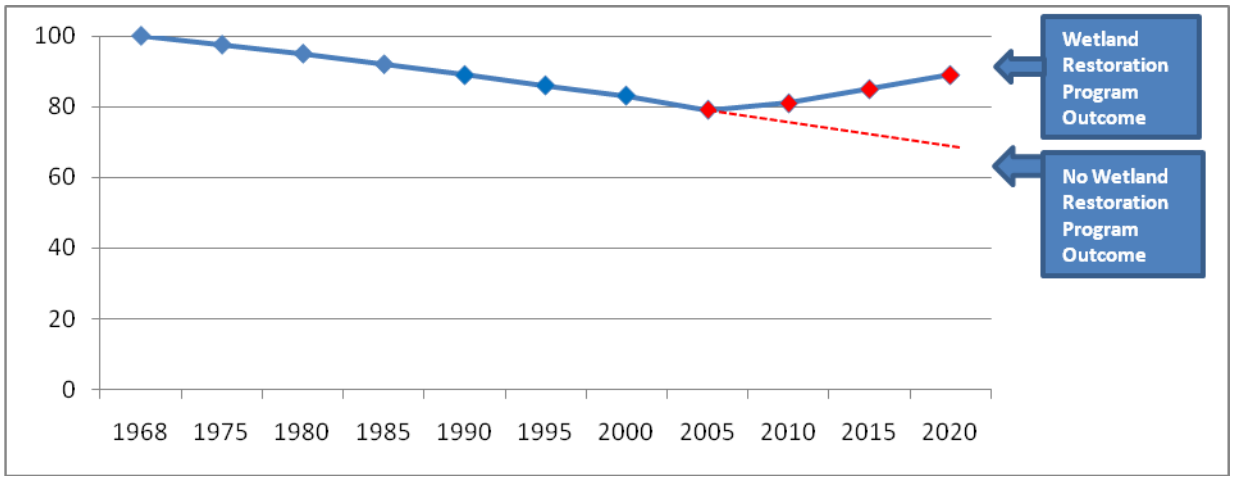
Wetland retention programs could prevent further loss of wetlands and maintain wetland areas at their current levels in the prairie pothole region. This requires landowners to stop any further drainage of wetlands on their property – a financially difficult decision given high grain prices today.



An illustration of wetland retention program outcomes in Manitoba

Reversing the Loss and Degradation of Wetlands in Manitoba

Beyond stopping the loss and maintaining wetlands at the levels we see today, programs are being developed to *restore* many of the wetlands that have been lost. Increasing the acres of wetlands will enhance the values that wetlands provide to society. However, these programs may negatively impact farmers in southern Manitoba – cropping areas will be reduced and the costs of farming around restored wetlands will increase.



An illustration of a possible wetland restoration program outcomes in Manitoba.

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Tough Choices!

Wetland conservation programs, if developed, would stop or reverse the trend of wetland loss and increase the area of wetlands in the province. It should be noted that even if significant restoration programs are implemented, the total increase would not restore all the wetlands that have been lost due to the fact that some of these wetlands simply cannot be restored.

Decisions about the future of Manitoba's wetlands are not easy to make. While wetland retention and restoration programs will enhance the values that wetlands provide society, these activities will not be free.

So who should pay for wetland conservation - private landowners or the taxpayer?

Should the costs be shared?

If wetland conservation is left in the hands of private landowners it is likely that few wetlands will be retained and that little restoration will occur. **Existing estimates of the costs of retaining and restoring wetlands range from about $700 to $1300 per wetland acre**.[33] Without changes to existing policies, if wetland numbers are to increase, then the costs of wetland conservation will continue to be born by landowners, most of whom are farmers. If government funds are used for wetland conservation, there may be less money available for other environmental and social programs including health care, infrastructure development, and education. It is a tough choice.

Question 5. *If programs were developed to share the cost of wetland restoration and retention, approximately what financial share would you expect the following groups to contribute?*

	Under 25%	**25-50%**	**50-75%**	**75-100%**
Government (taxpayers)				
Private Landowner				
Conservation Organisations (Nature Conservancy, Ducks Unlimited, etc)				

[33] Depending on assumptions relating to lost crop revenues for the lands that were drained.

The Future of Manitoba's Wetlands

We want to know the amount of public funds you believe should be spent on retaining and restoring wetlands in the Manitoba prairie pothole region. In the next section, you will be asked to vote on policies representing various hypothetical situations regarding the future amount of wetlands in the province.

For each scenario, you will be asked to choose between two different alternatives:

1. **The Current Trend:** where Manitoba will continue to experience the current trend of 0.57% annual wetland degradation and loss. Our estimates suggest that by 2020 wetlands will further decline from the current level of 77% (1,040,000 acres) to about 70% (950,000 acres) of their 1968 levels. Each voting scenario will describe the net impacts by 2020.

2. **A Proposed Program**: The program presented will be one of two possibilities: a *retention* program which will stabilize southern Manitoba's wetlands at their current level, or a *retention **and** restoration* program in which wetland loss will be halted and wetlands will increase by some amount greater than the current level.

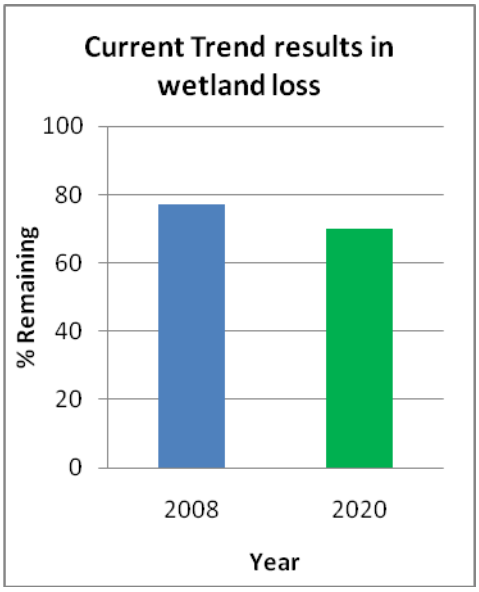
The scenarios will be described by three characteristics:

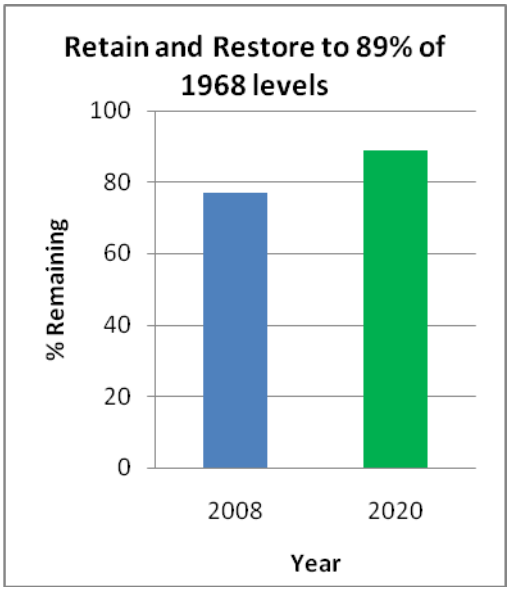
1. Wetland area targets.
2. Description of the estimated impacts of the program.
3. Annual investment of public funds.

Under each vote the proposed program will carry a price tag that represents your household's annual share of the investment towards wetlands in Manitoba over the next 5 years. **Collected funds will be used to compensate landowners for the retention and restoration of wetlands in the province of Manitoba.**

THE RELATIVE SIZE OF WETLAND AREAS

Graphs will be used to indicate the size of the wetland conservation program. For example, the policy below would restore wetlands in southern Manitoba to 89% of their 1968 levels:



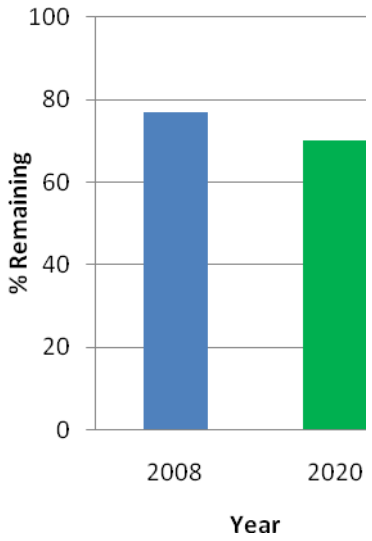
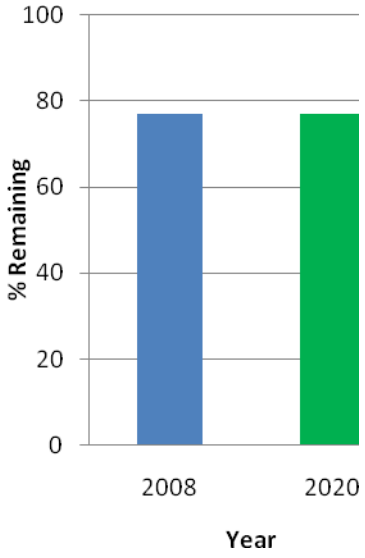


PLEASE NOTE: Research has shown that how people vote on a survey is often not a reliable indication of how people would actually vote at the polls. In surveys, some people ignore the monetary and other sacrifices they would really have to make if their vote won a majority and became law. We call this **hypothetical bias**. In surveys that ask people if they would pay more for certain services, research has found that people may say that they would pay 50% more than they actually will in real transactions.

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

You will now vote 5 times:
• Assume that the options on EACH SCREEN are the ONLY ones available
• Each time, please vote independently from the other votes - do not compare options on different screens

PLEASE TREAT EACH VOTE INDEPENDENTLY FROM OTHER VOTES. IN OTHER WORDS, NO OTHER WETLAND CONSERVATION PROGRAM IS BEING CONSIDERED.

Vote	The Current Trend	A Proposed Program
Wetland Area Targets	Results in further wetland loss: 77% of 1968 wetlands currently remain in southern Manitoba, but this will decline to 70% (950,000 acres) by 2020. 	**Maintain** wetlands at their current level through 2020, which is **77%** (1,000,000 acres) of 1968 levels in southern Manitoba 
Water Quality *By 2020 wetlands will annually filter the equivalent of about:*	4500 semi-truck loads of fertilizer	5000 semi-truck loads of fertilizer
Flood Control *By 2020 wetlands will annually control about:*	1.1 billion cubic meters of water	1.2 billion cubic meters of water
Soil Erosion *By 2020 wetlands will annually control about:*	6 million tonnes of soil from being eroded	6.8 million tonnes of soil from being eroded
Wildlife Habitat *By 2020 wetlands will annually provide habitat for about:*	1.8 million breeding pairs of ducks	2 million breeding pairs of ducks
Carbon Capture and Storage *By 2020 wetlands will annually store carbon*	740,000 cars	800,000 cars

equivalent to the emissions of about:		
Your household's annual share investment paid through tax increases for the next 5 years, 2008-2012	$0 annually for 5 years	$ annually for 5 years

Question X. Please carefully compare the two alternatives presented in the table above. If you had to vote on these two options, which one would you choose?
Please treat independently from all other votes. Please mark one box only.

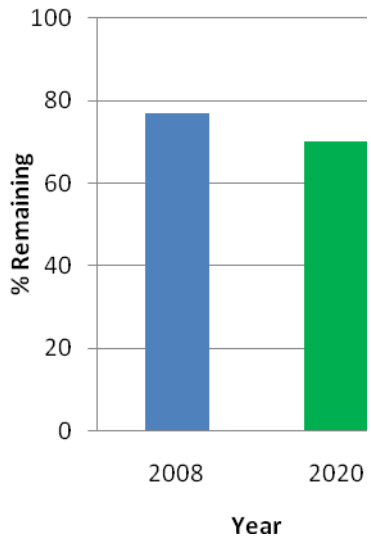
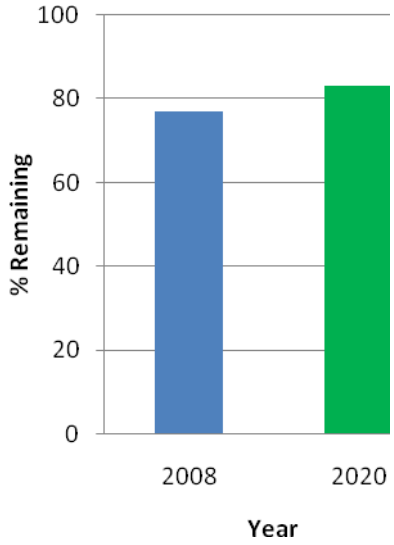
Current Trend ☐ ***Proposed Program*** ☐

Question X. How confident are you that this is the choice you would make if this was an actual referendum? *Circle one only.*

1. Very uncertain 2. Somewhat uncertain 3. Somewhat certain 4. Very certain

Question X. If this really was a referendum, what percentage of Manitobans do you think would vote FOR the proposed program? ☐

PLEASE TREAT EACH VOTE INDEPENDENTLY FROM OTHER VOTES. IN OTHER WORDS, NO OTHER WETLAND CONSERVATION PROGRAM IS BEING CONSIDERED.

Vote	The Current Trend	A Proposed Program
Wetland Area Targets	Results in further wetland loss: 77% of 1968 wetlands currently remain in southern Manitoba, but this will decline to 70% (950,000 acres) by 2020. 	**Restore** wetlands in southern Manitoba to **83%** (1,122,000 acres) of 1968 levels by 2020 
Water Quality *By 2020 wetlands will*		

annually filter the equivalent of about:	4500 semi-truck loads of fertilizer	5300 semi-truck loads of fertilizer
Flood Control *By 2020 wetlands will annually control about:*	1.1 billion cubic meters of water	1.4 billion cubic meters of water
Soil Erosion *By 2020 wetlands will annually control about:*	6 million tonnes of soil from being eroded	7 million tonnes of soil from being eroded
Wildlife Habitat *By 2020 wetlands will annually provide habitat for about:*	1.8 million breeding pairs of ducks	2.2 million breeding pairs of ducks
Carbon Capture and Storage *By 2020 wetlands will annually store carbon equivalent to the emissions of about:*	740,000 cars	875,000 cars
Your household's annual share investment paid through tax increases for the next 5 years, 2008-2012	$0 annually for 5 years	$ annually for 5 years

Question X. Please carefully compare the two alternatives presented in the table above. If you had to vote on these two options, which one would you choose?
Please treat independently from all other votes. Please mark one box only.

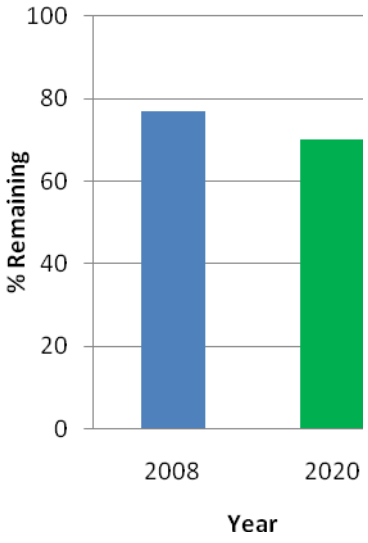
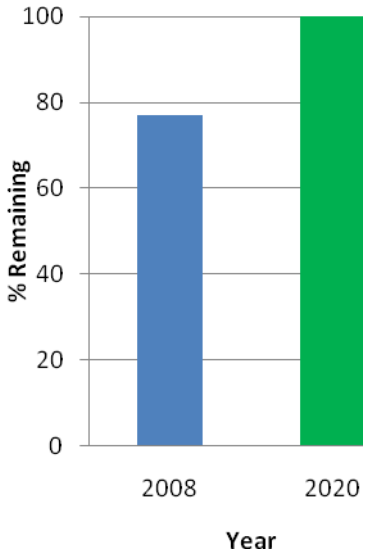
Current Trend ☐ ***Proposed Program*** ☐

Question X. How confident are you that this is the choice you would make if this was an actual referendum? *Circle one only.*

1. Very uncertain 2. Somewhat uncertain 3. Somewhat certain 4. Very certain

Question X. If this really was a referendum, what percentage of Manitobans do you think would vote FOR the proposed program? ☐

PLEASE TREAT EACH VOTE INDEPENDENTLY FROM OTHER VOTES. IN OTHER WORDS, NO OTHER WETLAND CONSERVATION PROGRAM IS BEING CONSIDERED.

Vote	The Current Trend	A Proposed Program
Wetland Area Targets	Results in further wetland loss: 77% of 1968 wetlands currently remain in southern Manitoba, but this will decline to 70% (950,000 acres) by 2020. 	**Restore** wetlands in southern Manitoba to **100%** (1,350,000 acres) of 1968 levels by 2020 
Water Quality *By 2020 wetlands will annually filter the equivalent of about:*	4500 semi-truck loads of fertilizer	6400 semi-truck loads of fertilizer
Flood Control *By 2020 wetlands will annually control about:*	1.1 billion cubic meters of water	1.6 billion cubic meters of water
Soil Erosion *By 2020 wetlands will annually control about:*	6 million tonnes of soil from being eroded	8.8 million tonnes of soil from being eroded
Wildlife Habitat *By 2020 wetlands will annually provide habitat for about:*	1.8 million breeding pairs of ducks	2.7 million breeding pairs of ducks
Carbon Capture and Storage *By 2020 wetlands will annually store carbon equivalent to the emissions of about:*	740,000 cars	1,000,000 cars
Your household's		

annual share investment paid through tax increases for the next 5 years, 2008-2012	$0 annually for 5 years	$ annually for 5 years

Question X. Please carefully compare the two alternatives presented in the table above. If you had to vote on these two options, which one would you choose?
Please treat independently from all other votes. Please mark one box only.

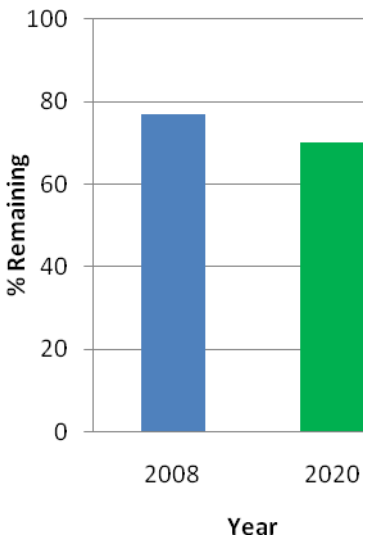
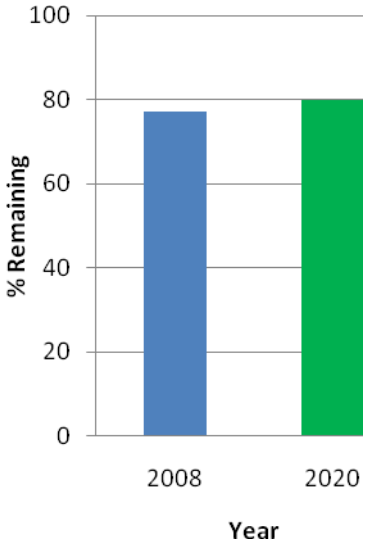
Current Trend ☐ ***Proposed Program*** ☐

Question X. How confident are you that this is the choice you would make if this was an actual referendum? *Circle one only.*

1. Very uncertain 2. Somewhat uncertain 3. Somewhat certain 4. Very certain

Question X. If this really was a referendum, what percentage of Manitobans do you think would vote FOR the proposed program? ☐

PLEASE TREAT EACH VOTE INDEPENDENTLY FROM OTHER VOTES. IN OTHER WORDS, NO OTHER WETLAND CONSERVATION PROGRAM IS BEING CONSIDERED.

Vote	The Current Trend	A Proposed Program
Wetland Area Targets	Results in further wetland loss: 77% of 1968 wetlands currently remain in southern Manitoba, but this will decline to 70% (950,000 acres) by 2020.  	**Restore** wetlands in southern Manitoba to **80%** (1,080,000 acres) of 1968 levels by 2020 
Water Quality *By 2020 wetlands will annually filter the equivalent of about:*	4500 semi-truck loads of fertilizer	5100 semi-truck loads of fertilizer

Flood Control *By 2020 wetlands will annually control about:*	1.1 billion cubic meters of water	1.3 billion cubic meters of water
Soil Erosion *By 2020 wetlands will annually control about:*	6 million tonnes of soil from being eroded	7 million tonnes of soil from being eroded
Wildlife Habitat *By 2020 wetlands will annually provide habitat for about:*	1.8 million breeding pairs of ducks	2.1 million breeding pairs of ducks
Carbon Capture and Storage *By 2020 wetlands will annually store carbon equivalent to the emissions of about:*	740,000 cars	840,000 cars
Your household's annual share investment paid through tax increases for the next 5 years, 2008-2012	$0 annually for 5 years	$ annually for 5 years

Question X. Please carefully compare the two alternatives presented in the table above. If you had to vote on these two options, which one would you choose?
Please treat independently from all other votes. Please mark one box only.

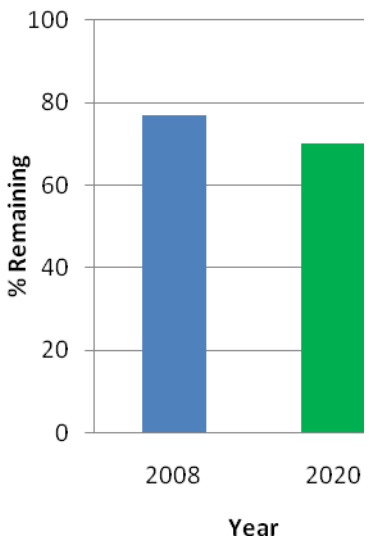
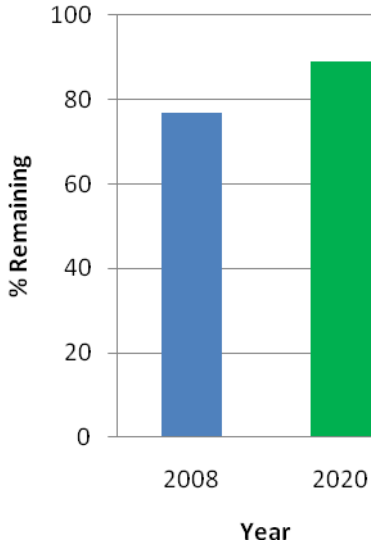
Current Trend ☐ ***Proposed Program*** ☐

Question X. How confident are you that this is the choice you would make if this was an actual referendum? *Circle one only.*

1. Very uncertain 2. Somewhat uncertain 3. Somewhat certain 4. Very certain

Question X. If this really was a referendum, what percentage of Manitobans do you think would vote FOR the proposed program? ☐

PLEASE TREAT EACH VOTE INDEPENDENTLY FROM OTHER VOTES. IN OTHER WORDS, NO OTHER WETLAND CONSERVATION PROGRAM IS BEING CONSIDERED.

Vote	The Current Trend	A Proposed Program
Wetland Area Targets	Results in further wetland loss: 77% of 1968 wetlands currently remain in southern Manitoba, but this will decline to 70% (950,000 acres) by 2020. 	**Restore** wetlands in southern Manitoba to **89%** (1,200,000 acres) of 1968 levels by 2020 
Water Quality *By 2020 wetlands will annually filter the equivalent of about:*	4500 semi-truck loads of fertilizer	5600 semi-truck loads of fertilizer
Flood Control *By 2020 wetlands will annually control about:*	1.1 billion cubic meters of water	1.5 billion cubic meters of water
Soil Erosion *By 2020 wetlands will annually control about:*	6 million tonnes of soil from being eroded	7.8 million tonnes of soil from being eroded
Wildlife Habitat *By 2020 wetlands will annually provide habitat for about:*	1.8 million breeding pairs of ducks	2.4 million breeding pairs of ducks
Carbon Capture and Storage *By 2020 wetlands will annually store carbon equivalent to the emissions of about:*	740,000 cars	940,000 cars
Your household's annual		

share investment paid through tax increases for the next 5 years, 2008-2012	$0 annually for 5 years	$ annually for 5 years

Question X. Please carefully compare the two alternatives presented in the table above. If you had to vote on these two options, which one would you choose?
Please treat independently from all other votes. Please mark one box only.

Current Trend ☐ ***Proposed Program*** ☐

Question X. How confident are you that this is the choice you would make if this was an actual referendum? *Circle one only.*

1. Very uncertain 2. Somewhat uncertain 3. Somewhat certain 4. Very certain

Question X. If this really was a referendum, what percentage of Manitobans do you think would vote FOR the proposed program? ☐

END OF VOTING SCENARIOS

Question 6. When voting, how important was each of the following characteristics to you?

Characteristic	**Not important**	**Slightly Important**	**Very Important**	**Extremely Important**
Size of wetland expansion				
Water quality				
Flood control				
Soil erosion				
Wildlife habitat				
Carbon capture and storage				
Additional annual cost to your household in taxes				

Question 7. If you voted for the CURRENT TREND, it was because:
In the first column, please check all the reasons that apply. In the second column, of those selected, please check the MOST IMPORTANT REASON by marking one box only.

REASON	**Please check all that apply**	**Of those selected, please check the most important reason**
I do not believe the programs presented will actually benefit the environment		
I think tax money could be better spent on other issues		
I do not have enough information to make this decision		
I felt the wetland targets would be reached too late		
I felt the wetland targets were reached too soon		
I thought the total size of the proposed wetland expansion was too small		
I thought the total size of the proposed wetland expansion was too large		
The tax increase was too high		
I do not think wetland loss is an important issue		

Question 8. If you voted yes for any of the PROPOSED PROGRAMS it was because:
In the first column, please check all the reasons that apply. In the second column, of those selected, please check the MOST IMPORTANT REASON by marking one box only.

REASON	**Please check all that apply**	**Of those selected, please check the most important reason**
I think that this is a small amount to pay for the benefits received		
I think we should protect wetlands regardless of the cost		
I feel it is the "right" thing to do		
It is important to invest in protecting wetlands for future generations		
The program is important but I don't really think it will cost me directly		
I might be affected by the loss of wetlands directly		
I think that our government does not do enough to protect our water and wetland resources		

Thank you for participating in this survey.