Investigating the use of Reverse Auctions for Restorable Wetlands on the Prairies

by

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Abstract

Prairie potholes are drained for the purposes of agricultural production and land development. However, restoring these drained basins is a hard sell. Three reverse auctions involving restoration identified low uptake of wetland restoration contracts by private landowners. This study explores the phenomenon of low participation in reverse auctions using the aforementioned case studies as test cases. Communication records between auction technicians and eligible participants were used to investigate salient considerations for non-participation. Semi-structured interviews were conducted with participants and non-participants to examine the motivations and barriers that limit landowner participation in wetland restoration programs. Findings suggest that private economic considerations are of pivotal concern. Moreover, trust between landowners and providers of restoration contracts, and the complex nature of understanding what wetlands are makes them a difficult good to auction. Wetland restoration comes at a cost to landowners and the public, so the correct allocation of wetland restoration contracts and funding must be properly understood.

The cost effectiveness of reverse auctions depends on a number of factors that include bidder competition, but also the pricing method. Two commonly used pricing methods in reverse auctions for environmental goods and services are disciminatory and uniform. Discriminatory pricing methods pay each bidder their bid in ascending order, up to the point where the auction budget is fully allocated. Uniform priced methods pay each bidder the same amount, which is usually related to the bid distribution. This thesis compares the uniform and disciminatory pricing methods in three actual reverse auctions for prairie wetland restoration. Results suggest

that uniform priced methods generated lower levels of information rent sought by bidders. Thus, in uncovering prices for restoration the uniform approach is superior to the dsicriminatory one.

This study informs the use of reverse auctions for wetland restoration and reveals important considerations surrounding the participation of landowners, as well as appropriate auction design.

Preface

This thesis is an original work by Anna Marie Kauffman. The research project, of which this thesis is a part, received research ethics approval from the University of Alberta Research Ethics Board, Project Name “Nose Creek Conservation Auction”, PRO00057790_REN1, July 2016-July 2019.

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I would like to acknowledge that this work would not have been possible without several participants in Wheatland County, Rocky View County, and the Assiniboine River Watershed. Thank you for sharing your individual opinions and perspectives with me; you have helped deepen my understanding of the challenges of wetland restoration in the Prairies.

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Chapter 1 - Introduction

Restorable wetlands generate positive externalities by filtering water, sequestering carbon, and attenuating floods, etc. Wetland drainage and degradation fundamentally impacts the hydrological landscape and increases the likelihood of flooding (Creed et. al, 2017). But, the restoration of drained wetlands is a significant challenge. First, the restoration activity must take place in such a way as to re-establish lost wetland ecological functions. Second, in most cases drained and impacted wetland basins are located on private lands and they must first be identified[1] and secured by contractual arrangements with the landowner to be restored. This is a challenge because restoring basins requires willing private landowners interested in participating in wetland restoration programs.

Many of the private landowners who could supply drained basins for restoration are agricultural producers. These producers vary in their level of expertise, in their intrinsic motivation for environmental sustainability, and in the product from which they derive economic profit. In the past the Alberta Government provided incentives for producers to drain wetlands because they served as obstacles to most farming practices, and removed land from productive uses.[2] Thus, many producers likely require economic incentives to provide wetland basins for restoration activity. The size and the form these incentives should take are largely unknown, and thus the supply of restorable wetland basins to serve as offsets for newly impacted wetland basins in the new *Alberta Wetland Policy* is unknown.

Most existing agri-environmental programs subsidize the adoption of beneficial management practices (BMPs) by producers in order to increase the provision of environmental goods and services. The largest of these is part of Growing Forward which is the most recent agricultural policy framework agreement between the federal and provincial governments. In Alberta Boxall (2018) indicates that about $2 billion was spent from 2013-2018 incenting BMP adoption. One of these BMPs is wetland restoration, and the level of uptake since the inception

[1] This requires varying degrees of effort by GIS personnel, scientists and aerial photography specialists including high detection survey methods (LiDAR).

[2] Cortus (2005) estimates the costs of reducing farm acreage for wetlands. Costs incurred by landowners include reduced acreage for cultivation and an increase in fuel and chemical inputs.

of the environmental elements of the agricultural policy frameworks has essentially been nil. One hypothesis for this lack of interest by producers in this BMP has been the size of the incentive payments which are likely to have been much less than the actual levels of the willingness to accept compensation. This hypothesis motivates the use of a price discovery tool such as a reverse auction in a field setting.

Reverse auctions (or conservation auctions)[1] are market-based instruments used by governments and environmental agencies for the procurement of ecosystem goods and services (EG&S). To illustrate this instrument in the case of Alberta drained wetlands, conservation leases were offered to landowners by a wetland replacement agent (Ducks Unlimited Canada (DUC)) for a bid amount that was competitively tendered amongst the landowners (Novak 2016). These bid amounts ought to represent the landowners' willingness to accept (WTA) compensation which comprises, in part, the cost of giving up the land. Wetland restoration contracts are offered for a defined period of time. Once a wetland is restored it falls under the provisions of the Alberta *Water Act* and therefore; it may not be drained again without appropriate approval[2].

Empirical literature on economic decisions and their impacts on the adoption of conservation practices are extensive (Vercammen, 2011). However, few studies of reverse auctions cite the number of eligible auction participants that could submit bids as a subset of the number of targeted landowners. Furthermore, there is sparse literature on the rationales landowners face in participating in auctioned conservation contracts.

Organization of Thesis

This thesis is organized in to five chapters. The first chapter describes wetland restoration and outlines the requirements to identify and construct a restored wetland in the Prairie Pothole region. The first chapter also provides background information on the history of drainage on

[1] Reverse auctions for EG&S are also referred to as procurement auctions, conservation auctions, or eco-tenders.

[2] Regulatory approval is required for the restoration of wetlands. Wetlands, once restored, are subject to the requirements of the Water Act (Alberta Wetland Restoration Directive, 2016)

prairie landscapes and describes some of the policies and institutions that govern the use of water in the prairies.

This chapter goes on to describe wetland loss as a problem that has gained considerable attention over the past twenty years. This chapter further outlines the agencies that currently exist with interests that are grounded in conservation, preservation, and restoration of wetlands. I provide some theoretical literature in the field of environmental economics that supports the use of reverse auctions as a policy mechanism to encourage landowner participation in wetland restoration and provide a summary of three reverse auctions for wetland restoration contracts.

The objective of this research is to broadly investigate reverse auctions for wetland restoration. Information from three field trials (two in Alberta and one in Saskatchewan) will be examined in this thesis to examine the ability of auctions to incent restoration and to highlight the challenges of a mandate to restore wetlands under the *Alberta Wetland Policy*. Specifically, this thesis reviews wetland restoration programs in the Canadian Prairies and their rates of adoption. Three reverse auctions for wetland restoration contracts are described in detail and their results are presented. One of the Alberta auctions serves as a case study and the other Alberta auction will be used to outline the determinants of participation in the reverse auctions. Finally, the bids for each reverse auction will be analyzed and benchmarked against land rental rates to examine potential rent-seeking behavior among bidders.

Chapter 2 - Prairie Wetlands

2.1 Restorable Wetlands

The Prairie Pothole Region is characterized as having small, depressional wetlands that formed post glaciation (Winter, 1989). Prairie potholes have very important and specific functions: they store water, they retain nutrients, and they serve as habitat for species (Leibowitz, 2003; Cobbaert et al., 2011). Wetlands are filled or altered on landscapes by mechanical means such as ditching, channelizing, and cultivating (Watmough and Schmoll, 2007). In the prairies wetlands are typically drained using ditches, which move water from the basins following spring runoff. Drained wetlands are integrated into the farm production system, providing additional land for growing crops and/or raising livestock. The cultivation of land, development, and fragmentation has resulted in a 70% loss of prairie potholes in specific watersheds within Alberta (Dahl, 2014; Waz & Creed, 2016).

While some wetlands have been permanently lost on Prairie landscapes, a significant inventory of restorable wetlands continues to exist. Most wetlands in the prairies are mineral wetlands. Mineral wetlands that are tilled or seeded can be restored to their original state on two conditions: a functional hydrologic basin remains; and an aquatic plant seed bank is present to allow wetland soils to form following restoration activities (National Wetlands Working Group, 1997). Wetland basins are restored by plugging a ditch and contouring basin rims as to restore hydrology (Figure 1) (Galatowitsch and Van der Valk 1994).

Restorable wetlands are situated on farms in the Prairie region (Figure 2). Agricultural producers require economic incentives to restore wetlands, as this floods their land and no longer allows it to be used for crop or livestock production. Wetland restoration results in two types of costs for the producer. Opportunity costs, which are typically calculated as the rental rate and nuisance costs, which are the increased costs from maneuvering farm machinery around restored wetlands. Cortus (2005) simulated these costs based on the number of wetlands, the farm size, and machinery operating costs and found them to be significant.

Figure 1: A restorable wetland on private property showing linear drainage feature.

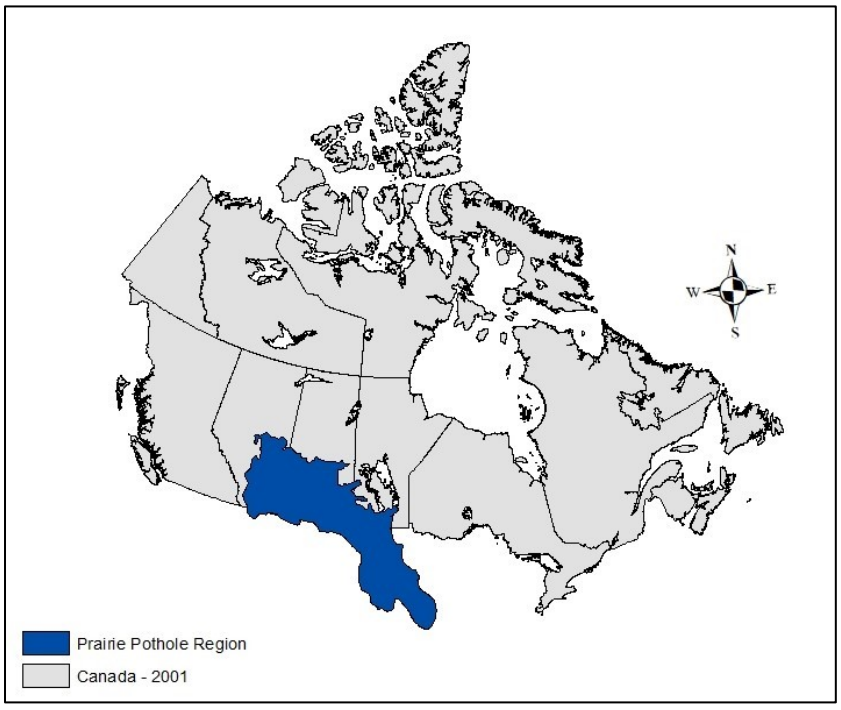

Figure 2: The Prairie Pothole Region of Canada.

Figure 3 Construction of a ditch plug on the prairies.

2.2 A History of Water Policy in the Settled Area of Alberta

"The water ran down the ditches in 1914 as planned and settlement began in a spirit of confidence. But a world war followed… [In] less than a decade, the bright promise of the project had tarnished… [But] amid all the dislocations was a core who clung tenaciously to their dream."

-Tapping the Bow, Eastern Irrigation District (1985)

Throughout history on the Plains, the continued flux of water on the landscape shaped the physical and sociopolitical landscapes of rural agrarian communities. In the 1900's the plains became a space for opportunity for farmers moving west. Doug Owren (2007) described the West as "A Settlement Frontier" (p.6). The expansionist vision fostered a public relations campaign that succeeded in encouraging the colonization of people on the Prairies. At this time, there was uncertainty regarding the ability to cultivate lands on the semi-arid landscape of Alberta. The successful cultivation of land in the 1900's was determined by a primary input for agriculture: water.

This laid the foundation for numerous policies and plans aimed at the channelization and diversion of water from water bodies, including wetlands (Northwest Irrigation Act, 1894). The water policies that emerged throughout the 20th century contributed to the pursuit and securement of water resources. Ditch-draining became a common agricultural management practice due to its ability to increase cropping productivity (Van der Gulik et al. 2000).

The ditching of wetlands would continue with several years of drought. Policies aimed at the control and delivery of water resources followed the settlement of family districts in Alberta. In 1931 the Water Resources Act, section 405, gave authority to the Government of Alberta to grant licenses for the diversion and use of water resources. The *Act* facilitated the dispersal of water licenses to agricultural landholders for the intent of "domestic purposes" (p. 405). Pivotal to the institutional framework on water rights is the notion of "first in time, first in right." The rules that govern water allocations follow this principle. The drainage of land for intensive agricultural production coupled with the development of land has resulted in the substantial reduction of prairie wetland ecosystems.

Ducks Unlimited Canada was established in 1938 as waterfowl populations began to decline. Their efforts at the conservation of wetlands for critical waterfowl habitat offered a glimpse into a conservationist outcry for the loss of wetlands on the Prairies. However, the continued loss of wetlands was further exacerbated by increases in technological innovations that make wetland drainage cost-effective with minimal effort coupled with the inability of government agencies to correctly follow their own policy directives (Clare and Krogman 2013).

An interim policy for wetlands was established in the settled area of the province in 1993. Following this, the Water Resources Act was amended in 1999 to reduce the impact of development on water bodies. The Water for Life strategy emerged in 2003 and the Alberta Water Policy followed 10 years later in 2013. The new Wetland Policy emerged in September 2013.

2.2.1 The Alberta Wetland Policy

In September 2013, the Government of Alberta released the new Wetland Policy (identified below as the Policy). The Policy is mandated to *"conserve, restore, protect and manage Alberta's wetlands to sustain the benefits they provide to the environment, society and the*

economy" (Alberta Wetland Policy, 2013: p.2). The Policy requires all parties interested in filling in wetlands to compensate the Government of Alberta on the basis of the loss of wetland ecological functional attributes. Wetland conservation is aimed at "*All Alberta's… [through] voluntary stewardship activities*" (p.22). Priority areas for restoration are identified in the *Policy* as being conducted through "*the identification of priority areas*" (p.6). Priority areas of restoration are where, historically, wetlands were ditched and drained for the purposes of cultivation and watering livestock. However, the mandate to restore wetlands is proving to be a challenge for wetland replacement agencies, due to low uptake by landowners.

Under this policy, wetland loss must be compensated for on the basis of their lost functional attributes (i.e. capability to improve water quality, increase habitat for fauna, and relative abundance). Prior to this, wetlands were compensated for only on the basis of size. The Policy recognizes a variety of wetland classifications on the basis of function and uses cross-comparisons using *relative wetland value.* The assignment of relative wetland value determines the compensation amount.

The Alberta Wetland Mitigation Directive (The Directive) informs land decisions and highlights key pieces of legislation that correlate with its directive to conserve wetland resources. Within the Directive, replacement is outlined as a compensatory mechanism for the loss of wetlands. The replacement of wetlands in the settled areas of Alberta may be done in one of two ways. The first is through restorative replacement, which is the attempt to make up for the permanent loss of a wetland through the restoration, enhancement or construction of another wetland. The other way is non-restorative replacement where an *in-lieu* fee payment is made as financial restitution for the wetland loss; funding is benchmarked for replacement, but also investment in science, data, research, and education related to wetlands.

Wetland restoration in Alberta must be completed by a designated Wetland Replacement Agent (WRA). The restoration of a wetland must include a wetland restoration plan, a validation report and a verification report that is signed-off on by a professional regulatory organization and is in compliance with the standards set out in the *Professional Responsibilities in Completion and Assurance of Wetland Science Design and Engineering Work in Alberta.* Presently, there are

only three Wetland Replacement Agents (WRA) in the Province of Alberta: The City of Calgary, the County of Vermillion, and Ducks Unlimited Canada (DUC).

The implementation of the Alberta Wetland Policy is proving to be difficult given that there is low uptake of wetland restoration contracts. A history of water policy aimed at pro-development activities provides further context for the investigation as to what the motivations exist or participation in wetland restoration. Further, this study will highlight what the disincentives for participation in wetland restoration are among agricultural producers. This investigation is important for policymakers who hope to use wetland restoration as a means of restoring wetland functional attributes.

2.3 Market Failure

Modern markets fail to value wetlands appropriately. The private benefits resulting from the drainage of wetlands by agricultural producers comes at a trade-off to the social benefits generated by them (De Laporte 2010). Wetland benefits are types of public goods because they exhibit characteristics of non-excludability and non-rivalry in their consumption. Wetlands provide an array of economic values, which can be categorized as both use and non-use values (Figure 3). Historically, wetlands have suffered from information, market, and intervention failures in Alberta. Market failures exist through the lack of price signals that indicate the functional value properties of wetlands. The ditch-draining of wetlands has resulted in surface water depletion and reduced the productive capacity of wetlands. To a landowner, the ability to cultivate defines production capacity, and this misalignment of values is an information failure that subsequently results in the overexploitation of wetland resources. This supports the rationale that government intervention is required in the form of various agri-environmental programs.

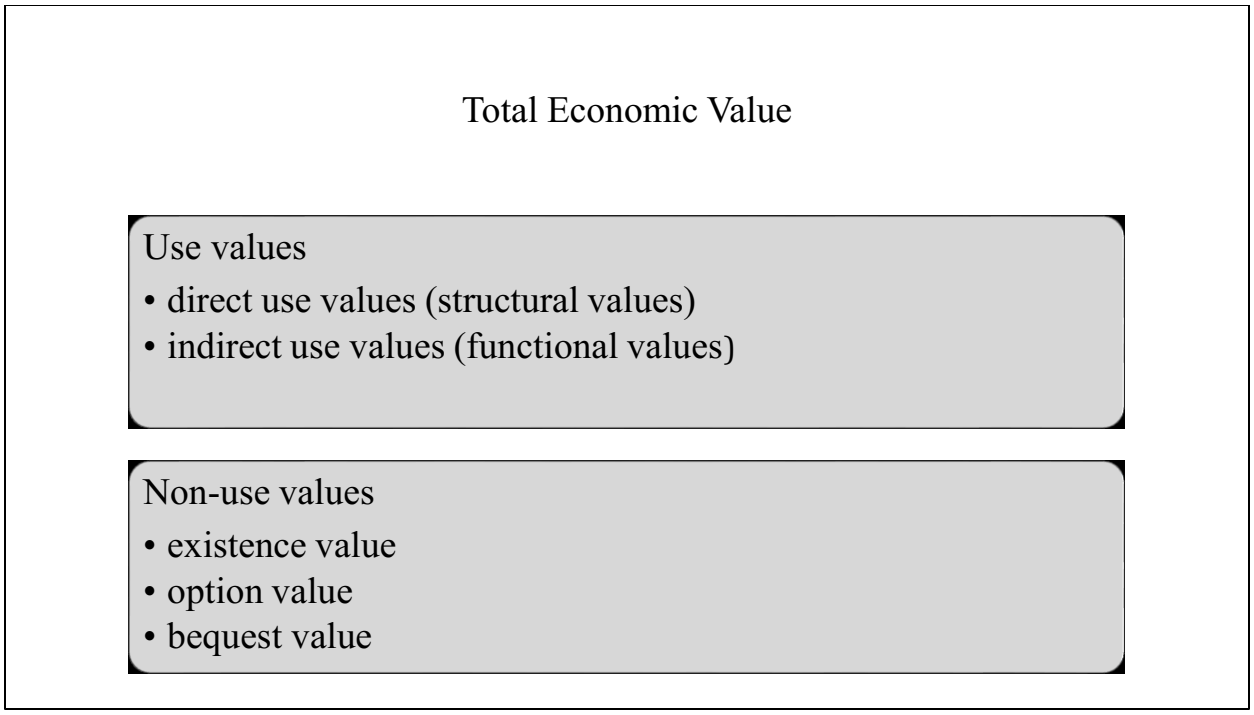

Figure 4: Wetland benefits valuation (from Whitten, 2001 p. 9)

2.4 Alberta Wetland Restoration Programs

Voluntary programs are used as the primary policy instrument for the restoration of wetlands. Typically, these programs are delivered by special interest organizations. Conservation land trust organizations (CLTO's) are increasing in number in Canada (The institute for Governance, (n.d.). CTLO's will often offer a fixed price to restore wetlands. Wetland restoration can happen by way of CLTO's providing information about how to better manage land holdings or by offering a fixed-price for conservation contracts. Often, CLTO's will use vulnerability assessments to justify landowner engagement to inform landowners of their eligibility to participate in conservation programs. In the case of wetlands, CLTO's will use aerial photography to determine whether drainage ditches have impacted wetlands. This coarse-grained approach reduces eligibility of landowners because often this approach will result in false positives (omitted restorable basins).

2.4.1 Ducks Unlimited Canada

Prior to the implementation of the Alberta Wetland Policy, Ducks Unlimited Canada (DUC) had been conserving wetland habitat for 80 years; recently with the aim of restoring waterfowl populations to mid-1970's levels. DUC is a waterfowl conservation non-profit whose messaging historically centered on renewal of habitat for duck breeding to sustain recreational hunting opportunities. Providing critical breeding habitat for waterfowl is a key objective of DUC; however, the objectives of this organization have shifted to encompass a broader conservation narrative that is more inclusive of capitalist discourse regarding the marketization of ecosystem goods and services and the capitalizing of nature (DUC, 2006).

DUC offers a wetland restoration lease program where landowners are typically offered a fixed-price for the restoration of privately held wetlands. Over the past ten years, DUC has used a Revolving Land Conservation Program (RLP) as a mechanism for the restoration and retention of wetlands. Under this program, DUC purchases the land and restores the wetlands on the property, DUC places a conservation easement on the land title, and the property is then sold by way of an online auction (DUC 2018). A study of Canadian Conservation Offsets by Noga & Adamowicz (2014) found that landowners prefer temporary contracts due to the desirability to have substantial flexibility in the adjustment of future business conditions. The RLP can also impose high costs and risks and these are borne by the wetland restoration agency (Noga, 2014).

Recently, there has been a move by DUC to reduce the stringency of contract terms in order to increase landowners' acceptability (W. Robb, Personal Communications, 2017). Recruitment is done by way of targeting landowners who may have restorable wetlands on their property.

2.4.2 Growing Forward On-Farm Stewardship Program (GFI & GFII)

Another example of wetland restoration programs in the PPR in Alberta is through the On-farm Stewardship Programs that form part of Growing Forward I and II. Under these programs, farmers would sign up to partake in several environmental stewardship programs. Under Growing Forward I (GFI), farmers with an Environmental Farm Plan applied to have up to 50% of their restoration costs covered up to some maximum cost level. This cost share amount

increased to 70%. No wetland restoration projects were accepted under GFI. Under Growing Forward II, cost share increased still further, and two wetland restoration projects were funded (Boxall, 2018).

2.5 Economic Justification for Reverse Auctions

Using reverse auctions as the instrument of choice is based on the need to determine the landowner's opportunity costs and nuisance costs of wetland avoidance i.e. to discover price. The use of a reverse auction is justified by it's ability to provide landowners with a flexible option for wetland restoration. Alternatively, wetland restoration is provided by extension programs with conservation agencies, however, these programs offer fixed-price schemes and fail to differentiate contracts on the basis of private benefits as a function of farm characteristics, distance to metropolitan areas, and personal characteristics such as age, gender, and degree of intrinsic environmental motivation.

Reverse auctions aim to correct information problems that exist in land use markets. A reverse auction is a process by which multiple landowners with restorable wetlands on their property submit bids to one buyer of wetland restoration contracts. The bid is a representation of the value the landowner would like to be paid to restore the wetland over a defined contract length. These bids are competitively tendered against each other and those bids which are deemed cost-effective by the buyer win. The restoration contract is essentially a lease and includes various parameters of payment, the restricted activities that maybe conducted within the wetland acreage, and the length of time the wetland will be protected. Examples of auctions for environmental improvements are Australia's BushTender (Stoneham et al. 2003) and the Conservation Reserve Program in the U.S.

Conservation auctions are a beneficiary-pays mechanism. In the context of wetlands, the auctioneer pays the landowner by securing funds from the Provincial Government. Falconer, Dupraz, and Whitby (2001) examine and conclude that auctions ought to be used when landowners have a high degree of heterogeneity in their opportunity costs and a high degree of heterogeneity in potential conservation outcomes (Figure 4). This is true of the characteristics of landowners in the cited reverse auctions. Pannel's (2013, 2008) public-private benefits

framework asserts that when private net benefits are negative and public net benefits are positive, positive incentives ought to be used to correct the misaligned incentive structure.

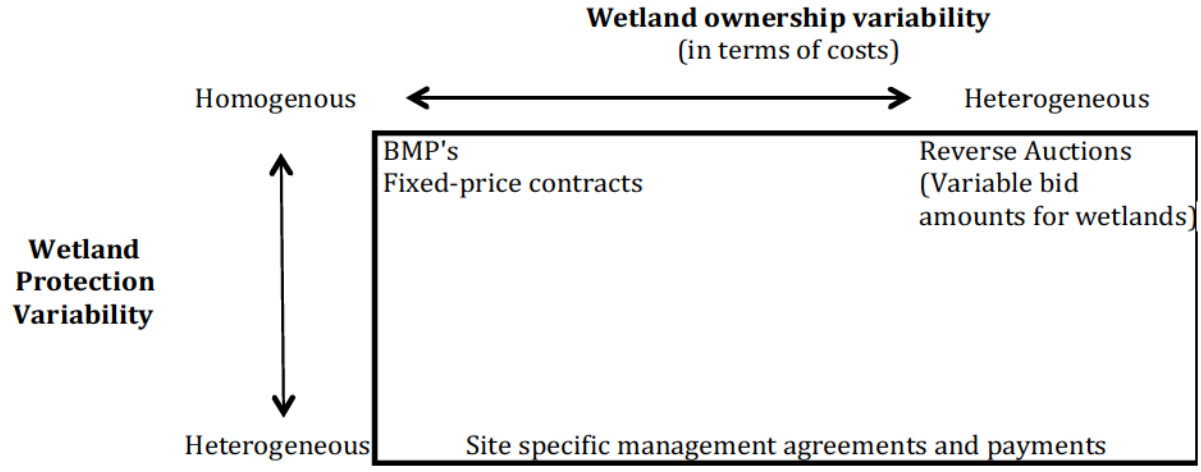

Figure 5: Instrument choice and producer type (from Falconer, Dupraz and Whitby, 2001)

Reverse auctions facilitate voluntary agreements by incentivizing landowners to reveal their costs of participation in wetland restoration. However, successful delivery of these market-based instruments requires a high amount of information about what is to be achieved. Detection of restorable wetlands is an important first step. Detection of drained and impacted wetlands by remote sensing coupled with information on land ownership provides researchers with a viable participant pool. However, drained wetland inventories are not always available, and they increase the administrative costs of conducting wetland restoration programs.

Another advantage of using reverse auctions to facilitate voluntary wetland restoration is that they provide early adopters an opportunity to restore wetlands. Reverse auctions also provide public education opportunities and capacity building opportunities for the development of future restoration markets. On the other hand, they may allow for rent-seeking opportunities by bidders and they may not achieve environmental goals on their own due to low participation.

2.6 Uniform versus Discriminatory Priced Actions

Auction design is important for conservation auctions due to economic efficiency considerations.

Auction design must consider the principal-agent problem within incentive theory as the foundation for mechanism deign (McFadden, 2008). The essential role of reverse auctions is to reduce information asymmetry by facilitating the revelation of cost of adopting a pre-determined pro-environmental behaviour. In the context of wetland restoration, this action would be wetland avoidance. However; the contract that was used in this research study allowed winning participants the ability to use the wetland for private interest i.e. to use the wetland to water livestock or grazing. Therefore, it is important to note that wetland auctions involve a certain degree of cost heterogeneity, which make reverse auctions attractive as a cost revelation tool. Auctions are noted as being effective mechanisms for costs revelation, even when there is little known about the opportunity costs of the landholder (Mcafee and McMillan, 1987).

Features of auction design for auctioneers have to do with the provision of information offered to the seller of the restorable wetland. Different provisions of information include information about the bid evaluation system i.e. which sellers have the 'best' wetlands. Information provision may also include information about the budget of the auction as reverse auctions for public good provisioning are always budget constrained. An important premise that is relevant to this research study is that sellers of restorable wetlands not only consider the provision of information but also the reliability of this information and the interests of other agents. Another important consideration of auction design is the pricing method, which is an extension of the payment method that outlines the organization of bid payments[1].

The pricing method of a reverse auction is the rule that stipulates the way that bids are paid out after the auction. Pricing methods must be evaluated because they have the capacity to impact cost effectiveness and the ability of the reverse auction to act as a cost revelation tool. Reverse auctions typically use one of two pricing rules: discriminatory and uniform. As described by Packman and Boxall (2010) a discriminatory priced auction pays the bidder the amount equal to their bid. Under this pricing rule, there is an incentive for low cost bidders to shade their bids and submit a bid that is an inflation of their true costs of wetland avoidance. A discriminatory price rule (pay-as-bid) is a pricing method where bids are ranked and accepted in

[1] The payment method includes the number of years that the contract will be paid out. In reverse auctions for wetlands bid payments are made 50% upon signing and 50% over the remaining years of the contract.

ascending order up to the point where the budget is exhausted (Hill et al. 2011). Each bidder under this method receives the amount which they solicited as a bid.

A uniform priced auction is an auction where all bidders are paid the amount which is typically the bid amount associated with the first bidder who was not selected (in other words the cheapest losing bid). Under uniform priced methods the bid submitted by the bidder is based on the probability of winning and not the level of payment that will be received. Under a uniform pricing method, bidders have a greater incentive to reveal their true cost, thereby minimizing bid shading. The application of different pricing rules on reverse auctions for wetland restoration will be discussed and analyzed further in Chapter 4.

2.7 Canadian Reverse Auctions for Wetland Restoration Leases

There have been few reverse implemented in Canada. However, there have been four used for wetland restoration on the Canadian prairies. The first reported use of reverse auctions in Canadian conservation was conducted by DUC in Manitoba (Brown et. al. 2010). This series of auctions focused on wetlands and native grasslands and requested bids for conservation easements (CEs): contracts that were in perpetuity. Two types of CEs were offered: agricultural use CEs and no-agricultural use CEs. In order to be eligible, landowners had to have undisturbed wetlands and/or native grasslands on their property. No bids were accepted for no-agricultural use CEs. Placing permanent easements on land reduces option value and this is especially true when landowners face uncertainty about future regulation and its implications for management decisions (Thorsen, 1999).

The other three auctions followed this first attempt and utilized contracts with bidders that were not in perpetuity. For these, data was provided by DUC, University of Alberta researchers, and the Assiniboine Watershed Stewardship Association Inc. for the three reverse auctions. All three involved wetland restoration and took place in agricultural areas located in the prairie pothole region (Figure 5). Proximity to metropolitan areas differed, as well as the year, that each auction took place. Proximity to urban centers is relevant due to increasing development of urban areas, which affects potential land values. In addition to spatial and temporal differences among the auctions, the auction technicians who solicited bids from landowners differed, as did the payment method. The Assiniboine River Auction was conducted by the local watershed council; the Wheatland

County Auction was conducted by Ducks Unlimited Canada; Rocky View County Auction was conducted by the University of Alberta. Actual wetland restoration work was conducted by DUC. Despite differences in the associations of the auction technicians, landowner recruitment was conducted in similar fashion. Communication with eligible bidders was done by "cold-calling" or by door to door interaction. The highlights of each auction are further described below. Specific auction design features and payment methods for auctions listed below will be covered in Chapter 4.

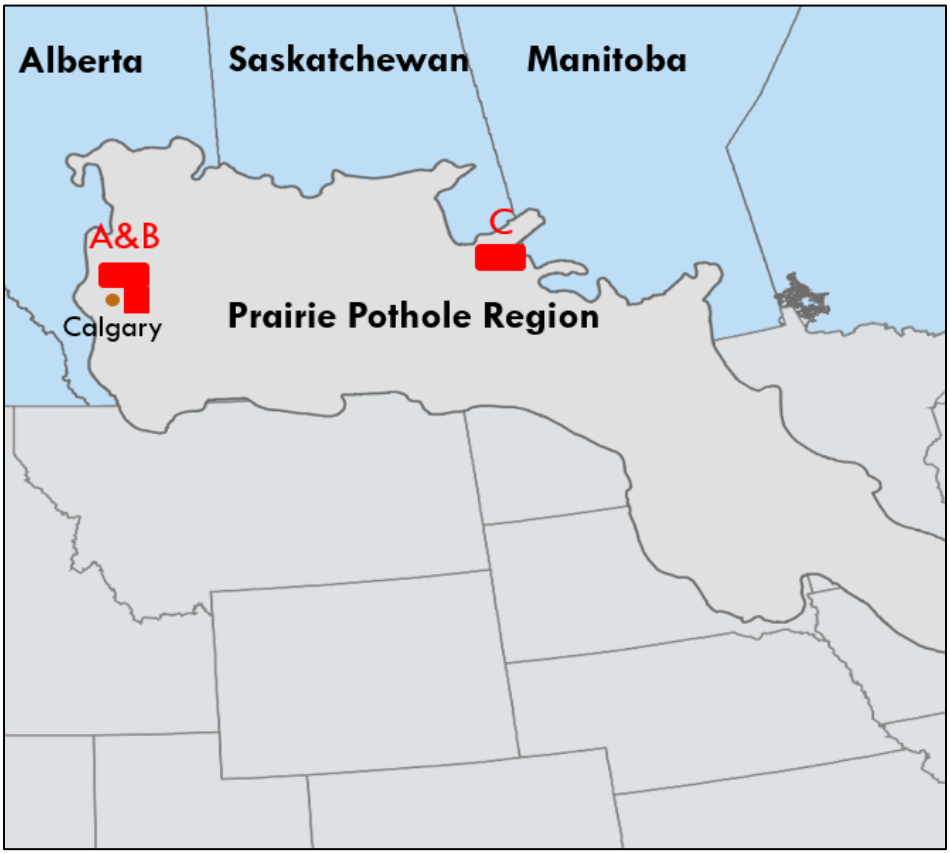

Figure 6: Map showing approximate study areas A: Rocky View County, B: Wheatland County, and C: Assiniboine River Watershed

2.7.1 The Upper Assiniboine Watershed Wetland Restoration Auction

The Assiniboine River Watershed Reverse Auction was conducted in Eastern Saskatchewan from 2008 to 2009 (Hill et al. 2011). Assiniboine River Watershed (ARW) encompasses 17,300 square

kilometers and includes 24 municipalities; however, the area is not in close proximity to any major metropolitan area. Cropland comprises 58% and pasture comprises 17 % of total farmland (ARW 2006).

This auction was a two-round, sealed-bid, discriminatory auction with a hidden budget cap. In this first round, 118 bids were submitted by 22 landowners; and in the second round, only 46 (39%) of the 118 initial bids were considered in the second round. As noted by Hill et al. (2011), there was very little revision of the bids among those bidders that submitted in both rounds. The second round of bids in this auction determined winners.

Two types of contracts were offered in this auction. Landowners could have bid on a conservation easement; this easement would be placed on their land title in perpetuity. The second bid option was a conservation lease, which was an agreement to restore the basin and keep it intact for 12 years. Hill et al. (2011) report that there were no bids submitted for the perpetual easement, only for the 12-year lease option. The payment scheme of this auction was a 50% payment upon signing with the remaining 50% paid over the 12-year contract, paid with1.6% annual interest. Bids were ranked in this auction based on an index of hatched waterfowl nests and were accepted on the dollars per environmental benefit score.

Participation rates are reported as low in Hill et al. (2011). However, a definitive participation rate cannot be defined due to lack of knowledge about the number of restorable wetlands could be provided by landowners.

2.7.2 The Wheatland County Auction

The Wheatland County auction was conducted in southeastern Alberta in 2015. This study area (Figure 5) is located approximately 80 kilometers of the City of Calgary, a major metropolitan area with a population of about 1.5 million (Statistics Canada, 2016). There are 782 farms and cropland comprises about 70% majority of the farmland (Table 1)

DUC determined the eligibility of landowners through aerial photography. Landowner recruitment was done by cold calling or simply showing up on the landowner's property (DUC Auction Technician, personal communication April, 2017). In total, 87 landowners were eligible to bid in the auction, with eight landowners submitting sealed bids, signifying about a 9% participation rate. This auction was a uniform-price, sealed-bid, single-round auction. Winning

bidders were paid 50% upfront and 50% over the remaining contract years, paid with 1.6% interest.

2.7.3 The Rocky View County Auction

In 2015 the University of Alberta launched a wetland restoration project called "Alberta's Living Laboratories" with the aim of testing a market-based instrument for wetland restoration. This was in conjunction with Alberta Environment and Parks (AEP) Wetland Restoration and Resiliency Program (WRRP). The aim of this program is to improve the capacity and resiliency of watersheds and to reduce the risk of flooding and drought (GoA, 2013). Research technicians contacted 66 landowners who were considered eligible[1]participants. Of the 66 landowners who were contacted, four landowners submitted bids; this is representative of a 6% participation rate. The Rocky View County (RVC) auction was conducted in Southeastern Alberta, Canada. RVC is located directly north of and adjacent to the City of Calgary and surrounds the City of Airdrie. This county has the highest rate of urban development of the three auction study areas. Agricultural holdings are situated on prairie grassland and involve both cropped and pasture areas. There were 1271 farms in the county in 2011 (Table 1). Of the total farm land area, 52% of the land is dedicated to cropland. The average size of the farms is 761 acres.

Eligibility requirements were assessed using both remote sensing and aerial photography and parcel ownership information provided by Rocky View County. This course-grain approach was used to delineate drainage ditches that had left scaring on the agricultural landscape. Using Arc GIS, the aerial photography was overlaid with landowner information in order to identify the postal code information of eligible participants. Postal code information was used to determine phone numbers via an online platform.

Sixty-six participants were contacted by the research team from the University of Alberta. Mail outs were sent and phone calls made by three auction technicians. A script was used in order to ensure consistent communication deliverance through the recruitment phase. The phone script for

[1] Eligibility is based on wetland restorability. Wetland restorability is based on the identification of linear features that come off of a historically present wetland. This is a coarse-grain approach, which uses a technician, and aerial photography has a 65% success rate (Waz 2016).

Table 1: A select set of agricultural statistics for Assiniboine River Watershed (ARW), Wheatland County (WC), and Rocky View County (RVC)

	ARW[1]	WC[2]	RVC[3]
Number of Farms	6,578	782	1271
Farm land area (1000 acres)	-	1121	967
Cropland (1000 acres)	-	769	503
Other Land (1000 acres)	-	281	432
Woodland and Wetland	-	19	17
Average size of Farms	-	1434	761
Average operator age (years)	-	55	57
Woodland and Wetland	-	19	17

[1] ARW intersects and partially encompasses two agricultural census regions (5A & 5B). Data could not be verified. Information provided from Hill et al. (2011)

[2] [3] Select agricultural statistics for RVC and WC (Alberta Agriculture & Rural Development, 2011)

landowner recruitment purposes is provided in Appendix D. Expressions of interest by landowners were followed-up with phone calls, home visits, and town hall meetings. Landowner engagement and communications plans required a high degree of effort. Communications brochures as well as a website intended on transmitting information on the importance of restoring wetlands and the auction to be held.

Landowners who agreed to home visits were met with auction technicians in order to explain the parameters of the auction including the acreage that they were eligible to bid on and where the restorable wetland is located (Figure 2), payment methods, and the timeline of construction with the restoration agency. Landowners were asked if they would be interested in submitting a bid for the acreage of the restorable wetland(s). Bidders were presented with a bid form that is provided in Appendix C.

Of the targeted participants, four people submitted bids, signifying a 6% participation rate. Similar to the Wheatland County Auction, this auction was a uniform-price, sealed-bid, single-round auction. Landowners were paid 50% upon signing and 50% over ten years, paid at 1.6% interest.

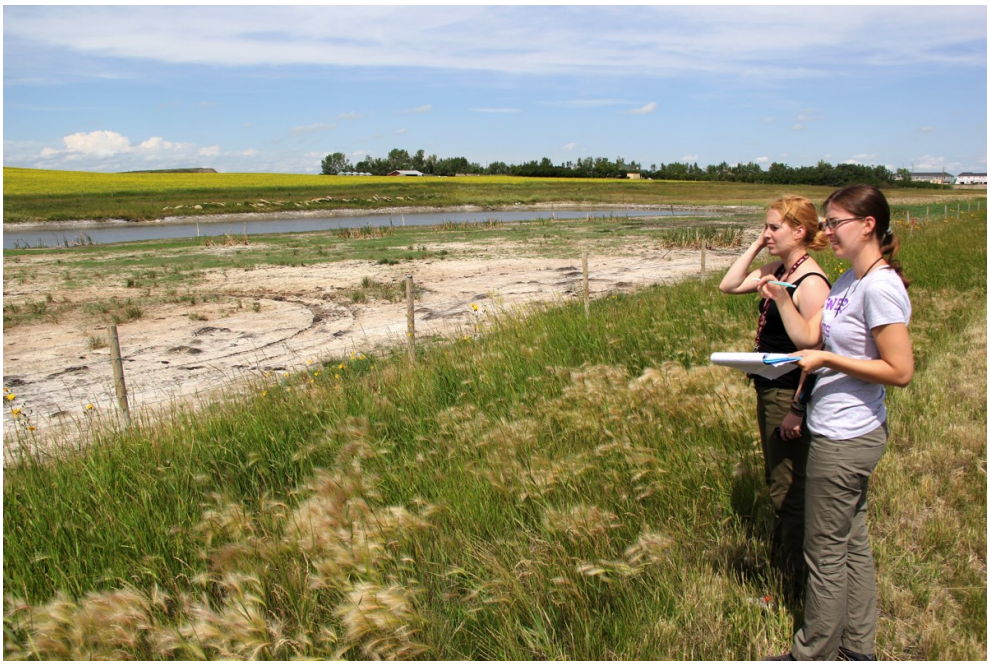

Figure 7: Ground truthing drainage ditches in Rocky View County feat. Anna Waz (right) and Anna Kauffman (left). (Photo credit: Tam 2015)

Figure 8: Rain cloud formation above conventional pump jack in Rocky View County (Photo credit: Kauffman 2015)

2.8 Research Questions and Objectives

The research objectives of this study are to broadly investigate the use of reverse auctions as an instrument for attaining the rights to restore wetlands on privately held property. Throughout the research process, new insights emerged, as there are key limitations in attempting to use reverse auctions to price wetland restoration contracts. Wetlands have recently gained notoriety for their highly complex and crucial role in ecosystem function. Under uncertain future conditions, wetlands act as a cushion for the effects of climate change. Therefore, understanding people's role in the land management and how landowner's perceive the "wicked problem" of wetland loss is an important first step in wetland management. It is also important to consider what existing conflicts exist within the context of water management, wetlands management and how existing institutional conflicts influence participation and cost efficiency in wetland restoration auctions.

The first objective of this thesis is to uncover some considerations for producers and developers when it comes to participating in a wetland restoration reverse auction. Growing Forward programs and Ducks Unlimited Canada are interested in the uptake of these types of contracts; however, there is a long standing history of wetland drainage on the prairies. Furthermore, the practice of drainage has been reinforced and rewarded for in terms of economic profit. An understanding of the history of drainage and the actors of the wetland restoration movement guided the following research questions:

(1) What are the disincentives for the uptake of wetland restoration contracts by way of reverse auction?

(2) What informed the decision of non-participation in wetland restoration contacts?

The second objective of this thesis is to consider the parameters of wetland restoration auctions. Producers have heterogeneous costs of wetland avoidance in terms of their opportunity costs and input wastage costs. In order to maximize the amount of wetland benefits purchased by the restoration agent while minimizing the cost of doing so, an auction format seems appropriate. Auction design features, including the pricing method, for conservation auctions are crucial to auction success. In their use as a cost discovery tool, auctions design must incorporate incentive compatible strategies to encourage landowners to reveal their true costs. It has been shown in the

experimental economic literature that certain pricing methods contribute to rent seeking more than others. However, no study has looked at the impact of pricing methods on rent seeking in field studies for ecosystem goods and services. The reliability of the pricing method in field studies has contributed to the formulation of the following research questions:

(1) How did the auction format, specifically the pricing method, contribute to rent seeking?

2.9 Summary

This chapter provides context for the upcoming discussion regarding reverse auctions for wetland restoration. This chapter outlines the rational for the use of reverse auctions for wetland restoration contracts from theoretical and economic standpoint. The chapter begins by chronicling the history of water policy on the Prairies. The use of drainage ditches to increase agricultural productivity is a legal activity that was facilitated and encouraged through the use of various water policies. While draining wetlands still occurs, the new Alberta Wetland Policy has been unveiled as a policy that seeks to offset the loss of further drainage by requiring that all landowners seek a Water Act approval before commencing any drainage activities. Eradicating the practice of drainage on Prairie landscapes would generate a host of positive externalities in the form of ecosystem services such as water retention, biodiversity, and waterfowl production. However, the private benefits that are incurred by the landowner incent landowners to drain wetlands. The negative externality resulting from the drainage of wetlands on society is due, in theory, to the lack of a pricing scheme that would correctly price the wetlands ecosystem services. The result of this is overexploitation of the wetlands resources and a resulting market failure. As a result of wetland overexploitation, Ducks Unlimited Canada as well as ALUS have succeeded in garnering some participation from landowners with regard to the conservation and restoration of wetlands. However, wetland loss in Alberta continues at a 0.5% rate, annually (Badiou, 2014).

This chapter describes two types of payment methods that have been used in reverse auctions for wetland restoration contracts. It describes three reverse auctions conducted in Alberta and Saskatchewan and shows the agricultural statistics that are available for the study

regions (Table 1). These summary statistics highlight that the study regions are similar with regard to their agricultural farm characteristics. These study areas' auction communication data, coupled with interviews can provide some useful insight as to the important considerations for landowners when choosing whether or not to participate in a reverse auction with the prospect of winning a wetland restoration contract.

Chapter 3 - Participation in Reverse Auctions for Wetland Restoration

Landowner participation in wetland restoration is critical for the *Alberta Wetland Policy*. This policy, since 2013 has collected *in lieu* compensation payments from mainly land developers. Through to *Alberta Wetland Restoration Directive* the GOA intends on dispensing these compensation funds for both research and education or through on-the-ground restoration of wetlands.

The allocation of restored wetland restoration contracts in three reverse auctions involved the recruitment of private landowners. Private landowners communicate a variety of reasons why wetland restoration is not feasible on their property. Through the use of the Reasoned Action Approach Framework I demonstrate, using communications and interview data, some key points of saliency in the landowner's participation decision for wetland restoration.

3.1 The Participation Decision

Agricultural producer's decision to participate or not in a reverse auction for wetland restoration contracts requires specific context. Salient considerations for non-participation must be understood through the history of agricultural drainage on the Prairie, which is now common agricultural practice. A recent interventionist strategy by the Alberta Government to correct for the 70% loss of wetlands by restoring them on privately held land faces significant challenges. As the three reverse auctions for wetland restoration held recently show, despite offering monetary compensation to incent landowners to participate, participation in reverse auctions for wetland restoration remains low.

Low participation[1] in reverse auctions is not a novel phenomenon. Throughout the world, reverse auctions for environmental goods and services seem to fail to incent ample participation (Table 2). This is problematic, as thin markets for public goods create price uncertainty. Furthermore, a low number of bids offered for wetland restoration contracts results in low levels of competition among bidders and thus poor levels of cost effectiveness (Schilizzi and Van der Hamsvoort 1997; Iftekar 2014). Sufficient levels of participation are a necessary condition for the success of reverse auctions (Glebe 2013; Whitten 2013; Zanella et al. 2014).

Reverse auctions often involve public goods and services provided by privately held lands that require specific management practices by rural landowners. These landowners are agricultural producers of varying demographics and attitudes. Auction technicians, whose main objective is to recruit eligible participants, face objections from landowners. There are many studies which aim to quantify the factors of influence in voluntary agri-environmental programs. However, the driving factors that influence landowner participation remain uncertain (Lastra-Bravo et al. 2015; Sorice and Donlan 2018). Although, some studies reveal that a farmer's characteristics, structural factors, and institutional elements play a role in the participation decision for agri-environmental programs (Mettepenningen et al. 2013; Reimer et al. 2014). The literature tends to focus on the voluntary adoption of agri-environmental schemes without focusing in on specific environmental goods, such as wetlands. Cyr, Parkins and Boxall (2018) found evidence linking social norms and pro-environmental attitudes to wetland restoration. Though, there is no conclusive evidence based on field studies in Canada on the various disincentives landowners face in becoming involved in wetland restoration programs.

There are many studies that focus on the adoption of agri-environmental programs by landowners, although most of these programs are voluntary programs and market-based programs. Reverse auctions differ in that they are premised on the 'provider gets principle'

[1] It is important to note that participation in the conservation auction literature is often ill-defined, as participation rates ought to represent the total number of bidders who submitted bids in to the auction out of the total number of targeted participants who were eligible to bid (they are able to provide the public good via alternate management activities).The differential in cited experimental participation rates and field participation rates in reverse auctions motivates the research question: What are the barriers to wetland restoration in the Prairie Pothole Region?

(Hanley et al. 1998). Reverse auctions offer monetary compensation for the reduced production activities of landowners in restorable wetland areas. Survey methods are often employed to characterize the 'types' of landowners who participate in agri-environmental programs. Voluntary agri-environmental participation is linked to farm characteristics such as farm size, location, and production type (Daberkow and McBride 2003; Hadrich and Winkle 2013; Wilson and Hart 2000). It has been shown that past experience with agri-environmental contracts can positively influence participation in voluntary environmental schemes (Ducos and Dupraz 2006). A study by Greiner and Gregg (2011) found that ranchers had a high degree of conservation and lifestyle motivation and stewardship ethic. Landowners beliefs and attitudes influence the participation decision as well (Cyr et al. 2018). Landowners that hold intrinsic motivations for conservation are more likely to adopt conservation contracts, whereas landowners with economic/financial and social goals are more likely to require financial incentives (Burton, 2004).

Factors that influence the adoption decision in agricultural BMP's are relative advantage, compatibility, complexity, trialability, and observability (Rogers, 2003). Observability is a considerable factor which influences wetlands because their private benefits are often unseen. The observability of private benefits is linked to landowner adoption of agri-environmental management practices (Pannell et al. 2006). The participation decision may hinge on a variety of factors which are influenced by the characteristics of the landowner. In order to determine what the factors are, I will employ a semi-structured interview approach to ask eligible landowners why they chose not to participate in a reverse auction for wetland restoration contracts.

The body of literature on conservation auctions (reverse auctions) signifies that there is evidence of low participation around the world. Economists aim to achieve environmental objectives by using incentive mechanisms to encourage participation. However, theories as to why landowner participation in wetland restoration remains low in developed countries remains unknown. Although studies have looked at the determinants of participation in agri-environmental schemes in Europe (Defrancesco et al. 2008; Hynes and Garvey 2009) and in Australia (Morrison et al. 2011) .Studies tend to focus on a brad range of management activities related to agri-environmental improvements. This study focuses solely on wetlands and their restoration on the Prairies of Canada. The purpose of this chapter is to explore low participation

in the context of reverse auctions for wetland restoration contracts. Specifically, this chapter aims to understand the factors that negatively or positively influence the participation decision.

Table 2: Participation rates in reverse auctions for environmental improvements.

Level	Study	Participation Rate[1]	Number of Participants	Focus	Study Area
Low (0-30%)	Brown et al. 2010	1%	46 of 3665	Native grasslands & wetlands	Manitoba, Canada
	Cummings et al. (2004)	7%	106 of 1423	Irrigation permits	Georgia, US
	DePiper (2015)	13%	492 of 3676	Crab fishing licenses	Maryland, U.S
	Ducos and Dupraz (2006)	12%	Unknown	Agro-environmental contracts	France
	Gole et. al (2005)	21%	10 out of 48	Native Grassland	Australia
	Kauffman (2018)	6%	4 out of 66	Wetland Restoration	Alberta, Canada
	Novak (2016)	9%	8 out of 87	Wetland Restoration	Alberta, Canada
	Palm-Forster et al. (2016)	1%	11 out of 1085	Phosphorus reduction	Ohio, NW
Medium (31-60%)	Hill et al. (2011)	35%[2]	7 out of 22	Restorable wetlands	Sask., Canada
	Comerford (2014)	35%	Unknown	Native grasslands	Queensland, Australia
	Iho et al. (2010)	42%	Unknown	Phosphorus reduction	Finland
	Jack et al. (2008)	41%	Unknown	Erosion prevention	Indonesia
High (61-100%)	Jindal et al. (2013)	67%	268 of 400	Tree planting contracts	Tanzania
	Hartwell and Aylward (2007)	72%[3]	Unknown	Irrigation permits	Oregon, U.S

[1] Number of participants who submitted bids of the total number of eligible bidders

[2] This rate of participation is not well defined as it does not represent the number of bidders that participated as a subset of targeted landowners

[3] irrigation permits covering 69 acres as the median of the given range {4,142} assuming that one irrigation permit is held by one landholder

3.2 Method I: Word Count Analysis

I analysed two sets of data to look for theme's relating to non-participation in wetland restoration auctions. The first data sets were phone communications response records. These records were kept by technicians of the Assiniboine River Watershed and Rocky View County. A total of 67 open-ended responses to Assiniboine reverse auction technicians and Rocky View County auction technicians were reviewed. These telephone conversations with landowners essentially asked if they would be interested in participating in a reverse auction to restore a wetland on their properties. The resulting responses were open-ended and the answers varied amongst respondents. Each response was categorized as being 'positive' or 'negative' in terms of participation (Table 5), and each open-ended reason was categorized using keywords (Table 4). The responses from both participants and non-participants were categorized thematically to highlight the factors of the participation decision and a summary of these can be found in Figure 7. These results serve as preliminary evidence of the foundational theme's relating to non-participation in wetland restoration.

Themes identified in the preliminary investigation informed the development of interview guides that I used to conduct interviews with participants and non-participants in both Alberta auctions. The purpose of these interviews was to identify t any limitations that could influence auction non-participation. The interviews followed a semi-structured approach, and thematic analysis was chosen as a method for interpreting respondent's answers to the question of whether or not to participate in the wetland restoration auctions. This approach was deemed suitable for analysis because it allowed for a way of interpreting individual's views and opinions on the issue of wetland restoration on their property. The interviews stopped when responses did not offer further insights to participation and *saturation* was reached (Goulding 1998).

3.3 Method II: Interview Analysis

A secondary, more in-depth analysis was informed by 15 semi-structured interviews I conducted with landowners who were eligible (i.e. have a restorable wetland on their property) in either the RVC and WC reverse auctions for wetland restoration. Each landowner had been contacted by a University of Alberta researcher or a Ducks Unlimited Canada representative between October

2013 and October 2016 in-person or over the phone and were asked if they would participate in a reverse auction for wetland restoration.

The semi-structured interviews were conducted from July 2016 to November 2017. Within RVC, five non-participants were interviewed over the telephone and four participants were interviewed in person. Within WC two non- participants and three participants were interviewed over the phone. Summaries of landowner interviews by county are found in Table 3. Interviews were conducted using an interview guide shown in Appendix 1. These interviews focused on the landowners' motivations to participate or not and also contained questions about current farming practices and perceived environmental benefits of these practices. Interviews ranged from 2 - 90 minutes and included landholders that both rented and owned farmed properties, were crop producers and were livestock producers. The interviews were recorded and transcribed verbatim.

Table 3: Landowner Interviews of Participants and Non-participants by County

Landowner Interview Summary		
	WC	RVC
Participant	2	4
Non-participant	3	6
Total	5	10

3.4 Results

The preliminary review of 67 open-ended responses from the Assiniboine River Watershed (ARW) and Rocky View County (RVC) reverse auctions offers insight as to the primary motivations for non-participation (Figure 7). Some respondents provided more than one response type and all reasons given for non participation are given in Table 5. Communications records "factors" are defined in Table 4. Time is defined as the landowner's time resources required to implement the management activities associated with a wetland restoration contract. Time resources may also refer to the time required to formulate a bid and communicate this bid to the auctioneer. Economic factor refers to the landowner's perception of whether the reverse auction would result in a net positive or negative financial circumstance as a result of participating in the

reverse auction. Social factor relates to a landowners' social network; the landowner provided either a positive or negative rationale for participation based on neighbours. Ecological factor is defined here as relating to the biological factors that the wetland provides, summarized as being either wildlife or waterfowl. Control factor relates to concerns related to landowners' property and is expressed as wetland restoration being conducive to the current property characteristics or against them. A trust factor is related to the trust between the landowner and the conservation agency or the government. Not a wetland is a factor that relates to the landowner not believing that there is a viable wetland on their property and this relates to a misalignment of definition between the landowner and the government or conservation agency.

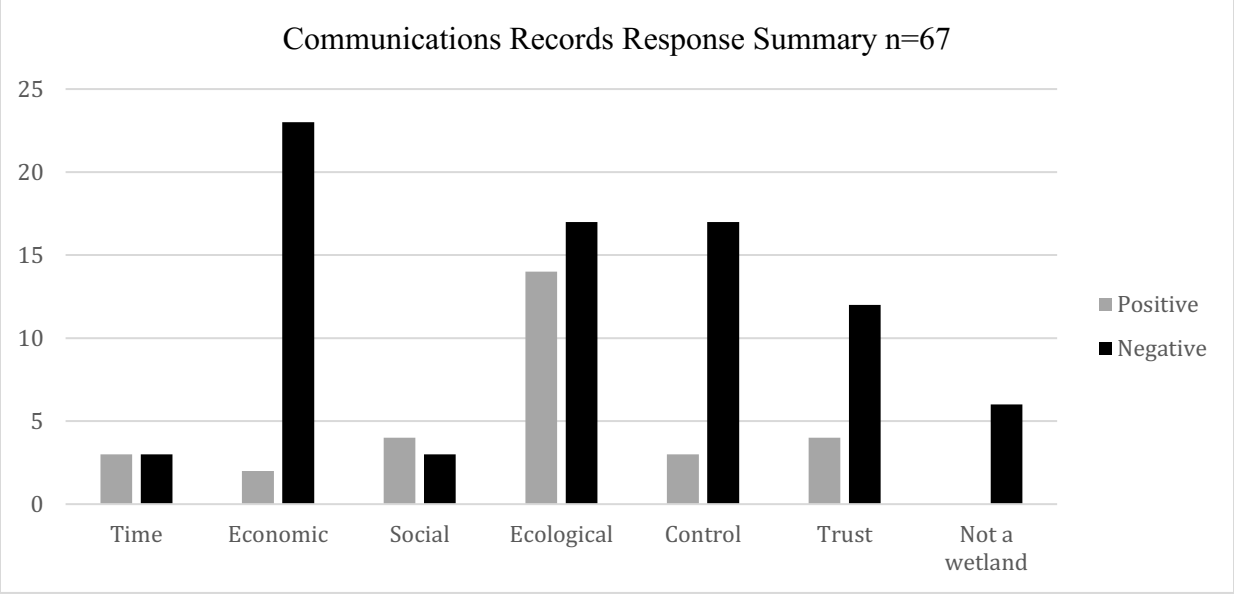

Figure 9: Communications Response Summary from n=67 landowners in Rocky View County and Assiniboine River Watershed who were asked to participate in a reverse auction for wetland restoration.

Table 4: Response Summary for n=67 respondents in Assiniboine River Watershed and Rocky View County

Factor	Response Summary	
	Positive	Negative
Time	3	3
Economic	2	23
Social	4	3
Ecological	14	17
Control	3	17
Trust	4	12
Not a wetland	0	6

Table 5: Response Types for n=67 respondents in Assiniboine River Watershed and Rocky View County

Factor	Response Type	
	Positive	Negative
Time	Bid Method	Contract length
Economic	Benefit	Cost
Social	My neighbors	My neighbors
Ecological	wetlands and wildlife	wetlands and wildlife
Control	Conservation easement	Property rights/contracts
Trust	The Government/Special Interest group	The Government/Special Interest group
Not a Wetland	Not defined	Not defined

Communications responses were coded and summarized. Responses were coded as either a positive or negatively affecting the participation decision. A negative influence on willingness to participate came from a combination of factors or from one specific factor. Communication records show certain factors are more likely to influence the participation decision in a positive or negative way. Based on communication records, willingness to participate was influenced most negatively by economic considerations (Figure 8). These results show that 23 landowners indicated that economic factors negatively influenced their willingness to participate. Negative influences on participation were cited as being attributed to increases in waterfowl on landowner property. Landowner's articulated this as not wanting an increase in waterfowl due to nuisance fact or not wanting an increase in hunters on their property due to having increased waterfowl or deer on their land. Another factor that negatively influenced the participation decision for landowners was control. Landowners indicated that control over property rights was of pivotal concern and indicated an aversion to the potential loss of property that would be incurred if they were to sign a contract with a conservation agency.

3.5 Interview Findings

Salient Features in the Participation Decision

A review of the communication records above reveals that some key themes that hinder participation are related mostly to economic, control over property rights, and nuisance factors that are specific to wetlands. In my interviews, these factors remained as the most salient factors contributing to non-participation. In the following section, I will show landowner quotes that detail the identified themes. These themes are organized according to interviewees most prominently identified reasons for non-participation. A key feature of non-participation was economic considerations. Following this feature was a theme that concerned property rights and aversion to conservation agencies. Finally, interviewees expressed concern about the features of wetlands, how wetlands are identified, and how they are defined by governments and conservation agencies.

<u>Economic Barriers</u>

Technicians identified nuisance costs as an important factor for non-participation in the restoration auctions. The interviews I conducted with Alberta landowners confirmed this - the cost of avoiding restored wetlands was the most cited non-participation consideration of eligible participants in Wheatland and Rocky View Counties. Of the 15 landowners interviewed, 13 landowners stated that financial considerations were an important issue when deciding whether or not to participate in the restoration auctions. Economic barrier's including transactions costs act as a main barrier to participation in reverse auctions have been revealed in other studies (Palm-Forster et al. 2016). However, the type of costs cited by landowners differed. The most cited was nuisance costs, as these costs are linked to the spatial configuration of the wetland. Nuisance costs have been shown to be significant (Cortus 2005). One non-participant, who is a crop producer, stated that wetlands could be acceptable in certain spaces but not in others:

> Wetlands cost a lot of money to work around. If [the land] is for grain, then let it be for grain. If it is for forage, then let it have more natural wetland areas. Pasture areas can have more wetlands. Grain lands should be different… especially when it comes to fertilizer and pesticide application, if you are no longer working with a square box; the land becomes more difficult to farm.

Other interviewees also credited the creation of higher input wastage costs for farming in intensively cultivated areas. Other non-participants described the land as being suitable for some types of activities but not for others. Landowners who are situated on forage and pasture are likely to bid lower amounts, because they face lower opportunity costs for the reestablishment of wetlands (Cortus et al., 2011). The auction format was also believed to utilize a reserve price, and the price that the participant would require to be paid for converting the drained basin could not possibly be attained. As one crop producer put it

> Ha! [wetland restoration] isn't economical enough. They don't have a big enough bank account.

Many landowners also expressed that they do not feel that wetland restoration would yield any economic benefits. Landowners would often 'anchor' their responses in the interviews on prior experiences with other agri-environmental programs, such as the On-farm Stewardship Programs in Alberta's Growing Forward II & II. This was expressed by another non-participant who operates a mixed farm:

> [Wetland management] isn't a cost that we can shoulder ourselves. It is not economically viable for us to do it. The Growing Forward programs have helped but sometimes they aren't easy to work with and honestly, there isn't enough money to cover the cost.

Almost all of the non-participant landowners who I spoke to discounted the wetland restoration agency`s ability to provide ample compensation for them to sign a restoration contract. One landowner lamented that the process is costly and complicated:

> They want to save wetlands? Why don't they come to me to figure out a plan to manage the water? Make the process simple and cost effective and you would have way more people on board.

An important issue with regulating prairie pothole landscapes is that landowner perceptions of wetland benefits are not realized. Wetland benefits are often spread over large expanses of area given their hydrologic connectivity and spatial distribution (Cohen, 2016). However, the costs of management and retention are concentrated on privately-held lands. Thus, the legacy of wetland drainage is onerous. One non-participating landowner described the difficulties of balancing agricultural production with environmental stewardship:

> A lot of these problems are inherited problems. I didn't drain the wetlands; I didn't mismanage the wetlands; and yet, I seem to be holding the bill. I just wish sometimes that the government would realize that farmers are trying to do better.

Property Rights/Trust

Contracts outlining the details of wetland avoidance are made with landowners. These agreements can change the management capacity of the farmer. A non-participant crop farmer explained that losing control of property rights to a conservation agency as being a disincentive to participate:

> I can tell you right now, I wasn't interested in participation because I didn't want Ducks Unlimited to have any control of what I can do on my property. They wanted to increase the wetlands I already have in my property and I am not interested in doing that.

Of the 15 landowners who I interviewed, 5 expressed concern with the agency that is involved in the restoration process (e.g. DUC). Some landowners felt that prior experiences with the restoration agency were negative and had used this as a rationale as to why they were not interested in participation in the auction. As remarked by one non-participating, mixed-farmer:

> My neighbor, across the fence here, she passed-away. Ducks Unlimited was supposed to put a plug in there… They did the engineering studies and all that kind of stuff and, in the end, they didn't have the financing to do the project. We are talking millions of dollars.

Another highly interested landowner, who after serious consideration of participation in the auction did not submit a bid, described the process of wetland restoration as cumbersome. They expressed their frustrations with the wetland restoration agency. He explained how the agency had expressed their own interests on a site visit:

> One of the first things the Ducks Unlimited representative said to me was 'do you allow duck hunters on here?' that really soured me; it was unprofessional.

Another crop farmer, when asked whether he talks to his farmers about wetland restoration said:

> Yeah, [wetland restoration] has come up. Ducks Unlimited is not very popular. With the wetland aerial maps—they make them. They have way too much power. They have their own interests. And we have to run a business, they are not good for business and they go about it the wrong way.

Complexity of the Asset

Prairie potholes are a specific type of wetland that are geographically isolated. These wetlands can be seasonally wet or dry, depending on the availability of surface water (Tiner, 2003). Wetland functions are, to their detriment, mainly unobservable (Millennium Ecosystem Assessment 2005). Thus, it is the spatial and temporal variability of prairie wetlands that make them a particularly difficult public good to auction. The Government of Alberta defined wetlands as "Land saturated with water long enough to promote wetland or aquatic vegetation, and various kinds of biological activity that are adapted to a wet environment" (Alberta Wetland Policy, p.25). This definition of wetlands is a mismatch between landowner perceptions of them, as stated by a non-participating crop producer:

> I have looked at what they call "wetland" and what they call "wetland" we have been farming through for the past 50 years… [it] doesn't take long for a cattail to get going. And that pops up and all of a sudden you have slough grass and it only seems to go one way. You can get in to a wetland and never get out of one.

Indeed, "getting out of a wetland" is a difficult endeavor for landowners, especially in the spring when snow melts and residual water is an issue for farm machinery. In addition, permits for wetland drainage have become increasingly difficult to attain. These conditions and restrictions on landowners with regard to managing the continued flux of water on farm properties is a challenge:

> They are getting really sticky now. It's a permit process. We deal with Calgary; Alberta Environment. I don't think they know what they are doing. When I first approached them [for a Water Act Approval] they wanted full hydrology reports…

> [And] it's not necessary. We are helping the environment. We aren't using as much chemical fertilizer because there is less surface runoff.

The definition of a wetland is characterized by landowners as being “wet” and often characterized as being “large”. Colloquially referred to as a “slough”, one non-participant defined wetlands in their own terms:

> Significant wildlife and vegetation that is absolutely natural. A big slough with all the slough features. Like I said, you get a couple of wet years and there is some water-- that is not a wetland. I mean, I kind of laugh at their definition of a wetland.

word counts indicate that non-participants see wetlands themselves as an undesirable quasi-public good for auctioning. Wetland were noted in negative connotation 53 times by non-participants. The second most cited participation barrier was cost, which was cited 23 times. Finally, loss of control will regard to property rights was cited 12 times as a rational for non-participation.

3.6 Discussion

Among participants and nonparticipants of the Rocky View County and Wheatland County reverse auctions, there is no consensus on the legitimacy of wetland restoration. All interviewees expressed that wetlands are fundamental to farm operations and/or life. However, the wetlands issue in the Province of Alberta has become deeply politicized with certain groups calling to action the need to save wetlands, while others actively-seek ways to remove them from Prairie landscapes via tile drainage and other methods (Alberta Farmer Express, 2017). My interviews revealed that economic conditions contribute to the decision to participate in reverse auctions for wetland restoration. However, it also brought to light other attitudes surrounding the restoration of wetlands and the implementation of the *Alberta Wetland Policy*. Landowners expressed distrust as a primary motivation for non-participation. Some producers articulated that wetland restoration by way of contract is a power move by governments and special interest organizations. And that wetland restoration contacts may threaten the livelihoods of producers.

Benefits of wetland restoration are largely unrealized by crop producers. For these types of producers, wetland restoration is an unlikely sell. For crop producers, the opportunity cost of removing wetlands from productive land is high, as is the nuisance cost, also referred to as input wastage costs. The addition of wetlands poses a variety of threats to grain and oilseed yields due to the increased risk of seed-loving migratory birds that flock to restored wetlands. As one producer put it "I would rather look out my window and see rows of gold than a bunch of snow geese." Another landowner expressed that putting a wetland back on his property was equivalent to putting and old rusty car on his property, and there was no amount of money that you could pay him to do it. Loss of income due to flooding also poses a significant threat for grain producers (Agriculture and Agri-food Canada, 2018); but it's interesting that these producers don't see wetlands as providing flood mitigation. Thus, the uptake of contracts aimed at facilitating more water storage on productive land was described as an implausible scenario. Programs such as AgriInvest and AgriStability are offered as disaster relief support; however, they may not offer full support for flooding. Draining remains a legal activity requiring *Water Act* approval. This process is under scrutiny by landowners, who expressed the process of attaining a *Water Act* approval as toilsome and costly. Advances in technology for crop production such as precision agriculture may help to alleviate pressure on wetland resources by actualizing returns on investment for saturated land. Cost share programs are currently offered by Alberta Agriculture and Forestry under the Canadian Agricultural Partnership (CAP) program can assist in mitigating costs for activities affecting wetlands such as nutrient management.

Trust of government and special interest organizations is a common theme that was revealed in my interviews with participants and non-participants of reverse auctions. Horton et al. (2015) describes trust as a dimension of credibility, which also encompasses goodwill and expertise. Interview respondents questioned the expertise of Provincial Government, and described the *Alberta Wetland Policy* as a biased policy that seeks to undermine producer's rights as land owners and managers. Producers explained how drainage is a necessary activity in order to manage production activities and that the *Alberta Wetland Policy* is a policy that was crafted by bureaucrats and biologists who did not consult the agricultural community member that it would impact most. They

questioned the ability of the Alberta Wetland Policy to deliver any sort of outcome. One interviewee criticized DUC, because of the organization's special interest in the recreational opportunities created by wetlands for duck hunters. These values were not held by all participants or non-participants. Recreational hunting was expressed as an interest by one participant, who is a self-identified "ranch hobbyist." Trustworthiness with wetland restoration practitioners is an important dimension for future study, as other conservation agencies such as ALUS use other methods of landowner engagement to incent landowner participation. An approach to wetland conservation that is successful must be strategic (M. Weber, personal communication, April 19, 2018).

3.7 Conclusion

Through this research, some conclusions can be drawn about the current state of the wetlands debate. In Southern rural agrarian communities, there are pivotal concerns with regard to the management of water resources, including wetlands. Market-based management solutions for certain goods, such as native grassland restoration on pasture may be possible. However, there are some key conflicts that exist between special interest groups in charge of restoring wetland basins and economic agents with high opportunity costs of wetland restoration participation. It is an important observational finding that there are clear differences in *local knowledge* of wetlands and their importance in the ecosystems and *scientific knowledge* systems. In addition, emerging policy enforcement action has weakened trust between provincial government and producers.

Ongoing support and extension programs must aim to narrow the knowledge gap that exist pertaining to the *Alberta Wetland Policy* and the *Water Act.* It is critical that the Provincial Government of Alberta works with landowners to understand the management decisions that landowners face within the current context of cropped landscapes. Allowing land managers to make decisions about who should restore wetlands on their property would perhaps increase landowner participation. An understanding of landowner's historical water management decisions would allow for greater insight into how current conflicts emerged.

3.8 Limitations & Future Research

Limitations of this thesis are that single interviews with landowners only offer a glimpse in to the opinions of potential participants of the reverse auction for wetlands. The research that was conducted is based on a pilot project, which used a reverse auction as an incentive mechanism. It is possible that this mechanism was not fully understood by participants. Furthermore, it is possible that research participants did not trust the auctioneer in submitting a bid that would be equal to their true opportunity costs.

Ducks Unlimited Canada is well known within agricultural communities. A limitation of this study is that landowners tended to hinge their willingness to participate in wetland restoration on potential for hunting on their property. A further inquiry in to how wetlands have been symbolized to portray duck-breeding habitat and how this has shaped landowners' perceptions around wetland restoration would be an interesting study.

A further and important limitation of this study is that high priority areas for wetland restoration were not targeted. Using a hydrologic model couples with land prices could help to identify potential areas for wetland restoration. Furthermore, local knowledge systems could help inform where areas of wetland restoration ought to be.

Chapter 4 – Rent Seeking and Pricing Methods

4.1 Introduction

Reverse auctions may employ several different sets of parameters in attempting cost-effective delivery of conservation contracts. Much of the work concerning the reduction of information asymmetry between auctioneers and private landowners is done under experimental procedure and in "context free" settings. In the field, there is never complete information for the auctioneer or the landowner and the bidding behaviour relies on the social, political, and historical context of the study region. Regardless, some measures of cost effectiveness may be studied given the bid amount elicited by the landowner and the rental rate, which is known by the auctioneer. Various parameters matter when it comes to design reverse auctions, but the focus of this research is to zero

in on one and that is the pricing method[8]. Consensus on the cost effectiveness of discriminatory versus uniform price methods is varied (Cason and Gangadharan 2008; Hailu et al. 2011). However, there is no existing study that focuses on one key aspect that guarantees loss of cost efficiency and that is bidder rent-seeking.

Uniform price auction winners are typically paid the same amount, and that amount can be determined in a number of ways. The most common approach is where the lowest rejected bid amount is paid to all successful bidders. This results in all successful bidders being paid more than their bid amount submitted in the auction. The fact that payments are greater than bids in theory results in bidders submitting offers equal to or close to their true costs in order to maximize their chances of "winning". Thus this pricing mechanism generates an incentive-compatible cost revelation strategy which results in lower levels of information rent seeking (Latacz-Lohmann and Schilizzi 2005). This suggests that a uniform price auction is the preferred method to use if price discovery is the main feature of the auction. A drawback of the uniform pricing-rule from an auctioneer's perspective, however, is that all successful bidders receive payments higher than their costs, which could have political or managerial consequences. Furthermore, in comparison with discriminative pricing rules in experimental and simulation studies (e.g. Cason and Gangadharan 2005; Hailu et al. 2008) the rule that minimized the costs for the auctioneer depends on the context of the auction. The underlying cost curve thus impacts the cost effectiveness of the auction (Boxall et al. 2013). In the two Alberta auctions examined in this present study, the uniform price method was utilized where the payments equaled the amount bid by the highest winning bidder.[9]

The literature on conservation auctions and their design has mostly utilized economic experimental procedures. For example, Cason and Gangadharan (2005) claim

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[8] Pricing Methods are also referred to as payment methods and pricing rules. These all refer to the rules that determine how winners of the auction are paid.

[9] This method of choosing the uniform bid amount is not typically done as the highest winning bidder does not get more than their bid amount. However, pleas to change the auction format in the Wheatland County auction conducted by DUC fell on deaf ears. Hence the Rock View County auction used the same approach in order to allow comparisons between the two Alberta auctions.

that the discriminant auction out-performed the uniform pricing rule in terms of cost minimization for a given environmental objective, while Boxall et al. (2013) find results more consistent with those of Hailu et al. (2008). Comparisons of the performance of the three wetland restoration auctions held in Western Canada mentioned above provides a unique opportunity to examine actual bidder behavior in a field setting in order to examine the question of whether the uniform pricing rule outperforms the discriminant pricing rule. Using a relatively simple calculation, we estimate the level of information rent seeking across the three auctions. We expect to find that bidders in the discriminant auction in Saskatchewan sought higher levels of rent in their bids than bidders in the two uniform price auctions in Alberta.

4.2 Methods

Annual rental payments are one approach that is used to signify the foregone economic benefits of land to an agricultural producer over some period of time such as the contract term for a restored wetland. Thus, in this study we assumed that the opportunity cost (foregone benefit) of a restored basin was considered to be the annual agricultural rental value of the land. To determine these values, we consulted experts on land valuation and were provided with an estimated rental rate of 3% of land market value (e.g. B. Burden, personal communication, April 26, 2017; J.P. Gervais, personal communication January, 2017). However, we were advised that this rate could be high for agricultural lands in close proximity to major metropolitan areas such as Rocky View County. Thus, while the 3% rate would be suitable for estimating the opportunity costs of losing drained basin areas for wetland restoration in the Wheatland and Assiniboine auctions, we selected a lower rate of 2.5% in Rocky View County due to its proximity to the large metropolitan center of Calgary. To estimate the total opportunity costs of losing land to restoration over the contract term in each auction, we developed estimates of the market value of local agricultural lands in the year each auction was held, applied the rental rate percentage, and then multiplied the result by the number of years of the restoration securement contract. Since bids were submitted for basins located on pasture as well as cropland, our market value estimates were for an average of both agricultural land uses.

We adjusted bids by opportunity costs to reveal information rent as discussed by Schilizzi and Latacz-Lohmann (2005). We used the following formula to develop adjusted bids, q:

$$q = ([bid - ((L * i) * n)])/bid \quad (1)$$

where *bid* is the average bid amount submitted to the auctioneer, L is equal to the land value at the time of bid submission adjusted to 2016 dollars, i is the rental rate of the land for each region, and n is the number of years the contract between the restoration agent and landowner would be in force. The result, q, represents an estimate of the proportion of the submitted bid that is information rent.

4.3 Results and Discussion

Table 6 summarizes auction features and calculations for the three reverse auctions. The first round of the Assiniboine Auction consisted of 118 bids; which was reduced to 46 in the second round with 30 bids being selected for restoration contracts. The Wheatland County auction received 27 bids and Rocky View County auction received 14, of which 26 and 13 bids were selected respectively for contracts. The average bid in each auction was calculated over 117, 27 and 12 bidders in each auction respectively because in our calculation we excluded bids of $0 under the justification that rent seeking was not part of these bid valuations.[10] This yields mean bids of $2,250/acre in the Assiniboine River, $3,032/acre in Wheatland County, and $5,148/acre in Rocky View County auctions. These bid amounts represent the total payment requested over the contract lengths. Bids selected after ranking procedures were applied were less - the discriminatory price auction in the Assiniboine paid $1606/acre over 12-years and successful bidders in the uniform price auctions were paid $3038/acre in Wheatland County and $5600/acre in Rocky View County, each over 10 years.

[10] Interestingly in the Assiniboine and Rocky View County auctions, a few bids were for $0. We excluded these from the calculation of the mean bid in each case because these bids were apparently for lands strictly dedicated to recreation or conservation. In the Assiniboine auction, the $0 bids appeared in the first round only and were withdrawn prior to the second round of bidding.

Land values for the years of the auctions adjusted to 2016 were $303/acre in the Assiniboine River area, $2,038/acre in Wheatland County, and $5,885/acre in Rocky View County. The valuation information was gathered for each specific area and time period from Farm Credit Canada arm's length land sales. Since submitted bid values were associated with drained wetland basins located on pasture and cropland, we used an average of both land use types to estimate land values for each region.

Table 6: A summary of the results of the various Western Canadian reverse auctions for wetland restoration.

	Assiniboine River (2009)	Wheatland County (2015)	Rocky View County (2016)
Auction parameters	Pricing Method		
	Discriminatory Two rounds	Uniform Single round	Uniform Single round
Contract length (yrs)	12	10	10
Total number of bids received	118[a]	27	14
Number of bids selected for contracts	30[a]	26	13
Average bid ($2016/acre)	$2,250[b]	$3,032	$5,148[b]
Average selected bid ($2016/acre)	$1,606	$3,038	$5,600[b]
Annual land value ($2016/acre)	$303	$2,038	$5,885
Estimated annual rental rate	3.00%	3.00%	2.50%
Annual rental payment over contract term ($2016/acre)	$109.08	$611.40	$1,471.25
Proportion of bid that is rent	0.95	0.80	0.71

[a] Note that there were 118 bids submitted in round one; after revision, 46 bids were received and 30 were selected for restoration contracts.

[b] Note that these calculations excluded bids of $0; this included 0 bids in the Assiniboine auction and 2 bids in Rocky View County.

Applying the formula in equation 1, we estimate that the proportion of the average bid in each auction that is information rent is 0.95 in the Assiniboine River auction, 0.80 in the Wheatland County auction, and 0.71 in the Rocky View County auction. The differences in proportions are consistent with theory in that the proportion for the discriminant auction is the highest of the three. Our results suggest that on average, bidders were seeking significant profits in their bids – over 95% of the average submitted bid amounts were higher than estimated opportunity costs. These numbers were lower for the two uniform price auctions at 80% and 71% for the Wheatland County and Rocky View County auctions, respectively.

To further illustrate these results we generated bid curves by plotting the individual bid amount ($/acre) on the cumulative area of restored basins in each auction region (Figure 8). For comparison, we plot the estimated land value in each panel in the figure. The shape of the uniform price auctions is consistent with Connor et at. (2008) paper that shows a hockey stick-shaped bid curve: a steeply increasing bid curve for the few last bids. Inspection of these graphs reveals that the discriminatory auction bids are almost all significantly higher than land values (97%).In the two uniform price auctions, the bids are much closer to estimated land values. In the Wheatland County auction the bids are higher than land values, but only by about one-third, while in Rocky View County the bids are all lower than estimated land values but only by about one sixth. We also note a large degree of heterogeneity in the bids from the discriminatory auction in comparison to those from the uniform auctions. This information shown in Figure 8 further supports the presence of significant rent seeking in the discriminatory auction.

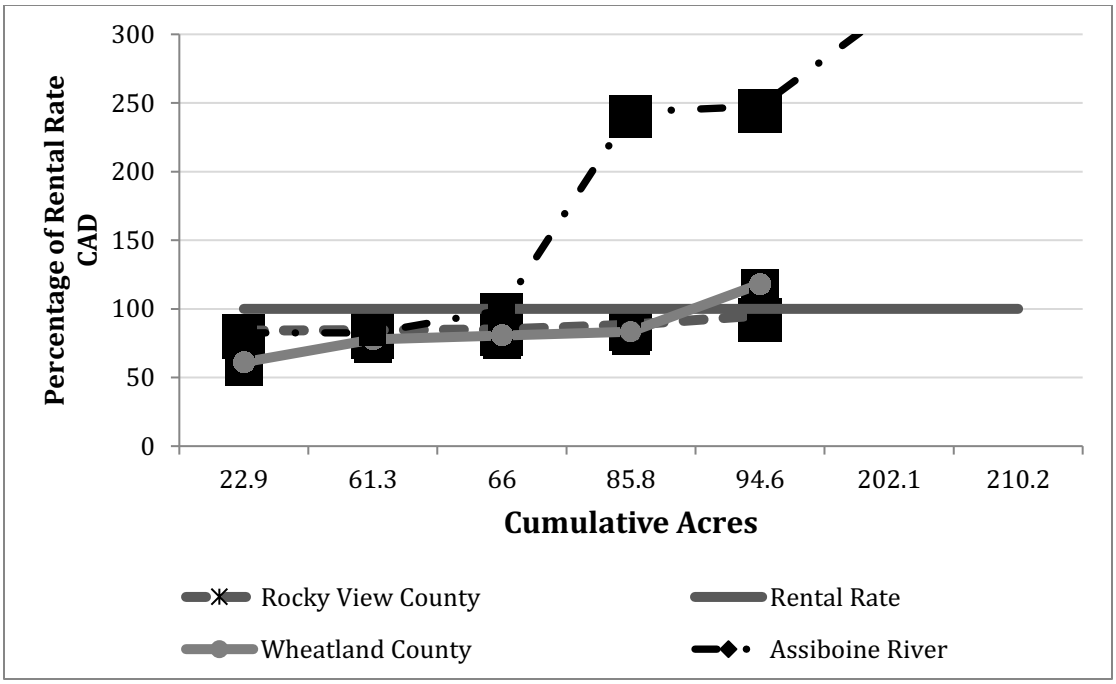

Figure 10: Bid Curves for Uniform and Discriminatory Reverse Auctions in Alberta and Saskatchewan from 2009-2016. Dotted line indicating land values (2016 dollars). Data for bids provided by Ducks Unlimited Canada (2016), for land value from Farm Credit Canada (2016).

4.4 Conclusion

This relatively simple comparison of initial bids from three actual reverse auctions for the same environmental improvement – wetland restoration - demonstrates that the pricing method selected to secure contracts can influence bidder behavior. Bidders may increase their bids above opportunity costs associated with the auctioned contracts; in particular in discriminatory priced auctions. This finding is consistent with theory in the conservation auction literature e.g. Cason and Gangadharan (2005) that shows uniform price auctions are superior in terms of price discovery due to the incentives for bidders to submit bids closer to their actual opportunity costs.

In addition, we suggest that in at least the two Alberta auctions bidders appeared to use land values as a heuristic to develop their bid amounts. This was particularly the case in the Rocky View County auction which took place in a region near an expanding urban population; it would make sense for bidders to think of land values as opportunity costs even though the contract length (10 years) is not perpetual. The process of attaining

a *Water Act* approval is burdensome and costly, effectively landowners must agree to having a restored wetland on their property in perpetuity or include the cost of reversal in to their bid amount.

In this simple analysis we examined average bids and averages of land values across the three auctions. Improvements could be made by examining individual bids and associated land values, although it would be difficult to tease out individual land values and rental rates associated with individual bidders. While reducing information asymmetries with regard to cost of conservation contracts can be done by way of reverse auctions, it is important to consider the potential for bid inflation. For challenging environmental improvements such as the restoration of wetlands which, when restored, can impose costs on agricultural operations, determining the appropriate levels of compensation using auctions requires consideration of the appropriate auction design.

Chapter 5 - Summary

This thesis examined some of the dimensions of the use of reverse or conservation auctions as a policy tool in incenting agricultural land managers to undertake the restoration of drained wetland basins. I started this examination by noting that there seemed to be very low participation rates by landowners in most published reverse auction studies that attempted to increase the provision of environmental benefits. In two of the three Canadian wetland restoration auctions examined in this present research, I could document exceedingly low rates of participation by eligible landowners. In the third study I examined I could not find information that allowed the determination of a participation rate; something that I found in a large number of published studies in my literature review. Thus the first finding I think this thesis uncovers is the need for researchers to appropriately determine and document the response by eligible bidders in reverse auction studies.

Given the observation that participation rates in these types of auctions are typically low, and that in the three wetland restoration auctions I could identify bidders (participants) and eligible non-bidders (non-participants), I examined the reasons that supported their participation decisions. Since there was little literature to guide a priori the reasons behind positive or negative participation decisions I employed a qualitative

approach through interviews that I report in Chapter 3 to uncover the obstacles that prevent landowners from participating in reverse auctions

These interviews revealed some useful insights that seem to be consistent with the literature on land use management related to conservation outcomes. For example, my data suggest that the primary reason for non participation in the wetland restoration auctions was perceived economic constraints. These finings are consistent with the results of Morrison et al. (2011). Economic constraints for landowners arise from two sources of wetland avoidance once the wetland is restored. The first is the foregone economic benefits resulting from the cultivation of the land area the restored wetland basin would occupy. The other are the costs associated with the wastage of inputs that would be incurred as a result of wetland avoidance (Cortus, 2005).

Another reason that arose from the interviews of landowners was concern over loss of property rights associated with the restored basins and the adjoining land areas. This concern over loss of property rights was mainly due to a lack of confidence with regard to future relations with governmental and conservation agencies. This finding is consistent with a study by Manfrendo et al. (2017), which explains that conservation movements can result in "cultural backlash" from those who would like to maintain their cultural identity and may perceive a lack of representation in political processes. Throughout my interviews with landowners, landowners often expressed that they felt the *Alberta Wetland Policy* did not involve of consider the opinions of land managers. These opinions expressed were strongly against the restoration of wetlands because landowners felt this was an imposition on their property rights. Non-participation, for some landowners was a form of "backlash" towards a perceived top-down approach by governments and conservation agencies. Gavin et al. (2015) assert that a biocultural approach to conservation can result in greater successes. A biocultural approach is one which incorporates socio-ecological contexts into conservation, and uses community-based conservation, co-management, and integrated conservation and development as tools for environmental projects. It is important to note that restored wetlands may not be an appropriate public good for auctioning within this particular social context due to their recent politicization and attempts by provincial authorities to manage them through a top down approach.

Wetlands also tend to possess the unfortunate characteristic of non-observability. Landowners emphasized in the interviews that the definition of what is a wetland differs from that used by policy makes and scientists. Questions arose in my interviews about what conservation of wetlands should mean. One landowner expressed that they felt that wetland management should be adaptable. Furthermore, the landowner felt that the onus of wetland restoration was falling on already strained production systems. Therefore, defining wetland restoration suitability must come with the caveat of landowner acceptability. A paper published by Moreno-Mateos and Comin (2010) show that wetland management objectives must be well-aligned with the needs of the community; also, they emphasize the need to integrate landscape-level planning to develop well-integrated strategies for wetland restoration and creation. My review of three reverse auctions supports this. Further, that the inability to overcome social constraints ought to result in no wetland restoration activity. Strategies by community leaders and government leaders are necessary to align priorities for wetland restoration. Communication is necessary in order to build trusting relationships between conservation agencies and community members.

This information in Chapter 3 largely suggests that low participation was not due to the use of a reverse auction mechanism, but rather the type of ecological asset that was the "target" of the auction, and the relationship between that asset and land use. This would suggest that *any* conservation program that provides incentives for wetland restoration would be a "hard-sell" with landowners focused on agricultural production. Indeed this would seem to be the case in terms of my brief examination of related wetland restoration programs which are largely unsuccessful in generating significant levels of restoration activity (e.g. Growing Forward wetland restoration BMP adoption levels).

While Chapter 3 focused on non-participants in reverse auctions, Chapter 4 reports a detailed examination of bidding behaviour from those who actually participated in the three Canadian wetland restoration auctions. In that chapter I focused on predications from economic theory to examine information rent seeking amongst the bidders. I was fortunate in this to be able to examine bids from two uniform priced and

one discriminatory priced auction. Theory suggests that rent seeking would be higher in the latter due to the form of the incentive system employed. Through comparing unsuccessful and successful bids in the three auctions with relevant land rental rates we were able to show that bidders sought higher information rents in the discriminatory auction. However, information rent seeking was quite high in all three auctions, suggesting that bidders (who were agricultural producers) were seeking significant financial payments for restoring wetland basins. Given that in two of the three auctions the levels of acceptance of bids by the auctioning agency were quite high, it appears that once a decision to participate was made by an eligible bidder, significant financial outlays were available. This information suggests that wetland restoration in voluntary settings is likely to be quite expensive for restoration agencies to generate significant levels of restoration, conditional of course on landowners being interested at all in restoration.

Since the Alberta Wetland Policy will significantly rely on restoration of existing drained basins to serve as offsets for newly impacted wetlands the information in this present research suggests low levels of interest in restoration by agricultural producers, and where interest is observed, it is likely to be very expensive. Reverse auctions are typically employed as a price discovery method. The prices thus uncovered in the Canadian wetland restoration studies examined in this thesis are much greater than agricultural land rental rates, and in most cases approximate arms length land values. This suggests that a reasonable approach to gaining drained basins may lie in their outright purchase from the landowner. Indeed, Ducks Unlimited Canada, the only real wetland restoration agent employed by the Alberta Government, now utilizes a revolving land purchase approach to restoration. This involves land containing drained basins being purchased at market rates from landowners followed by restoration and the establishment of a conservation easement. These modified lands are then sold back into the land market with the easement protecting the restoration works. This approach, however, takes time and requires significant initial outlays of funds that may be difficult to find. (Noga 2014).

Future research can be directed in three areas: 1) defining conservation activities where reverse auctions could be usefully employed; 2) further study of the underlying reasons for low participation rates in reverse auctions; and 3) finding cost effective ways

to meet the Alberta Wetland Policy objectives to find replacement wetlands for those about to become lost due to development. The first two research areas are obviously related – in order to be usefully employed participation must be understood. However, I believe that this thesis is one of the first studies to highlight the issue of participation in conservation auctions. The third research area may lie more in the scope of biophysical and natural scientists; for example, it could be that wetland replacement may not have to rely on restoring previously drained basins, but through developing engineered wetlands to better replace lost ecological processes and ecosystem services that are affected by the loss of existing wetland basins to development.

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Appendix A Water/Wetland Policy

Table A1: A Selected Summary of Municipal, Provincial, and Federal Water and Wetland Legislation in Canada

Act	Year	Description
Federal		
British North America Act[11]	1867	Gives federal authority over navigable waters including interprovincial waters.
Fisheries Act	1868	Empowers the Department of Fisheries and Oceans to conserve and protect fish. Amended in 1977 to included habitat protection and pollution prevention.
Navigable Waters Protection Act	1882	Lists watercourses that are navigable and requires that regulatory approval is required for works that place significant interference on navigation.
Northwest Irrigation Act	1894	Abolished riparian rights and allowed those who sought a water license to divert water. The Act declared all water as vested in the Crown
Makowecki v. Yachimyc[12]	1917	Resulted in a legal ruling that adopted civil law, which effectively allowed for the undisputed right of an upper land owner to drain naturally accumulated water through a channel onto lower landowner property without obstruction, thus encouraging more drainage of land than permitted under the common law
Income Tax Act	1970	Provided tax incentives "for clearing land, levelling land or installing a land drainage system for the purposes of the business"
Canada Water Act	1970	Encouraged the use of fresh water through efficiency and equity. Enabled the establishment of institutional arrangements, and empowered the federal government to address pollution problems. Facilitated the cooperative federal-provincial arrangement for water management.

[11] Section I of the Constitution Act, 1982 replaces the Canadian constitution to the British North America Act, 1867

[12] Income Tax Act 1970, c.63, s.1 "30"

Canadian Environmental Protection Act	1988	Aims to protect the environment and human health through sustainable development.
Provincial		
The Irrigation Districts Act	1914	Established 13 irrigation districts and a Irrigation council made up of agricultural producers
Water Resources Act	1931	Required landholders to acquire a license for the diversion of water unless for domestic purposes
Public Lands Act	1984	Amended the definition of a waterbody to exclude seasonal and ephemeral wetlands.
Water Act	1999	Replaces the Water Resources Act and requires a permit approval for impacts to water bodies. Excludes agricultural users that use water for domestic purposes
Wetland Management in the Settled Area of Alberta	1993	Established a hierarchy for wetland management in the 'White Area'. Focused on the conservation of marsh wetlands.
Water for Life Strategy	2003	Outlined three main goals aimed at improving water quality and increasing quantity. Also, it emphasized the preservation of aquatic ecosystems.
The Alberta Wetland Policy	2013	Outlines a wetland avoidance hierarchy to support and increase in avoiding the overall loss of wetland resources. Gives conservation agencies some jurisdiction over flood control and management
Municipal		
The Municipal Government Act	1996	Authorizes municipalities in the province to establish bylaws to protect water at the local level

Source: Primarily adapted from Clare (2013[a]).

Appendix B Interview Guide

Participation/Non-participation in *Alberta's Living Laboratories*

YOUR INTEREST/DISINTEREST IN THE PROGRAM

1a) Why were you interested (or not interested) in participating in *wetland restoration*?

……

……

……

1b) Have you ever sought a *Water Act* approval—Have you ever attempted to cultivate a wetland area—Are wet area's an obstable on your property?

(Yes (No If yes, what actions?……

……

……

……

1c) Have you participated in or received funding or support from any other programs?

(Alberta's Growing Forward I or II.
(Nature Conservancy
(ALUS
(Ducks Unlimited

THE INFORMATION PROVIDED ABOUT ALBERTA'S LIVING LABORATORIES

2a) Was the general information adequate for you to understand the scheme? (e.g. phone discussions with project manager and Expression of Interest package containing a brochure, fact sheets,?

(Yes (No If no, what was unclear?……

2b) Did the information provided make it clear that you would be competing against other landholders for limited funds?

(Yes (No If no, when did you become aware of this?……

SITE ASSESSMENT PROCESS (ADMINISTRATION/COMMUNICATION)

3) For the site assessment process, how would you rate *(please tick appropriate box)*:

	Very good	Good	Fair	Poor	Very poor	If dissatisfied, what with *(please write comments)*
Discussions with Ducks Unlimited Representatives /University of Alberta regarding site locations and management options?	(	(	(	(	(	.....
The amount of information provided about the assessment of draine wetlands?	(	(	(	(	(	.....
The amount of information provided about the condition of existing wetlands?	(	(	(	(	(	.....
Your ability to decide on appropriate management actions at the end of discussions with the site assessment officer?	(	(	(	(	(	.....
Your overall satisfaction with communications with researchers?	(	(	(	(	(	.....
The Management Action List sent to you soon after the visit, in helping to clarify the appropriate management actions?	(	(	(	(	(	.....

Any suggestions on how the site visits and discussions could be improved?

.....

.....

THE MANAGEMENT PLAN PACKAGE (CONTRACT CONSIDERATION)

4) How would you rate the contract (ten years, 50% up front, 50% over contract term)

	Very good	Good	Fair	Poor	Very poor	If dissatisfied, what with *(please write comments)*
Length of contract?	(	(	(	(	(	.....
Clarity of contract?	(	(	(	(	(	.....
Contract requirements?	(	(	(	(	(	.....
Adequacy of the information provided to help you determine the bid price?	(	(	(	(	(	.....

Any suggests on how the management plan package could be improved?

.....

BID DETERMINATION

5a) How many hours in total did it take to put your bid together? …….. hours

5b) What did you consider when formulating your bid?:

- Time taken to carry out the annual management actions? (Yes (No
- Area of management? (Yes (No
- Foregone land use option costs? (Yes (No
- Other, please specify?…… (Yes (No

5d) Did you seek information to help you determine your bid price from*:*

- Contractors or material suppliers? (Yes (No

  ……...

- Land Management Advisors (e.g. University of Alberta Rep)? (Yes (No

  ……

5e) Was the bid price easy to determine? (Yes (No
If difficult to determine, please explain……

MANAGEMENT AGREEMENTS

6) Do you think the terms of the agreement are reasonable? (e.g. carry out all commitments as set out in the Third Schedule, annual payment for length of Agreement, annual reporting, no payment if progress is not demonstrated) (Yes (No
If no, please explain which terms are not reasonable……

OUTCOMES FROM *ALBERTA'S LIVING LABORATORIES*

7a) For the **overall** *Living Laboratories* scheme, how would you rate *(please tick appropriate box)*:

	Very good	Good	Fair	Poor	Very poor	If dissatisfied, what with *(please write comments)*
Quality of the information provided	(	(	(	(	(	.....
Access to assistance	(	(	(	(	(	.....
Explanation of the tender process	(	(	(	(	(	.....
Length of time of the process	(	(	(	(	(	.....

7b) What did you like about the *Alberta's Living Laboratories* Scheme?

.....

7c) By being involved in *Alberta's Living Laboratories*, do you think you have learnt something about *(please tick the appropriate boxes and comment):*

- The condition of the wetlands on your property? (Yes (No If no, why?.....
- How to manage the wetlands on your property? (Yes (No If no, why?.....
- The costs of managing wetlands? (Yes (No If no, why?.....

7d) Do you feel the process has made you more aware of the environmental issues affecting your property and the local area?

(Yes (No

Comments.....

7e) Since being involved in *ALL*, has your enthusiasm increased in managing your wetlands for conservation?

(Yes (No

Comments……..

IMPROVEMENTS TO *ALBERTA'S LIVING LABORATORIES*

8) Do you have any suggestions to streamline or improve the process (including expression of interest, site visit, management plan, bid and notifications)?

……

FINAL QUESTION

9) Do you have any other comments?……..

……

……..

Thank you for your time and involvement in Alberta's Living Laboratories

Appendix C Reverse Auction Bid Submission Form

Reverse Auction

Bid Submission Form

- Alberta's Living Laboratory Project wants to restore wetlands in Rocky View County.
- This bid sheet is your opportunity to bid the price you are willing to accept to restore eligible wetlands on your land.
- Eligible wetlands are located on the attached plan.
- The formal agreement that will be used is a 10-year wetland restoration lease agreement (template attached).
- We will consider all bids; however, we have the right to disregard any or all bids that are considered to be too high.
- Each accepted bid will receive the same $/acre payment for restored wetland area (acres).
- The standard payment per acre of restored wetland will be equal to the $/acre bid submitted by the highest winning bidder that can be accommodated within the program budget.
- All bids must be submitted in a **dollar per acre ($/acre)** format.
- Bid submission deadline: **March 31/2016**
- Bid submission to: **Alberta's Living Laboratory Project**

Name and/or Company Name:

Legal Land Location/s:

Basin 1: NW&SW X-XX-XX-X WX

Basin 2: SW X-XX-X-WX

The bids are based on the wetland/s associated with the legal land location/s as listed above.

I, _____, submit the following bids to Alberta's Living Laboratory Project:

- BID 1: $_____ per acre on **basin 1** (X acres).
- BID 2: $_____ per acre on **basin 2** (X acres).

Note: Please only fill in information on basins that you want to bid on. Please leave blank if you don't want to submit a bid.

In addition, I confirm that I have received, read and understood all the information needed to formulate my bid.

Signed: _____

Date: _____

Signing this document verifies your bid. It does not enter you into any contract. If your bids are successful, you will then have the choice to enter into an agreement to restore the wetlands that were included in the bid.

Appendix D Landowner Recruitment Phone Call Script

Phone Call script – For Landowners with Drained Basins

GENERAL SCRIPT - Voicemail

- Hello, I'm ___ and I'm calling from the University of Alberta.
- I am a part of a research project about wetland restoration in Rocky View County.
- We are aiming to pay farmers to restore wetlands on their property.
- I'm calling to follow up on some information that we sent you a couple weeks ago by mail.
- We would be happy to chat about the project at a convenient time for you.
- You can give us a call back a XXX-XXX-XXXX or email at wetlands@ualberta.ca

GENERAL SCRIPT – Speaking to someone

- Hello, I'm ___ and I'm calling from the University of Alberta.
- I'm part of a research project about wetland restoration in Rocky View County.

- We sent you some information in the mail a couple weeks ago and I'm calling to follow up.

- We are looking for landowners who might want to get paid to have a wetland restored on their land.

- If you are interested, we can send you more specific information and maps about the areas that could be eligible for restoration on your property.

- Then, you can choose if you'd like to participate.

- We'll be holding some information sessions in the fall, but we wanted to see if you had any questions in the meantime.

- We have more information about the project on our website – restoreourwetlands.ca.

- If you would like to speak to us later, please just give us a call – 780-248-1073.

- [*For questions you're not sure about*]: If you would like to leave your phone number, another member of our team would be happy to phone you back.

Questions / Comments and Answers / Responses

Q: I'm not in the Nose Creek watershed.

- We are working in what you might know as the Nose Creek and the West Nose Creek watershed.
- If you'd like to see the map of our study area, you can see it on our website, www.restoreourwetlands.ca or I can check for you.

Q: I got this letter, but I don't have a drained wetland.

- While our maps might have indicated that there was a drained wetland on your property, they were detected through maps and satellite imagery so might not be 100 percent correct all of the time.
- If you'd like, we can get some maps sent to you of the areas that we were interested in restoring, then we can discuss further whether or not you'd like to participate.

Q: I didn't get a letter from you.

- I would be happy to send another if you'd like, or I can email you the information if you provide me your email address.

Q: What happens next?

- We will be in Rocky View County talking to residents throughout the summer of 2015, describing the research project and telling people about the reverse auction.
- By the fall of 2015, we hope to have a list of landowners who are interested in participating in the reverse auction.
- We will begin working closely with this group of people, and for each interested landowner, we will conduct a land survey to delineate the area that would be restored if they participated in the project.
    - This detailed survey information can then be used landowners to help them formulate a bid for the auction.
- We will start accepting bids from landowners early in 2016, and the successful bids will be selected in the spring of 2016.
    - Each bid that we receive will be ranked according to the environmental benefits that we think each wetland will provide once it is restored:
        - potential flood storage,
        - nutrient removal, and
        - carbon sequestration.
    - Wetlands that provide the greatest environmental benefit for the lowest cost will be selected for restoration.
- We plan to carry out the wetland restoration activities in the fall of 2016.

Q: Who is paying for this? Who are you funded by?

- The **research component** of the project is funding my several grants that the researchers have received, including from:
    - Alberta Land Institute,
    - Alberta Innovates – Bio Solutions,

    - Provincial government, and,
    - a private charitable foundation.
- All of the **money that we will be using to pay landowners** to restore wetlands in Rocky View County will be coming from the provincial "wetland compensation fund."
    - The majority of wetland compensation in Alberta is provided through a payment that is made in-lieu of restoring or constructing wetland habitat.
    - Each payment is given to a Wetland Restoration Agency, who is then responsible for creating or restoring wetland habitat to replace the habitat that was lost.
    - This money was collected primarily from industrial and land development projects in the City of Calgary.
    - The research team has been given the authority to use some of this compensation money to test the effectiveness of using a market-based instrument to select wetland restoration sites.

Q: How much will you pay me to restore my wetland?

- The amount of money that we will pay to restore your wetland depends upon you.
- As part of this project, you tell us how much you are willing to accept as payment for restoring a wetland on your land. You get to tell us the price for your wetland, because you know your costs better than anyone else.