A Reverse Auction for Wetland Restoration in Southern Alberta

by

Lucas Novak

A thesis submitted in partial fulfillment of the requirements for the degree of

Master of Science

in

Agricultural and Resource Economics

Department of Resource Economics and Environmental Sociology
University of Alberta

© Lucas Novak, 2017

Abstract

Since European settlement of the Canadian Prairies there has been substantial loss of wetlands. This loss occurs in large part due to drainage by private agricultural operators seeking to boost the productivity of their land. Policy makers now seek not only to conserve wetlands and prevent drainage but also to restore drained wetlands where possible. The purpose of this thesis is to assess whether or not a reverse auction could be a useful policy mechanism for securing drained wetland basins where restoration can take place. Ducks Unlimited Canada conducted a single round, uniform price auction in the Wintering Hills area of Wheatland County, Alberta. The results of this auction are compared to a similar auction conducted in Saskatchewan in 2009. In general we find that while reverse auctions are time consuming and potentially expensive, they do have the potential to secure drained basins for restoration and could therefor be used as a policy instrument for wetland restoration in the future.

Preface

This thesis is an original work by Lucas Novak. The research project, of which this thesis is a part, received research ethics approval from the University of Alberta Research Ethics Board,, No. Pro00057790_AME2

This thesis is based on a project run by Ducks Unlimited Canada.

This thesis is an original work by Lucas Novak. No part of this thesis has been previously published.

Dedication

I dedicate this thesis to my Parents, Frank and Jeanne Novak who never fail to remind me that I once promised I had no interest in studying agriculture.

Acknowledgements

I would like to thank my supervisor Dr. Peter Boxall for his insight and guidance on this project. I would like to thank Ducks Unlimited Canada Staff Warren Robb and Barry Bishop for their work on the Wintering Hills Auction. I would also like to thank Ducks Unlimited Canada and MITACS Canada for their financial support of this thesis research. Finally I would like to thank my various officemates and fellow grad students, especially those who were on the REESSA Executive team with me.

I would like to acknowledge the examination committee, Dr. Peter Boxall (Resource Economics and Environmental Sociology), Dr. James Rude (Resource Economics and Environmental Sociology), Dr. Bruno Wichmann (Resource Economics and Environmental Sociology), and Dr. Henry An (Resource Economics and Environmental Sociology).

Table of Contents

List of Figures

List of Tables

Chapter 1 Introduction

An important policy issue facing the Alberta Government is wetland loss. Development activities have resulted in the loss of wetlands across Alberta (Alberta Environment & Sustainable Resource Development, 2013) and the Canadian prairies (Yu and Blecher, 2011). Wetlands provide a number of important ecosystem services, including flood control, biodiversity support, groundwater recharge, and carbon sequestration (Alberta Environment & Sustainable Resource Development, 2013; Brander et al., 2006). However, despite the environmental significance of wetlands they continue to be lost, and as of 2014, an estimated 64% of wetlands in the "white zone" (the settled area of Alberta) had been drained (Simieritsch, 2014). Since the benefits of wetlands are public benefits that come at a cost to the private agricultural producer (Cortus et al., 2011), private landowners have little incentive to provide these benefits by retaining wetlands on their properties (Ma et al., 2012); rather they have incentives to drain wetlands for private benefit (Cortus et al., 2011).

One solution to the problem of wetland loss is to offer financial incentives to landholders to preserve or restore wetlands on their property. These Payment-for-Ecosystem-Services (PES) systems transform the non-market value of environmental services into a real financial incentive for the landholder (Engel et al., 2008). These systems are found all around the world for a variety of environmental services (Wunder et al., 2008). However, PESs suffer from information asymmetries between the landholder and the agency offering payments due to the landholder having information on their true opportunity cost of providing the environmental service the agency seeks to purchase (Ferraro, 2008). This can lead to difficulties in finding the optimal price to induce the desired behavior (Yu and Blecher, 2011). Too low a payment will fail to induce the behavioral changes desired by the conservation agency (Jack et al., 2009); however PES systems become costly when the landholder is paid above their willingness to accept compensation (WTAC)

(Ferraro, 2008). This creates problems for the agencies trying to develop and purchase these agreements.

A policy instrument that can be used to deal with this information asymmetry problem is the reverse auction. A reverse auction is like a regular auction, but with a single buyer and multiple sellers (Greenhalgh et al., 2007). A regular auction, one with a single seller, is useful because it elicits buyer's willingness to pay in the form of bids (Krishna, 2002). The information seeking aspect of an auction is what makes it particularity valuable for conservation agencies. However the roles are reversed and participants' bids reveal their WTAC in order to provide the environmental service (Jack et al., 2009; Brown et al., 2011). While a relatively new practice, reverse auctions have been used around the world for the purchase of a number of environmental services. Despite their theoretical attractiveness, only three such auctions have ever been conducted in Canada, and only a few nations have made reverse auctions a mainstay of their environmental policy.

The objective of this thesis is to examine whether or not a reverse auction can be an effective method of securing wetland restoration contracts from private landowners in Alberta. To do this, a reverse auction was conducted by Ducks Unlimited Canada in the Wintering Hills region of Wheatland County, a rural municipality east of the City of Calgary. Preparation for this auction started in the summer of 2015, while bids were collected in January 2016. The results of this auction are compared to a previous auction for wetland restoration contracts that took place in Saskatchewan in 2009, as well as to other studies that examine landowner WTAC in exchange for wetland restoration.

1.1 Structure of the Thesis

Chapter 2 gives a brief overview of wetlands, policy that pertains to wetlands, and some previous attempts to address drainage issues. Chapter 3 reviews the literature on the design of reverse auctions and a review of literature relating to participation in reverse auctions and participation in agri-environmental programming more generally. Chapter 4 is an outline of the design of the auction itself, and all activities that took place prior to the auction. Chapter 5 covers the results of the auction and finally chapter 6 discusses some of the challenges and opportunities of reverse auction that came up during the Wheatland County Auction.

Chapter 2 Wetlands and Alberta's Wetland Policy

2.1 Wetlands

Wetlands cover approximately 20% of Alberta's land surface (Alberta Environment & Sustainable Resource Development, 2013). Parts of Alberta are included in the Prairie Pothole Region, which consists of regions across Alberta, Saskatchewan, and Manitoba as well as Minnesota, Iowa, and the Dakotas in the United States (Mitsch and Gosselink, 2000). Pothole wetlands were formed by glacial action and tend to be small wetlands (Mitsch and Gosselink, 2000). It is estimated that prior to European settlement, there were 80,000 square kilometers of potholes; meaning that approximately 10% of land cover in the region was covered in wetland (Mitsch and Gosselink, 2000). 90% of the wetlands in Alberta are peatlands (Alberta Environment & Sustainable Resource Development, 2013) that are found across the Northern Hemisphere and as such vary from region to region making them hard to classify (Mitsch and Gosselink, 2000). Wetlands in general are tricky to classify which Mitsch and Gosselink (2000) claim is because prior to the mid-20th century there was little interest in defining them as the most desirable activity was to drain them to make way for more productive uplands. As such there is no single widely agreed upon definition of a wetland (Brander et al., 2006). For example, Mitsch and Gosselink (2000), define wetlands by three main components:

1. The presence of water, either on the surface or within the root zone.
2. Unique soil conditions that differ from the adjacent area.
3. Vegetation adapted to wet conditions and an absence of flooding-intolerant vegetation.

Mitsch and Gosselink (2000) note that some features of wetlands make them more difficult to define - for example wetlands may only hold water for parts of the year. The Canadian federal government defines wetlands as "land where the water table is at, near, or above the surface or which is saturated for a long enough period to promote such features as wet-altered soils and water tolerant vegetation" (Environment Canada, 1996).

Since European settlement of North America there have been significant wetland loss (Alberta Environment and Sustainable Resource Development, 2013; Cortus et al., 2011; Yu and Blecher, 2011). This is because wetlands impose costs on private agricultural producers and thus gives them an incentive to drain them. By draining wetlands, producers free up more land for crop or livestock production and decrease their nuisance costs (Cortus et al., 2011). For example, Gelso et al. (2008) estimates nuisance costs by asking farmers how much they would pay to rent a hypothetical parcel of land covered in wetlands. Given a hypothetical quarter section (160 acres) of land with 1.6 acres of wetlands on them, Gelso et al. (2008) finds that farmers would be willing to pay up to 52% less per acre for a quarter section with 1.6 acres of wetlands on it, depending on the number of wetlands and whether or not they are permanent or temporary. Cortus et al. (2011) used a farm simulation model to estimate the benefits a producer would get by draining wetlands to increase productive area and reduce nuisance costs. They estimate that a producer gains between $27.76 and $40.66 per hectare per year from draining between 40%-52% of the total area of wetlands on their property, depending on the size of the farm.

2.2 Wetland Policy in Alberta

Since wetlands provide public benefits that come at private producer costs they must be protected through public policy. In theory, wetlands in Alberta are protected under a number of provincial and federal laws. Provincially, wetlands are regulated by the Water Act, the Environmental Protection and Enhancement Act, the Public Lands Act and the Surveys Act (Alberta Environment, 2001). In addition they are regulated federally by the Fisheries Act and the Migratory Birds Convention Act as well as the Navigable Waters Act (Alberta Environment, 2001). The federal government also has a Wetland Conservation policy. This policy contains a number of goals, including no net loss of wetlands on federal land and securement of wetlands of critical value (Environment Canada, 1991). One of these goals is the enhancement and restoration of wetlands in areas of significant degradation, however the federal policy does not contain any specific mechanism to secure this restoration, nor does it call for more wide spread restoration on land that does not belong to the federal government (Environment Canada, 1991).

In addition to these laws, Alberta has a provincial wetland policy. From 1993 to 2013 Alberta Wetlands were under the Interim Provincial Policy, called Wetland Management in the Settled Area of Alberta (Alberta Environment, 2001, Alberta Environment & Sustainable Resource Development, 2013). The interim policy called for the removal or amendment of any policy or program that encouraged the removal or degradation of wetlands (Alberta Water Resource Commission, 1993). The policy also calls for the creation of incentives for landowners to retain wetlands on private land and considers the use of financial incentives and private conservation agreements (Alberta Water Resource Commission, 1993). The interim policy also prohibited the sale of public lands with "significant wetlands". The interim policy only applies to the "White Area" of Alberta and like the federal policy specifies no mechanisms for wetland restoration.

In 2013 the Alberta Government introduced a new policy to conserve and restore Alberta's wetlands. Amongst the many points and goals laid out in the new policy, two are of particular interest. The first is that wetlands have relative functional ecological value (Alberta Environment & Sustainable Resource Development, 2013), and thus under the new policy, not all wetlands are treated equally. The new policy, "acknowledges the relative contribution of an individual wetland to water quality improvement, hydrology, biodiversity, and various human uses". There are five value categories that are used to classify wetlands:

1. Biodiversity and Ecological Health
2. Water Quality Improvements
3. Hydrological Function
4. Human Uses
5. Relative Abundance

Based on these five metrics, wetlands in Alberta are assigned one of four grades, A, B, C, or D, with A being the highest value and D being the lowest Alberta (Environment & Sustainable Resource Development, 2013). This factors into the other key element of the policy, the Wetland Mitigation Hierarchy Alberta (Environment & Sustainable Resource Development, 2013). The Wetland Mitigation Hierarchy refers to a three-step process for managing impacts on wetlands. The three steps of the hierarchy are:

1. Avoidance: if impacts to a wetland can be avoided they should be
2. Minimization: if impacts cannot be avoided then they should be minimized.
3. Replacement: if an activity will result in the loss of the benefits of a wetland, that wetland must be replaced.

Avoidance is the preferred solution because it has no uncertainties attached to it. Minimization of impacts applies once avoidance has been deemed infeasible. Finally, if impacts cannot be minimized such that benefits of a wetland are lost or reduced, the wetland must be replaced.

Replacement is where the relative value of different wetlands becomes especially important. Each high value hectare of wetlands lost must be replaced by an equally valuable hectare, or by multiple hectares of less valuable wetland. To illustrate, for each hectare of high value A-grade wetland drained, eight hectares of the lowest D-grade wetland could be provided. A high ratio like this is meant to try and discourage the loss of the highest value wetlands. The midpoint replacement ratio is 3:1, based on three assumptions. First, those replacement wetlands will not function at the same level as the original. Second, replacement is expected to occur some time after the original wetland is lost. Last, some portion of replacement wetlands is expected to fail. Table 2.1 contains the Wetland Replacement matrix.

Table 2.1: Alberta Wetland Policy: Wetland Replacement Matrix

Wetland Replacement Matrix					
		Value of Replacement Wetland			
		D	C	B	A
	A	8:1	4:1	2:01	1:1
Value of Lost Wetland	B	4:1	2:1	1:1	0.5:1
	C	2:1	1:1	0.5:1	0.25:1
	D	1:1	0.5:1	0.25:1	0.125:1

Source: 2-1 Alberta Environment and Parks

Replacement actions are further divided into a number of sub actions. Replacement may either be Restorative of Non-restorative, and in addition, replacement can occur as an in- lieu payment or as permittee responsible replacement. Restorative replacement refers to the restoration, enhancement, or construction of replacement wetlands, whereas non-restorative replacement refers to investment in activities that "support the maintenance of wetland value". These activities may include research, monitoring, education and outreach programs etc. Permittee-responsible replacement refers to the drainage permittee undertaking restorative actions themselves, whereas in-lieu payments refer to the permittee paying financial restitution in place of undertaking any action themselves. In-lieu payments are collected and used to fund projects to replace or enhance wetlands. Table 2.2 shows the fees charged to permittees from the Alberta Mitigation Directive

Table 2.2: Replacement Fees for Wetland Drainage

Relative Wetland Value Assessment Unit Natural Region and Basin	In-lieu Rate ($/ha)	In-lieu Rate ($/acre)
Dry Mixedwood South Saskatchewan	$19,139	$7,745
Dry Mixedwood North Saskatchewan	$19,388	$7,846
Dry Mixedwood Athabasca	$18,450	$7,467
Dry Mixedgrass South Saskatchewan	$17,650	$7,143
Northern Fescue South Saskatchewan	$18,211	$7,370
Dry Mixedgrass Milk	$17,328	$7,013
Central Parkland South Saskatchewan	$18,523	$7,496
Central Parkland North Saskatchewan	$18,619	$7,535
Dry Mixedwood Peace/Slave	$18,206	$7,368
Mixedgrass Milk	$17,661	$7,147

Source: 2-2 Alberta Environment and Parks

This collection of payments is what motivates the need for a policy mechanism to actually restore wetlands using the money that has been collected. Collecting money for drainage with the intent of using it to restore drained basins creates a demand for restored drained basins. The problem then becomes finding a supply of basins to meet this demand. Physically, the supply of drained basins that could be restored is available; however the problem is not only physical supply, but also economic supply. While there is certainly a physical inventory of drained basins, landowners with drained basins may have no interest in having them restored. The Agricultural Watershed Enhancement program under Growing Forward and Growing Forward 2 programs have made funding available for landowners to cover a portion of their expenses for wetland restoration projects on their land. Under Growing Forward, Landowners could receive funding for 50% of the eligible expenses spent on wetland restoration (Alberta Agriculture & Rural Development, 2009). Under Growing Forward 2 this limit was increased to 70% (Alberta Agriculture & Forestry, 2013). There have been no applications under Growing Forward for such expenses, and while there have been applications, no applications were approved for funding under Growing Forward 2 (Personal correspondence with Scott McKie. AAFRD)

Chapter 3 Reverse Auctions

This chapter explores some of the literature on Reverse Auctions. Section 3.1 is a brief introduction to the motivation for using Reverse Auctions; section 3.2 gives an overview of some of the design elements of a reverse auction and how they may affect the performance of the auction. Finally section 3.3 explores participation in reverse auctions drawing on literature relating to reverse auctions, adoption of agri-environmental practices, and adoption literature in general to try and get an idea of what factors affect potential participants decision to participate in a reverse auction or not.

3.1 Why Use Reverse Auctions

Paying landowners to induce environmentally beneficial behavior is an established policy practice. In the past many of these policies have been fixed-payment policies or policies that involved negotiation with individual landowners (Brown et al., 2011; Latacz-Lohmann and Schilizzi, 2005). Ideally, the agency purchasing environmental services would want to pay landowners their exact minimum WTAC to provide that service (Vickery, 1961). However, landowners have better information on their costs of adoption than the agencies trying to procure them, this may lead to payments either being insufficient to induce the desired behavior (Jack et al., 2009) or to payments that are higher than they should be for the environmental benefits offered (Latacz-Lohmann and Schilizzi, 2005).

This information asymmetry problem is what a reverse auction should ideally mitigate. By creating a market-like environment, competition for funds should induce landowners to bid their closer minimum WTAC, which should lead to more cost effective provision of environmental services (Whitten et al., 2013). In practice this may not be the case and an auction may fail to illicit true WTA from participants. This might be due to insufficient participation, which could result in a lack of competitive behavior (Whitten et al., 2013), participants bidding on factors other than their own costs (Latacz-Lohmann and Schilizzi, 2005), or bidders learning to manipulate the auction (Latacz-Lohmann and Schilizzi, 2005; Riechelderfer and Boggess, 1988). Some of the design considerations agencies can make when designing auctions may address these problems.

Compared to a fixed payment system, reverse auctions have the potential to be much more cost effective. There are claims that the BushTender Auction from Victoria, Australia procured more than 700% of the environmental benefits that a comparable fixed price scheme would have obtained (Latacz-Lohmann and Schilizzi, 2005; Stoneham et al., 2003) depending on which fixed price scheme the auction is compared to (Latacz-Lohmann and Schilizzi, 2005). Another Australian auction, Auction for Landscape Recovery (ALR), was also significantly more cost effective than a fixed-price scheme (Latacz-Lohmann and Schilizzi, 2005). While impressive, the cost effectiveness advantage of these auctions may depend on the heterogeneity of bidders' costs, the environmental benefits, how the two interact, and how much bidders shade their bids by (Latacz-Lohmann and Schilizzi, 2005). Nevertheless, these numbers paint an encouraging picture of how effective a reverse auction could be as a policy tool.

3.2 Design Issues in Reverse Auctions

Not all auctions are alike and there are a number of different attributes that make up a reverse auction. Some features are the same in every auction. All reverse auctions are multi-unit auctions, the buyer is looking to buy multiples of the same good (Latacz-Lohmann and Schilizzi, 2005). Additionally, these environmental goods are not necessarily homogeneous, for example two parcels of land may not provide the same levels of environmental benefits (Latacz-Lohmann and Schilizzi, 2005). Many of the other attributes of reverse auctions vary from auction to auction and when designing a reverse auction there are a few questions that need to be considered:

1. Does the auction use discriminatory pricing or uniform pricing?
2. Does the auction last just one round? Or are there multiple rounds of bidding?
3. Does the auction have a fixed budget or a fixed target? Are these targets made public?
4. Does the auction have a reserve price? Is it made public?
5. Who is eligible? How are the environmental benefits of their bids calculated? Are bidders informed how these environmental benefits are calculated?

3.2.1 Uniform vs. Discriminatory Pricing

There are two different pricing systems that can be used in a reverse auction. The first is commonly called discriminatory pricing, also known as first price (Latacz-Lohmann and Schilizzi, 2005) or pay-as-you-bid (Reeson and Whitten, 2014). Under this pricing rule each successful bidder is paid what they bid and the auctioneer selects the most cost effective bids till their target rule is met. The other system is known as uniform pricing. Under uniform pricing, all successful bidders are paid the same amount, but the amount paid is determined by the distribution of bids received in the auction, usually equal to the lowest of the high (rejected) bids, sometimes called a second price auction (Latacz-Lohmann and Schilizzi, 2005). It has not yet been determined with certainty if one pricing system is superior to the other (Boxall et al., 2013).

One of the primary differences that arise from using one system versus the other is its impact on bidding strategies. Under discriminatory bidding, a successful bidder has more incentive to bid above their true costs of providing whatever environmental service is desired (Latacz-Lohmann and Schilizzi, 2005; Boxall et al.,

2013) because they paid based on their bid. Hartwell and Aylward (2007) suggest that this may be a more significant problem in auctions with low participation. On the other hand, in a uniform price auction, bidders should have less incentive to bid above their true costs because they will receive higher payments then their bids so long as they are successful in the auction (Boxall et al., 2013). Therefore in uniform price auctions bidders have incentive to bid their true costs because bidding higher than their true costs reduces the probability of winning "at a profitable or at least not-unprofitable price" (Vickery, 1961). Vickery (1961) also notes that assuming no collusive behavior takes place, the price paid in a uniform auction is not affected by any individual bidders bid. This makes uniform pricing theoretically better for cost revelation and so uniform pricing might be used in conservation auctions where the motive is price discovery (Brown et al., 2011).

Another difference between uniform and discriminative pricing is the cost of paying the winners. Since uniform pricing pays all successful bidders the same amount, they can generally be more expensive (Latacz-Lohmann and Schilizzi, 2005). However, if bidders in a discriminatory auction shade their bids significantly above their opportunity costs then uniform auction may be the more cost-effective choice (Latacz-Lohmann and Schilizzi, 2005) assuming bidders in a uniform price auction actually bid their true costs. Uniform pricing may also outperform discriminative pricing when the cost curve of bidders is relatively flat (Boxall et al., 2013). Cason and Gangadharan (2005) found that discriminative pricing was more efficient than uniform in an experiment, though they noted the result was unexpected.

While uniform pricing has many theoretically attractive properties it is used far less often in actual reverse auctions. One reason could be because uniform pricing is much more complex to explain to potential participants (Latacz-Lohmann and Schilizzi, 2005). Another concern with uniform pricing is that it may discourage high cost providers from participating because they anticipate lower chances of being successful in the auction. (Brown et al., 2011; Latacz-Lohmann and Schilizzi, 2005). In a discriminatory price auction the low cost bidders should consume less of the auction budget (assuming they bid proportional to their costs) but in a uniform auction they would use up more of the budget due to the equal payments. Therefore less budget may be available for high cost bidders. Yet another concern is equity. Under uniform pricing, the bidders that stand to gain the most are low cost, potentially low benefit bidders who will gain substantially higher payments for providing less (Latacz-Lohmann and Schilizzi, 2005). Bidders who offer higher benefits may be unhappy if low cost, low benefit bidders receive the same payment as they do (Cummings et al., 2004; Latacz-Lohmann and Schilizzi, 2005).

It is not clear if one of the two pricing systems is better than the other. Reeson and Whitten (2014) suggest that discriminatory pricing might work better when the environmental good is a less tangible or less well defined and the bidders might not understand exactly how much environmental benefit they have included in their bid.

3.2.2 Reserve Prices

Another important design feature of a reverse auction is whether or not to set a reserve price. In a reverse auction, a reserve price is the maximum price that an auctioneer is willing to pay for a unit of an environmental good (Latacz-Lohmann and Schilizzi, 2005). A reserve price may be based off some alternative cost of procuring the environmental service (Reeson and Whitten, 2014) or may be based off some value reflecting the maximum benefit of the service (Latacz-Lohmann and Schilizzi, 2005). A reserve price then acts as a safeguard that prevents the auctioneer from overpaying for the environmental service (Latacz-Lohmann and Schilizzi, 2005).

Should a reserve price always be used? A potential drawback of a reserve price is that it may deter participation in the auction since a reserve price limits bidders potential gains (Latacz-Lohmann and Schilizzi, 2005; Brown et al., 2011).

Reserve prices should be used in auctions where competition is not anticipated to be high or where there is a high risk of bidder collusion (Latacz-Lohmann and Schilizzi, 2005). Reserve prices are also useful if one budget extends across multiple auctions (Latacz-Lohmann and Schilizzi, 2005). They are less critical in auctions with strict budget constraints, where the budget may set an implicit maximum price (Latacz-Lohmann and Schilizzi, 2005).

Another decision auctioneers need to make is whether or not reserve prices are made public. Reeson and Whitten (2014) state that a reserve price should not be made public because it might lead to bidders submitting their bid based on the reserve price as opposed to their true opportunity cost of providing the service.

A related design feature is a reserve quantity. A reserve quantity is simply a maximum number of units a bidder can include in their bid (Latacz-Lohmann and Schilizzi, 2005). This prevents a single bidder from entering a huge quantity of desired units at a low unit price that ends up taking up a considerable amount of the budget (Latacz-Lohmann and Schilizzi, 2005). This feature could be introduced as an equity measure to prevent participants from feeling negatively towards future auctions (Latacz-Lohmann and Schilizzi, 2005).

3.2.3 Target Constraints vs. Budget Constraints

Normally reverse auctions are either budget constrained or target constrained. A budget-constrained auction is simply one with a fixed budget (Latacz-Lohmann and Schilizzi, 2005). A target-constrained auction is one where the auctioneer sets a minimum quantity of an environmental good they must meet (Latacz-Lohmann and Schilizzi, 2005). While budget-constrained auctions are much more common (Latacz-Lohmann and Schilizzi, 2005), there is experimental evidence to suggest that target-based auctions can reduce bidders rents and increase the efficiency of the auction (Boxall et al. In Press). Target constrained auctions tend to be used in auctions such as government buybacks where there is a set target that needs to be met. This occurred in the case of the Georgia Irrigation Reduction Auction, where the government needed to buy back a certain amount of irrigation permits in order to meet its drought prevention goals (Cummings et al., 2004).

3.2.4 Single vs. Multiple Rounds

Another important decision is whether or not an auction occurs over a single round or if bidders can revise their bid over multiple rounds of bidding. Single round auctions are more straightforward and less expensive (Hartwell and Aylward, 2007), but multi-round or iterative auctions allow for bidders to revise their bids (Hartwell and Aylward, 2007), which could have several different effects on the auction. On one hand bid revision could allow bidders who bid too high and would be rejected to lower their bids in subsequent rounds (Hartwell and Aylward, 2007). In an experimental auction, Cummings et al. (2004) found this may lead to lower average costs. On the other hand bidders who initially bid low may raise their prices, leading to higher costs (Latacz-Lohmann and Schilizzi, 2005; Hartwell and Aylward, 2007, Reeson and Whitten, 2014). Bid revision is often called bidder learning (Latacz-Lohmann and Schilizzi, 2005) or speculative bidding (Reeson and Whitten, 2014).

One example of bidder learning comes from the Conservation Reserve Program in the United States, where the average bid rose over subsequent bidding rounds, almost to the cut-off level (Latacz-Lohmann and Schilizzi, 2005; Riechelderfer and Boggess, 1988). As such it is important not to release average bids, maximum accepted bids, or distribution of bids between round (Latacz-Lohmann and Schilizzi, 2005). Bidder collusion may also become an issue in a multi-round auction (Cummings et al., 2004; Hartwell and Aylward, 2007).

Multi-round auctions may be beneficial when bidders are uncertain about what to bid. Comerford (2014) found that uncertainty regarding what level of bid amount to submit might have been a reason some bidders dropped out of the Vegetation Incentives Program. Multiple rounds of bidding may give participants time to come up with their bids and reduce potential uncertainties. However, Hill et al. (2011) found that bidders may drop out of the auction if there is a significant time gap between rounds of the auction.

3.2.5 Bid Evaluation Systems

Bid evaluation is the process describing how received bids are actually ranked. These systems tend to vary widely and could take the form of some Environmental Benefit Index (EBI), to a specific measure of pollution reduction (i.e. kg/yr), or something as simple as dollars per acre. The bid evaluation system should be closely related to the environmental benefits the auctioneer seeks to procure (Latacz-Lohmann and Schilizzi, 2005).

Before an auction even begins the auctioneer needs to establish who is eligible to bid (Latacz- Lohmann and Schilizzi, 2005). This is usually defined by either a geographic characteristic (is the bidder in a targeted watershed?) Or some environmental amenities criteria (e.g. does the landowner have a drained wetland on their property?) or some combination of both (Latacz-Lohmann and Schilizzi, 2005). One potential problem is that eligibility criteria may limit participation (Latacz-Lohmann and Schilizzi, 2005). Another problem that may arise is that eligibility criteria may cause potential participants to change their behavior so that they meet the eligibility criteria (Latacz-Lohmann and Schilizzi, 2005).

Bid selection criteria are used after the auction to evaluate the bids received. There is some debate on whether or not bid selection criteria should be made known to bidders, as bidders may modify their bids to result in higher environmental benefits as opposed to bidding true opportunity costs (Latacz-

Lohmann and Schilizzi, 2005). However sometimes the bid selection criterion can be a complex system developed by a team of scientists (Windle and Rolfe, 2007) and in such cases it may be difficult for bidders to know exactly how much environmental benefit they are offering in their bid. It is unclear if these complicated bid selection methods enhance reverse auction outcomes (Windle and Rolfe, 2007).

3.3 Participation in Reverse Auctions

This section reviews literature on why potential participants in a reverse auction may or may not choose to participate. The discussion will draw on both reverse auction literature and the adoption of innovation literature to gain an understanding of what factors influence the decision to participate in an auction by submitting a bid.

Since conservation auctions rely on competitive behavior, there has to be sufficient participation to induce said behavior (Whitten et al., 2007; Whitten et al., 2013). On one hand, as the number of participants increases, so too does the administrative cost of conducting the auction and potentially the number of losing bidders who may become disenfranchised with future participation (Whitten et al., 2007). However, the other participation element that needs to be considered is who is participating. Ideally, the landholders who participate are those who can offer a high environmental benefit at a reasonably low cost. This is not always the case, and in agri-environmental contracting in general there are concerns that land-holders with lower potential environmental benefits have a greater incentive to participate than those landholders with higher potential environmental improvements (Latacz-Lohmann and Schilizzi, 2005).

To gain possible insights into participation existing literature was summarized and is presented in Table 3.1.

Table 3.1: Participation in Selected Auctions

Auction/ Study	Year of Auction	Eligible Bidders	Participants	Proportion of Bids Successful	Percent successful	Budget	Notes
Brown et al (2010)	2002	3665 households	46	13/112	12%	?	Uniform Price auction for conservation easements on Native Grasslands and wetlands held in the Canadian Prairies
Comerford (2014)	2005/2006	Unknown	97	38/110	35%	$12,000,000 AUD (Four auctions)	Single-round discriminatory price auction in Queensland, Australia. Intended to protect vegetation., four auctions conducted in total
Cummings et al 2004	2001	576 permits eligible for auction	194 permit holders	42/194	22%	?	Five-round discriminative price auction in Georgia, USA. Target Constrained irrigation

							permit buyback auction
DePiper (2015)/DePiper et al 2013	2009	3676 license holders	Unclear if license holder could hold multiple licenses	0/492*	0%	Initial auction budget was $2.5 mill USD	Single round, discriminative crab fishing license buyback in Maryland. Low turnout caused auction to be cancelled and replaced with fixed price offers.
DePiper (2015)/DePiper et al 2013	2009	?	359 Bids across 6 categories submitted	284/359	79%	$6,724,470 USD in Virginia	Single round, discriminative price crab fishing license buyback in Virginia. Despite low participation, auction was not cancelled.
Gole et al 2005	2004-2005	?	59	21/88	24%	$200,000 AUD	Two round, discriminative price auction in Western Australia to conserve natural Landscape.

Greenhalgh et al (2007)	2005/2006	?	8 bids in '03, 23 bids in 04' (unclear if farmers submitted multiple bids)	19/31	61%	$540,000 USD(between two auctions)	Two discriminatory price auctions conducted in Pennsylvania, USA for Phosphorus reduction.
Hartwell and Aylward (2007)	2003/2004	?	16	13/18	72%	$100,000 USD (Two auctions)	Two single round discriminatory price auctions to buyback irrigation permits.
Hill et al (2011)	2009	92 farmers contacted	20 (9 made it to second round)	30/46 second round bids	65%	$400000 CAD	Two round, discriminative price auction for wetland restoration contracts in Saskatchewan Canada.
Iho et al (2014)	2010	?	9	10/24	42%	€ 25,000.00	Single round, discriminatory price auction for phosphorus reduction in Finland
Jack et al 2008		83	82	34/82	41%		Uniform price auction for soil erosion

							prevention in Indonesia
Jindal et al 2013	2009	400 (from a survey)	268	23/498	5%		Two single round, uniform price auctions for tree planting contracts in Tanzania
Khalumba et al 2014	2009	?	114	???	???	?	Seven-round, discriminatory price, auction in Western Kenya for forest enrichment contracts
Packman et al 2013	2012	?		7/15	47%	$75,000 CAD	Discriminatory Price, single-round auction in Manitoba, Canada. Contracts were for actions to address rising water levels around Dennis Lake.
Schilizzi and Latacz-Lohmann 2012	2001, 2003	607	357	198/357	55%	£25 million in 2001, £31 million in 2003	Two discriminative price auctions held in Scotland, UK for

							fishing vessel retiring.
Smith et al (2012)	2007/2008	?	13 bidders in 2007 auction	46/61	75%	$67,525 USD Three auctions	Three separate auctions for pollution reduction in Kansas, USA.
Thurston et al (2010)	2007/2008	?	Unclear if households could submit multiple bids	114/122	93%	?	Discriminatory price auction for rain water runoff management in Ohio, USA. Many zero bids, 73 bids submitted in 2007 and 49 submitted in 2008

While there is an expanding literature that looks specifically at what factors affect participation in reverse auctions, there is a substantial literature on what influences adoption of new innovations in general. Since the 1940s and 1950s various disciplines have strove to understand how innovations spread through social systems and how they come to be adopted by members of those social systems (Rogers, 2003). This body of literature is referred to as the diffusion literature by Rogers (2003). Diffusion scholars are often interested in how various socioeconomic factors affect the diffusion of innovations, and economists looking at what affects participation in reverse auctions also study many of these factors. Therefore, diffusion research may give us insight into how landowners decide whether or not to participate in reverse auctions. According to Rogers (2003), there are five perceived attributes of an innovation:

1. Relative advantage: how much better does this innovation seem relative to what it replaces? This may be measured in economic terms but also in terms of social status, convenience, and satisfaction. The innovation's perceived advantage is more important than its actual objective value. Innovations with a higher perceived advantage to an adopter are more likely to be rapidly adopted.
2. Compatibility: the innovation has to be compatible with existing values, experiences, and the needs/wants of potential adopters. Adoption will be slower with incompatible innovations.
3. Complexity: how complicated is the innovation perceived to be? More complex innovations will be adopted less rapidly.
4. Trialability: to what extent can the innovation be trialed and on what scale can it be trialed? New ideas that can be trialed on a smaller scale tend to be adopted more quickly.
5. Observability: are the results of an innovation visible to non-adopters? When people can see the results of an innovation they are more likely to adopt them their selves.

Pannell et al. (2006) groups these attributes of innovations into two categories: Relative Advantage (in which they include Compatibility and Complexity) and Trialability (which includes the Observability of an innovation).

Are there specific factors that affect the participation decision, and do they relate to Rogers' (2003) or Pannell et al.'s (2006) perceived attributes of innovations? A number of studies have investigated what demographic factors might affect innovation adoption decisions as well as what affects participation in conservation auctions. Some common features investigated are demographic factors such as age, education, income, etc. Often investigated are economic aspects of the participant's lifestyle, such as parcel size, type of farm, or any off-farm income (similarly, analysis of fisheries buybacks will investigate factors like number of licenses held, size of vessel).

3.3.1 Demographics

Demographic factors are thought to affect adoption of new innovations and participation in programs like reverse auctions. Demographic factors such as age and education are commonly thought to influence the adoption/participation decision. In addition, some analyses will also look at gender as a demographic influence on bidding behavior or auction participation.

How age affects participation in auctions or adoption of new innovation is not entirely clear. If an innovation or farming practice takes longer to show effects, landowners will often be inclined to give priority to shorter-term projects. Therefore, older landowners might be less likely to adopt new practices or participate in auctions because they are less likely to accrue the benefits, especially of an environmental good where the benefits may take a long time to be realized (Coggan et al., 2013). In reverse auctions this could mean bidders prefer shorter-term contracts because benefits are realized sooner (or costs are spread out over less time). Mendham et al. (2007) found older landholders felt a strong sense of duty to leave the land in the best condition possible, and might be more inclined to undertake environmentally beneficial practices. Ma et al. (2012) found evidence that older landowners may actually be more likely to participate in agri-environmental programs. Ma et al. (2012) asked farmers to make enrolment decisions in four hypothetical crop rotation and land management schemes. Of these four schemes, age affected only one of the acreage enrolment decisions, and older farmers enrolled more land in the plan. In general, Rogers (2003) notes that the evidence of the effect of age on adoption of new innovations is inconsistent; with about half of the studies he surveyed finding no relationship between being an early adopter and age. Is one of these age trends more prominent in actual auctions? Coggan et al. (2013) found that older farmers were less likely to submit bids in Australia's Environmental Stewardship Program and Takeda et al. (2015) found bidders in a Japanese auction were on average younger than the prefectural mean. However there are a number of auctions where older bidders were found to be more likely to participate in auctions. Brown et al. (2011) found bidders in their auction were older than the population average and Blackmore et al. (2014) found older landholders were more likely say they would participate in future auctions. However, DePiper (2015) did not find any statistically significant relationship between age and auction participation in the Maryland Crab Fisheries buyback.

Another factor that has been found to affect participation in reverse auctions is gender. There is no specific theory to suggest why gender may affect this participation, and many studies do not actually make of point of studying it. Brown et al. (2011) found bidders were more likely to be female than nonbidders, and Blackmore et al. (2014) found that females were more like to say they would participate in future auctions. However Jack (2013) found no evidence that female bidders in a Malawi auction bid any differently than their male counterparts.

The level of education is also thought to affect landowner inclination to participate in auctions or adopt new innovations. Increased education has been found to lead to more rapid adoption of innovations, but also may assist landowners in finding flaws with innovations (Pannell et al., 2006, Coggan et al., 2013). While many studies examine the influence of formal education on adoption, Coggan et al. (2013) noted that a number of studies indicate that informal education or one-on-one training often has a positive effect on adoption. Ma et al. (2012) found farmers with higher education were more likely to adopt hypothetical crop rotation programs. In actual auctions, the effect of education on auction participation is ambiguous. Comerford (2014) notes that participants in the Vegetation Incentives Program had very high levels of education but could not say with certainty if this was indicative of participants being more highly educated than non-participants, or simply selection bias in the survey. Comerford (2013) found that auction participants with bachelor's degrees submitted lower bids in an Australian auction, while Jack (2013) found higher education led to higher bids in an auction in Malawi. Brown et al. (2011), Coggan et al. (2013) and Blackmore et al. (2014) found no effect of education on participation in reverse auctions. DePiper (2015) found that crabbers with some college education were actually less likely to participate in a Maryland crab fishery license buyback.

3.3.2 Economic and Financial Factors

Real economic or financial costs and benefits are an important determinant in the decision to adopt a new innovation or participate in programs like reverse auctions. This is not a surprise if we assume that the decision of whether or not to participate in an auction or adopt an innovation is primarily a comparison of the benefits of participating or adopting and the costs of doing so. Financial factors may actually be the most important influence on a landholder's decision whether or not to participate (Mendham et al., 2007). Economic factors that are considered include the size of the farm operation, sources of off farm income, different types of farms, or fisheries operations.

Unsurprisingly, when the proposed action of an auction has high opportunity costs, bids are higher. In a Saskatchewan wetland restoration auction, bids on cropland ranged from $619.20 - $666.70/acre in the second round of bidding while bids on forage land were much lower, between $20.80 - $391.20/acre (Hill et al., 2011). Brown et al. (2011) found that bids for conservation easements that prohibited any agricultural activity were on average $100/acre more expensive than conservation easements that allowed for some agricultural activity. DePiper (2015) looked at multiple aspects of how higher opportunity costs affected bidding behavior and participation in Maryland and Virginia's crab fishery license buyback. Maryland crabbers who crabbed commercially or commercially in addition to recreationally were less likely to participate in the buyback. Crabbers in Virginia that made higher profits from crabbing were less likely to bid as well (DePiper, 2015). Wichmann et al (In Press) found participants in an experimental auction bid higher when the costs of implementing environment services were uncertain.

Another factor that influences participation is the timeline of the action proposed by the auction. This has been especially visible in auctions that tried to procure any kind of permanent contract. In wetland restoration and conservation auctions, farmers were highly reluctant to bid on permanent restoration contracts due to concerns that it would affect the resale value of their land (Brown et al., 2011; Hill et al., 2011). Comerford (2013) notes permanent clauses in contracts as a major reason landholders choose not to participate in Queensland's Vegetation Incentives Program.

Potential participants may be more likely to participate in reverse auctions when their livelihood is less dependent on the activities the auction targets. For example, landholders on bigger farms tend to be more likely to participate in reverse auctions (Coggan et al., 2013; Takeda et al., 2015). Similarly, Virginia crabbers who had multiple types of crabbing licenses were more likely to participate in reverse auctions (DePiper, 2015). Another example is off- farm income. Farmers who have higher off-farm income may be more likely to participate in reverse auctions because they risk less of their enterprises value by participating (Coggan et al., 2013). On the other hand, landholders making less money may have greater incentive to participate in auctions. For example Coggan et al. (2013) found households making less than $100,000 a year were more likely to participate in the Australian Environmental Stewardship Program.

3.4 Summary

This chapter explored two major issues; the design of reverse auctions and participation in reverse auctions. Auction design affects a number of aspects of the auction, such as cost of the auction, the behavior of participants, and what kinds of environmental services get purchased. These design choices can have a huge impact on the outcome of the auction. The factors that affect participation in reverse auctions is not clearly defined. However the literature on adoption of innovation can be related to individuals' inclination to participate in reverse auctions. Furthermore, some general observations on participants in past auctions can help inform who will be most inclined to participate in reverse auctions.

Chapter 4 The Reverse Auction in Wheatland County

4.1 Wintering Hills

The Wintering Hills is an eight-township block northeast of the town of Strathmore located in Wheatland County, Alberta, which itself is located just east of the city of Calgary. Within the county, the biggest populated settlement is Strathmore which has a population of 12,165 (Statistics Canada, 2011a). The rest of the county has a rural population of 7,045 (Statistics Canada, 2011b). According to the 2011 Alberta Census of Agriculture, there are 782 farms operating on 1,121,462 acres of farmland. The majority of farmland in the county is operated by their owners (811,811 acres). Approximately half of the farms primarily produce wheat, grains other than wheat, or oilseeds (363 farms); but cropland makes up almost 70% of the total farmland acres in the county (Alberta Agriculture & Rural Development, 2011). The county has a number of large farms, 35% of the County's farms are larger than 1120 acres (compared to 30% for the South Saskatchewan region and 27% for the Province) and 10% of farms are larger than 3520 acres (compared to 7% for the province) (Alberta Agriculture & Rural Development, 2011). In 2015 the average transfer price of agricultural land in Wheatland County was $3,263.11/acre (Alberta Agriculture & Forestry, 2016)

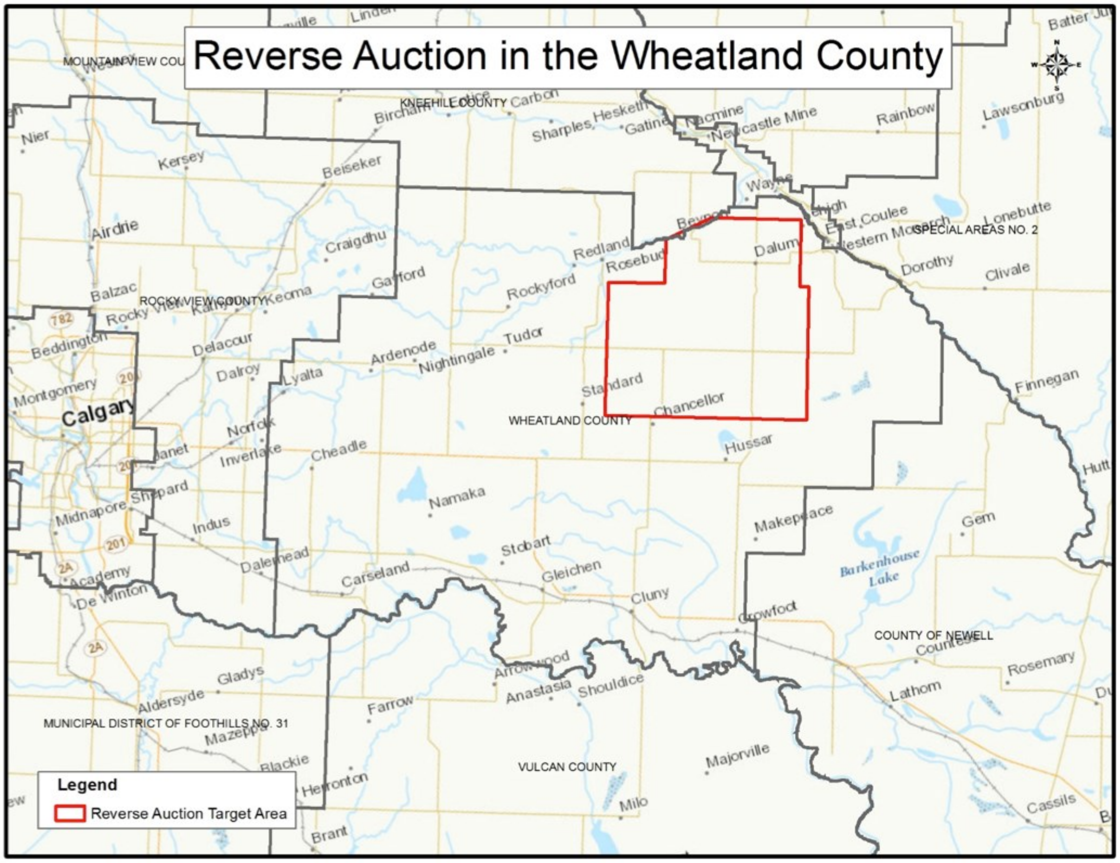

Figure 4.1: Wintering Hills in Wheatland County

4.2 Auction Design

The Wintering Hills auction was a uniform price, single round auction with a reserve price conducted by Ducks Unlimited Canada. Uniform pricing was selected for two reasons; first because landowners perceived it to be more fair, and second to establish an accurate per acre price for securement of drained basins for wetland restoration activities. DUC felt that landowners would prefer a pricing system where all successful bidders received the same per acre payments. At initial contact, landowners seemed in favor of the uniform pricing system, contrary to predictions by Cummings et al. (2004) and Latacz-Lohmann and Schilizzi (2005) who suggest participants may dislike uniform pricing on equity grounds. In addition, DUC hoped to get a per acre price for wetland restoration contracts that they could use for future dealings with landowners in the region. The program managers felt it would be easier if landowners had not been paid a variety of per acre rates, which could result in landowners developing varying expected levels of compensation. While a budget was not explicitly set, a reserve price of $3,000/acre was considered. This is based approximately on the market value of land in the surrounding area as well as past contracts DUC had established with producers in other areas of the province.

The lease agreement landowners could bid on was for 10 years. Half of the payment would be made up front and the other half would be made in annual payments, with interest, over the term of the lease. The lease agreements only prohibited landowners from breaking or draining the wetland, meaning that landowners would be able to plant hay, or water livestock. Landowners were not required to install a fence or to conduct any other type of management action. Bids were ranked on a simple cost per acre basis, as opposed to a more complicated EBI system (e.g. Hill et al. 2009).

4.3 Prior to the Auction

4.3.1 Identifying Drainage

Prior to making contact with any landowners, DUC staff identified potential drained basins to identify landowners that would be eligible to participate in the auction. Using satellite images and historical photography, a DUC staff member identified 506 potential drained basins covering 1661.36 acres in the eight Townships. Figure 4.2 shows the distribution of drained basin size. Overall a large number of drained basins were small in size - the mean size is 3.28 acres - but over a third (33.9%) are less than 1 acre in surface area and 84.9% of identified basins are less than 5 acres in surface area. Basins were not differentiated by ecological significance.

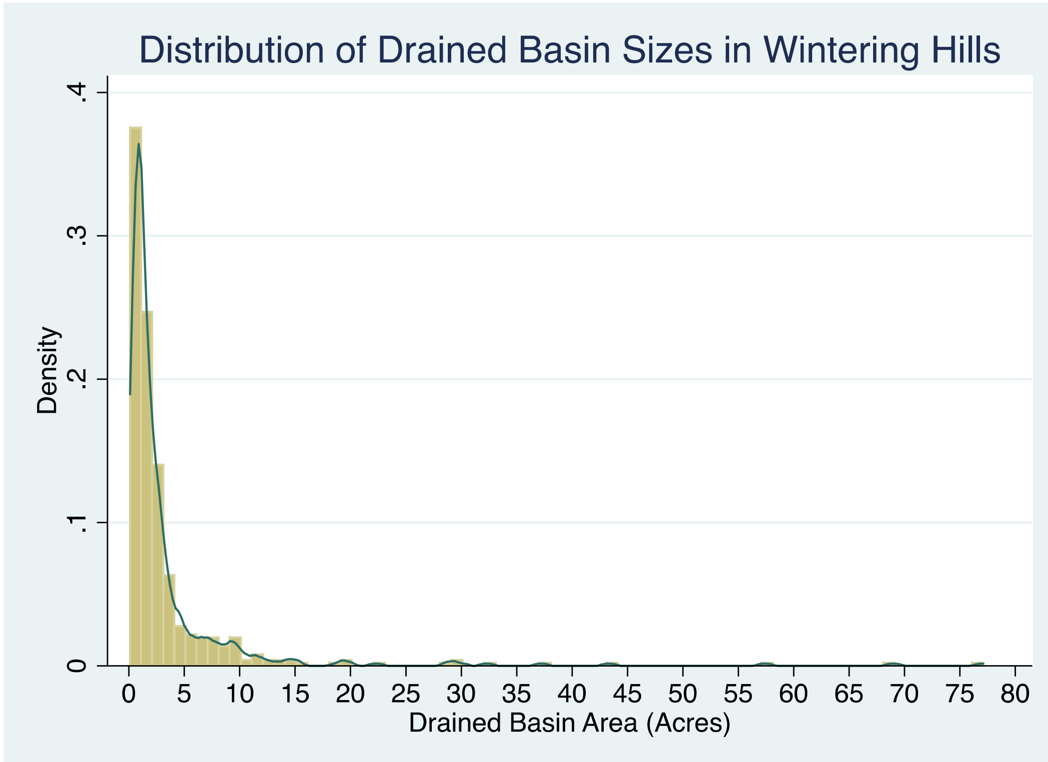

Figure 4.2: Distribution of Size of Drained Basins

4.3.2 Initial Contact with Landowners

Initial contact with potential participants began on September 1st, 2015. Ducks Unlimited Canada prepared an initial contact package that consisted of three documents. The first was a document explaining that DUC was running a reverse auction in collaboration with the University of Alberta, and a brief description of what a reverse auction is, a timeline of how the auction would run, and how the payment schedule would work. The second document described wetlands, wetland restoration, and the remote sensing process that Ducks Unlimited uses to identify drained wetland basins. The final document consisted of a satellite image of the potential participants' section with target wetlands marked, a closer view image with those wetlands marked out and acreage of the wetlands estimated, a Google Maps image of the section, and if it existed, a historical photograph of the image. A package was prepared for each targeted section and the county land map was used to determine who owned the land the drained basin was located on, so landowners who had multiple drained basins on different sections received multiple packages.

A DUC program specialist then delivered initial contact packages in person to the landowner's home. If a landowner was not present at the contact time, follow up visits were made. Landowners were informed that DUC was running a wetland restoration reverse auction in the area, and that they were asking landowners to submit bids of how much compensation they would require to allow drained basins on their property to be restored. The voluntary aspect of the program was emphasized and landowners were encouraged to submit bids even if they thought they were too high and had little chance of succeeding. Landowner phone numbers were collected to make sure DUC could contact them at a later date so a surveyor could be sent to any interested parties. It was made clear landowners were not required to participate even after a surveyor came out, but after a surveyor had come out they would know exactly what wetlands they could bid on. One issue that was encountered in delivering contact packages by hand was finding the landowners in question. A few landowners would own land under multiple names or corporate titles, so some landowners would receive packages under multiple names. A bigger issue came up with some landowners who were no longer living on the land, especially older landowners who had moved into the nearest town, or landowners who owned land in the county but did not actually live on that land.

During initial contact there were questions raised by multiple landowners. Some landowners wanted to know whether or not they could bid in existing wetlands that they already had on their property. One landowner revealed that he had permits to drain a wetland that he had spent a lot of money maintaining, and would be inclined to keep it if he could get help paying the costs to maintain it. Another had recently dammed a drainage ditch and wanted to know if they could get paid for that restoration work. DUC's funding in this case was limited strictly to restoration of wetlands, so these landowners could not be participate in the auction. Other concerns landowners brought up were more directly related to the physical restoration work itself. One question was whether or not DUC would seed any particular plants around restored wetlands, likely because some of the drained basins had various weeds growing around them. Another question was who would bear the costs of the restoration work. DUC informed these landowners that the ditch plugs they installed would be seeded and that landowners would have input in what seed was used and that hopefully the restoration of wetlands would help deal with noxious weeds in the basin. DUC would also bear all the costs of the restoration work.

Overall, 99 packages were developed, of which 87 were delivered. Some of the landowners could not be contacted for various reasons, for example they had retired and moved away.

4.3.3 Landowner Information Meeting

After initial contact, DUC staff invited landowners to a dinner and information session on the Auction. The meeting was held at the Dalum town hall, a small hamlet in the target area. This information session described the wetland restoration process, the conservation easement contract and the reverse auction process. The information dinner was also an opportunity for interested landowners to ask any further questions they had regarding any part of the process. One question that was discussed at some length was whether or not landowners would be allowed to drain a restored wetland after they signed a lease with DUC. Attendees were informed that after the ten-year lease expired they were still legally permitted to drain the wetland so long as they got the relevant drainage permits from the provincial government. As with other landowner interaction, the question of whether or not landowners could bid on existing wetlands came up as well.

Chapter 5 Results

5.1 Summary of Results

DUC received bids on 27 drained basins from 8 bidders. Submitted bids are on average 10.2 acres in size, but these basins range from 0.3 acres to 106.13 acres. Bids ranged from $2,200 to $4,250 per acre. Of the 27 bids, 22 of them are for $3,000/acre, which results in a very flat bid curve shown in Figure 5.1

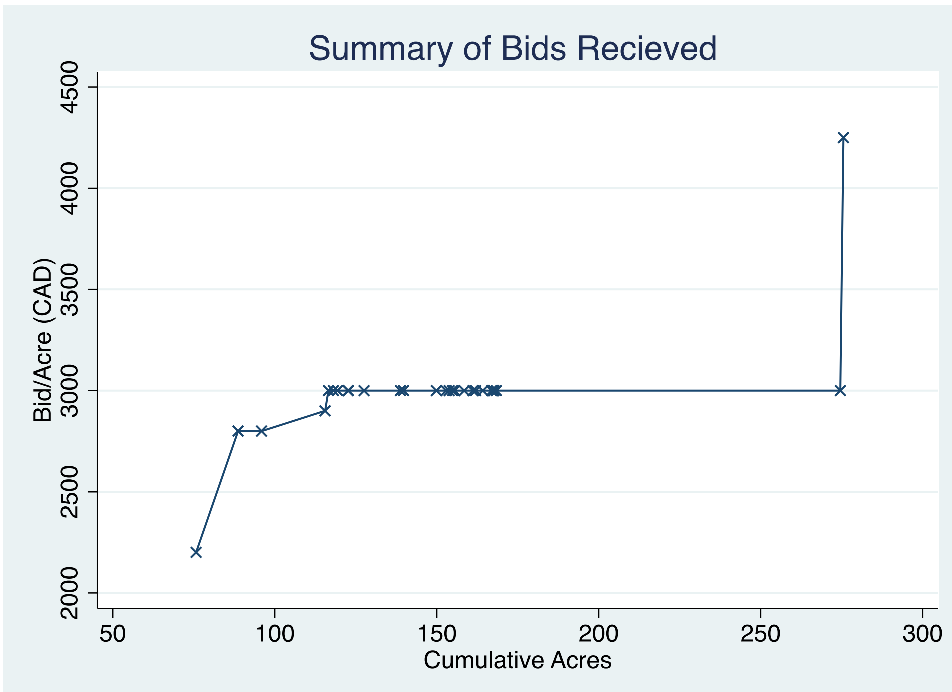

Figure 5.1: Wheatland County Reverse Auction Bid Curve

Despite the relative lack of heterogeneity in the bids we still see the "hockey stick" shape that Brown et al. (2011) states is characteristic of bid curves in reverse auctions.

All but one bid was successful. The last bid, $4,250/ acre on a 0.98-acre basin was not approved because it exceeded the $3,000 reserve price. This means that the average successful bid included 10.56 acres of wetland to be restored. In total, 275.22 acres of wetland was included in approved bids. At the $3,000/acre the auction secured basins at a price comparable to average value of agricultural land values in Wheatland County (Alberta Agriculture & Forestry, 2016), which as Hill et al. (2011) noted is how some landowners formed their bids in the Assiniboine River Watershed Auction. Table 5.1 shows a breakdown of successful bids by what the land is used for.

Table 5.1: Summary of Successful Bids by Land Use

Summary of Successful Bids by Land Use			
Land Use	**Number of Bids**	**Average Size (Acres)**	**Average Bid ($/Acre)**
Cultivated Land	9	5.16	$2,966.67
Cultivated/Grassland	2	59.55	$2,900.00
Grassland	14	2.43	$3,000.00
Grassland/Irrigated	1	75.70	$2,200.00
Overall	**26**	**10.59**	**$2,950.00**

One observation to be made is that cultivated land appears to trade at a slight discount to grazing land (grassland). At first glance this flies in the face of reason, as the cropland would be expected to have higher opportunity cost than grazing land. Two of the participating bidders submitted a large number of grassland bids all at $3,000/acre. This is therefore potentially the result of rent seeking behavior, as opposed to an actual reflection of opportunity costs. One of the bids placed by these two bidders was the sole unsuccessful bid of $4,250/acre, which reinforces the observation that there is some exploratory rent-seeking in the Wheatland County Auction. Alternatively, this could indicate that landowners do not see a difference in pastureland and cropland for the purpose of submitting bids.

5.2 Comparison with the Assiniboine River Watershed Auction

The results of our auction are most comparable to the Assiniboine River Watershed (ARW) Auction since both were reverse auctions for wetland restoration contracts with DUC. Conducted in Saskatchewan in late 2008 and early 2009, this was a two-round, discriminatory price auction for 12-year wetland restoration contracts (Hill et al., 2011). After the first round of bids was submitted, ground trothing took place at submitted bid location and then a second round of bids took place (Hill et al., 2011). The first round of the auction had 118 bids submitted by 20 different bidders on 713 drained basins covering 670 acres (Hill et al., 2011). This dropped to 46 bids from 9 bidders covering 302 basins and 287.10 acres of wetland in the second round (Hill et al., 2011). In the end 30 bids from 7 bidders were approved, covering 210.9 acres of wetland from 211 basins (Hill et al., 2011). The average bid was $118.52/acre/year ($133.34/acre/year in $2016), ranging from $20.80/acre/year - $391.20/acre/year ($23.40 - $440.10/acre/year in $2016), and the average area included in each bid was 7 acres (Hill et al., 2011). The total securement cost of the auction was $182,000 ($204,750 in $2016) (Hill et al., 2011).

How does this compare to the auction held in Wheatland County? Table 5.2 is a comparison of the two auctions, all dollar figures are in $2015.

Table 5.2: Comparison of the Wheatland County Reverse Auction and the Assiniboine River Watershed Auction

	Assiniboine River Watershed Auction	**Wheatland County Reverse Auction**
Length of Lease	12 Years	10 Years
Acres from Successful Bids	210.90	275.22
Total Securement Cost	$204,750.00	$825,660.00
Securement Cost/Acre	$970.84	$3,000.00
Number of Successful Bidders	7	8
Number of Successful Bids	30	26
Average Acres/Successful Bid	7.00	10.59
Average Value of Land and Buildings/Acre	$581.63	$2282.00
Securement Cost/Acre as Percent of Average Land Value	167%	131%

Overall the Wheatland County auction was much more expensive than the ARW auction, but it succeeded in securing more acres of wetlands. In addition, the size of the basins restored is on average much larger than the ARW Auction. While the average acreage included in each bid is comparable, the ARW Auction secured 210.9 acres from 211 basins, compared with 274.56 acres from 26 basins in the Wheatland County auction. However, the securement costs are several times more expensive than the ARW Auction; total securement costs were 4.03 times higher in the Alberta auction and per acre costs were 3.09 times higher than the ARW auction. One possible reason for the large divergence in price is the difference in the value of farmland between Alberta and Saskatchewan. According to Statistics Canada (2015) the average price of agricultural land and buildings in Alberta in 2014 was $2,092/acre, compared to the 2009 average values of agricultural land and buildings in Saskatchewan, which was $581.63/acre in $2016. So while per acre securement costs are 3.6 times higher in the Wheatland County Auction compared to the ARW auction, average land values in Alberta are 4 times greater than average land values were in 2009 in Saskatchewan.

Another way to examine the difference in cost between the two auctions is to compare bids to the rental rates of land. Assuming that annual rental rates in the ARW are approximately 3% of land value, based on the $581.63/acre land value (2008 value adjusted to $2015) this translates into an annual rental rate of $17.45/acre. The average bid in the ARW auction was $970.84/acre, or $80.90/acre/year. This translates into average bids equal to approximately 4.6 times the average value of land. How does this same breakdown compare to the Wheatland County Auction? Assuming a rental rate of 3.125% based on an average land value of $3263/acre, rental rates in Wheatland County are $101.97/acre. The average bid was $2950/acre, or $295/acre/year. This translates into average bids of approximately 2.9 times the rental rates in Wheatland County. What if these rates are carried forward? If ARW bidders placed bids at the same rate of bid shading with current average land values in Saskatchewan ($1159/acre) then average bids would be $161.39/acre/year, or $1936.67/acre for a 12 year lease. Table 5.3 summarizes this comparison. The bold bids for Wheatland County in 2008 and the ARW in 2016 are projected bids based on the level of bid shading that took place in the actual auctions.

Table 5.3: Comparison of Bids in Relation to Rental Rates

		Assiniboine River Watershed	Wheatland County
2008	Average Land Value	$581.63	$1,965.43
	Annual Cash Rent Calculation	$17.45	$61.42
	Bid ($/acres)	$970.84	**$1,776.90**
	Bid ($/acres/yr)	$80.90	**$177.69**
	Bid/Rent	4.6	2.9
2016	Average Land Value	$1,159.00	$3,263.00
	Annual Cash Rent Calculation	$34.77	$101.97
	Bid ($/acres)	**$1,936.67**	$2,950.00
	Bid ($/acres/yr)	**$161.39**	$295.00
	Bid/Rent	4.6	2.9

Source: 5-1 Alberta Agriculture and Forestry, Statistics Canada

5.3 Comparison with Stated Preference Estimation

One of the purposes of a reverse auction is to try and uncover a willingness to accept measure for providing an environmental service. How do the results of this auction compare to estimations of WTA from other studies? The most relevant study is likely Kanjilal (2015). In her study, Landowners from Eastern Alberta (Beaver County, Wainwright County, and Vermillion River County) and Western Saskatchewan were asked to accept or reject varying levels of bids to restore a hypothetical, 7-acre wetland on their best pasture or cropland. Kanjilal (2015) found Alberta landowners WTA for wetland restoration on cropland to be $617.85/acre/year and on pastureland to be $140.14/acre/year. By comparison the Wheatland County Auction secured cropland at a much lower rate and pasture and at a much higher rate than Kanjilal (2015) estimates for Alberta landowners. These lower estimates come in spite of lower land values in the surveyed counties $1,694.65/acre in Beaver County, $1799.55/acre in Vermillion River, and

$1983.83/acre in Wainwright (Kanjilal 2015). While this is only a comparison between one stated preference and one actual auction, it is encouraging to see that a reverse auction could illicit some lower bids from producers, especially despite higher land values. The fact that the Wheatland reverse auction paid out much higher bids on grazing land does draw attention to the need to try and reduce rent-seeking behavior in future reverse auctions.

5.4 Summary

This chapter discussed the results on the Wheatland County Auction. This auction managed to secure wetland restoration basins at $3,000/acre, which is lower than but comparable to the price of land in the county. At 275 acres restored, the Wheatland County Auction was able to procure a similar area of wetland from a similar number of bidders as the Upper Assiniboine River Watershed Auction, previously held in 2009. This was achieved at a much higher per-acre payment, but this difference could be explained by the much higher land values in Alberta compared to Saskatchewan. Also encouraging, the Wheatland County Auction secured wetlands on croplands at a much lower price than a recent state price estimate. On the other hand it secured wetlands on grazing land at a much higher price, which may highlight the importance of reducing rent-seeking behavior from bidders in reverse auctions.

Chapter 6 Discussion

Overall, the Wheatland County Reverse Auction was a successful execution of the reverse auction mechanism. Wetland restorations contracts were secured at a slightly lower cost than might have otherwise have been paid, if price of land was paid. In principle this is an indication that a reverse auction can be used in Alberta to secure wetland restorations at a lower cost than other programs. The Wheatland County auction also highlighted some of the challenges that need to manage to administer a reverse auction for wetland restoration in Alberta.

6.1 Challenges to using Reverse Auctions in Alberta

One of these challenges is that reverse auctions are time consuming. Most phases of the auction process tended to be slow processes involving considerable labor hours. For example, in the Wheatland County auction, considerable time went into identifying drained basins and contacting the producers who owned the associated lands. However using satellite imagery and historical photography still contains a fair degree of uncertainty. Basins that were drained and then extensively farmed are difficult to identify, as are basins drained using tile drainage. These difficulties added to the workload of the auction administrators, increasing the labor cost of the auction.

Initial contact with landowners was also a time consuming process, especially when landowners are difficult to contact. Follow up visits need to be made when landowners cannot be contacted during the first visit. Even when they have been contacted at that first occasion, follow up phone calls may be needed to encourage participation, which is still not guaranteed.

Surveying basins of the landowners who are inclined to participate is also a time consuming process. This is problematic because landowners who are uncertain about participating in the auction may choose to drop out of the auction process while waiting for a surveyor to verify their eligibility.

Another challenge arises if bidders are uncertain about what to bid. First, this uncertainty may cause some landowners not to participate, as noted by Comerford (2013). Additionally, landowner uncertainty adds to the cost of the auction if auction personnel have to make follow up visits to help landowners decided on a bid. Finally, if landowners are uncertain about their bids then they are likely not bidding their true Minimum WTAC, thus undermining the cost effectiveness of the auction. If bidders base their bids on the price of land this may reduce uncertainty for bidders, however it is not clear if this heuristic would increase landowner participation or not.

6.2 Observations

6.2.1 Bids based on the price of land

An important observation from the Wheatland County Auction is that landowners may base their bids at least in part on the value of land. This was also observed in the Assiniboine River Watershed Auction (Hill et al., 2011). While it requires more auctions to confirm that this is the general trend in Alberta, if bids are based on the value of land it has some important implications for reverse auctions in Alberta. First it implies auctions will be more expensive in higher value areas. This could be a problem when targeting more valuable land in Southern Alberta, where restoring wetlands is an important goal to reduce flooding and restore waterfowl habitat. However, it also makes it possible for auction administrators to estimate the cost of paying winners based on the area the auction is conducted in. Another important question is whether or not this trend undermines the entire purpose of using an auction. If bidders want the price of land as compensation for restoring wetlands then it begs the question why not just buy the land? Using reverse auctions means that conservation agencies can do restoration work on land that's not for sale, which could potentially allow for more restoration to take place. Additionally, even if auctions pay out the price of land, they only pay for land where conservation takes place as opposed to paying for the entire parcel of land.

One interesting observation in the Wheatland County auction was that there was almost no difference between bids on cropland and pastureland in the Wheatland County Auction. This is especially interesting given the wide spread between cropland and pasture bids in the ARW auction (Hill et al., 2011) and in the auction conducted by Brown et al. (2011). A possible explanation is that Wheatland County bidders did not differentiate between different land uses in bidding. This may be supported by the fact that land prices of the two land types in Wheatland County are much closer together, in percentage terms, than in Saskatchewan. Table 6.1 shows the difference between the two land uses in dollar terms and the percentage difference between pasture and cropland values. Dollar values are a 24-month average from Farm Credit Canada's online farm values database in 2016 dollars. The Saskatchewan figure is an average of the RMs of Orkney, Good Lake, and Wallace.

Table 6.1: Land Values by Use - Wheatland County vs Southeast Saskatchewan

	Wheatland County	Southern Saskatchewan
Average Cultivated Cropland Value	$3,801.00	$1,038.00
Average Native Grassland Value	$2,070.00	$314.00
Percentage Difference	84%	231%

Source: 6-1 Farm Credit Canada

While there is a much greater dollar difference in Wheatland County, the percentage difference between the two types of land use is much greater in Saskatchewan. This discrepancy might explain the difference between bidding behaviors in the Wheatland County auction and the ARW auction. Also worth noting is that the midpoint of the two values for Wheatland County is $2,935.50/acre, approximately equal to the average bids from the Wheatland County auction ($2,950.00/acre). This suggests that landowners might use land values as a bidding heuristic, but do not differentiate between different land uses in their bids.

6.2.2 Bidding on Intact Wetlands

A possible modification that could be made to future auctions is allowing participants to bid on intact wetlands that exist on their property, in addition to drained basins to be restored. Throughout the initial contact phase of the Wheatland County Auction potential bidders stated that they would bid on easements on intact wetlands on their properties. It is hard to tell whether or not this would increase participation in a reverse auction for restoration the auction conducted by Brown et al. (2011) allowed landowners to bid on intact wetlands and it had very low participation. It could be that landowners in Wheatland County expressed interest in bidding on intact wetlands because they were approached about drained basins, which would indicate that an auction could possibly include both options. One obvious drawback of this approach is that it would divert funds away from restoring wetlands and likely result in fewer acres of wetland restored. Furthermore this option will be restricted in auctions where funding is restricted to restoring previously drained wetlands. Another issue is the fact that draining wetlands is technically only legal if a landowner has a drainage permit from the provincial government. It is counterintuitive to pay landowners not to break the law, when in theory simply enforcing the Water Act to prevent drainage could protect these wetlands. If intact wetlands were an option for bidders in future wetlands they would likely have to be bid on in perpetuity so that a landowner surrenders their right to drain the wetland, even legally. Another option would be to rank bids on conservation differently than bids on restoration, which could incentive landowners to increase their bids for conservation easements. Including intact wetlands in a future auction remains an interesting possibility nonetheless.

6.2.3 Improving Participation

Arguably one success of the Wheatland County Auction was that it showcased how a targeted effort at engaging landowners can have a positive effect on participation in a reverse auction. At first glance this might be hard to see, of the 87 landowners identified as eligible to participate only 8 choose to do so. However, this is compared to the 7 landowners who participated in the Assiniboine River

Watershed Auction. Hill et al. (2011) estimate that there are 6,000 eligible landowners in the Assiniboine River Watershed. This indicates that targeting smaller areas and making an effort to contact eligible landowners in person can increase participation. While this will be accompanied by higher costs (namely in labor costs) mentioned earlier, this may also mean more wetlands get restored in a region if that region can be divided into smaller areas.

6.3 Participation in the Wheatland County Auction

Despite improved participation over other auctions, the Wheatland County auction still had a relatively low participation rate (8 out of 87 landowners, or 9.19%). This low participation can be linked back to the attributes on innovation discussed by Rogers (2003) and Pannell et al. (2006). Recall the five attributes of an innovation (according to Rogers (2003)) are Relative Advantage, Compatibility, Complexity, Trialability, and Observability.

For crop farmers, wetlands have little to no relative advantage (to an operation without restored wetlands) and minimal compatibility with their operations. Wetlands represent area that crops cannot be planted in and therefore result in less production. In addition, wetlands impose a nuisance cost on crop farmers who have to maneuver their machinery around wetlands. For cattle producers this is less of an issue because the reduced land area does not have the same effect on production. Furthermore in the case of the Wheatland County Auction, landowners were not required to fence off the wetland area, they were allowed to water their cattle at the wetlands, and could still hay that area if the area is dry enough, so long as they do not break ground. So while restoring wetlands may not have much advantage for cattle producers, they are at least much more compatible with their operations. The low relative advantage and compatibility of wetland restoration with these operations is one explanation for low participation rates in wetland restoration auctions.

Another attribute of innovation that can help explain the low participation rates in reverse auctions is Trialability. Wetland restoration is an all or nothing choice. While a landowner might opt to restore all the drained basins on their property of a selection of them, these wetlands either have to be restored or left drained. In order for wetland restoration to yield meaningful environmental services, the restored basins have to stay intact for a reasonably long period of time, which can impact the resale value of the land. These two factors mean landowners have very little chance to 'trial' wetland restoration, which will make risk-adverse farmers less inclined to participate.

What about the two remaining attributes of innovation? One way that complexity comes into play in a reverse auction is in the bidding process. Auction staff reported that some participants had difficulty coming up with a bid, which could be a reason landowners use the price of land as a benchmark for their bids, and could also be why participation was low. This complexity may discourage potential participants from submitting bids if they are unsure of what to bid. The last attribute of innovation is Observability. While landowners can easily observe the impact of restoring wetlands, what may be more relevant is that they can see the impact of draining them (and by therefore they can see the benefit of not restoring them). Equally problematic, landowners rarely actually observe wetlands being restored because it is not a widely adopted practice.

Further adding to the problems outlined by Rogers (2003) attributes, participating in reverse auctions can involve substantial transaction costs to participants. Landowners have to attend information meetings, develop a bid and fill out all the paperwork necessary to submit a bid. Based on interviews with auction staff, we do not believe bidders dropped out of the auction at the paperwork stage, however some may have decided not to participate because they were not inclined to attend the information session after initial contact. In the Wheatland County Auction, the paperwork was relatively simple and a program specialist was available to assist with paperwork throughout the auction. While this may have helped prevent bidders dropping out during the final phase of the auction, it also added to the labor cost of the auction. Future auctions should endeavor to keep the paperwork they require participants to complete as simple as possible to save both labor time from the auction administrators and try to prevent landowners from dropping out of the auction late in the auction.

6.4 Conclusion and Recommendations

The Wheatland County Reverse Auction was a reverse auction for wetland restoration. It was the first auction of its kind in Alberta and only the second of its kind in Canada. In general this was a successful auction as a portion of landowners submitted bids for restoration, the least cost effective bid was rejected and wetland restoration will take place. However, participation was still quite low which is a frequent problem in these programs and costs were quite high. Future auctions for wetland restoration will have to address these problems.

There is strong evidence that the Wheatland County Auction secured drained basins at a lower markup than the ARW Auction. This is likely due to the use of uniform pricing as opposed to discriminative pricing. Given the relatively low level of participation, it is impossible to rule out the possibility of any collusive behavior in the Wheatland County Auction, however it is noteworthy that despite this the uniform pricing method still managed to obtain bids at a lower markup. Future auctions should therefore consider using uniform pricing over discriminatory pricing for its ability to reduce bid shading in auctions. Additionally, as was noted earlier there is some evidence that landowners appreciate the fact that uniform pricing means everyone receives the same payment and therefore comes across as a more fair payment system.

Future auction administrators have to be prepared to bear the high cost of running an auction. If bids are correlated with land values, then securing land for wetland restoration can be quite high, especially in high value areas where wetland restoration is most needed, so the auctioneer should be prepared to budget quite a bit of money for securement. In addition, auctions require a substantial amount of labor for everything from identifying drained basins to contacting landowner and helping landowners develop their bids. All of these aspects take time so future reverse auctions could benefit from dedicated staff. The need for so much labor will increase the overall cost of the auction. As auctions become more mainstream policy instruments they may be allotted larger budgets, but anybody running a wetland restoration auction needs to be prepared to spend a lot of time and money to get the results they want.

While the amount of labor involved in running an auction increases the cost of the auction, it also could yield better results in terms of securing ecological assets. One of the key successes of the Wheatland County auction was targeting a small area for the auction as opposed to a much broader one. When compared to the ARW Auction of 2009, the Wheatland County auction secured more acres of wetland and similar participation from landowners by targeting a much smaller area and engaging eligible landowners as opposed to relying on landowners to engage the DUC staff running the auction. The Wheatland County Auction only had one program specialist who did all of the work involved in contacting and engaging landowners. A possible change that future auction administrators could consider is having more contact people, each responsible for a small area. This way the area of the auction could be expanded while still maintaining the targeted approach of the Wheatland County Auction. While this would add to the labor cost it may help to elicit more bids and increase the effectiveness of the auction.

The objective of this thesis was to examine whether or not a reverse auction could be a mainstay policy mechanism for wetland restoration in Alberta. The Wheatland County auction successfully secured drained basins for restoration work, using funds collected by from drainage permits. Therefore as a concept the Reverse Auction mechanism can work. In addition to the concerns outlined above there is an issue of how well this policy mechanism could work in the big picture. If wetland restoration funds totally rely on wetland drainage to occur, this means the funding for wetland restoration becomes reliant on drainage, which makes it more difficult for a net positive increase in wetlands to occur. However one mitigating factor is the fee collected for drainage (~$7,000/acre) is much higher than the price paid in the Wheatland County Auction ($3,000/acre). If the payment for restoration remains lower than the fee charged for drainage then the policy is more self-sustaining because more acres of wetland can be restored than need to be drained to fund the policy. While this does not fully account for the difference in ecological benefits between a drained wetland and a restored basin, on a simple area basis as long as the funds collected are higher than what is spent the policy could be an effective method of wetland restoration.

References Cited

Alberta Agriculture & Forestry, Government of Alberta (2013). 2013-2018 Growing Forward On-Farm Stewardship Program.

Alberta Agriculture & Forestry, Government of Alberta (2013). (2016). Wheatland County - Agricultural Real Estate Transfers. url: http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/sdd1613?opendocument.

Alberta Agriculture & Rural Development, Government of Alberta (2011). Alberta Census of Agriculture.

Alberta Agriculture & Rural Development, Government of Alberta (2009). 2009-2013 Growing Forward Stewardship Plans Program: Grazing and Winter Feeding Management Funding List.

Alberta Environment & Sustainable Resource Development, Government of Alberta. (2013).Alberta Wetland Policy.

Alberta Environment, Government of Alberta (2001). Administrative Guide for Approvals to Protect Surface Water Bodies Under the Water Act.

Alberta Water Resource Commission, Government of Alberta (1993). Wetland Management in the Settled Area of Alberta: An Interim Policy.

Blackmore, L., G. Doole, and S. Schilizzi (2014). "Practitioner versus participant perspectives on conservation tenders". Biodiversity Conservation 23, pp. 2033–2052.

Boxall, P. C., O. Perger, and M. Weber (2013). "Reverse Auctions for Agri-Environmental Improvements; Bid-Selection Rules and Pricing for Beneficial Management practice Adoption". Canadian Public Policy 34.

Boxall, P.C, Perger, O., Packman, K., and Weber, M. (In Press) "An Experimental Examination of Target Based Conservation Auctions" Land Use Policy (forthcoming)

Brander, L. M., R.J. Florax, and J. E. Vermaat (2006). "The Empirics of Wetland Evaluation: A Comprehensive Summary and Meta-Analysis of the Literature". In: Environmental & Resource Economics 33, pp. 223–250.

Brown, L. K. Troutt, E., Edwards, C., Gray B., and Hu, W. (2011). "A Uniform Price Auction on the Canadian Prairies". Environmental & Resource Economics 33, pp. 223–250.

Cason TN and Gangadharan L (2005) "A laboratory comparison of uniform and discriminative price auctions for reducing non-point source pollution". Land Econ 81:51–70

Coggan, A., T.G. Mesham, and D. Fleming (2013). Socioeconomic monitoring for the environmental stewardship program. Report prepared for the Department of Sustainability, Environment, Water, Population and Communities. Canberra: CSIRO Ecosystem Sciences.

Comerford, E. (2013). "The impact of permanent protection on cost and participation in a conservation programme: A case study from Queensland". In: Land Use Policy 34, pp. 176–182.

Comerford E. (2014). "Understanding why landholders choose to participate or withdraw from participation in a conservation programme: A case study from a Queensland conservation auction". Journal of Environmental Management 141, pp. 169–176.

Cortus, B. G. Jeffery, S.R., Unterschultz, J.R., and Boxall, P.C. (2011). "The Economics of Wetland Drainage and Retention in Saskatchewan". Canadian Journal of Agricultural Economics 59, pp. 109–126.

Cummings, R. G., C.A. Holt, and S.K. Laury (2004). "Using Laboratory experiments for Policymaking: An Example for the Georgia Irrigation Reduction Acution". Journal of Policy Management and Analysis 23.2, pp. 341–363.

DePiper, G. S. (2015). "To Bid or Not to Bid: The Role of participation in Conservation Auction Outcomes". American Journal of Agricultural Economics 97.4, pp. 1157–1174.

Engel, S., S. Paigola, and S. Wunder (2008). "Designing payments for environmental services in theory and practice: an overview of the issues". Ecological Economics 65, Pp. 663–674.

Environment Canada, Government of Canada (1991). The Federal Policy on Wetland Conservation.

Environment Canada, Government of Canada (1996). The Federal Policy on Wetland Conservation: Implementation Guide for Federal Land Managers.

Farmland Values Online. (2016). Retrieved October 31, 2016, from https://www.fcc-fac.ca/OnlineServices/fcc/en/common/FCCLoginPage.jsp

Ferraro, P (2008). "Asymmetric Information and Contract Design for Payment for Ecosystem ervices". Ecological Economics 65, pp. 810–821

Gelso, B. R., J. A. Fox, and J. M. Peterson (2008). "Farmer's Perceived Costs of Wetlands: Effects of Wetland Size, Hydration and Dispersion". American Journal of Agricultural Economics 90.1.

Greenhalgh, S., Guiling, J., Selman, M., St. John, J., (2007). Paying for Environmental Performance: Using Reverse Auctions to Allocate Funding for Conservation. Washington, DC: World Resources Institute.

Hartwell, R. and B. Aylward (2007). Auctions and Reallocation of Water Rights in Central Oregon. Deschutes River Conservancy.

Hill, M.R. McMaster, D.G., Harrison, T., Hershmiller, A., Plews, T. (2011). "A Reverse Auction for Wetland Restoration in the Assiniboine River Watershed, Saskatchewan". Canadian Journal of Agricultural Economics 59.2, pp. 245–258.

Jack, K. (2013). "Private Information and the Allocation of Land Use Subsidies". American Economic Journal: Applied Economics 5.3, pp. 113–135.

Jack, K., B. Leimona, and P. J. Ferraro (2009). "A Revealed Preference Approach to Estimating Supply Curves for Ecosystem Services: Use of Auctions to Set Payments for Soil Erosion Control in Indonesia". Conservation Biology 23.2, pp. 359–367.

Kanjilal, Manikarnika (2015). "Agricultural Producers Costs of Adoption of Wetland Restoration Beneficial Management Practice: Estimation and Spatial

Transferability”. Doctoral Dissertation. Department of Resource Economics and Environmental Sociology, University of Alberta.

Krishna, V. (2002). Auction Theory. Orlando, Florida: Academic Press.

Latacz-Lohmann, U. and S. Schilizzi (2005). Auctions for Conservation Contracts: A Review of the Theoretical and Empirical Literature. Scottish Executive Environment and Rural Affairs Department.

Ma, S., Swinton, S. M., Lupi, F., and Jolejole-Foreman, C.. (2012). “Farmers' Willingness to participate in payment for Environmental- Services Programmes”. Journal of Agricultural Economics 63.3, pp. 604–626.

Mendham, E., J. Millar, and A. Curtis (2007). “Landholder participation in native vegetation management in irrigation areas”. Ecological Management & Restoration 8.1, pp. 42–48.

Mitsch, W. J. and J. G. Gosselink (2000). Wetlands. New York City, New York: John Wiley & Sons.

Pannell, D. J. Marshall, G.R., Barr, N., Curtis, A., Vanclay F., and Wilkinson, R. (2006). “Understanding and promoting adoption of conservation practices by rural landholders”. Australian Journal of Agricultural Extension 46, pp. 1407–1424.

Reeson, A and S. Whitten (2014). Designing Auctions for Different Environmental Commodities. Canberra: CSIRO Sustainable Agriculture Flagship.

Riechelderfer, K. and W. G. Boggess (1988). “Government decision-making and program performance: The case of the Conservation Reserve Program”. American Journal of Agricultural Economics 70, pp. 1–11.

Rogers, E. M. (2003). Diffusion of Innovation. 5th. New York, New York: Free Press.

Simieritsch, T. (2014). Wetland Conservation and Restoration as Flood Mitigation Tools in the Bow River Basin. Ducks Unlimited Canada.

Statistics Canada, Government of Canada (2011a). NHS Profile, Strathmore, T, Alberta, url: https://www12.statcan.gc.ca/nhs- enm/2011/dp-pd/prof/details/page.cfm?Lang=E&Geo1=CSD&Code1=4805018&Data=Cou

nt&SearchText=Strathmore&SearchType=Begins&SearchPR=01&A1=All&B1=All&Custom=&TABID=1.

Statistics Canada, Government of Canada (2011b). NHS Profile, Wheatland County, MD, Alberta, 2011. url: https : / / www12 . Statcan.gc.ca/nhs-enm/2011/dp-pd/prof/details/page.cfm?Lang=E&Geo1=CSD& Code1=4805012&Data=Count&SearchText=wheatland%20county&SearchType=Begins& SearchPR=01&A1=All&B1=All&Custom=&TABID=1.

Statistics Canada, Government of Canada (2015). Statistics Canada. Table 002-0003 - Value per acre of farmland and buildings, at July 1, annual (dollars). url: http://www5.statcan.gc.ca/cansim/a26.

Statistics Canada, Government of Canada (2016). Statistics Canada. Table 176-0003 - Consumer Price Index (CPI) statistics, alternative measures, unadjusted and seasonally adjusted, Bank of Canada, monthly (percent unless otherwise noted).

Stoneham, G. et al. (2003). "Auctions for conservation contracts: an empirical examination of Victoria's BushTender trial". The Australian Journal of Agricultural and Resource Economics 7.4, 477-500.

Takeda, M., D. Takahashi, and M. Shobayashi (2015). "Collective action vs. conservation auction: Lessons from a social experiment of a collective auction of water conservation contracts in Japan". Land Use Policy 46, pp. 189–200.

Vickery, W. (1961). "Counterspecualtion, Auctions, and Competitive Sealed Tenders". The Journal of Finance 16.1, pp. 8–37.

Whitten, S. Reeson, S., Windle, J., and Rolfe, J. (2007). Barriers to and Opportunities for Increasing Participation in Conservation Auctions. CSIRO Sustainable Ecosystems.

Whitten, S. Reeson, S., Windle, J., and Rolfe, J. "Designing conservation tenders to support landholder participation: A framework and case study assessment". Ecosystem Services 6, pp. 82–92.

Wichmann, B., Boxall, P., Wilson, S., & Pergery, O. (In Press). Auctioning Risky Conservation Contracts. Environmental and Resource Economics. (Forthcoming).

Windle, J. and J. Rolfe (2007). Competitive Tenders for Conservation Contracts: A practical guide for Catchment Management Authorities and regional NRM groups. Australian, State, Territory Governments' National Action Plan for Salinity, and Water Quality.

Wunder S., Engel, S. and S. Pagiola (2008). "Taking stock: A comparative analysis of payments for environmental services programs in developed and developing countries". Ecological Economics 65, pp. 834–852.

Yu, J. and K. Blecher (2011). "An Economic Analysis of Landowners' Willingness to Adopt Wetland and Riparian Conservation Management". Canadian Journal of Agricultural Economics 59, pp. 207–222.

Appendix A: An Example of the Wheat land County Auction Bid Form

Reverse Auction in Wheatland County Bid Form

- Ducks Unlimited Canada (DUC) wants to restore wetlands in Wheatland County.
- This bid sheet is your opportunity to bid the price you are willing to accept to restore eligible wetlands.
- Eligible wetlands are located on the attached sketch plan.
- The formal agreement that will be used is a 10-year wetland restoration lease agreement (template attached).
- DUC will consider all bids however; DUC has the right to disregard any or all bids that are deemed by DUC to be too high.
- Each winning bidder 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: **February 15/2016**
- Bid submission to: **Ducks Unlimited Canada, Box 60031, Strathmore, Alberta T1P0C2.**

Name and/or Company Name

Legal Land Location/s

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

I Landowner bid $_____ per acre on **basin 1** (12 acres).

I Landowner bid $_____ per acre on **basin 2** (24 acres).

I Landowner bid $_____ per acre on **basin 3** (6 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 with DUC. If your bids are successful, you will then have the choice to enter into an agreement with DUC to restore the wetlands that were included in the bid.