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Implicit Prices of Habitat Conservation Easements

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Implicit Prices of Habitat Conservation Easements[*]

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Abstract

Perpetual conservation easements permanently remove the option to convert existing habitat to more intensive agricultural production. If existing habitat is at threat of conversion, removing the option to convert will reduce land values. In this paper, we estimate the land value discount due to perpetual habitat conservation easements using propensity score matching. We find that land values fall by $0.79/acre for every 1% increase in habitat protected by a conservation easement. On average, our results suggest that landowners have been adequately compensated by conservation agencies, receiving a premium of roughly 25%. Further, our results suggest that conservation agencies have successfully secured habitat at risk of conversion.

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1. Introduction

According to recent estimates, more than half of the wetlands in the North American prairie pothole region have been lost or degraded since European settlement of the region (Euliss et al. 2006; Dahl and Watmough 2007). Attempts to mitigate these losses through the use of mandatory regulatory restrictions on conversion of existing habitat require government agencies to make significant investments—both economic and political—in designing and enforcing regulations, and such restrictions have proven costly for landowners as well. Conservation easements, by contrast, are voluntary agreements entered into by conservation agencies and willing landowners. Consequently, both private and public conservation agencies in the region have turned to conservation easements as an important retention tool for wetlands and their associated upland habitat.

Public and private conservation agencies purchase conservation easements in order to protect existing habitat at risk of conversion to agricultural or other uses. The conservation easement removes the option to convert existing habitat and, to the extent that this option has value, reduces the value of the encumbered land parcel (Brown 1976). Landowners enter into conservation easements when the compensation offered by the conservation agency offsets the cost of forfeiting the right to convert existing habitat. Economic theory suggests that since entering into conservation easements is voluntary, it is in the landowner's interest to begin by offering the habitat with the lowest opportunity cost and therefore the lowest probability of conversion. Previous research by van Kooten and Schmitz (1993) suggests this is precisely what happened in western Canada in the mid-1980s. On the other hand, conservation agencies face ongoing budget constraints, and it is in their interest to target ecologically valuable habitat that they believe is at substantial risk of conversion (Costello and Polasky 2004). Thus, an ever-present concern of private and public conservation agencies is whether conservation easements are simply encumbering lands never destined for an alternative use.

In this paper, we estimate the land value discount due to habitat conservation easements in an area of intensive agricultural production. Specifically, we examine the impact of permanent habitat conservation easements on agricultural land values in the prairie pothole region of southwestern Manitoba. Our estimates shed light on the extent to which public and private conservation agencies operating in Manitoba have been successful in targeting habitat at risk of conversion. They also provide an estimate of the premium paid to enrolled landowners.

Previous research dealing with perpetual easements finds that US farmland preservation easements have a relatively small impact on agricultural land values (Anderson and Weinhold 2005; Lynch, Gray and Geoghegan 2007; 2010).[1] Results of this research suggest that agencies may be paying too much, are not targeting farmland that is under significant development pressure, or are simply preserving land where there exist adequate high-value buyers willing to bid the price to near non-encumbered values. Unlike the easements used in our study area, these easements typically pertain to the entire operation. Temporary easements, such as those utilized by the US Conservation Reserve Program, are closely related to this study because they directly target the preservation of natural habitat using the Environmental Benefits Index, a formulaic ranking mechanism. Feather, Hellerstein, and Hansen (1999) calculate significant non-market benefits to habitat preservation especially in wildlife viewing and hunting from this program. Unlike Feather, Hellerstein, and Hansen, our focus is a revealed preference evaluation of the transaction price of encumbered lands.

Perhaps most closely related to this study, Shultz and Taff (2004) examine the impact of Fish and Wildlife Service (FWS) wetland easements on agricultural land values in North Dakota, an area of production agriculture with few alternative uses. They estimate an implicit price of easements in excess of the easement payment, suggesting that landowners systematically volunteer to enroll habitat despite the fact that doing so leaves them worse off financially. We analyze a more restrictive permanent easement utilizing highly detailed spatial data from a large region of Manitoba over more than a decade and attempt to address selection issues arising from heterogeneity in wetland and upland habitat and easement enrollment across the region. Shultz and Taff's study pertains to a tri-county region of North Dakota selected because of the prominence of wetlands on 98% of sold parcels and easements on 26% of all sales in their sample. We take advantage of recent advances in GIS technology and the availability of more spatially explicit data, allowing us to be less restrictive in our choice of study area. This allows us to explicitly address the selection issues that are implicitly acknowledged in Shultz and Taff.

We assemble a large dataset documenting agricultural land sales transactions, habitat conservation easements signed by both public and private conservation agencies, and detailed GIS layers documenting parcel-level agricultural capability and the ecological value of parcels determined in part by land use on surrounding parcels. Even with this highly detailed data there still exists the potential of bias from selection issues. There are three areas of concern with regard to selection. First, easements are voluntary and as such are not randomly assigned across the landscape. Second, conservation agencies are more likely to purchase easements on parcels that have more existing habitat and are therefore less suited to agricultural production. Third, on the supply side, landowners are expected to enroll habitat with lower opportunity cost first. All of these factors suggest, *ex ante*, that easements will be placed on lower-valued land, making it difficult to draw conclusions regarding the impact of easements on land values. We use propensity score methods to address non-random assignment of easements in an effort to compare parcels that are virtually identical in all relevant attributes except easement acreage. Recent examples of the use of propensity score matching in the conservation literature include Liu and Lynch (2011) and Langpap and Kerkvliet (2012).

To demonstrate robustness we estimate a number of models. We refine our sample to a set of comparable sales parcels with easements (the treated group) and sales parcels without easements (the control group) using propensity score matching. Our main results suggest that land values fall by $0.79/acre for every 1% increase in habitat protected by a conservation easement. This implies that for the average eased parcel, which is 248 acres with 124 acres under easement, the total price discount is $9,796. Since the average eased parcel has 50% of its total acreage in eased habitat, the easement reduces sales prices by $79/acre of eased habitat. Estimated as an elasticity, we find that a 1% increase in habitat acreage under easement reduces the sales price by 0.25%.

Our estimates of the impact of easements on land values are all statistically different from zero, suggesting that the conservation agencies have, on average, been securing habitat at risk of conversion. The agencies purchasing the majority of perpetual conservation easements in Manitoba's prairie pothole region pay roughly $100/acre of eased habitat, which suggests that landowners are being adequately compensated for easements. This result is consistent with expectations: landowners do not systematically enroll habitat that will leave them worse off financially. Rather, they appear to be enrolling habitat for a premium of roughly 25%. This is an expected outcome in a program that offers a fixed payment for voluntary enrollment, and where landowners presumably have more information about the value of the option to convert existing habitat than do conservation agencies.

This paper contributes to a couple of literatures. The first literature examines optimal reserve site selection, which involves balancing the ecological value of sites with cost of acquisition (Ando et al. 1998; Polasky, Camm, and Garber-Yonts 2001).[1] Newburn et al. (2005) demonstrate the importance of accounting for potential land-use conversion when selecting habitat to be conserved. This is particularly important when there is a positive correlation between acquisition costs and vulnerability to conversion (Newburn, Berck, and Merenlender 2006). The analysis in this paper is the first to our knowledge to examine the ability of conservation agencies to target habitat vulnerable to conversion, based on the actual behavior of the agencies. Our results suggest that conservation agencies take vulnerability into account and have successfully targeted habitat at risk of conversion.

The second literature examines conservation on privately held land in situations of asymmetric information, where the landowner has more information on the opportunity costs of conservation than the conservation agency and adverse self-selection is a potential problem (Ferraro 2008). Under these conditions landowners are able to extract information rents from conservation agencies. Kirwan, Lubowski, and Roberts (2005) examine US Conservation Reserve Program (CRP) auction bids and find that participants receive a premium of 10-40% over their estimated reservation values. As mentioned earlier, we estimate that landowners are receiving, on average, a premium of approximately 25% for the conservation easements in our study. This suggests that a fixed payment scheme, such as the one employed in our study area, may generate information rents similar in magnitude to those observed in CRP auctions.

The conservation easements applied in Manitoba are perpetual and are applied to existing habitat.[2] The one-time payments associated with perpetual easements can be quite high (relative to annual payments) and landowners are wary of making choices that permanently encumber their property. On the other hand, a clear advantage of a perpetual easement to the conservation agencies wanting to protect habitat is that it secures the land over the long term, and, aside from covering enforcement costs, does not require additional funding in future periods. In contrast to the easements studied in this paper, the CRP makes annual rental payments for land-use change for relatively short time frames of ten to fifteen years. Heimlich (2007; 2008) suggests that repeatedly renting land costs as much (or more) than purchasing the land outright and suggests that a permanent conservation easement program—in which cropping rights are removed on

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[1] Consistent with this literature, a recent GAO report on FWS easements in the US prairie pothole region suggests that more habitat could be protected if acquisition costs were taken into account (GAO 2007).

some land in perpetuity but the landowner retains ownership of the remaining land—may be a more cost effective means of transitioning land to less intensive uses.

The remainder of the paper proceeds as follows. In the next section we provide a background of the regulatory environment in Manitoba as it pertains to habitat conservation. In section three we describe the process of placing an easement on natural habitat, outline the expected impact of perpetual conservation easements on agricultural land values, and describe the empirical models we estimate. A description of the data is presented in section four. Results of the propensity score model and estimates of the price discount of easements are presented in section five. The final section provides concluding remarks.

2. Background

Despite the fact that more than half of wetlands in the prairie pothole region of North America have been lost or degraded since European settlement, conversion of wetland and upland habitat persists. Of the 500,000 wetland acres (5% of total wetland area) lost in western Canada between 1985 and 2001, it is estimated that more than 60% were converted to cultivated crops (Watmough and Schmoll 2007). Conversion of natural habitat to more intensive annual cropping is expected to continue due to agricultural expansion and intensification as the result of increased growth and volatility in agricultural commodity prices (Rashford, Bastian, and Cole 2011) and technological developments that increase the productivity of marginal land (GAO 2007).[3] The nuisance costs of maneuvering farm machinery around patches of natural habitat are also a significant factor in farmers' perceived costs of wetlands (Gelso, Fox, and Peterson 2008). As the size of farm machinery increases, the nuisance costs of wetland and upland habitat in annual cropping operations will also increase.

In the past, various government agencies in North America provided economic incentives encouraging wetland drainage and cultivation of native grassland with the intent of increasing agricultural productivity and stimulating rural economic development (Danielson and Leitch 1986; Heimlich et al. 1998). In western Canada, the federal government facilitated drainage of "wet prairie" in the interest of encouraging European settlement. Among the three Prairie Provinces this was particularly true in Manitoba, which, unlike Alberta and Saskatchewan, is subject to frequent flooding and excess water in the spring planting season (Stunden Bower 2011). Federal and provincial agricultural support policies have continued to provide economic incentives to convert wetlands, natural uplands, and other marginal land to cultivated crop production (van Kooten 1993; Cortus et al. 2009).

At the same time, as awareness of the social value of wetlands and natural upland habitat has increased, government agencies have designed programs with the intent of slowing the rate of wetland drainage and native grassland conversion (Prince 1997). However, enforcement of these policies has proven difficult in a number of jurisdictions.[4] For example, in Manitoba, the *Water Rights Act* prohibits drainage of permanent and semi-permanent wetlands and requires that landowners obtain a license to drain seasonal or temporary wetlands. Yet the provincial government department charged with enforcement of these regulations is understaffed and enforcement is therefore very weak (Manitoba Ombudsman 2008). Lack of monitoring and enforcement has contributed to a culture of ignoring wetland drainage regulations (Pankratz 2010). Such a culture has been longstanding, with many landowners who typically believe they have the explicit or implicit right to convert habitat on their land. This right has been capitalized into land values and regulatory restrictions that remove or limit this right are resisted by landowners who argue that they should be compensated for any conservation or preservation efforts they undertake on their privately held land (Doremus 2003).

This combination of weak regulatory monitoring and enforcement and widespread landowner resistance to such regulation of private property without compensation has led to a positive environment for the use of conservation easements as an important tool for habitat conservation. Because landowners enter into conservation easements voluntarily and are compensated for the conservation activity they undertake, they are more likely to comply with any voluntary restrictions, thereby reducing the cost of monitoring and enforcement. In addition, the conservation agencies secure protected habitat for the term of the easement, with perpetual easements securing the habitat value for the long term by encumbering all subsequent landowners with identical restrictions without additional funding. Since future landowners are free to negotiate price reductions due to the encumbered acreage there are no welfare costs.[5]

Conservation Easements in Manitoba

The Manitoba *Conservation Agreements Act*, passed in 1997, allows landowners and conservation agencies to place conservation easements on existing habitat on agricultural land. Three conservation agencies actively purchase conservation easements in Manitoba, including the Manitoba Habitat Heritage Corporation (MHHC), a provincial government agency; Ducks

Unlimited Canada (DUC); and Nature Conservancy of Canada (NCC). MHHC and DUC purchase the majority of conservation easements in the prairie pothole region of Manitoba and the sample of easements in this study is drawn from DUC and MHHC.[6]

The majority of conservation easements in the prairie pothole region of Manitoba are funded through the North American Waterfowl Management Plan (NAWMP).[7] The NAWMP, initiated in 1986, focuses on restoring waterfowl populations with a goal of reaching 1970 levels (Williams, Koneff, and Smith 1999). As Williams, Koneff, and Smith (1999) goes on to report, the initial budget necessary to attain the stated objectives for the NAWMP was $1.5 billion. The NAWMP envisioned broad regionally based public-private partnerships called "joint ventures" as a unique mechanism to address the continental scope of the waterfowl population decline.

One such joint venture is the Prairie Habitat Joint Venture (PHJV) in the prairie pothole region of western Canada. The region encompassed by the PHJV accounts for 20% of North America's total duck production and is an important breeding ground for the Pacific, Central, and Mississippi flyways (van Kooten 1993). And as of 2010, PHJV contributions from Canadian, US federal, and US non-federal sources totaled more than CN$930 million, with 64% of that total coming from US sources. These contributions have allowed the PHJV to secure close to 8 million acres between 1986 and 2010 in permanent conservation easements, fee simple acquisitions, land donations, Crown land transfers and land designations, and long-term arrangements such as cooperative land use agreements (NAWMP Committee 2010). As of March 2007, the PHJV had enrolled 222,173 acres in perpetual conservation easements (PHJV 2008).

3. Conservation Easements and Their Impact on Land Values

Easements are placed on existing wetlands and uplands, restricting wetland drainage and cultivation of uplands.[8] DUC or MHHC field staff negotiates conservation easements with landowners. In some cases, DUC and MHHC personnel approach prospective landowners to solicit their interest in enrolling their habitat in an easement, while in other cases, interested landowners initiate contact with DUC or MHHC. All potential habitat is ranked according to its ecological value and vulnerability to conversion. As an example, MHHC ranks prairie pothole habitat according to its Canadian Land Inventory waterfowl rating, an index predicting waterfowl breeding pairs per square mile (calculated by DUC), acreage of existing habitat (including wetlands and natural upland), the number of wetlands within the parcel, the percentage of permanent cover within one mile, and the number of wetlands within one mile. The conversion vulnerability of the parcel is assessed based on agricultural soils capability class (as calculated by the Canadian Land Inventory) and the percentage of surrounding wetland acreage within one mile that has been drained. Conservation easements are often placed on multiple habitat parcels under the same agreement. Each parcel being considered is scored according to the above criteria and if the minimum standard is met, the conservation agency and the landowner proceed to negotiate the compensation to be paid to the landowner.

Compensation is calculated based on the acreage of habitat that is enrolled in an easement and the average assessed values of surrounding land parcels. Landowners typically receive 30-40% of the assessed per-acre value of surrounding agricultural land, to a maximum of $100/acre of habitat.[9] As an example, a landowner may enroll 42 acres of wetlands, 275 acres of grassland/shrub, and 115 acres of wooded area on six quarter sections. A quarter section is a 160-acre square plot of land;[10] thus, 432 acres of the total 960 acres on those six quarter sections would be under easement. At a per-acre payment of $100, the landowner in this example would receive a one-time payment for a perpetual easement equal to $43,200. Once the landowner and conservation agency agree on the terms of payment, the conservation agency conducts a baseline assessment of the proposed habitat for use in annual compliance monitoring. The baseline assessment documents the extent, type, and condition of existing habitat. In Manitoba, conservation agencies have the right to re-access the property as part of compliance monitoring, which may include annual visits as well as aerial monitoring of the eased property.

Impact on Land Values

As mentioned previously, easement agreements restrict the landowners' right to convert habitat and will reduce land values in cases when the option to convert has value (Brown 1976). The value of the option to convert existing habitat is a function of the anticipated net benefits of conversion, which depend on the potential agricultural productivity of the acreage as well as any nuisance costs of working around the habitat.[11] Landowners incur costs when they convert natural habitat to agricultural use, including the one-time cost of conversion and periodic maintenance costs. The expected value of converting habitat is the expected net present value of the annual stream of benefits minus costs of conversion.

The current value of conversion to agricultural uses varies across habitat in the landscape. Habitat with the highest current value of conversion to the landowner is nearly always converted first. The habitat that has not been converted to date may still be converted at a future time. Retaining the right to convert habitat in the future is an option value. This option value incorporates landowner beliefs about the future benefit of conversion, the future cost of conversion, as well as the likelihood that the land will be purchased by a new landowner with the capacity to benefit from conversion. Conservation agencies seek to obtain habitat that is ecologically valuable and at risk of conversion when they define their easement pricing strategies.

One can think of three distinct classes of land that is currently in habitat with regard to the option value of conversion and the easement target price. First, "free habitat" refers to land with a zero option value. This is land that is simply not suitable for production agriculture now or in the foreseeable future and is very likely to remain as habitat. Second, some land is suitable for habitat and has a positive option value of conversion that is below the targeted easement price. We call this class of habitat the "target" acreage because easement agencies expect to place easements on these lands and the higher the easement price the more land that will fall into this group. In most cases, the conservation easement payment must compensate the landowner for the lost option value of conversion as a necessary condition of the landowner enrolling habitat.[12] Given conservation agency and landowner objectives, we expect nearly all conservation easements to be placed on habitat in the target group. If the agencies are successfully targeting acreage at risk of conversion then the revealed sales price discount of land under conservation easements should be greater than zero and less than the per-acre payment for the easement (reflecting the fact that landowners voluntarily enter into easements). Finally, the portion of the landscape that is currently in habitat but has an option value of conversion that exceeds the easement target price make up what we refer to as the "high value" agricultural lands.

Empirical models

The primary empirical challenge in estimating the impact of easements on land values is the fact that easements are not randomly assigned across the landscape. The typical approach involves inclusion of an easement dummy or easement acreage as an independent variable in a regression model. The two primary criticisms of this type of approach are now standard: first is concern about reliance on linear or simple functional forms, and second is concern about the possibility of failure of the common support—that is, cases where treated observations are substantially different from untreated observations in terms of their likelihood of receiving treatment.

Conservation agencies attempt to quantify the ecological value of habitat by considering several factors, including total acreage of the habitat, number of wetlands, the portion of neighboring land that is in wetland or permanent cover, and overall suitability of the land as waterfowl habitat. Vulnerability to conversion is assessed based on agricultural capability classes of the land as well as conversion activity in neighboring parcels. While both of these factors are observable, it is not clear if any of these factors can be plausibly excluded from one another. That is, variables that describe likelihood of enrollment in a conservation easement are also likely strong predictors of sales price. The matching procedure demands no such exclusion restriction but requires us to observe variables that influence both selection into an easement and sales price.

Since entering into an easement is voluntary, we expect landowners to choose to enroll habitat with the lowest conversion potential first, including land with lower inherent agricultural capability, higher soil salinity problems, more slope, poor drainage, and less suitability for irrigation. This also includes land that is farther from major grain elevators and in areas of less intensive annual crop production, which likely reduces proximity to agricultural services such as chemical dealers and public or private extension agents.

Propensity Score Matching Method

To estimate the average impact of conservation easements on agricultural land values, we begin by comparing land sales values of parcels with easements, denoted Y_1, to land sales values of parcels without easements, denoted Y_0. These two types of sales parcels are designated as treated and control parcels, respectively. Treatment status is denoted by T, where $T=1$ indicates the sales parcel had an easement at the time of sale and $T=0$ indicates the sales parcel did not have an easement at the time of sale.[13] We want to estimate the average treatment effect on the treated parcel (ATT), which is given by

$$\text{(1)} \qquad \text{ATT} = \mathrm{E}\left[Y_1 - Y_0 \mid Z, T=1\right] = \mathrm{E}\left[Y_1 \mid Z, T=1\right] - \mathrm{E}\left[Y_0 \mid Z, T=1\right]$$

where the vector Z is a set of covariates that affect both the likelihood that a parcel has an easement and the sales value of the parcel. The first term on the right hand side of (1) is the average sales price of eased parcels, which is easily obtained. The second term on the right hand side represents the counterfactual—the outcome a treated parcel would have received had it not been treated. Since a parcel can be in only one state, treated or control, the matching procedure boils down to an estimate of $\mathrm{E}\left[Y_0 \mid Z, T=1\right]$, which is unobservable. Thus, in order to estimate the ATT, a proxy must be obtained for this unobserved counterfactual.

Matching estimators can be used if, conditional on the covariates in Z, outcomes are independent of the selection process, commonly referred to as selection on observables. In other words, after conditioning on Z, any unobserved factors that influence the likelihood of a parcel having an easement must be assumed not to influence sales values, setting up a matching procedure that attempts to recreate a randomized experiment from observational data. At the same time, it is also necessary that no combination of covariates in *Z* guarantee treatment. In short, the matching procedure suggests that all observables determining treatment and sales price should be included in the model but we do not need to specify which variables influence treatment nor which influence price. In fact, this would be impractical, if not impossible, in our case without untestable restrictions. Unobservable attributes that characterize landowner type, including factors such as attitudes towards conservation, age, and financial situation are potentially important if we want to fully characterize selection but these factors should not influence land prices directly and thus make propensity score matching the preferred estimation option.[14]

Propensity score matching allows for conditioning on a one-dimensional function of the vector of covariates in *Z*. The propensity score is defined as the probability of selection conditional on the covariates contained in *Z*:

(2) $$P\left(Z\right) = \Pr\left(T = 1 \mid Z\right)$$

Combining the expression for ATT with the propensity score, the ATT can be rewritten as:

(3) $$\text{ATT} = \mathrm{E}[Y_1 - Y_0 \mid P(Z), T=1] = \mathrm{E}[Y_1 \mid P(Z), T=1] - \mathrm{E}[Y_0 \mid P(Z), T=1]$$

To implement propensity score matching the propensity score is estimated for each sales parcel. The conservation easement selection equation includes variables that affect both the likelihood of a parcel having an easement and the per-acre sales value of sold parcels.

4. Data

Our study area is the southwestern region of Manitoba, as shown in Figure 1. We have collected data concerning this region from a number of sources. Land transaction data come from records provided by the provincial assessor with Manitoba Local Government, the provincial department responsible for assessing rural property and maintaining land transaction records. We obtained data on all bare land transactions in our study area from 1997 through 2010, including the quarter sections involved in the sale, the date of the sale, the sale price, and the stated value. These data also document land cover on each quarter section, including arable land acreage and acreage in slough, brush, hay, pasture, waterways, and other uses such as roads and ditches. We use the land transaction data to calculate the total acres in the sale as well as the sale price per acre.

We also obtained data on the location of conservation easements (at the quarter-section level) and the dates they were signed, from the two dominant conservation agencies within our study area, MHHC and DUC.[15] By combining our land transaction data with the conservation easement data, we have come up with a set of "treated" land sales, defined as a land sale with at least one quarter section that has habitat enrolled in a conservation easement at the time of the sale. In addition, we collected data on a variety of landscape features at the quarter-section level from the Manitoba Land Initiative (MLI), which compiles data from a number of provincial and federal government sources. The soils data allow us to document the percentage of each quarter section that belongs to one of the seven agricultural capability classes (ACC) as categorized by the Canadian Land Inventory (CLI) and made publicly available by Agriculture and Agri-Food Canada (AAFC).[16] Land in ACC 1 has soils with no significant limitations in use for crops, with land becoming increasingly less suited to agricultural production from ACC 1 through to ACC 7 so that land in ACC 7 have no capacity for arable cultivation or permanent pasture.. We have grouped these agricultural capability classes into three divisions, with ACC 1 and 2 defined as high-quality agricultural land, ACC 3 and 4 defined as medium-quality agricultural land, and ACC, 5, 6, and 7 defined as low-quality agricultural land. High-quality agricultural land is the omitted category for this analysis.

The ACCs categorize land parcels according to the relative intensity rather than type of limitations to their agricultural production capability. We also control for a number of types of agricultural production limitations that may influence the costs and benefits of drainage or land clearing as well as sales values. We use additional MLI soils data to document the extent to which each quarter section is steeply sloped, has poorly drained soil, or is severely saline, and also to document the extent to which each is highly suited for irrigated crop production. We expect steeply sloped, poorly drained, and severely saline land to sell at a discount and to be more likely to have a conservation easement, whereas land that is more suited to irrigated crop production should sell at a premium and be less likely to have a conservation easement.

Since we are able to geo-reference each sale, we can compute the average distance of each sale parcel to the nearest large elevator (defined as having an annual capacity in excess of 25,000 tons), as well as average distances to the cities of Brandon and Portage la Prairie, the two largest urban centers in the study area, both with populations greater than 10,000. We expect that agricultural land decreases in value as the distance between it and major grain elevators increases. We include distance to Brandon and Portage to control for urban development pressure.[17]

We use digital elevation maps to document the average elevation (in meters) of each sale. Average elevation controls for a number of factors, including risks of frost and the likelihood that a parcel is upstream or downstream of surrounding parcels. All else being equal, we know that the higher the elevation, the greater the likelihood that a sale parcel is upstream of neighboring parcels and easier to drain as a consequence.

Wetland dispersion has been shown to increase nuisance costs (Gelso, Fox, and Peterson 2008; Cortus et al. 2011). We use the number of wetlands within a sales parcel as a proxy for wetland dispersion, basing our count on the number of unique wetland polygons in the 1995 land cover data provided by MLI. The resolution of this land cover data is 30 meters by 30 meters, so our measure tends to undercount the number of very small wetlands on a sales parcel.

We also collected data on the suitability of each sales parcel as waterfowl habitat according to indices generated by DUC and the CLI. DUC's breeding pair index is based on a predictive model of the number of breeding pairs that could typically be supported within a one-square-mile area. This predictive model takes into account factors such as the abundance of habitat suitable for waterfowl breeding, proximity to typical flyways, and historical breeding pair counts. Both DUC and MHHC use the DUC breeding pair index to assess the ecological value of potential sites. The CLI waterfowl suitability index assesses lands in Canada along a number of dimensions, including capability to support or produce waterfowl as documented by the Canadian Wildlife Service (Environment Canada 1981).[18] Classifications in the CLI waterfowl index are based on factors such as the variety and abundance of habitat elements including fertility of soil, water-holding capacity of soil, suitability of the topography for the formation of permanent and seasonal wetlands, and the presence of marshes and large open water bodies. MHHC uses both of these waterfowl indexes in its assessments of potential conservation easement sites, and we expect the two to be highly correlated. The southwestern portion of Manitoba has been divided into regions that are targeted under the PHJV. We include an indicator variable equal to one if at least one quarter section in the sales parcel is within a PHJV targeted region.

Surrounding land use influences the ecological value of habitat. For example, a parcel increases in value as waterfowl habitat if it is surrounded by wetlands and permanent cover. Therefore, we use land cover data provided by MLI to document neighboring land cover data using a two-quarter-section buffer around each quarter section within a sale parcel.[19] This allows us to look at the extent of permanent cover within one mile of the sale parcel, which is the criterion used by MHHC. This land cover data permits us to calculate the share of neighboring land that is in annual crop production, forest, grassland, wetland, and forage, and the type of agricultural development in the immediately surrounding area. A sale parcel surrounded by annual crops is more likely to be in a region of more intensive grain and oilseed production, and as a consequence there are usually more agricultural services such as chemical dealers and extension agents in the immediate area. A sale parcel surrounded by grassland, on the other hand, will tend to be further from these services.

We also account for the location of sales parcels based on crop insurance risk zones categorized by the Manitoba Agricultural Services Corporation (MASC), the provincial crop insurance agency, rather than basing this on geopolitical boundaries, such as rural municipalities. Each sales parcel is assigned to one of MASC's seven possible risk zones in our study area, which take into account such risk factors as drought, frost, excess heat, excess moisture, and risk of insect, disease, and weed infestation when setting crop insurance premiums and coverage levels.[20] Inclusion of crop insurance risk zones controls for correlated unobservables that influence land values, with risk zone 1 omitted for this analysis.

Descriptive statistics for treated and untreated parcels are presented in Table 1. First note that sales parcels with easements sell for approximately $128/acre less than sales parcels without easements. This is consistent with the notions that landowners are more likely to voluntarily sign up lower-valued land in a conservation easement and that conservation agencies target land with a significant amount of existing natural habitat, which lowers agricultural land values. The descriptive statistics also show that treated sales tend to have more acreage in poorer-quality land (ACC 5, 6, and 7) and have more land in native hay and slough. More refined measures of soil quality indicate that eased and non-eased land sales are roughly equivalent with respect to slope and salinity, while eased sales parcels tend to have soil with more severe drainage problems and are less suitable for irrigation. As expected, eased sales parcels are more suitable as waterfowl habitat, both in terms of the DUC breeding pair index and the CLI waterfowl suitability index. Eased parcels are also more likely to be located within the PHJV target region and tend to have more neighboring wetland acres within a one-mile buffer, again consistent with targeting on the part of the conservation agencies.

5. Results

Table 2 reports the results of the logit model of the likelihood that a sales parcel sold between 1997 and 2010 has at least one quarter section with a conservation easement (purchased either prior to or subsequent to the sale). Overall, the results of the model are generally consistent with expectations. The pseudo-R2 of the model is 0.22, based on a total sample of 6,161 sales parcel observations, of which 307 have at least one quarter section with an easement.

We find that sales parcels with a larger share of acreage in ACCs 3 or 4 tend to be more likely to have a conservation easement than those in ACCs 1 or 2. This is consistent with the notion that landowners are less likely to enroll habitat on higher-quality land in an easement. We also find that the likelihood land will have a conservation easement does not vary appreciably among parcels with large shares of acreage in any of the lowest three agricultural capability classes—ACCs 5, 6, and 7. This is likely due to correlation between the ACC 5, 6, and 7 share variable and the various controls for significant soil limitations included in the model.

Sales parcels with more acreage in natural habitat (including slough, brush, and native hay) are more likely to have at least one quarter section with a conservation easement. This is consistent with conservation agency targeting and with the assumption that parcels with larger acreage in natural habitat may be more difficult to convert on a per-acre basis and thus have lower anticipated net benefits of conversion, making landowners more likely to enroll them in an easement. Conservation easements are more likely on sales parcels with more saline soil, which is again consistent with conservation agencies' targeting of land that has more water and is more suitable for waterfowl habitat, and suggests that landowners are more likely to enroll parcels with excess water problems.

In contrast, the shares of highly sloped land, poorly drained land, and land more suitable for irrigation do not have a statistically significant impact on the likelihood of a sales parcel having at least one quarter section with a conservation easement. Similarly, elevation does not have a statistically significant impact on the likelihood of having an easement. Distance to large grain elevators and to cities also tend to have little impact on the likelihood of a parcel having an easement.

The logit model results suggest that conservation agencies have successfully targeted parcels according to their suitability as waterfowl habitat and also suggest that our dataset is sufficient to identify the likelihood of easement. Parcels with high DUC breeding pair indices and high CLI waterfowl suitability indices are more likely to have a conservation easement, as are parcels within PHJV-targeted areas. Neighboring habitat also plays a role in the likelihood of a parcel having a conservation easement, with additional grassland habitat within a one-mile buffer increasing the likelihood. Specifically, a 1% increase in the share of surrounding acreage in grassland increases the likelihood of a conservation easement by 1.4%. Surrounding wetland has a positive but statistically insignificant impact on the likelihood of a sales parcel having an easement. Similarly, we find that neighboring forage and forest area do not have a statistically significant impact on the likelihood of a sales parcel having an easement. The lack of significance of many of the surrounding habitat variables may be due to a high degree of correlation with the habitat acreage on the sales parcel itself.

By using dummy variables for MASC's crop insurance risk zones in our study area, we are able to control for spatially correlated unobservables that may impact the agricultural productivity of the parcel; the cost of crop insurance premiums; and, as a consequence, the likelihood of a parcel having a conservation easement. We find that risk area 3 is less likely than risk area 1 to have a conservation easement, whereas the likelihood of a conservation easement on a sale parcel in the other risk areas is no different from the likelihood in risk area 1. Finally, we find that the size of a sales parcel is an indicator of the likelihood of its having a conservation easement, with increasing size correlating with an increasing likelihood.

Matching and balance

We use nearest neighbor matching with replacement to select five sales parcels without easements for each sales parcel with an easement.[21] There are ample control observations in our sample and virtually no issues of common support as the distribution of the propensity score predictions for the control observations overlaps the predictions for the treated observations without gaps. We therefore focus the discussion of results using multiple nearest neighbor matches, which utilizes more information to construct each counterfactual and thus leads to lower variances at the presumably small cost in bias from including these marginally worse matches. There are probably significant market-wide unobserved temporal variables that influence land sales prices.[22] We control for these by narrowing our match to those control (non-eased) parcels that are sold in the same year as the treated (eased) sales parcel. Our large sample of potential control parcels allows us to conduct an exact match on year and still have a large set of possible controls for each treated observation. Once the match is restricted to sales that occur in the same year, we match five untreated parcels to each treated parcel, thereby reducing our potential sample to 480 sales parcels.

Table 3 reports the results of balancing tests for each of the covariates used to generate the propensity score estimates. Our balancing test assesses whether or not the mean of each of the covariates is statistically different in the treated and control samples. Our matched sample consists of 78 eased parcels and 390 non-eased parcels on common support. As reported in Table 3, we find that after matching, the covariate means are not statistically different from one another, at least at the 5% significance level, suggesting that, on the basis of first moments, the matched sample is balanced across the observable covariates. Thus, we are unable to differentiate eased from non-eased parcels in the matched sample, as desired.

Treatment Effect Results

We present results from a number of model specifications in Table 4. The first result is obtained directly from a comparison of eased and non-eased sales prices in the matched and balanced sample. Although the matched sample is well balanced, we also use it to estimate the ATT by using a regression adjustment on the treatment dummy, controlling for the covariates used in the selection equation.[23] This corrects for any residual differences in the covariates that may be present in the matched sample (Ho et al. 2007). Finally, we report the ATT from a regression using the matched sample where sales price is regressed on treated habitat and untreated habitat, each as a share of total acreage, as well as the covariates used in the selection equation. These results are presented in columns 3 and 4 in Table 4, where sales price is entered in linear and log forms respectively. This final set of results account for the fact that sales parcels differ according to the share of total acreage that has habitat enrolled in an easement.

As reported in Table 4, using the propensity score matching model we estimate that the average impact of a habitat conservation easement on sale value is -$40.83 per acre over the entire sale acreage. This implies that a parcel with an easement sells for approximately $41/acre less than a comparable parcel without an easement. The 95% confidence interval suggests that this estimate is statistically different from zero, providing evidence that conservation agencies in Manitoba have been targeting habitat with positive value placed on retaining the option to convert. This implies that the agencies have been successful in targeting vulnerable habitat. The average sale with an easement is 248 acres, of which 124 acres are under easement. At an implicit price of $41/acre, the reduction in land value on the entire sale is $10,168. Since the average eased parcel is comprised of approximately 124 acres of eased habitat, this works out to a discount of approximately $82/acre of habitat. In other words, the conservation agency will have to pay an average of $82 for every acre of habitat it enrolls in an easement to fully compensate the landowner.

As also reported in Table 4, using the regression adjusted model with easement status entered as a dummy variable we find that on average an eased parcel sells at a discount of $36.08/acre on the entire sale acreage, as compared to a parcel without an easement. Once again, since the average eased parcel is 50% habitat, this suggests that the conservation agency needs to pay approximately $72/acre of habitat enrolled in an easement to fully compensate the landowner.

The previous two estimates of the ATT treat the impact of an easement as a binary variable. In Table 4 we also present the results of regressions where we interact the treatment dummy with the percentage of the parcel that is habitat, including both wetland and upland habitat.[24] The effect of the easement in this model is a $0.79/acre discount, which captures the average impact of a conservation easement on agricultural land values.[25] For an average eased parcel that is 50% habitat, the effect of an easement is to reduce land values by $39.50/acre over the entire sale acreage. This also suggests that, for an average eased parcel, the conservation agency needs to pay approximately $79 for each acre of habitat enrolled in an easement to fully compensate the landowner. Finally, to ease interpretation of the results, the final column in Table 4 presents the ATT using the log of the sales price as the dependent variable. We find that a 1% increase in habitat under easement reduces the sales price by 0.25%. To put this into perspective, a 1% increase in eased habitat acreage on a parcel valued at $340/acre (prior to the easement) will reduce the sales price by $0.85/acre.

6. Conclusion

In this paper, we examine the land value impact of permanent conservation easements on existing habitat. Our study region is an area of intensive production agriculture that continues to lose wetland and upland habitat, primarily to cultivated crop production. We find evidence suggesting that landowners are adequately compensated for easements, consistent with the fact that landowners voluntarily enter into these easements. We also find that the conservation agencies—both public and private—have successfully protected existing habitat vulnerable to conversion, which suggests that public-private joint ventures can be an effective means of achieving conservation objectives. Our results indicate that landowners have received, on average, a premium of roughly 25%. This is within the range of the premiums of 10-40% in CRP auctions as estimated by Kirwan, Lubowski, and Roberts (2005).

Conservation agencies may be able to secure more habitat at lower cost if payments are designed to better reflect heterogeneity in opportunity costs across parcels and landowners. Habitat acreage continues to be converted, and in the absence of estimates of the distribution of expected net benefits of conversion across all existing habitat, it is difficult to know if increased payments for easements would allow the agencies to protect habitat at greater risk of conversion. An auction for conservation easements as examined in Brown et al. (2011) might attract a larger pool of landowners and assist with price discovery across all existing habitat in the region. Alternatively, payments could be tied to the ecological value of habitat as assessed by conservation agencies in an effort to increase the benefit-cost ratio of dollars spent. A strictly enforced ban on habitat conversion is another option, although this type of regulatory action has proven difficult to implement in a number of jurisdictions due in large part to the potentially significant transfer of wealth from landowners to society that this type of policy would involve. Enforcement of such a ban would also benefit from detailed information on opportunity costs in order to focus costly monitoring effort on those landowners most likely to ignore the ban.

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Table 1: Summary statistics

Variable	Eased sales		Non-eased sales	
	Mean	**Std. dev.**	**Mean**	**Std. dev.**
Price per acre (Cdn $ 2002)	298.60	166.42	427.33	264.85
ACC 3 & 4 (% of sale acreage)	41.14	38.67	37.58	37.61
ACC 5, 6, & 7 (% of sale acreage)	31.77	34.93	18.23	27.24
Other (% of sale acreage)	0.49	2.71	1.47	7.84
Waterways (% of sale acreage)	1.33	10.38	1.61	6.80
Native Hay (% of sale acreage)	13.07	28.06	8.88	20.89
Slough (% of sale acreage)	12.81	16.90	4.98	9.04
Slough, Brush (% of sale acreage)	10.89	21.44	5.00	13.16
Slough, Hay (% of sale acreage)	5.37	15.18	2.34	7.51
Brush (% of sale acreage)	10.16	24.86	9.65	22.87
Wetland count/acre	0.02	0.02	0.02	0.02
High slope (% of sale acreage)	10.47	23.71	11.38	24.06
Strong salinity (% of sale acreage)	0.80	5.44	0.73	6.29
Poor drainage (% of sale acreage)	20.69	31.11	7.26	16.24
Suitable for irrigation (% of sale acreage)	0.13	0.83	1.67	9.04
log(distance to elevator (meters))	10.61	0.58	10.50	0.67
log(distance to Brandon (meters))	11.17	0.42	11.15	0.53
log(distance to Portage (meters))	11.94	0.35	11.82	0.41
Elevation (meters)	496.41	65.58	474.35	71.11
High DUC breeding pair index (0-1)	0.097	0.289	0.014	0.111
High CLI waterfowl suitability index (0-1)	0.65	0.42	0.35	0.45
PHJV target region (0-1)	0.69	0.47	0.36	0.48
Neighboring forest (% of area)	8.37	11.12	10.02	13.03
Neighboring grassland (% of area)	27.70	18.01	22.47	14.96
Neighboring wetland (% of area)	7.07	5.67	4.36	5.23
Neighboring forage (% of area)	2.04	2.54	2.18	3.32
Total sale acres	248.34	174.77	233.29	161.82
Year sold	2007	3.82	2003	3.95
MASC risk area 2	0.13	0.33	0.17	0.38
MASC risk area 3	0.10	0.30	0.13	0.34
MASC risk area 4	0.09	0.28	0.16	0.37
MASC risk area 5	0.09	0.28	0.18	0.38
MASC risk area 6	0.21	0.41	0.16	0.37
MASC risk area 7	0.20	0.40	0.08	0.27
Number of observations	80		6,081	

Table 2: Logit (selection equation) results

Variable	Coefficient	Std. Err.
ACC 3 & 4 (% of sale acreage)	0.003*	0.002
ACC 5, 6, & 7 (% of sale acreage)	0.004	0.004
Other (% of sale acreage)	0.015*	0.008
Waterways (% of sale acreage)	0.006	0.029
Native Hay (% of sale acreage)	0.027***	0.003
Slough (% of sale acreage)	0.046***	0.006
Slough, Brush (% of sale acreage)	0.027***	0.005
Slough, Hay (% of sale acreage)	0.032***	0.006
Brush (% of sale acreage)	0.028***	0.004
Wetland count/acre	1.596	2.699
High slope (% of sale acreage)	-0.002	0.003
Strong salinity (% of sale acreage)	0.020***	0.007
Poor drainage (% of sale acreage)	0.004	0.004
Suitable for irrigation (% of sale acreage)	-0.021	0.029
log(distance to elevator)	-0.124	0.199
log(distance to Brandon)	-0.174	0.279
log(distance to Portage)	0.388	0.483
Elevation (metres)	0.002	0.002
High DUC breeding pair index	0.782**	0.314
High CLI waterfowl suitability index	0.876***	0.205
PHJV target region	0.960***	0.214
Neighboring forest (% of area)	-0.004	0.008
Neighboring grassland (% of area)	0.014***	0.006
Neighboring wetland (% of area)	0.006	0.013
Neighboring forage (% of area)	0.013	0.020
Total sale acres	0.001**	0.000
MASC Risk Area 2	-0.461	0.354
MASC Risk Area 3	-0.652***	0.234
MASC Risk Area 4	-0.749	0.481
MASC Risk Area 5	-0.715	0.472
MASC Risk Area 6	-0.494	0.428
MASC Risk Area 7	-0.290	0.340
Constant	-8.078	6.050
Number of observations	6,161	
Pseudo-R^2	0.22	

*** p<0.01, ** p<0.05, * p<0.1

Table 3: Covariate balance

Variable	Sample	Eased sales	Non-eased sales	p-value
ACC 3 & 4 (% of sale acreage)	Unmatched	41.14	37.59	0.40
	Matched	40.92	39.66	0.84
ACC 5, 6, & 7 (% of sale acreage)	Unmatched	31.77	18.23	0.00
	Matched	31.30	24.61	0.21
Other (% of sale acreage)	Unmatched	0.49	1.47	0.26
	Matched	0.50	1.19	0.42
Waterways (% of sale acreage)	Unmatched	1.33	1.61	0.72
	Matched	1.36	1.41	0.97
Native Hay (% of sale acreage)	Unmatched	13.07	8.87	0.08
	Matched	13.41	22.91	0.07
Slough (% of sale acreage)	Unmatched	12.81	4.98	0.00
	Matched	11.48	9.13	0.29
Slough, Brush (% of sale acreage)	Unmatched	10.89	5.01	0.00
	Matched	11.17	5.70	0.06
Slough, Hay (% of sale acreage)	Unmatched	5.37	2.34	0.00
	Matched	5.51	4.20	0.55
Brush (% of sale acreage)	Unmatched	10.16	9.66	0.85
	Matched	9.67	14.13	0.30
Wetland count/acre	Unmatched	0.02	0.02	0.00
	Matched	0.02	0.02	0.25
High slope (% of sale acreage)	Unmatched	10.47	11.38	0.74
	Matched	10.74	13.81	0.46
Strong salinity (% of sale acreage)	Unmatched	0.80	0.71	0.91
	Matched	0.82	1.67	0.51
Poor drainage (% of sale acreage)	Unmatched	20.69	7.26	0.00
	Matched	20.38	12.57	0.07
Suitable for irrigation (% of sale)	Unmatched	0.13	1.66	0.13
	Matched	0.13	0.19	0.89
log(distance to elevator)	Unmatched	10.61	10.50	0.16
	Matched	10.63	10.56	0.51
log(distance to Brandon)	Unmatched	11.17	11.15	0.73
	Matched	11.18	11.16	0.80
log(distance to Portage)	Unmatched	11.94	11.82	0.01
	Matched	11.95	11.96	0.80
Elevation (meters)	Unmatched	496.41	474.37	0.01

	Matched	495.68	499.71	0.73
High DUC breeding pair index	Unmatched	0.097	0.014	0.00
	Matched	0.073	0.05	0.53
High CLI waterfowl suitability index	Unmatched	0.65	0.35	0.00
	Matched	0.64	0.59	0.49
PHJV target region	Unmatched	0.69	0.36	0.00
	Matched	0.68	0.64	0.59
Neighboring forest (% of area)	Unmatched	8.37	10.03	0.26
	Matched	8.51	11.75	0.15
Neighboring grassland (% of area)	Unmatched	27.70	22.45	0.00
	Matched	27.47	30.63	0.28
Neighboring wetland (% of area)	Unmatched	7.07	4.37	0.00
	Matched	6.76	6.08	0.46
Neighboring forage (% of area)	Unmatched	2.04	2.18	0.71
	Matched	2.08	2.77	0.20
Total sale acres	Unmatched	248.34	233.24	0.41
	Matched	250.65	250.92	0.99
MASC Risk Area 2	Unmatched	0.13	0.17	0.29
	Matched	0.12	0.14	0.67
MASC Risk Area 3	Unmatched	0.10	0.13	0.41
	Matched	0.10	0.14	0.44
MASC Risk Area 4	Unmatched	0.09	0.16	0.07
	Matched	0.09	0.09	0.91
MASC Risk Area 5	Unmatched	0.09	0.18	0.04
	Matched	0.09	0.08	0.87
MASC Risk Area 6	Unmatched	0.21	0.16	0.25
	Matched	0.21	0.20	0.91
MASC Risk Area 7	Unmatched	0.20	0.08	0.00
	Matched	0.21	0.16	0.43

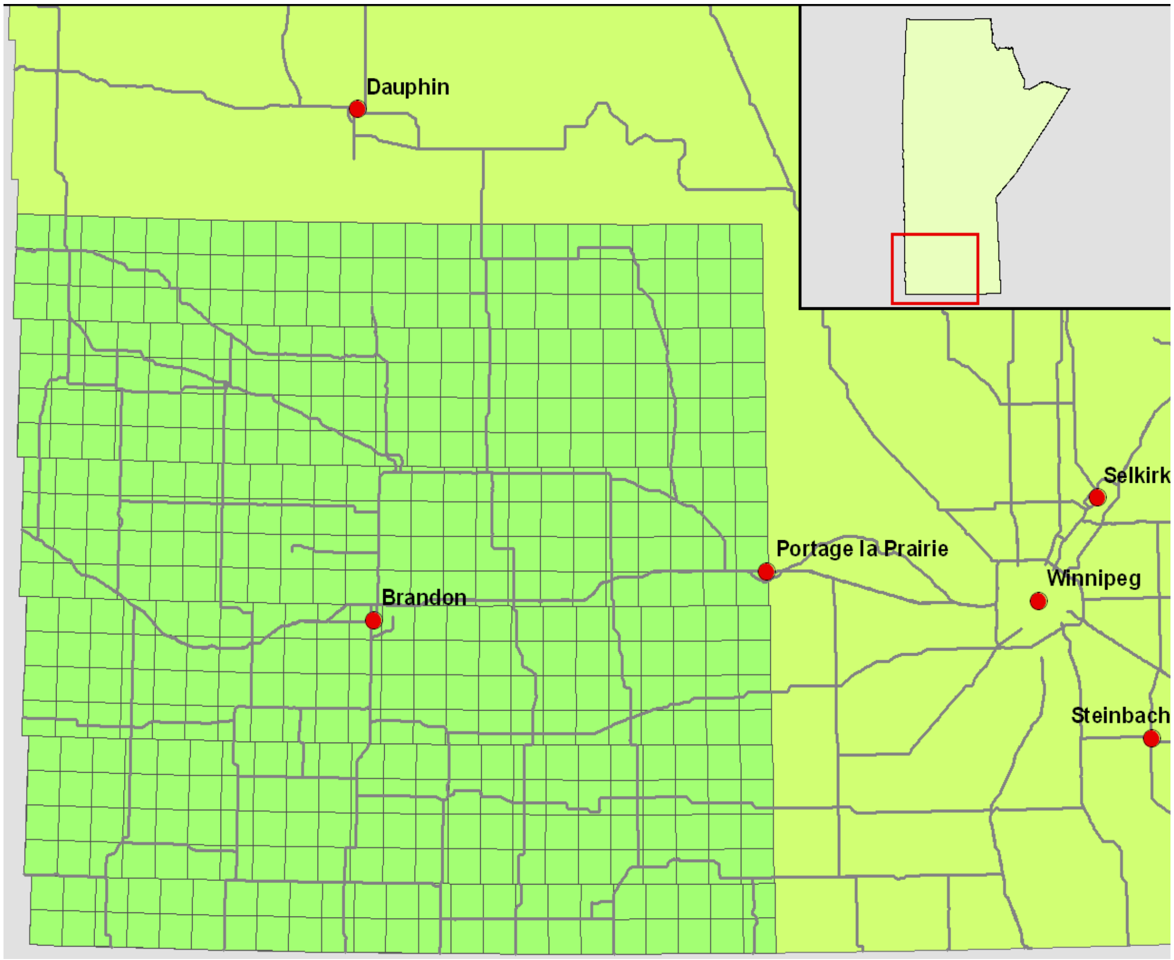
Table 4: Average treatment effect on the treated (ATT)

	Propensity score matching	Regression adjusted		
	Linear price	Linear price (dummy variable)	Linear price (% of sale)	Log price (% of sale)
ATT	-40.83**	-36.08**	-0.79**	-0.0025**
Bootstrap Std. Err.	20.84	18.08	0.33	0.0011
95% confidence interval	(-88.13, -4.69)	(-71.51, -0.66)	(-1.43, -0.14)	(-.005, -.0003)

*** p<0.01, ** p<0.05, * p<0.1

Notes: All results based on 5 nearest neighbors matched sample, which consists of 78 eased and 390 non-eased sales. All covariates (including year dummies) are included in the regression adjusted models. The 95% confidence interval (bias corrected) for the propensity score model is based on 300 bootstrap draws. The bootstrapped standard errors and 95% confidence interval (normal-based) for the regression adjusted models are based on 1000 bootstrap draws.

Figure 1: Study area



[1] In a related literature, Deaton and Vyn (2010) examine the impact of agricultural zoning that restricts the development of agricultural land in Ontario. They find that agricultural zoning can have significant negative impacts on agricultural land values for those parcels in close proximity to urban areas.

[2] The Manitoba Provincial government sponsors a new program—the Wetland Restoration Incentive Program (WRIP)—which uses public funds to restore wetlands (land-use change) on land that is currently cropped. As a part of the program, conservation agencies (MHHC and DUC) place a perpetual conservation easement on the restored wetland acreage and surrounding upland acreage in exchange for a one-time payment for the easement. The WRIP is a young program and the acreage restored to date has been relatively small. A significant hurdle for program delivery has been reluctance among landowners to sign perpetual easements as opposed to shorter-term easements.

[3] Rashford, Bastian, and Cole (2011) estimate a land-use share model for the three Canadian prairie provinces at the Census Agricultural Region level. Their results suggest that pasture was converted to spring grains and oilseeds to varying degrees across the region; the conversion rate was around 5% in the more intensively cropped regions, such as southern Saskatchewan. The conversion rate is higher (in the neighborhood of 20%) in regions that have historically been relatively less intensively cropped.

[4] For example, in the US, the Swampbuster cross-compliance provision restricts drainage of existing wetlands. However, the provision does permit agricultural production on wetlands areas so long as woody vegetation is not removed and in practice, this implies that landowners are prohibited from permanently converting existing wetlands, but are permitted to crop temporary wetlands in dry years (Gelso, Fox, and Peterson 2008). Enforcement of the cross-compliance

provisions (Sodbuster and Swampbuster) by the USDA's Natural Resources Conservation Service has been inconsistent due to a lack of staff dedicated to enforcement, weak oversight of field offices, and discomfort with an enforcement role (Lichtenberg and Smith-Ramirez 2011; Government Accounting Office 2003).

[5] It is possible "non-market" costs may exist due to the psychological costs experienced by the operators navigating machinery around eased areas as mentioned in van Kooten and Schmitz (1992).

[6] NCC has focussed its conservation easement purchases in the southeastern and northwestern portions of the province.

[7] Some of the easements held by MHHC are purchased using funds intended to protect species at risk as designated under the Federal *Species At Risk Act* (SARA). These easements use similar criteria to the criteria used to assess easements purchased under the NAWMP but with more of an emphasis on the presence of species at risk—a factor that is likely highly correlated with the landscape variables controlled for in this analysis.

[8] Conservation easements prohibit the landowner or anyone else from breaking, burning, draining, degrading, or converting the ecosystem components of the conserved habitat. Easements also prohibit the establishment of new commercial or residential buildings on conservation lands. In Manitoba, easements permit haying or grazing of eased acreage in dry years, but annual cropping is prohibited on virtually all eased acreage. This is in contrast to the FWS easements in the US, which permit annual cropping in dry years (Schultz and Taff 2004).

[9] Surrounding land parcels include all quarter sections that are immediately adjacent to the eased quarter sections, commonly known as queen contiguity.

[10] The Dominion Land Survey system is used to divide most of Manitoba into one square mile sections. A quarter section is one-quarter of a section. The quarter section is the basic unit of sale. Sales of agricultural land typically involve multiple quarter sections.

[11] As outlined in Gelso, Fox, and Peterson (2008), habitat can impose significant nuisance costs on a grain/oilseed producer due to the additional costs of manoeuvring large machinery around habitat and increased input use (fertilizer/pesticide applications, fuel, and time) due to overlapping passes in the field.

[12] Landowners may enroll habitat without adequate financial compensation if they are motivated by a sufficiently strong environmental ethic.

[13] A sales parcel without an easement at the time of sale may have an easement placed on it sometime after the sale.

[14] If one had access to these types of variables an instrumental variables approach might be preferable to matching.

[15] Nature Conservancy Canada (NCC) has purchased a limited number of easements on the northern fringe of our study area, close to Riding Mountain National Park.

[16] http://res.agr.ca/cansis/nsdb/cli/intro.html

[17] Note that easements are not purchased on habitat that is close to Brandon and Portage la Prairie so development pressure is not a significant factor in this study.

[18] AAFC has made CLI maps available at: http://res.agr.ca/cansis/nsdb/cli/intro.html

[19] The MLI documents land use in 1995 based on LandSat 7 images.

[20] Delineation of the MASC risk areas can be found at http://www.mmpp.com/mmpp.nsf/ym_2009_09_risk_areas.pdf

[21] Similar results are attained for 1 and 3 nearest neighbors as well as the Epanechnikov kernel.

[22] Temporal variables might include changes in output prices, input prices, trade barriers, and macroeconomic variables such as interest rates and exchange rates.

[23] See Hill, Reiter, and Zannuto (2004), Schoengold and Sunding (2011), and Arriagada et al. (2012) for other applications of this method.

[24] Wetland and upland habitat consists of all acreage in combinations of slough, brush, and hay.

[25] Using this approach we find that a 1% increase in non-eased habitat reduces the sales price by $2.21/acre over the entire sales acreage, while a 1% increase in treated habitat reduces the sales price by $3/acre over the entire sales acreage. The difference between these estimates is the impact of the easement: $3.00 - $2.21 = $0.79. The statistical significance of this difference as reported in Table 4 is based on a test of equality of these two parameters.