CAPI
THE CANADIAN AGRI-FOOD POLICY INSTITUTE

Land use change in agricultural landscapes: Incentives and conservation programs

Paper prepared for CAPI

by

Chad Lawley
Department of Agribusiness and Agricultural Economics
University of Manitoba

March 2019

The Canadian Agri-Food Policy Institute

960 Carling Avenue, CEF

Building 49, Room 318

Ottawa, ON K1A 0C6

Telephone: 613-232-8008

Fax: 613-232-8008

www.capi-icpa.ca

Canada

Introduction

Continued land use changes are a persistent feature of agricultural landscapes. In the Canadian prairies, widespread adoption of conservation tillage in the 1990s substantially altered land use practices; use of zero tillage increased from approximately 5% to more than 40% across the Canadian Prairie Provinces between 1991 and 2006 (Awada 2012). This has since risen to 59% in 2016, according to Statistics Canada's Census of Agriculture (2016). Within the same landscape, estimates suggest that between 40% and 70% of prairie pothole acreage has been lost or degraded since European settlement (Watmough and Schmoll 2007). Some estimates suggest that approximately 5% of remaining wetland acreage in the Canadian prairies was lost between 1985 and 2001 and native grasslands declined by 10% over the same time period (Watmough and Schmoll 2007).

Landscape changes such as those that have occurred in the Canadian prairie pothole region (PPR), are a result of market incentives faced by farmers and private landowners. They are also the result of government policies. As an example, early wetland drainage in Manitoba was initiated and supported by the provincial government (Bower 2011). Land conversion to more intensive agricultural uses is expected to continue for several reasons. Changes in the relative returns to different land uses (for example, increased crop returns relative to livestock returns) due to changes in market prices and government support programs, play a central role in cultivation of new cropland (Gardner, Hardie, and Parks 2010). Wang et al. (2017) summarize many of the factors that influence land use change in the U.S. PPR, including U.S. biofuel policy, government subsidized crop insurance, agronomic advances, such as improved crop cultivars, and adoption of

larger farm machinery. Whithey and van Kooten (2011) present evidence that reduced productivity of wetland ecosystems due to climate change will result in fewer wetlands in the PPR in the future.

Changes in land use incentives

Land use incentives change over time. One approach to quantifying changes in incentives is to look at the impact of non-crop acreage on the price of farmland. Non-crop acreage, including wildlife habitat such as wetland, grassland, and trees, constrain the use of farmland in annual crop production. Land parcels with more habitat are expected, on average, to sell at a discount relative to parcels with more cropland acreage. The land value discount reflects the present value of the long-run expected benefits or costs of converting the acreage to annual crop production (or other higher valued uses). This implies that farmland value discounts due to habitat acreage are an indirect measure of incentives to convert to alternative land uses. Changes in incentives to convert can therefore be measured by assessing the extent to which land value discounts on habitat acreage have changed over time.

Lawley (2014) conducts such an analysis in the PPR of Manitoba. Farmland price discounts due to wetland, bush and pasture, and native hay acreage are estimated using farmland transaction data spanning the 20 year period, 1990 to 2009. Estimated discounts for five four-year intervals (1990-93, 1994-97, 1998-2001, 2002-05, and 2006-09) are presented in Figure 1. The results suggest that in the 1990-93 period, a 1% increase in the share of the parcel in wetland reduced the sale price by 1.1%, a 1% increase in the share of the parcel in bush and pasture reduced the sale price by 0.9%, and a 1% increase in the share in native hay reduced the sale price by 0.5%. These discounts are

consistent with expectations; all else equal, farmland buyers pay discounted prices for sales parcels with less cropland acreage.

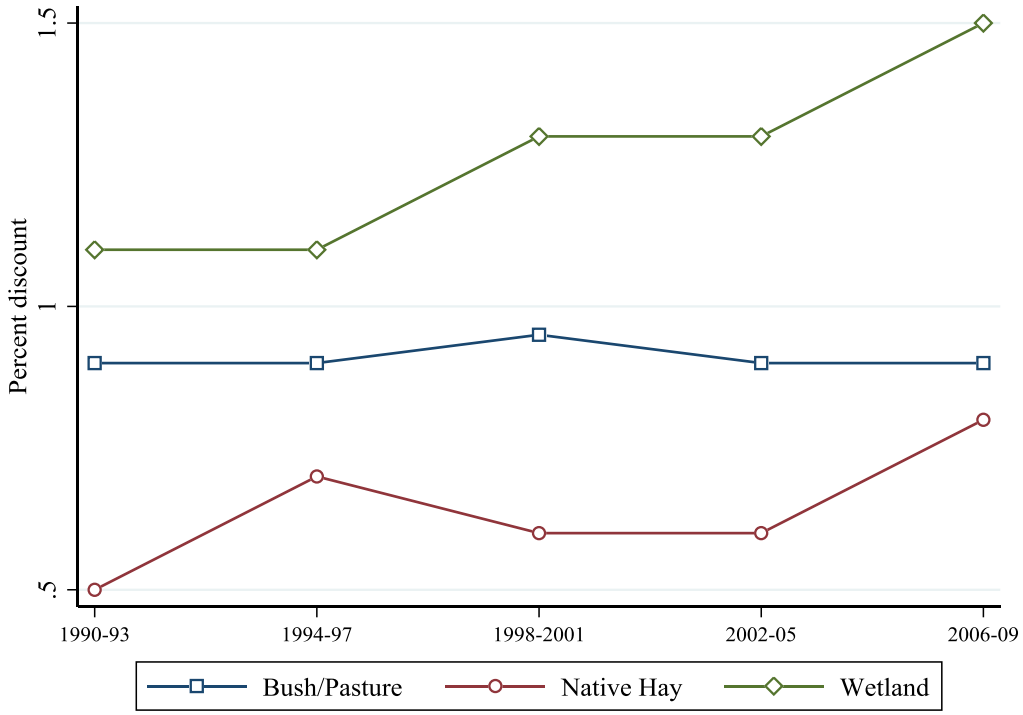

Figure 1: Farmland price discount due to habitat acreage

Source: Lawley, Chad. 2014. "Changes in implicit prices of prairie pothole habitat," *Canadian Journal of Agricultural Economics*, 62(2): 171-190.

The results also suggest that the discounts on habitat acreage have increased over time. In the 2006-09 period, a 1% increase in the share in wetland, bush and pasture, and native hay reduced sales prices by 1.5%, 0.9%, and 0.8%, respectively. As displayed in Figure 1, the discount on wetland acreage increased by approximately 40% between the 1990-93 and 2006-09 periods. This represents a substantial increase in incentives for wetland conversion, such that landowners faced much stronger incentives to convert wetland acreage to annual cropland in 2006-09 compared to the incentives they faced just 20 years earlier.

Conservation program design

Because private landowners do not extract social value from conservation, conservation programs are needed to provide them with an incentive to preserve this land. Social value includes benefits to society from wetlands, as an example, such as water filtration, wildlife habitat, and even carbon sequestration. Incentives can take the form of subsidies to encourage conservation or a combination of regulations and penalties to prevent conversion. Various programs have been introduced to encourage conservation, including the Conservation Reserve Program (CRP) in the United States and conservation easement payments in Canada and elsewhere. These programs are subject to several important design challenges, including slippage, targeting, and additionality (Lawley and Towe 2018).

Slippage

The United States' CRP is a land set aside program that offers landowners temporary rental contracts (10-15 years) to remove annual cropland from production and temporarily places that land in permanent cover. The CRP acts as a control on agricultural commodity supply and is a large enough program that it might increase commodity prices. Increased commodity prices provide producers with incentives to bring new land into commodity production, with the potential to offset some of the environmental benefits of the land retired in the CRP. This is referred to as slippage. Research suggests that slippage in the CRP may be as high as 20%. For every 100 acres of cropland retired in the CRP an additional 20 acres are brought into commodity production as new cropland (Wu 2000), although subsequent investigations debate the robustness of this result (Roberts and Bucholtz 2005; Wu 2005).

Targeting conservation investment

The history of conservation investment in Canada and the United States suggests that conservation agencies in both the public and private sectors have had difficulty in targeting that investment to maximize net benefits. Early experience with the CRP suggested that the program was targeted towards low cost land that was easier to enroll, to the detriment of the supply control and erosion reduction objectives of the program (Reichelderfer and Boggess 1988). Subsequent policy design changes have emphasized environmental benefits as a primary objective of the CRP.

Similar to the experience with the CRP, early attempts to protect prairie potholes in the Canadian prairies tended to focus on maximizing enrollment. van Kooten and Schmitz (1992) found that early pilot programs under the North American Waterfowl Management Plan (NAWMP) tended to protect lower quality wetlands and upland habitat that were easier to secure but provided lower environmental benefits. Environmental benefit targeting is now an important component of conservation investment in the PPR. Ducks Unlimited Canada (DUC) invests substantial resources in research to identify and target investments on the basis of the landscape's suitability to support waterfowl populations. Nature Conservancy Canada (NCC) targets grassland protection on the basis of environmental benefits to species at risk, among other objectives. Although there is now substantial emphasis on the environmental benefits of conservation investment, little attention is paid to the risk that protected land would have been converted to cropland, in the absence of protection. Assessment of the vulnerability to conversion is needed when determining the *expected* benefits of conservation investment. Accounting for this vulnerability is important when higher cost land is more vulnerable to conversion, which is a situation typically faced by conservation agencies (Newburn et al. 2005).

Additionality

Voluntary participation in habitat conservation programs leads to problems of adverse selection, where those landowners and farmers with the lowest costs of compliance are also the landowners and farmers that are most likely to participate in the program. This implies that the "additionality"—the extent of conservation activity that occurs solely due to the conservation payment—in these programs is potentially quite low. Additionality is likely to be lowest in programs that make payments to *maintain* current land uses. Evaluating the additionality of conservation spending in these contexts remains relatively rare (Ferraro and Pattanayak 2006).

From a conservation agencies perspective, identifying which land parcels are vulnerable to conversion is a significant challenge. A relatively small share of land is converted in a given year, but these small changes can amount to substantial alteration of the landscape over several years. Figure 2 presents air photos of quarter sections of land in the PPR of Manitoba. These air photos clearly illustrate the dilemma faced by conservation agencies. The left panel presents images in the early 1990s and the right panel presents images of the same quarter sections in the mid 2000s. All four of the quarter sections in Figure 2 contain land uses typical of this landscape, including a mix of annual cropland, pasture, trees, and wetlands. Visual inspection suggests that the land uses on quarter sections (1) and (2) do not change between the early 1990s and the mid 2000s. This is consistent with what would have occurred on much of the landscape in this region over that time period: land uses that persisted for more than 100 years of agricultural development were maintained over the roughly 15 years between the early 1990s and the mid 2000s.

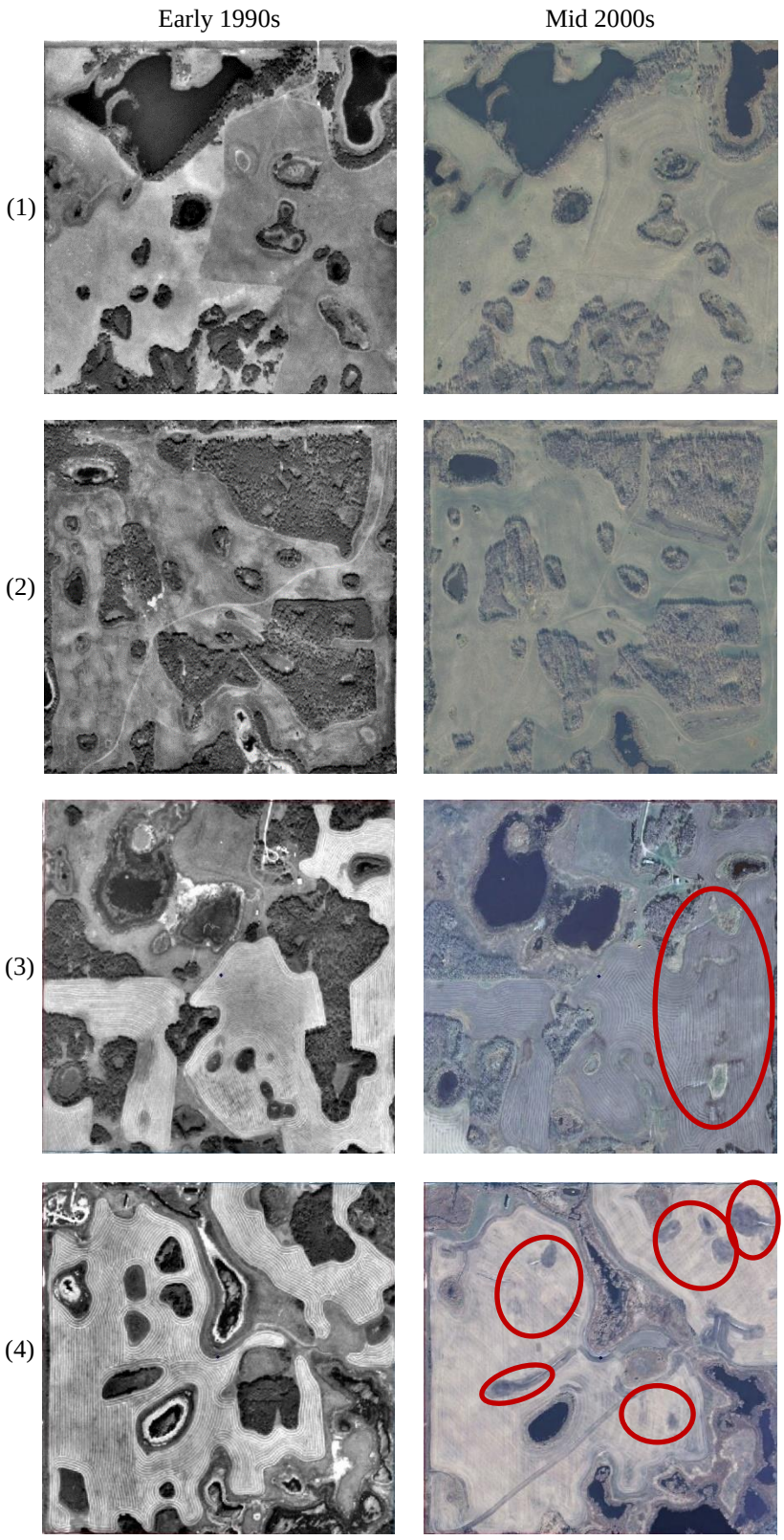

Figure 2: Land cover on selected quarter sections in Manitoba

Quarter sections (3) and (4) are a mix of annual cropland, trees, and wetlands in 1990. Both of these quarter sections underwent substantial land use changes between the early 1990s and mid 2000s: a large bluff of trees was cleared on quarter section (3) and several wetlands or small bluffs of trees were drained or cleared on quarter section (4). The land use change on the latter two quarter sections is the type of conversion that conservation agencies are attempting to prevent with conservation easements and other tools. The challenge facing conservation agencies is to direct investment of scarce conservation dollars to the most vulnerable habitat, such as the habitat parcels that existed in the early 1990s in quarter sections (3) and (4), and to avoid directing resources to habitat on quarter sections (1) and (2), which appear to be less vulnerable to conversion.

Conservation Easements

Conservation easement legislation was introduced in several Canadian Provinces in the late 1990s to early 2000s. Conservation easements are agreements between conservation agencies (in Manitoba, these include DUC, Manitoba Habitat Heritage Corporation (MHHC), and NCC) and landowners. An easement placed on habitat limits the landowner's rights to convert that habitat from its current use. In return, the conservation agency provides the landowner with a one-time payment as compensation for giving up the ability to convert. The easement follows the land title in perpetuity and therefore applies to all future owners of the land.

Figure 3 presents a framework for thinking through issues of additionality in conservation investments, with an application to conservation easements. This figure depicts all existing habitat within a region on the horizontal axis and anticipated net private returns to landowners if that habitat is converted to a higher valued use, such as cropland. Existing habitat is ordered according

to increasing anticipated net benefits of conversion. The per acre payment depicted in Figure 3 represents average payments for conservation easements offered by conservation agencies. It is important to note that the anticipated net benefit of converting reflects the potential actions of current and future landowners; although the current landowner may not find it worthwhile to convert existing habitat, future landowners may due to a number of factors, including the nature of the farming operation (for example, draining a wetland or clearing trees may be worthwhile for a farmer focussed on annual crop production but not for a farmer primarily engaged in livestock production) and shifting incentives for land use change.

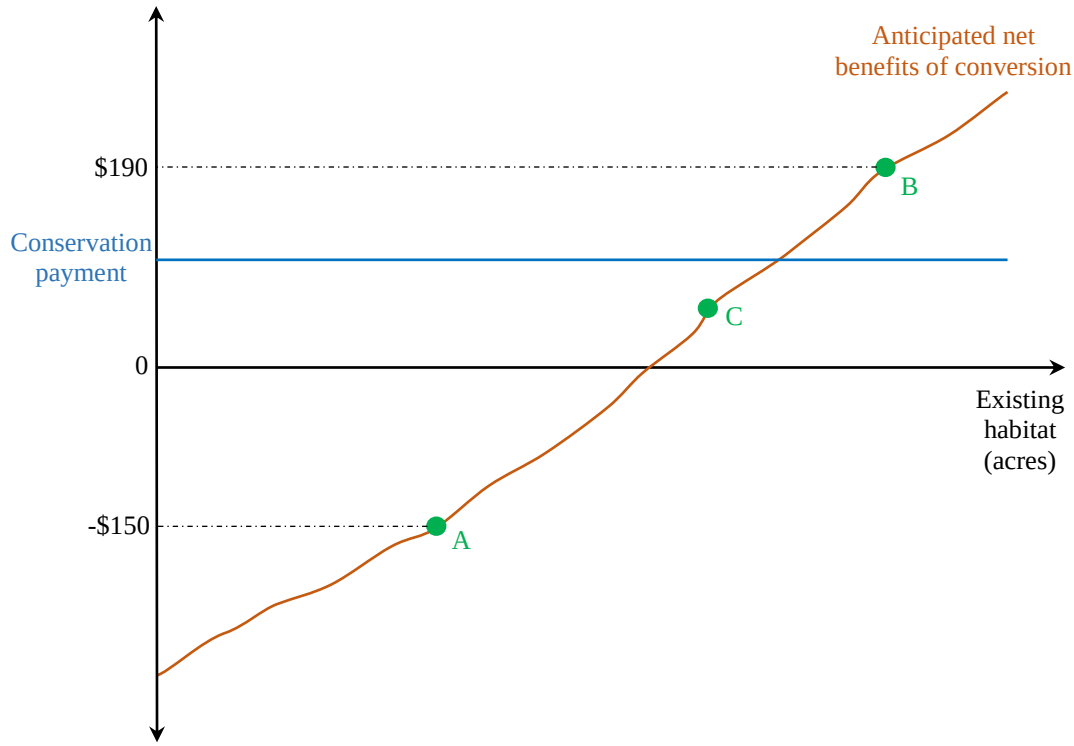

Figure 3: Anticipated net benefits of converting habitat

Three distinct types of habitat are presented in Figure 3. The net benefit of converting habitat parcel "A" is negative and it is therefore highly unlikely that current or future landowners will find

it worthwhile to convert this habitat now and into the foreseeable future. This habitat offers zero additionality. Landowners are more likely to offer to enroll this habitat in conservation easements in an effort to capture "windfall" payments. Conservation agencies, on the other hand, try to avoid enrolling zero additionality habitat since there is little expected benefit from investing scarce conservation dollars in these parcels.

The net benefits of converting habitat parcels "B" and "C" are positive. Habitat parcel "B" has an expected benefit of conversion that far exceeds the costs of conversion, such that the net benefits of conversion are $190 per converted acre. This habitat is most vulnerable to conversion and therefore offers the highest additionality. As presented in Figure 3, the value to the current landowner of retaining the ability to convert this habitat exceeds the conservation payment offered by the conservation agency. Therefore, the landowner will enroll this habitat in a conservation easement only if he or she 1) receives a "warm glow" from preserving the habitat or 2) makes an error in judgement and enrolls this habitat at personal financial expense.

Finally, habitat parcel "C" represents habitat with lower but still positive additionality. The easement payment offered by the conservation agency compensates the landowner for foregoing the ability to convert this habitat—this is the type of habitat that the conservation easement program targets.

Easements follow the land title in perpetuity and are expected to reduce the price of farmland in cases where the option to convert existing habitat has value. In Figure 3 above, easements on parcels "B" and "C" are expected to reduce the price of farmland parcels, while an easement on parcel "A," which is not at risk of conversion, should have no impact on the price of farmland.

The impact of conservation easements on farmland values reflects the additionality of the habitat protected by the easement. If the conservation agencies are placing easements on habitat that is at little risk of conversion, then easements will have very little impact on farmland prices. Alternatively, if easements are placed on habitat offering the highest levels of additionality, such as habitat parcel "B," then easements will have a substantial negative impact on farmland prices that, on average, will exceed the per acre conservation payment. If the conservation easement program is operating as intended, then the average impact of easements on land values will lie somewhere between zero and the average conservation payment for easements.

Lawley and Towe (2014) examine the impact of easements held by DUC and MHHC on farmland prices in Manitoba. On average, conservation easements reduce farmland prices by $86 per eased acre, suggesting that the conservation easements were protecting habitat at risk of conversion. Over the course of the study period, the per acre conservation payment was approximately $100 per eased acre. Landowners were therefore earning a premium on easement payments of approximately 16%. Overall, the easement program appears to operate as expected: agencies are successfully targeting habitat vulnerable to conversion and landowners are capturing premiums on conservation payments for easements.

Revolving Land Purchase Program

DUC introduced an innovative Revolving Land Purchase (RLP) program in the late 2000s (Noga and Adamowicz 2014 discuss various economic aspects of the RLP program). The RLP program has the potential to overcome several issues associated with targeting and additionality of conservation investment. Under the RLP program, DUC purchases farmland, places a perpetual

conservation easement on existing, enhanced, or restored habitat, and then sells the farmland back to producers with a conservation easement on the title. The difference in farmland sale prices before the easement and after the easement should equal the anticipated benefits of converting the habitat on that sale parcel. For example, the sale price of farmland parcel "B" in Figure 3 should decrease by $190 per eased acre due to the easement, while parcel "A" should sell at the same price before and after the easement (this is zero additionality habitat and an easement should impose zero discount on the sale price). In a standard conservation easement program, price discovery occurs through one-on-one negotiations between landowners and conservation agencies, based on their expectations of the impact of the easement on future sale prices. In the RLP program, price discovery is achieved directly within the farmland market where several buyers are evaluating the potential impact of the conservation easement on farmland price and bidding accordingly. The RLP program therefore assists in price discovery.

Perhaps more importantly, the RLP program addresses some of the more challenging issues associated with additionality and targeting. In the standard conservation easement program with a fixed conservation payment the conservation agency tends not to enroll habitat parcels "B" as depicted in Figure 3—the payment offered does not fully compensate the landowner for giving up the option to convert that habitat. There is no such limitation in the RLP program, in which the conservation agency is able to target habitat based on expected benefits and costs of conservation without the constraint of a fixed payment. This design also reduces the cost of mistakes. Consider an easement placed on zero additionality habitat such as parcel "A" in Figure 3. This is a costly mistake in a traditional conservation easement program with a fixed per acre payment. The same decision within the RLP program carries little cost to the conservation agency since the easement

does not result in a discounted sale price. The RLP program therefore removes some of the uncertainty associated with the additionality of protected habitat. Agencies can focus on targeting worthwhile habitat, and transactions within farmland markets determine the necessary "payment" levels for easements on that habitat.

Concluding remarks

Agri-environmental conservation programs in Canada have tended to rely on subsidized conservation. Well-functioning land and credit markets, combined with widely available public and private extension, suggest that there are few barriers to the use of conservation practices that provide on-farm benefits to farmers and landowners (Lichtenberg 2014). There is therefore little justification for subsidies to encourage adoption of a conservation practice like zero tillage, which provides substantial on-farm benefits. Subsidized conservation is justified on the basis of the off-farm social benefits that it provides, which might include improved water and air quality, increased biodiversity, and increased carbon sequestration. Scarce conservation resources imply that attention needs to be paid to the cost effectiveness of these conservation investments. Assessing the additionality of investments, and efforts to design innovative conservation programs to achieve the greatest returns on this investment are of critical importance.

References

Awada, L. (2012). The adoption of conservation tillage innovation on the Canadian Prairies, (Doctoral Dissertation, University of Saskatchewan). http://hdl.handle.net/10388/ETD-2012-09-646

Bower, S.S. (2011). *Wet prairie: people, land, and water in agricultural Manitoba*. UBC press. https://www.ubcpress.ca/wet-prairie

Ferraro, P. J., & Pattanayak, S. K. (2006). Money for nothing? A call for empirical evaluation of biodiversity conservation investments. *PLoS Biology*, *4*(4), e105. https://doi.org/10.1371/journal.pbio.0040105

Gardner, B., Hardie, I., & Parks, P. J. (2010). United States farm commodity programs and land use. *American Journal of Agricultural Economics*, *92*(3), 803-820. https://doi.org/10.1093/ajae/aap039

Lawley, C. (2014). Changes in implicit prices of prairie pothole habitat. *Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie*, *62*(2), 171-190. https://doi.org/10.1111/cjag.12022

Lawley, C., & Towe, C. (2014). Capitalized costs of habitat conservation easements. *American Journal of Agricultural Economics*, *96*(3), 657-672. https://doi.org/10.1093/ajae/aau012

Lawley, C., & Towe, C. (2019). Habitat conservation in agricultural landscapes. In *The Routledge Handbook of Agricultural Economics* (pp. 211-231). Routledge. https://www.taylorfrancis.com/books/e/9781317225768/chapters/10.4324/9781315623351-13

Lichtenberg, E. (2014). Conservation, the Farm Bill, and US agri-environmental policy. *Choices*, *29*(3), 1-6. http://choicesmagazine.org/choices-magazine/theme-articles/3rd-quarter-2014/conservation-the-farm-bill-and-us-agri-environmental-policy

Newburn, D., Reed, S., Berck, P., & Merenlender, A. (2005). Economics and land-use change in prioritizing private land conservation. *Conservation Biology*, *19*(5), 1411-1420. https://doi.org/10.1111/j.1523-1739.2005.00199.x

Noga, W., & Adamowicz, V. (2015). *A study of Canadian conservation offset programs: lessons learned from a review of programs, analysis of stakeholder perceptions, and investigation of transactions costs*. Sustainable Prosperity (University of Ottawa). https://institute.smartprosperity.ca/sites/default/files/publications/files/Noga%20Adamowicz%20Conservaton%20Offsets%20Oct%202014.pdf

Reichelderfer, K., & Boggess, W. G. (1988). Government decision making and program performance: the case of the conservation reserve program. *American Journal of Agricultural Economics*, *70*(1), 1-11. https://doi.org/10.2307/1241970

Roberts, M. J., & Bucholtz, S. (2005). Slippage in the Conservation Reserve Program or spurious correlation? A comment. *American Journal of Agricultural Economics*, *87*(1), 244-250. https://doi.org/10.1111/j.0002-9092.2005.00715.x

Wang, T., Luri, M., Janssen, L., Hennessy, D. A., Feng, H., Wimberly, M. C., & Arora, G. (2017). Determinants of motives for land use decisions at the margins of the Corn Belt. *Ecological Economics*, *134*, 227-237. https://doi.org/10.1016/j.ecolecon.2016.12.006

Watmough MD, Schmoll MJ. *Environment Canada's Prairie and Northern Region habitat monitoring program phase II: recent habitat trends in the Prairie Habitat Joint Venture*. Edmonton: Environment Canada, Canada Wildlife Service; 2007. Technical Report 493. http://publications.gc.ca/site/eng/9.858859/publication.html

Withey, P., & van Kooten, G. C. (2011). The effect of climate change on optimal wetlands and waterfowl management in Western Canada. *Ecological Economics*, *70*(4), 798-805. https://doi.org/10.1016/j.ecolecon.2010.11.019

Wu, J. (2000). Slippage effects of the conservation reserve program. *American Journal of Agricultural Economics*, *82*(4), 979-992. https://doi.org/10.1111/0002-9092.00096

Wu, J. (2005). Slippage effects of the conservation reserve program: Reply. *American Journal of Agricultural Economics*, *87*(1), 251-254. https://doi.org/10.1111/j.0002-9092.2005.00716.x

van Kooten, G. C., & Schmitz, A. (1992). Preserving waterfowl habitat on the Canadian prairies: economic incentives versus moral suasion. *American Journal of Agricultural Economics*, *74*(1), 79-89. https://doi.org/10.2307/1242992