Lower Souris Watershed
Ecological Goods and Services Pilot Proposal
Advancing Canadian Agriculture and Agri-Food Program

Agri-Environmental Policy Measure Analysis

Project Report

March 7th, 2009

Ken Belcher
Department of Bioresource Policy, Business and Economics
University of Saskatchewan
51 Campus Drive
Saskatoon, Saskatchewan
S7N 5A8
Tel: (306) 966-4019
Fax: (306) 966-8413
Email: ken.belcher@usask.ca

Acknowledgements

The financial support of the Lower Souris Watershed Committee Inc. via Advancing Canadian Agriculture and Agri-Food (ACAAF) Program is gratefully acknowledged. The assistance and direction of Etienne Soulodre, Range Agrologist with Saskatchewan Watershed Authority and Sheldon Kyle watershed coordinator and the Lower Souris Watershed Board of Directors were valuable in providing feedback and suggestions.

1. Lower Souris Watershed Ecological Goods and Services: Landscape Policy Analysis

Introduction

Concerns over the under-provision of ecological goods and services on agricultural landscapes have resulted in the development of a range of policy instruments. In general the policy instruments can be categorized as either regulatory approaches, economic instruments, market measures or advisory and institutional measures. While each of these measures can play a role in increasing the quantity and quality of ecological goods and services provided by agriculture, economic instruments are receiving more attention as a viable policy alternative. The purpose of this report is to quantify the impact that land management payments will have on the provision of wildlife habitat within a study region of the Lower Souris Watershed in South Eastern Saskatchewan. Specifically this analysis focused on the costs and habitat benefits of converting annual cropland, and to a lesser extent native grass and aspen, to perennial forage. The results show that for a relatively extensive program (converting approximately 350,000 acres of annual cropland, grass and aspen to perennial forage) for the study area, will require from $0.75 to $1.25 million in annual payments. A more moderate program (converting 95,000 acres of annual cropland to perennial forage) will require from $240 to $390 thousand in annual payments. However the analysis also shows that the conversion of annual cropland to perennial forage conserves significant areas of wetlands. To conserve equal areas of wetlands through a direct wetland payment would cost approximately $2 million and $778,000 for the extensive and moderate program respectively. The following analysis also provides support for targeting lower value land in habitat programs, for both economic and ecological good and service reasons.

Background and Context

An analysis was performed on a sample of 3 Rural Municipalities within the Lower Souris watershed (Silverwood, Reciprocity and Storthoaks). The analysis is based on land cover data, at the quarter section scale, provided for each of these Rural Municipalities. This land cover data categorized the landscape into 17 different land cover categories. To be consistent with the 6 habitat types used in the White (2008) report the data was translated (Table 1). For example the area of the grass habitat type is the sum of the area of grassland, native grass and shrub land cover categories. The landscape of the three sample rural municipalities is dominated by crop (57.33%) and perennial forage (18.88%) with the remaining 23.80% of the landscape allocated to native vegetation and wetlands (Table 2; Figure 1). It is worthwhile to note that the habitat composition of this sample landscape has less cropland, slightly more perennial forage and more native cover than the composition of the entire Lower Souris Watershed – 66.1% annual cropland; 21.7% perennial crops, and 11.7% allocated to native vegetation and wetlands (AAFC, 2008) – overall the landscapes are not dramatically dissimilar. Based on this the pattern and influence of the habitat scenarios developed based on the sample landscape will be relatively straightforward to interpret for the larger watershed.

Table 1. Conversion of habitat types using land cover categories from the sample Rural Municipalities.

Habitat Types	Land Cover Categories
Crop	Cropland
	Wetland (Cultivated)
Perennial Forage	Tame Grass
Grass	Grassland
	Native Grass
	Shrub
Aspen	Tree
Lentic	Dugout
	Wetland (EM)
	Wetland(OW)
Lotic	Lotic
Not Used	TBD
	Sheet Water
	Headland
	Cultural
	Exposed
	Road

Table 2. Baseline Landscape Habitat types and area.

Habitat Type	Baseline Landscape (acres)
Crop	284,423
Perennial Forage	93,651
Grass	37,442
Aspen	29,302
Lentic	39,093
Lotic	12,179
Total	496,090

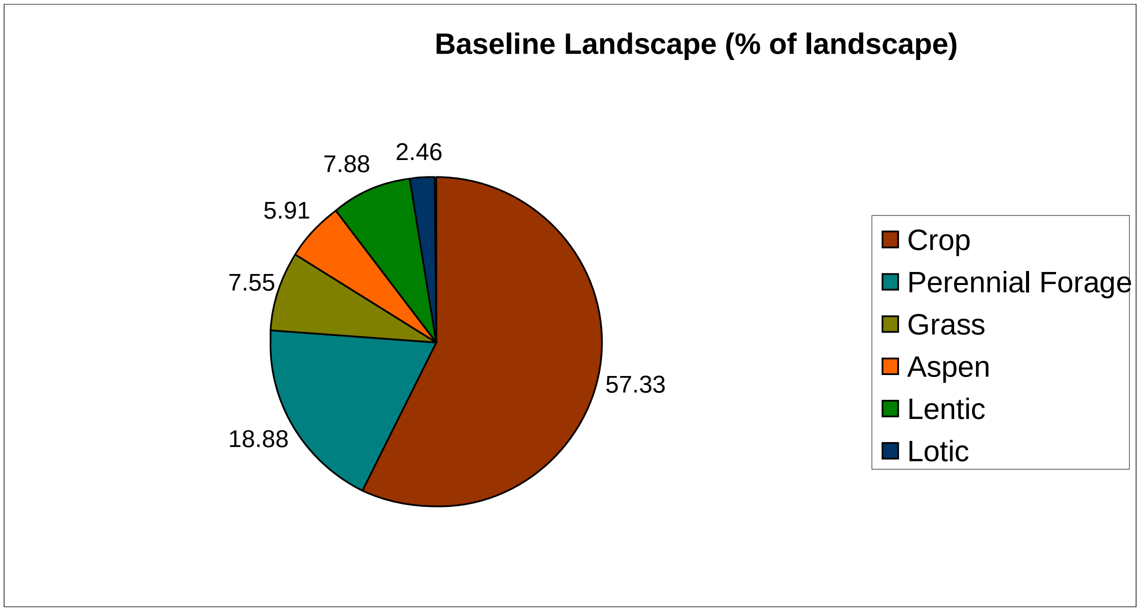

Figure 1. Baseline habitat categories of the Silverwood, Reciprocity and Storthoaks Rural Municipalities.

In order to develop an analysis of the impact of policy scenarios on the habitat provided by the sample landscape within the Lower Souris Watershed an understanding of the potential for economic instruments to alter land management is required. For example, if an agri-environmental economic incentive provided to a land owner is not large enough to offset the costs of adopting the conservation management – including the opportunity cost of the land, the transition costs to change management and the transactions costs involved in settling the contract – then the conservation management will likely not be adopted. While these costs will be variable from farm to farm and even from field to field, an indicator that can be used as a partial proxy for these costs is the land assessment value for each quarter section. The magnitude of the land assessment value corresponds to the relative productivity of the land and in this study will be used to represent the opportunity cost of the land.

Within the sample landscape the relationship between the magnitude of the land assessment and the land use on that quarter section indicates land with lower assessment values will have lower opportunity cost imposed by allocation to higher quality wildlife habitat (Figure 2; Figure 3). For example, Figures 2 and 3 shows that, in general, land with a higher assessment value will have fewer acres of native habitat (defined as areas of aspen, grass, lentic and lotic wetlands) and more acres of cultivated land (defined as crop and perennial forage land) and vice versa. To provide a general sense of this relationship the linear trend lines in these figures suggest that the area of habitat on a quarter section will decrease by 1 acre with each increase in assessment value of approximately 190 units. This analysis tends to support the approach to agri-environmental policy, where the improvement of wildlife habitat is a specific objective, that targets land with lower assessment value as it will likely have greater areas of existing wildlife habitat. In addition, owners of these lower assessed lands will tend to have lower opportunity costs associated with adopting conservation management and as a result are more likely to adopt the agri-environmental measure at lower compensation levels. Therefore, in general, the following analysis adopts the assumption that the habitat objectives of the different scenarios will be met by changing land use on land with lower assessment values.

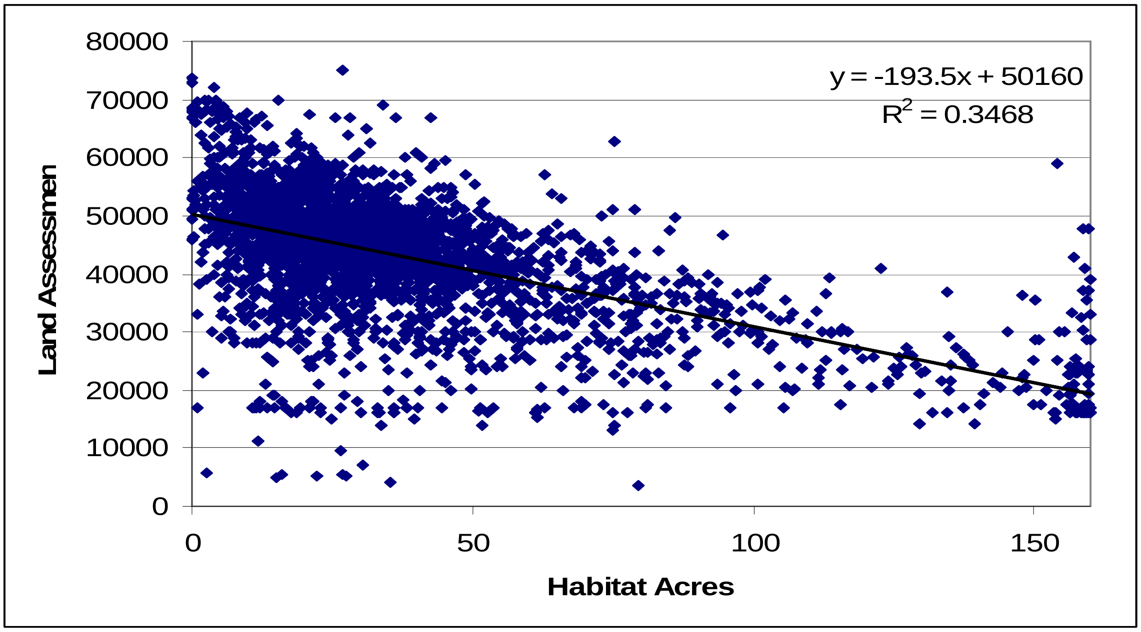

Figure 2. Scatter plot of quarter sections in study area showing linear trend line and correlation between land assessment and acres of native habitat (aspen, grass, lentic and lotic wetlands).

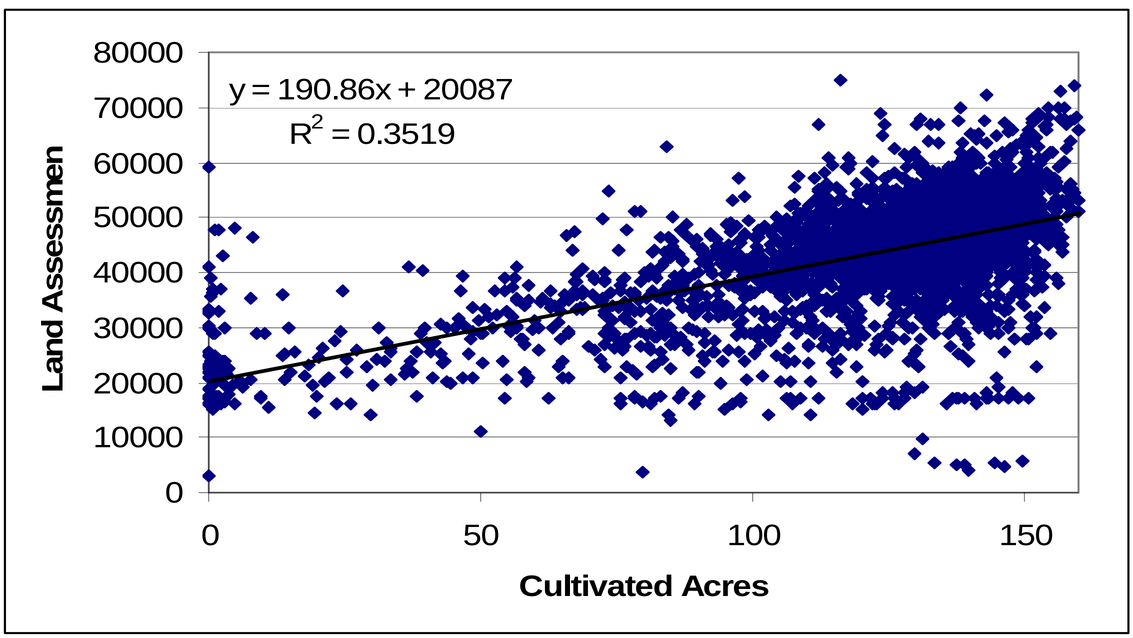

Figure 3. Scatter plot of quarter sections in study area showing linear trend line and correlation between land assessment and cultivated acres (crop and perennial forage).

Habitat Scenarios

Habitat Scenario #2

Consistent with the scenarios developed in White (2008) the present analysis evaluates different land cover scenarios. Scenario 1 presented in the White (2008) report requires an almost complete conversion of the landscape to annual crop. This was deemed by the author as not an interesting scenario for the present analysis so it was not carried out.

The first scenario developed here is analogous to Scenario 2 in White (2008). In this scenario there is extensive conversion of upland cover types (crop, grass, aspen) to perennial forage (Table 3; Figure 2). However, within the landscape the baseline areas of lentic and lotic wetlands are maintained such that the total area of wetland will be non-decreasing. It should be noted that it is possible that wetland areas that were formerly located within cropped fields, that were not physically drained to enable cultivation, may, over time, transition back to wetland vegetation in the absence of cultivation pressure. The program costs of this landscape change are calculated based on the results provided in Dollevoet et al. (2008). These authors found that converting annual crop land to tame pasture provided landowners an annual net benefit of $9.98/acre. This result would imply that landowners will adopt this management change without any additional incentive or payment program. However, the fact that 57% of the sample landscape is currently in annual crop and only 19% is in perennial forage is a strong indication that other factors such as individual farm make-up, accepted management practices and personal preferences are influencing land use decisions.

Table 3. Habitat Scenario #2 - Landscape habitat types and area within the sample landscape.

Habitat Type	Landscape (acres)
Crop	0.00
Perennial Forage	444817.39
Grass	0.00
Aspen	0.00
Lentic	39093.01
Lotic	12179.07
Total	496089.46

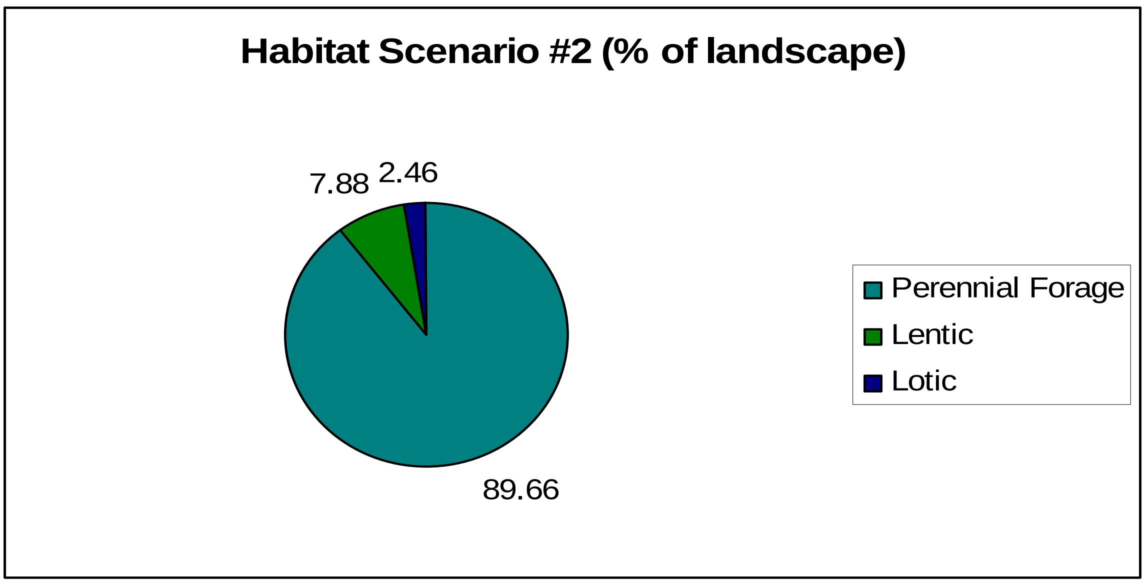

Figure 4. Habitat categories under habitat scenario #2 in the Silverwood, Reciprocity and Storthoaks Rural Municipalities.

Based on the present land allocation pattern in the sample landscape it is assumed that some form of financial incentive is required to encourage landowners to convert annual crop land to perennial forage. Fortunately there are a number of examples of incentive-type programs that have been implemented with the objective of converting annual cropland to perennial cover. The Greencover program, implemented in the past by Agriculture and Agri-Food Canada, required a 10 year agreement to convert annually cultivated land to perennial forage. This program provided a $20.00/acre payment to establish the cover and then an additional $25.00/acre payment once the forage was deemed established (it is assumed here this would be in the second year after seeding). Based on a 10% discount rate the present value of Greencover payments are equivalent to $4.07/acre/year for the 10 year contract. A second approach, that has been implemented with success in the Lower Souris Watershed, is a one time $25.00/acre payment provided by the Provincial Government through the Saskatchewan Watershed Authority (Soloudre, 2009) to landowners who agree to convert annually cultivated land to perennial forage for a 10 year period (Table 4).

Another category of land conversion required in habitat scenario 2 is the conversion of native grass and aspen to perennial forage. Dollevoet et al. (2008) reported that the conversion of aspen to perennial forage imposed a cost on the landowner of approximately $2.93/acre/year. Therefore, it is assumed that an annual payment of at least $2.93/acre would be required for landowners to agree to convert aspen to perennial forage (Table 4). These same authors did not calculate the economic impact of converting native grass to perennial forage so this value can not be included in the analysis.

Table 4. Land cover changes and program costs for habitat scenario #2

Habitat Change	Acres affected	Financial cost (benefit)	Annual Program Cost ($/acre incentive)
Crop to perennial forage	284,423	$9.98	$711,057.50 ($2.50/ac/yr)
			$1,157,601.61 ($4.07/ac/yr)
Grass to perennial forage	37,442	-$2.93	$85,854.86 ($2.93/ac/yr)
Aspen to perennial forage	29,302		

Scenario 2 results in the complete conversion of annual cropland, grassland and aspen to perennial forage with Lentic and Lotic wetlands remaining. To consider the marginal influence of this scenario on wetland habitat the land context of the wetlands was evaluated. While it is beyond the scope of this study to determine the specific land use context for all wetlands within the study area, and indeed the land cover data is not detailed enough to determine these patterns, it was assumed that wetlands located within quarter sections that were dominated by annual crop would be more likely to provide improved habitat conditions than those wetlands located in quarter sections dominated by perennial cover.

The area of wetland located within quarter sections that were dominated by annual cropland was calculated. Within quarter sections that had 80 acres or more of cropland there were 26,296 acres of lentic wetlands (67% of the study area lentic wetlands) and 4,554 acres of lotic wetlands (37% of the study area lotic wetlands). Based on these results habitat scenario 2 would improve the habitat provided by approximately 67% of the lentic wetlands and 37% of the lotic wetlands located in the study area. Dollevoet et al. (2008) reported that draining wetlands located in cropland provided a net benefit to landowners of $79.55/acre/year but draining wetland in pasture imposed a cost of $38.66/acre/year. Therefore, the conversion of annual cropland to perennial forage appears to provide an incentive to not drain wetlands. Based on these values, the approximately 26,296 acres of lentic wetlands conserved, and potentially improved in terms of habitat quality provided, by habitat scenario #2 would require an equivalent annual payment of approximately $2 million to offset the costs of maintaining wetlands within annually cultivated land. It is worthwhile to note that the Alternative Land Use Services (ALUS) program pilot in the Blanshard municipality of western Manitoba has compensated farmers $15.00/acre to conserve wetlands with no use, $7.50/acre with haying and $5.00/acre with grazing allowed.

Scenario #3

Another scenario presented in White (2008) is characterized by the full range of habitat types being represented on the landscape (scenario #3). In the present analysis the scenario preserves that spirit by maintaining the area of grass, aspen, lentic and lotic wetlands. The remainder of the landscape is approximately equally allocated to perennial forage and annual crop (Table 5; Figure 3). This scenario requires the conversion of 95,433 acres of cropland to perennial forage. As discussed earlier, it is assumed that less productive land, as represented by a lower land assessment score, would be the first land converted due to, on average, this land imposing lower opportunity cost on the landowner when converted from annual crop production.

Table 5. Habitat Scenario #3 - Landscape Habitat types and area.

Habitat Type	Landscape (acres)
Crop	188989.96
Perennial Forage	189083.46
Grass	37442.45
Aspen	29301.52
Lentic	39093.01
Lotic	12179.07
Total	496089.47

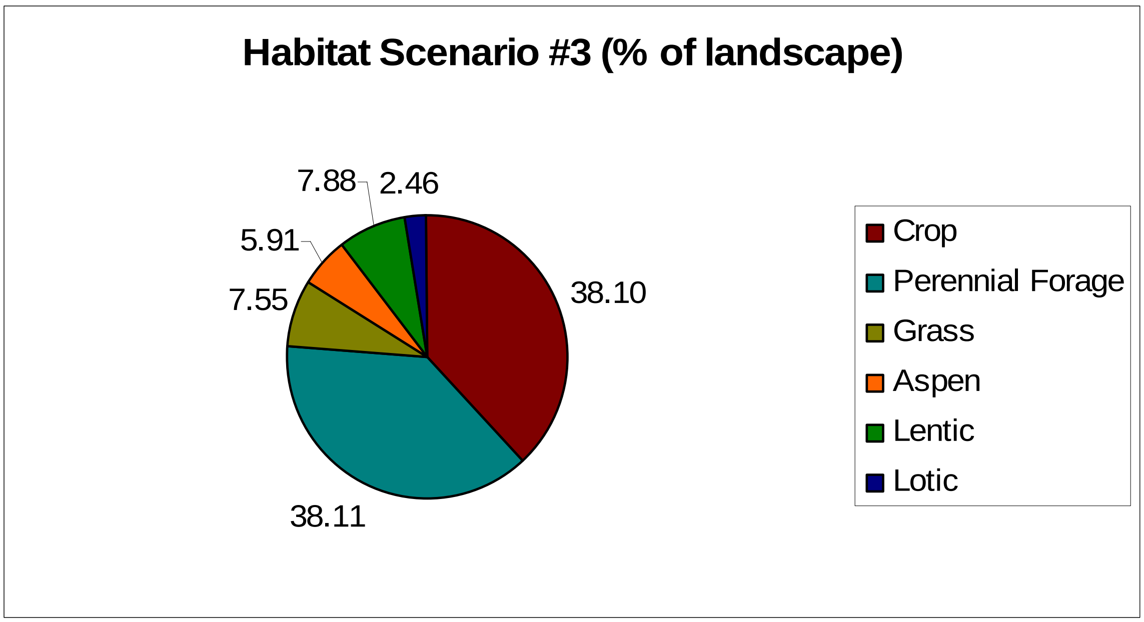

Figure 5. Habitat categories under habitat scenario #3 in the Silverwood, Reciprocity and Storthoaks Rural Municipalities.

The process used for selecting land to convert from crop to perennial forage was to choose quarter sections, beginning from the land with the lowest land assessment, until 95,433 acres of cropland was converted. The cost of this program, using the incentive values discussed for scenario #2 are reported in Table 6. This approach necessarily assumes that any quarter section targeted will convert all of the existing cropland to perennial forage. When considering only those quarter sections that have at least 5 acres of crop land, to meet the habitat objective of this scenario requires the conversion of crop land to perennial forage on approximately 887 quarter sections of land. This scenario will result in a total of approximately 1463 quarter section (46% of all quarter sections in the study area) (887 quarters with converted cultivation and 576 quarters with existing perennial cover) that are completely allocated to perennial vegetation within the target landscape. The total habitat area included in these 1463 quarter section is reported in Table 7. On these quarter sections the habitat quality of the 18,288 acres of lentic wetlands and 8,997 acres of lotic wetlands will be improved with more of the surrounding uplands in perennial vegetation.

Table 6. Land cover changes and program costs for habitat scenario #3

Habitat Change	**Acres affected**	**Financial cost (benefit)**	**Annual Program Cost ($/acre incentive)**
Crop to perennial forage	95,433	$9.98	$238,582.50 ($2.50/ac/yr) $388,412.31 ($4.07/ac/yr)

As discussed in scenario #2, to quantify the incremental changes to wildlife habitat that are provided by the land conversion program, it is more appropriate to consider the area of wetlands that fall within quarter sections that are predominantly annually cultivated before the implementation of the conversion program. Within these quarter sections the uplands around the wetland stock is more likely to be cultivated in the baseline landscape. Those quarter sections that have greater than 80 acres of cropland that are converted to perennial forage in this scenario contain approximately 9,780 acres of lentic wetlands and 2,113 acres of lotic wetlands. As discussed before the incentive to conserve wetlands due to conversion to perennial forage provides wetland conservation values equivalent to $777,999.00/year, assuming that in the absence of the conversion to perennial forage landowners would need to be compensated the opportunity cost of wetland conservation ($79.55/acre/year) as reported in (Dollevoet et al. 2008).

Table 7. Habitat area on quarter sections completely allocated to perennial vegetation under habitat scenario #3.

Habitat Category	**Habitat area on 1463 quarter sections**	**Habitat area on quarters with >5 acres of crop (887 quarters)**	**Habitat area on quarter sections with >80 acres of crop**
Crop converted	95,432.78	95,071.34	86,146.15
Existing Perennial Forage	57,147.06	9,756.37	2,466.79
Grass	29,202.19	10,283.94	5,433.51
Aspen	19,949.89	9,109.00	4,854.04
Lentic	18,287.99	11,677.38	9,780.49
Lotic	8,997.29	3,629.95	2,113.16

Economic Targeting Analysis

In the analysis up to this point the scenarios have assumed that the habitat program targeted land with the lowest opportunity cost as represented by land assessment values. To evaluate the influence that targeting quarters with higher assessment values may have on the quantity of habitat provided, the land conversion objectives of habitat scenario #3 was estimated again by targeting land with assessment values that fall above the median for the sample landscape. As described earlier, targeting land with the lowest assessment, meeting the habitat requirements will require the conversion of crop land to perennial vegetation on 887 quarter sections of land each with greater than 5 acres of crop land in the baseline (28% of the quarter sections in the landscape). The targeted quarter section in this approach have assessment values ranging from 3,600 to 43,900. When targeting quarter sections with intermediate assessment values (44,600 to 50,100) the conversion of cropland to perennial forage will occur on 761 quarter sections (24% of the quarter sections in the landscape) (Table 8). Under these two targeting scenarios the habitat contribution can be compared. The results show that the intermediate assessment land has only 35% of the native grass that the low assessed land provides, 53% of the area of aspen cover, 35% of the lotic wetlands and 88% of the lentic wetlands. Therefore, the stock of native habitat will be significantly smaller if targeting moderately assessed land. Further, converting this land to perennial forage will impose higher opportunity costs on farmers making many less willing to adopt the management change. However, the fact that fewer quarter sections will need to be contracted (761 versus 887) will decrease the delivery costs of the program. To expand this analysis of targeting, targeting only the highest assessment values (49,300 to 75,000) will require 800 quarter sections (25% of the quarter sections in the landscape), each of which with greater than 5 acres of cultivated land (average of 134 acres per quarter), to meet the requirement. However this land only provides 7,181 acres of lentic wetlands (Table 8). In general this analysis shows that targeting higher value land, while not only requiring greater levels of compensation to offset the higher opportunity cost of the land, also does not provide as much existing native habitat in the target landscape. As a result, the conversion of cultivated land to perennial forage on these lands will not provide as many habitat benefits simply due to the fact that there are less other habitat types (wetlands, aspen,

Table 8. Habitat area on quarter sections targeted at different land assessment values

Habitat Category	Habitat area on low assessment quarters with >5 acres of crop (887 quarters)	Habitat area – Median Assessment on quarters with >5 acres crop (761 quarters)	Habitat area – High Assessment on quarters with >5 acres crop (566 quarters
Crop converted	95,071.34	95,254.46	95,169.79
Perennial Forage	9,756.37	5,302.37	9,691
Grass	10,283.94	3,590.31	2,770.42
Aspen	9,109.00	4,838.49	3,083.61
Lentic	11,677.38	10,339.12	7,181.79
Lotic	3,629.95	1,281.80	1,316.42

native grass) that the additional area of forage will complement. This simple assessment suggests that targeting lower assessed lands to convert cultivation to perennial forage is not only less expensive but will also likely provide greater habitat benefits.

Conclusion

The analysis presented in this report provides insight into the impact that land management payments will have on the provision of wildlife habitat within Lower Souris Watershed in South Eastern Saskatchewan. It is anticipated that information from this study will help direct program to increase the provision of ecological goods and services from agricultural landscapes. The analysis is based on land cover and land assessment data for three municipalities within the watershed. While these municipalities are reasonably representative of the watershed scaling up of these results to develop policy recommendations for the entire watershed should be done with caution. In addition, in the absence of detailed, spatially referenced information, the habitat implications of the program scenarios can only be predicted based on general trends of land cover and as such will not precisely reflect the landscape. However, the results appear to provide a useful summary of the ecological goods and services implications of the programs evaluated.

Literature Cited:

Agriculture and Agri-Food Canada Prairie Farm Rehabilitation Administration District Office, 2008. Map Document: O:\Arc_Maps\Four Creeks Watershed\Lower Souris Plannin Area 2000 Landcover by percentage. Mxd.

Dollevoet, B., S. Koeckhoven, S.R. Jeffrey and J. Unterschultz. 2008. Lower Souris Watershed Ecological Goods and Services Pilot Proposal: Farm Level Economic Analysis. Deparment of Rural Economy, University of Alberta. Project Report.

Soloudre, E. 2009. Personal communication.

White, C.L. 2008. The Relationship Between Wildlife and Habitat Quality and Quantity in the Lower Souris Watershed. Lower Souris Watershed Ecological Goods and Services Project: Literature Review of State of Knowledge for Landscape Targets. Saskatchewan Watershed Authority.