University of Alberta

Farm Wealth Implications of Ecological Goods and Services Practices and Policies

by

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Abstract

Ecological goods and services (EG&S) represent the benefits that humans derive from ecosystem functions. The private wealth implications of on-farm EG&S practices that promote wildlife habitat are determined for the Lower Souris River Watershed in South-eastern Saskatchewan. Monte Carlo simulation is used, coupled with NPV analysis, to examine the impacts of practices at a representative farm level. Linear programming is utilized to determine the farm wealth implications of imposing landscape targets across selected parts of the study area.

In both models, implementing an EG&S policy or practice comes with costs to farm wealth. Potential exceptions include converting cropland to tame pasture, and EG&S enhancing herd management practices. However, without policy intervention there is continued conversion of native prairie, perennial forage, and lotic riparian landscapes to cropland. Imposing landscape targets preserves these landscape uses, but with a loss in private economic value ranging from $3,196 to $7,179 per quarter section.

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1 Introduction

1.1 Background

Ecological goods and services (EG&S) represent the benefits that humans derive from ecosystem functions (Prairie Habitat Joint Venture, 2005; Costanza et al., 1997; Costanza et al., 1998). EG&S can be categorized into four separate categories: provisional services, regulating services, cultural services, and supporting services (Millennium Ecological Assessment, 2005; Swinton, 2008) (explained further in section 2.2). Examples of EG&S include groundwater recharge, flood and erosion control, carbon sequestration, biodiversity, and air and water purification. EG&S may provide benefits to people whether they are aware of it or not. Whether it is the clean air they breathe, the clean water they drink, or the sight-seeing of wildlife they enjoy, people attach value to protecting and enhancing EG&S. For this reason, if property rights could easily be distinguished for an individual's clean air, the price he or she would be willing to pay would likely be substantial.

Farmers maintain and manage land for food production and concurrently provide EG&S through the preservation of healthy ecosystems. Depending on land management practices, farmers have the ability to increase, hold steady, or decrease the level of EG&S production. Historically, land use practices have served mainly for the purposes of provisional services (i.e. food production), usually at the expense of environmental protection (Ruhl, 2008; Olewiler, 2004). However, EG&S production may be further increased through implementation of specific agricultural practices and programs. Examples of these practices include, but are not limited to: buffer strips, rotational herd management, no-tillage seeding, and habitat conservation. Some of these practices can be implemented at no cost to the farmer, while others result in a hindrance to farm profitability (e.g., Koeckhoven, 2008; Brethour et al., 2007). In fact, farmers may have direct incentives to decrease the level of EG&S production. For example, a farmer may use herbicides to reduce pest weeds in crop production, and at the same time, pollute nearby waterways. As a result, there may be limited private incentives to increase EG&S production on the agricultural landscape.

One form of EG&S is the conservation and enhancement of wildlife habitat. White (2008, pg. 2) defines wildlife habitat as "a distinct set of physical environmental factors that a species uses for survival and reproduction". Wildlife habitat is unique in that it affords EG&S through all the categories of ecosystem services as described by Swinton (2008), meaning provisional, regulating, cultural, and supporting services. With regards to cultural services, wildlife habitat is an important recreational resource in Canada (van Kooten, 1992). Belcher et al. (2001) estimated that society benefits $10.71/hectare/year for increased wildlife hunting, and $4.16/hectare/year for increased wildlife viewing in the Upper Assiniboine River Basin. With regards to supporting and regulating services, wildlife habitat can preserve wildlife species required for predator-prey relationships that

stop the form of pathogens, and can increase soil quality for food production through gradual decomposition. This is discussed further in section 2.2.

Farmers can manage their respective lands to enhance wildlife habitat areas. Miller (2002) found that farmers can achieve stable and favourable financial results when using a conservative grazing strategy that promotes a healthy range. Many farmers utilize available programs to plant shelterbelts and woodlots that both increase wildlife habitat, and provide protection to crops from wind and pests (Agriculture and Agri-Food Canada, 2001). Despite this, the problem of wildlife habitat preservation in the face of alternative land uses that displace wildlife is still widespread. According to Agricultural and Agri-Food Canada (2007-b, pg. 1), "since the late 1800s, nearly 99% of the wild mammal biomass has been eliminated in the prairie and parkland biome". Specifically, agriculture land use practice continually encroaches into wildlife habitat areas to retrieve the full market-value out of the land (Cortus, 2005; Ruhl, 2008; Heimlich et al., 1998). This suggests that the private costs of maintaining wildlife habitat on agricultural land exceeds the private benefits. However, given there might exist a substantial social (i.e. public) benefit in wildlife habitat protection, there is potential for conflict with regards to the appropriate level of wildlife habitat on the landscape.

1.2 Economic Problem

There are conflicting interests at work in decisions related to the provision of wildlife habitat on the agricultural landscape. Agricultural practices that increase the level of food production but also decrease the level of EG&S provided by wildlife habitat may result in a net loss to society. Conversely, those practices that may be employed by farmers to further increase EG&S production may provide a net social benefit but also a cost to the farmer, and are therefore not implemented. For this reason, there is likely a need for government intervention to realize the socially optimal level of wildlife habitat.

The type of intervention to use for wildlife habitat conservation is unclear. Pannell (2008) provides a framework for choosing alternative policy schemes for land-use change for environmental improvement. Pannell states that the policy chosen should depend on whether public and/or private net benefits associated with a land-use action are positive or negative, and the relative magnitude of the result in changing private or public net benefits. Furthermore, the policy action should also depend on the changing of circumstances from the land-use change that is sought from the policy (Pannell, 2008). For example, if a farmer restores a riparian area by blocking a drainage ditch, and the public net benefits of increased waterfowl habitat outweigh the costs the farmer receives from having land out of production, then there is justification for a positive incentive from the public to the farmer. Conversely, consider a scenario where a farmer ploughs native range to seed for crop production. Here, the decrease in public net benefits due to soil integrity and native prairie wildlife habitat loss outweigh the private benefits the farmer enjoys from increased crop production. In this case there is justification for an negative incentive policy, such as regulation or a tax (Pannell, 2008).

The types of policy mechanisms that may be utilized for wildlife habitat enhancement or conservation include positive incentives or negative incentives, such as financial instruments; extension policies, such as technology transfer, education, and communication; or technological innovation, such as research and development into technologies to improve use of existing land, and new land management constructs (Pannell, 2008). However, there is limited information as to the change in private or public net benefits resulting from various land-use actions.

Unless there is information available regarding the extent of public and private net benefits associated with alternative land uses, the choice of policy to realize a targeted level of wildlife habitat for a region remains uncertain. For a policymaker to properly evaluate the trade-off between the EG&S benefits of wildlife habitat and additional land for agricultural production, one must be able to compare the value of EG&S lost versus the value of provisional services gained (Costanza et al., 1998; Daly, 1998). However, public benefits are difficult to determine, as there is often no market mechanism to provide price signals (Kroeger and Casey, 2007). To warrant this, there have been studies undertaken that attempt to measure the social value or public benefit of wildlife habitat conservation (Phillips et al., 1993; Kramer and Jenkins, 2009; Kulshreshtha and Loewen, 1997).

The purpose of this study is to determine the change in private net benefits of various land-use practices and policies that either maintain or enhance the level of wildlife habitat on the agricultural landscape. Combined with the information from other studies regarding valuation of the public benefits of conserving wildlife habitat, this study provides policymakers with an effective dataset as to determine appropriate policy-making. Previous studies have determined the private net benefits or costs to farmers of providing other types of EG&S production (e.g., Miller, 2002; Cortus, 2005; Koeckhoven, 2008). This study focuses on the EG&S afforded through wildlife habitat provision. EG&S from wildlife habitat encompasses a wide spectrum of landscape types, along with the respective habitat quality associated with various landscape types.

1.3 Research Problem and Objectives

In this study, the opportunity cost or benefit to farmers of maintaining, and improving wildlife habitat is considered. The study focuses on farmers in the Lower Souris watershed region in southeast Saskatchewan. The goal here is to quantify private net benefits or costs associated with land use practices and potential land use changes that promote EG&S production within the watershed. In this manner, dollar amounts of benefits or costs can be compared to results from valuation studies of wildlife habitat in a social welfare benefit-cost analysis. However, since a valuation study of the public benefit of wildlife habitat has not been done for the Lower Souris region, this study does not undertake a social welfare benefit-cost analysis to derive conclusions.

First, a representative farm for the region is defined and used to determine the net benefit or cost of implementing practices that promote wildlife habitat conservation and

restoration. Here, the objective is to determine which on-farm practices can be implemented that result in the most public (EG&S) benefit and least private cost to farmers. It is expected that greatest EG&S practices will result in a private cost to farmers. However, another objective was to determine whether there any possible practices that may result in a private benefit to farmers in the Lower Souris region.

The second part of the study seeks to determine the cumulative impact on farmers, meaning the total change in farm wealth across all farms in a specific area, of a regional EG&S policy that promotes wildlife habitat conservation. Analysis is done on the farm wealth impact across a large land area, equal to a township of agricultural land. Considering the cumulative impact on private net benefits provides information useful for policy decisions, as efficiencies could be gained in the preservation of wildlife habitat across neighbouring farms. In this manner, the actual cumulative cost to individual farmers of preserving large tracts of wildlife habitat can be determined.

Other specific objectives were considered in this study, as follows:

- The nature of landscape change required to ensure maintenance of targeted levels of wildlife habitat is examined. These results may be used to predict land-use change trends from wildlife habitat preservation policy that may occur in regions similar to the one utilized for the current study.

- The net costs or benefits associated on-farm practices are analyzed in order to determine which practices may increase EG&S production at the least cost to farmers. These comparisons provide information for policy-makers as to what may be the least costly on-farm practice to promote on the agricultural landscape. In addition, light is shed on whether there are certain agricultural land use practices that would provide both increased wildlife habitat and a financial benefit to farmers if they were implemented.

- The impact of enforcing a wildlife habitat EG&S policy on farmers specifically within the study area is determined. The preservation and enhancement of wildlife habitat is a pressing issue in the region, and the impact of current land use practices is a sensitive topic for farmers. Through the research presented in this study, land-use planning and policy recommendations for providing EG&S for public benefit can be established with specific regard to the impact on farmers in the region

The objectives of the second part of the study are achieved through linear programming optimization, which is explained further in Chapter 4. It is important to note that a model of this nature has not been utilized to inspect the impact of EG&S practices on farmers, or other firms that seek to determine the impact of environmental policy. In this sense, this study serves to act as a proof of principle of using a linear programming approach for these purposes. Many of the objectives listed above (i.e. the total amount of expected landscape change) could not have been properly answered without the use of linear programming.

1.4 Organization of the Study

The remainder of this thesis is divided into six chapters. In Chapter 2, further background information is provided regarding the research and economic problem addressed in the study. A review of the importance of protecting and enhancing land for wildlife habitat to society and people is undertaken. A review of studies that attempt to assign a value to EG&S and wildlife habitat is provided. This leads to a general discussion about the relationship between wildlife habitat and agricultural practices and a synthesis of existing farm programs and policies to encourage wildlife habitat protection.

In Chapter 3, the study area in question is introduced and described. The Lower Souris region's geographical area, wildlife and landscape types, and vegetative land-use mix across the watershed is discussed. From this, the activities that influence wildlife habitat in the region can be generalized. This is followed by a review of the descriptive statistics derived from Agricultural Census data for the region, from which a representative farm was established.

Chapter 4 provides background on the modelling structures utilized, and the economic theory that encompasses these structures. A review of capital budgeting modelling and Monte Carlo simulation used for the representative farm simulation model is provided. The economic theory behind linear programming for resource allocation is then described. Finally, the general theory behind hedonic estimation models specific to land use is provided. The chapter presents the general structure of the two models used in the study.

The empirical methods used to carry out the modelling are presented in Chapter 5. First, the work to construct the representative farm simulation model (RFSM) is discussed, including the development of stochastic variables and biophysical relationships within the model. Following this is a breakdown of the steps taken to construct the landscape target optimization model (LTOM). A description of the scenarios imposed on the RFSM, and the land-use targets imposed on the LTOM is provided. The results from these analyses are presented and discussed in Chapter 6.

Finally, Chapter 7 presents the conclusions from the research study. Conclusions relate to the potential extent of positive incentives required for habitat enhancement, and other forms of policy that may be utilized for the region given the results. The limitations of the empirical methods and possible future research extensions end the chapter.

2 Chapter 2: Preliminary Research

2.1 Overview

This chapter presents the background and issues relevant to the research objectives of this study. It is a general discussion of previous studies, literature, and types of programs and policies specific to the research problem. It gives explanation as to the purpose of the study, the problems around the research question, and the usefulness of results and conclusions with regards to policy decision-making. Through reading the background and issues of the research problem, justification for undertaking of this study is established. Furthermore, an overview of existing studies that determine the public benefit of the EG&S afforded from wildlife habitat is given for comparison purposes. The results of this study can be compared to valuations of public benefit of wildlife to determine to what extent policy is warranted.

This chapter provides insight into what wildlife habitat conservation entails, and whether conservation aligns with current agricultural practices. Wildlife habitat conservation is important because society may attach a substantial positive value to a habitat's existence. An explanation as to the various benefits society receives from wildlife habitat is explained here. However, farmers may have direct incentives to reduce the amount of wildlife habitat. The continual conversion of habitat to agricultural land uses has led to private wealth benefits for farmers. As a result, a number of farm programs have been designed in recent years to conserve wildlife habitat.

2.2 EG&S Production

This section provides a general review of literature associated with EG&S production. To reiterate, EG&S are the direct benefits that humans receive from nature (Prairie Habitat Joint Venture, 2005; Costanza et al., 1997; Costanza et al., 1998). There are many types of EG&S, a few of which were described earlier in Section 1.1. Swinton (2008, pg. 28) clarifies four broad categories of ecosystem services (i.e. EG&S) as determined by the Millennium Ecological Assessment (2005):

- *"Provisioning services* include food, fiber, wood, fuel and fresh water that provide for human subsistence.
- *Regulating services* maintain the balance of the Earth's systems at levels that enable human survival. These services include climate, flood, water quality, and disease regulation. Examples include vegetation that buffers the effects of natural flooding, or predator–prey systems that limit the spread of pathogens.
- *Cultural services* include the spiritual, inspirational, aesthetic, heritage, recreational and tourism benefits.
- *Supporting services* include the myriad natural systems that enable the three tiers above. For example, organic matter cycling contributes to soil creation,

which makes food provisioning possible. Photosynthesis transforms solar energy into plant matter, enabling provisioning services, carbon cycling, and various other services."

The types of EG&S that humans receive from wildlife habitat are numerous and fall across each of the above categories. Wildlife provides many assorted uses for people, including food, bird watching, nature enjoyment, and a number of recreational activities. However, non-users of wildlife habitat attribute value in preserving habitat due to concern over issues including species at risk, ecological fragmentation, climate change, threats from introduced disease and exotic species, and decreased biodiversity (Environment Canada, 2000). This concern for wildlife habitat conservation has resulted in a steady increase in membership for conservation organizations, and high expectations of government agencies for conservation action (Environment Canada, 2000). As such, the benefits of wildlife habitat conservation are sufficient to induce government policies that protect habitat on the agricultural landscape.

Wildlife habitat users often place the highest value on wildlife habitat protection. Phillips et al. (1993) found that hunters and anglers that participated in the Buck for Wildlife Program (Macnab and Brusnyk, 1993) were willing to pay upwards of $767.63 per acre to improve wildlife habitat quality. Furthermore, it is clear that there are a substantial number of wildlife habitat users in Canada. In a 1991 survey, the Canadian Wildlife Service found that an estimated 91% of Canadians were involved in wildlife-related recreational activities (Filion, 1993). These users understand that the fate of wildlife is directly tied to the fate of its habitat (Saskatchewan Wetland Conservation Corporation, 2009). Access to wildlife habitat areas is also important for occasional sightseeing, hiking, camping, and other sports for outdoor enthusiasts (Environment Canada, 2000). Recently, wildlife recreation activities have emerged as an increasing income stream for farm operators (Henderson and Moore, 2006). People, whether from urban or rural areas, use wildlife habitat directly.

The non-use value of wildlife habitat conservation may be much more significant to society than the use value. Non-use, or 'passive use' value exists where people associate value to the protection of wilderness area, despite not belonging to a particular user group. People may place considerable value in keeping species such as elephants, tigers, and rhinoceros intact, despite never seeing these species in their lifetime (Bulte et al. 2003). As mentioned above, there is growing concern over global issues such as species at risk, decreasing biodiversity, and ecological integrity that in part, stem from wildlife habitat loss. In this context, loss of wildlife habitat can be characterized as a global problem as everyone receives benefit (at various levels) from keeping habitat intact. Wildlife habitat also provides regulating and supporting services through its existence, rather than just assisting in mitigating problems. Wildlife habitat affords increased water filtration, germination, pest control, nutrient cycling, soil generation, pollination, carbon sequestration, and environmental quality for pollutant degradation, on which a functioning healthy ecosystem depends (Egan et al., 1995). As for provisional services,

many medicines, consumer products, and advances in science can be attributed to wildlife habitat preservation (Egan et al., 1995).

The benefits of preserving wildlife habitat are not lost on Canadians, as indicated in the 1996 survey by Environment Canada. The survey titled "*The Importance of Nature to Canadians"* (Environment Canada, 1999, pg. 11) found that "an estimated 9.0 million Canadians (38.3 percent of the population aged 15 years and over) participated in residential wildlife-related activities". Furthermore, the survey found that "an estimated 4.4 million Canadians (18.6 percent of the population aged 15 years and over) participated in wildife viewing in Canada" (Environment Canada, 1999, pg. 11). In the same survey initiated in 1991, it was found that 86% of Canadians believe that it is important to maintain abundant wildlife, while 83% of Canadians believe that endangered or declining wildlife species need to be protected (Filion, 1993). Although wildlife habitat has not historically been thought of as contributing to human welfare, Canadians are becoming increasingly aware of the benefits of its maintenance.

2.3 Valuation of EG&S

The nature of most EG&S, especially those that fall in the regulating, cultural, and supporting service categories, is such that the benefits and costs of levels of production are difficult to ascertain through a market mechanism. For example, land allocation based on the 'private' productive capability and for housing and urban development is quite efficient with respect to reflecting current price signals. However, the public benefits of the land, which include other EG&S, are not captured within these land values (Bowker, 1994). Because of limited incentives for EG&S due to a lack of market mechanisms, EG&S are often not provided efficiently (Polasky, 2008). The nature of most EG&S is such that the amount of good or service available changes over time. Consumers are unaware of what level of benefit they retrieve from EG&S, and the amount of EG&S left for future use is uncertain after consumption (Prairie Habitat Joint Venture, 2005). These challenges make up most of the difficulty economists face in placing a value for given levels of EG&S.

Despite the challenges, a number of methods have been developed to try to properly assign value to EG&S production. Farber et al. (2002, pg. 375) clarify the term 'value' to mean "the contribution of an action or object to user-specified goals, objectives or conditions". In the context of EG&S, value is the contribution of an ecological good (e.g., biodiversity) to human welfare. 'Valuation', on the other hand, is the "process for expressing a value for a specific object or action" (Farber et al., 2002, pg. 376). Typically, this process is achieved for non-market goods and services through either a revealed preference approach, such as travel cost or hedonic methods, or an expressed preference approach, such as conjoint analysis or contingent valuation (Heimlich et al., 1998). Studies where the public benefits of EG&S are derived typically use one or more of these approaches.

There are often large discrepancies as to the results generated from valuation studies. In a meta-analysis of wetland valuation studies, Brander et al. (2006) found that these studies are diverse in terms of the values estimated, and that this was most likely a result of the methods employed and wetland type considered. In fact, of 33 wetland valuation studies done over 26 years the value per acre has ranged from US$0.06 to US$22,050 (Brander et al., 2006). Nevertheless, the non-market valuation of EG&S is required for the purpose of comparison in policy development.

A number of studies have attempted to value the benefit from wildlife habitat preservation or enrichment. Determination of the existence value of wilderness in Saskatchewan is the objective of a study by Kulshreshtha and Loewen (1997). Specifically, the study estimates the non-use value of wilderness protection. The total economic value of a wilderness area is the sum of the use and non-use values for that area. Open-ended contingent valuation methodology is employed throughout the study. The full dataset, collected from surveys distributed randomly across the province for non-aboriginals and 30 aboriginal households in Prince Albert, were separated by aboriginal versus non-aboriginal to retrieve qualitative willingness-to-pay results specified for aborginal populations (Kulshreshtha and Loewn, 1997). Results give an average willingness-to-pay for non-aboriginals of $60.89 per household, while for aboriginals, willingness-to pay was $80 per household (Kulshreshtha and Loewn, 1997). This would equate roughly to $100 per hectare or $40.47 per acre, considering the number of households in Saskatchewan and the given landscape. Respondents were also asked to assign percentages to the types of use for attributing their payment. The majority of value (approximately 69.4%) was assigned to non-use or passive uses. These results demonstrate that there is merit to having a wildlife habitat protection as a province-wide policy goal, as people place significant non-use value on the existence of wildlife habitat.

A second study used valuation methods to determine farmers' willingness-to-accept wildlife habitat programs. The benefits of EG&S programs associated with conserving red wolf habitat in North Carolina were estimated by Kramer and Jenkins (2009). Kramer and Jenkins (2009, pg. 8) state "through the Red Wolf Recovery Program (RWRP), the U.S. Fish and Wildlife Service manages the only wild red wolf (*Canis rufus*) population in the world". This study used surveys collected from farmers in the program area to determine perceptions of current conservation programs (Kramer and Jenkins, 2009). A total of 298 usable surveys were collected, indicating that 63% of respondents would participate in a payment program to conserve EG&S on their land. Contingent valuation questions were given for both red wolf habitat and general wildlife habitat found in the study area. From these questions, the mean willingness-to-accept of a conservation payment program to provide red wolf habitat was $202 per acre, but only $36 per acre for general wildlife habitat (Kramer and Jenkins, 2009). The results signify that a generic wildlife habitat protection program (rather than one specific to red wolf habitat) would be attractive to farmers, as their willingness-to-accept a generic program is $166 per acre less (202 – 36) than one for red wolf habitat. It is clear that wildlife habitat conservation provides value to individuals and farmers alike.

2.4 Wildlife Habitat and Agriculture

Despite the human benefits from maintaining wildlife habitat, the quantity and quality of this habitat present on Western Canadian agricultural land has been declining historically. Historically, government policihave directly and indirectly encouraged farmers to increase the amount of productive land for crop production, through converting natural pasture, wetlands, and other marginal lands into cropland. For example, at one time governments in Canada and the U.S. provided subsidies to drain wetlands in order to increase the amount of productive land (Danielson and Leitch, 1986; Douglas, 1989). Furthermore, the Farm Credit Act of 1959 encouraged the mechanization and growth of farm size and provided government-subsidized credit to do so (Skogstad, 2007). With the rapid growth of the size of farms, annual cropland became dominant over other land uses due to its alignment with mechanization. The widespread conversion of lands led to a immense loss of habitat across the praire pothole region of Western Canada (van Kooten and Schmitz, 1992). This loss in habitat resulted in a decline in wildlife diversity as explained by Environment Canada: "by 1999, 340 wildlife species in Canada, including 52 birds, had formal classification as species at risk, and three of the 12 species confirmed as extinct were birds." (Environment Canada, 2000, pg. 4).

Farmers continue to expand their respective operations to include more cultivated land. This places strain on forested, riparian, and native grassland areas located across agricultural land. Hobson et al. (2002) completed a study in Saskatchewan that indicated the risk to the boreal forest posed by the rapid expansion of agriculture along its southern border. The authors estimate deforestation rates for central Saskatchewan to be higher than the world average (0.3% per annum) between the years 1966 and 1994 (Hobson et al., 2002). The continued search for agricultural land is but one incentive farmers have to continue wildife habitat loss. There are nuisance and direct costs to farm operations in maintaining wildlife habitat areas on the agricultural landscape. In this manner, farmers might achieve more benefits from clearing wildlife habitat areas, in both forgone costs and added direct benefits, than that individually received from conserving wildlife habitat.

2.4.1 Private Costs of Conserving Wildlife Habitat

Farmers must deal with financial and operational costs in maintenance of wildlife habitat on their land. Areas within the agricultural landscape that provide habitat for wildlife can be difficult to manage from a farm operator perspective. Wetlands and aspen bluffs are spotted across quarter sections leadiung to difficulty in machinery practices (due to driving around these areas), perennial flooding of surrounding land, and a large portion of prime agricultural land being kept out of production. Wildlife may also be a direct nuisance to farm operation, as species such as ducks, deer, moose, and antelope eat and use crops for habitat. Insect species that may prove a pest to farmers may be hatched and

flourish from areas that provide wildlife habitat. For these reasons, farmers may perceive a large cost to maintaining wildlife habitat on their agricultural lands.

Wetlands are a source of significant wildlife habitat on agricultural lands, but might prove unprofitable for farmers to maintain. Cortus (2005) determined the economic feasibility of draining wetlands on farms in eastern Saskatchewan. From this analysis, it was found that a rational farm operator would drain wetland areas, rather than purchase new lands to expand his cultivated land base. The cost of purchasing land in the study area averaged around $640 per hectare, while the cost of draining wetlands was approximately $500 per hectare (Cortus, 2005). Conducting drainage on existing lands was profitable to the farm operator if there was access to a land scaper. Wetland areas do not provide direct financial benefits to crop producers, so the incentive to convert wetlands can be considerable.

Furthermore, in a survey of landowners, Gelso et al. (2009) found that farmers` perceived costs of wetland areas in cropland can be as high as 56% of farmland rental value. This perceived cost of maintaining wetland areas is high enough to warrant conversion of wetland areas to cropland. A large part of this perception may be due to direct nuisance costs associated with maintaining wetlands. Cortus (2005) found that forgone nuisance costs make up approximately 35% of the benefits achieved from draining wetlands, and estimated that total nuisance costs of wetlands were $2,126 to $2,245 for a eight quarter section sized farm ($4,675 to $5,225 for a 16 quarter section sized farm). Similar characteristics can be found in other areas that provide wildlife habitat, such as aspen bluffs, lotic riparian areas, or native range, as these areas are dotted across the agricultural landscape similar to wetlands. The perceived costs of maintaining wildlife habitat on agricultural land may provide a limitation to the success of wildlife habitat conservation practices.

2.4.2 Improvements in Managing for Wildlife Habitat

In recent years, governments, not-for-profit organizations, and agricultural associations have been promoting the management of agricultural land in balance with environmental priorities. From this, a number of management practices (referred to as Beneficial Management Practices, or BMPs) have been identified to foster an improved state for ecosystems on the farm. There are many simple changes that a farmer can undertake to increase the quality of wildlife habitat and other forms of EG&S production on the farm land. The planting of shelterbelts to protect crops from wind and neighbouring volunteer crops provide corridors for wildlife to travel. Inclusion of winter wheat and other fall-seeded crops in the crop rotation can dramatically increase waterfowl nesting habitat (Devries and Moats, 2009). Enhancing native prairie forage habitat can be attained through decreasing stocking rate for pasture. In some cases, small changes in managing agricultural land can increase wildlife habitat quality with minimal impact to the farm operation.

In recent years, many farmers are adopting environmentally sensitive practices, such as integrated pest management, and precision farming methods (Agriculture and Agri-Food Canada, 2001). These practices have direct benefits for farm operations and at the same time enhance the natural system on which wildlife depend. Practices such as keeping a clean farm yard and limiting agricultural waste from operational practices, lead to efficiency gains, reduced costs, and improved environmental quality on the farm. Low tillage seeding, crop rotation, and nutrient cycling plans are being utilized to improve soil and farm ecosystem quality (Agriculture and Agri-Food Canada, 2001). In addition to farm operational benefits, there may exist direct financial incentives to maintain healthy wildlife habitat on the farm. Henderson and Moore (2006, pg. 597) state that "according to the 2002 U.S. Census of Agriculture, more than 2800 farms averaged $7,217 from recreation services, where recreation service income was characterized by hunting and fishing". Farmers can implement management practices to reap both biophysical and financial benefits from enhanced ecosystem services.

In many cases, farmers only need information as to what they can do to improve environmental quality to instigate change. Agriculture and Agri-Food Canada (2001, pg. 6) points out that "farmers understand that good land stewardship promotes economically viable farms". As farmers become more aware of the environmental and economic benefits that wetlands, native grasslands, and lush forests provide, some may change practices to enhance environmental quality and still maintain profitability. As an example, a farmer may maintain a wetland because they know it enhances water quality and quantity, increases forage production, reduces soil erosion, and improves air quality (Ducks Unlimited Canada, 2007). Providing farmers with information is but one type of policy that policymakers have at their disposal to encourage wildlife habitat conservation. In the next section, a review of the existing government policies and programs to conserve wildlife habitat is undertaken.

2.5 Farm Programs and Policies

There have been a number of farm programs and policies at the federal, provincial, and local level that encourage environmental sustainable land management on private agricultural lands. In their infancy, environmental stewardship policies focused solely on soil quality retention, herbicide and pesticide usage, and manure management. Recently, however, the EG&S benefits from wildlife habitat have been increasingly important in policy formulation. A number of national programs have been created to link agricultural activities to wildlife habitat preservation and enhancement, including the Conservation Security Program, United States; the Environmental Stewardship Scheme, England; the Environmental Quality Incentives Program, United States; and the National Farm Stewardship Program, Canada (Rae and Beale, 2008). These programs along with others, signify the start of a shift in agriculture policy from production related income-support toward farmers recieving payments for the provision of EG&S.

2.5.1 Information and Encouragement Programs

Information programs rely on brochures, manuals, workshops, and seminars to increase awareness of environmental issues on agricultural land. In this manner, the information received can provide farmers with additional tools and skills for environmental land management. Of the large number of information programs from governments, not-for-profit organizations, and farmer-group associations, one national information-oriented encouragement program that has seen extended success is the Environmental Farm Plan Initiative. This program, first developed in Ontario in 1993 (Agriculture and Agri-Food Canada, 2008), focuses on increasing awareness and understanding of the BMPs that may be employed by a farmer. Every province manages an Environmental Farm Plan (EFP) program that is directed by Agriculture and Agri-Food Canada. The programs, which are completely voluntary, encourage farmers to adopt BMPs. As part of their EFP, farmers develop their own action plan, and identify practices they can partake in to reduce environmental risk on their farm. In Saskatchewan, the Provincial Council of Agriculture Development and Diversification Boards (PCAB) is responsible for delivery of the EFP initiative to all farmers in the province, and staffs representatives to implement the program throughout the province (PCAB, 2010). A large factor associated with the program's success was the requirement that every farm must complete an EFP before being eligible for the farm stewardship program described below. However, the Environmental Farm Planning initiative ended on March 31, 2009 and was replaced by the new Growing Forward policy framework (Agriculture and Agri-Food Canada, 2010-a).

Pannell (2008) refers to information programs as examples of extension policies. This form of policy is also associated with technology transfer, education, communication, and community support (Pannell, 2008). Pannell concludes that extension policies are effective if there are actions that landholders can take that increase both public and private net benefits. It may be the case that there are a number of actions farmers can undertake that increase public benefits, such as increased EG&S, and increase private benefits, such as farm wealth. If this is the case, information and encouragement programs would be an appropriate and cost-effective strategy to instigate change (Pannell, 2008). In this study, a number of practices (i.e. BMPs) that are supposed to lead to increases in EG&S are modelled to determine cases where the practice leads to an increase in private net benefits. If it is assumed that these practices also increase public benefits, then the appropriate policy would be a policy by extension to promote change.

2.5.2 Regulation

In general, regulation is used in cases where the objective is to discourage landholders from undertaking a particular action and are instead encouraged to maintain the status quo. Regulation is effective to employ for those cases where the action is considered extremely harmful if carried out. For example, if a pollutant leaching into a vulnerable waterway causes substantial human health concerns from drinking water, regulation (along with enforcement) could be used to immediately stop further pollution. Examples