Ecological Goods & Services Technical Meeting

Lord Elgin Hotel, Ottawa, Canada

April 29-30

2009

An exploration of ecological goods and services concepts and options for agri-environmental policy.

Proceedings

Acknowledgements

The Ecological Goods and Services Technical Meeting represented the culmination of three years of pilot projects and their collective field efforts from federal and provincial governments, non-government organizations and landowners. These results formed the basis for reporting and discussion.

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prairie habitat joint venture

North American Waterfowl Management Plan
Plan nord-américain de gestion de la sauvagine
Plan de Manejo de Aves Acuáticas de Norteamérica

EHJV•PCHE

Agriculture and Agri-Food Canada
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Setting the Stage: Introduction to EG&S Technical Meeting Proceedings

Peter Joyce[1] and Ian Campbell[2]

In conjunction with other federal and provincial departments, Agriculture and Agri-Food Canada (AAFC) is exploring ecological goods and services (EG&S) concepts and options that may advance progress toward sustainable agriculture objectives, and contribute to more comprehensive, integrated approaches. Industry projects funded by AAFC's Advancing Canadian Agriculture and Agri-Food (ACAAF) program, as well as other initiatives showcased in these proceedings, are key elements of this investigation.

The purpose of this paper is to describe the context in which these studies were undertaken, their position in the broader examination of EG&S concepts and options by AAFC and its partners, and to review some fundamental principles that form the basis for discussion.

EG&S is a new twist on an old idea

EG&S is a relatively new concept in the agriculture sector, but stewardship of land and water resources is not. AAFC, provincial government partners and industry have worked together for many years to encourage and implement agri-environmental stewardship activities. The National Soil Conservation Program, Permanent Cover Program, Green Plan and Agricultural Policy Framework (APF) have invested significant financial resources to increase agricultural sustainability over the past several years.

The APF integrated environmental actions across governments, and focused them on helping producers to reduce environmental risks and improve benefits. Programs such as Environmental Farm Planning, the National Farm Stewardship Program, and Greencover Canada provided assistance to farmers to supply some EG&S. Growing Forward programs will continue to encourage agricultural producers to adopt beneficial management practices (BMPs) that benefit the environment and sustain the natural systems that provide EG&S.

Public EG&S benefits have been considered in AAFC programs for some time. For example, the objectives of the Community Pastures Program focus on conserving rangelands and optimizing multiple benefits including grazing, species at risk, wildlife habitat and recreation (Kulshreshtha et al. 2008). Similarly, the PFRA shelterbelt program, which provides free tree seedlings and technical assistance for establishment of prairie shelterbelts, used estimates of EG&S and other public goods values (Kulshreshtha and Knopf 2003) to rationalize continued public investment in this program.

Integrating EG&S concepts more fully into agri-environmental policy may offer opportunities to better recognize the stewardship actions of agricultural producers, to make the sector more profitable and sustainable and to align it with higher federal commitments related to water stewardship, climate change mitigation and adaptation, biodiversity conservation and sustainable development.

What's been done on EG&S

Since the late 1990s, there has been growing interest by government, industry, non-government

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organizations, and agricultural producers in EG&S concepts, applications and new land and water resource stewardship opportunities. Recognizing the increasing importance of EG&S to industry stakeholders and the public, federal, provincial and territorial (FPT) agriculture ministers agreed in September 2004 to establish a Deputy Minister (DM) committee to explore EG&S policy options. Agriculture and Agri-Food Canada (AAFC) and the DM co-chairs subsequently decided on a two-track approach to (1) build a conceptual basis to support policy development; and (2) to develop criteria for industry pilot projects.

An FPT EG&S Working Group was established in early 2005 to administer the two-track approach. Co-chaired by AAFC and Manitoba, the working group put forward the following policy principles and criteria for pilots, which were subsequently approved by FPT Policy ADMs.

Principles

Agri-environmental policy should:

1. Recognize the values and benefits of natural capital and foster agricultural management practices that will sustain and enhance flows of EG&S over time.
2. Focus on environmental objectives that are based on sound scientific knowledge of the state of the environment, that reflect the expectations of Canadians, and that are sensitive to regional issues and opportunities.
3. Work in concert with broad sustainable development, agriculture and public policy objectives
4. Achieve agri-environmental targets in an efficient, effective and equitable manner.
5. Balance the costs of farm stewardship action among farmers and society relative to the corresponding EG&S benefits these groups receive.
6. Recognize the rights of agricultural producers and build on their basic responsibilities for sound environmental stewardship.
7. Take an ecosystem approach and coordinate on-farm stewardship actions for the achievement of higher scale environmental objectives.
8. Take an adaptive, science-based approach and utilize a systematic process of planning, objective setting and evaluation to facilitate policy development and improvement over time.
9. Build on contemporary agri-environmental policies and programs and advance progress toward sustainable agriculture objectives.
10. Engage farmers and other affected stakeholders in policy development using a community-based approach.

Criteria for pilots

Pilot research initiatives should:

1. Support national EG&S policy development and be consistent with the EG&S policy principles.
2. Provide new information to help examine policy alternatives that efficiently achieve environmental targets.
3. Be based on sound science and utilize a systematic process of planning, objective setting and evaluation to facilitate policy and program development.
4. Assess environmental outcomes and consider economic and social costs and benefits.
5. Include an explicit plan to assess specific measurable outcomes at appropriate scales, communicate results, and thereby inform policy and program development.
6. Not duplicate on-going research, monitoring and assessment initiatives.
7. Seek appropriate involvement and participation by community members affected by the proposed policy or program actions.

Later that same year, Ministers agreed to support new research pilots that met the criteria, and to hold a national symposium on EG&S. Industry pilot proposals were accepted by AAFC's Advancing Canadian Agriculture and Agri-Food (ACAAF) program until October, 2006, and were evaluated against the approved EG&S and ACAAF funding criteria. Eight projects were approved for approximately $4.5 M and were completed between January 2007 and March 2009; the results of these studies are a centerpiece of the EG&S Technical Meeting and these proceedings.

AAFC and Environment Canada also sponsored a national EG&S Symposium in Winnipeg in February 2006 which brought together over 200 individuals, including many international participants, to share experiences and research on EG&S approaches[1]. Participants discussed what a Canadian EG&S approach could entail. The primary messages coming out of the EG&S Symposium were that EG&S policy should be:

- Driven by clear environmental goals;
- Partnered with producers in design and implementation;
- Science-based with measurable outcomes for evaluation;
- Based on a suite of policy tools appropriate to different situations.

In the fall 2006 FPT Ministers also requested a cost-benefit analysis of potential EG&S policy options and programming in Canada; the study was completed by EcoRessources Consultants in March 2008, and is the basis for one of the core papers in these proceedings. In addition, the FPT Policy ADMs also endorsed a 2001 OECD Secretariat multifunctional framework as a prototype for Canada to be used to integrate and address EG&S issues in agri-environmental programs and policy development which, among other things, may help to identify appropriate policy responses in cases of market failure and undersupply of specific EG&S.

Concurrent analytical studies by the FPT Working Group and others in Canada and abroad have brought attention to a range of new approaches that could better link environmental demand with on-farm decision making. Studies completed by the FPT Working Group include work on agri-environmental reference levels; an inventory of agri-environmental policy instruments, ancillary work on conservation easements, transferable development credits and property tax credits; collaborative work between Environment and Agriculture Canada on reverse auctions, analysis of agri-environmental programming in other countries; and others.

Taken together, EG&S Technical Meeting, symposium and analytical outcomes will contribute to the adaptation and improvement of agri-environmental policies and programs and support a balanced policy approach.

Speaking a common language: EG&S and natural capital

The terms Ecological Goods and Services (EG&S), environmental goods and services, ecosystem services, natural capital and others have all been used, sometimes interchangeably, in the agricultural policy context. In order to anchor its discussion and analysis the FPT Working Group agreed in November 2006 on the following working definition, based on the United Nations Millennium Ecosystem Assessment (MA):

[1] For more information see http://www.agr.gc.ca/pol/egs-bse

Ecological Goods and Services (EG&S) are the benefits human populations derive from healthy functioning ecosystems. These include the products received from ecosystems (e.g. food, fibre, clean air and water), the benefits from ecosystem processes (e.g. nutrient cycling, water purification, climate regulation) and non-material benefits (e.g. recreation and aesthetic benefits).

EG&S and natural capital concepts are related (Figure 1). In simple terms, ecosystems are the natural capital "factory" that produces EG&S, including market goods (e.g. agricultural crops, timber), and non-market services (e.g. water supply, air quality).

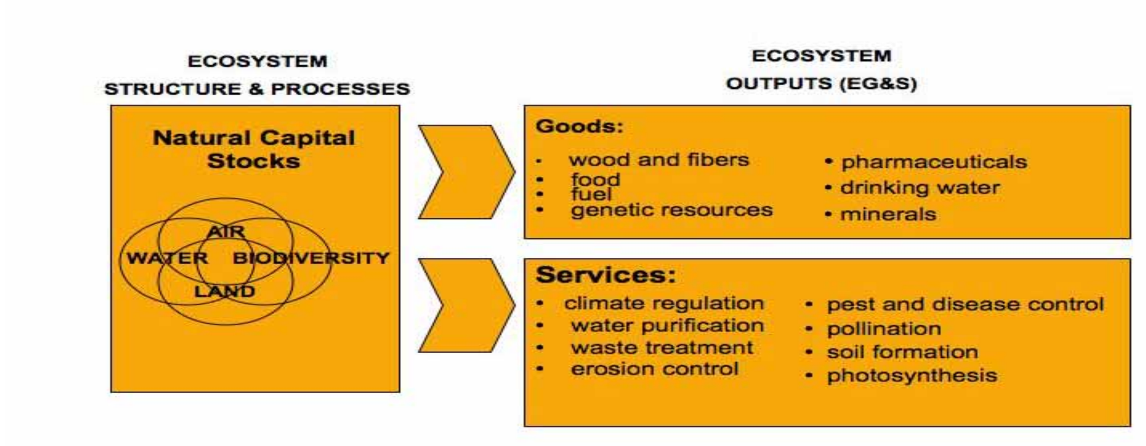

Figure 1: Natural Capital Stocks and EG&S

Source: Environment Canada (Unpublished, 2006)

As a user of natural capital, agriculture can enhance or diminish the flow of EG&S, which has implications for the sector and the broader public. For example, nutrient cycling and soil renewal are affected by agricultural practices and also directly affect agricultural productivity; likewise range health and productivity are impacted by grazing practices, which in turn affects forage availability, weight gain of cattle and habitat for species at risk. The impact of agriculture on EG&S has significant implications for the environmental and economic sustainability of the sector and for the welfare of all Canadians.

Market failure is the challenge

Some EG&S (especially provisioning services like food, fibre or timber) are recognized in the market system, and some (such as wildlife habitat, water purification and aesthetic values) are not. Market failures occur when markets are missing altogether or when they do not reflect the full social costs or benefits generated by market actors. In the case of EG&S, market failures mainly occur for three reasons (Daly and Farley 2004):

1. Many EG&S display the characteristics of public goods, and it is therefore difficult to accurately express the value society places on these outcomes relative to the private costs and benefits that an individual acts upon;
2. Their provision is often an externality, which means the outcome is an unintended result from another decision; and
3. Information concerning the impacts of individual human actions on the functioning of ecosystems is imperfect in informing the respective decisions of economic agents.

Well managed agricultural landscapes provide EG&S benefits to agricultural producers and broader society however "public" EG&S are not recognized in the market system and are not factored into the prices farmers receive for agricultural commodities. Consequently farmers may not be rewarded for managing or conserving all EG&S values. Farmers are business-people and naturally focus on what pays - the production of food and fibre – potentially at the expense of non-market EG&S. Consequently, the capacity of farm ecosystems to provide these benefits may diminish over time. Many EG&S are important inputs to agriculture and therefore the undersupply of EG&S has implications for the sustainability and long-term productivity of the sector as well as for the welfare of Canadians.

Tough questions

Integrating EG&S concepts and options into agri-environmental policy may improve progress toward sustainable agriculture objectives, and our thinking has advanced considerably over the last several years. But there are still a lot of complex issues to sort out. For example:

How to measure and place value on public demand for EG&S? In the absence of environmental markets, a comprehensive set of natural capital accounts, and satisfactory information about ecosystem conditions and functions, available estimates of the value of EG&S are still relatively coarse (Smith 2006, Olewiler 2004, Anielski and Wilson 2005). Measuring the environmental impacts of farm practices even in well managed field experiments can also be very expensive and time intensive. These challenges of estimating the costs and benefits of farm management practices are a significant impediment for program and policy development.

When does polluter pay stop and provider get begin? In agriculture it is often hard to draw the line between producer's basic responsibilities to minimize agricultural risks and actions that mainly provide public environmental benefits. For example, should farmers be entirely responsible for their contribution to phosphorous in watercourses, or should the public support nutrient management practices?

How to ensure results are accountable to the market place? Without the discipline of a competitive market, governments and the public need assurances that they are getting measurable environmental results in return for any new public expenditure.

How to avoid perverse side-effects? Analysis of US agriculture policy (e.g. Mayrand et al. 2003) suggests that large production subsidies encourage cultivation of marginal lands while initiatives like the Conservation Securities Program concurrently pay for set-aside of those same lands. It is desirable to avoid such contradictory policies in Canada; however this requires careful consideration of the impacts of new interventions in the existing system of agri-environmental approaches.

2009 Ecological Goods & Services Technical Meeting

At the request of Assistant Deputy Minister, Jamshed Merchant, Agriculture and Agri-Food Canada in partnership with the Prairie Habitat Joint Venture (PHJV), Eastern Habitat Joint Venture (EHJV) and the North American Wetlands Conservation Council (Canada) (NAWCC Canada) organized the two-day meeting on April 29-30, 2009 at the Lord Elgin Hotel, Ottawa.

The organizing partners share both a common interest in EG&S as well as the implementation of the North American Waterfowl Management Plan (NAWMP). Specifically, NAWMP is an international action plan to conserve migratory waterfowl and other wetland associated bird species in Canada, United States and Mexico. Since inception in 1986, the NAWMP goal is to return the number of waterfowl to the levels of the 1970s through conservation of wetlands and uplands. The resulting environmental benefits extend beyond biodiversity to a broader suite of ecological goods and services ranging from water quality to carbon sequestration.

Canadian delivery of the NAWMP program is led by NAWCC (Canada) through regional joint ventures that include the PHJV and the EHJV. The PHJV comprises Alberta, Saskatchewan, Manitoba, north-eastern British Columbia, Yukon and Northwest Territories while the EHJV is made up of Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador. Partners include all resource sectors including agriculture and environment in federal, provincial and territorial governments, non-government organizations, industry and landowners.

Increasing the understanding and awareness of EG&S concepts and options has been a high priority action for policy leadership at all levels of NAWMP program delivery. Of the eight pilot EG&S projects, three projects are located within the PHJV and five projects are found in the EHJV. Individual JV partners participate in some pilot projects as the lead organization or play a supporting role in others. Pilot results are expected to advance EGS policy development for valuation of natural capital including wetlands and upland habitat. Conserving habitat and EG&S through agri-environmental policy development would substantially contribute to NAWMP goals.

With this background, the Meeting organizers set out with three specific objectives:

1. Communicate results from ACAAF funded EG&S pilots and up to four other invited Canadian EG&S projects. This was later expanded to include poster abstracts on related EG&S projects.
2. Foster a national community of practice among key EG&S stakeholders involved in these projects.
3. Facilitate the documentation and delivery of project results for consideration in the design of environment programming including Growing Forward.

A total of 110 invited attendees from 62 organizations across Canada were selected for their interest in EG&S. By design the meeting engaged attendees through facilitated discussion. Following the Meeting, papers and power point presentations were compiled into these Proceedings.

Next steps

As suggested in Jamshed Merchant's opening remarks, policy makers will seek to integrate the concrete results of the ACAAF pilot projects, cost benefit analysis and ancillary research including the results of initiatives such as the Watershed Evaluation of BMPs project in program and policy development. The lessons learned from the industry pilots and invited presentations at the EG&S Technical Meeting are a critical component of the developing body of knowledge needed to support integration of EG&S concepts and options during Growing Forward and subsequent policy frameworks.

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Full Paper Presentations

Integration of Watershed Planning and the Agricultural Policy Framework for the Provision of Ecological Goods and Services: A Pilot Watershed Approach for Wetland Restoration & Retention

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Executive Summary

The values of wetlands in providing ecological goods and services such as flood alternation, water quality, and wildlife benefits have been widely recognized. In light of the growing concerns about adverse environmental effects of agriculture on water quality, there is a need to incorporate wetland conservation into the federal government's agricultural conservation programs. However, designing wetland programs requires an integrated study of prioritizing locations for wetland restoration and retention, examining agricultural producers' uptake and satisfaction of wetland programs and policies, and estimating non-market benefits of wetland programs for society and landowners. The ACAAF project, a collaborative effort between Ducks Unlimited Canada, University of Guelph, and University of Alberta, has three components to create knowledge for developing cost effective wetland restoration and retention programs.

The purpose of the first component is to develop an integrated economic and wetland-watershed modeling system for examining cost effectiveness of wetland restoration scenarios. Specifically, the component has three interrelated objectives: 1). Develop an integrated economic and wetland-watershed hydrologic modeling system to estimate wetland restoration costs and water quality benefits in the South Tobacco Creek (STC) watershed; 2). Calibrate and validate the integrated modeling system to fit into the conditions of the STC watershed; 3). Apply the integrated modeling system to prioritize locations for wetlands restoration in the STC watershed. Our modeling results show that there exist considerable spatial variations of economic costs and water quality benefits from wetland restoration. The economic costs of wetland restoration range from $225 to $1,094/ha/y with an average of $438/ha/y. Similarly, the TN abatement benefits range from 14.7 to 218.2 kg/ha/y with an average of 48.8 kg/ha/y. The TP reduction benefits have a minimum of 1.7 kg/ha/y and a maximum of 20.1 kg/ha/y with an average of 5.0 kg/ha/y.

We set an environmental goal of TP reduction at 0.44 tons/y or 4.8% TP reduction at the STC outlet, which is equivalent to the environmental benefits achieved by 27 small dams in the STC watershed. Under a targeting scenario based on benefit to cost ratios, we have identified 24 producers that need to restore wetlands with a total of 28.5 ha and the corresponding economic cost is $10,874/y. For comparison purpose, we have also simulated a scenario based on cost minimization criterion, which sets a price ceiling and identifies wetland restoration with economic costs below the ceiling. In order to achieve a similar environmental goal, the price ceiling scenario needs 7 producers to restore 60.2 ha of wetlands with an economic cost of $17,642/y. In comparing to the targeting scenario, the price ceiling scenario needs to restore 111% more of the wetland areas and incur 62% more of the economic costs. The comparison shows the importance of targeting wetland restoration based on benefit to cost ratios in order to achieve cost effectiveness.

Background and Rationale for Investigation

Wetlands serve important hydrologic, geochemical, and biological functions in a watershed (De Laney, 1995; Hart, 1995; National Research Council, 1995). Wetland functions include flood mitigation, groundwater recharge, water quality improvement, carbon sequestration, and wildlife habitat. Unfortunately, Canada has lost more than 70% of its original wetlands in the prairie region (DUC, 2007). In light of the growing concerns about adverse environmental effects of agriculture on water quality, there is a need to incorporate wetland conservation into federal government's agricultural conservation programs. However, designing wetland programs requires an integrated study of prioritizing locations for wetland restoration and retention, examining agricultural producers' uptake and satisfaction to wetland programs and policies, and estimating non-market benefits of wetland programs for society and landowners.

The South Tobacco Creek (STC) watershed is located near Miami, Manitoba, approximately 150 km southwest of Winnipeg. The watershed has a drainage area of 74.6 km^2 which originates in the Manitoba Escarpment. STC drains into the Morris River and eventually into the Red River, which then flows north into Lake Winnipeg. Lake Winnipeg has recently been the focus of concern regarding water quality. As part of the plan to clean up the lake, the Manitoba Government announced in 2003 its intention to reduce the amount of nitrogen and phosphorous entering Lake Winnipeg. Much of this reduction must come from non-point sources upstream in the watershed. Prioritization of BMP implementation such as wetland restoration may have a significant impact on where and how efforts to reduce this loading should be focused. The STC watershed has been chosen as a pilot site for the Watershed Evaluation of BMPs (WEBs) project. Extended from the WEBs project, the ACAAF project further allows for the comparison of wetland restoration with key BMPs that have been implemented in the STC watershed.

Objectives

The purpose of the first component of the project is to develop an integrated economic and wetland-watershed modeling system for examining cost effectiveness of wetland restoration scenarios. Specifically, the project has three interrelated objectives: 1). Develop an integrated economic and wetland-watershed hydrologic modeling system to estimate wetland restoration costs and water quality benefits in the STC watershed; 2). Calibrate and validate the integrated modeling system to fit into the conditions of the STC watershed; 3). Apply the integrated modeling system to prioritize locations for wetlands restoration in the STC watershed.

Funding and Partnership

This research was funded by the Advancing Canadian Agriculture and Agri-Food Program (ACAAF). Ducks Unlimited Canada provided in-kind and logistical support. We thank the Deerwood Soil and Water Management Association and staff at Environment Canada, Manitoba Agriculture, Food and Rural Initiatives, and Manitoba Water Stewardship for assistance with this research.

Methods and Implementation

1. **Identifying locations for wetland restoration**
   Historically, the STC watershed had numerous pothole wetlands. However, most of these wetlands were drained for agricultural production in the last century. The potential wetland restoration sites in the STC watershed were identified using GIS functions based on Lidar DEM and land use data. The generated depression grid was used to create four wetland restoration scenarios. Scenario 1 was constructed by considering all potential wetland sites in the depression grid that would be restored and the wetland surface area is 185.8 ha or about 2.5% of the STC watershed area. Next, the wetland grid of Scenario 1 was converted into polygons using GIS with a continuous serial number. The polygons with even serial number were then removed from the polygon list resulting in the wetland coverage of Scenario 2 having wetland surface area 92.5 ha or 1.2% of the total watershed area. Scenario 3 was developed from Scenario 2 following the same procedure as for Scenario 2 resulting in wetland surface area 47.0 ha or 0.6% of the total watershed area. At last, Scenario 4 was created from Scenario 3 resulting in wetland surface area 22.2 ha or 0.3% of the total watershed

area. The four wetland restoration scenarios, as shown in Figure 1, represent four wetland restoration options in the STC watershed.

2. **Estimating the economic costs of wetland restoration**
The economic costs of wetland restoration are comprised of three components: opportunity costs, restoration engineering costs, and nuisance costs. The opportunity costs of wetland restoration were calculated as the per acre forgone cropping returns of the farm field multiplied by the restored wetland acres. Annualized opportunity costs were calculated both as average costs over 12 years of production cycle from 2007 to 2018, as well as discounted at 10%. Some adjustments were made for producers with pasture land, where there may be extra potential costs for installing an off-site watering system or fencing around a wetland. The restoration engineering costs are comprised of a fixed administration cost and construction costs based on the number of wetlands present on a given producer's property. Based on Manitoba conditions, the estimated administrative cost for restoring one wetland is $321 and the engineering cost is $157/acre. The wetland restoration costs are treated as one time costs in the first period. Nuisance costs represent the inconvenience costs for agricultural production (e.g. machinery operations) when wetland are within farm fields. Nuisance costs were given as per acre costs and converted to total nuisance costs for each producer. Annualized nuisance costs were calculated as average costs over 12 years as well as discounted for 12 years at 10% discount. The annualized economic costs of wetland restoration in the STC were estimated by summing the three components for each producer.

3. **Estimating the water quality benefits of wetland restoration**
In this study, the Soil and Water Assessment Tool (SWAT), developed by the Agricultural Research Service of the United States Department of Agriculture, was selected as the hydrologic model for simulating the watershed processes (Arnold and Fohrer 2005, Arnold et al. 1998). The SWAT was setup based on soil, DEM, and landuse and climate data from 1991 to 2006. Land management data such as planting and harvesting dates, fertilizer application, tillage and straw management were prepared based on STC farm data collected by Deerwood Soil and Water Management Association. Because most of the existing wetlands are not the focus of wetland restoration, they are not simulated independently in the SWAT but are treated as forest HRUs in the sub-basin. Small dams as a prominent feature of the watershed are characterized with a developed small dam module in SWAT setup. A multi-period and multi-site calibration and validation strategy was implemented for the STC SWAT model. Results show that the SWAT modelling for the STC watershed was able to reproduce streamflow, sediment, TN and TP at satisfactory magnitudes (Yang et al., 2008).

The wetland component of the SWAT was adapted to simulate water quality effects of wetland restoration at both sub-basin and producer levels. In accordance with the SWAT wetland simulation structure, wetlands within a sub-basin need to be lumped into one equivalent wetland and the modelling results reflect the aggregated effect of the wetlands within the sub-basin (Liu and Yang 2007, Liu et al. 2008). Even though the effect of individual wetlands cannot be evaluated, the modelling results can still meet our purpose of restoration scenarios assessment. The value of wetland parameters were obtained based on field investigation, GIS data processing, and literature. The SWAT was run for the four wetland scenarios and the simulated results were generated at both sub-basin and producer levels.

Results, Costs & Benefits & Discussions

1. **Spatial variations of economic costs of wetland restoration**
   The economic costs of wetland restoration in the STC are shown in Table 1. The four wetland restoration scenarios need to restore 185.8, 92.5, 47.0, and 22.2 ha of wetlands. The corresponding economic costs are $64,800/y, $32,700/y, $17,100/y, and $8,810/y, respectively. From the data we can also see that wetland restoration costs vary considerably within a scenario and also across different scenarios. In Scenario 1, the economic costs have a minimum of $260/ha/y and a maximum of $869/ha/y. In Scenario 2, the economic costs vary from $225 to $846/ha/y. In Scenario 3, the economic costs range from $236 to $857/ha/y. In Scenario 4, the economic costs are from $258 to $1,094/ha/y. The average economic cost shows an increasing trend from Scenario 1 to Scenario 4 with $394, $401, $433, and $532/ha/y, respectively. The trend indicates locations with smaller wetland restoration acreage have higher economic costs.

2. **Spatial variations of water quality benefits of wetland restoration**
   The SWAT was run for the four wetland restoration scenarios and the simulation results were compared to the baseline (without wetland restoration) to estimate water quality benefits of wetland restoration. The reductions of TN load from each producer at the STC outlet for the four restoration scenarios are presented in Table 2. The four scenarios need to restore 186, 92.5, 47.2, and 22.2 ha of wetlands. The corresponding TN reductions are 5,370 kg/y, 2,930 kg/y, 1,770 kg/y, and 1,370 kg/y, respectively. The average TN reduction benefits vary considerably within a scenario and also across different scenarios. In Scenario 1, the average TN reductions have a minimum of 17.7 kg/ha/y and a maximum of 64.6 kg/ha/y. In Scenario 2, the average TN reductions vary from 17.9 to 87.9 kg/ha/y. In Scenario 3, the average TN reductions range from 19.2 to 105 kg/ha/y. In Scenario 4, the average TN reductions are from 14.7 to 218 kg/ha/y. The average TN reductions show an increasing trend from Scenario 1 to Scenario 4 with 32.6, 38.0, 47.9, and 81.1 kg/ha/y, respectively. The trend indicates a decreasing TN reduction efficiency as wetland acreage increases.

   The reductions of TP load from each producer at the STC outlet for the four restoration scenarios are presented in Table 3. Corresponding to the 186, 92.5, 47.2, and 22.2 ha of wetland restoration under the four scenarios, the TP reductions are 1,340 kg/y, 744 kg/y, 442 kg/y, and 338 kg/y, respectively. Similarly, the average TP reduction benefits vary considerably within a scenario and also across different scenarios. In Scenario 1, the average TP reductions have a minimum of 4.6 kg/ha/y and a maximum of 19.3 kg/ha/y. In Scenario 2, the average TP reductions vary from 4.9 to 26.4 kg/ha/y. In Scenario 3, the average TP reductions range from 5.2 to 26.7 kg/ha/y. In Scenario 4, the average TP reductions are from 4.2 to 49.3 kg/ha/y. The average TP reductions show an increasing trend from Scenario 1 to Scenario 4 with 8.4, 9.9, 12.2, and 20.3 kg/ha/y, respectively. The trend indicates a decreasing TP reduction efficiency as wetland acreage increases.

3. **Spatial variations of benefit to cost ratios of wetland restoration scenarios**
   Modeling results in previous sections demonstrated considerable variations of economic costs and environmental benefits from wetland restoration in the STC watershed, both within a scenario and across different scenarios. A wetland conservation program should jointly consider both the economic costs and environmental benefits of wetland restoration in order to achieve cost effectiveness. Therefore, benefit to cost ratio is an important indicator for identifying wetland restoration locations.

   The TN benefit to cost ratios for wetland restoration in the STC watershed are shown in Table 4. In

Scenario 1, the TN cost to benefit ratios have a minimum of $5.2/kg and a maximum of $49.4/kg. In Scenario 2, the TN cost to benefit ratios vary from $4.3 to $39.7/kg. In Scenario 3, the TN cost to benefit ratios range from $3.6 to $38.2/kg. In Scenario 4, the TN cost to benefit ratios are from $2.1 to $32.3/kg. The TN cost to benefit ratios show a decreasing trend from Scenario 1 to Scenario 4 with $13.7, $12.5, $11.1, and $9.2/kg, respectively. The pattern indicates a decreasing trend on cost effectiveness of TN reduction as wetland acreage increases.

In Scenario 1, the TP cost to benefit ratios have a minimum of $17.3/kg and a maximum of $171.6/kg. In Scenario 2, the TP cost to benefit ratios vary from $18.8 to $161.6/kg. In Scenario 3, the TP cost to benefit ratios range from $14.6 to $137.0/kg. In Scenario 4, the TP cost to benefit ratios are from $9.3 to $129.1/kg. Similarly, the TP cost to benefit ratios show a decreasing trend from Scenario 1 to Scenario 4 with $53.4, $48.3, $42.8, and $35.2/kg, respectively. The pattern indicates a decreasing trend on cost effectiveness of TP reduction as wetland acreage increases.

4. **Examining cost effectiveness of wetland restoration scenarios**
   Based on simulated results on economic costs, water quality benefits, and cost to benefit ratios, we have examined two wetland restoration scenarios based on different policy instruments. The targeting scenario is based on cost to benefit ratios, which identify locations for wetland restoration starting from the lowest cost to benefit ratio and moving up the queue until the environmental goal is achieved. The targeting scenario represents a cost effective wetland program where the economic costs are minimized and environmental benefits are maximized. The price ceiling scenario, instead, resembles a typical management scenario under which wetland restoration locations are identified based on least cost criterion in order to minimize conservation investment. Under this scenario, wetland locations are identified starting from the lowest economic costs and moving up the queue until the environmental goal is achieved and a price ceiling is reached. With the integrated economic-hydrologic modeling system, we are able to examine the relative performance of these two scenarios.

For comparison purpose, we set an environmental goal of TP reduction at 0.44 tons/y or 4.8% TP reduction at the STC outlet for both the targeting and the price ceiling scenarios. This TP reduction level is equivalent to the environmental benefits achieved by 27 small dams in the STC watershed. The selection of TP reduction as the environmental goal is based on the fact that excess TP level is the primary water quality concern in the Lake Winnipeg Basin. For identifying wetland restoration locations, we pool together the economic costs, TP reduction benefits, and cost to benefit ratios for the four scenarios. For each producer, either no selection or only one wetland restoration option will be chosen out of the four options in the wetland identification process.

Under the targeting scenario, 24 producers are chosen to restore wetlands with a total of 28.5 ha and the corresponding economic cost is $10,874/y. The cost to benefit ratios range from $9.3 to $37.4/kg with an average of $24.5/kg. The pattern indicates that considerable variations of cost to benefit ratios still exist across the targeted wetland restoration locations. Among the 24 producers, 17 producers are identified to restore wetlands under Scenario 4, three producers are under Scenario 3, and four producers are under Scenario 2. The pattern indicates that the targeting scenario prefers smaller acreage for wetland restoration, with an average wetland size of 1.2 ha for each producer (Table 5 and Figure 2).

Under the price ceiling scenario, seven producers are identified to restore 60.2 ha of wetlands with a price ceiling of $302/ha/y and total economic cost of $17,624/y. The cost to benefit ratios range from

$24.1 to 36.4/kg with an average of $35.4/kg, which are considerably higher than the targeting scenario. Among the seven producers, two producers are identified to restore wetlands under Scenario 4, 2 producers are under Scenario 3, and three producers are under Scenario 1. The pattern indicates that the price ceiling scenario selects larger acreage for wetland restoration, with an average wetland size of 8.6 ha for each producer (Table 6 and Figure 3).

In comparing to the targeting scenario, the price ceiling scenario needs 111% more wetlands and 62% more economic costs. The difference in cost effectiveness can be explained by several factors. The average economic cost under the targeting scenario is $475/ha/y, which is higher than $272/ha/y of the price ceiling scenario. However, the targeting scenario has an average cost to benefit ratio for TP at $24.5/kg while that for the price ceiling scenario is $35.4/kg. The pattern shows that in the targeting scenario, the targeted wetlands are more expensive with higher average economic costs. However, these wetlands contribute much more environmental benefit in terms of TP reduction. Therefore, the average cost to benefit ratio under the targeting scenario is considerably lower than that of the price ceiling scenario. The comparison shows that identification of wetland restoration only based on economic costs may not be the cost effective policy because the total economic costs for achieving a specific environmental goal may be much higher than the targeting scenario based on cost to benefit ratios.

Furthermore, the targeting scenario identifies wetlands of small sizes for restoration. In this scenario, a total of 24 producers are identified for wetland restoration. However, 17 of the 24 producers only need to restore wetlands with sizes less than one hectare. The minimum and maximum wetland sizes are 0.1 to 5.1 ha respectively, with an average size of 1.2 ha. In contrast, in the price ceiling scenario, seven producers are selected for wetland restoration with an average wetland size of 8.6 ha for each producer. Among these producers, only two of them need to restore wetlands with sizes less than 1 ha, which are 0.7 and 0.8 ha respectively. The rest of the five producers need to restore wetlands of sizes from 2.9 to 40.1 ha. Based on assessment from a DUC technical expert (personal communication with Rick Andrews, Head of wetland/habitat restoration in Manitoba), wetlands of small sizes are more suitable for establishing wildlife habitats such as waterfowl habitat. From this point of view, wetland restoration under the targeting scenario is not only cost effective in achieving water quality goals, but also more effective for establishing wildlife habitats in the STC watershed.

Conclusions

This study develops an integrated economic and watershed-wetland modeling system to estimate economic costs and environmental benefits, and examine the cost effectiveness of wetland restoration scenarios in the STC watershed. Under the four uniform scenarios with wetland restoration acreage 185.8, 92.5, 47.0, and 22.2 ha, the corresponding economic costs are $64,800, $32,700, $17,100, and $8,810 per year, respectively. The corresponding TN reductions at the STC outlet are 5,370, 2,930, 1,770, and 1,370 kg per year, which represent relative reductions of 15.1%, 8.2%, 5.0%, and 3.8%, respectively. The corresponding TP reductions at the STC outlet are 1,340, 744, 442, and 338 kg per year, which represent relative reductions of 14.6%, 8.1%, 4.8%, and 3.7%, respectively.

Our modeling results also show that both the economic costs and environmental benefits of wetland restoration exhibit considerable variations in the STC watershed. The economic costs of wetland restoration range from $225 to $1,094/ha/y with an average of $438/ha/y. Similarly, the environmental benefits of wetland restoration also show considerable spatial variations. The TN abatement benefits range from 14.7 to 218.2 kg/ha/y with an average of 48.8 kg/ha/y. The TP reduction benefits have a minimum of 1.7 kg/ha/y and a maximum of 20.1 kg/ha/y with an average of 5.0 kg/ha/y. Therefore, a wetland conservation program needs to consider these spatial heterogeneities to target locations based on cost to benefit ratios.

We set an environmental goal of TP reduction at 0.44 tons/y or 4.8% TP reduction at the STC outlet, which is equivalent to the environmental benefits achieved by 27 small dams in the STC watershed. Under a targeting scenario based on cost to benefit ratios, we have identified 24 producers that need to restore wetlands with a total of 28.5 ha and the corresponding economic cost is $10,874/y. For comparison purpose, we have also simulated a scenario based on cost minimization criterion, which sets a price ceiling and identifies wetland restoration with economic costs below the ceiling. In order to achieve a similar environmental goal, the price ceiling scenario needs to restore 60.2 ha of wetlands with an economic cost of $17,624/y. In comparing to the targeting scenario, the price ceiling scenario needs 111% more wetlands and 62% more economic costs. The comparison shows the importance of targeting wetland restoration based on cost to benefit ratios in order to achieve cost effectiveness.

Furthermore, the targeting scenario identifies wetlands of small sizes for restoration with an average size of 1.2 ha for each producer, in comparing to that of 8.6 ha in the price ceiling scenario. Due to the fact that wetlands of small sizes are more suitable for establishing wildlife habitats such as waterfowl habitat, the modeling results show that wetland restoration under the targeting scenario is not only cost effective in achieving water quality goals, but also more effective for establishing wildlife habitats in the STC watershed.

Future Work

The research shows the importance of spatial targeting in achieving cost effectiveness wetland conservation programs. The study can be extended to examine wetland restoration at regional levels or transfer the study to other study watersheds. A comparison of wetland restoration with other BMPs also needs to be conducted to examine joint implementation of wetland restoration and with other BMPs for improving water quality and the provision of ecological goods and services.

Table 1: Economic costs of wetland restoration in the South Tobacco Creek Watershed.

Prod-ID	Scenario 1		Scenario 2		Scenario 3		Scenario 4	
	Area (ha)	Cost ($/ha/y)	Area (ha)	Cost ($/ha/y)	Area (ha)	Cost ($/ha/y)	Area (ha)	Cost ($/ha/y)
4	1.2	319.6	0.9	284.8	0.7	249.8	0.1	605.8
9	0.8	505.5	0.0	0.0	0.0	0.0	0.0	0.0
14	4.1	344.6	1.3	382.3	0.8	442.2	0.1	671.3
17	0.5	413.5	0.5	406.2	0.2	532.9	0.2	540.3
18	13.8	308.2	7.7	295.9	4.1	286.9	2.9	262.3
20	0.1	869.1	0.1	846.1	0.1	857.0	0.1	884.3
21	5.7	322.0	3.1	337.1	1.7	338.3	0.3	440.9
24	4.0	366.2	1.9	409.0	1.3	391.4	0.6	409.7
25	4.6	282.5	2.2	316.4	0.8	331.8	0.4	457.6
26	1.6	334.6	0.9	352.6	0.2	377.1	0.0	0.0
28	6.4	407.6	3.7	384.9	2.3	368.3	1.3	344.0
29	1.5	418.9	0.7	472.7	0.3	625.4	0.2	645.3
32	4.4	431.7	3.0	425.4	1.1	490.9	0.6	548.8
33	4.7	454.6	2.1	492.8	1.0	520.2	0.9	535.6
34	5.0	393.8	2.4	403.5	1.5	395.9	0.2	798.8
39	6.8	351.6	1.8	413.7	1.3	399.6	0.7	380.0
40	7.5	297.8	1.7	380.5	1.3	364.9	0.5	405.0
41	2.0	357.1	1.1	367.6	0.5	446.1	0.1	1093.9
43	0.5	600.3	0.0	0.0	0.0	0.0	0.0	0.0
44	5.4	393.8	2.8	428.3	0.9	486.9	0.6	529.4
47	40.1	301.5	20.1	306.7	11.2	307.9	5.1	326.4
49	8.5	346.8	3.6	383.4	2.1	422.4	0.6	533.1
50	1.1	491.6	0.3	635.1	0.3	692.6	0.2	839.3
51	7.2	366.6	3.1	382.7	0.8	522.9	0.8	532.4
52	1.8	363.3	0.9	346.5	0.0	0.0	0.0	0.0
56	4.3	302.6	2.6	345.1	1.5	335.5	0.8	270.7
58	2.5	389.1	1.4	393.7	1.2	393.7	0.0	0.0
62	6.1	363.9	2.0	393.2	1.0	435.6	0.9	442.1
101	14.8	414.2	8.5	390.7	2.6	442.1	1.4	462.0
102	8.9	432.5	4.7	430.7	2.7	422.6	0.6	614.8
103	10.1	259.5	7.4	224.5	3.7	236.0	2.0	257.5
Tot.	**185.8**		**92.5**		**47.0**		**22.2**	
Avg	**6.0**	**393.7**	**3.2**	**401.1**	**1.7**	**432.7**	**0.9**	**532.0**

Table 2: Total nitrogen (TN) reduction from wetland restoration in the South Tobacco Creek Watershed.

Prod-ID	Scenario 1		Scenario 2		Scenario 3		Scenario 4	
	Area (ha)	TN (kg/y)	Area (ha)	TN (kg/y)	Area (ha)	TN (kg/y)	Area (ha)	TN (kg/y)
4	1.2	34	0.9	24	0.7	17	0.1	16
9	0.8	28	0.0	0	0.0	0	0.0	0
14	4.1	109	1.3	62	0.8	45	0.1	16
17	0.5	27	0.5	28	0.2	18	0.2	22
18	13.8	266	7.7	137	4.1	79	2.9	101
20	0.1	2	0.1	2	0.1	3	0.1	3
21	5.7	178	3.1	137	1.7	80	0.3	5
24	4.0	155	1.9	50	1.3	74	0.6	63
25	4.6	184	2.2	132	0.8	75	0.4	86
26	1.6	100	0.9	71	0.2	24	0.0	0
28	6.4	154	3.7	76	2.3	57	1.3	43
29	1.5	50	0.7	21	0.3	11	0.2	16
32	4.4	118	3.0	84	1.1	47	0.6	52
33	4.7	215	2.1	109	1.0	39	0.9	44
34	5.0	194	2.4	114	1.5	61	0.2	33
39	6.8	122	1.8	39	1.3	26	0.7	23
40	7.5	256	1.7	91	1.3	59	0.5	49
41	2.0	96	1.1	55	0.5	45	0.1	20
43	0.5	13	0.0	3	0.0	0	0.0	0
44	5.4	130	2.8	103	0.9	61	0.6	56
47	40.1	1169	20.1	625	11.2	365	5.1	292
49	8.5	287	3.6	174	2.1	110	0.6	30
50	1.1	63	0.3	30	0.3	23	0.2	8
51	7.2	214	3.1	76	0.8	33	0.8	44
52	1.8	41	0.9	24	0.0	0	0.0	0
56	4.3	106	2.6	66	1.5	47	0.8	23
58	2.5	72	1.4	36	1.2	25	0.0	0
62	6.1	198	2.0	73	1.0	37	0.9	49
101	14.8	279	8.5	199	2.6	70	1.4	66
102	8.9	297	4.7	136	2.7	107	0.6	50
103	10.1	217	7.4	158	3.7	131	2.0	161
Tot.	**186**	5370	**92.5**	2930	**47.2**	1770	**22.2**	1370

Table 3: Total phosphorus (TP) reduction from wetland restoration in the South Tobacco Creek Watershed.

Prod-ID	Scenario 1		Scenario 2		Scenario 3		Scenario 4	
	Area (ha)	TP (kg/y)	Area (ha)	TP (kg/y)	Area (ha)	TP (kg/y)	Area (ha)	TP (kg/y)
4	1.2	9	0.9	7	0.7	4	0.1	4
9	0.8	9	0.0	0	0.0	0	0.0	0
14	4.1	29	1.3	16	0.8	13	0.1	5
17	0.5	6	0.5	6	0.2	4	0.2	5
18	13.8	64	7.7	38	4.1	22	2.9	25
20	0.1	1	0.1	1	0.1	1	0.1	1
21	5.7	47	3.1	36	1.7	20	0.3	1
24	4.0	38	1.9	12	1.3	18	0.6	15
25	4.6	48	2.2	32	0.8	19	0.4	19
26	1.6	30	0.9	16	0.2	6	0.0	0
28	6.4	43	3.7	22	2.3	16	1.3	12
29	1.5	14	0.7	6	0.3	4	0.2	5
32	4.4	27	3.0	20	1.1	10	0.6	10
33	4.7	51	2.1	32	1.0	9	0.9	14
34	5.0	52	2.4	30	1.5	14	0.2	8
39	6.8	32	1.8	10	1.3	7	0.7	6
40	7.5	56	1.7	23	1.3	13	0.5	11
41	2.0	24	1.1	13	0.5	10	0.1	4
43	0.5	3	0.0	1	0.0	0	0.0	0
44	5.4	33	2.8	26	0.9	15	0.6	15
47	40.1	261	20.1	139	11.2	78	5.1	66
49	8.5	83	3.6	44	2.1	27	0.6	8
50	1.1	14	0.3	9	0.3	7	0.2	2
51	7.2	57	3.1	22	0.8	9	0.8	12
52	1.8	9	0.9	5	0.0	0	0.0	0
56	4.3	26	2.6	19	1.5	13	0.8	6
58	2.5	16	1.4	9	1.2	7	0.0	0
62	6.1	57	2.0	21	1.0	10	0.9	13
101	14.8	71	8.5	51	2.6	18	1.4	16
102	8.9	77	4.7	36	2.7	32	0.6	14
103	10.1	50	7.4	42	3.7	36	2.0	41
Tot.	**186**	1340	**92.5**	744	**47.2**	442	**22.2**	338

Table 4: Cost to benefit ratios for wetland restoration in the South Tobacco Creek Watershed.

Prod-ID	Scenario 1		Scenario 2		Scenario 3		Scenario 4	
	TN ($/kg)	TP ($/kg))	TN ($/kg)	TP ($/kg)	TN ($/kg)	TP ($/kg)	TN ($/kg)	TP ($/kg)
4	11.4	42.9	11.0	38.3	9.8	42.5	4.2	17.8
9	13.6	43.3	0.0	0.0	0.0	0.0	0.0	0.0
14	13.0	49.4	8.3	31.5	7.9	27.4	5.7	18.7
17	7.5	31.8	7.2	31.5	5.7	25.1	4.8	21.6
18	15.9	66.1	16.6	60.6	14.9	54.7	7.6	31.0
20	49.4	171.6	39.7	161.6	38.2	137.0	32.3	129.1
21	10.3	38.9	7.6	28.6	7.3	29.2	30.0	105.7
24	9.4	37.9	15.1	61.0	7.0	28.4	3.7	15.2
25	7.0	26.9	5.4	22.1	3.7	14.8	2.1	9.3
26	5.2	17.3	4.3	18.8	3.6	14.6	0.0	0.0
28	16.8	59.7	18.7	65.1	14.7	51.8	10.4	36.4
29	12.9	46.6	14.9	49.8	14.0	43.0	9.8	30.4
32	16.3	72.3	14.9	63.7	11.2	55.6	6.4	32.8
33	10.0	42.3	9.3	31.2	13.4	55.0	10.5	32.4
34	10.1	37.6	8.5	31.8	10.0	43.8	3.9	16.5
39	19.8	76.3	19.1	76.7	19.8	71.3	11.4	46.2
40	8.7	39.4	7.2	28.9	7.8	35.0	4.2	18.7
41	7.4	30.0	7.5	31.9	5.1	23.0	6.6	30.5
43	22.3	86.0	0.0	0.0	0.0	0.0	0.0	0.0
44	16.5	64.2	11.6	46.8	7.2	28.6	5.8	22.2
47	10.4	46.4	9.9	44.6	9.5	44.4	5.7	25.4
49	10.2	35.5	7.9	31.2	8.1	33.3	11.1	40.0
50	8.7	39.3	7.2	24.0	7.7	25.9	16.6	56.8
51	12.4	46.9	15.4	53.0	12.2	46.6	9.2	32.2
52	15.6	69.0	13.5	61.2	0.0	0.0	0.0	0.0
56	12.1	49.6	13.4	47.3	10.6	37.4	9.1	37.8
58	13.4	59.9	14.8	61.0	17.9	65.5	0.0	0.0
62	11.1	38.9	10.8	37.9	11.1	40.6	8.4	30.9
101	22.0	86.3	16.8	65.7	16.2	62.5	9.6	39.1
102	12.9	50.2	14.9	56.6	10.8	36.4	7.5	26.2
103	12.1	52.0	10.4	39.4	6.6	24.1	3.2	12.7
Min	**5.2**	**17.3**	**4.3**	**18.8**	**3.6**	**14.6**	**2.1**	**9.3**
Max	**49.4**	**171.6**	**39.7**	**161.6**	**38.2**	**137.0**	**32.3**	**129.1**
Avg	**13.7**	**53.4**	**12.5**	**48.3**	**11.1**	**42.8**	**9.2**	**35.2**

Table 5: Wetland restoration under a targeting scenario.

Prod-ID	Scenario	Area(ha)	TN(kg/y)	TP(kg/y)	Avg. cost ($/ha)	TN-C/B ratio ($/kg)	TP-C/B ratio ($/kg)
25	4	0.4	86.4	19.5	457.6	2.1	9.3
103	4	2.0	161.0	40.9	257.5	3.2	12.7
26	3	0.2	23.7	5.8	377.1	3.6	14.6
24	4	0.6	62.7	15.5	409.7	3.7	15.2
34	4	0.2	33.4	8.0	798.8	3.9	16.5
4	4	0.1	15.8	3.7	605.8	4.2	17.8
40	4	0.5	49.5	11.3	405.0	4.2	18.7
14	4	0.1	16.0	4.9	671.3	5.7	18.7
17	4	0.2	21.6	4.8	540.3	4.8	21.6
44	4	0.6	56.1	14.6	529.4	5.8	22.2
41	3	0.5	44.7	9.8	446.1	5.1	23.0
50	2	0.3	30.1	9.0	635.1	7.2	24.0
47	4	5.1	291.7	65.6	326.4	5.7	25.4
102	4	0.6	49.5	14.1	614.8	7.5	26.2
21	2	3.1	137.2	36.5	337.1	7.6	28.6
29	4	0.2	16.2	5.2	645.3	9.8	30.4
62	4	0.9	48.9	13.3	442.1	8.4	30.9
18	4	2.9	100.6	24.6	262.3	7.6	31.0
49	2	3.6	173.8	44.2	383.4	7.9	31.2
33	2	2.1	108.8	32.4	492.8	9.3	31.2
51	4	0.8	43.7	12.4	532.4	9.2	32.2
32	4	0.6	52.5	10.3	548.8	6.4	32.8
28	4	1.3	43.5	12.4	344.0	10.4	36.4
56	3	1.5	47.0	13.3	335.5	10.6	37.4
25	4	0.4	86.4	19.5	457.6	2.1	9.3
Total		28.5	1,714.4	432.0			
Average		1.2			474.9	6.4	24.5

Table 6: Wetland restoration under a price ceiling scenario.

Prod-ID	Scenario	Area(ha)	TN(kg/y)	TP(kg/y)	Avg. cost ($/ha)	TN-C/B ratio ($/kg)	TP-C/B ratio ($/kg)
103	3	3.7	131.1	36.0	236.0	6.6	24.1
4	3	0.7	17.2	4.0	249.8	9.8	42.5
18	4	2.9	100.6	24.6	262.3	7.6	31.0
56	4	0.8	23.1	5.6	270.7	9.1	37.8
25	1	4.6	183.8	48.2	282.5	7.0	26.9
40	1	7.5	256.4	56.3	297.8	8.7	39.4
47	1	40.1	1168.7	260.9	301.5	10.4	46.4
Total		60.2	1881.0	435.6			
Average		8.6			271.5	8.5	35.4

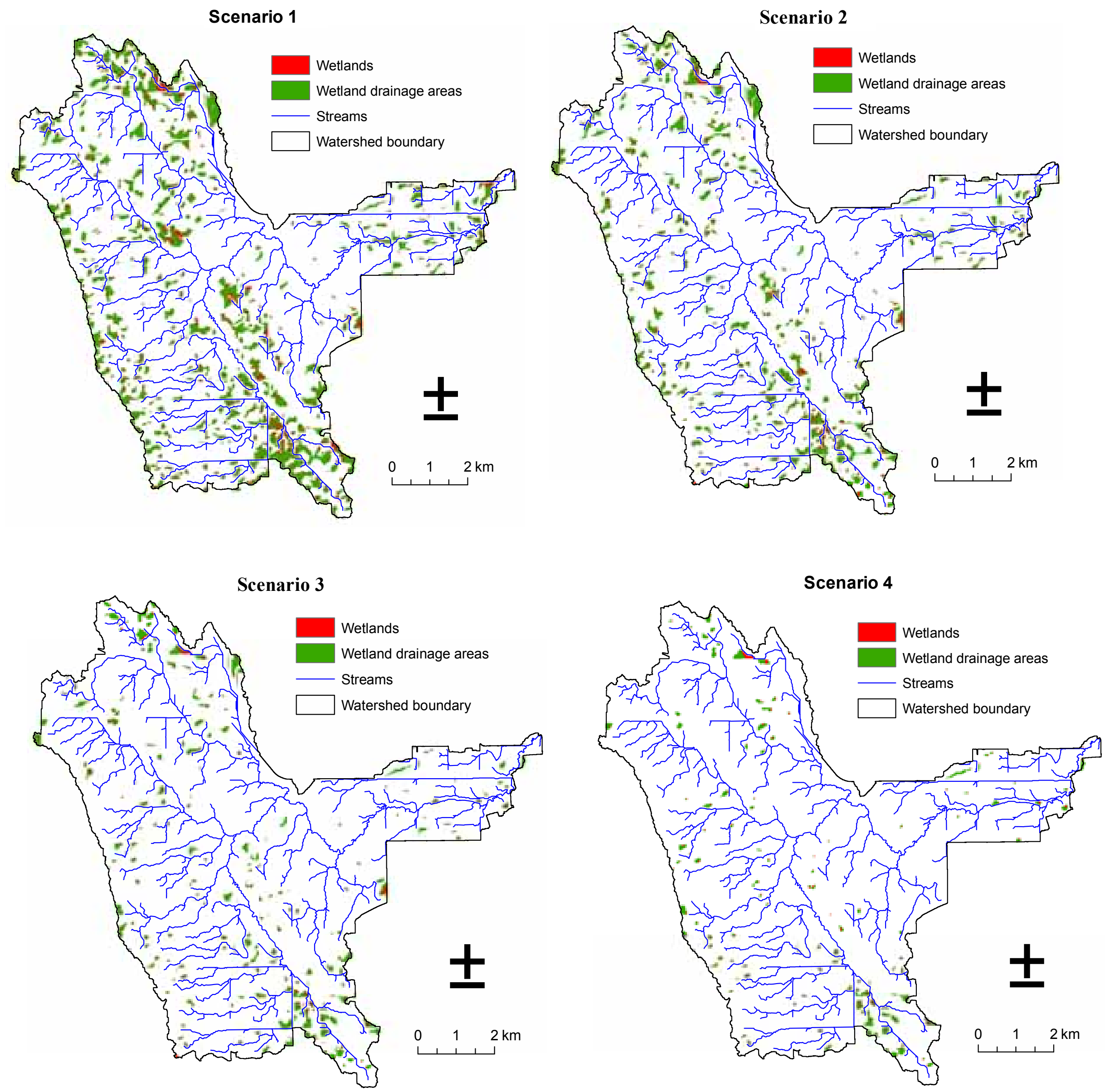

Figure 1: Four wetland restoration scenarios in the STC watershed with restored wetland areas of 2.5% (1), 1.2% (2), 0.6% (3), and 0.3% (4) of the total watershed area.

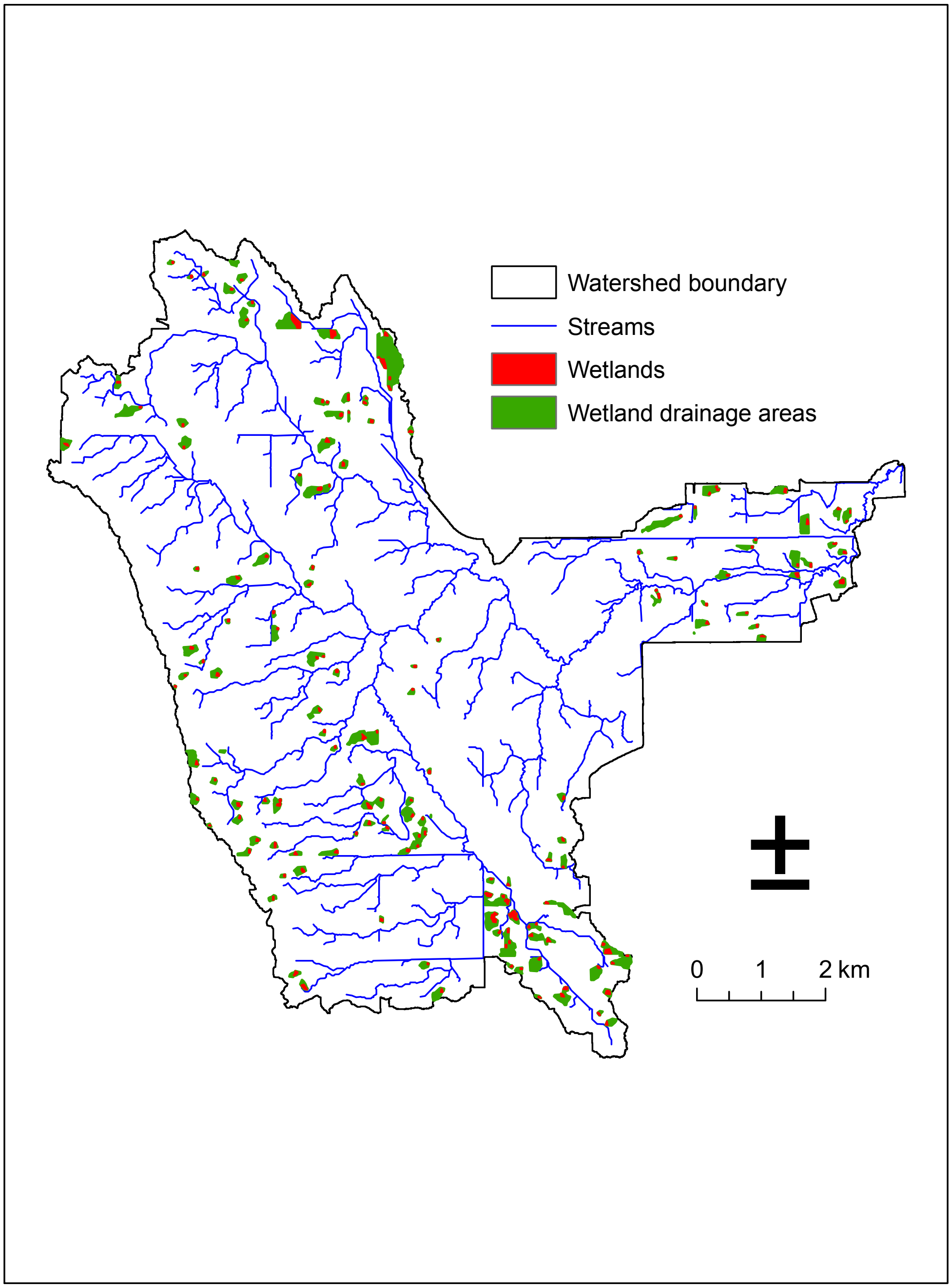

Figure 2: Spatial distribution of wetland restoration locations under the targeting scenario.

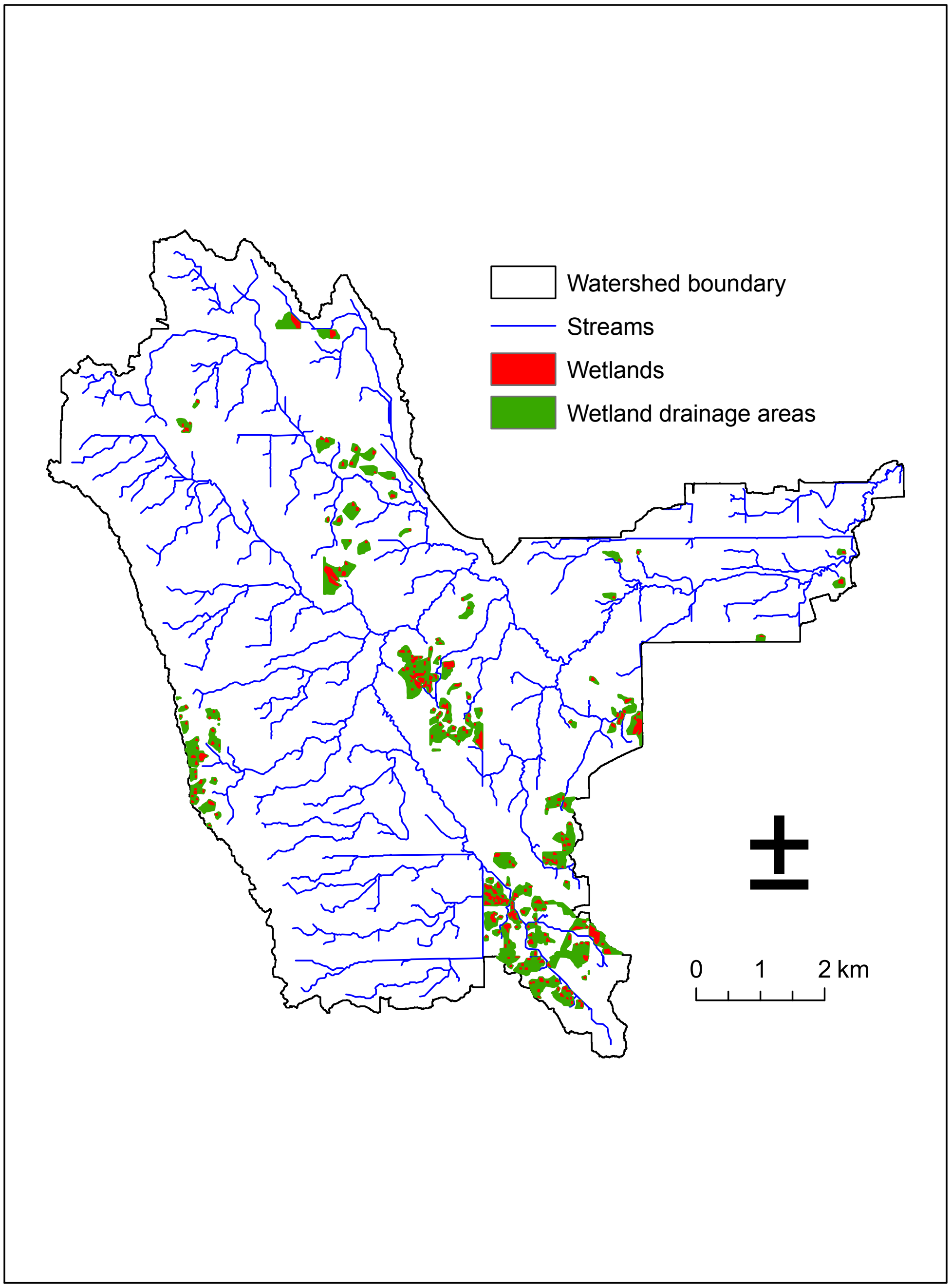

Figure 3: Spatial distribution of wetland restoration locations under the price ceiling scenario.

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Estimates of Passive Use Values of Wetland Restoration and Retention in Southern Manitoba

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Executive Summary

This paper presents results from a wetland restoration valuation study in Manitoba. Wetland loss is a concern in Canada, with significant loss in urban and agricultural areas. Due to their levels of the provision of ecological goods and services, wetlands have been identified as a potential beneficial management practice (BMP) for agricultural producers. As such, there is need for more economic information on the benefits wetlands provide to society, such as water quality improvement, carbon sequestration, flood control, biodiversity, etc.

A stated preference survey instrument was designed between the months of May and November 2008. The survey instrument included information on benefits and costs associated with wetland restoration; a referendum portion where they were asked to vote for one or more restoration programs that would increase wetland areas or the current situation in which loss of wetlands would continue. A rigorous design was followed in order to address inherent issues such as hypothetical bias.

The survey was administered online by Ipsos Reed in January 2009 to 1980 respondents. Results indicate that respondents are willing to pay to retain and restore wetlands in the province of Manitoba. Conservative willingness to pay estimates ranged from $290/household/yr for retaining existing wetlands to $360/household/yr for restoring wetlands to 1968 levels. Aggregated to the entire province over a five year period (discounted), the values are about $600 and $730 million, respectively.

Background & Rationale for Investigation

Wetland conservation is an important issue in Canada, with approximately 20 million hectares drained or lost since 1800 (Environment Canada 2009). Concern for this loss of habitat was confirmed when Canada signed the Ramsar Convention in 1971 and the federal government enacted a wetland policy in 1991. The goal of this policy was to promote the conservation of Canada's wetlands and to sustain their ecological and socio-economic functions, now and in the future. Unfortunately there is little economic information on the benefits – such as water quality improvement, carbon sequestration, flood control, biodiversity, etc. - of increasing wetlands in Canada to fully implement this policy.

Determining the value of wetlands is challenging because they provide a multitude of ecological goods and services (EG&S) such as scenic views and recreation. Krutilla (1967) discussed problems with traditional measures of valuing natural environments, pointing out that missing markets for many environmental goods and services inevitably led to their degradation. In situations where there is no easily observed benefit, or none that is easily identified by consumer behaviour such as in the preservation of wetlands, there is *existence value* individuals derive even though they receive no direct (use) benefit from them (Grafton *et al*. 2004). A key extension of existence value is *passive use value*. An individual may obtain utility from the knowledge that an environmental good or ecosystem will be maintained in the future in the event they would like to visit it, or that their children would have the opportunity to visit it. In other words, there are potential future use values in addition to existence values.

Economists employ a number of tools to assess the values of these non-market goods and services. The most common approach is called the stated preference (SP) method which involves the presentation of a survey instrument containing a series of questions to individuals comprising some sample of the population of interest. Some of these questions involve one or more hypothetical situations in which a respondent is required to make simulated market-like transactions (Haab and McConnell 2002). This information is used by researchers to estimate the respondent's willingness to pay for these public goods. Since these survey methods include the presentation of information to respondents administered in a number of different ways (i.e. mail, in person, internet, etc), determination of the scope of the program in which public goods are supplied (i.e. different levels of wetland restoration provide different levels of EG&S), proper identification and reminders of substitutes, and the reduction of biases such as hypothetical bias and strategic behaviour form critical components of the exercise. This presentation summarizes the approach and results from a study on values of wetland restoration in southern Manitoba using stated preference methods. In this study state-of-the-art methods were employed to ensure the effectiveness and salience of the survey and the resulting data. A number of innovative approaches were also incorporated into the contingent valuation methodology (CVM).

Funding and Partnerships

This research was funded by the Advancing Canadian Agriculture and Agri-Food Program. Our partners were Ducks Unlimited Canada and Drs. Wanhong Yang and Yongbo Lui from the University of Guelph. We thank staff at Environment Canada, Manitoba Agriculture, Food and Rural Initiatives, and Manitoba Water Stewardship for assistance with this research.

Previous Wetland Valuation Research

A wide range of wetland valuation studies have been conducted internationally (EVRI, 2009). The majority of existing wetland valuation studies have taken place in developed countries, where issues such as property rights, resources for funding and more complex survey designs and modes of administration were examined (EVRI 2009). Very few, however, have been conducted in Canada. Canadian wetland managers have not invested in collecting this information because valuation studies are typically costly and difficult to implement due to the complex survey design procedures employed. Once a significant database of values exists, however, it can be useful to conduct meta-analyses to understand common factors that influence economic value estimates and use this to transfer benefit estimates among geographic areas. The large number of wetland valuation studies in jurisdictions outside of Canada led to several attempts to conduct a meta-analysis of these studies (Brouwer *et al*. 1997; Woodward and Wui 2001; and Brander *et al.* 2006). Essentially a regression of regressions, results from meta-analyses could save time and money and become a useful guide for policy regarding wetland conservation.

The problem with these meta-analyses and benefits transfer, however, is the large diversity in types/classification of wetlands studied and the types of valuations conducted. Some studies focused on recreational values of prairie wetlands (Hammack and Brown 1974; Johnson 1984) while others analyzed marine wetlands (Gosselinck *et al*. 1974; Breaux *et al*. 1995). Other studies focused on testing and developing new valuation approaches or novel experimental design methods (Ledoux 2003; Campbell *et al*. 2002). This diversity of empirical approaches and geographical locales studied makes the merging of the various wetland valuation data into one large valuation model ineffective, and the resulting estimates may not yield results of use to policy and program managers. This is particularly the case if the researchers hope to draw conclusions about Canadian wetlands when few studies involving Canadian wetlands or respondents are used in the meta-analysis.

Wetland Status and Provision of Ecological Goods and Services

A major issue with prior wetland valuation studies has been an unclear understanding of the benefits wetlands provide. Various qualitative descriptions have been utilized, but in order for valuation exercises to be successful, respondents need to understand changes in quantities and qualities of the EG&S being provided by wetland conservation programs. Thus, in order to be useful, researchers require information on the historic and future conversion of wetland areas as well as differences in the provision of EG&S that result from these changes.

It is important to define baseline, or the current situation, in SP studies. In the case of wetlands, this involved whether to use historical or present wetland status data as the baseline. There are an array of estimates cited regarding wetland loss in Canada and the prairie pothole region. Environment Canada's website, as well as most other references, claim that an estimated 70% of wetlands in the prairie pothole region have been lost since human settlement. Information is not provided regarding the calculation of this value or how many wetlands or acres this 70% loss corresponds to.

Environment Canada has actively pursued the issue of wetland conservation, and a number of reports have been published recently on the current status of wetlands in Manitoba and the entire Prairie Pothole Region. The Canadian Wildlife Service assisted us in determining the current levels of wetlands in the Manitoba portion of the prairie pothole region. In particular, Watmough and Schmoll's (2007) study regarding the state of Prairie wetlands was instructive in outlining the situation and methods of measuring wetland levels. Concern was expressed, however, that this study did not include degraded wetlands, which should be included to more accurately represent the loss of EG&S provided by wetlands.

Ducks Unlimited has recognized the lack of information surrounding wetland status and has embarked upon their own project to provide accurate estimates of wetland status in Manitoba. Dr. Wanhong Yang's group provided GIS data and hydrologic information for our use, particularly from the South Tobacco Creek and the Broughton Creek Watersheds (Yang *et al*. 2008). The Broughton Creek Watershed was accurately modeled for wetlands in 1968 and 2005 and DU considers this watershed as representative of the prairie pothole region. Upon consultation with various Manitoba experts it was determined that the Broughton Creek data could be used to represent the status of wetlands in the entire prairie pothole region of the province.

Broughton Creek contains many small pothole wetlands and high levels of agriculture and wetland drainage. For the purposes of this survey, the wetland acreage in Broughton Creek in 1968 and 2005 was used to determine the trend of wetland loss. Satellite imagery and GIS modeling indicated that approximately 7,406 acres of undisturbed wetlands existed in 1968, compared with 5,874 acres in 2005. This represents an overall wetland loss of 1,530 acres (77% of 1968 level). As there were only two points of reference, this was divided by the number of years (40) for an average loss rate of 0.57% per year. Expanded to the entire Manitoba prairie pothole region, this corresponds to 1,044,102 acres in 2005 compared with 1,355,977 acres in 1968 or an annual loss rate of approximately 7,700 acres (see Figure 2.1 below). This was then projected forward at a 0.57% linear loss rate annually until 2020, indicating the situation that would exist should wetlands continue to be lost.

We also used the Broughton Creek study data to quantify changes in the levels of EG&S provided by wetlands in the pothole region. Yang *et al*. (2008) found that a wetland acre in the region can: filter approximately 0.043 kg/N/yr, 0.009 kg/P/yr, store 4 tons of CO2 equivalents per year, and control 6.5 tons of soil erosion and 1200m^3 of flood water. In terms of biodiversity, the great variation between wetland types naturally leads to varying degrees of carrying capacity for different organisms. However, Cowardin *et al*. (1995) found that a typical prairie pothole wetland acre can provide habitat for approximately 2 breeding pairs of ducks per year, which we considered an indicator for biodiversity.

We expanded this per acre information for five different scenarios: full wetland retention at 77%, restoration to 80%, restoration to 83%, restoration to 89% and restoration to 100% of 1968 wetland levels. These figures were chosen because they corresponded to restoring 13%, 25% 50% and 100% of the wetlands that had been lost since 1968. Based upon 1968 levels of wetlands and using expanded wetland levels from the Broughton Creek watershed, various acreage levels and associated increases in EG&S were calculated (Table 1).

This is critical information needed for the economic valuation of these wetland ecosystems. Respondents in SP surveys will know *what* they are purchasing, rather than presenting them with a vague qualitative statement on the benefits of wetland conservation. In order to make these numbers understandable, however, we adjusted some of them to reflect semi-truck loads of fertilizer to convey water quality improvements, and numbers of cars on provincial roads for carbon sequestration. We hoped these quantitative estimates of wetland services would allow survey respondents to make informed decisions about trade-offs between personal income (taxes) and wetland conservation.

Table 1: Calculation of benefits associated with the five wetland retention and restoration levels.

Program	% of 1968 wetlands	Total wetland acres	Nutrient reduction (tonnes)		Flood Control (m^3)	Erosion control (tonnes)	Biodiversity (breeding duck pairs)	Carbon capture (tonnes)
			N	P				
Per acre annually	------	------------	0.043	0.009	1214	6.5	2	3.9
Southern Manitoba Prairie Pothole Region								
Current situation	77%	1,044,102	44,896	9,397	1,267,539,828	6,786,663	2088204	4,071,998
Full retention	77%	1,044,102	44,896	9,397	1,267,539,828	6,786,663	2088204	4,071,998
By 2020	70%	949,184	40,815	8,543	1,152,309,376	6,169,696	1898368	3,701,818
13% restoration	80%	1,083,087	46,573	9,748	1,314,867,618	7,040,066	2166174	4,224,039
25% restoration	83%	1,122,071	48,249	10,099	1,362,194,194	7,293,462	2244142	4,376,077
50% restoration	89%	1,200,040	51,602	10,800	1,456,848,560	7,800,260	2400080	4,680,156
100% restoration	100%	1,355,977	58,307	12,204	1,646,156,078	8,813,851	2711954	5,288,310
Annual loss	0.57%	7,702	331	69	9,350,167	50,063	15403.9	30,038

Methods and Implementation

Stated preference methods involve the presentation of a survey instrument containing a series of questions to individuals comprising some sample of the population of interest. Rigour and attention to detail in the development of these survey instruments is necessary in order to capture the passive use value of wetland retention and restoration and to address design issues inherent in contingent valuation studies. This section describes the development of the survey instrument employed, the administration of the survey, and a basic description of the econometric modeling technique we used to estimate willingness to pay for wetland programs.

Survey Design Issues

Contingent valuation is the most commonly used stated preference method and typically involves the structuring of a single scenario where the respondent is offered an environmental improvement in return for increased taxes. Because this approach seems simple, many researchers developed CVM instruments and generated values that were controversial. This led to the improvement of CVM methods and the ability of these economic estimates to assess the economic magnitude of environmental damages caused by human activity.[1]

We followed the guidelines proposed by Carson (2000) in developing the survey instrument. These procedures involved focus groups with experts involved in providing the public good, as well as focus groups with representatives from the universe from which the sample of respondents is drawn. Involving experts ensures that the information in the survey is accurate and that the results will assist in policy development. Focus groups with potential respondents provide qualitative information on whether the instrument is understandable and consequential. Finally, it is critical that pre-tests of the survey instrument be conducted to provide some quantitative checks on the resulting data.

Research was initiated on the survey in May 2008 in Winnipeg with the formation of an expert advisory group of stakeholders and interested parties to provide input into the content of the survey. This group served as a “steering” committee in terms of providing information and advice on wetland policy and ecology and wetland issues in Manitoba. Several meetings were held with these experts as well as numerous conference calls and emails as the information was developed, and as the survey instrument was constructed. Interacting with this group of experts served as the initial scoping exercise for the development of the survey instrument.

Further to suggestions received from the steering committee, thorough research into wetland literature was conducted that allowed for a first draft of the survey to be completed. Much information and correspondence occurred between researchers at the University of Guelph and the steering committee in order to gain accurate and current information regarding the costs and benefits of wetlands. In August 2008 a trip was taken to Manitoba to see the prairie pothole region of interest, meet with members of Ducks Unlimited at Oak Hammock Marsh, conduct a focus group with wetland experts and have a second meeting with the expert advisory group. This provided the final input, and after revisions were made, a series of public focus groups were conducted in early October to finalize the draft before administration. Finally, pilot tests involving hundreds of respondents were administered to clarify any remaining ambiguities.

Throughout these procedures, we assessed concerns expressed that the survey was biased towards conserving wetlands. Some suggestions were provided to address this, but participants of the public focus groups felt it would naturally occur for two reasons: the public is under-informed as to the full benefits of wetlands and the historical rates of loss, and the use of quantitative means to describe the benefits would naturally push towards conservation. Most participants believed that, with some minor adjustments, the survey instrument would be suitable in the form used in the focus group examination.

Due to concerns with potentially “pushing” respondents to support wetlands and possible misrepresentation of agricultural producers, it was decided that the survey should be discussed with producers. While Alberta is a different situation than Manitoba, producers still deal with the same issues surrounding wetlands. Completion and discussion of the survey with five different families all yielded the same results: they did not feel that the survey was unfairly biased towards agriculture and that the

[1] Perhaps the most famous of these was the Exxon Valdez oil spill case, where CVM estimates of passive use values could have been employed by government officials in assessing the magnitudes of public damages caused by the oil spill from the tanker in Alaska (see Carson et al. 2003). This potential spawned a significant debate in the economics profession (see Portney 1994), and led to significant and important research into the development of improved CVM methods and procedures to test the validity of the resulting data.

trade-offs articulated were accurate. They also did not feel pushed towards supporting wetland restoration scenarios. They felt that they should not be penalized for draining wetlands - if society derived benefit from the wetlands, then the government should be compensating landowners for their protection.

An Overview of the Final Survey Instrument

The final version of the survey instrument (see Boxall and Pattison 2009) consisted of three parts. The first question asked respondents to rate the level of effort the provincial government should be applying to a broad list of current issues, including health, education, environment, etc. This was followed by a section that provided respondents with a base level of information consistent with the methodology outlined by Carson (2000). The opening pages provided a description of environmental issues in Manitoba, followed by questions regarding the respondents' familiarity with these issues.

Next, the survey moved into describing wetland conservation issues. This included information on the benefits of wetlands, the rate and reasons for wetland loss, the current state of loss and the trade-offs associated with wetlands conservation. After information themes were presented, simple questions requiring the respondent to rate their levels of concern were presented. This procedure was utilized to keep the respondents interested in reading further. In addition, we elicited opinions on who should be financially responsible for addressing wetland loss.

The survey then presented and described a number of potential programs to address wetland decline, including retention of current wetlands and restoration of previously drained areas. At this point the financial costs of implementing the programs were described. This was meant to set the stage for respondents to understand that trade-offs would be necessary for addressing wetland loss. This was framed as "Tough Choices".

In this present empirical case, five hypothetical wetland retention and restoration programs were designed (see Fig. 2). These programs would either maintain current wetland areas (retention) or increase wetland areas to some higher proportion than the (current situation of) the 1968 wetland acreage baseline (restoration). The retention scenario held wetland area constant at 77% of the estimated 1968 wetland area, while the levels of restoration involved increasing wetland area to 80, 83, 89 and 100% of the wetland levels existing in 1968. Essentially respondents in the design were asked to choose between the current wetland loss trajectory (0.57% annually) and some new situation in which programs would arrest wetland loss or improve wetland coverage. Associated with each proposed program was a randomly assigned increased tax level that respondents would pay annually for the next 5 years.

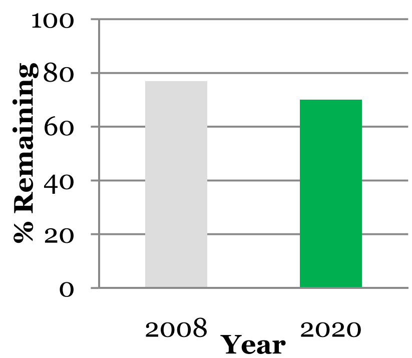
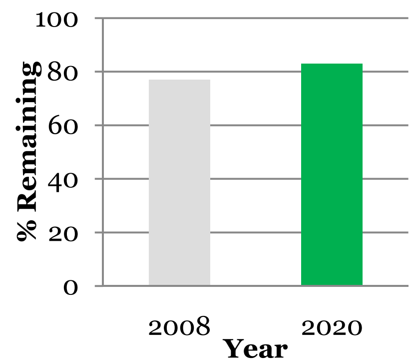
In order to facilitate the comprehension of wetland expansion, the choice scenarios were constructed to compare the magnitude of the current trend in loss by 2020 with programs that arrested or improved this by 2020. This was presented to respondents using figures, but also using estimates of the level of EG&S provided by wetlands. These services included: removal of nutrients (N and P), soil erosion, flood control, waterfowl production and carbon sequestration. In each scenario these were developed in terms we thought respondents could easily understand, as described above. For example, nutrient reduction was described as "bags of fertilizer", carbon sequestration was structured as "removal of cars from Manitoba roadways", etc.

Respondents were asked to vote for a proposed program in a series of five voting scenarios (see Fig. 1 for an example). In essence this was framed as a vote for continuing the current trend of wetland loss, or a program in which this loss was addressed. Attached to each program alternative was a randomly drawn tax level from a uniform distribution of tax values. The choice framework employed a referendum approach to address the issue of incentive compatibility. Referendums in a democratic government require a majority, and if a majority is reached, the entire collective must live up to the terms of the proposal successfully voted on by the majority. CVM experts claim that this referendum approach addresses free-riding in which an individual may prefer improved environmental conditions, but relies on others to fund the actual improvement. This is one of the early developments in CVM methodology that experts consider critical to developing high quality data (e.g. Arrow *et al*. 1993).

While the presentation used in the survey instrument addressed many of the concerns raised by CVM experts, a number of innovations were also employed. The use of five voting scenarios was utilized instead of the typical CVM case where only one is used.[1] This permits a "richness" of preference information to be collected from respondents and may allow the use of smaller samples or respondents for appropriate levels of statistical efficiency in estimation of willingness to pay. Furthermore, the presentation of these voting scenarios was randomized in the final administration of the instrument. Thus, one is able to assess the responses to the first vote as well as the series of votes provided by the sample of respondents. This is important for tests of scope of the environmental quality changes implied by the various wetland programs (Carson and Mitchell 1993).

The final sections of the survey contained a series of debriefing questions and elicited individual-specific information such as demographics and environmental attitudes.

[1] In some CVM application multiple votes are employed but the level of the environmental quality change is held constant and the tax level is varied depending on whether the respondent agreed to pay some original level or not. This is called double bounded CVM. This provides a great level of detail on the marginal utility of income. However, in this present study we varied the wetland level which provides more detail on preferences over the environmental quality change of interest.

Vote	The Current Trend	A Proposed Program
Wetland Area Targets	Results in further wetland loss: 77% of 1968 wetlands currently remain in southern Manitoba, but this will decline to 70% (950,000 acres) by 2020. 	**Restore** wetlands in southern Manitoba to **83%** (1,122,000 acres) of 1968 levels by 2020 
Water Quality *By 2020 wetlands will annually filter the equivalent of about:*	4500 semi-truck loads of fertilizer	5300 semi-truck loads of fertilizer
Flood Control *By 2020 wetlands will annually control about:*	1.1 billion cubic meters of water	1.4 billion cubic meters of water
Soil Erosion *By 2020 wetlands will annually control about:*	6 million tonnes of soil from being eroded	7 million tonnes of soil from being eroded
Wildlife Habitat *By 2020 wetlands will annually provide habitat for about:*	58,000 breeding pairs of ducks	67,000 breeding pairs of ducks
Carbon Capture and Storage *By 2020 wetlands will annually store carbon equivalent to the emissions of about:*	740,000 cars	875,000 cars
Your household's annual share investment paid through tax increases for the next 5 years, 2008-2012	$0 annually for 5 years	$ annually for 5 years

Question 6a. Please carefully compare the two alternatives presented in the table above. If you had to vote on these two options, which one would you choose? *Please treat independently from all other votes. Please mark one box only.*

Current Trend ☐ ***Proposed Program*** ☐

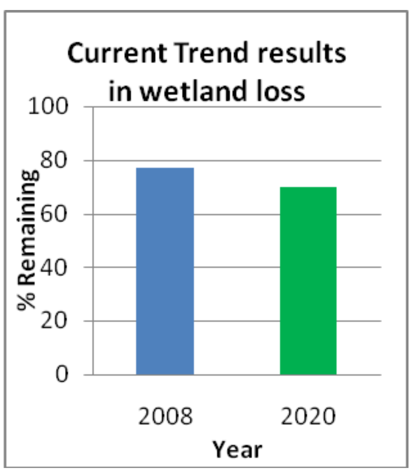
Figure 1: An example of one of the five voting scenarios used in the study.

Design and Analysis Issues

A number of state-of-the-art design principles were used in the survey and analysis of the data. First, the use of household taxes as the payment vehicle effectively described a realistic method of payment for a public good, and the referendum format provided respondents with incentives to report their true willingness to pay. For the payment vehicle to be incentive compatible it needs to be consequential, and credibly impose costs on the entire sample of interest while avoiding voluntary contributions (Arrow *et al*. 1993; Carson and Hanemann 2005). The initial distribution of tax levels employed ranged from $25 to $600. The endpoints of the distribution were initially examined in the public focus groups ($25-$400) and were adjusted for the pre-test ($25 - $500). Following the pre-test, the endpoints were further adjusted ($50 - $600). These adjustments followed examination of the percentage of respondents voting for the restoration program regardless of their scope at the highest and lowest tax levels - many would vote for the program at the lower level while few would vote at the higher level. The highest tax level used in this study ($600) is considerably higher than others we have used in similar studies (e.g. Olar *et al*. 2007).

Two versions of the survey were administered in the pre-test and differed in the graphical presentation of the restoration levels in the voting scenarios (see Fig. 2). Version 1 had two histograms to illustrate the current or future wetland situation in southern Manitoba. The first bar showed the current area of wetlands in southern Manitoba as a percentage of wetlands remaining from the 1968 base area. The second was the anticipated future area in 2020 based on a linear trajectory of loss based on the period 1968-2008 in an absence of restoration. Version 2 had this information as well as a third histogram which clearly showed the 1968 base level as a 100% wetland area. The construction of two versions arose from the focus group comment that Version 2 was a better way to illustrate the wetland decline that had occurred historically in the province.[1]

Version 1



Version 2

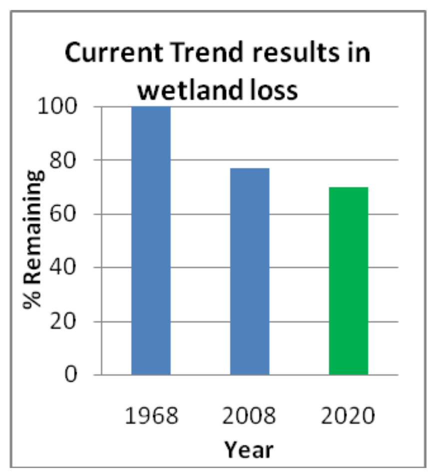


Figure 2: An illustration of the presentation of wetland area loss in two versions of the non-market valuation survey.

[1] When presented with the two options, most individuals preferred the graph with 3 histograms because they could "see what the earlier level had been". This was an indication that participants may be anchoring on the earlier level and not basing the decisions soley on the information provided. Hence we examined both approaches in this study.

Some respondents will vote for a proposed environmental improvement regardless of the personal cost to them. This can be a legitimate response as long as they actually will pay the amount presented if the situation was "real", and that they have the income available to do so. However, research has shown that these individuals are sympathetic to causes such as environmental degradation and simply feel good about allocating money to what they deem to be a worthy cause. These altruistic individuals can bias measures of economic values upwards as they ignore budget constraints and do not recognize tradeoffs they are making between environmental improvements and income loss (Blamey et al. 1999). This problem, called "yea-saying" can be mitigated by incorporating debriefing questions following the voting scenarios. We asked respondents why they voted for the restoration scenarios and those that chose the answer "I think we should protect wetlands regardless of the cost" as their most important reason were termed yea-sayers and were deleted from the final dataset.

Some critics of non-market valuation techniques doubt that the use of hypothetical scenarios can convincingly replace the absence of real market transactions. This raises the spectre of hypothetical bias in SP data. Various calibration techniques in correcting this bias were employed. The first involved the use of "cheap talk" scripts. These have been found to mitigate hypothetical bias by convincing respondents that the survey has policy implications and reminding them of the consequential trade-offs they are making in the valuation scenarios. The cheap talk script also makes respondents aware of hypothetical bias and how it can skew willingness to pay results upward. Studies by Cummings et al. (1999), List (2001) and Lusk (2005) confirmed the effectiveness of cheap talk in mitigating hypothetical bias. We used cheap talk script prior to the voting scenarios to remind respondents of the consequential trade-offs they are making by voting yes or no to the proposed programs.

Participants were also probed for their level of certainty following each of their choices in the wetland voting scenarios. If a respondent indicated uncertainty in their response to a vote, their answer was considered a vote of "no" to the proposed wetland program. Studies have shown that hypothetical values are not statistically significant from real values when respondents are certain of their responses (Champ *et al*. 1997; Blumenschein *et al*. 1998). Furthermore, uncertain responses are not as appealing for policy guiding purposes as certain responses (Champ *et al*. 2003). In order to reduce hypothetical bias, all uncertain responses were calibrated in this fashion, achieving more conservative estimates of the WTP for the wetland programs.

Administration of the Survey and Pre-Tests

Ipsos Reid was contracted to administer the instrument to a sample representing the population of Manitoba. We utilized their internet panel as the mode of administration of the survey. Internet panels are now a preferred mode of administration and offer a number of advantages over mail, telephone and other methods (Dillman1999). While some thought was given to the fact that this form of survey would preclude the participation of households without access to the internet, statistics show that a high percentage of Manitoban households have access to the internet at home, and of those that do not have home access, many of them are still panel members as they have internet access at work (Statistics Canada 2007).

Ipsos Reid maintains a panel of about 10,000 Manitobans for survey purposes. Ipsos Reid staff actively manage their panel members and can provide data on panel member's demographic characteristics (e.g. city/town of residence, gender, age, income, children in household, household size, education, etc.). The availability of this information means that this does not need to be collected from respondents in the survey which reduces response burden. Panel members are selected through a rigorous screening process with the intent to ensure representation of all demographic and market segments, and panel members receive various coupons and perks as an incentive to respond to various surveys that are sent to them. It is also important to note that the Ipsos Reid panel is frequently "refreshed" (new members added and old ones excused) to ensure accurate representation of the changing demographics of the current population of interest.

The pilot or pre-test was launched by Ipsos Reid to their internet panel of Manitobans on November 21st, 2008. A total of 353 individuals were surveyed, 84 of which only partially completed the survey. This resulted in a total of 269 completed surveys. Following adjustment of the tax levels, a second pilot survey was administered to a further 177 respondents. The results from this second pilot were deemed satisfactory and the final survey was administered in January 2009 to an additional 1803 respondents. This yielded a total final sample of 1980 individuals (note that there were additional respondents who only partially completed the survey).

Results and Discussion

Respondents' impressions of this survey were quite favourable with over 90% indicating that they learned something new, found the survey meaningful and that it was fun to answer. However, about half found that the survey was perhaps too long. Information from respondents who partially completed the survey indicated that interruption while completing it (32%) and the length of the survey (25%) were the cause.

Table 2 below compares socio-demographic characteristics of the sample versus the population of Manitoba. Except for the slightly higher median age, the characteristics of the respondents match those of the provincial population characteristics fairly well with income, gender ratio, household size and percentage married close to that of census data of the Manitoba population. Most of the respondents (80%) were raised in the province of Manitoba. The remainer of individuals were mainly from the rest of Canada, while only a very small percentage were from the US or elsewhere (5%). About half of the sample members were raised in a city, while the rest were from either a small town or rural area.

Table 2: Socio-demographic characteristics of the sample vs. Manitoba population.

Characteristic	Full sample	Manitoba population
% Male	49	48
Median Household Income	$50,000 – $59,000	$60,754
% Married	49.6	50
Average Household Size	2.62	3
Median Age	48.7	38.1

http://www12.statcan.gc.ca/censusrecensement/indexeng.cfm

Respondents indicated that improving roads and highways, reducing crime and improving health care ranked quite high as areas where government should be expending more effort. Supporting the arts, improving education, encouraging economic growth, increasing jobs in rural communities and lowering taxes were also all considered to be needing more government attention, but to a lesser degree. Protecting the natural environment ranked 4th in terms of emphasis on more action.

Respondents seemed to be least familiar with wetland loss in comparison to other environmental issues in the province. This could be attributed to the significant media coverage of some of the other issues, such as water pollution in Lake Winnipeg from agricultural and international sources, or the current topic of climate change that most Canadians are becoming familiar with due to widespread media coverage.

When provided with information regarding wetland benefits and loss rates, almost 90% percent of respondents suggested some level of concern about the issue (Fig 3). While most respondents felt that landowners bore some level of responsibility for wetlands restoration, few felt that they should bear the full costs of addressing the issue.

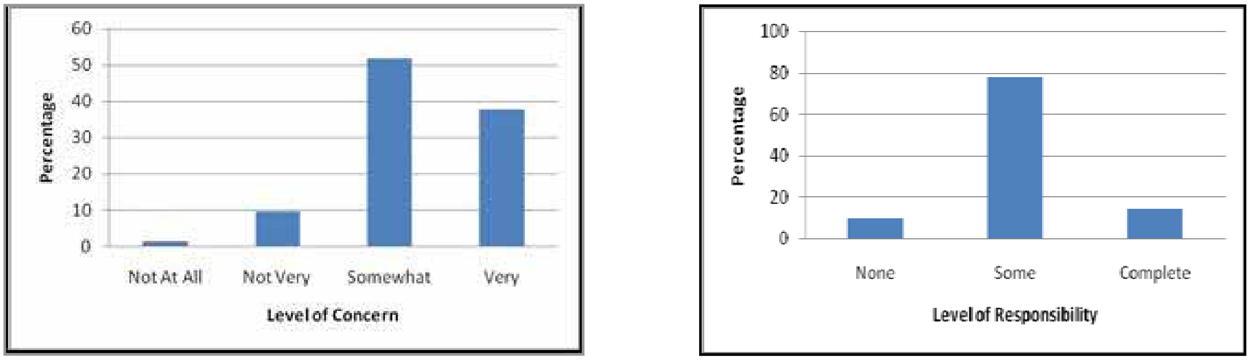


Figure 3: Levels of concern expressed by respondents over wetland loss and opinions on the financial responsibility of landowners for wetland conservation in southern Manitoba.

While respondents felt that landowners should bear some financial responsibility for wetland restoration, government should pay the larger share of restoration costs (see Fig. 4). Respondents also felt that conservation groups should also share some portion of the financial costs of wetland restoration.

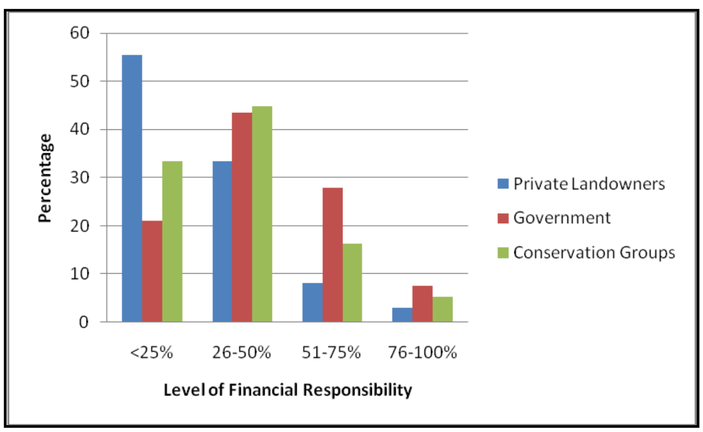


Figure 4: Distribution of the level of financial responsibility for wetland conservation in Manitoba based upon full survey response.

Addressing Hypothetical Bias

Yea-sayers were identified using the debriefing question described above. Figure 5 suggests that they were not sensitive to the tax levels they faced in comparison to other respondents. Data from these individuals was not included in the estimation of economic values for wetland restoration.

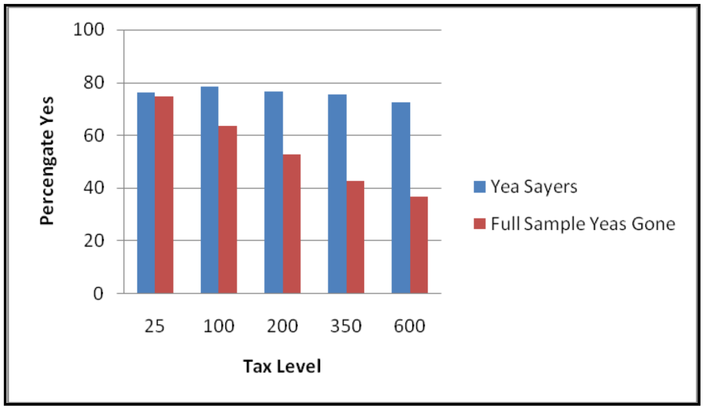


Figure 5: Distribution of percentage of yes votes for yea-sayers vs. the full sample with yea-sayers removed.

As expected, when respondents faced scenarios with increased taxes they became more uncertain regarding their voting decisions. Hence, as mentioned above, votes for the proposed program that were uncertain were coded to "no".

Tests of Scope

The scope test has been suggested as a means to test the validity of valuation estimates in CVM studies (Carson and Mitchell 2005). If respondents are sensitive to scope of the environmental change it means they regarded the hypothetical scenarios seriously and considered the relevant trade-offs posed to them. When respondents are sensitive to scope they should be willing to pay more for greater levels of provision of the public good (Champ *et al*. 2003). The scope test results presented in Table 3 arose from WTP estimates using design parameters from model 1 shown below. First vote responses were selected in order to perform the test without any sequencing or anchoring effects. Both scope tests had yea-sayers removed and uncertain votes treated as no´s.

Table 3: Estimates of annual household WTP ($) for the lowest and highest levels of wetland restoration and vote order.

	All votes combined	1st vote	2nd vote	3rd vote	4th vote	5th vote
Retention of wetlands at the existing 77% of 1968 levels	271.67	463.87	318.88	225.28	272.51	175.42
S.D	17.60	951.00	45.67	39.72	29.83	44.44
Restoration to 100% of 1968 levels	359.48	519.39	380.75	405.55	396.45	359.96
S.D.	21.17	390.00	40.02	35.65	28.06	20.85

When all votes are combined, the WTP estimates pass the scope test – that is, respondents are willing to pay more for the 100% level of restoration than simply retaining the current level of 77% wetlands. This suggests that they are distinguishing between restoration levels and are deciding between increased taxes and the different levels of wetland services provided. However, while the mean WTP estimates in the first vote are higher for the 100% level than the 77% level as expected, the difference in mean WTP is not statistically significant and these first vote results do not pass a test of scope. This is the only "pure" vote where respondents have not been influenced by other votes, and it is this vote that would truly validate the model. As can be seen, the standard deviations are very high, inferring that the responses in the first vote are more variable than the later votes. It could be that this instrument was complex and that respondents had some difficulty choosing a vote the first time they saw these voting scenarios. This requires further research to fully understand this potential.

Mullarkey and Bishop (1999) found that wetlands may be a unique case of valuation studies that will not pass scopes test due to unclear understanding of the benefits provided at the various levels of wetland service provision. However, our survey employed clear quantification of the benefits, so we expected that it would pass the first vote scope test. In some regards this is unfortunate, but may also point to some undefined characteristic of wetlands that is causing people to respond differently. While it can be observed that as respondents are presented with more scenarios they are more sensitive to scope – and perhaps anchoring on the levels we are providing them – evidence from focus groups and pre-test suggested that we are in the right region of bid levels, making the results more reliable than the single vote scope test might suggest.

Variables in the Models

Uncovering the determinants of voting behaviour requires the use of specific regression techniques. The dependent variable is binary (a vote indicating a "yes" or "no" response) which means that using OLS procedures would generate inappropriate parameter estimates. Thus, as with most CVM studies, we employed binary logit models using various specifications of explanatory variables to understand the significant determinant of voting choices. Estimation involved maximum likelihood procedures using LIMDEP software (Greene 2007). The parameter estimates are displayed in Table 4.

Table 4: Parameter estimates (t-statistics) for four binary logit models.

	Model 1	Model 2	Model 3	Model 4
Intercept	0.2593 (1.117)	-0.3388 (-1.319)	-0.5901* (-2.268)	-0.6198* (-2.377)
Tax level ($)	-0.0028* (-25.755)	-0.0029* (-25.848)	-0.0029* (-25.932)	-0.0029* (-25.977)
Restoration level (%)	0.0075* (2.812)	0.0076* (2.825)	0.0077* (2.833)	0.0077* (2.836)
Household income ($1000)		0.0002* (2.560)	0.0001 (1.580)	0.0001 (1.666)
Male gender		0.0284 (1.490)	0.0241 (1.260)	0.0223 (1.158)
Age		0.0117* (6.801)	0.0129* (7.439)	0.0131* (7.523)
Number of people in the household		-0.0407* (-2.217)	-0.0377* (-2.042)	0.0361* (-1.947)
Member of an environmental organization			0.3948* (4.095)	0.4025* (4.168)
Visited a park			0.2937* (6.008)	0.2922* (5.947)
Resident of Brandon				0.4035* (3.406)
Resident of Thompson				-0.0046 (-0.020)
Rural resident				-0.2396 (-0.422)
Log-likelihood	-6004	-5968	-5940	-5933

Model 1 includes the tax and restoration levels. The parameter estimates show that tax was negative and highly significant - as tax levels increased respondents were less willing to vote for the proposed programs. The level of restoration was positive and significant, indicating that respondents preferred restoring more wetlands to less. It is interesting to note, however, that the restoration parameter was not as highly significant as the tax level.

Model 2 added several demographic variables to the specification. Household income was found to be positive and statistically significant. This is intuitive in that wealthy individuals may have more money to contribute to causes such as wetland protection. Age was positive and significant, indicating that older individuals were more likely to vote yes to the proposed wetland program. Male gender was statistically insignificant. The number of people in a respondent's household had a negative and statistically significant effect on voting for the proposed programs. This result probably indicates that as there are more people to care for in a household there is less disposable income that is available for spending on environmental issues.

Model 3 included the endogenous variables of environmental sentiments – membership in an environmental organization and visitation to parks in Manitoba in the previous year. Not surprisingly, both variables were positive and significant. Those individuals that joined environmental organizations and visited national or provincial parks obviously placed value on the natural environment and were willing to pay to preserve it. We note that the tax and restoration variables maintained their signs and statistical significance did not change with the addition of new variables.

The final model added some location dummy variables in order to determine if region played a role in voting behaviour. Residents of Thompson, a northern town far from the prairie pothole region, were found to be less likely to vote for the proposed program; while residents of Brandon were more likely to vote for the program (positive and significant). The dummy variable for rural residents was included in the model as these are the individuals that will have to face consequences of any government decisions on the issue of wetland conservation. However, while this variable had a negative parameter, it was statistically insignificant.

In an attempt to understand why respondents voted the way they did, questions were asked following the votes probing the importance of attributes of the choices. In terms of the various EG&S that wetlands provide, respondents identified that water quality benefits provided by wetlands were the most important reasons for voting for restoration programs (Fig. 6). Increased household taxes were also one of the major deciding factors in their voting decisions. Wildlife habitat was also another important reason why respondents voted the way they did in the survey.

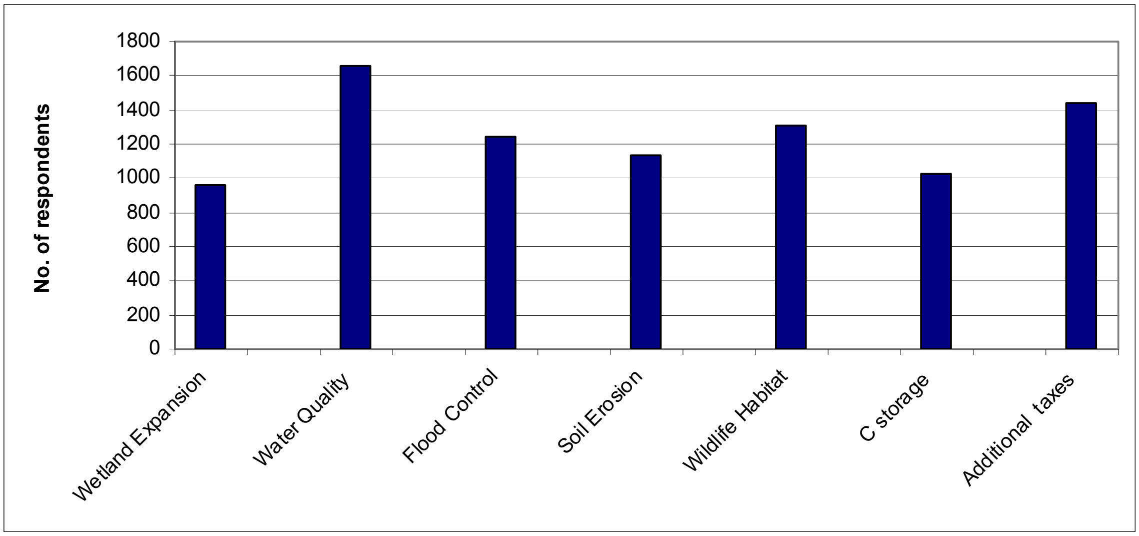


Figure 6: Most important attributes (pooled very and extremely important categories) indicated by respondents that explained their voting behaviour for wetland restoration programs.

In terms of voting for the current situation and not for a restoration program, the major factor was the increase in taxes (Fig. 7). This was evident from the logit models (taxes were negative and highly significant). Other issues were relatively small by comparison; very few people felt the program would not be of benefit or that the issue was not important. Some individuals did feel that taxes could be better spent on other issues; and some respondents felt that they did not have enough information to make an informed decision. In terms of reaching targets, some felt that targets would be reached too soon, and there was no real sense of urgency. Very few respondents felt that the targets would be reached too late. Of particular note was that very few individuals felt that the levels of wetland expansion were too large. Thus, the restoration level did not appear to play a major role in determining why people voted against the proposed programs.

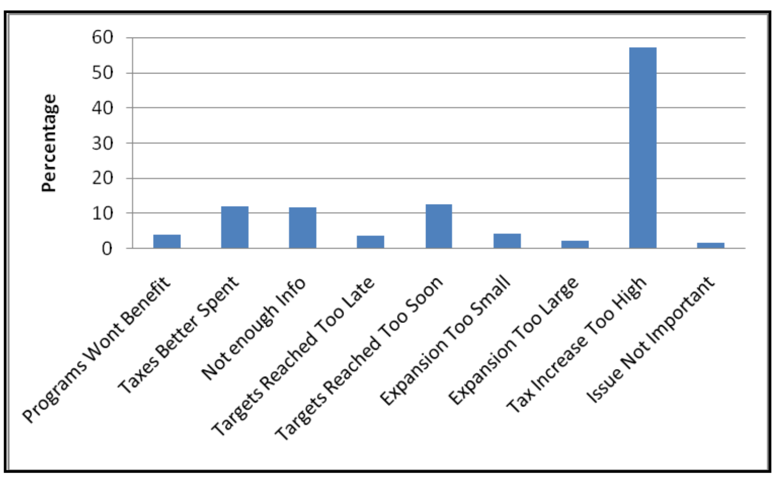


Figure 7: Most important reason respondents voted at least once for maintaining the current trend of wetland loss in southern Manitoba.

In terms of voting for a restoration program, most respondents felt that it was little to pay for the benefits received and that it was important to invest for the future (Fig. 8). This corresponds directly with the concept of passive use values. Some voted for the program because of moral reasons – "it is the right thing to do", while others felt that the government does not do enough to protect the natural environment. The number of respondents who felt that they would be directly impacted was similar to the number who felt they would not be directly impacted by the project.

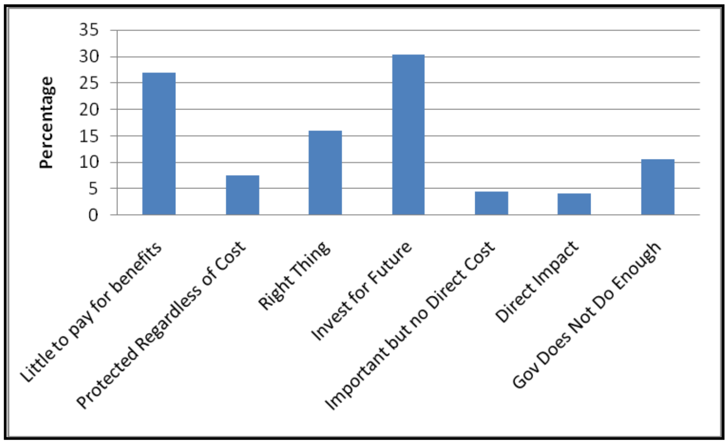


Figure 8: Most important reason respondents voted for at least one of the proposed restoration or retention wetland programs in southern Manitoba.

Aggregate Estimates of Economic Value

In order to be a more effective mechanism in the guidance of public policy, household WTP levels should be expanded to assess the aggregate levels of WTP at the provincial level. First, we examined several specifications for the restoration parameter to determine which functional form was the most appropriate. We compared linear (see Table 3), quadratic and logarithmic forms for this parameter. The squared term in the quadratic functional form was statistically insignificant indicating that this form was not appropriate to use in assessing aggregate WTP. The linear and logarithmic functional form specifications exhibited similar McFadden R^2 values (0.0565 vs. 0.0566 respectively) and percent correct predictions. However, as the logarithmic specification had a slight larger R^2 value, it was chosen for the aggregate WTP calculations.

Using the procedures developed by Hanemann (1984) and Krinsky and Robb (1986), WTP estimates were generated. These are reported for each restoration level in Table 5.

Table 5: Estimates of annual WTP ($) for wetland programs using a logarithmic specification for level of restoration.

	77% retention	80% restoration	83% restoration	89% restoration	100% restoration
Mean annual WTP per household	294.02	304.36	313.16	329.84	357.75
SD	11.86	10.76	9.84	8.96	15.57

To generate aggregate values, recall that when respondents voted for a program they were to pay increased taxes for a 5 year period. This stream of payments for restoration level *i* must be discounted to the present using the simple net present value formula:

$$NPV = \sum_{t=1}^{5} \frac{WTP_i^t}{(1+r)^t},$$

where WTP_i^t is the willingness to pay estimate for wetland program *i* in time *t,* and *r* is the discount rate. Using a discount rate of 5%, aggregate WTP was estimated by multiplying the discounted household WTP by the current number of households (448,766) in Manitoba, as indicated by the 2006 Statistics Canada National Census. The resulting estimates ranged from $602 million for retention to $729 million for 100% restoration.

Summary and Conclusion

Wetlands are very valuable resources that provide a variety of EG&S. However, agriculture and other human activity have led to significant levels of impact on these ecosystems, particularly in agricultural intensive areas such as the prairie pothole region of Manitoba. Little economic information exists in Canada regarding the benefits and costs of wetland conservation programs.

This study focused primarily on addressing that issue through the use of a stated preference model. A survey was designed and implemented in early 2009 that sampled opinions from approximately 2000 members of the Manitoba population. From this survey it was determined that Manitobans expect their government to play an important role in wetland conservation, and that they are willing to pay increased taxes to fund retention and restoration programs in the province. Passive use values associated with maintaining or increasing wetland levels were estimated to range from $602 – $729 million.

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The Alternative Land Use Services (ALUS): An Ecological Goods & Services Research Project in the Rural Municipality of Blanshard, Manitoba

Ian Wishart, President, Keystone Agricultural Producers, Manitoba

Executive Summary

The ALUS pilot project was developed to determine whether or not existing agricultural agencies and producers could effectively work together to deliver Ecological Goods and Services (EG&S). The program emerged as a response to ineffective ecological preservation programs and increased regulation of agricultural practices in the name of environmental stewardship.

The municipality of Blanshard in Western Manitoba was chosen as a pilot because it is economically dependent on farming, there was considerable initial interest by the population, and the geography of the region lends itself to ecological diversity. Funding for the pilot was provided by federal, provincial, and municipal governments.

The administration was done jointly by a collective of government and agricultural organizations which included; PFRA (AAFC), DWF, KAP, MAFRI, MASC, LSRCD, and MHHC and the RM of Blanshard. The University of Manitoba and the George Morris Centre provided analysis and assessment of the program. The program was administered by three committees consisting of members of the various groups; a technical committee, a management committee, and a local advisory committee.

The program ran from December 2005 to November 2008. Local farmers were first engaged with the program, when they expressed interest they contacted MASC or LSRCD and provided the location of the land they were interested in enrolling. LSRCD and MASC then determined the number of eligible acres and the application was reviewed. Throughout the three years the land was monitored and audited to ensure agreed to conditions were upheld. Producers were eligible to receive payment for wetland services, riparian buffer services, natural area services, and ecologically sensitive land services at the following pay scale.

Service	% Enrollment allowed	Payment/acre, no use	Payment/acre, haying	Payment/acre, grazing
Wetland	100%	$15	$7.50	$5
Riparian	100%	$15	$7.50	$5
Natural	100%	$15	$7.50	$5
Ecologically Sensitive	20%	$25	$10	$5

In the first year 162 contracts were signed adding up to 20,940 acres with expenditures of $294,000. The second year had 155 contracts totaling 21,470 acres at a cost of $300,900

A summarized evaluation of the ALUS pilot determined that the existing agricultural agencies were effective in administering the ALUS pilot and the return for investment in the EG&S was relatively high compared to other conservation programs.

The most significant issues the pilot encountered were increased audit and administration costs when land was partially engaged in the production of public EG&S benefits and partially producing private benefits (used for grazing or haying). In these cases, project verifiers had to assess the level of private use on a case by case basis because it was assumed that land had the highest value when it was dedicated entirely to the provision of EG&S. There is indication that this may not be true and some degree of land use/management for private benefit leads to increased levels of public benefit. Future

ALUS programs will incorporate these findings and develop a model to assess a value for EG&S rendered without regard for how the level of EG&S is achieved.

Background and Rationale for Investigation

Modern intensive farming methods have restricted the natural functions of many agricultural ecosystems. Millions of dollars have been spent across Manitoba on programs which attempt to reduce or offset the damage to the rural environment. Examples include the Species at Risk Act, the North American Waterfowl Management Plan, Environmental Farm Plans, conservation lands purchase, flood protection, zoning rules, water laws, and drainage regulations. There is a tendency within government to try to regulate certain activities, such as drainage, on the private landscape as a way to manage water and to prevent non-point source pollution. But experience has shown that the regulation of extensive land use activities on the private agricultural landscape is expensive and ineffective. Excessive regulations only serve to alienate the rural community from urban residents and decision makers. Furthermore, none of the various programs have been effective on the scale required to deliver "landscape size" environmental results.

Sustaining an ecologically healthy and diverse landscape in Manitoba's agricultural region can be accomplished if it is in the economic interests of agricultural producers to deliver an "environmental crop" to Manitobans at large. Landowners currently bear all the costs of providing Ecological Goods & Services (EG&S) to society. Without a demand and payment for these services, market signals will continue to direct producers to bring more naturally diverse land into production for the sake of economies of scale, further reducing the total EG&S they are able provide.

Providing farmers and ranchers with public financial incentives to deliver EG&S, such as clean water, would create a "market" for public environmental goods. New York State has such a program whereby New York City provides conservation incentives to farmers in key watersheds in order to supply clean drinking water to urban residents. There would be strong rural and urban support in Manitoba for an incentive-based program for agricultural producers along this line. Canada is the only industrialized country without an incentive-based, large scale landscape conservation program. Such programs have been declared "trade neutral" or "green box" by the World Trade Organization (WTO). Most of Canada's agricultural organizations have collectively lobbied federal and provincial governments in Canada to develop a policy framework to facilitate the delivery of a publicly funded EG&S program on the agricultural landscape.

Keystone Agricultural Producers (KAP) is a general farm organization based in Manitoba and is the province's largest producer group. KAP's memberships range from individual producers to commodity groups. In 1999 KAP released an EG&S concept paper which outlines producers' perspective on how an EG&S program could be developed and delivered in Canada. KAP titled this program concept "Alternative Land Use Services (ALUS)." The paper received widespread recognition and much support in Manitoba and across Canada. Many presentations were made to agricultural interests, rural municipalities, and communities across Manitoba. A consistent theme that emerged in these presentations was that the ALUS idea needed to be tested via a pilot project. Rural and agricultural organizations and the Manitoba Government were supportive of this idea realizing that many problems and issues could be addressed through an incentive-based landscape conservation program. One municipality in particular, the Rural Municipality of Blanshard (RMB) in Western Manitoba, was strongly supportive and proposed that such a pilot project be conducted in their municipality. Blanshard was in many ways an ideal location for this experimental program. It is a pure agricultural region with little or no urban influences and the landscape is dotted with "potholes," low lying areas ideally suited for wetland development. The combination of ideal geographic and socio-economic elements meant Blanshard was ideal to test and refine project management, implementation procedures and to measure real environmental benefits.

It was calculated that there would be between 25,000 and 30,000 acres of land eligible for the program. A proposal was developed specific to the Rural Municipality of Blanshard and was eventually fully-funded in late 2005.

A description of the Rural Municipality of Blanshard is as follows:

- Home to 686 people in 2001 (up 4.7% since 1996)
- Contains 2 communities: Oak River and Cardale
- Predominant industry is agriculture
- 113 farms
- Average farm size is about 1,000 acres
- About half of the farms are mixed grain & livestock
- 56 farms with cattle (4,210 in total)
- 7 farms with hogs (21,994 in total)
- 4 dairy operations
- Cultivated acres are approximately 2/3 cereals and 1/3 oilseeds

Objectives

The Manitoba ALUS Pilot Project in the Rural Municipality of Blanshard ran from December 2005 to November 2008 and tested the ALUS model of conservation delivery. The objectives of the project were:

- To test the feasibility of the ALUS concept at the local level
- To test the ability of agricultural agencies to administer landscape conservation programming
- To determine whether landowners and farmers would enroll land in an ALUS program

The ultimate purpose of the project was to provide practical information that could be utilized in the design of large-scale landscape conservation programs.

Funding and Partnerships

Funding was provided by Agriculture and Agri-Food Canada (AAFC) via the Manitoba Rural Adaptation Council (MRAC), Manitoba Agriculture, Food, and Rural Initiatives (MAFRI), the Delta Waterfowl Foundation (DWF), and the Rural Municipality of Blanshard. The funding from Blanshard was especially noteworthy since municipalities have rarely provided conservation project funding from their general revenues.

The significance of the Blanshard funding provided project proponents with a ready and affirmative answer when asked if local people supported the project. Furthermore, this funding showed the advantage of projects based on political boundaries as opposed to ecological boundaries such as watersheds. While watersheds may be the most significant ecological units, human affairs are not constructed around watersheds; they are constructed on political boundaries. Municipal councils can speak with authority on behalf of their constituents and in turn are locally accountable for the expenditure of tax dollars. The Blanshard Council made a powerful statement when they agreed to provide funds for the pilot project; a statement that was not lost on decision makers at other government levels.

Methods and Implementation

Nine organizations were involved with the implementing and evaluating the Blanshard ALUS pilot project. They were:

- The Manitoba Agricultural Services Corporation (MASC) – formerly Crop Insurance
- The Little Saskatchewan River Conservation District (LSRCD)
- Manitoba Agriculture, Food and Rural Initiatives (MAFRI)
- Prairie Farm Rehabilitation Administration (PFRA) of Agriculture and Agri-Food Canada (AAFC)
- Keystone Agricultural Producers (KAP)
- Delta Waterfowl Foundation (DWF)
- Manitoba Habitat Heritage Corporation (MHHC)
- University of Manitoba – Faculty of Agriculture
- George Morris Centre (GMC) – University of Guelph

Three committees were formed to administer the project.

The Management Committee included MAFRI, AAFC/PFRA, KAP, DWF, LSRCD, MASC, and RMB. The Management Committee met quarterly to review the progress of the project and to make any policy decisions as required. The decisions of this committee were final.

The Technical Committee was composed of MAFRI, AAFC/PFRA, MASC, LSRCD, and MHHC. This committee developed the technical aspects of the project such as the "terms and conditions" of contracts, appropriate technological methods (GIS technologies etc), auditing protocols, and the delineation of ecological boundaries.

The Local Advisory Committee was composed of local producers plus one non-farming local resident (a retired teacher in this case). This committee provided constant feedback to the other two committees on issues such as community reactions, points of potential conflict, and also acted as an appeals committee in the case of a dispute.

Once these committees were in place the project was initiated and the following steps were undertaken:

1. Landowner expresses an interest in ALUS.
2. Landowner contacts LSRCD or MASC to express interest in ALUS, informs agency of locations of owned land.
3. Eligible acres determined by LSRCD or MASC.
4. Application form reviewed, landowner signs application.
5. Monitor/audit/inspection for compliance with application conditions.
6. Landowner receives payment in December.

Step 3 was completed using recent aerial photographs and GIS technologies. These technologies are precise and were able to map features to the tenth of an acre. These were verified to be accurate by ground surveys.

Step 4 was completed with the landowner who verified the "ALUS lands" as calculated on the aerial photographs. It was here where the landowner could change and adjust the preliminary analysis done in Step 3 to conform to their specific production needs.

Step 5 was conducted by MASC who managed the funds and hence issued the cheques as per Step 6.

The four types of ALUS-eligible land, labeled as "services" were as follows:

1. **Wetland Services**

   Under the ALUS pilot program, all isolated wetlands and wetland complexes including associated uplands were eligible under wetland services. Areas eligible for wetland services were delineated along the field boundary (crop edge).

   a. An isolated wetland is a single wetland that is entirely surrounded by land with agricultural use.

   b. A wetland complex is a series or group of wetlands interconnected contiguously by associated permanent cover upland areas.

   c. Wetlands could include margins or uplands sown down with permanent cover to interconnect wetlands.

      The ratio of permanent cover upland areas to wetlands may not exceed 5 to 1.
      - 3 wetlands in a cultivated field
      - 2 acres per wetland
      - 6 acres total
      - The established upland area around these 3 wetlands may not exceed 30 ac (6 acres * 5)
      - Total wetland complex may not exceed 36 acres

   d. Restored wetlands by plugging an existing drain would be included.

   The payment structure for eligible wetland services were as follows:

   a. Maintenance of wetlands with no agricultural use <u>$15.00/acre/year</u>
      Leave in natural state (No burning, draining, filling or clearing)

   b. Maintenance/enhancement of wetlands, haying permitted <u>$7.50/acre/year</u>
      No burning, draining, filling or clearing
      Haying permitted between July 15th and August 31st inclusive

   c. Maintenance/enhancement of wetlands, grazing permitted <u>$5.00/acre/year</u>
      Minimum 75% ground cover surrounding wetland areas
      Continuous season long grazing not permitted (no grazing before July 1st)
      Less than 15% of the total shoreline has evidence of pugging*, rutting* and or hummocking*
      Maintain average minimum height for grasses 10-15 centimeters
      Adequate off-site watering system required at a minimum 15 meters setback from water source

2. **Riparian Buffer Services**
   A riparian buffer included the riparian area plus areas of perennial cover that extend beyond the riparian area. A riparian buffer is an area of land developed or conserved to reduce erosion, intercept contaminants and provide wildlife habitat along the side of a watercourse or water body. Payment level at $15.00/acre/year.

3. **Natural Area Services**
   Natural areas were lands that had not been cultivated for 20 years or more excluding wetlands and riparian areas. These areas have grass or bush, or any combination of these two. Payment levels at $15.00/acre/year.

4. **Ecologically Sensitive Land Services**
   Ecologically sensitive lands were areas that are currently cultivated or have been cultivated in the previous 20 years and are subject to severe water erosion, wind erosion, flooding, salinity, runoff or leaching. Included were land classes 4, 5, and 6. Payment levels at $25.00/acre/year.

The following table summarizes the payment schedule. These are all annual payments but the payment for converting cropland to permanent cover is received after the cover is established.

Service	% Enrollment allowed	Payment/acre, no use	Payment/acre, haying	Payment/acre, grazing
Wetland	100%	$15	$7.50	$5
Riparian	100%	$15	$7.50	$5
Natural	100%	$15	$7.50	$5
Ecologically Sensitive	20%	$25	$10	$5

Results, Costs & Benefits & Discussion

The initial evaluation of the RMB ALUS pilot project was conducted by Dr. Charles Grant and graduate student Janelle Mann, both of the University of Manitoba. This extensive evaluation was summarized by researchers at the George Morris Centre (GMC), an agricultural policy analysis institution at the University of Guelph.

Key findings from the George Morris Centre Executive Summary are: "*The pilot project was successful in terms of landowner acceptance and uptake. More than 70% of the landowners within the rural municipality participated in the pilot project. Prior to this project, only 50% of the landowners surveyed in Blanshard stated that they had participated in other conservation or environmental programs. "<u>The high levels of participation in the project will likely create environmental benefits for society.</u>"*

In the first year, 162 contracts were signed adding up to 20,940 acres. Expenditures were $294,200 and there were seven appeals. In the second year there were 155 contracts totaling 21,470 acres. Expenditures were $300,900 and there were no appeals.

The payment levels presented above were based on the principle that maximum payment would be received if the ALUS lands in question were solely given over to the production of public EG&S with no "private" benefit. Hence the "no haying" payment was the maximum of $15.00/acre while "delayed haying" was 50% of the maximum. Research is showing, however, that some management of EG&S lands is desirable. For example, periodic haying removes accumulated phosphorus. It is anticipated that any large-scale program would have a land management component built into program implementation. However, the management programs must be congruent with trade law since WTO rules prohibit production subsidies that distort commodity production.

Regarding the administration of the Blanshard pilot project by MASC, the GMC concluded: *"The administration of the ALUS pilot by the Manitoba Agricultural Services Corporation (MASC) and the Little Saskatchewan River Conservation District (LSRCD) has been quite effective."*

Administrative costs for traditional conservation programs are high. The Manitoba ALUS project proved that significant financial efficiencies can be achieved by utilizing existing agricultural agencies to administer landscape conservation programs.

The Blanshard ALUS pilot project also revealed that there is a tradeoff between flexibility and program administration. More "flexible" terms and conditions of a contract may reflect the complex reality "on the ground" but does introduce a more expensive compliance verification process. The issue of grazing "ALUS lands" exemplified this problem. The measurement of grazing levels, unlike whether a field was hayed or not, proved to be a challenge. Project verifiers had to judge almost on an individual basis whether an area was lightly, moderately, or over grazed. And in the course of a large-scale program across the country these grazing categories will complicated by rainfall patterns and other weather events. The most feasible means of overcoming this issue is to revise the payment model to most accurately reflect the public value of the EG&S regardless of the private benefit to the producer. In many instances it turned out that land management through a small level of production actually increased the level of public benefit and EG&S provided, as described prior.

The Blanshard project also supported the principle that landowners should be compensated for the maintenance of existing environmental assets such as wetlands. This is a sharp point of disagreement among policy makers since some assume that a natural feature on the landscape will "always be there." Real data from the landscape shows that this assumption is false and the accelerating loss of wetlands proves the point. As well, refusing to compensate producers for bearing the costs of having natural features on their land introduces the problem of producers who have borne the cost of retaining these features being penalized with extra costs (e.g. the expense of farming around wetlands) while producers who have drained wetlands are the beneficiaries of subsidies to restore wetlands. The principle must be that the EG&S that are produced on private lands are what is supported regardless of whether those EG&S are produced from existing environmental assets or restored assets.

Conclusions

It can be concluded from the RMB ALUS pilot project that:

- Significant efficiencies in the delivery of conservation programs can be achieved through the use of existing agricultural agencies;
- Producers will use the ALUS model to optimize their farming operations;
- Producers will respond to conservation programming that is designed within the "culture of agriculture" and will enroll significant amounts of conservation land;

- The ALUS model will be able to successfully provide EG&S at a relatively low cost.

The ALUS concept was designed with the producer first and foremost in mind. Large-scale conservation of agricultural land works best within the culture of agriculture. This was shown by the higher than expected level of producer participation rates in ALUS, which were originally based on participation rates in other conservation programs.

Future

The advantage of the ALUS model lies in its simplicity and ease of implementation. It was quite efficient to use MASC as the administrative agent and since all provinces have Crop Insurance agencies/corporations there would be little difficulty in extrapolating the Blanshard model across Canada. Crop Insurance agencies have staff in the field across Canada and have developed a relationship with producers. It was proven in the Blanshard project that grafting a conservation mandate to the current crop insurance mandate was not difficult. Crop Insurance agencies view this as a business opportunity as they should. However, it is vital to have scientific information guide any landscape conservation program. The distinction made between program management, to be done by conservation specialists, and program administration, to be carried out by Crop Insurance agencies is critical for the success of the program.

Given the extent of modifications that have been made on the agricultural landscape, the protection of important ecological features need to be addressed. The stage of analyzing information and developing priority areas remains a weakness in many environmental protection programs. ALUS was successful because it assumed that all natural features that remain on the agricultural landscape are important. The goal of future ALUS programs will be to develop a program that evolves as it is implemented to discover the most valuable and cost effective EG&S possible. This approach obviates the necessity for extensive (and interminable) evaluation and provides the equity required for the political decision makers.

Acronyms

AAFC – Agriculture and Agri-Foods Canada
ALUS – Alternative Land Use Services
DWF – Delta Waterfowl Foundation
EG&S – Ecological Goods and Services
GIS – Geographic Information Systems
GMC - George Morris Centre
KAP – Keystone Agricultural Producers
LSRCD – Little Saskatchewan River Conservation District
MAFRI – Manitoba Agriculture, Food, and Rural Initiatives
MASC – Manitoba Agricultural Services Corporation
MHHC – Manitoba Habitat Heritage Corporation
PFRA –Prairie Farm Rehabilitation Administration
RMB – Rural Municipality of Blanshard

Prince Edward Island
Ecological Goods & Services Pilot Project

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Executive Summary

The Souris and Area Branch of the PEI Wildlife Federation acted as the main applicant and administrator of the PEI Ecological Goods and Services Pilot Project while co-hosting this project with the Trout River Environmental Committee (Founds Watershed). This document is meant to give a short overview of this two year project with the final report submitted prior to June 30, 2009.

This document consists of seven key sections. Firstly, the **Background and Rationale for Investigation** explores the history of agriculture on Prince Edward Island and the environmental problems that have become associated with it.

Secondly, the **Objective** of this project was to evaluate the effectiveness of implementing a set of financial incentives to agricultural producers for the provision of ecological goods and services through a Comprehensive EG&S Land Management Package (CLMP). This should address environmental priorities identified in both watershed management plans.

Thirdly, the **Funding and Partnerships** are identified that make a project of this magnitude work. The total project costs of the activities and objectives Prince Edward Island Ecological Goods and Services Pilot project was projected at $551,500 over two years with projected contribution of $354,000 from ACAAF funding.

Fourthly, the **Methods and Implementation** explores several sections, including the producer uptake in the activities promoted under the Comprehensive EG&S Land Management Package. A socio-economist Dr. Van Lantz from the University of New Brunswick was hired by the Souris & Area Wildlife Branch to determine the social benefits of environmental actions performed in the PEI Ecological Goods and Services Pilot Project through a major public survey. Water quality testing within freshwater tributaries and the estuary were conducted. LEACHM-N modeling was conducted to determine results on nitrate leaching in nutrient management trials. The Quebec Pesticide Risk Indicator model (QPRI) was used to evaluate environmental and health risks associated with the active ingredients applied per hectare in producers' fields in both watersheds.

Fifthly, the **Results, Cost & Benefits** were discussed. A number of tables appear reflecting percentage uptake of the Comprehensive Land Management Package by producer in year 2 vs. year 1. A computer model gives results in a chart fashion on the leaching of nitrates in various crop rotations, specific variety of potatoes and grain combined with some element of spring ploughing. Results from a pesticide risk model also depicted the environmental risks and health risks of pesticides in both watersheds.

Finally, some **Conclusions** and suggestions to the **Future** are drawn from the experiences in this project that could have implications on a broader basis.

Background and Rationale

Prince Edward Island's history, culture, and economy are deeply rooted in agriculture. In 2003, total farm cash receipts totaled $354.3 million, with crop production accounting for 53% of this total [1]. Both nationally and internationally, PEI is renowned in particular for its potato production. In fact, PEI stands as the largest potato producing province in Canada, accounting for 24.9% of national production in 2004 [1]. Aside from this significant, direct economic contribution, the agriculture industry provides meaningful employment to thousands of Islanders annually. Furthermore, the farming lifestyle has been engrained in the culture of the Island, establishing itself as the heart of rural PEI. While agriculture has been a viable industry in the province for almost a century, changing markets and emerging technologies have resulted in a monumental shift in the way the industry is conducted. The availability of high powered equipment has resulted in a marked expansion of the average farm size, from 44 ha in 1951 to 119 ha in 1996 [2]. In accordance, the number of farms on PEI has dropped by 78% during this period [2]. Essentially, farming on PEI has changed from a small scale, subsistence based operation to a big business enterprise driven by a challenging marketplace.

The impacts of such a paradigm shift extend far beyond the agriculture industry directly. Changes in traditional farming methods, combined with increasing pressures on farmers to maximize yield to gain even a modest profit, have altered the delicate relationship between the farmers and their lands. Efforts to increase production have often come at the expense of the environmental health, with agricultural activities being implicated in a variety of contentious issues in the province. Erosion from large fields, for example, has led to degradation of stream habitat throughout the province, and has been shown to impact brook trout in the Wilmot River [3]. In addition, agricultural pesticides have been implicated in fish kills throughout the province [4], catastrophic events with long term ramifications in terms of community structure [5] and health. Such ecosystem impacts are numerous and varied, and demonstrate the profound influence that agriculture can have on environmental health. Effects are not limited to wild systems, however, as nitrate concentrations in groundwater reserves, for example, have been correlated with agricultural production [6, 7] on PEI, and research has related living in PEI watersheds with high nitrate levels to premature births and intrauterine growth restriction [8].

As the body of knowledge concerning agricultural impacts has expanded, so too has the public understanding of these issues. On PEI, events such as fish kills and estuarine anoxia receive considerable media attention [9, 10, 11, 12, 13]. As a result, the public as a whole has begun to voice its concern over the impacts of agriculture on the environment around them. As informed individuals, the public is aware that these problems are directly relevant to their quality of life, and are eager to ensure that such issues are promptly resolved.

Environmental groups on PEI have a rich history of tackling such challenging problems. Two such organizations, the Souris and Area Branch of the PEI Wildlife Federation and the Trout River Environmental Committee Inc., have gained recognition as provincial leaders in environmental protection. These groups have taken a pro-active approach, engaging in Watershed Management Planning with the support of their respective communities. The Souris & Area Branch (SAB) was formed in 1954, as a chapter of the Prince Edward Island Wildlife Federation, formed in 1906. The Souris River Watershed Management Committee, a sub-committee of the Souris & Area Branch of the P.E.I. Wildlife Federation (SAB), is specifically concerned with the quality of water resources within the Souris River drainage basin. The committee recognizes that healthy water resources are contingent on proper practices in all areas of the watershed. Keeping with this holistic approach, the watershed management committee has representatives from the aquaculture, agriculture, and forestry sectors, recreational and commercial fishery, Souris Wildlife Federation, municipal, provincial & federal governments and the community at large. The committee has developed strong contacts with the agricultural producers within the watershed who have been active participants in the watershed planning process. The Trout River Environmental Committee Inc. (TREC) is a volunteer, non-profit, non-partisan, community-based watershed improvement group that was originally formed in 1993. TREC was later incorporated on March 4th, 1999 with the stated purpose of restoring and conserving the natural integrity of the Trout River watershed and to promote good environmental stewardship in the drainage basin. Although TREC originally focused its efforts in the Trout River watershed, it became evident that water quality issues in the entire estuary would only be addressed by working on the whole of the Stanley River watershed, including the Granville Creek and Found's Mill river systems. In the winter of 2002, TREC once again expanded its boundaries to include three other watersheds in the Bayview area that also flow into the Southern portion of New London Bay. In total, the six watersheds consist of 30,559 acres (12,367 ha) of land and more than 150 kilometers of fresh water tributaries carrying water to New London Bay, which ultimately empties into the Gulf of St. Lawrence. Surface water quality and fish habitat restoration have always been a priority for TREC and will continue to be the focus of future work in the area. TREC will continue to work closely with farmers, fishers, home and cottage owners, tourist operators and federal and provincial government departments to reduce the input of various contaminants including sediment, bacteria, nutrients and pesticides, and to restore natural flushing action of streams and estuaries.

The communities served by these groups are fortunate to not only have an informed public , but also a responsible farming contingent willing to cooperate with environmental organizations for the betterment of the community. Agricultural producers in these areas are acutely aware of the damage their operations can potentially cause, and are willing to implement practices designed to prevent/mitigate these impacts. However, such practices can be costly to incorporate, and increasing market pressures means that they must not compromise the quality or quantity of the harvest. Essentially, farmers in these regions are hindered in their efforts to become more ecologically responsible by the prohibitive costs associated with doing so.

In recognition of this dilemma, the Souris and Area Branch of the PEI Wildlife Federation seized the opportunity provided by the Ecological Good and Services program administered by Agriculture and Agri-Food Canada. The core of this project, financially compensating farmers for implementing Best Management Practices (BMPs) on their farms, provided an opportunity to effect significant change, lessening the impacts of their operations in tangible, quantifiable ways. The practices rewarded by EG&S have been proven to do just that. Kachanoski and Carter [14] showed that soil erosion on PEI is more severe in steep sloped fields than in shallow sloped fields, lending credence to the concept of retiring sensitive land. Carter et al. [15] demonstrated that spring plowing on PEI did not affect potato yield and caused little change in soil quality, and suggested that this practice could be used for soil conservation as rewarded by EG&S. Edwards et al. [16] showed that straw mulching cut rain-induced soil erosion by half in test plots in PEI, a practice endorsed by EG&S. White and Sanderson [17] determined that applying nitrogen fertilizers in excess of 134 kg/ha did not improve yield on PEI, suggesting that nutrient management (as advocated by EG&S) may be a viable option for farmers to reduce their impacts on groundwater nitrate levels. These few examples show clearly that the programs offered as part of the EG&S project have the ability to produce meaningful changes on PEI.

Furthermore, this project allowed these groups to gauge the public interest in allocating tax dollars to offset otherwise prohibitive costs to farmers implementing such practices. Programs such as this are impossible to deliver without public support and part of EG&S consisted of quantifying the community interest in doing so. The willingness of the community to devote some of their tax dollars, in such harsh economic times, to supporting environmental initiatives is a powerful tool when developing and implementing future projects.

Put simply, the Souris and Area Branch of the PEI Wildlife Federation and the Trout River Environmental Committee Inc. chose to investigate the feasibility of EG&S to ensure the ongoing viability of sensitive ecosystems and habitats in their areas. The mandate of environmental protection guides all management decisions made by these groups, with subsequent benefits contributing to improved public health and quality of life for residents.

Project Objectives

The objective of this project was to evaluate the effectiveness of implementing a set of financial incentives to agricultural producers for the provision of ecological goods and services through a Comprehensive EG&S Land Management Package (CLMP). This should address environmental priorities identified in both watershed management plans. The initiatives that have been implemented through the CLMP should lead to improved water quality and biodiversity in each of the watersheds. This project has provided the opportunity to assess the benefits/costs of the various incentives in the CLMP and the level of adoption by producers in what are considered to be the most effective solutions to enhance EG&S in the province of Prince Edward Island.

Specific sub-objectives included:

1. Estimate the social value (or natural capital) benefits from providing EG&S in the pilot watersheds.
2. Estimate the private costs to agricultural producers for the provision of EG&S in the pilot watersheds.
3. Deliver a Comprehensive Land Management Package.
4. Determine the extent to which the local watershed communities, in partnership with government, the agricultural industry and agri-business, are an effective delivery agent for encouraging the adoption and implementation of EG&S activities that address watershed priorities indentified in the watershed planning process.
5. Determine the extent to which a CLMP can provide appropriate incentives to encourage widespread adoption of sustainable practices resulting in a measureable impact on environmental outcomes at a watershed level.
6. Conduct a cost-benefit analysis of specific EG&S activities provided by agricultural producers in the pilot watersheds.
7. Determine the cost implications of delivering a similar program on a broader basis.

Funding and Partnerships

The total project costs of the activities and objectives Prince Edward Island Ecological Goods and Services Pilot project was projected at $551,500 over two years with projected contribution of $354,000 from ACAAF funding.

The Souris and Area Branch of the PEI Wildlife Federation was the main applicant. They were responsible for the administering and delivering the activities and objectives indentified in their Agreement. They also provided the Project Manager and were represented on the Management, Technical Advisory, Watershed Agricultural and Evaluation and Monitoring committees.

The Trout River Environmental Committee was a co-partner watershed group to the main applicant. They provided in-kind assistance as a member of the Technical Advisory and Watershed Agricultural Committees. They also were ex-officio members of the Management Committee.

The PEI Federation of Agriculture provided in-kind assistance to the Management, Technical Advisory, and Watershed Agricultural Committees. They assisted in garnering producer support in the project, and became a strong advocate of the project.

The PEI Department of Environment, Energy and Forestry provided in-kind assistance to the Management, Technical Advisory, and Monitoring and Evaluation Committees. They conducted water quality monitoring in cooperation with Environment Canada. They also provided a hydrogeologist who performed the predictive water quality monitoring. The PEI Department of Agriculture provided in-kind assistance to the Management, Technical Advisory, Monitoring and Evaluation Committees. They also provided technical support for soil conservation, nutrient management and pesticide risk reduction. They also performed lysimeter monitoring. The PEI Agricultural Insurance Corporation administered the payments to the producers.

The University of New Brunswick provided the services of an economist who conducted the valuation of various EG&S activities and provided the social and economic evaluation. Dr. Van Lantz was also a member of the Technical Advisory and Evaluation and Monitoring Committees.

Agriculture and Agri-Food Canada's Regional Office provided a representative on the Management, Technical Advisory and Evaluation and Monitoring Committees.

Ducks Unlimited Canada provided in-kind assistance with GIS mapping and had representation on the Technical Advisory and Evaluation and Monitoring Committees.

Syngenta provided funding for the EG&S Activities and recommendations for pesticide risk reduction strategies.

Cavendish Agri-Services provided nutrient management recommendations for potatoes and determined the financial returns for split field nutrient management trials.

Methodology and Implementation

Producer Uptake

Producers in both the Souris & Founds Watersheds were supported in this project by two agrology specialists and a part time project manager. This project was initially promoted by meetings with producers and repetitive visits by the agrology specialists and the project manager. Most producers became very willing to participate, but needed time to get a full understanding of the project and to develop a trust between all cooperating bodies.

The signing of the Contribution Agreement (May 23, 2007) was in the middle of cropping season so much of what happened in year one of the EG&S Pilot Project could be considered status quo. In year 2 we saw many producers incorporate many features of this project that applied to their farm.
All measurements of soil erosion structures, retired land, grassed headlands, hedgerows, sensitive land adjacent to legislated buffers, and reduction of red land over winter were done by the agrology

specialists utilizing the Global Plotting System. The agrology specialists were also very much involved with the nutrient management trials and the collection of data for the pesticide risk section.

Socio-Economic Survey
A socio-economist Dr. Van Lantz from the University of New Brunswick was hired by the Souris & Area Wildlife Branch to determine the social benefits of environmental actions performed in the PEI Ecological Goods and Services Pilot Project.

The purpose of his study was to estimate the social benefits of seven environmental actions performed by agricultural producers in the Souris and Founds watersheds on PEI. The specific activities included: (1) an increase in acres of erosion control structures; (2) an increase in acres of sensitive high sloped land retired; (3) an increase in acres of hedgerows; (4) a reduction in pesticide risk; (5) a reduction in acres of tilled (red) land over winter; (6) an increase in acres of sensitive land adjacent to legislated buffers retired; and (7) an increase in acres of permanent grassed headlands.

A stated preference choice experiment (CE) method was used to facilitate his analysis. Specifically, he used a total of 4 public surveys to present samples of households in the watersheds with hypothetical government incentive programs that would encourage agricultural producers to perform specific environmental actions that improve EG&S in the watersheds. He then asked them to choose among the programs. A cost was attached to each program, indicating the amount of additional income tax each household would have to pay to implement the specific programs. Through statistical analysis of the responses, an estimate of the average household's willingness-to-pay for each environmental action in each watershed was derived. These values were then aggregated to the local population in each watershed and converted into per acre annual social benefits in order to set the stage for a comparison with the costs outlined in Lantz et al. [18].

Evaluation and Monitoring of Fresh and Saltwater
The PEI Department of Environment, Energy, and Forestry in partnership with Environment Canada sampled the fresh water river systems and the estuary of Souris River regularly on a bi-weekly manner (May-Oct) for bacterial contamination and nutrient load over the past three years. It is suggested that over such a short period of time that it would be inconclusive to indicate that the land use practices of the Ecological Goods and Services Pilot Project had any effect on the nutrient load entering the estuary. Important baseline data has been collected and over a longer period of time a conclusion may very well be developed.

Bacteriological Water Quality Souris River
The Souris River estuary is an area of importance to the shellfish industry on PEI. The area has a number of seed mussel leases as well as some oyster resources and a significant clam fishery. In terms of shellfish classification status, Colville Bay and the tidal portion of Souris River have had relatively stable water quality in recent years. Restrictions on the harvest of bivalves within this area have existed since the 1960's. Overall, the amount of closed shellfish harvesting area has been reduced as the town of Souris has improved its sewage treatment system over the years.

In 2005, analysis of recent and historical water quality data revealed that the approved portion of the Souris River no longer met acceptable criteria and the classification for that section of the river was downgraded to closed. While the area could still be utilized as a seed and relay source of shellfish, this closure effectively closed the entire Souris River to the harvest and direct consumption of shellfish above the causeway.

Sanitary surveys of the area did not uncover any significant changes in local conditions or land use practices. The change in water quality was not dramatic and examination of the data showed that the water quality in Souris River with respect to Canadian Shellfish guidelines had been marginal for some time. Since there were few livestock operations and no new sources of contamination discovered in the area, it was felt by some that little could be done to improve water quality in the short term. An education and awareness program was initiated by the Souris and Area Wildlife Federation with the hope of improving practices so that, over time, the area could be reopened. Under the stringent criteria used by the Canadian Shellfish Sanitation Program this could take up to five years to achieve. Discussion ensued between the regulatory authorities (Environment Canada, Fisheries and Oceans Canada and the Canadian Food Inspection Agency), the Province of PEI (Departments of Environment, Energy and Forestry and Agriculture, Fisheries and Aquaculture), stakeholders and the Souris and Area Wildlife Federation in order to make the best of the situation. This resulted in additional water quality sampling being carried out.

Preliminary Assessment of the Impacts of Nutrient Management on Water Quality in the Souris River Watershed

This study is to investigate the effects of nutrient management (NM) on nitrate levels in groundwater and associated surface water in the Souris River watershed. The study covers an area of 14341 ha, including the Souris River watershed and the Norris Pond watershed. Several commercial fields (known as A, B, C, D, E and F) were selected for testing purposes during 2007-2008. Each field was split into conventional treatment (CON) and nutrient management treatment (NM) parts. Field locations and management details on each field were discussed by Thompson et al. [19].

Nitrate concentration of lysimeter water samples and soil nitrate content were used as measurement of nutrient management efficiency. The hypothesis is nitrate in lysimeter samples under NM will be lower than that under CON treatment, and total N (mineralization N) in the soil profile upon harvest under NM is lower that under CON treatment.

Another hypothesis is that average nitrate level of well water and nitrate levels in Souris River and its tributaries would show declining trend under NM. This hypothesis is not tested during this work because the sampling program did not extend long enough to demonstrate the trend, and the effects of NM may be lost into the noise derived from the other processes (such as spatial variability of soil property, buffer effect of soil on nitrate leaching, spatial variability of management and weather).

In this work, models were employed to assess the effects of NM on water quality. A LEACHM-N model was developed by Jiang et al. [20] to examine nitrate leaching from a potato production system in PEI. The model was calibrated to data from a management experiment conducted at the Harrington Farm during 1988-1992. Information that was required for model input and was not included in the experiment reports was derived from a database maintained by Jerry Ivany (personal communications, 2007) or from Zebarth et al. [21, 22, 23, 24]. Details on the modeling can be found in Jiang et al. [20]. This model was customized to the Souris River watershed by assuming that the soil properties of the Harrington Farm are similar to those in the Souris River watershed and the weather conditions of 1988-1992 in the Harrington Farm are typical and could reoccur in the Souris River watershed. Site specific crop information and management practices (fertilizer rates and timing of fertilizer applications) were incorporated into the model. It is also assumed that the cropping sequence for the tested period (1988-1992) was wheat, barley, red clover, potato (Russet Burbank) and barley. Simulated nitrate leaching for the period 1989-1991 was used as an indicator of NM efficiency on reducing nitrate loading to groundwater and associated surface water.

The effects of NM on water quality at the watershed scale were also evaluated using an acreage-weighted leaching model. Details about the modeling approach were discussed in Jiang et al. [25]. Land use information and associated nitrate leaching rates are required as model input. To generate land use input, land uses in the watershed were categorized as A) agriculture (6385 ha) and B) others (14341-6385 ha), and acreage for each category was calculated based on data from 1990. Category A was further subdivided into A1) land in potato production rotation (3705 ha) A2) pasture/grass based on data of period 1996-2000 (2680 ha). Rotation lengths for Category A1 were based on GIS analysis by PEIDA. LEACHM-N simulations, tile drain measurements [26], field N budgets and groundwater modeling [27] were employed to define annual nitrate leaching to shallow groundwater for each land use category. Acreage-weighted nitrate leaching concentration was calculated. With the assumption that the acreage-weighted nitrate concentration is equal to mean nitrate concentration of well water, percentage of well water samples with nitrate level >10 mg N/l was predicted based on a normal distribution derived from statistics of well water samples across PEI [25]. Acreage-weighted nitrate concentrations for several scenarios, which include A) current land use practices (2-3 yr rotation) continue, B) 3-yr rotation plus current management, C) 3-yr rotation plus NM and D) 3-yr rotation, NM and spring plow are evaluated respectively (see Table 2). By assuming the acreage-weighted nitrate concentrations are equal to nitrate levels of low flow [27], the effects of NM on surface water quality were predicted.

Quebec Pesticide Risk Indicator Model

The Quebec Pesticide risk Indicator (QPRI) model was used to determine the environmental and health risks associated with the active ingredients applied per hectare on potatoes. The QPRI has 2 separate components: the Environment Risk Index (ERI) and the Health Risk Index (HRI). The ERI of each product takes into the impact of the active ingredients (AI) on terrestrial invertebrates, birds, and aquatic organisms, its mobility, persistence in soil, and bioaccumulation. The HRI of each product takes into account the acute and chronic toxicity of the AI, as well as persistence potential in the environment and the bioaccumulation potential in the body. Application method/end use can impact both ERI and HRI values. As the ERI and HRI are based on different variables, and weighted differently, the health index of products/AIs must be considered independently of its environmental index.

Spray records were collected by the agrology specialists from the producers and they were entered into this model by staff of the PEI Department of Agriculture. Agricultural meetings with staff from the (PEI Department of Agriculture, project manager, watershed coordinators and agrology specialists) with producers in each watershed at the end of year one explained the model to producers and the environmental and health risks associated with the various products. In the Souris and Trout River watershed the sum of the ERI and HRI (E-ERI&HRI) was calculated in each year for each field and the mean overall value was determined. Fields with E-ERI&HRI below the mean value received EG&S payments.

Results, Cost Benefits & Discussion

Producer Uptake

It was felt by the Souris & Area Branch, Trout River Environmental Committee and the producers involved that this was a very worthwhile project. Producers that have a history of doing many environmentally friendly practices on their farm felt that they were finally getting recognized. That encouragement prompted them to attempt new practices and the payment encouraged them to expand older practices that fit the mandate of the project that they normally couldn`t afford.

It took a year for everyone to get comfortable and gain a full understanding and trust with the project and significant producer uptake occurred in year 2 using year 1 as the status quo. This uptake is reflected in the table as follows:

Table 1: Producer percentage increased uptake.

Structure/Activity	Total Acres 2007	Total Acres 2008	Percentage Increase Uptake
Land Utilized by Terraces	26.03	26.03	0
Land Utilized by Grassed Waterways	48.83	56.4	15.5
Land Utilized by Farmable Berms	1.78	1.78	0
Land Utilized by Non Legislated Grassed Headlands	25.21	33.61	33.3
Land Utilized by Hedgerows That Meet Standard	53.27	57.55	8.03
Retired Sensitive High Sloped Land	72.59	83.69	15.3
Enhanced Stream or Wetland Buffers	22.81	43.16	89.2
Spring Plough	285.3	1031.2	261.4
Winter Cover	732.55	862.15	17.7
Nutrient Management Split Field Trials	31	73.9	138.4
Total Acres	1299.37	2269.47	
Structure	**Total (ft.)**	**Total (ft.)**	**Percentage Uptake**
Maintaining electric fence@ stream/wetland/hedgerows	9134.35	20716.35	126.8
Maintaining barbed wire fence @stream/wetland/hedgerows	10149	10149	0
Structure	**Total**	**Total**	**Percentage Uptake**
Maintaining alternate watering systems	19	19	0
Maintaining stream crossings	6	6	0
Maintaining both water source and stream crossing within the same field	0	2	200

Impacts of Nutrient Management on Water Quality in the Souris River
LEACHM-N modeling showed that nitrate leaching mainly occurred between crop harvest and the planting of subsequent crop (i.e. between earlier October and earlier May of the following year). Simulated leaching concentration peaked at 25-35 mg N/l in late October or earlier November and declined to above 4 mg N/l in earlier May, depending on fertilizer N rate, managements, land use history and weather.

The model respected the timing of nitrate leaching processes observed in the experiment (see Fig.) and reported by Thompson et al. [19]. The model predicted nitrate leaching following grain harvest was generally lower than that following potato crop but not significantly. The magnitude of simulated concentrations generally agreed with measurements from the experiments mentioned above, given that the measurements were subject to large variability. The model indicated NM reduced nitrate leaching while observations may show leached concentrations under NM higher than those under conventional treatments (Fig.). The discrepancy could be due to the effects of previous land use and/or the lack of spatial uniformity of management. Longer period of data and more sampling sites on each field are required to diagnose the causes.

LEACHM-N predicted switching from B to C, annual volume-weighted leached concentration would decrease by ~2 mg N/l, and from C to D, by ~0.7 mg N/l respectively, suggesting that the effects of NM and spring plow were relatively significant for shallow groundwater directly underlying the field; however, the effects of NM and spring plow at a watershed scale (Table 2) as predicted by the acreage-weighted leaching model were marginal because only a small percentage of land mass is under crop rotation production in the watershed (26%). The acreage-weighted leaching model also predicted marginal reductions on nitrate loading to shallow groundwater and surface water (Table 2) by NM and NM plus spring plow at the watershed scale.

The acreage-weighted leaching model predicted average nitrate of well water (steady state) was (4.2 mg N/l) and was very close to the average (4.6 mg N/l) based on the statistics of 198 samples during 2004-2008 in the watershed, implying the prediction agreed with the measurements well.
Ideally, longer period of experiment, more sampling sites on a field and experiments in more watersheds are required to validate the models and help decide what the Island wide picture looks like.

Table 2: Predicted effects of NM on water quality in the Souris River watershed.

Scenario	A: 2-3 yr rotation, 220-240 kg N/ha for RB and 90 kg N/ha for grain	B: 3-yr rotation, 240 kg N/ha for RB and 90 kg N/ha for grain	C: 3-yr rotation, 180 kg N/ha for RB and 60 kg N/ha for grain (NM)	D: 3-yr rotation, 150 kg N/ha for RB and 60 kg N/ha for grain (NM & spring plow)
Average nitrate in shallow groundwater/dry-season surface water (mg N/l)	4.2	3.9	3.8	3.7
Percentage of wells with nitrate > 10 mg N/l	2.1%	1.7%	1.4%	1.3%
Nitrate loading to shallow groundwater and associated surface water (kg N/ha)	17.6	16.4	16.0	15.5

Notes: fertilizer N for red clover was assumed 0 for all the simulations; RB represents Russet Burbank; nitrate leaching from septic effluent was super-imposed; N credits from manure were assumed accordingly offsetting N fertilizer applications.

Bacteriological Water Quality Souris River
Results from this intensive set of sampling runs demonstrated that part of the Souris River could be classified as Conditionally Approved from the beginning of April to the end of June. This type of seasonal classification is an accepted form of management under the Canadian Shellfish Sanitation Program.

It is difficult to say definitively whether improved practices within the Souris River watershed will lead to improved bacteriological water quality over the long term. It is however, quite likely, that local water quality conditions would have continued to degrade and perhaps affect a larger portion of Colville Bay without the efforts of the Souris and Area Wildlife Federation. The involvement of the Federation has been instrumental in the establishment of the Conditionally Approved portion of Souris River has resulted in great benefit to the local fishing community and leaseholders.

Costs & Benefits
At the time of preparation of this paper the final details of payment to producers is being developed. Because of several delays in determining the pay-out or non pay–out within the nutrient management section the final payments to producers were determined on March 30, 2009. It is impossible for us at this early date to do a cost benefit analysis. It is planned that a cost benefit analysis will appear in our final report.

We find it difficult to produce well researched documentation in all aspects of our project on April 1st when the project ends on March 31st and final reports are not due until June 30th.

Estimating the Social Benefits of Environmental Actions Performed by the Agricultural Producers in the Souris & Founds Watersheds

Socio-demographic characteristics of respondents
This section will simply deal with the highlights of the socio-demographic characteristics of respondents to the public survey conducted by Dr. Van Lantz. Gender, age, education, income, employment and household size characteristics tended to be similar in both watersheds with some marginal differences. The largest age group that responded was the 50-64 year age class. The largest education group that responded in both watersheds was post secondary education. The annual household income was also quite similar in both watersheds with the largest income group classification in the $20-39 or $40-59 thousand ranges.

The respondents with family members having worked on a farm, their agricultural education, their membership in environmental organizations and frequency in recreation around their watershed were relatively similar in both watersheds.

Respondents' knowledge of selected watershed questions and their importance rating of environmental characteristics within their watersheds
A very large majority of respondents were aware of the definition of a watershed before receiving the survey. Souris respondents were more knowledgeable in this environmental area than those from the Founds. Souris had more recently gone through a watershed planning process in their community which probably explains this difference.

A large majority of the respondents indicated that water, wildlife habitat, soil and scenic quality were all very important to them.

Respondents' perceptions about current/future state and management of their watersheds
In most cases a large proportion of respondents across samples rated the current state of water, wildlife habitat, soil and scenic quality in their respective watersheds as either good or fair. Respondents from Souris tended to lean more closely to good than those from Founds. Respondents' perspectives about the future state of these environmental characteristics over the next 10 years indicated that they believed the quality to become slightly worse or much worse in the future.

When considering the activities that they thought negatively impacted environmental quality in the watersheds, a majority of respondents across all samples indicated that row crop farming, timber harvesting and livestock farming were the major contributors, in descending order.

Finally, when considering their perceptions of financial incentives and paying higher taxes to improve the environment, respondents across both watersheds replied in a similar fashion. Specifically, a majority of respondents indicated they thought environmental regulations and enforcement in PEI should be stricter, farmers should receive financial incentives to farm in an environmentally friendly way and the environment is worth paying for.

Average household willingness-to-pay and social benefits of environmental action

It is clear in the following tables that respondents across both watersheds are most willing to pay for increasing hedgerows, retiring high sloped land and reducing pesticide risk on agricultural land. Additionally respondents in both watersheds indicated a positive willingness to pay for reducing tilled (red) land over winter. Increasing grassed headlands, increasing retired land adjacent to legislated buffers and increasing erosion control structures were valued differently by individuals in both watersheds.

Table 3: Estimates of household's willingness-to-pay/yr and social benefits/acre/yr for agricultural producer actions that improve ecological goods & services in the Souris Watershed.

Landowner Activities	Average Household willingness-to-pay/yr[1]	Social benefits/Acre/Year[2]
Increase in hedgerows (26 acre increase)	$18.58	$869
Increase in retired sensitive high sloped land (44 acre increase)	$32.55	$900
Reduction in pesticide risk (a large reduction in risk across agricultural land in the watershed totaling 5,093 acres)	$56.44	$14
Reduction in tilled (red) land over winter (310 acres additionally covered)	$32.61	$128
Increase in grassed headlands (20 acre increase)	$0	$0
Increase in land adjoining legislated buffers (18 acre increase)	$23.67	$1599
Increase in erosion control structures (52 acre Increase)	$10.90, 23.38[3]	$255, $547[3]

Table 4: Estimates of household's willingness-to-pay/yr and social benefits/acre/yr for agricultural producer actions that improve ecological goods & services in the Souris Watershed.

[1] The method of payment was defined as increase in provincial taxes over a 10-year period.
[2] Social benefits were annualized over a 10 year period (discounted by 5%) and based on a total of 1500 households in the region.
[3] The two values presented here are due to the same erosion control structure activity being included in two random survey samples of households in the region, and each produced a different estimate.

Landowner Activities	Average Household willingness-to-pay/Year[1]	Social benefits/Acre/Year[2]
Increase in hedgerows (26 acre increase)	$35.65	$1993
Increase in retired sensitive high sloped land (44 acre increase)	$69.39	$3309
Reduction in pesticide risk (a large reduction in risk across agricultural land in the watershed totaling 5,093 acres)	$37.59	$156
Reduction in tilled (red) land over winter (310 acres additionally covered)	$3.90	$21
Increase in grassed headlands (20 acre increase)	$21.60	$1,751
Increase in land adjoining legislated buffers (18 acre increase)	$0	$0
Increase in erosion control structures (52 acre Increase)	$0, 0[3]	$0, 0[3]

Pesticide Risk

There was no consistent trend among the indexes. Pest management decisions change each year depending on pest pressures, crop and varieties grown, field history, available treatments. The growing season in 2008 saw unprecedented rains in August and as a result the disease pressure was much greater than in 2007. As a result pest management strategies may have changed on farm which could have resulted in increased pesticides being applied. Although farmers could utilize the QPRI to make choices that posed less risk to environment and health, if more overall product were applied as a result of increased pest pressures, an increase in ERI or HRI value between years could still result. In future crop/variety and product choices and application numbers should be more closely examined.

Farmers should be rewarded for making better pesticide decisions that impact themselves, as well as their environment and, in turn, their community. The QPRI can be used to assign value to each farm field based on pesticide choices. Decreasing ERI and HRI values could indicate selection of reduced risk pesticide products and/or increase in adoption of pest management strategies which reduce the requirement for pesticide use.

[1] The method of payment was defined as increase in provincial taxes over a 10-year period.

[2] Social benefits were annualized over a 10 year period (discounted by 5%) and based on a total of 1500 households in the region.

[3] The two values presented here are due to the same erosion control structure activity being included in two random survey samples of households in the region, and each produced a different estimate.

Conclusions

Much was learned from the Prince Edward Island EG&S Pilot Project, both in terms of advantages and drawbacks. Producers appreciated the "carrot vs. stick" approach employed by the project. Essentially, participating producers welcomed the opportunity to voluntarily implement BMPs on their farms rather than being forced to do so by legislation. These producers valued being able to contribute to the improvement of their respective watersheds while not incurring prohibitive costs.

Participation of producers in the Pesticide Risk component exposed them to chemicals that have less environmental risk but are still effective at controlling the challenges of producing a good crop. Producers that participated in the Nutrient Management section were exposed to two year field trials that showed no significant change in yield with less fertilizer, meaning they can still produce a similar yield at less economic and environmental cost. Producers in general, at the completion of this project, are much more aware of the resources at their disposal, and have adopted an improved attitude towards environmental protection.

Another positive outcome of this project was the development of a PEI Alternative Land Use Services (ALUS) program. This provincial program was based on the payments developed for the PEI EG&S Pilot Project, and it includes many of the Comprehensive EG&S Land Management Package components. This will offer producers the opportunity to continue with some of the environmentally responsible practices implemented under EG&S.

While these outcomes and lessons are important, the EG&S Project nonetheless featured some drawbacks. Firstly, a two-year pilot project is not long enough to collect the data that is needed to reach long term outcomes. Producer interest and participation is just beginning to peak as the project is concluding, and this might discourage producers from participating in similar projects in the future. It is suggested that the minimum duration for this type of project be 3 years, with 5 years being an optimum timeframe to reach the project goals.

The timing of signing contribution agreements is crucial to ensure producer uptake in the first year. Having a contribution agreement signed (May 23rd) in the middle of cropping season is detrimental to producer uptake in year one, as it is too late to implement many of the practices at this time.

Another lesson learned from this project is that having a strong project manager and agrology specialists who are familiar with the producers, environmental issues, and who also have experience in agriculture is crucial to quick producer uptake. Producers who respect and trust these individuals are more willing to participate. We must realise that there are many failed government projects that have soured producers' attitudes, and knowing the project officials they are dealing with can reconcile many of these issues.

It is felt that all services provided by the EG&S Project will contribute to the long term health of the Souris and Founds River watersheds. During the summers of 2007 and 2008, both watersheds experienced above average rainfall. The general perception of the stakeholders, especially in the Souris watershed, was that the river experienced less "red" events and this was attributed to the farmers' implementation of the CLMP services. Approximately nineteen (19) anoxic events occurred in the summer of 2008 in Prince Edward Island, with none in the Souris River. It must be emphasized that it is the combination of all EG&S services offered that enables the project to be successful.

The provincial ALUS program has implemented compensation for the following BMPs with rate payment taken from the PEI EG&S Pilot Project; soil erosion control structures, sensitive high sloped land retired, sensitive land adjacent to legislated buffers retired, and permanent grassed headlands. The province has recognized that these are the most cost-effective practices to endorse, and that they are the most important for eliminating red water events during sudden, torrential rainstorms. These practices can be implemented across the total province with an annual budget of $750,000.

Future

The results of Dr. Van Lantz's socioeconomic survey illustrate the difficulties associated with implementing EG&S on a national scale. Respondents in the two watersheds surveyed differed in their opinions and priorities with regards to BMPs and the environment in general. This country is so large, with diverse geographic and economic features, that it is extremely difficult to satisfy everybody's needs.

Prince Edward Island is completely dependent upon groundwater for their drinking water. In the past 3 years, valuable data has been collected that will lead to solutions to mitigate the impact of nitrates. This research should be continued, with emphasis on understanding the relationship between nitrate leaching and spring plowing vs. fall plowing, and the long-term effects of reducing nutrient input on aquatic ecosystems. Continued data collection with lysimeters will result in a long-term data set that will enable managers to determine trends and respond as necessary.

The partnerships required to deliver a successful project like EG&S should include the following; Agriculture and Agri-Food Canada, Provincial Departments of Agriculture and Environment, municipal governments, local watershed groups, farm organizations, farm suppliers, agricultural processors, academic institutions, and local environmental groups.

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Ecological Goods & Services and Agroforestry (EG&S): The Benefits for Farmers and the Interests for Society

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Executive Summary

The project "Ecological Goods and Services (EG&S) and Agroforestry: The Benefits for Farmers and the Interests for Society" seeks to estimate the social value of Ecological Goods and Services that emanate from agroforestry practices and to evaluate their costs and benefits for agricultural businesses. This report is the synthesis of the whole project (step 14).

In order to verify whether the public benefits of agroforestry practices outweigh the costs for farmers in Québec, we developed a methodology that allowed us, on one hand, to determine the costs incurred by farmers who establish agroforestry systems and, on the other hand, to get a sense of the value of the ensuing benefits for society. Our work concentrated on the two agroforestry practices that are most likely to be established in Québec (windbreaks and riparian agroforestry systems). Our research approach also concentrated on the nine Ecological Goods and Services that seemed most important. As the value of ecological benefits and services is a function of the surrounding population and of the ecosystems that are primarily associated with agricultural production, we selected two watersheds that represent two very different realities for our analytical basis: one in a periurban agricultural area with intensive agricultural production (Esturgeon River watershed); the other in a remote area with extensive agricultural production (Fouquette River watershed). For the two watersheds, we conceived and developed three scenarios of agroforestry installations: a regulatory-level scenario that reflects Québec regulations on riparian buffers; a priority-level scenario developed with members of watershed committees who, as a matter of priority, seek to implement installations to protect watercourses and problematic road segments, and to reduce odours from livestock barns; and lastly, a high-level scenario, which seeks to generate a maximum of EG&S.

Four other stages were carried out in parallel to this general process. Based on the technical-economic analysis (step 6), a financial analysis model was developed in order to produce a decision-making tool. The latter intended to help farmers make choices regarding the species, types of agroforestry practices and implementation areas on the basis of the estimated costs and benefits of the diverse choices available to them. Subsequently, the obstacles and incentives for agroforestry development were identified through a literature review and expert consultations. The last step aims at structuring an exchange network at Québec and Canadian levels.

A comparison of the agroforestry systems in the two studied watersheds demonstrates that windbreaks along roads are less interesting for farmers (benefit-cost ratio is below 0.12). Next come riparian buffers (ratio of 0.2). Windbreaks that protect crops, which increase crop output, have a ratio approaching 1; while the ratio of windbreaks next to buildings is above 4. Windbreaks installed along livestock barns are therefore highly profitable and offer important benefits (avoided snow clearing and heating costs). Of the regulatory, priority, and high-level scenarios in the two watersheds studied, no implementation scenario is economically profitable for farmers. In fact, all benefit-cost ratios are below 1. In both watersheds, the only returns that can offset or earn back the total implementation costs are savings on heating and snow clearing as well as increased yields due to the protection of crops against the wind.
A comparison of expenditures both for the Fouquette River watershed as well as for the Esturgeon River watershed demonstrates that the first expenditure is the cost of setting up tree screens, followed by maintenance costs, and lastly, the opportunity costs related to the loss of farmland.

In a second step, to estimate the value of the nine EG&S generated by the implementation of agroforestry installations in the two watersheds, four economic evaluation methods were used. The results relating to the monetary value of EG&S, evaluated over a 40-year period and discounted accordingly, show that carbon sequestration is the EG&S that falls into first place in the two watersheds.

That value represents between 27% and 64% of the total benefits according to the implementation scenario.

The impact on the reduction of snow clearing costs for public roads is significant in both watersheds in the priority and high-level scenarios, while the biodiversity was attributed a high value.

The most surprising result was that improvements in the quality of surface water came in fourth in terms of the value of benefits provided by agroforestry implementations (it is a low estimation as the impact of agroforestry installations on phosphorous were not measured and the impact on the established parameters (turbidity and fecal coliform bacteria) were estimated at the river mouth).

The results about the value of landscapes support the idea that adding trees to places where many exist already, adds no value, whereas adding them to places where there are not many trees, does add value. An increase in the number of wild pollinating insects comes in sixth position on the basis of their monetary value for both watersheds, while the impact of agroforestry implementation on the reduction of treatment costs of potable water is fairly weak because the latter only takes water turbidity into consideration. It also seems that the implementation of agroforestry systems has no impact on the reduction of agriculture-related odours in either of the watersheds. Finally, the impact on the gravity of road accidents is statistically undeterminable in both watersheds.

The implementation scenario that generates the most public benefits is by far the high-level scenario, characterized by the most expansive area of agroforestry implementations. The regulatory-level scenario comes in last in the case of the Fouquette River watershed, and second in the case of the Châteauguay River watershed. It is important to note that the value of the priority-level scenario, characterized by the placing of installations in the most critical locations, is probably underestimated due to the evaluation methods used. These did not allow us to capture the added value of resolving the worst environmental problems.

The overview of the two watersheds shows that in all the scenarios in the Châteauguay River watershed, the public benefits outweigh the costs incurred by farmers to establish and maintain agroforestry practices. However, this is not the case for the Fouquette River watershed, in which only the high-level scenario results in sufficient public benefits to more than compensate the costs incurred by farmers for establishing and maintaining agroforestry practices.

If we take into consideration the number of EG&S that were not considered in the current analysis, as well as the practical difficulties of defining some of the EG&S we analyzed, we realize that this evaluation constitutes a low estimation of the total value of EG&S. We thereby find that the value of EG&S that emanate from the establishment of agroforestry practices is significantly higher for the public than the costs they engender for farmers.

At the Quebec level, the regulatory, priority, and high-level scenarios show private net deficits of $209, $211, and $1,038 million, respectively, and B/C ratios of 0.14, 0.16, and 0.43, respectively,. The public benefits of the scenarios for the entire Québec area go up to $244, $288, and $1,901 million for the regulatory, priority, and high-level scenarios, respectively. These social benefits are more significant than the private net costs and result in public net benefits of an order of $864 million in the case of the high-level scenario.

As public benefits outweigh private net costs, society gains from the implementation of agroforestry systems. Although the extrapolation is based on weaker information than that used for the representative watersheds, the obtained ratios both for the regulatory scenario (low estimation) and for the high-level scenario (high estimation) should comfort us. The implementation scenarios seem to result in enough public benefits to justify a government intervention in the establishment of agroforestry practices. But the benefits to society that agroforestry practices can offer will not be realized if certain vigorous measures are not carried out.

Introduction

Québec's agricultural sector is facing diverse environmental problems: water quality degradation, appearance of blue algae, soil erosion from wind and water, and the presence of odours associated with certain types of animal manure management. The voluntary and deliberated introduction of trees and bushes in the agricultural environment, of agroforestry techniques such as windbreaks and of agroforestry riparian systems can contribute to mitigating these problems.

In fact, agroforestry generates a number of Ecological Goods and Services (EG&S[1]) of value to society, such as the protection of watercourses, biological diversity, embellishment of the landscape, and carbon sequestration. The generation of EG&S by farmers is likely to ease their relations with other residents of rural areas and to improve their image vis-à-vis society.
However, it remains highly questionable that the benefits of the agroforestry systems that produce EG&S outweigh the costs for the farmers.

Objectives

The project "Ecological Goods and Services (EG&S) and Agroforestry: The Benefits for Farmers and the Interests for Society" seeks to estimate the social value of Ecological Goods and Services that emanate from agroforestry practices and to evaluate their costs and benefits for agricultural businesses.

The sub-objectives of this process include:

- Biophysically quantifying and economically evaluating the Ecological Goods and Services associated with agroforestry;
- Verifying whether the commercial products derived from agroforestry generate sufficient and immediate revenues to prompt farmers to establish agroforestry practices in their operations;
- Verifying whether the social value of EG&S that emanate from agroforestry justifies the creation of economic incentives to favour such implementations.

The parallel objectives of this project include:

- Identifying obstacles to agroforestry development;
- Identifying the conditions and incentives that are necessary for agroforestry development;
- Framing the dialogue between farmers, public administrators, and experts in the field by creating a formal information exchange network in Québec and Canada.

[1] According to Agriculture Canada (AAC 2006a), "EG&S are the advantages human populations gain, directly or indirectly, from the healthy functioning of evolving ecosystems including air, water, soil, and biodiversity."

Methodology

In order to verify whether the public benefits of agroforestry practices outweigh the costs for farmers in Québec, we developed a methodology that allowed us, on one hand, to determine the costs incurred by farmers who establish agroforestry systems and, on the other hand, to get a sense of the value of the ensuing benefits for society.

As we could not measure the costs and benefits of all agroforestry practices implemented throughout the entire province of Québec, our work concentrated on the agroforestry practices that are most likely to be established in Québec. Our research approach also concentrated on the Ecological Goods and Services that seemed most important. In order to estimate the private costs and public benefits of these EG&Ss, we chose two watersheds that represent two different realities - one in an agricultural area and the other in a periurban area – in which to simulate the implementation of agroforestry practices. The ensuing results were then extrapolated to the total area of Québec.

Figure 1 describes the principal stages of the project.

1: Definition and inventory of agroforestry practices

⇩

2: Definition of potential Ecological Goods and Services (EG&S) and selection of priority EG&S

⇩

3: Selection of representative territories to be studied and from which to acquire data

⇩

4: Characterization of representative watersheds

⇩

5: Development of implementation scenarios for each selected watershed

⇩

6: Analysis of technical-economic feasibility for farmers

⇩

8: Biophysical quantification of EG&S for each scenario tested

⇩

9: Evaluation of the value of EG&S for society per watershed and according to different implementation scenarios

⇩

10: Extrapolation, economic overview and global analysis

Figure 1: Principal Stages of the Project

Review of the primary methodology used

After having compiled an overview of agroforestry practices, we selected the two practices[1] most likely to be implemented in the province: windbreaks[1] and riparian agroforestry systems[2].

[1] In the agroforestry portrait of Québec, De Baets and co. (2007) short-list the following practices: windbreaks, riparian buffer systems, silvopastoral systems, silviculture, production under forest cover, intercropping and aqua-forestry.

As the value of ecological benefits and services is a function of the surrounding population and of the ecosystems that are primarily associated with agricultural production, we selected two watersheds that represent two very different realities for our analytical basis[3] : one in a periurban agricultural area with intensive agricultural production; the other in a remote area with extensive agricultural production. The watersheds were selected according to specific criteria: type of agricultural use of the watershed, proximity and distance from an urban center, availability of data, diversity of agricultural practices, population density, presence of environmental problems related to agricultural activities, existence of agroforestry installations, potential for recreation and tourism, as well as the presence of local actors. We selected two watersheds from the 33 priority watersheds that were short-listed in the framework of the National Water Policy of Québec: the Fouquette River watershed and the Esturgeon[4] River watershed.

Similarly, from all the EG&S identified in our literature review, we selected those that seemed likely to have the most value for Québec society. In this manner, nine priority EG&S were selected by process of gradual elimination in function of four criteria, which are listed below in order of importance:

- Biophysical changes had to be quantifiable (existence of evaluation methods or sufficient information for acceptable quantification);
- Biophysical changes induced by the agroforestry practices in question could not be marginal;
- The impacts from these installations had to be perceptible to the public (attribution of use);
- The EG&S had to be considered as priorities by the two watershed committees consulted.

The nine EG&S that were retained are: improvement in surface water quality, reduction in treatment of potable water, enrichment of terrestrial and aquatic biodiversity, reduction of odours in the proximity of agricultural areas, carbon sequestration, reduction in snow clearing of roads, reduction of road accidents, enrichment of terrestrial biodiversity, and aestheticism of the landscape.
For the two watersheds studied, we conceived and developed three scenarios of agroforestry installations: a regulatory-level scenario that reflects Québec regulations on riparian buffers[5]; a priority-level scenario developed with members of watershed committees who, as a matter of priority, seek to implement installations to protect watercourses and problematic road segments, and to reduce odours from livestock barns[6]; and lastly, a high-level scenario[7], which seeks to generate a maximum of EG&S. The selection and arrangement of plant species in the riparian agroforestry systems and in the windbreaks were made in function of protection objectives, climate zones, and watershed soils[8].

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[1] In Québec, we distinguish between two principal types of windbreaks: windbreak structures that protect crops and soils and windbreak structures around agricultural infrastructure (buildings, roads, farms, manure pits, etc).
[2] De Baets and co. (2007) propose applying the term “riparian agroforestry system” to riparian buffers that were intentionally created by planting arborescented or shrubby ligneous species.
[3] See stage 3 report: Selection of representative territories for the application of this research and the acquisition of data.
[4] The surface of the Châteauguay River watershed was too large for data collection and for a biophysical quantification of EG&S. Based on consultations with the Watershed Committee, the sub-watershed of the Esturgeon River was selected.
[5] The regulatory scenario in the two watersheds encompassed trees and shrubs every 3 meters with a width of 3 meters on all banks qualified as “weak”, “very weak”, and “average”.
[6] The priority scenario in the Fouquette River watershed encompassed trees and shrubs along 10 meters in width on very weak banks and along both banks of the fish spawning area. The priority scenario of the Esturgeon River watershed encompassed trees and shrubs along 10 meters in width on very weak banks of the Esturgeon and Noire Rivers and on the main Saint-Rémi watercourse (Cinq branch).
[7] The high-level scenario in the two watersheds encompassed riparian installations of 25 meters in width for all riparian zones in agricultural environments qualified as “very weak”, “weak” and “average”.
[8] See stage 5 report: Elaboration of implementation scenarios.

Modifications to the nine chosen EG&S, following the establishment of agroforestry implementation scenarios, were measured by developing quantification protocols based on a literature review for the two types of agroforestry practices and three implementation scenarios[1]. This quantification served as a premise for the economic evaluation.

Some of the challenges encountered in the course of the project

- A lack of basic information and scientific knowledge (biophysical) in Québec.
- The zoning of watersheds and their lack of administrative status. This resulted in minimal socio-economic data being available. Example: a special compilation was necessary to establish the population of the watersheds studied.
- The fact that scientists tend to work on small territorial areas (small watersheds), which they master well, and economists need to work on much larger scales (large watersheds) in order to support public administrators in their decision- and policy-making process. As a result, we encountered problems reconciling the existing knowledge and scientific expertise with the socio-economic needs at the heart of this decision-making exercise.
- The almost complete lack of original economic studies on the values of Ecological Goods and Services in Québec made it difficult to use existing studies to support our estimates. As a result, the use of the benefit transfer method is rooted in a weaker premise.
- The extrapolation to the entire territory of Québec is based on weaker information than that which we have for the representative watersheds. In fact, one of the factors that led to the selection of those watersheds, which later provided the basis for extrapolation, was the fact that information was available.

Parallel Stages

Four other stages were carried out in parallel to this general process. Figure 2 illustrates these stages.

7: Development of a decision-making tool for farmers

11: Identification of institutional obstacles to the development of agroforestry

12: Identification and evaluation of different forms of incentives to favour the development of agroforestry

13: Structuring an exchange network at Québec and Canadian levels

Figure 2: Parallel stages to the general process.

A technical-economic analysis enabled us to evaluate the implementation and maintenance costs of the retained agroforestry practices. Based on this, a financial analysis model was developed in order to produce a decision-making tool. The latter intended to help farmers make choices regarding the species,

[1] See stage 8 report: Quantification of EG&S.

types of agroforestry practices, and implementation areas on the basis of the estimated costs and benefits of the diverse choices available to them.

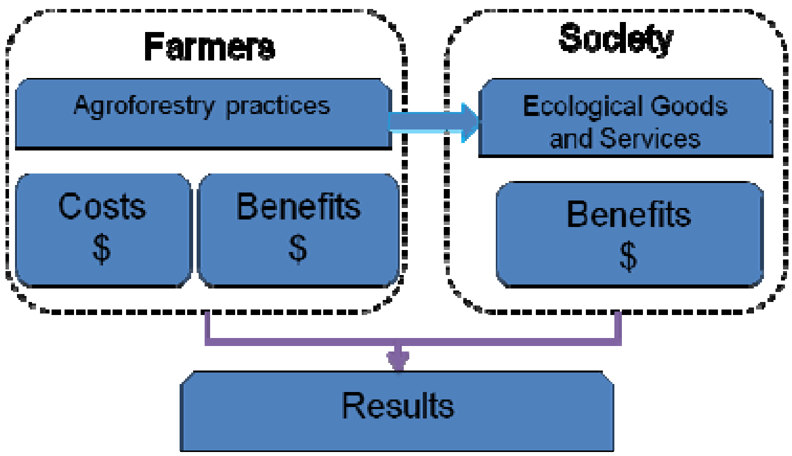
Subsequently, the obstacles and incentives for agroforestry development were identified through a literature review and expert consultations[1].

Economic Results

The economic analysis began with a study of the private costs and benefits of agroforestry implementation[2]. The net costs for famers were then compared with the social benefits evaluated for the nine EG&S, which were first selected at the level of the reference watersheds and then at a Québec level. These findings sought to answer the following question: If the implementation of agroforestry systems by farmers does not provide sufficient financial benefits to offset their implementation costs, will the social benefits be significant enough to justify an intervention from the government to remunerate farmers for the production of these public benefits and to favour the implementation of these systems in Québec?

We carried out a cost-benefit analysis according to factor costs (thereby excluding government transfers) on a 40-year planning horizon with a real discount rate of 6%.

The following figure outlines the economic analysis carried out.



[1] See stage 11 and 12 reports: "Identification of institutional obstacles to the development of agroforestry" and "Identification and evaluation of different forms of incentives to favor the development of agroforestry".
[2] See stage 6 report: "Technical-economic feasibility analysis for farmers".

Private cost-benefit analysis

The CEPAF calculator (www.wbvecan.ca) was used in order to estimate the private costs and benefits associated with the three implementation scenarios in each of the two watersheds studied.

Comparison of agroforestry systems

The following table presents the economic results of the high-level implementation scenario for the two watersheds studied and allows us to compare to what extent the different agroforestry systems are of interest to farmers.

Table 1: Economic results from the high-level scenario in the two watersheds (in thousands of dollars).

	RB		**WBb**		**WBc**		**WBr**	
	Fouquette	**Esturgeon**	**Fouquette**	**Esturgeon**	**Fouquette**	**Esturgeon**	**Fouquette**	**Esturgeon**
Length (km)	134	296	9.43	24.81	140	219	8.15	48.48
Total costs (C)	3,293	8,007	83.12	239.72	663.92	1,093	24.92	158.86
Total benefits (B)	754.92	1,664	387.25	1,074	412.27	1,210	2.69	16.01
B-C	**-2,538**	**-6,343**	**304.13**	**834.81**	**-251.65**	**117**	**-22.22**	**-142.85**
Ratio (B/C)	**0.23**	**0.21**	**4,66**	**4.48**	**0.62**	**1.11**	**0.11**	**0.10**

Source: CEPAF Calculator

Legend:
RB = Riparian buffers
WBb = Windbreaks adjacent to buildings
WBc = Windbreaks protecting crops
WBr = Windbreaks adjacent to roads

m: meter
B: benefits; C: costs
B/C: benefits/costs ratio

A comparison of the agroforestry systems in the two studied watersheds demonstrates that windbreaks along roads are less interesting for farmers because their benefit-cost ratio is below 0.12. Next come riparian buffers with a ratio of 0.2. Windbreaks that protect crops, which increases crop output, have a ratio approaching 1 while the ratio of windbreaks next to buildings is above 4. Windbreaks installed along livestock barns are therefore highly profitable and offer important benefits (avoided snow clearing and heating costs).

If installed riparian buffers also have a windbreak function that protects crops or livestock barns, one would have to calculate the additional benefits and the findings would improve. According to our hypothesis, a riparian buffer is likely to become profitable only if it also offers wind protection for buildings and roads close to farms.

Comparison of three scenarios on two watersheds
Of the regulatory, priority, and high-level scenarios in the two watersheds studied, no implementation scenario is economically profitable for farmers. In fact, all benefit-cost ratios are below 1. The following table outlines the economic results of the three implementation scenarios studied for the two watersheds that were analyzed. The high-level scenario is most in deficit (-$2.5 million margin for the Fouqette river watershed and -$5.5 million for that of the Esturgeon river).

Table 2: Private overview of the three scenarios in the two watersheds (in thousands of dollars).

	Regulatory-level		**Priority-level**		**High-level**	
	Fouquette	**Esturgeon**	**Fouquette**	**Esturgeon**	**Fouquette**	**Esturgeon**
Total costs (C)	554.18	1,401	1,627	1,039	4,065	9,499
Total benefits (B)	79.40	199.07	346.10	175.86	1,557	3,965
B-C	**-474.77**	**-1,202**	**-1,281**	**-863.59**	**-2,508**	**-5,534**
Ratio (B/C)	**0.14**	**0.14**	**0.21**	**0.17**	**0.38**	**0.42**

Source: CEPAF Calculator

It is important to note that in the Esturgeon River watershed, the length of installations in the priority-level scenario (79 km) is smaller than in the regulatory-level scenario (296 km).

The benefit-cost (B/C) ratios of the scenarios go from 0.14 for the regulatory-level scenario of the two watersheds to 0.42 for the high-level in the Esturgeon River. Even though the high-level scenarios are more in deficit in absolute terms than the others, they demonstrate a more favourable B/C ratio (however, the costs remain more than two times higher than the benefits). This is due to the composition of the other two scenarios (regulatory and priority-level), which include less beneficial agroforestry systems made up of riparian buffers (for the regulatory-level scenario) and windbreaks adjacent to roads (for the priority-level scenario). For these two scenarios, the total costs are four to seven times higher than the total benefits.

Comparison of private benefits associated with different implementations in the two watersheds
In both watersheds, the only returns that can offset or earn back the total implementation costs are savings on heating and snow clearing as well as increased yields due to the protection of crops against the wind. The only situations in which the benefits are equal to or greater than the costs (in other words in which the B/C ratio is greater than or equal to 1) are those in which windbreaks (WB) protect either crops or buildings.

Table 3: Private benefits of the high-level scenario in the two watersheds ($)

	RB		**WBb**		**WBc**		**WBr**	
	Fouquette	**Esturgeon**	**Fouquette**	**Esturgeon**	**Fouquette**	**Esturgeon**	**Fouquette**	**Esturgeon**
Length (m)	134,409	296,297	9,430	24,815	140,466	219,311	8,152	48,480
Heating ($)	*N/A*	*N/A*	70,961	399,689	*N/A*	*N/A*	*N/A*	*N/A*
Snow clearing ($)	*N/A*	*N/A*	297,211	624,647	*N/A*	*N/A*	*N/A*	*N/A*
Berries ($)	266,392	587,244	6,230	16,395	46,400	72,444	2,693	16,014
Wood ($)	488,534	1,076,950	12,846	33,798	47,975	74,903	*N/A*	*N/A*
Yields ($)	*N/A*	*N/A*	*N/A*	*N/A*	317,897	1,063,432	*N/A*	*N/A*
Total benefits ($)	**754,926**	**1,664,194**	**387,249**	**1,074,529**	**412,271**	**1,210,779**	**2,693**	**16,014**

Source: CEPAF calculator
Legend: RB = Riparian buffers; WBb = Windbreaks adjacent to buildings
WBc = Windbreaks protecting crops; WBr = Windbreaks adjacent to roads
N/A: Not Applicable

The production of wood and berries is not enough to create a net benefit for farmers. In the case of wood harvesting, which is carried out over a period of 20 years for poplar trees and 40 years for other tree species, the discount rate used (6%) explains why the present value of wood harvesting is so low.

Comparison of expenditures

A comparison of expenditures both for the Fouquette River watershed as well as for the Esturgeon River watershed demonstrates that the first expenditure is the cost of setting up tree screens, followed by maintenance costs, and lastly, by the opportunity costs related to the loss of farmland[1].

Table 4: Comparison of expenditures associated with the total implementation of the high-level scenario in the two watersheds.

	Fouquette	Esturgeon
Length (m)	292,457	588,903
Implementation costs ($)	2,577,267	5,520,829
Maintenance costs ($)	1,071,344	2,631,299
Opportunity costs ($)	416,729	1,347,495
Total costs ($)	4,065,340	9,499,624

Source: CEPAF calculator

Even though the *Prime-Vert* program is not aimed exclusively at agroforestry policies, it pays 90% of implementation costs at the beginning of the project (i.e. at the moment when expenditures are highest). If we included this program, the importance of implementation costs would fall into second or third place behind maintenance costs, which would go up into first.

Thus, it is understandable that farmers are reluctant to implement agroforestry systems, particularly riparian agroforestry systems. The real costs they face are most often higher than the expected benefits, particularly because the latter are less tangible (avoided costs and not additional revenues, or benefits that are difficult to measure) or because they are related to unusual activities or markets (berries, wood).

Farmers' lack of enthusiasm for agroforestry practices can be explained in part by the fact that the discounted private benefits rarely outweigh the costs farmers incur. Except for windbreaks that protect livestock barns and windbreaks that protect crops, the aggregate private costs of the studied agroforestry systems are 4 to 20 times higher than the private benefits they generate. On average, for all the simulations carried out in the framework of this stage, the costs are three times higher than the benefits. This conclusion holds even truer for farmers if we include the support of *Assurance stabilisation des revenus agricoles* (ASRA), which increases costs related to the loss of farmland. What remains to be determined is whether the Ecological Goods and Services that agroforestry practices provide to society justify Government intervention.

[1] As specified in the stage 6 report, the support from ASRA was excluded from this calculation.

Obstacles

Several elements create obstacles for the adoption of agroforestry practices in Québec. In first place come the implementation costs, followed by the loss of farmland discussed above, and anticipated nuisances (roots that block drains and branches that extend into fields, obstructing farming operations). Then come transaction costs, the costs of transitioning into a new and little known crop, uncertainty about the possible trade outlets for some agroforestry products, and lastly, sociological factors such as cultural reluctance, risk aversion, lack of succession, etc. These elements provide rationale that can obstruct the development of agroforestry in Québec.

In addition, several internal factors in provincial and federal institutions slow the establishment of agroforestry programs and thereby the adoption of identified agroforestry practices. These factors include: a lack of recognition for agroforestry and particularly for some agroforestry practices, weak transfers of technology and know-how relating to the implementation of certain agroforestry installations, a lack of long-term technical and financial support, high public transaction costs, as well as occasional lack of coherence between different government policies.

Social benefits

To estimate the value of the nine EG&S generated by the implementation of agroforestry installations in the two watersheds, four economic evaluation methods were used. The hedonic method helped to evaluate the reductions in agriculture-related odours and the aestheticism of the landscape. Experimental economics were used in the evaluation of the enrichment in terrestrial and aquatic biodiversity, as well as in the aestheticism of the landscape. The benefit transfer method was used for the monetary evaluation of the improvement of water quality, carbon sequestration, enrichment in terrestrial and aquatic biodiversity, and reduction in road accidents. The productivity method was used to calculate reductions in costs for clearing snow from roads and treating potable water, and to estimate the economic value of an increase in the number of wild pollinating insects.

The results relating to the monetary value of EG&S, evaluated over a 40-year period and discounted accordingly, are presented in the following table. The EG&S are organized according to monetary order of importance.

Table 5: Classification of EG&S and current monetary value (in million $ 2008).

Order	EG&S	Scenario	Monetary value	
			Fouquette	**Châteauguay**
1	Carbon sequestration	Regulatory-level	0.224	7.317
		Priority-level	0.689	4.080
		High-level	2.057	56.081
2	Terrestrial biodiversity	Regulatory-level	0.540	2.422
		Priority-level	0.358	1.830
		High-level	1.351	50.308
3	Reduction in costs for clearing snow from roads	Regulatory-level	Not applicable in the case of RB	
		Priority-level	0.088	4.229
		High-level	0.142	12.147
4	Improvement in the quality of surface water	Regulatory-level	0.068	3.618
		Priority-level	0.068	2.763
		High-level	0.070	3.618
5	Improvement of the landscape	Regulatory-level	0	1.770
		Priority-level		1.145
		High-level		3.437
6	Increase in the number of wild pollinating insects	Regulatory-level	0.0001	0.533
		Priority-level	0.0005	0.590
		High-level	0.002	3.442
7	Decrease in treatment costs of potable water	Regulatory-level	Not applicable: subterranean source of potable water in this watershed	0.393
		Priority-level		0.085
		High-level		0.393
8	Reduction in agriculture-related odours	Regulatory-level	Not applicable because there are no WBb in these scenarios	
		Priority-level		
		High-level	0	0
9	Reduction in the gravity of road accidents	Regulatory-level	Not applicable in the case of RB	
		Priority-level	Indeterminable	Indeterminable
		High-level	Indeterminable	Indeterminable
Total		Regulatory-level	**0.347**	**16.056**
		Priority-level	**1.205**	**14.725**
		High-level	**3.623**	**129.430**

Source: Model developed by ÉcoRessources Consultants
Legend: RB = Riparian buffers WBb = Windbreaks adjacent to buildings

It is highly interesting and surprising to note that carbon sequestration is the EG&S that falls into first place in the two watersheds. That value represents between 27% and 64% of the total benefits according to the implementation scenario. As a result, carbon sequestration provides a considerable benefit. The absolute value is even more important in the Châteauguay River watershed because of the implementation surface. As this watershed is less wooded than that of the Fouquette River, more agroforestry installations are possible and, as a result, there are more possibilities to sequester carbon. Biodiversity was attributed a high value but it remains comparable to those found in other literature reviews. We note that the aggregate value is higher in the Châteauguay River watershed than in that of the Fouquette River. This is due to the fact that the implementation surface in the Châteauguay River watershed is larger than that of its counterpart. We also note that the priority-level scenario offers fewer benefits than the two other scenarios in the case of the Châteauguay River. This is due to the decreased surface of agroforestry installations implemented in this scenario.

The impact on the reduction of snow clearing costs for public roads is significant in both watersheds in the priority and high-level scenarios. In fact, according to the results of the measurement protocol that was used, the presence of hedges along roads diminishes the number of snow clearing rounds by 29%, which affects the absolute value of avoided costs.

The most surprising result was that improvements in the quality of surface water came in fourth in terms of the value of benefits provided by agroforestry implementations. It is important to underline that the estimated value of the improvement of water quality is a low estimation as the impact of agroforestry installations on phosphorous were not measured and the impact on the established parameters (turbidity and fecal coliform bacteria) were estimated at the river mouth. This in part explains the low result. On the other hand, we note that the value is much higher in the Châteauguay River watershed than in that of the Fouquette River, primarily due to the larger number of households found there.

As for the value of landscapes, our results indicate that the implementation of agroforestry systems has no impact on the improvement of the landscape in the Fouquette River watershed, which has large forest coverage, contrary to that of the Châteauguay River. These results are interesting because they support the idea that adding trees to places where many exist already adds no value, whereas adding them to places where there are not many trees adds value to the landscape.

The priority-level scenario in the Châteauguay River watershed offers the least benefits because the number of properties to have improved landscapes depends directly on the length of agroforestry installations, which are the shortest in the priority-level scenario.

However, it is important to mention that the value of the landscape is only captured in part because the methodology used only targets the residents of the two watersheds. Non-residents' appreciation of the landscape is ignored by this methodology.

An increase in the number of wild pollinating insects comes in sixth position on the basis of their monetary value for both watersheds. The difference in value between the two watersheds is essentially due to the larger crop variety found in the Châteauguay River watershed as well as its larger surface area. The most important value is traced back to the high-level scenario, followed by the priority-level scenario and the regulatory-level scenario, both for the Châteauguay River and the Fouquette River watersheds. This classification is due to the fact that the high-level scenario encompasses the most expansive area of agroforestry implementations and that wild pollinators increase with the habitat areas available to them.

The impact of agroforestry implementation on the reduction of treatment costs of potable water is fairly weak because the latter only takes water turbidity into consideration. Savings on the annual treatment costs of potable water in the watershed can be considered negligible.

It also seems that the implementation of agroforestry systems has no impact on the reduction of agriculture-related odours in either of the watersheds. There are few pig farms in the area of the watersheds studied, which is probably why the value of a reduction in odours is not significant. However, all the values found are comparable to those in other literature reviews.

Finally, the impact on the gravity of road accidents is statistically undeterminable in both watersheds. This surprising result can possibly be explained by the fact that drivers tend to be twice as careful in wintertime when weather conditions are bad. The impact of agroforestry systems is, in fact, impossible to isolate from other factors that affect the gravity of accidents.

For the Châteauguay River watershed, the value of all EG&S is in the same ballpark for the regulatory and priority-level scenarios ($16 and $14.7 million, respectively). This is essentially due to the fact that the agroforestry implementation area, in the case of the Châteauguay River watershed, is higher in the regulatory scenario that in the priority-level scenario. The social benefits in the regulatory-level scenario are therefore higher in absolute value, and even more so as the value of carbon sequestration is significant. For the Fouquette River watershed, the value of all EG&S is, in contrast, three times higher in the priority-level scenario than in the regulatory-level scenario.

For the high-level scenario, which encompasses agroforestry implementation seeking a maximization of EG&S, the social value of EG&S is $129.43 million for the Châteauguay River watershed and $3.6 million for the Fouquette River watershed. This difference in scale between both watersheds for the same scenario can be explained by the larger surface area of the Châteauguay River watershed. The fact that average revenues are higher there also increases the value. In addition, the improvement of the landscape and reduction in the treatment costs of potable water were, respectively, zero and unquantifiable in the Fouquette River watershed.

The implementation scenario that received the highest value is by far the high-level scenario, characterized by the most expansive area of agroforestry implementations. The regulatory-level scenario comes in last in the case of the Fouquette River watershed and second in the case of the Châteauguay River watershed. It is important to note that the value of the priority-level scenario, characterized by the placing of installations in the most critical locations, is probably underestimated due to the evaluation methods used. These did not allow us to capture the added value of resolving the worst environmental problems.

Experimental Economics

Experimental economics allow us to test economic theories, market models, and the preferences of market actors in a controlled environment. It is an interesting alternative approach to measuring the non-market value of public goods.

The application of this experimental approach in the current project allowed us to evaluate the value that individuals place on the agroforestry practices studied. It aimed to measure: the value of the landscape or of ecological biodiversity following the installation of riparian buffers and/or windbreaks in a watershed, as well as the impact on these values of an increase in the width and length of the riparian buffers and/or windbreaks in a watershed.

According to the results of this experimental approach, there is a willingness to pay between $65 and $135 per hectare of agroforestry installations in order to benefit from improvements in landscape and biodiversity. According to the model used in the calculation of biodiversity, for both the Fouquette and Esturgeon River watersheds, the value of biodiversity is situated between $101 and $301 per hectare of agroforestry installations per year. As a result, we note that the willingness to pay is slightly lower when calculated using an experimental approach. The latter may only reflect the willingness to pay for the implementation of these installations and not the annual value of the biodiversity they generate.

Overview of the two watersheds

The total social benefits and private net costs for both watersheds were compared in order to confirm or disprove the starting hypothesis that an intervention by the Government favouring the establishment of agroforestry practices would be justified.

The two following tables show the net present values (NPV) and benefit-cost ratios (B/C) at the private level (table 6), as well as the benefit-cost ratios at the level of society (table 7) in the Fouquette and Châteauguay River watersheds.

Table 6: Private net costs and public benefits for the two watersheds (millions of dollars).

		Private net costs		Public benefits	
Scenario		**Fouquette**	**Châteauguay**	**Fouquette**	**Châteauguay**
Regulatory-level	NPV (M$)	-0.474	-15.658	0.347	16.056
	B/C	0.14	0.14	*N/A*	*N/A*
Priority-level	NPV (M$)	-1.293	-1.441	1.205	14.725
	B/C	0.21	0.17	*N/A*	*N/A*
High-level	NPV (M$)	-2.508	-73.310	3.623	129.430
	B/C	0.38	0.42	*N/A*	*N/A*

Source: CEPAF and ÉcoRessources Consultants

Legend: NPV = Net Present Value B/C: Benefit/Cost Ratio N/A: Not Applicable

Table 7: Overview of the cost-benefit analysis for the two watersheds (millions of dollars).

		Public benefits – Private net costs		Ratio of public benefits / private net costs	
Scenario		**Fouquette**	**Châteauguay**	**Fouquette**	**Châteauguay**
Regulatory-level	NPV (M$)	-0.1	0.4	*N/A*	*N/A*
	B/C	*N/A*	*N/A*	0.73	1.03
Priority-level	NPV (M$)	-0.09	3	*N/A*	*N/A*
	B/C	*N/A*	*N/A*	0.93	1.29
High-level	NPV (M$)	1.1	56	*N/A*	*N/A*
	B/C	*N/A*	*N/A*	1.44	1.77

Source: CEPAF and ÉcoRessources Consultants

Legend: NPV = Net Present Value B/C: Benefit/Cost Ratio N/A: Not Applicable

In reading the table we note that in all the scenarios in the Châteauguay River watershed, the public benefits outweigh the costs incurred by farmers to establish and maintain agroforestry practices. However, this is not the case for the Fouquette River watershed, in which only the high-level scenario results in sufficient public benefits to more than compensate the costs incurred by farmers for establishing and maintaining agroforestry practices. In this manner, installations in Fouquette-type watersheds (extensive) are less profitable than those in Châteauguay-type watersheds (intensive).

If we take into consideration the number of EG&S that were not considered in the current analysis, as well as the practical difficulties of defining some of the EG&S we analyzed, we realize that this evaluation constitutes a low estimation of the total value of EG&S. We thereby find that the value of EG&S that emanate from the establishment of agroforestry practices is significantly higher for the public than the costs they engender for farmers.

Global analysis at a Québec level

Following our analysis of two watersheds that are representative of two different realities affecting the territory of Québec, an extrapolation was carried out for the totality of Québec's agricultural land. The global overview (stage 10) sought to integrate all the results from the two watersheds and to extrapolate them to a Québec scale by basing itself on 13 watersheds. The selection of the 13 watersheds[1] was made according to different criteria:

- The agricultural watersheds (of level 1) have to have a cultivated area higher than 20% of their total area;
- The watersheds have to be amongst the 33 priority watersheds outlined by the National Water Policy;
- The data of the River Network of the Ministry of Sustainable Development, Environment and Parks in Québec (MDDEP) must be available.

The following figure illustrates the location of the 13 watersheds on which we based our extrapolation. We note that almost all of Québec's agricultural land was covered.

[1] The thirteen watersheds studied are Baie Missisquois, Bayonne, Bécancour, Boyer, Châteauguay, Chaudière, Etchemin, Fouquette, Kamouraska, Nicolet, Richelieu, Saint-François and Yamaska.

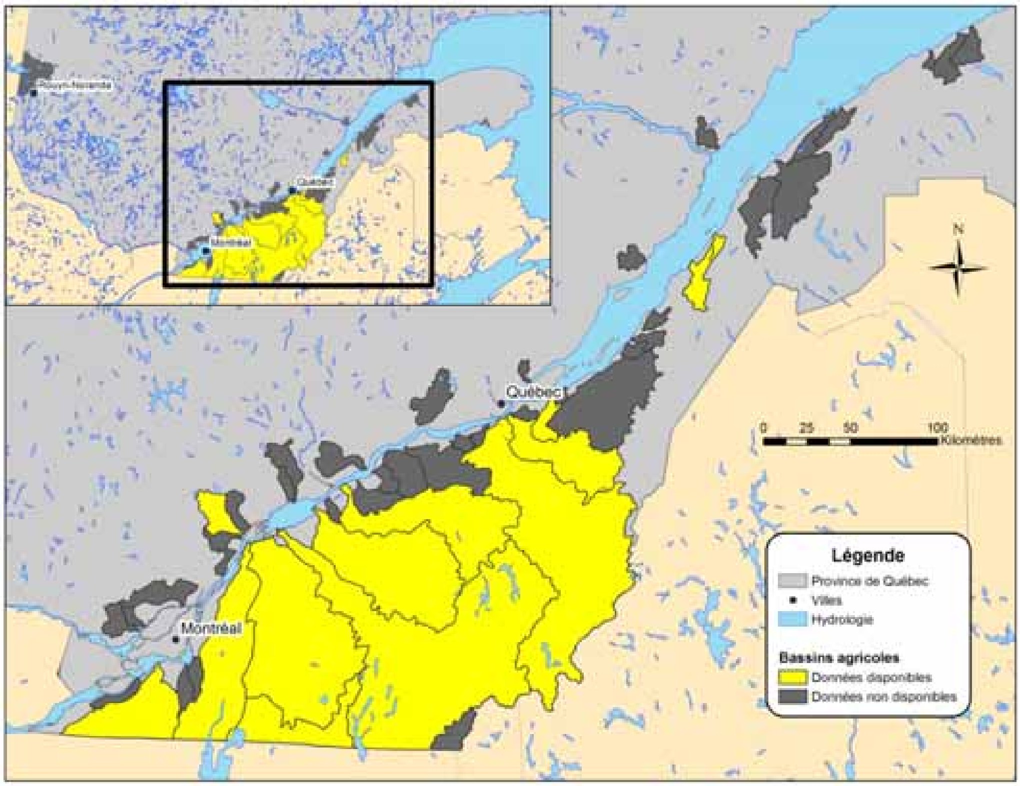


Figure 3: Location of the 13 extrapolated watersheds.

Source: Compilation made by Activa Environnement based on data from the Ministry of Natural Resources and Fauna (MRNF), the *Commission de protection du territoire agricole du Québec* (CPTAQ) and the *Centre d'expertise hydrique du Québec* (CEHQ).

The extrapolation was conducted per EG&S, agroforestry system, and implementation scenario. The following table shows the net present values (NPV) and the private and public benefit-cost ratios (B/C) of the three implementation scenarios at a Québec level.

Table 8: Results from the cost-benefit analysis at a Québec level.

Scenario		Private Net Costs	Public Benefits	Public benefits – Private net costs	Ratio of public benefits / private net costs
Regulatory-level	NPV (M$)	-209.39	244.15	35 M$	*N/A*
	B/C	0.14	*N/A*	*N/A*	1.11
Priority-level	NPV (M$)	-211.05	288.8	78 M$	*N/A*
	B/C	0.16	*N/A*	*N/A*	1.37
High-level	NPV (M$)	-1,038.54	1,902	864 M$	*N/A*
	B/C	0.43	*N/A*	*N/A*	1.83

Source: CEPAF and ÉcoRessources Consultants
Legend: NPV = Net Present Value B/C: Benefit/Cost Ratio N/A: Not Applicable

At the level of the 13 watersheds, the regulatory, priority, and high-level scenarios show private net deficits of, respectively, $209, $211, and $1,038 million, and B/C ratios of 0.14, 0.16, and 0.43. Although the high-level scenario was in greater deficit than the others, it offers a more favourable B/C ratio (0.43). This is explained by the fact that this scenario contains profitable agroforestry installations such as windbreaks that reduce heating and snow clearing costs and that enable higher crop turnout.

The public benefits of the scenarios for the entire Québec area go up to $244, $288, and $1,901 million for the regulatory, priority, and high-level scenarios, respectively. These social benefits are more significant than the private net costs and result in public net benefits on an order of $35 million in the case of the regulatory-level scenarios, of $78 million in the case of the priority-level scenario, and of $864 million in the case of the high-level scenario. In the case of the high-level scenario, EG&S-related benefits are twice as great as the private costs incurred by farmers.

At first glance, it is a bit surprising to note that the priority-level scenario leads to lower results than the high-level scenario. Indeed, one of the starting assumptions was that the public benefit/cost ratio of the priority-level scenario would be higher because it targeted what seemed to be priority installations. However, our results simply reflect the fact that, contrary to previous beliefs, the most important benefits relate to carbon sequestration and not water quality. The area of the implementation, which determines the carbon sequestration capacity, is the element that most affects the public value of agroforestry installations. The high-level scenario generates a higher ratio of public benefits / private net costs than the priority-level scenario, which wrongly assumed that the most important benefits would be derived from improvements in water quality.

As public benefits outweigh private net costs, society gains from the implementation of agroforestry systems. Although the extrapolation is based on weaker information than that used for the representative watersheds, the obtained ratios both for the regulatory scenario (low estimation) and for the high-level scenario (high estimation) should comfort us. The implementation scenarios seem to result in enough public benefits to justify a Government intervention in the establishment of agroforestry practices.

The Rationale Behind Government Intervention

The results of this study lead us to the conclusion that identified agroforestry practices do not generate sufficient and immediate private revenues to prompt farmers to implement such practices. In light of the results of the report on technical-economic interests of different agroforestry scenarios for farmers (stage 6), we note that no proposed agroforestry installation offers private benefits that are higher than the private costs for farmers in the two watersheds studied.

Furthermore, the results show that the public value of EG&S (stage 9) provided by agroforestry installations justifies transfers from society to farmers in order to, on the one hand, prompt them to implement agroforestry installations and, on the other, to compensate or remunerate them for maintaining such installations.

Incentive programs that encourage farmers to adopt these practices should cover private costs, in whole or in part, which would amount to an annual total of between $14 million and up to $69 million in an ideal scenario such as the high-level scenario. On another note, a portion of the public surplus should be transferred to farmers in order to compensate them for the obstacles identified in the stage 11 report. More concretely, the net benefits derived from the high-level scenario across 40 years indicate that it would be justified for the Québec government to invest up to $57 million annually, on average, in agroforestry practices in Québec in the course of the next 40 years. The net benefits derived from the priority-level scenario across 40 years indicate, for their part, that it would be justified for the Québec Government to invest $5 million annually, on average, over the course of the next 40 years.

Discussion

The results of this study lead us to the conclusion that identified agroforestry practices do not generate sufficient and immediate revenues to prompt farmers to implement such practices. On average, for all the simulations carried out in the framework of this project, the private costs were three times higher than the private benefits. This conclusion would hold even truer from the perspective of the Québec farmer if we considered the support of ASRA, which would increase the costs related to lost farmland. Nonetheless, the ratio of public benefits / private net costs obtained for the different implementation scenarios can comfort us. Although our extrapolation is based on weaker information than that used for the representative watersheds, the ratios seem to result in sufficient public benefits to justify providing assistance to farmers in order to help them implement and maintain agroforestry practices.

Although agroforestry can offer important benefits to society, these will not be realized if certain vigorous measures are not carried out. Concretely, such measures should include, amongst others:

- Defining the status of agroforestry and recognizing it within agriculture and forest policies;
- Applying the principle of ecoconditionality to all Québec and Canadian agricultural programs;
- Setting up a dialogue between agricultural and forestry finance organizations in order to make funding effective and efficient;
- Establishing an effective incentive program that remunerates Ecological Goods and Services and covers at least the implementation and maintenance costs of agroforestry practices;
- Adapting the modalities of support program to the characteristics and needs of the watersheds;
- Linking agroforestry support programs with existing support programs in Québec (ASRA, amongst others);
- Opening traditional insurance programs to agroforestry practices;
- Facilitating the development of markets for agroforestry products;
- Adopting an integrated and multi-sectoral intervention approach in the watersheds;
- Emphasizing research and development in order to learn about and optimize the productivity of different agroforestry practices in Québec;
- Supporting the dissemination of knowledge and transfer of technology, particularly regarding the results obtained in this study, to stakeholders in both agricultural and municipal fields;
- Providing reliable information on the market entry potential of products resulting from agroforestry practices;
- Encouraging concrete local actions in concert with the interventions of the agriculture and forestry sectors.

Incentives

The investment subsidies (*Prime-Vert, Programme de mise en valeur de la biodiversité des cours d'eau en milieu agricole*, Greencover Canada program) currently in place in Québec can be used to effectively prompt farmers to establish targeted agroforestry practices but are not enough to support their maintenance. As a result, they fail to secure real engagement from farmers.

In the Québec context, environmental conditionality is one of the most interesting financial incentives for the establishment of agroforestry practices. However, this tool is not rigorously applied (except in the framework of the *Politique de protection des bandes riveraines et des zones inondables)*. It is necessary to first ensure that the current agricultural programs conform to this principle.

The establishment of subsidies is administratively easier and lighter because these are managed by the appropriate ministry. One could therefore envisage subsidizing organizations that are currently working on establishing and maintaining riparian agroforestry buffers and windbreaks in Québec's regions. Despite the complexity of compensation programs and the important public transaction costs this would entail, if the subsidies were high enough to compensate opportunity, installation, and maintenance costs, they may be the most appropriate way to lift most of the obstacles identified for farmers and within government institutions.

On the other hand, one would have to propose measures to address the internal factors in provincial and federal institutions that obstruct the establishment of agroforestry programs and, thereby, the adoption of identified agroforestry practices. These factors include the lack of recognition for agroforestry and agroforestry programs, weak transfers of technology and know-how relating to the implementation of agroforestry installations, technical support, insufficient long-term technical and financial support, and occasional lack of coherence between different government policies.

At the scientific level, it would help to:

- Target the acquisition of scientific knowledge on EG&S emanating from agroforestry;
- Encourage work by multi-disciplinary teams of specialists from both the biophysical and the social sciences in order to develop knowledge that is useful to decision-making;
- Carry out applied monetary evaluation studies of EG&S in order to enlarge the knowledge base and thereby gain more data with which to support decision-making; and
- Develop a knowledge base with the help of new information technologies on the conditions to establish and to respect in order to extrapolate the results of local-level studies to scales that are useful for resources management.

A Research Avenue

Most of the work being done on the impact of agricultural practices or best management practices on water quality is conducted at the level of a sub-basin of small size. This is particularly due to constraints imposed by scientific experimentation protocols, which have to deal with the complexity of the ecosystems and the diversity of anthropogenic interventions.

Due to the nature of the information obtained in this manner, it is difficult to generalize and transpose scientific results into language that could feed into the public decision-making process. The difficulty resides in the challenge of generating scientific results that will be useful on the scale of the territories where decisions are to be taken.

We should therefore ask ourselves, considering our policy-making needs and the state of information, what are the most effective extrapolation strategies and at which scale would they be appropriate? The answer to this question could differ across Canada's regions in function of ecosystem differences and availability of knowledge. An underlying question is, what do we need to know in order to improve the quality of such extrapolations?

A basic component of any project that seeks to explore this question will be the use of new information technologies (satellite imaging, etc) and geomatics.

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Farmer's Contributions to the Production of EG&S in Targeted Sub-basins of the Missisquoi Bay, Pike River Watershed: Assessment of the Two-Year La Lisière Verte Project

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Executive Summary

In recent years, Missisquoi Bay in Lake Champlain has been affected by severe blooms of blue-green algae (cyanobacteria).

Since 1996, scientific research in the area has clearly demonstrated that agricultural activities are largely responsible for the high nutrient levels in the waters of Missisquoi Bay, which lead to algal blooms.

The project **"Contribution des agriculteurs à la production de biens et services environnementaux dans les sous bassins ciblés de la Baie Missisquoi" [**Contribution of farmers to the production of environmental goods and services in the targeted sub-watersheds of Missisquoi Bay] is a research-action project consisting of two components. This project is funded by Agriculture and Agri-Food Canada under the Advancing Canadian Agriculture and Agri-Food (ACAAF) Program.

The first component involved proposing that farmers, in exchange for compensation, establish, along five targeted streams in intensive agricultural areas, 8-m buffer zones planted with non-fertilized perennial crops, including runoff control structures to promote drainage while encouraging sedimentation of nutrient-rich suspended matter.

The second component involved evaluating the new modelling and remote-sensing tools used to identify areas particularly vulnerable to erosion and exploring the willingness of farmers to change their agricultural practices in these plots.

For the first component, 88.8% (56/63) of the targeted agricultural enterprises agreed to take part, and more than 600 runoff control structures were installed for an area of 97 ha out of a possible area of 113.5 ha, or 85.3%.

For the second component, the predictions of three tools were compared and it was the fine- scale tools that proved most effective at predicting erosion and drainage problems.

These results were presented to the farmers, who had the opportunity to compare their own perceptions with the results obtained by these tools. Tables were prepared to illustrate their willingness to modify their practices. Their openness to this idea varied considerably depending on the agricultural practices proposed.

Introduction

The project entitled "Farmers' Contribution to the Production of Ecological Goods and Services in Targeted Sub-Basins of Missisquoi Bay" was supported by the Coopérative de Solidarité du bassin-versant de la Rivière-aux-Brochets.

The idea behind the project was to establish a continuous eight-metre-wide riparian buffer zone (exceeding the one-metre-wide buffer zone required by law) on either side of the five targeted watercourses in an intensively farmed region and to construct the requisite surface runoff control structures. The overarching goal was to establish a buffer zone to control runoff and reduce losses of nutrients, particularly phosphorus.

The project also involved testing tools that can be used for the diagnostic assessment of areas vulnerable to erosion and runoff and examining ways farmers can adapt their farming practices in vulnerable zones.

Background and the Idea behind the Project

Missisquoi Bay on Lake Champlain, specifically the Quebec side of this large lake, has been affected by severe algal blooms for a number of years, and this is also one of the first places in Quebec that has had to grapple with problems caused by blooms of cyanobacteria (blue-green algae).

Agriculture has long been identified as being largely to blame for the problem.

In view of this situation, in 1995, the local office of the Quebec Department of Agriculture, Fisheries and Food (MAPAQ), working in co-operation with the Institut de Recherche et de Développement en Agroenvironnement (IRDA), installed measuring instruments on Ruisseau-aux-Castors, a stream located in an intensively farmed area, and set out to document the agricultural practices of farmers in this watershed. The initial goal was to suggest concrete remedial measures and to encourage farmers to implement them.

In 1999, after three years of research and work with the farmers, and in light of the directions adopted by MAPAQ, a co-operative called the Coopérative de Solidarité du bassin-versant de la Rivière-aux-Brochets was established. The farmers who set up this non-profit organization wanted to work on improving water quality in watercourses that run across farmland.

Beginning in 1999, since the water quality monitoring results brought to light, among other things, significant phosphorus loading to streams during runoff events, the co-operative suggested that the local farmers implement runoff control measures including the following: installation of inlet wells; planting of hedgerows on field margins along watercourses; and construction of rock chutes in strategic locations. The water quality monitoring measurements carried out by a team led by Aubert Michaud, an IRDA researcher, subsequently showed a significant decrease of about 25% in the mean phosphorus load.

The idea for the “Lisière verte” (green filter strip) project came from this earlier work: it consisted of establishing a riparian buffer zone wide enough to support a perennial forage crop on either side of a given watercourse.

However, to make this approach work, it was also necessary to install drainage structures (including in the area around lot lines) that would ensure the settlement of nutrient-rich suspended matter that could otherwise adversely affect water quality.

Meanwhile, the IRDA carried out a parallel project which involved testing the SWAT (Soil and Water Assessment Tool) software in the Rivière-aux-Brochets (Pike River) watershed. One of the functions performed by this software includes identification of areas potentially vulnerable to runoff erosion and therefore loss of nutrients.

This gave rise to component 2 of the project, which centred on verifying the data obtained and sitting down with farmers to look at how they could adapt their cultural practices in light of the findings.

The project area encompassed five watercourses (Castor, Granger, Pelletier, Petit Ruisseau and Ewing), which were divided into two sectors of comparable size. These five watercourses are located in the heart of an intensively farmed region in the Rivière-aux-Brochets watershed, dominated by annual crops.

Sector 1, comprising the Castor, Granger, Petit Ruisseau and Pelletier watercourses, has a total area of 2,336 hectares.

Sector 2, consisting of the Ewing watercourse, covers an area of 2,973 hectares.

Objectives and Means

The objectives of the project were as follows:

Component 1: construction of runoff control structures in upstream areas to break the hydraulic connection between the land and the watercourse, and establishment of a continuous eight-metre-wide (or nine-metre-wide if the one-metre strip required by law is included) grass buffer strip on either side of the watercourse, to minimize the loss of nutrients transported in runoff.

Component 2: evaluation of the SWAT model, including fieldwork to assess the status of parcels of land identified as vulnerable to nutrient exports, and the practical implications in terms of the changes farmers should make to their management practices.

To ensure the attainment of these objectives, the project featured a series of financial incentives intended to encourage farmers to participate. For example, the investments required to construct the infrastructure (well inlets, filtration trenches, etc.) were reimbursable in full. At the time the project proposal was drafted, the cost of such works was covered to the tune of 70% under the Prime Vert program (MAPAQ) whereas the current coverage is 90%.

An amount of $675/ha was paid to farmers as compensation for two years of lost income ($337.50/ha per year), and the producers were allowed to harvest forage produced in the buffer strips.

When the project proposal was drawn up, a subsidy for collective action against eutrophication ($1,000/farm) was established as payment for the environmental service provided by the co-ordinated activities of the farmers along the targeted watercourses. Payment of the subsidy was made conditional on the participation of all farmers in each sector. Since this subsidy and the associated condition were not accepted by the Advancing Canadian Agriculture and Agri-Food (ACAAF) program officers during the analysis of the project proposal, the provincial government decided to bear the cost of this incentive. However, it modified the associated condition so that the subsidy amount would be adjusted according to the participation rate of the farmers concerned.

On the research and analysis front, focus groups of farmers were planned along with focus groups made up of citizens to promote discussion regarding various aspects: motivation of farmers to participate in such a project, relevance of a watershed-based approach, the concept and value of ecological goods and services (EG&S), adjustment of the approach over time, citizen expectations, etc.

Finally, the analysis of this information and the project evaluation were entrusted to a multi-stakeholder group composed of participants and representatives from the agricultural and environmental sectors, as well as provincial and federal government analysts.

Funding and Partnerships

The project proponent is the Coopérative de Solidarité du bassin-versant de la Rivière-aux-Brochets, whose background and mandate are described above. This co-operative has 55 members, and most of the membership consists of farm businesses that want to work on improving water quality through enhancing farming practices.

The funding for the project breaks down as follows: maximum grant of $917,664 from Agriculture and Agri-Food Canada (AAFC), cash contribution of $92,500, contribution in kind of $143,240 from MAPAQ, and contribution in kind of $120,000 from the sector.

One project partner, the IRDA, played an important role by ensuring follow-up of component 2.

The Dura-Club de Bedford, a sustainable agriculture club, and specifically agronomist Florent Ruyet, was given a mandate to conduct interviews with farmers under component 2 and to prepare an associated draft report.

In addition, the Brome-Missisquoi Regional County Municipality helped to expedite clean-up work along the watercourse sections where runoff control structures were to be built.

Thanks also go to MAPAQ's Montérégie Ouest division for allowing civil engineer Georges Lamarre to devote several days to walking along the watercourses in order to make appropriate recommendations regarding the dimensions of the required runoff control structures. We are also grateful to the municipal inspectors working for Saint-Alexandre and Saint-Sébastien for expediting issuance of the permits for the construction work.

Last but not least, the Corporation du bassin-versant de la Baie Missisquoi deserves recognition for its unstinting support.

Methods and Implementation

Component 1

We received the project approval response from Minister Chuck Strahl on April 23, 2007.

In the spring of 2007, conditions were very favourable for seeding, with warm dry weather, and on May 17, 2007, we set up an initial meeting with farmers in the sectors targeted by the project. Obviously, much of the seeding work had already been done by that point.

We devoted considerable effort to ensuring that most of the farm businesses would attend this important meeting. In addition to sending out an invitation letter, the project leader made phone calls to persuade local farmers to attend. Representatives of forty farm businesses attended the meeting, together with representatives of four of the five municipalities located in the project area.

It should be noted that the number of farm businesses expected to participate in the project was originally estimated at 78 based on the business registration numbers for each municipality. As it turns out, however, many of the farmers have land that straddles the boundaries of several municipalities. Based on a careful review of taxation accounts, the project leader drew up a new list of the businesses concerned, which gave a revised total of 63.

When the project proposal was drawn up, the number of runoff control structures required was estimated from aerial photographs of the project area. It was nonetheless necessary to have engineers visit the sites to determine the interventions required and suitable dimensions for the structures. In early May, we therefore initiated the work of walking along the watercourses with a view to producing maps showing the required infrastructure along with technical design parameters. This was done with the help of Georges Lamarre, MAPAQ engineer, and Nicolas Stampfli of Golder Associates Ltd., a consulting engineering firm. This phase of work, which lasted the entire month of May and part of June, involved systematic visits along all the watercourses.

Two weeks after receiving the official project approval letter, we received another letter from the ACAAF program setting out the terms and conditions governing the allocation of funding. The first condition that had to be met consisted in conducting an environmental assessment in compliance with the *Canadian Environmental Protection Act*.

We had to act fast to retain the services of an environmental assessment firm, Arbour, to prepare the environmental assessment document as quickly as possible, considering our already tight schedule. The required document describing the main proposed interventions was produced and submitted within a time frame of about a month.

In mid-June, the infrastructure work got under way and continued throughout the summer and fall and even into the early part of winter. Wherever possible, suitable works were constructed, and then the land was prepared and the grass buffer strip established.

In the first year, a 51.4-hectare area of flood plains and grass buffer strips was established. Each farm business signed a written undertaking to maintain this area as such for a period of two years, as stipulated in the pilot project, in return for which the agreed-on financial compensation was paid out. Each file includes the farm map for the area concerned, a description of the land for which compensation was paid, the measurements used to calculate the surface area, and the agreement signed by the farm business, along with a copy of the compensation cheque.

In the second year of the project, the infrastructure construction work continued and 602 interventions were completed, that is, 514 inlet wells and 88 other types of infrastructure (rock chutes, rip-rap, rock armouring and wellpoints).

The total area of the interventions encompassed nearly 100 hectares of buffer strips and flood plains.

The participation rate of farm businesses amounted to 82.7% in sector 1 (24/29 businesses) and 87.8% in sector 2 (36/41 businesses).

A total of seven farm businesses own land in both sectors.

Note that with respect to the participation rate, the majority of farm businesses, that is, about 80%, carried out interventions covering 100% of the targeted surface area. The others, often for excellent reasons it should be noted, implemented measures but the coverage did not amount to 100% of the targeted surface area. They nonetheless participated and so are included in the participation rate statistics.

We also calculated the percentage of surface area in which interventions were carried out in relation to the potential surface area. The reasons given for not completing work on the entire potential area count among the lessons learned from the pilot project. To summarize, work was carried out on 96.9 hectares out of a potential area of 113.5 hectares. This represents 85.3% of the potential surface area.
Here are a few of the reasons given by farmers: very small fields located at the confluence of watercourses which would be very difficult to manage if cut off by the eight-metre-wide buffer strips; fields parallel to watercourses rather than perpendicular to them; distant fields which would make buffer strip management difficult.

Farmers who refused to participate in the project gave the following reasons: lack of interest; not receptive to the idea of collective management of riparian areas; worried that people would not respect their private property.

Component 2
The object of component 2 was to verify the SWAT modelling results through on-site verification of the land parcels identified as being vulnerable to nutrient exports and to explore the practical implications in terms of the changes farmers should make to their farming practices.

A few weeks after the project got under way, we began verifying the parcels identified as vulnerable by the modelling tool (SWAT), and we discovered that the real situation was not consistent with the predictions. We pondered the reasons for this and discovered major biases in certain parameters used in the model.

When the available data were input to SWAT, we noticed that some of the information was incomplete, including the soil fertility data. Since MAPAQ transferred its laboratory services to the private sector, it takes longer to obtain the results of soil analyses. The IRDA team therefore had to generalize the soil analyses available for the municipality to all fields in the municipalities.

The model designated land parcels as vulnerable when they met three criteria: steep slope, high soil fertility and annual crop. Aside from the bias associated with generalizing soil analysis results, if a crop rotation system is used for some parcels of land system, this creates an additional bias interfering with the software's identification of vulnerable land parcels.

For component 2, we could have simply stipulated that, further to the on-site evaluation, SWAT was not a suitable tool for accurately identifying parcels of land that are vulnerable to nutrient exports.

However, in spring 2006 a very precise characterization was carried out in project sector 2, that is, Ewing Stream and its watershed, using airborne multi-spectral digital images as well as LIDAR data.

On May 28, 2006, the Quebec firm Laser Image used its LIDAR 2050 to acquire imagery for a 60-km^2 area, including the drainage basin of Ewing Stream at an altitude of 1,200 metres. During the overflight, more than 175 million elevation points were acquired, and, following processing, very precise relief maps of the region were produced with an accuracy of 5 to 15 centimetres. These data made it possible to model the water flow pathway and identify micro-basins as well as natural depressions in fields. This type of information is very useful for decision making and for designing runoff control structures.

A second overflight was made the same day, at an altitude of 2,000 metres, permitting the acquisition of more than 420 million multi-spectral digital images with a Duncan MS3100 camera owned by the Institut de technologie agroalimentaire (ITA) in La Pocatière. Imagery obtained with this camera can be used to characterize hydrologically active zones.

The data acquired were used to produce maps showing the soil brightness index, which can be used to identify soil moisture conditions that are typically associated with less productive areas of fields and indicate high vulnerability to erosion and runoff.

Personalized copies were submitted to the farmers who own fields in the Ewing Stream area. In addition, predictions of runoff, erosion and non-point source phosphorus export rates were produced for all the fields using ODEP, a software tool designed for the diagnostic assessment of phosphorus exports. A meeting was held with each agricultural producer to verify the data produced by an external consulting agronomist. The interviews included an evaluation of the following: (1) the accuracy of these tools and their usefulness for producers and (2) the decision-making factors that determine whether or not producers adopt soil conservation practices, along with the usefulness of the tools for implementing hydro-agricultural measures complementing the riparian buffer zone and runoff control structures constructed in the Lisière Verte project.

We can affirm that the work done under component 2 went beyond the original proposal, in that remotely sensed survey data and phosphorus export risk indices were used in assessing the predictions derived with the SWAT hydrological model for the entire region.

Focus groups and multi-stakeholder committee
Three focus group meetings were held. The first was on February 19, 2008, when a group of nine citizens who reside in the Missisquoi Bay area and are active in various ways in their milieu discussed their views of the issues related to agricultural non-point source pollution and their views of the project and the concept of environmental goods and services.

The other two focus groups met on February 19 and 20. The first group consisted of nine farmers, and the second, eight farmers. They shared their views regarding the farming community's responsibility for the deterioration in water quality, the responsibility of various sectors of society, the actions that need to be taken, and their personal views of the green filter project.

The focus groups were moderated by an environmental communications firm (François Rondeau), and Isabelle Breune of AAFC and Mélanie Tremblay of MAPAQ acted as co-moderators. A set of verbatim minutes was prepared by Mr. Rondeau's firm.

Results, Costs and Benefits

In terms of the results, as described above, there was an 85% participation rate among the targeted farm businesses, a similar percentage of the targeted total acreage planted to perennial crops (30 hectares of flood plain previously used for annual crops converted to perennial crops), and 85 kilometres of eight-metre-wide buffer strips planted to perennial crops, for a total of about 100 hectares. In addition, 602 runoff control structures were constructed.

Under component 2, the diagnostic assessment derived with the SWAT model was verified on site, fine-resolution relief maps of the area were produced using the LIDAR data and complementary data (micro-basins and flow pathways), and soil brightness index maps were produced. In addition, the general maps were divided up, separate farm maps were produced and the farm businesses were asked about the usefulness of the maps. A report is currently being written on the evaluation process; it will be submitted at the end of the project.

To our knowledge, this is the first concerted action project in a watershed to use such highly accurate geospatially referenced diagnostic assessments of field drainage and surface runoff.

In terms of the measurable impacts on water quality, although monitoring was conducted throughout the project using automated multi-parameter probes installed at the outlets of the Castor and Ewing watercourses, we knew from the outset that the two-year time frame of the project precluded measurement of the impacts of practices on water quality.

However, the monitoring will continue after the project ends, thanks to funding obtained by the IRDA and McGill University from the Fonds Québécois de la Recherche sur la Nature et les Technologies (FQRNT, cyanobacteria program).

There are several key results that are not quantifiable but are nonetheless noteworthy: creation of a regional agricultural sector dynamic around the project, promotion of a dialogue between farmers and other citizens, popularization and demystification of this type of approach through contacts with local advisory clubs, other regions and environmental organizations, increase in watercourse stability (which will help to reduce maintenance and clean-up efforts over the long-term), and biodiversity enhancement.

The obstacles encountered in the implementation of the project are as follows:

1. Time: we accomplished a lot in spite of the very tight schedule. We needed at least another year, and we should have had the go-ahead a few months earlier.

2. The conditions imposed on project funding. It was not until two weeks after project approval that we were advised of certain conditions, as follows:

    i. An environmental assessment had to be done before any work could be undertaken in fields, and the time frame was very tight.
    ii. A 10% holdback is imposed on all federal projects; however, the Coopérative de Solidarité du bassin versant de la Rivière-aux-Brochets is a non-profit organization with limited financial means. A great deal of effort went into obtaining a line of credit and a loan to cover the 10% holdback on this $1-million project, and the president of the co-operative and the project leader ended up having to personally guarantee the financing arrangements.

3. Delayed payments under the project: payments for the project were often delayed for various reasons, which put us in a difficult situation.

4. The functioning of the multi-stakeholder committee: the idea of working in collaboration with a committee composed of representatives of various agricultural and agri-environmental organizations seems promising. In practice, however, it is difficult to work within such a framework, since the different stakeholders have a vision that is shaped by the culture of their respective organizations. It is therefore difficult to have a shared vision of the undertaking.

5. Reservations expressed by some farmers: at group meetings and one-on-one meetings, producers shared some of their concerns related to the project, such as their worry that hunters would encroach on their property, that illicit plants would be planted, and that motorized vehicles (all-terrain vehicles, snowmobiles) would use the riparian buffer zone as an access point.

6. Non-participation of some farmers: as a general principle participation in the project was to be completely voluntary and this was made clear at the outset.
   The main idea behind the project was to create a continuous riparian buffer zone on both sides of the targeted watercourses to facilitate management of farming operations, among other things. Because some farm businesses did not take part in the project, the buffer zone does not cover the entire targeted area.

7. Turnover of government representatives: this was a major stumbling block throughout the project. The provincial team that got the project off the ground underwent an organizational realignment. Shortly afterwards, an official was appointed as the provincial government representative, but then in April 2008, this person left the department to work in the private sector without giving notice. MAPAQ then sought to fill the position, but the job posting and subsequent interviews did not lead to hiring for various reasons; for instance, the candidates did not find the conditions attractive enough or the interview committee did not find the candidates suitable. In short, during a period of about six months, MAPAQ did not have anyone at headquarters working on the project, a situation that affected several aspects, which consequently could not be completed according to schedule. Those aspects included the analysis of the focus group results and the staging of the second focus group meeting.

   Later on, the same situation occurred at the federal government level, with the departure of the person in charge of financial follow-up of the project. The money needed for project operations was delayed, held back, etc.

   To reiterate, this was one of the biggest problems we faced. It is not easy for a non-profit organization to deal with the administrative hurdles that can arise when dealing with the machinery of government.

Conclusions

This project enabled the participants to learn various things at various levels. In terms of the farmers' receptiveness to the idea of ecological goods and services, the participation rate was very high, and it appears that when technical and financial support is available, farmers are ready to join in. However, and this is a conclusion that emerged from the farmer focus groups, farmers are not willing to leave productive land fallow without receiving financial compensation. With respect to acreage removed from production, they want to earn income comparable to that generated by the crops previously grown on the land concerned. Clearly, it is a matter of deciding how much compensation should be paid for their participation and how long this compensation should be provided.

Farmers are aware that governments do not want to have to pay compensation in perpetuity and that a compromise has to be found. One thing is certain: two years is much too short a time to assess the effect that the riparian buffer strips and the runoff control structures have on water quality.

In addition, this is too short of a time period to assess the profitability of buffer strips in light of the crops planted there. Growing hay in the strips may be viable for dairy producers, but the profitability of growing switch grass in the riparian buffer zone remains to be demonstrated and measured, and the profitability of such crops will be largely dependent on the existence of facilities for processing the biomass. Ideally, the acreages concerned should become profitable over the medium to long term.

Another conclusion that emerged is that if a policy is put forward to promote the establishment of riparian buffer strips, sufficient flexibility should be accorded in terms of implementation.

Here, I am referring to situations such as fields that are parallel to the watercourse instead of perpendicular to it. In such cases, the width of the buffer strip could be reduced to four metres from eight because farmers are unwilling to “lose” this much land given the reduced effectiveness.

The same logic applies to very small fields, because if they are cut off by an eight-metre buffer strip, they can become very difficult to manage with agricultural machinery.

This project also taught us that producers want assurance that people will respect their private property. They are very attached to their land, and this is an aspect that should not be underestimated. Finally, the fact that participation in the project was voluntary was a key factor in securing their support and involvement.

The lessons learned also include the fact that collaboration with the different jurisdictions concerned is very important. The excellent collaboration of the Brome-Missisquoi RCM and the municipal inspectors of St-Alexandre and St-Sébastien has already been mentioned.

A final lesson, possibly the most important lesson, is that a non-profit organization, the Coopérative de Solidarité, agreed to take on this ambitious project. As mentioned above, however, a number of problems arose in our dealings with the two levels of government. The high turnover of government representatives caused delays and created havoc for us.

The president of the Coopérative, Ernest-William Gasser, and the project leader had to guarantee the loans and lines of credit; our suppliers, especially the contractor who carried out the construction, also had to put up with delays and they prevented him from purchasing the requisite materials. For a small non-profit organization, this is an untenable situation, and we will certainly think twice about this kind of arrangement in the future.

The project involved many local stakeholders: the construction contractor who worked during evenings, weekends and the winter without ever asking for overtime, the regional players, farmers, municipalities, the RCM, the Corporation du bassin versant, the sustainable agriculture club and, obviously, the board of directors of the Coopérative all put their heart and soul into the project.

It should be kept in mind that this was a **pilot project**.

Future

Following an analysis of the verbatim focus group discussion transcripts and the preliminary report prepared by the consultant hired by MAPAQ, the multi-stakeholder committee will make recommendations setting out its vision of an ecological goods and services program.

The provincial government is currently looking at how to maintain the project outcomes. In our view, an approach similar to the one described here should be based on common sense, that is, it should be limited to regions where intensive farming or other activities have caused a water quality problem, whether in Quebec or elsewhere in Canada.

A very important point to consider in the future relates to the need to close the loop, that is, it is crucial to ensure that market outlets exist for the crops that will be grown in the riparian buffer strips. The agricultural community would rally behind such an approach, leading to a diversification of activities, and if the crops are profitable, government support would not have to be provided in perpetuity.

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Identification and Assessment of the Provision of Environment Goods and Services by the Primary Agriculture Sector and Determining Societal Expectations of the Farm Community

The Nova Scotia Federation of Agriculture
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Executive Summary

This project consisted of two main components designed to allow Nova Scotia Federation of Agriculture (NSFA), and other stakeholders, to better understand the agricultural sector's interface with the environment and how the benefits from environmental goods and services (EG&S) provided by farmers can be enhanced. The two project components were:

1. Conducting in-depth consultations with primary producers who are members of the NSFA about the impacts of changing environmental standards and societal expectations on their farm businesses.
2. Developing a pilot program to support environmentally beneficial activities on farms that are in a designated watershed but that, for a variety of reasons, may not be able to take advantage of existing provincial programs.

The results of Component I indicate that farmers have reacted in many positive ways to changes in expectations of their relationship with the environment. Farmers recognize the value of protecting the environment for themselves as rural residents, for their industry, their community and society as a whole. They make management and investment decisions that reflect their environmental attitudes and accept that these activities are necessary.

Component II resulted in fifteen projects on six farms in the St. Andrews Watershed, the drinking water source for the Town of Stewiacke, NS. Several lessons were learned on designing and delivering an effective program to small, non-traditional farming operations. Specifically, project timelines require a minimum of three years for the program to reach maturity and meet its goals, effective communication is key because many of these lifestyle farmers do not consider themselves part of the agricultural sector, and issues with the potential to create barriers to program acceptance by agricultural landowners in the Watershed need to be identified and mitigated.

The results of this project will provide useful information for NSFA and policy makers to enhance programs and projects related to Environmental Goods and Services.

Introduction

Nova Scotia agriculture has been a leader in environmental issues with an environmental farm plan program that has been in place for almost a decade. The industry was also one of the first to develop a formal nutrient management planning process. The commercial farming sector and part-time farms alike have embraced these programs and made substantial investments in both time and capital to ensure an environmentally compliant food and fibre production system.

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1. Conducting in-depth consultations with primary producers who are members of the NSFA about the impacts of changing environmental standards and societal expectations on their farm businesses.
2. Developing a pilot program to support environmentally beneficial activities on farms that are in a designated watershed but that, for a variety of reasons, may not be able to take advantage of existing provincial programs.

The following report summarizes the results of the study.

Component I: Identification and Assessment of Environmental Goods and Services

The objective of Component I of this project was to determine the impact of changes in environmental regulations and expectations on the primary Nova Scotia agricultural industry through a literature review and survey of Nova Scotia's farming community. Based on this research, identification and assessment of the benefits and costs of the range of environmental goods and services that are provided by Nova Scotia's farming sector was completed.

The scope of this project was a broad consultation process with the farm community and the greater community which recorded and documented their experiences with policy and industry changes that have led to the increase in environmental goods and services (EG&S) provided by the sector. This component is a follow-up to an industry survey, *Impact of Changes in Regulatory Requirements and Societal Expectations on Nova Scotia Farmers*, completed February through April 2006.

Methodology

Consultation with the primary agricultural sector took three forms:

1. A survey of NSFA membership designed to provide information on how their farm businesses have changed in response to environmental issues.
2. A series of workshops with farmers was developed based on the survey results to provide more detail about the changes on their farms.
3. Case studies of individual farms covering a range of commodities to provide further detail of specific activities on these farms.

Highlights of the results of these activities are presented in the following sections.

Survey Highlights

Throughout September 2008, Kelco Consulting conducted a survey of the membership of Nova Scotia Federation of Agriculture (NSFA). The purpose of the study was to identify perspectives on environmental issues affecting the farming community in this province.

The approach taken in the survey process consisted of the development and circulation of a survey that was designed to collect data on a number of issues related to farm practices around environmental goods and services provided by agriculture. The survey was developed from an earlier version that was administered in 2005. A total of 407 surveys were completed, of a total sample of 2,350, providing an error rate better than +/- 5%, 19 times out of 20 (95% confidence). The major findings include:

- The majority of farms were in the group of less than $250,000 in annual farm sales with almost 45% of respondents having sales less than $25,000. Higher income earning farms tended to be livestock only, followed by farms that reported livestock and crop combined. The survey respondent distribution is in line with the 2006 census.
- The majority of participants categorized themselves as part-time farmers (61%) while full-time farmers made up the rest (39%).
- A majority of farmers have completed an Environmental Farm Plan (EFP) (56% of 407 farms responding). A smaller group (45%) indicated they had completed a Nutrient Management Plan (NMP). The average year in which EFPs were completed was 2005, while 2006 was the year with

the largest number of EFPs completed. The average year in which NMPs were completed was 2006 and the largest number of plans was completed in 2007.
Results indicating that there has been substantial uptake of EFPs and NMPs in 2006 and 2007, respectively, may relate to:
    - The requirement that these plans be completed to qualify for funding under provincial and federal government assistance programs,
    - The inclusion of the cost of a NMP in the provincial Farm Investment Fund, and
    - Additional human resources added to the Environmental Farm Plan program. One-hundred-and-two (102) farmers indicated they were on a waiting list for an EFP or NMP.
- Farmers were asked what steps they have taken that would preserve the environment. The largest share of respondents to this question indicate that they restrict applications of manure and fertilizer depending on "weather" and "time of year", 47.6% and 47.3%, respectively. Fuel storage upgrades and setbacks from watercourses were reported by 36.2% and 34.6%, respectively, of respondents. 18.6% of respondents indicated that "No particular activities come to mind". It may be that these respondents made investments or changed farm practices several years ago and these have been "internalized" to the operation so that they do not recognize them as being environmentally beneficial actions.
- Farmers were asked what activities they have taken related to environmental and nuisance issues out of consideration for their neighbours. The majority of the respondents indicate that they restrict manure/fertilizer use for spreading depending on weather and time of year out of consideration for neighbours (43% and 41.9% respectively). Setbacks were also reported by 22.8% of respondents. 27.2% of the respondents indicated that "No particular activities come to mind", a substantially larger proportion than for the previous question on protecting the environment.
- Survey participants were asked what changes they have made as a result of environmental concerns or changes in government regulations. The largest group of farmers indicated that environmental concerns or changes in government regulations and societal expectation have resulted in "no change to our operations". Responses were as follows:
    - 43.8% There has been no change to our operations as a result of environmental issues.
    - 37.4% Made capital investment
    - 31.2% Paid more for certain activities (that address requirements)
    - 9.8% Changed the area of production associated with your farm
    - 6.7% Reduced the area of production associated with your farm
    - 5.3% Other (included riparian fencing, adopting more efficient methods, reduced sprays, etc.)
- Respondents were asked what types of capital investment were made that related to the environment. Those most frequently identified were manure storage and handling improvements (52 respondents), fuel storage improvements (35 respondents), pesticide and chemical storage (13 respondents), fencing waterways (12 respondents). Several other investments that related to water issues were also identified.
- The largest group of farmers (49%) identified the Farm Investment Fund (FIF) as a funding source to help deal with the costs associated with addressing compliance issues. The second largest share (48%) indicated they have not used a fund or program to deal with these costs. The FIF normally covers a maximum of 50% of capital investment, yet farmers regularly reported assistance programs covering 75% or higher of their capital cost. Assistance in amounts in excess of the FIF limits is covered from federal government programs, particularly the Beneficial Management Practices program. This program is delivered with the provincial FIF program by

the Nova Scotia Department of Agriculture. It appears that farmers do not differentiate between the FIF program and funds provided by Agriculture and Agri-Food Canada's Beneficial Management Practices (BMP) program because it is delivered by the provincial department.

- With respect to capital investment, the largest group of respondents (38.4%) indicated that programs should cover between 75% and 100% of their costs. The next largest group (21.8%) indicated that between 50% and 75% of costs should be funded. The next largest group (17.3%) said that none of the costs should be funded.
- Farmers were asked to identify those who they believe have benefited from changes in environmental issues that impact their farm. A ranking system with 1 as the least benefit and 5 as the greatest benefit was used and then an average rank calculated. Nova Scotia residents were seen as the greatest beneficiaries (average of 3.6), followed by consumers (average of 3.3), the agricultural industry (average of 3.2), and farmers themselves (average of 3.1). Other beneficiaries identified included neighbours, the general public, the environment and rural communities. Farmers appreciate the positive impact on both their industry and themselves of protecting the environment.
- Farmers were asked who they believe is driving environmental concerns. The same ranking system was used as described above. The government was ranked highest at 3.3 out of a maximum of 5, as were consumers. Urban residents were ranked 3.1, followed by farmers themselves at 2.7. Other drivers identified included environmental organizations and special interest groups.
- Farmers were asked why they believe they are being asked to make changes to their farms, using the same ranking system as described above. Farmers believe that they are being asked to make changes to their farms to meet public expectations (average rank of 3.7), followed by meeting government targets (average rank of 3.4), and to meet market expectations (average rank of 3.3).

Survey results were cross-tabulated to farm sales groups as a proxy for size of farm business under the assumption that businesses with lower sales are relatively smaller than those with larger sales. The cross-tabulation analysis did not indicate significant differences in response by size of farm operation. Generally, farms of varying size exhibit similar environmental outlook and activity profiles.

It appears from the summary and perusal of the detailed survey results that most farmers accept and support evolving public attitudes toward the environment and believe that they benefit from these changing attitudes. Farmers also appear to be well aware of the importance of environmental protection and the benefits that all of society receives from a healthy environment. However, some respondents expressed frustration over the pace of change and their belief that the costs are being unfairly borne by the farmers themselves.

Workshop Highlights

Some results of the survey conducted for this project and from the 2006 survey raised questions as to the extent to which farmers separate the impacts of environmental issues from other industry changes, including those associated with food safety (e.g.: on-farm quality assurance programs). It is also difficult to determine to what extent environmental issues may have influenced a particular activity that may have been part of the normal course of business. For example, expansion or replacement of manure handling and storage facilities in conjunction with a business expansion is not an environmentally-driven capital investment. However, if the manure storage was expanded to increase capacity beyond previous practices (e.g.: storage for a longer period of the year), then that incremental cost can be associated with changing environmental expectations. The workshops were designed to try to identify the incremental activities related to environmental issues.

The workshop focused on the key areas of impact that were identified by the survey. These were:

1. Capital investments a business undertook to conform to changes in regulations, guidelines, or general expectations.
2. Increased operating costs as a result of changes to their operations.
3. Decreased revenue as a result of changes to their operations.
4. Increased management to ensure environmental compliance.

Capital Investments

Capital investments that had direct or indirect impacts on the environment included such things as:

- Improved or new manure storage and handling facilities. These expenditures normally were part of an expansion or upgrade of facilities in conjunction with an expansion or to reduce the potential for runoff into watercourses. In most situations, the investments were made to enhance the operations of the business and benefits to the environment were indirect (e.g.: reduced runoff into watercourses). Siting of manure storage facilities is significantly influenced by environmental issues.
- New and expanded buildings as part of the normal course of business that used enhanced environmental features, which usually were beneficial to the business as well. These features include such things as natural ventilation replacing fans that reduce power demands, more efficient equipment in the building that operates using less power, whether electrical or fossil-fuel based, or heat recovery systems to supplement other heat sources.
- Many farmers have built or improved fuel and chemical storage facilities to reduce the potential for spills that will harm the environment.
- Two types of capital investment are directly related to environmental issues – stream crossings and fencing cattle from watercourses. Farmers have installed numerous approved stream crossings so that they do not take equipment through watercourses destroying stream habitat and creating stream-bank erosion. Cattle have been fenced from watercourses to reduce the same types of damage, which not only requires investment in fences but also in alternative water sources for the cattle.
- Drainage investment, including tile drainage to reduce soil compaction, and water runoff control using extensive ditching to reduce erosion are common on many farms.
- Some farmers have moved toward reduced tillage systems that reduce erosion. These systems require capital investment in specialized equipment.
- Many livestock farmers who have moved to liquid manure systems have purchased equipment to inject the manure into the soil to reduce runoff, nitrogen evaporation into the air, and odours.

Increased Operating Costs

Some operating cost increases associated with environmental issues relate to the capital investments for stream crossings and fencing watercourses. The number of stream crossing sites has been reduced requiring more travel to move equipment, and fences and alternative watering systems need to be maintained on a regular basis.

Cropping activities used to be conducted in very close proximity to watercourses. Farmers have increased the size of the setbacks (i.e.: distance) from waterways over time. In many situations, farmers mow or otherwise maintain these uncropped areas to reduce weeds, disease and pest damage. These activities increase cropping costs.

Livestock farmers have changed the timing and frequency of manure applications so that they apply smaller amounts more frequently, which reduces pollution potential but increases equipment and labour costs.

Decreased Revenue
The major source of decreased revenue identified is the reduction in land being farmed as a result of increased setbacks from waterways and property lines and reduction of cropping land that is not suitable for a certain type of crop. For example, steeply sloped land has been taken out of annual crops such as grain and planted to less valuable perennial forage crops, or removed from production altogether.

Management Change
Management changes frequently relate to items discussed above, including:

- Reduced tillage cropping practices.
- More effective management of livestock pastures.
- Use of GPS systems with equipment when doing fieldwork ensures accurate applications of fertilizer and sprays and reduces the use of fossil fuels.
- More frequent and better targeted manure and fertilizer applications based on Nutrient Management Plans and soil tests.
- Pesticide applications based on Integrated Pest Management systems that monitor pests rather than using preventative sprays.
- Reduced use of chemicals in general that requires more production monitoring by management.
- Some farms have committed to organic or non-chemical production systems, frequently because of a lifestyle commitment.

Case Study Highlights

Case studies were conducted to see how individual farms have responded to environmental issues and if their commodity choice influenced their approach to environmental awareness. Five case studies were completed including:

- A mixed livestock operation that will begin processing their product for direct sales in the near future.
- A dairy farm that has developed their operation so that they produce virtually all of their feed.
- A large horticultural business with a variety of crops.
- A relatively large beef feeding operation that has a substantial land base.
- A mixed farm with a significant tree fruit component.

The case studies supported the previous information gathered. Farmers are aware of environmental issues in all aspects of their business. Capital investments are designed to comply with environmental regulations and, frequently, to reduce impacts, such as odour and noise, on neighbours. Management systems and decisions are made in such a way that they will not harm the environment, although many farmers have internalized the realities of environmental changes and do not realize that environmental impacts subconsciously enter their decisions.

While investments and management systems reflected the type of commodity produced, the level of awareness of environmental issues did not appear to vary by type of farm. Livestock farmers were more aware of manure issues and crop farmers appear to be more aware of pesticide impacts; however, all have a broad understanding of environmental issues and acceptance of the changes that they have made to their farms over the years in response to changing environmental regulations and expectations.

Summary

The results of the analysis of Component I provide interesting information about the interface between farmers and the environment. Farmers recognize the value of protecting the environment for themselves as rural residents, for their industry, their community and society as a whole. They make management and investment decisions that reflect their environmental attitudes and accept that these activities are necessary. Many farmers have internalized this changed way of doing business, as compared to farming 30 years ago, and do not even realize it when they incorporate environmental issues into their decisions. Generally, farmers do not make investments because they benefit the environment. They make investments because they are good business decisions. However, some investments do not have a direct impact on revenue, expense, or production, such as stream crossings, and are made because of changes in environmental regulations.

The results of this portion of the study support the agricultural industry's position that they are good stewards of the environment and conduct their businesses to the benefit of society in general as they relate to the environment.

Component II: Development of a Pilot Program for the St. Andrews Watershed

The objective of Component II is to deliver a pilot project to enhance the designated Watershed through delivery of EG&S by farm units within the Watershed. This model will serve as a guide to enhance other designated watersheds areas while maintaining agricultural activity in those watersheds.

The primary agriculture industry's approach to environmental issues frequently reflects the geographic reality in which it operates. For example, the Alternative Land Use Services (ALUS) pilot project being delivered by Keystone Agricultural Producers in the Blanshard area of Manitoba is designed to provide incentives for alternative uses for land in environmentally sensitive areas. While a valid approach in many provinces and regions, Nova Scotia agriculture must operate in a province whose geography makes this an inappropriate option to deliver EG&S.

Nova Scotia has a relatively small farmland base with pockets of fertile soil dispersed throughout the province, many of which are close to, or operate in, environmentally-sensitive areas such as watersheds. The St. Andrews River Watershed, the drinking water resource for the Town of Stewiacke, is a good example of this feature of Nova Scotia agriculture. It is a relatively settled area within one-half hour of Metropolitan Halifax, but has vibrant and varied agriculture activities within the Watershed boundaries. Farms within the Watershed include lifestyle and hobby farms as well as part-time farms that raise livestock and crops for a significant part of their income, and commercial farms, including dairy and beef operations.

However, many of the smaller part-time and hobby farms have not taken part in EG&S activities because they either are not aware of the programs or they cannot take advantage of them for a variety of reasons (e.g. scheduling conflicts, lack of financial resources, farm sales below threshold amount that qualify for assistance). These small farm operations have the potential to create an impact on the environment as significant as larger farm businesses and any environmental damage resulting from these small farms will reflect negatively on the Nova Scotia agricultural industry as a whole. This component is designed to ensure that every agricultural unit in the designated St. Andrews Watershed has the opportunity to provide the community with the same quality of environmental stewardship as larger farm businesses. This approach is designed to maintain and enhance environmental stewardship in designated areas based on prevention of environmental incidents rather than remediation after a problem occurs.

Methodology

A pilot project committee with membership from the Town of Stewiacke, Municipality of the County of Colchester, the St. Andrews Watershed Committee, Agriculture and Agri-Food Canada, Colchester County Federation of Agriculture and NSFA was established to lead the pilot project as a subcommittee for this project component. Project development approach included:

- Identification of the agricultural landowners in the St. Andrews Watershed boundaries.
- A program to visit each of the landowners prior to any public announcement of the pilot project to counter misunderstandings about the project's purpose.
- A communications program was developed for the general public.
- Program details were developed for funding on-farm activities.
- Fliers describing the program were delivered to all agricultural landowners in the Watershed and a series of "kitchen meetings" were held to discuss the project.
- EFPs were completed for all farms that chose to take part in the project.
- Projects were completed on the farms and inspected by representatives of the Nova Scotia Department of Agriculture prior to payment of costs.
- A follow-up survey was delivered to all agricultural landowners in the Watershed and committee members were surveyed for their opinions, including methods to improve future projects of a similar nature.

Program Development

Program Objectives

The objectives of the program were to identify environmental risks from current farm practices and encourage farmers and landowners to undertake beneficial management practices (BMPs) to address the risks. The goal was to enhance riparian zones and protect water quality (primary concerns) and to improve farm environmental performance in the areas of manure and product handling and storage, soil erosion, and wildlife habitat and biodiversity (secondary concerns).

Program Funding

Funding for beneficial management practices was based on the federal/provincial cost-share model available through the Province of Nova Scotia's Farm Investment Fund under the Canada-Nova Scotia Farm Stewardship Program. The program was delivered on a "first come, first served" basis, taking into account the priorities that had been established and the time frame within which the program had to be delivered.

Incentives for Farmers and Landowners

Cost-shared funding was made available to undertake beneficial management practices. All work had to be completed by December 31, 2008 and claims for eligible expenses received by January 31, 2009. Where applicable, it was the responsibility of the farmer/landowner and EFP coordinator to ensure appropriate permits and authorities were in place before work began. Assistance levels ranged from 50% to 100% of cost depending on whether the investment was a secondary or primary environmental concern.

Program Categories

There were six program categories within which projects qualified for funding assistance. Project activities had maximum dollar caps depending on the environmental importance of the category within which the activity fell and normal costs for the investment. Categories and activities included 1) Riparian Area Management, 2) Water Quality Protection, 3) Water Well Management, 4) Septic Systems, 5) Product and Waste Management, and 6) Enhancing Wildlife Habitat and Biodiversity.

Program Delivery

A senior EFP coordinator took part in all aspects of program development and delivery, met with all agricultural landowners in the Watershed, coordinated other environmental specialists as required, and supervised other EFP staff that took part in the project.

Landowners were provided with information in a variety of formats, including general press releases, hand-delivered announcements and project pamphlets, individual visits, and small group meetings held in various locations.

Landowners who chose to take part in the program contacted the EFP coordinator. An EFP was then completed for the farm property based on the model developed by the NSFA and in general use within the provincial agricultural industry, which includes a visit by the NSDA agricultural engineer. An EFP report was completed and delivered to the landowner. The landowner then completed an application for funding under the pilot program. The application was reviewed by the EFP coordinator to ensure that it met the requirements of the program and reflected issues identified in the EFP report. All projects that required a review under the federal government's Canadian Environmental Assessment (CEA) Act went through a CEAA-equivalency review consistent with the current provincial-federal arrangement. All permits necessary to complete construction were acquired and confirmation supplied to the EFP coordinator. Projects were inspected by representatives of the Nova Scotia Department of Agriculture who provide the same function for the provincial Farm Investment Fund program upon completion of the project. Payments from program funds were made upon inspection approval.

Pilot Project Results

Forty-one (41) agricultural landowners were identified in the St. Andrews Watershed of which six (15%) applied for funding under the program. These landowners completed 16 projects for a total cost of $40,766. Activities completed included:

- One farm fenced livestock away from a waterway.
- Three farms installed approved stream crossings.
- Three farms installed alternate water sources for livestock on pasture.
- Two farms completed projects to control farmyard runoff.
- Three farms built improved manure storage.
- One farm took advantage of water-well management.
- Three farms had septic tank maintenance completed.

Lessons Learned

Participation by agricultural landowners in the St. Andrews Watershed was disappointing. It had been hoped that at least one-third of the landowners in the Watershed would take part in the project. However, the purpose of a pilot project is to gather information on developing successful programs, and follow-up surveys and interviews were conducted in an attempt to identify weaknesses in project development. Issues identified included:

- Project timelines were relatively short because of funding requirements. The program had to be developed and delivered within 18 months. This tight schedule did not allow the project to mature. The first six farms may have been seen by other landowners as the test farms – "… if it works for them, I will give it a try". The EFP coordinator has been contacted by other landowners since the project was completed to find out if it will be offered in future. The lesson to be learned from this is that programs to assist small farms in Watersheds to take proactive steps to protect the environment have to have a longer term of at least three years. This allows time to develop and deliver a communications campaign that is effective in increasing awareness of both agricultural landowners and the general public.
- Small farms that are not active in the agricultural industry are not familiar with programs and how they work. As a result, a dedicated effort has to be put forward to educate them on project objectives, benefits, design, and steps to complete a project on their farm. The landowner survey, and discussions that the EFP coordinator had with landowners, indicated that many of these people do not consider that they are part of the agricultural sector, even though they identify themselves as living on a farm. As a result, they do not recognize the potential impact their activities could have on the environment. The lesson learned is that a good communications campaign needs to address this issue.
- No one involved with the development of this project recognized the time demands that it would place on personnel delivering the project, in particular EFP staff. As noted above, many lifestyle farmers are unfamiliar with projects and required assistance in every step of the program, including applying for funding, securing permits, and coordinating the work completed on their farms. Also, landowners frequently had to be educated in basic agricultural and environmental concepts. The lesson learned is that future programs to deliver EG&S programs to non-traditional farmers should have dedicated staff (at least a part-time person with environmental knowledge).
- It is important to identify any issues in a Watershed that may become barriers to project acceptance by the landowners. Over the last several years the Town of Stewiacke developed a Watershed plan to govern activities within the Watershed and protect water quality. Significant misunderstandings and ill feelings were generated in the early part of the Watershed plan development. Also, most residents of the Watershed are not within town boundaries but live in the Municipality of the County of Colchester and do not use water from the town's system. These features created some conflict and ill feelings around the Watershed plan development that appear to have had an impact on landowners' attitudes toward this pilot project. Comments were made to the EFP coordinator by landowners that they did not want to take part because the Town of Stewiacke was a partner in the process, even though Council has changed since the commencement of Watershed planning and most concerns were dealt with during development of the plan. The lesson learned is that identification of these types of issues will impact program delivery and communications so that they mitigate barriers to program acceptance.

Summary
The objective of this project was to design a program that will offer assistance to all farmers in a designated Watershed to take necessary actions to protect the environment. The nature of a pilot project is that it tests methods so that challenges and weaknesses can be identified in order for later programs to be effective and efficient in meeting objectives.

While participation levels in the project were lower than expected, it appears that other agricultural landowners would be interested in taking part if funds were available to continue the program beyond the one-year time frame available. Participants who responded to the survey were very happy with the project and indicated that it was beneficial to their farms.

Lessons were learned about the nature of the agricultural landowners targeted by this project regarding the difficulties of delivering programs to this group – the small hobbyist or lifestyle farmers. Also, sixteen projects were completed that will reduce threats to the environment in the St. Andrews Watershed and that can be used as models for other Nova Scotia Watersheds and watersheds in densely populated areas of the country as a whole.

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Lower Souris Watershed
Ecological Goods and Services Pilot Proposal

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Executive Summary

Currently, various Ecological Goods and Services (EG&S) are produced from Canadian agricultural landscapes. Private landowners act as the stewards of these land resources and as such have been responsible for the provision of various EG&S products. There are currently defined markets for many of the Ecological Goods produced from modern agriculture. These lands also produce various Ecological Services that do not have established markets. The provision of wildlife habitat by private landowners is one such scenario where no current value or market has been established for the provision of an Ecological Service.

The Lower Souris Watershed Committee Inc., with the financial assistance of the Advancing Canadian Agriculture and Food (ACAAF) program, have undertaken a policy/research project designed to explore how EG&S tools could be used to achieve desired environmental endpoints in an agricultural landscape. This project included three distinct components: develop local landscape targets for the quantity and quality of wildlife habit; determine the costs borne by producers to provide wildlife habitat; and explore which EG&S policy tools could achieve the locally developed landscape targets for wildlife habitat.

The need for a detailed inventory of the project area was paramount to the successful development of locally determined landscape targets for both quantity and quality of wildlife habitat. By including local landscape knowledge and personal values with appropriate biological science, achievable landscape targets were established. When determining the associated costs borne by agricultural land owners to provide wildlife habitat, it is very important that an appropriate model that utilizes relevant regional inputs be developed. To encourage the maintenance of the EG&S of wildlife habitat, provision of payment programs to private landowners will be required. Successful development of these programs will be extremely complex due to the dynamic relationship between the agricultural landscape and the evolving business of agriculture.

Project Background & Rationale for Investigation

Historically, the Lower Souris River Watershed was dominated by fescue grasslands and aspen parkland. Many riparian areas have been eliminated or diminished to narrow corridors along the tributaries, streams and rivers. Typical agricultural crops include cereals, oilseeds and pulse crops. Livestock production, largely beef cow-calf operations are also significant in the area. While agriculture has had a significant impact on altering the landscape of the region, the landscape continues to provide diverse Ecological Goods and Services that are important to society. Private landowners currently act as the stewards of the landscape, and are responsible for the provision of functional wildlife habitat as part of their regular business practices. As agricultural markets continue to evolve, there have been increased economic pressures for landowners to convert natural wildlife habitat acres to agricultural production acres.

The Lower Souris Watershed Committee Inc. (LS) is a group of rural municipalities, towns and conservation groups in the extreme corner of south eastern Saskatchewan. The LS has completed a source water protection plan for the Pipestone, Antler and Four Creeks watersheds in March 2006. LS was incorporated in 2005. However, members have been working on watershed planning since 1999, as members of sub-committees of the three above-mentioned sub-watersheds. Forty-nine representatives of municipalities and local conservation groups sit as representatives of the three sub-watershed committees. Each of the chairpersons of the sub-watershed committees and a representative from the Provincial Council of Agricultural Development and Diversification Boards (PCAB) sit as members of the overarching Lower Souris Watershed Committee. The vision of the LS is, “balancing the economic, environmental, and social values to sustain and improve the watershed for future generations.”

In 2006, the LS submitted a proposal to the national Advancing Canadian Agriculture and Food program to develop a pilot ecological goods and services (EG&S) project. The Lower Souris EG&S proposal consisted of a policy/research project conducted by a grassroots watershed group to aid the development of EG&S policy at the national scale. The project resulted in a case study of how EG&S tools could be used to achieve desired environmental endpoints in a working agricultural landscape. Three distinct steps were required for this process:

- Set specific landscape goals for the quality and quantity of wildlife habitat in the Lower Souris Watershed using a local co-management framework;
- Determine the net costs borne by agricultural producers in the Lower Souris to provide targeted quality and quantity of wildlife habitat;
- Conduct a policy analysis of EG&S tools to achieve specific landscape goals for the quality and quantity of wildlife habitat in the Lower Souris Watershed.

Achievable, realistic and sustainable project outcomes were expected by involving watershed residents in the development of local wildlife habitat targets, performing economic analysis using regional agricultural information, and including watershed residents in the development of program recommendations.

Objectives

There were three distinct yet interconnected objectives established at the onset of this project. Each distinct objective was integral to the success of the entire project. The first objective was to determine specific landscape goals for the quality and quantity of wildlife habitat in the Lower Souris Watershed. This objective required two main components: a detailed inventory and setting wildlife habitat targets for the watershed landscape. An extensive inventory of all riparian, aspen parkland and tame grassland wildlife habitat in the Lower Souris watershed needed to be completed. This step was necessary to properly set landscape goals and explore the implications of EG&S policy of the case study. Secondly, specific landscape goals needed to be established using a co-management framework. Landscape goals needed to be set by local watershed representatives using the best available science, while considering the goals of wildlife habitat agencies.

Secondly, there was a need to determine the net costs (or lack thereof) borne by agricultural producers in the Lower Souris to provide the targeted quality and quantity of wildlife habitat in the Lower Souris Watershed. Local historical land use data from an extensive network of producers involved with the LS needed to be collected. This data, in combination with agricultural census data, was utilized by researchers at the University of Alberta to model the actual net costs borne by producers to provide wildlife habitat.

The third project objective was to conduct a policy analysis of the various EG&S and non-EG&S tools to achieve specific landscape targets for the quantity and quality of wildlife habitat in the Lower Souris Watershed. The results of the previous objectives were to be utilized by members of the LS and a University of Saskatchewan researcher, who specializes in bio-resource policy, business and economics, to present options for EG&S policy in the Lower Souris Watershed.

Funding and Partnerships

The overall success of this project was dependent upon the strong partnerships that were fostered and established during the life of this project. Local municipal and individual participation was vital to ensuring that the local perspective was represented for the duration of the project. Collaboration from provincial and federal government organizations such as the Saskatchewan Watershed Authority (SWA), Prairie Farm Rehabilitation Administration (PFRA) and Ducks Unlimited Canada (DUC) were integral to project design and implementation. The partnerships that were fostered with the research teams at the Universities of Alberta (U of A) and Saskatchewan (U of S) were paramount to the successful exploration of local concepts and analyzing project data. The major financial funding for this project was provided by the Advancing Canadian Agriculture and Agri-Food (ACAAF) program, administered by Agriculture and Agri-Food Canada. The local residents, municipalities, SWA, DUC, and partnering Universities all provided personal resources or additional financial support toward the successful completion of this pilot project. By engaging a broad representation of our watershed community, we were able to accomplish what this project set out to achieve.

Methods and Implementation

The project was designed to achieve three distinct project goals. The overall project results were dependent upon the successful completion of each of these individual goals.

Determine specific landscape goals for the quantity and quality of wildlife habitat in the watershed using a local co-management framework

In order to focus the project, we divided the target setting exercise into quantity and quality of wildlife habitat. A detailed inventory of the existing landscape, in addition to a co-managed target setting exercise, was required to determine the local targets for quantity and quality of wildlife habitat.

Quantity of wildlife habitat in the watershed

To achieve this specific project outcome there was a need to break this into two distinct steps: a detailed inventory of the current level of wildlife habitat within the watershed and a co-managed determination of local wildlife habitat targets for the watershed landscape.

The detailed inventory was performed by qualified project partners at DUC, following an agreement to jointly develop a comprehensive land cover inventory for the Lower Souris River Watershed (LSRW). Within this agreement, DUC assumed responsibility for the production of a high resolution biophysical inventory to quantify the abundance and distribution of aquatic and terrestrial habitats across the LSRW. These baseline data would serve as the primary information source for the broader project.

Within this agreement, a basic framework of project governance was established. LS struck a steering committee of technical experts from partner agencies, SWA and the Prairie Farm Rehabilitation Administration (PFRA) to develop and approve functional requirements, project specifications, and project deliverables required for the broader EG&S project. DUC assumed responsibility for the production aspects of the project such as: project management, procurement selection, quality assurance processing, and documentation of final deliverables (Boychuk, 2009). Within the project governance structure, the technical advisory group provided guidance on a number of issues that arose during the project lifecycle. Decisions affecting project scope were vetted through the technical advisory group before they were implemented.

The scope of the project included the photogrammetric mapping of Lentic Wetland features utilizing existing collection, quality assurance, and geoprocessing protocols developed by DUC on similar projects across Prairie Canada. Additionally, DUC (in conjunction with external experts) developed and applied similar procedures for mapping the lotic areas within the watershed using photogrammetric techniques and procedures. Finally, DUC remote sensing experts utilized SPOT 5 multispectral imagery with object-oriented image analysis techniques to characterize the terrestrial portion of the watershed. All base data were integrated into a number of data deliverables required to meet project objectives.

The co-managed determination of local targets for quantity of wildlife habitat involved a process that engaged the local watershed representatives to infuse local knowledge, personal values and interests with science-based information regarding the relationship between habitat quantity and wildlife abundance. The wildlife abundance models developed by White (2007) were presented to watershed representatives. Participants were encouraged to express their personal values and concerns surrounding land use management and associated provision of wildlife habitat. Using all of the information available to them, local watershed representatives developed collaborative wildlife habitat quantity targets for the watershed area.

Quality of wildlife habitat in the watershed

In order to establish locally determined targets for the quality of wildlife habitat within the LSRW, a two-phase exercise was utilized. The first phase was to determine the current state of the various wildlife habitat types within the watershed area. The methods chosen to accomplish this were rangeland health and riparian health assessments. These assessment protocols evolved out of range management science to assess the ability of ecosystems to perform essential ecosystem functions. These techniques use a variety of biotic and abiotic measurements to determine the extent to which a riparian area is performing filtration, sediment trapping, biomass production, erosion control and groundwater recharge (Adams et al., 2005). These assessments are generally performed by a walk-through assessment and ocular estimates of key site indicators. This is an efficient sampling method and is a good indicator of land management impacts on a site. Each indicator is given a score, and scores are summed to give a total percent health. Based on this total, sites are described as either: healthy, healthy with problems or unhealthy.

Many of the variables gathered in range and riparian assessments are good correlates of habitat structure for wildlife. For example, range condition (a component of range health) was found to be a predictor of habitat quality for grassland songbirds in Saskatchewan (Davis, 2005). Warren (2004) found that range health was a good predictor of habitat quality for waterfowl in east central Alberta. In general, healthy rangeland and riparian areas will have tall structure, heavy cover and little bare ground. Unhealthy rangeland and riparian areas will typically have low habitat structure. It is important to note that wildlife species' preference for high or low habitat structure is variable, and it may be desirable to have a variety of habitat structure on the landscape (White, 2007). A health assessment technique does not currently exist for cropland, so cropland habitat was classified as cereal, oilseed or summer fallow. The second phase in determining local landscape quality goals involved engaging local watershed representatives to infuse local knowledge, personal values and interests with science-based information regarding the relationship between wildlife abundance and habitat quality. Watershed representatives were presented with the wildlife abundance models developed by White (2007) as a portion of this project. Using all of the information available to them, the local watershed representatives collaboratively developed wildlife habitat quality targets for the watershed area.

Determine the net costs borne by agricultural producers in the Lower Souris to provide targeted quality and quantity of wildlife habitat

In order to develop a meaningful model that would simulate the costs associated with the provision of wildlife habitat by landowners within the Lower Souris Watershed area, local producers were surveyed regarding their historical land use practices (Entem et al., 2009). The specific purpose of the survey was to collect information on the provision of wildlife habitat in many different farm settings. Rather than interviewing producers regarding their land practices on a farm-wide basis, producers were asked to provide management information regarding a piece of their land that is managed as a unit. The interview was designed to collect information on fields where wildlife habitat has been “lost”, “maintained” or “enhanced” through farm activities. The survey was divided into three primary sections: identifying wildlife habitat and costs of conversion; identifying inputs, operations and production from cropping enterprise; and identifying inputs, operations and production from grazing and haying enterprise. This information in conjunction with varying crop prices, beef prices and weather trends was used to simulate a representative mixed farm from the project area. This farm was representative of mixed farms within the Lower Souris River Watershed with 116-head cow beef herd, 960 acres of annual crop production and 960 acres of hay, tame pasture and native pasture. A stochastic simulation farm model was developed (Dollevoet et al., 2009) to estimate the benefits or costs of implementing various Ecological Goods and Services (EG&S) scenarios at the farm level using net present value (NPV) analysis. NPV is a measure of farm wealth in these models.

Three general scenarios were modeled in this study to estimate the benefits or costs to the farm. These scenarios were defined as follows:

- landowner maintains habitat rather than converting this habitat to cropland, either by draining wetlands or clearing bush;
- landowner converts cropland to tame grass, through converting a whole field which increases EG&S;
- landowner reduces grazing pressure on pasture lands, through a lower stocking rate or by adding cross fencing and off-stream watering.

It is recognized that representative farm modeling results are highly sensitive to model assumptions about costs, production and output prices. The base model uses input costs from 2005, although some alternative scenarios using an average of 2007 and 2008 input costs and output prices were presented.

Conduct a policy analysis of EG&S tools to achieve specific landscape goals for the quality and quantity wildlife habitat in the Lower Souris Watershed

In general, EG&S 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. We set out 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.

An analysis based on land cover data, at the quarter section scale, was performed on a sample of 3 Rural Municipalities within the Lower Souris watershed, Belcher (2009). It was recognized that opportunity costs would be variable from farm to farm, and even from field to field. An indicator that was used as a partial proxy for these costs was the land assessment value for each quarter section. The magnitude of the land assessment value corresponds to the relative productivity of the land, and was used to represent the opportunity cost of the land.

Following a consultation process that reviewed the overall project information, the local watershed representatives formulated final policy recommendations that would aid in achieving the determined landscape targets for wildlife habitat within the project area. While developing these policy recommendations, the representatives were asked to consider the following five questions:

- Are the initial targets realistic?
- Is the recommended program achievable and practical?
- Will the program be socially acceptable?
- Is this recommendation fiscally responsible?
- Does this type of program promote unintentional actions?

Project Results

Specific landscape goals for the quantity and quality of wildlife habitat in the watershed using a local co-management framework

Establishment of targets towards the quantity and quality of wildlife habitat within the Lower Souris Watershed area followed an informative process that engaged local watershed representatives to express individual ideals and values in addition to consideration of scientifically pertinent information.

Quantity of wildlife habitat in the watershed

At a meeting held on April 4, 2008 initial wildlife habitat targets for the watershed were established. Members were presented the wildlife abundance models developed by White (2007). By infusing local knowledge, personal values and interests with the information produced by the report produced by White (2007), members were to develop the initial wildlife habitat quantity targets for the watershed area.

Over the course of this exercise, numerous goals and values were brought forward for consideration by the group members. The group emphasized that the landscape needs viable industries that generate economic outputs in conjunction with providing sustainable wildlife habitat. An appropriate balance of industry and environment is needed to sustain quality of life and natural resources. Along with these points, the group wanted to ensure that EG&S programs would encourage the maintenance of natural resources while improving land management practices and promoting economic activity within the region.

Considering all of this information, the watershed representatives were then asked to develop locally set targets for the portions of the watershed they wanted to be in the following habitat classes: Lentic Riparian, Lotic Riparian, Perennial Forage, Native Grasslands, Aspen and Crop (Figure 1).

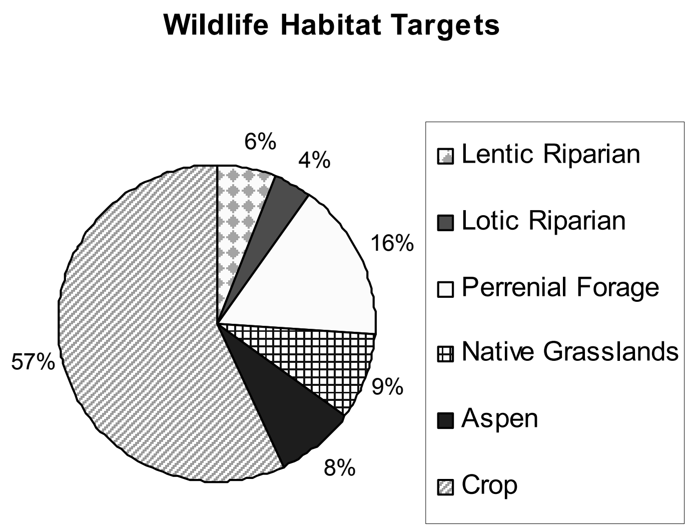

Figure 1: Landscape type targets towards the provision of wildlife habitat within the Lower Souris Watershed.

The results of the detailed inventory (Figure 2) that was performed by DUC (Boychuk, 2009) were presented to the watershed representatives collectively on February 25, 2009.

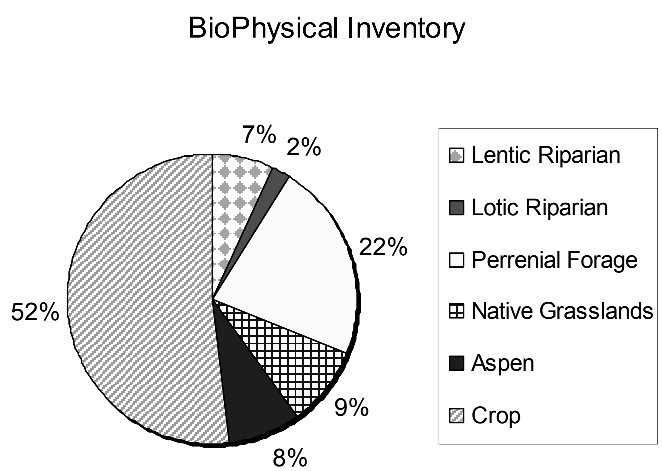

Figure 2: Landscape types as determined by DUCS detailed inventory of the Lower Souris Watershed.

Members discussed the results of the biophysical inventory. Upon review of this information, the watershed representatives were to determine if they wanted to adjust any of the initial wildlife targets that they had established. The group reached consensus that the wildlife habitat quantity targets that they previously determined were achievable, responsible and realistic. The watershed representatives were astonished by how closely the bio-physical inventory conducted by DUC mirrored the landscape targets that they had established. They noted that there is a portion of agricultural lands that will adapt between perennial forage and annual crop in response to fluctuating agricultural markets.

Quality of wildlife habitat in the watershed
At the target setting meeting hosted on April 4, 2008, watershed representatives were introduced to the concepts of range, riparian and forest health assessments as discussed in Soulodre (2008). They were then asked to develop targets for the state of habitat quality within the watershed for the following land classes: Lentic Riparian, Lotic Riparian, Perennial Forage, Native Grasslands, and Aspen (Table 1).

Table 1: Wildlife habitat quality targets for the Lower Souris Watershed.

	HEALTHY	HEALTHY WITH PROBLEMS	UNHEALTHY
PERRENIAL FORAGE	30%	63%	7%
NATIVE GRASSLANDS	36%	57%	7%
ASPEN	42%	53%	5%
LOTIC RIPARIAN	75%	22%	3%
LENTIC RIPARIAN	67%	23%	10%

Habitat quality assessments were performed across the entire watershed by the Lower Souris Watershed (Soulodre, 2008). The compiled results of these 379 individual health assessments are presented below (Table 2).

Table 2: Summary of health assessments in the Lower Souris River Watershed.

ASSESSMENT TYPE	# OF ASSESSMENTS	AVERAGE % HEALTH
NATIVE GRASSLANDS	62	33
PERRENIAL FORAGE	78	73
ASPEN	42	39
LOTIC RIPARIAN	79	73
LENTIC RIPARIAN	118	75
	379	

The data from these 379 individual site assessments was reviewed and compared to the Wildlife Habitat Quality Targets that had previously been determined by the watershed representatives (Table 3).

Table 3: Results of detailed wildlife habitat quality survey for the Lower Souris Watershed.

	HEALTHY	HEALTHY WITH PROBLEMS	UNHEALTHY
PERRENIAL FORAGE	46%	49%	5%
NATIVE GRASSLANDS	2%	18%	80%
ASPEN	5%	29%	66%
LOTIC RIPARIAN	28%	62%	10%
LENTIC RIPARIAN	41%	41%	18%

The watershed representatives were collectively gathered on February 25, 2009 to discuss the results of the wildlife habitat quality survey. Upon review of this information, the group recognized that the results of the wildlife habitat quality survey did not align well with the quality targets that were established. They chose not to alter the initial targets due to belief that the quality targets established are achievable, responsible, realistic, and will have a benefit to the long term sustainability of agricultural enterprises.

Net costs borne by agricultural producers in the Lower Souris to provide targeted quality and quantity wildlife habitat

The producer survey results were compiled from a total of 87 distinct parcels of land operated by 62 individual farms totaling 154,980 acres (Entem et al., 2009). The farms surveyed by the Lower Souris Watershed Committee averaged 2,626 acres. On average, a farm would manage 1,616 acres of annual cropland. 40 of the 62 farms (65%) manage livestock. Among those 40 farms, the size of the livestock operation varied between 39 animals and 882 animals. The surveyed farms contained an average of 483 acres of tame forage that could be used for haying, grazing or a combination of the two. The farms also averaged 640 acres of native land that could be used for livestock production. On the 87 units of land surveyed, annual cropland made up the largest percentage of land use during 1998-2008. Tame forage occupied the second largest percentage of land, and Aspen Parkland and riparian areas were the third most common land uses. Many producers in the area often stated economic reasons for their current land use division. Even ecological reasons (productive capacity of the soil, poor cropping soil, light soil etc.) often had an economic basis.

In order to understand the biophysical and economic results of implementing practices that promote EG&S, development of a working simulation model (Dollevoet et al., 2009) was required. This model would define all the basic working relationships within a representative farming operation. The representative farm was developed based on expert opinion and data from the 2006 Canadian Census of Agriculture.

The model predicted outcomes for the three defined EG&S scenarios at the farm level. It was determined that converting riparian habitat to annual cropland provides significant positive benefits to the farm. The model suggested that the benefits may be in the range of $70/acre/year for each acre converted. However, if the riparian areas are already being used for grazing, converting riparian areas to pasture would not benefit the farm, resulting in a net cost of -$38/acre/year for each acre converted. The additional grazing capacity after conversion is not sufficient to offset the costs of conversion from riparian habitat to pasture. Converting forested habitat to either annual cropland or pasture provides a significant positive benefit to the farm if the converted acres have similar productivity to the adjacent cropland.

The net benefits to the farm of converting existing annual cropland to tame pasture or hay is highly dependent upon annual crop prices (e.g. canola, wheat, barley) relative to calf prices or the price of tame hay. Under the model scenarios evaluated, there may be a small benefit to the farm to convert more crop land to pasture. However, due to the relatively lower market price for hay in the model, the net cost of converting annual cropland to hay land would be -$49/acre/year of land converted.

Management of existing farm resources such as native pasture and tame pasture carrying capacities are important to the financial health of the business. If the pasture is in a reduced carrying capacity, strategies to improve the grazing capacity can be implemented. For example, the farm could decrease stocking rates under the assumption that pasture forage production would then increase over time. The economic outcome of this strategy is highly dependent upon how quickly the grazing capacity improves. Adding cross fencing and off-stream waters (e.g. rotational grazing) can provide a small economic benefit to the farm if it results in improved forage production of at least 1%/year for six years. If management practices are combined with cross fencing and off-stream water such that forage production can be increased by 7% or more, then these investments may have a positive economic impact on the representative farm.

Policy analysis of EG&S tools to achieve specific landscape goals for the quality and quantity wildlife habitat in the Lower Souris Watershed

The watershed representatives were provided background information on the various policy tool classifications that may be used to increase the quantity and quality of EG&S provided by agriculture. In general these EG&S policy instruments were categorized as either regulatory approaches, economic instruments, market measures or advisory and institutional measures. The watershed representatives decided that economic instruments were the most viable policy alternative in order to achieve the determined landscape targets. As such, the analysis provided by the University of Saskatchewan focuses upon the efficacy of such a program in the Lower Souris Watershed area (Belcher, 2009).

For the purpose of this project, three representative Rural Municipalities within the Lower Souris Watershed (Silverwood, Reciprocity and Storthoaks) were studied. Project results show that, for an extensive program of converting approximately 350,000 acres of annual cropland, grass and aspen to perennial forage within the study area, will require in the range of $0.75 to $1.25 million in annual payments. A more moderate program of converting 95,000 acres of annual cropland to perennial forage will require from $240 to $390 thousand in annual payments. 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 policy analysis provides support for targeting lower value land in habitat programs, for both economic and ecological good and service reasons.

The complete project information was reviewed with the local watershed representatives and they were tasked to develop final policy recommendations. The watershed representatives concluded that it is evident that if the current level of wildlife habitat is to be maintained within the Lower Souris Watershed there is a need for annual payments to be made across all landscape types. These annual payments need to align with the opportunity costs borne by the individual landowner who continues to provide EG&S. It was discussed that these payments will not only have a positive effect on the current quantity of wildlife habitat, but there may be a positive shift in the associated quality of these areas.

Conclusions

It must be understood that agricultural land and wildlife habitat are not separate and mutually exclusive entities. Agricultural practices have varying effects on wildlife habitat provision. In order for realistic, achievable, responsible and sustainable targets for wildlife habitat to be established for local landscapes, broad representation of all affected individuals and organizations need to be involved in the establishment of these values. Landscape targets need to consider local knowledge, societal goals, relevant biological science and individual values. Paramount to the success of developing local landscape targets is the requirement to have a detailed bio-physical inventory that acts as the benchmark to measure future landscape changes.

The economic conclusions regarding EG&S farm level costs and benefits in the Lower Souris region are mixed. Farms generally have clear market incentives to reduce EG&S habitat (i.e. riparian or forested) when this land can be converted to production of annual crops (Dollevoet et al., 2009). In the case of forested land there is also a positive economic benefit to convert this land to pasture. Adding cross fencing and off-stream watering sites provides an economic benefit to the farm only if the associated pasture management changes (i.e. improved rotational grazing) lead to significant increases in the carrying capacity of the native and tame pasture.

It is evident that if the current level of wildlife habitat is to be maintained within the Lower Souris Watershed, there is a need for annual payments to be made. Developing an EG&S program that will effectively address the ever-evolving business of agriculture and the ever-changing landscapes where agriculture is practiced will be extremely difficult and complex.

Future Considerations

As the discussions surrounding EG&S evolve, it needs to be recognized that the continued reliance upon landowners to be responsible stewards of ecological services that hold undefined market values is an unsustainable policy. EG&S are as highly variable as the ecosystems that provide them. Regional and ecosystem-based programs need to be developed. Therefore, scaling up of policy recommendations for the Canadian agricultural landscape should be done with caution. In addition, in the absence of detailed, spatially referenced information, implications of EG&S program scenarios can only be predicted based on general trends of land cover and, as such, will not precisely reflect the landscape. EG&S programs need to recognize that there are opportunity costs associated with alternative land use practices, in order to be effective.

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Investigation of the Use of the Environmental Farm Plan (EFP) as an EG&S Management and Policy Development Tool

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Executive Summary

An Environmental Farm Plan (EFP) is an awareness document to help agricultural producers to assess environmental risks on their farm through risk assessment questions and to identify corrective actions to ensure the sustainability of their farm operations. The EFP does however also identify beneficial management practices or BMPs that are the positive actions a producer may undertake or have already implemented. In many situations these actions or BMPs may actually contribute to the creation of Ecological Goods and Services (EG&S).

Through this pilot project, the Eastern Canada Soil and Water Conservation Centre (ECSWCC) proposed to solicit the assistance of innovative producers, EFP and Agri-Environmental Club coordinators, and interested stakeholders throughout the province to evaluate and attempt to use the EFP as a management and policy development tool for Ecological Goods and Services within New Brunswick.

Due to the nature of the NB pilot project, the creation of a project Advisory Committee and a Technical Working Group was instrumental for project implementation. Both groups were instrumental in developing the list of EG&S that might be produced on NB farms and in the development of guiding principles. The active participation of all TWG members in the EFP question screening exercises identified a highly defendable list of 49 EFP questions and BMPs that have potential to provide EG&S in New-Brunswick.

This pilot project has demonstrated that the Environmental Farm Plan can be used as an EG&S program management and policy development tool. However, it is imperative that the EFP assessment questions go through a thorough screening and on-farm testing process to identify measurable or verifiable BMPs with potential to provide EG&S on the farm.

The consultation sessions and presentations made at various producer annual general meetings clearly demonstrated that producers are highly interested and in favour of using the EFP as an EG&S program management tool. This will allow them to identify their farm’s potential for delivering EG&S while they complete their EFP assessment.

Background & Rationale for Investigation

One of the ultimate targets of the Canadian Agricultural Policy Framework was to see every farm across Canada implement an Environmental Farm Plan, commonly known as an “EFP”. These EFPs are seen as a way for agricultural producers to review all their farming practices in order to identify corrective actions and ensure the sustainability of their farm operations.

Ontario has been at the forefront of the EFP development and implementation in Canada. They developed their EFP in the early 1990s, in part, by building upon the US Farm*A*Syst concept. The Atlantic provinces adapted the Ontario version to meet their needs in the mid 90s. The implementation of the EFP process began in New Brunswick and Prince-Edward-Island in 1996.

Since those early days, the EFP has been modified and refined, and has evolved into a broad and thought-provoking look at farm operations. The latest version, which was developed by the Eastern Canada Soil & Water Conservation Centre (ECSWCC) and released in late 2004, is an enhanced detailed workbook of 326 risk rating assessment questions contained within the 22 distinct sub-sections of 4 sections (Table 1). The latest version was developed to evaluate agricultural practices with respect to sustaining or improving water quality, air quality, soil quality, wildlife habitat and biodiversity. A software version of the new EFP was also produced by the ECSWCC.

Table 1: The Atlantic environmental farm plan structure (see Appendix 4).

♦ 4 sections ♦ 22 subsections ♦ 326 questions

Farmstead & Homestead section *(subsections and # of questions in subsection)*

1. Farm Management (7)
2. Water wells (10)
3. Petroleum Storage (10)
4. Pesticide Storage and Handling (12)
5. Fertilizer Storage and Handling (7)
6. Farm Waste (17)
7. On-Farm Composting (10)
8. Energy Efficiency (5)
9. Farmstead Windbreaks (5) ***total:*** (83) questions

Livestock Operations *(subsections & # of questions)*

10. Livestock Facilities (40)
11. Manure Storage and Handling (14)
12. Pasture Management (11) ***total:*** (65) questions

Soils and Crops *(subsections & # of questions)*

13. Soil Management (38)
14. Nutrient Management (32)
15. Pest Management (28)
16. Irrigation (14)
17. Field Windbreaks (4)
18. Peatlands, Dykelands, and Floodplains (29) ***total:*** (145) questions

Ecological Resources *(subsections & # of questions)*

19. Riparian Buffer Zones (6)
20. Wetlands (11)
21. Woodlots (13)
22. Species at Risk (3) ***total:*** (33) questions

Total: 326 questions

The new EFP version also takes into consideration food safety, bio-security, health and safety and animal well-being. It has become a tool that can be used as a systematic guide to evaluate practices and to assist with the development of an action plan to prioritize and address environmental issues.

To date the focus of the EFP process and its Action Plan has been on environmental risks. The EFP does however also identify beneficial management practices or BMPs that are the positive actions a producer may undertake. In some situations these will be corrective actions, to make a poor situation better. In others they will be maintenance or sustainability type of actions that may actually contribute to the creation of ecological goods and services or EG&S. Agriculture can be a source of activities that produce EG&S and it is quite likely that farming operations that carry out a number of BMPs are already providing some EG&S.

National discussion about possible contributions that agriculture can make to the creation or provision of Ecological Goods and Services present a new opportunity for the agricultural sector. However this may bring about a complete paradigm shift in comparison to what has been done in the past since the focus of the EFP could be shifted from solely risk assessment, to including more assessment of what is done correctly on a farm. This could then possibly lead to a more widespread acceptance and use of the EFPs on farms.

Leading producers in NB were closely involved with the creation of both the first and the enhanced version of the NB EFP. This made New Brunswick a logical choice to explore the possibilities of remodelling the EFP as a tool for the delivery of incentives for EG&S. In this pilot project, the ECSWCC solicited the assistance of innovative producers, EFP and Agri-Environmental Club coordinators, and interested stakeholders throughout the province to evaluate and attempt to use the EFP as a management and policy development tool for Ecological Goods and Services within New Brunswick.

Objectives

The main objective of the New Brunswick pilot project was to investigate the use of the EFP as a management and policy development tool for Ecological Goods and Services within New Brunswick. The project was sub-divided into three distinct components or sub-objectives:

1. Evaluation of the EFP as a potential delivery tool for an ecological goods and services (EG&S) program for agriculture.
2. Evaluation of databases as potential tools to supply information required for an EG&S program management.
3. Testing the application of EFP based EG&S program in selected areas.

The main activities identified to achieve the project objectives were as follows:

1. Identification of a list of EG&S that might potentially be produced by agricultural operations in New Brunswick.
2. Review of EFP questions to identify those appropriate for promotion of the identified EG&S.
3. Identification of activities from the EFP that can produce the identified EG&S.
4. Identification of gaps in EFP questions regarding EG&S and options to address them.
5. Evaluation of the use of the risk assessment questions and/or the Action Plan within the EFP to positively impact delivery of EG&S. This included options regarding the assignment of a point system and the weighting of questions.
6. Evaluation of the potential to establish a form of a common ground “baseline’’ for EG&S activities above which EG&S incentive payments might be used to promote further additional EG&S activity.
7. Evaluation and determination of the data and monitoring requirements for EG&S management
8. Consultations with the agricultural industry.

Funding and Partnerships

The pilot project was funded by the Advancing Canadian Agriculture and Agri-Food (ACAAF) Program, with a budget contribution from ACAAF of **$192,575.00.** The in-kind contribution, cooperation and assistance were provided by the following partners in the project:

- The New Brunswick Agricultural Alliance (AANB)

- New Brunswick Soil and Crop Improvement Association (NBSCIA)
- Potatoes New Brunswick(PNB)
- New Brunswick Department of Agriculture and Aquaculture (NB DAA)
- New Brunswick Department of Environment (NB ENV)
- Kennebecassis River Watershed Committee (KRWC)
- New Brunswick Wildlife Trust Fund (NBWTF)
- Agriculture and Agri-Food Canada (AAFC)
- Individual producers (test farms)

Methods and Implementation

The Eastern Canada Soil and Water Conservation Centre led and coordinated this project on behalf of the agricultural industry partners in the project.

Creation of a Project Advisory Committee and a Technical Working Group (TWG)

An initial stakeholder meeting was held in Fredericton soon after the project was approved. The selection of participants for this initial meeting necessitated numerous phone calls, email, meetings with individuals and department heads as well as coordination. The objectives of the initial stakeholder meeting were to brief participants on the EG&S pilot project, introduce them to the EG&S concepts and activities to date at the provincial and national level, and to create the **Advisory Committee** and the **Technical Working Group (TWG)**. The ECSWCC had developed a set of selection criteria for committee members that were:

- Good understanding & knowledge of EFPs
- Positive and constructive attitude toward EFPs & EG&S
- Key Interest and knowledge of EG&S
- Represents producer groups & departments

Both committees were created at the meeting with a mandate for the duration of the pilot project. Members (15 for the Advisory Committee and 11 for the TWG) were drawn from the Agricultural Alliance of New-Brunswick, Potatoes New Brunswick (PNB), the New-Brunswick Soil and Crop Improvement Association (NBSCIA) and their affiliated Agri-Environmental clubs, the New-Brunswick Department of Agriculture and Aquaculture (NB DAA), the New-Brunswick Department of Environment (NB ENV), Agriculture & Agri-Food Canada, the New-Brunswick Wildlife Trust Fund, the provincial EFP coordinators, the Kennebecasis Watershed Restoration Committee and the ECSWCC.

It was agreed upon that the role of the Advisory Committee would be to:

- Provide advice on potential EG&S activities for NB
- Review the Technical Working Group recommendations
- Provide advice to the ECSWCC & Technical Working Group
- Provide industry & stakeholder liaison
- Report to their respective association/NGO/department on progress of the project and provide feedback

The Technical Working Group's function was agreed upon as:

- Participate in the elaboration and implementation of the pilot project

- Provide a broad range of technical expertise in specific fields of interest
- Make recommendations to the Advisory Committee on gaps & opportunities
- Evaluate the potential of EFP Workbook questions for EG&S, identify gaps, etc.

EFP question screening and ranking process

The assessment and screening of the 326 EFP assessment questions and their related farming practices was carried out by the Technical Working Group through a series of thorough screening exercises which are summarized in this section of the report. The TWG went through five (5) distinct exercises and seven (7) meetings to screen the EFP assessment questions. During each exercise, the EFP questions were scored by adding the votes of each members (1 member-1 vote) and then ranking the votes against each other.

Identification of EG&S that might be produced by NB farms

The first exercise was to identify a list of EG&S that might potentially be produced by agricultural operations in New-Brunswick. The preliminary list of EG&S was developed during a brainstorming session at the initial stakeholders meeting. The TWG's first task was to assess each of the 326 EFP assessment questions against this initial list of EG&S. Following this initial assessment the TWG decided to further refine the list of potential EG&S and group them into six (6) distinct categories, that is, those that provide EG&S related to: Air, Water, Soil, Biodiversity, Climate and Other Societal Benefits. A brief definition (explanatory texts) was developed for each EG&S as follows:

List of EG & S that could potentially be delivered in NB

Air: On-farm practices that provide EG & S related to air quality

Air Purification: Practices that can augment natural air purification or air cleaning processes to remove impurities such as dust, odors and particulates.

Provision of Oxygen: Practices that increase the release of oxygen into the atmosphere through photosynthesis, such as planting trees, permanent cover, etc.

Maintain good air quality: On-farm practices that help to maintain good air quality.

Water: On-farm practices that provide EG & S related to water quality and quantity

Water purification: On-farm practices that can improve surface and groundwater filtration / purification including water treatment through natural processes.

Maintain Water Quality: Practices that can help to conserve or maintain good surface and groundwater quality including practices that can reduce the potential for surface and groundwater contamination or loading by nutrients, agri-chemicals, bacteria, sediments, etc.

Regulate Water Cycle: Practices that can help to regulate the hydrological cycle including the maintenance or improvement of the soil water infiltration and holding capacity, reducing field runoff, reducing evapo-transpiration, flood control, stream recharge, etc.

Soil: On-farm practices that provide EG & S related to soil health

Regeneration & Renewal of Soil: Practices that will help build soil and improve soil quality through improved soil structure, enhanced soil life, increased soil organic matter and improved nutrient cycling capacity.

Maintain good soil quality: Practices that reduce soil degradation and soil loss and maintain good and sustainable soil productivity.

Biodiversity: On-farm practices that maintain or enhance biological diversity at the farm

Provision of Terrestrial & Aquatic Habitat: Practices that provide or protect terrestrial and aquatic habitat, including nesting habitat, habit for pollinators and beneficial insects, etc.

Maintain & improve Genetic diversity: Practices that maintain or improve inter-species or intra-species genetic diversity, through diversification of crops, livestock, woodlands, etc.

Protect species at risk: Practices that protect species at risk, through protection of habitat or creation of habitat that can support species at risk, etc.

Definition of Biodiversity:
Biodiversity (or biological diversity) is a term used to describe the variety and variability within and among living organisms and their relationship with each other and with their physical environment. It includes diversity within species (intra-species diversity), between species (inter-species diversity), and within ecosystems (ecosystem diversity).

Climate: On-farm practices that help to regulate climate, reduce greenhouse gas emissions, or sequester carbon in the soil

Reduction of greenhouse gas emissions: Practices to reduce greenhouse gas emissions, such as improved manure management, improved ruminant feeding practices, reduced nitrogen fertilizer use, reduced tillage, etc.

Sequester carbon: Practices that help to sequester carbon in the soil, including conservation tillage, improved crop rotation, permanent cover, shelterbelts, etc.

Other Social Benefits: On-farm practices that provide other social benefits including recreational, rural aesthetics, eco/agro-tourism, social acceptability, cultural, etc.

Provision of aesthetically valued landscapes: Practices that provide aesthetically pleasing or valued landscapes such as windbreaks, woodlots, wetlands, or through restoration of heritage buildings, etc.

Enhance recreational opportunities: Practices that provide increased recreational opportunities, including agro/eco-tourism opportunities, hunting, fishing, canoeing, etc.

As a second screening exercise, the TWG was asked to assess once more all the 326 EFP assessment questions against the revised EG&S list.

Identification of EG&S Guiding Principles

As a means to further categorize or rank the EFP questions, a set of ***EG&S Guiding Principles"*** was prepared by the ECSWCC project coordination team and approved by the TWG and the Advisory Committee after review. As a third screening exercise, the TWG members were then asked to assess the 326 EFP questions against those EG&S Guiding Principles (Table 2).

Table 2: EG&S Guiding Principles.

1. **No short term net economic benefit –** The practice may not necessarily increase short term farm productivity but might have the potential to improve long term soil health and long term productivity.

2. **May increase production risk –** May decrease yield & livestock productivity, increase crop damage, etc.

3. **May reduce non-point source water pollution –** Practice has potential to considerably reduce ***non-point source*** surface and ground water contamination. Potential to maintain good quality water.

4. **Reduce nuisance –** Enhance social acceptability of agriculture. Provide cleaner air and reduce nuisance.

5. **Enhance fish & wildlife habitat –** Potential to increase fish and wildlife habitat. Has potential to maintain or enhance animal and plant biodiversity.

6. **Reduce or regulate flooding.**

7. **Positive EG&S –** New provision of EG&S.

8. **Reduce negative impact on EG&S** – Protection or improvement of water, air or soil quality and maintenance of existing practices that provide EG&S.

9. **Exceed acceptable practice –** Exceed regulated and/or normal farming practices.

10. **Exceptional practice in sensitive / designated areas –** Management practices to meet legislation in special designated areas.

11. **Requires high non cash and/or maintenance cost –** High maintenance cost to maintain practice in place.

12. **High opportunity cost.**

The question scoring from the first and second exercises were added together and ranked. The TWG reviewed the EFP question scoring from the two evaluations and decided upon a 65% "pass mark" for keeping EFP questions for EG&S purposes. As a result of this scoring process, 214 questions were deemed unacceptable for EG&S purposes. As a means to display the ranking of the 326 EFP questions, the TWG decided to colour code each EFP question based on that scoring (Table 3).

Table 3: Example of EFP question analysis for EG&S.

#	Sub-Section Title	Score	Rank
20	Wetlands		
1	Presence of natural wetlands	51	93.0%
2	Wetland restoration / alteration	74	98.0%
3	Wood harvesting in / near wetlands	18	45.0%
4	Discharge into natural wetlands	37	80.0%
5	Farming activities near wetlands	48	89.0%
6	Water extraction	15	36.0%
7	Wetland construction	55	95.0%
8	Farm safety	6	8.0%
9	Wetland inspection	17	42.0%
10	Type of wastewater treated	25	62.0%
11	Outflow of water from constructed wetland	46	87.0%

		# Q
A	90-100%	31
B	80-89%	34
C	65-79%	47
Fail	< 65%	214
		326

Determination of acceptable EFP risk assessment level for the remaining EFP questions and their measurability at the farm

During the fourth exercise, the TWG members were asked to re-assess the remaining 112 EFP assessment questions against the list of EG&S and determine the highest EFP risk assessment level that would be acceptable for provision of EG&S for each EFP question. As for most EFPs across Canada, the Atlantic EFP risk assessment is based on four risk assessment levels. In the Atlantic EFP workbook, Risk "1" is a low risk level and "4" is the highest risk level as shown and explained below.

1 *(low)*	2	3	4 *(high)*
Conditions that protect the environment, or have the lowest potential for environmental damage, or a BMP	Conditions that protect the environment or have a low potential for environmental risk	Conditions that have a potential to negatively affect the environment	Conditions that have the highest potential to negatively affect the environment

When completing his farm assessment, the producer indicates the risk rating level that best describes his farm practices or actual conditions.

An initial list of the EG&S-related BMPs addressed in each of the EFP questions retained for EG&S purposes was created. The TWG were again asked to assess the remaining questions and practices to determine their level of measurability that is, are the identified practices measurable and if so, how. The final selection was carried out to determine the level of acceptability of the remaining practices. EFP questions with a low potential of providing EG&S or that were deemed not measurable were eliminated. As a result, the number of EFP questions to be used for EG&S was cut down to 64. The ECSWCC staff then prepared a booklet listing the BMPs from the EFP questions retained. The booklet and a resulting power point presentation were used during the consultation sessions.

Development of an EFP-EG&S software and on-farm testing

After discussions with the Technical Working Group and Advisory Committee, it was decided that the 64

EFP questions with potential to provide EG&S would be tested on selected farms. In order to facilitate the testing it was decided to revamp the EFP software to measure potential EG&S at the whole farm level.

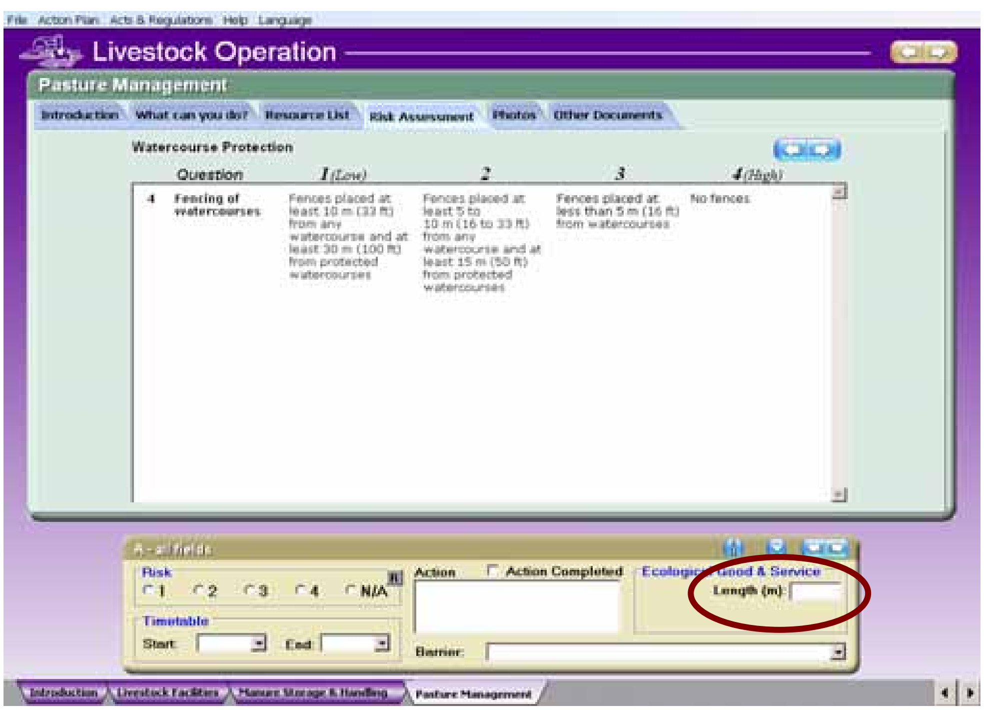
A computer programming consultant, the same one that had developed the EFP software, was contracted by the ECSWCC to complete the programming required to add EG&S data collection features to the existing computerized version of the EFP. That involved a lot of interaction / communication between the EG&S project coordinator and the programmer. The changes made to the original EFP software are as follows:

Addition of a field size column in the field sites table since many EG&S payments could be based on field size. A location in the action plan window to indicate specific measurements such as length of fence, windbreaks, terraces etc.

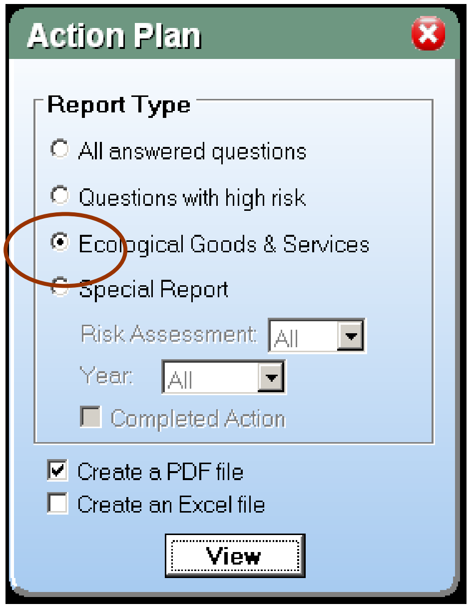
Field Sites

Site	PIN	Id. #/name	Area (ha)	Info. Well at Risk		Info. Surface Water at Risk		Soil Characteristics				Slope		Crop Rotation
				Well	Distance	Surface Water	Distance	Series	Drainage	Texture	HSG	%	Length	
A		all fields	150.8											
B		1	10.3									1.1		
C		2	6.65									1.7		
D		3	1.4									1.5		
E		4	8.76									1.9		
F		5	8									1.8		
G		6	9.2									1.4		
H		7	9.5									1.0		
I		8	1.76									2.8		
J		9	7.3									3.4		
K		10a	3.28									.5		
L		10b	3.32									3.4		
M		10c	9.92											
N		11a	0											
O		11b	5.84									4.2		
P		11c	0											
Q		11d	0.5											
R		12a	5.88									2.5		
S		12b	3.68									1.1		
T		15	9.04									3.5		
U		16	8.2									3.2		
V		17	7.88									3.1		
W		11e	1											
X		woodlot	485											
Y		14	5.9									1.4		

A new option in the Action Plan report window that will produce a separate EG&S report while still being able to produce the original EFP action plan report.



A new option in the Action Plan report window that will produce a separate EG&S report while still being able to produce the original EFP action plan report.



Capability to produce an EG&S credit or potential payment report which would indicate to the producers the potential for payments for each EFP sub-section. If an EG&S program is developed in the future, the numbers in the "Factor" column could be changed in dollar amount per unit. The credit column would then become a total payment column.

Ecological Goods & Services (Farmstead & Homestead)

Question	Site	Risk	Measure 1	Measure 2	Factor	Credit
Farmstead Windbreaks						
1) Presence of windbreaks and living snow fenc	1-general	3	Length (m): 350		0	0.00
	26-windbreak 1	1	Length (m): 204		0.57	116.28
	27-windbreak 2	1	Length (m): 90		0.57	51.30
	28-windbreak 3	1	Length (m): 45		0.57	25.65
4) Density and uniformity	26-windbreak 1	1	Length (m): 204		0.43	87.72
	27-windbreak 2	1	Length (m): 90		0.43	38.70
	28-windbreak 3	1	Length (m): 45		0.43	19.35
5) Wildlife protection and biodiversity	1-general	4	Length (m): 350		0	0.00
	26-windbreak 1	2	Length (m): 204		0.4	81.60
	27-windbreak 2	3	Length (m): 90		0.27	24.30
	28-windbreak 3	3	Length (m): 45		0.27	12.15
					Total:	457.05

As soon as the revised EFP-EG&S software was functional, the Agri-environmental Club coordinators and the EFP coordinators, who are the EFP delivery agents in the province, were provided with a training session on how to collect EG&S data with the EFP questions using the computerized version of the EFP. As part of the training session, GPS information, GIS software (fGIS), aerial photos (NBARMS) and other materials were prepared and distributed to the coordinators as training on how to collect GPS data and how to make measurements on aerial photos. Post training or follow-up sessions were provided by the ECSWCC mainly to ensure consistent interpretation of the EFP questions.

Subsequent to the training sessions, the ECSWCC also developed and provided the coordinators with a detailed checklist of the steps and data collection foreseen as required for testing the application of the computerized version on farms. They were also asked to keep records of the amount of time required to collect EG&S data to apply the EFP questions.

The purposes of the on-farm testing were to test the revised software, determine the measurability of the practices, test various measuring tools such as GPS and GIS software with geo-referenced aerial photos and determine the time required to complete the measurements and verifications at the farm. As a result, a total of 14 farms were tested across the province.

Consultation Sessions with Industry

As part of a project deliverable, eight (8) consultations sessions (Table 4) were held across New Brunswick in English and in French in late November 2008. Plans for the consultation sessions were developed in cooperation with the Agricultural Alliance of New Brunswick, (AANB), Potatoes New Brunswick and the New Brunswick Soil and Crop Improvement Association. A formal letters of invitation was prepared and sent to all commodity groups or Boards for the industry consultation sessions. The objectives of the consultation sessions were to inform the participants about EG&S, review the suite of 64 EFP questions and related BMPs identified as having potential to provide EG&S, obtain feedback and comments from participants and identifies gaps. The participants that had registered in advance of the sessions were sent a copy of the booklet listing the BMPs from the EFP questions retained.

Table 4: Ecological Goods & Services consultation sessions.

Location	Language	Date
Sussex	English	November 18
Bouctouche	French	November 19
Moncton	English	November 19
Bathurst	English	November 20
Tracadie	French	November 20
Fredericton	English	November 25
Wicklow	English	November 25
Grand Falls	French	November 26

The participants at the consultation sessions were all asked the same questions following the presentation that is:

- Do you agree on an EG&S program concept and using the EFP to manage an EG&S program?
- Are all the farm practices listed in the consultation acceptable?
- Would you be willing to implement these BMPs for EG&S purposes?
- Are there any practices that you are implementing on your farm that should be included?

Following the consultation sessions, the TWG met to review the results of the sessions and presented their recommendations to the Advisory Committee. As a result some additional EFP questions were added and others deleted.

Results, Costs & Benefits & Discussion

The following briefly summarize the results of the NB pilot project. More complete details regarding the EFP risk assessment question and BMPs retained for their potential to deliver EG&S are available in the BMP guide available in **Appendix 4.**

Advisory Committee and a Technical Working Group (TWG)

Due to the nature of the NB pilot project, the creation of a project Advisory Committee and a Technical Working Group was instrumental for project implementation. The selection of highly knowledgeable and dedicated members from a wide range of stakeholders was key. The expertise of every member was required and utilized throughout the EFP question screening process. Their impartiality made it easier to reach consensus. Both groups held six (6) and seven (7) meetings respectively throughout the project implementation time frame.

Both groups were instrumental in developing the list of EG&S that might be produced on NB farms and in the development of the guiding principles. The active participation of all TWG members in the EFP question screening exercises has identified a highly defendable list of EFP questions and BMPs that have potential to provide EG&S in New-Brunswick. The final list of EFP questions and BMPs was presented at various meetings throughout the winter of 2009 including three provincial producer group's Annual General Meetings and Conferences and at the NB EG&S provincial workshop held March 4, 2009. It is estimated that approximately 400 producers were exposed to the EG&S pilot project results over the winter. Comments received during these presentations were very positive.

EFP-EG&S software, database and on-farm testing

Implementing an EG&S program at the whole farm level will require a comprehensive software to complete the credit or payment calculation and to keep a database of where the payments were applied. The new EFP_EG&S software was very useful in completing the on-farm testing and demonstrated that the same software can be used for completing the EFP while at the same time completing an EG&S report. The EFF-EG&S software could also be used to create an EG&S database for managing a program and could be linked to a GIS-based agricultural resource management system such as NBARMS. On farms where the EFP had already been completed with the EFP software, the conversion to the new software was easy with the EFP information remained intact. The coordinator doing the assessment only had to enter the additional information required for EG&S. It was however determined that for EG&S evaluation purposes, all field assessment has to be completed on a field by field basis. This however provides a more comprehensive and precise assessment of the farm for EFP and EG&S purposes.

The on-farm testing provided very useful information in terms of potential issues related to on-farm measurements and verification. For the 14 farms, it took on average ten (10) hours to complete the on-farm verification including the acquisition of geo-referenced aerial photos, verifying the practices and completing the required measurements. It should be noted that initial farm assessment will take more time than the occasional verification to be completed in following years since many farm practices will be maintained from year to year such as riparian buffers, windbreaks, soil conservation structures, etc.

The on-farm testing revealed that many of the EFP questions and BMPs were not interpreted in the same manner by the club and / or EFP coordinators. This indicates that any groups or individuals assisting producers in their EG&S assessment will need to go through a comprehensive training session beforehand to assure consistency in the assessments. For EFP assessment purposes, this is not as critical since there are no direct payments tied to the assessment. For instance, the individuals need to be able to make a distinction between what is a riparian buffer zone, a windbreak, and a woodlot. The individual should also be able to measure windbreak density, identify species at risk, assess pasture condition and be capable of using various measuring tools. For many questions such as those for the soil, nutrient and pest management, the only means of verification is through on farm record keeping systems. A producer without a sound record keeping system should not qualify for payments for these practices. Natural wetlands may also pose verification issues if kept on the list. They may require external verification by a wetland specialist. The verification cost for a wetland may be unaffordable under an EG&S program.

As a result of the on-farm testing, some EFP questions were slightly modified to facilitate their interpretation. One question related to watercourse assessment was eliminated because of the difficulty in completing the assessment. Fifteen (15) other questions were also eliminated because they were complementary to and covered by other questions. For example, ten (10) questions were initially kept in the Nutrient Management sub-section. However, nine (9) of the ten (10) questions are simply questions that verify the most important question in that subsection, that is, has a nutrient management plan been developed and implemented? Similarly, the crop record keeping system should determine if the plan was actually done and followed. Therefore, as a result of the on-farm testing, the number of EFP questions was reduced to 48.

Consultation sessions with industry

The comments received from the participants at the consultation sessions were quite positive and in support of the concept of using the EFP for an EG&S program. The participants indicated that the BMPs listed in the consultation were acceptable to them however they provided some suggestions for additional practices to be considered for EG&S (Table 5). The producers indicated that they would, in general, be willing to implement these BMPs if sufficient funding were available, if they had the cash flow to implement them and if the practices were economically beneficial. It was also noted that many of the identified practices were already being implemented by many producers. The consultation sessions were very useful in identifying potential gaps in the EFP (Table 6).

Table 5: Questions in the EFP that producers wished to have reintroduced in the EG&S list.

- Manure storages (to include uncovered storages)
- Milkhouse Washwater- use of alternate chemicals
- Manure treatment
- Manure application vs. food safety
- Water use efficiency of irrigation system
- Land clearing (blueberries)
- Taking land out of production
- Rock crushing
- Sediment basin

Table 6: Gaps in the EFP as identified during the consultation sessions.

- Alternate energy -biomass, bio-energy
- Certified Organic Farms
- Animal welfare / confinement
- Nuisance wildlife, invasive species
- Wildlife protection
- Biodiversity
- Species at risk (weak)
- Agro-tourism, recreation
- Climate change adaptation
- Land use / zoning
- Bee keeping, pollination
- Christmas tree production

Following the consultation sessions, the TWG met to review the results of the sessions and to forward their recommendations to the Advisory Committee. It was determined that most of the practices that the producers wished to have reintroduced were unacceptable for EG&S since they did not fit within the "Guiding Principles" or did not provide enough EG&S. However, both committees agreed to add a question in the soil management sub-section related to sedimentation ponds or catch basin.

In terms of the potential gaps, the TWG and Advisory Committee determined that addition of organic farming could easily be integrated within the "Pest Management" sub-section. The other gaps identified were found to be valid however there is no need or urgency to revise the EFP workbook to include them at this moment. During the next revision of the EFP, new sub-sections should be included in the workbook to address these gaps. Then, new EFP assessment questions could be evaluated against the list of potential EG&S and the guiding principles to determine if they should be included for EG&S purpose.

As a result of the on-farm testing and consultation sessions, 49 EFP questions were kept as having potential to provide EG&S. The EG&S-BMP guide was revised accordingly (Appendix 4) and distributed to the participants at the final EG&S workshop. Due to the limitation in the number of pages for this final report, it is impossible to list all the EFP assessment questions that were kept for EG&S purposes. Table 7 illustrates the EFP sub-sections that were kept and the EG&S that could be provided by the questions kept and the guiding principles met by these sub-section questions.

Table 7: Potential EG&S provided by the EFP assessment questions and BMPs as grouped by the EFP workbook sub-sections.

EFP Sub-sections	7 - Farmstead Windbreak	11 - Manure Storage & Handling	12 - Pasture Management	13 - Soil Management	14 - Nutrient Management	15 - Pest Management	17 - Field Windbreak	18 - Peatlands, Dykelands, Floodplains	19 - Riparian Buffer Zone	20 - Wetlands	21 - Woodlots	22 - Species at Risk	
Potential EG&G	**9**	**3**	**8**	**8**	**6**	**5**	**11**	**7**	**12**	**6**	**11**	**4**	
Air purification	√						√		√		√		**4**
Provision of oxygen	√						√		√		√		**4**
Maintain good air quality	√	√	√		√	√	√				√		**7**
Water purification	√						√		√	√	√		**5**
Maintain water quality	√	√	√	√	√	√	√	√	√	√	√		**11**
Regulate water cycle				√				√	√	√	√		**5**
Regeneration & renewal of soil			√	√	√	√							**4**
Maintain good quality soil				√	√	√	√	√	√				**6**
Provision terrestrial & aquatic habitat			√	√			√	√	√	√	√	√	**8**
Maintain / enhance biodiversity	√		√	√	√	√	√	√	√	√	√	√	**11**
Protect species at risk												√	**1**
Carbon sequestration	√		√	√			√	√	√		√		**7**
Reduction GHGs emissions	√	√	√	√	√				√				**6**
Provision of aesthetic landscape	√		√				√		√	√	√	√	**7**
Enhance recreational activities							√	√	√		√		**4**
Guiding Principles	**6**	**6**	**6**	**4**	**6**	**6**	**10**	**6**	**10**	**6**	**5**	**8**	
No short term net economic benefits	√	√					√	√	√	√	√	√	
Increase production risk					√	√		√					
Reduce NPS water pollution		√	√	√	√	√	√	√	√	√			
Reduce nuisance	√	√					√						
Enhance fish & wildlife	√		√			√	√	√	√	√	√	√	
Reduce, regulate flooding							√	√	√	√	√		
Positive EG & S	√		√				√	√	√	√	√	√	
Reduce negative impact on EG & S			√	√	√	√	√	√	√	√	√	√	
Exceeds acceptable practices	√	√	√	√	√		√		√			√	
Exceptional practice in sensitive areas		√							√			√	
High non cash / maintenance cost			√	√	√	√	√		√			√	
High opportunity Cost	√	√					√		√			√	

Conclusion

This project has demonstrated that the Environmental Farm Plan can be used as an EG&S program management and policy development tool. However, it is imperative that the EFP assessment questions go through a thorough screening and on-farm testing process to identify the BMPs with potential to provide EG&S and that are measurable or verifiable at the farm.

The creation of a Technical Working Group and a project Advisory Committee which included a broad range of expertise and industry representatives was instrumental in the screening and consultation process.

The consultation sessions and presentations made at various producer annual general meetings clearly demonstrated that producers are in favour of using the EFP as an EG&S program management tool because they will be able to identify their farm's potential for delivering EG&S while they complete their EFP assessment.

The only potential drawback in using the EFP for EG&S program delivery purposes is that producers will need to compromise on confidentiality. However with the EG&S-EFP software, producers will have the option of providing only the EG&S report subsections that they wish to submit. Furthermore, only the EG&S providing questions and sub-sections are reported in the EG&S report.

The results of this project could easily be used in New Brunswick as a management tool to advance policy and programming for EG&S. The existing EFP software, as modified for EG&S purpose through this project, should be an adequate administrative tool for managing an EG&S program and could be linked to a GIS-based agricultural resource management system such as NBARMS.

Fairly few "gaps" were identified during the pilot project. Those that were identified could easily be addressed with minor changes to the EFP workbook and software versions however these changes could wait until the EFP workbook goes through a revision process.

Future

Since the same EFP workbook and software are being utilized in Prince-Edward-Island, Newfoundland and Labrador, these provinces could easily use the NB results as a base for their EG&S program however priorities may differ slightly. The other provinces that are using an EFP workbook format similar to the one used in NB such as Ontario, Manitoba, Saskatchewan and Alberta, could easily go through a screening process such as the one used in NB. However, in order to use efficiently the EFP as an EG&S program management tool, it is recommended that an EFP software be developed. Otherwise, it will be very difficult to calculate the potential whole farm EG&S credits. It is also important that the EFP assessment be carried out on a field-by-field or site-by-site basis. Grouping fields or sites together makes it difficult to identify the sites or fields that are delivering the EG&S.

When completing the EFP questions screening, it is important to involve as many stakeholders and as much expertise as possible in the process. Industry consultation through formal consultation sessions and through presentations to industry meetings ensures greater buy-in and acceptance of the results. Agriculture producer organisations need to be part of the screening and consultation process as well as other potential stakeholders such as ENGO's, the federal and provincial departments of Agriculture and Environment and EFP delivery agents.

Cost Efficiency Analysis of Possible Environmental Goods & Services (EG&S) Policy Options

Claude Sauve, Senior Associate, EcoRessources Consultants Ltd., Quebec City, QC

Executive Summary

Purpose

This report estimates the costs and benefits of several policies that could increase the supply of ecological goods and services (EG&S) from agricultural land in Canada. The following options were analyzed: annual payments, one-time payments, reverse auctions, and water quality trading. These options are similar to programs under consideration for EG&S in Canada. Annual payments are used in the Conservation Reserve Program (CRP) in the United States, and the Alternate Land Use Service (ALUS) project is used in Manitoba. One-time payments are a key tool of Canada's National Farm Stewardship Program (NFSP). Mixes of annual and one-time payments are being considered under the Growing Forward Framework for agricultural policy. Reverse auctions are currently used in Australia and are being tested in western Canada. Water quality trading is used in eastern Ontario and several areas of the United States.

These policy options can all increase the adoption of beneficial management practices (BMPs) that increase EG&S. The BMPs covered in this study include grassy and wooded riparian buffer zones, winter cover crops, conservation tillage, conversion of marginal farmland to wetland, retirement of flood-prone land, conservation of existing forests and wetland, and manure storage.

Caution

Please note that measurements of the value and cost of ecological services should be treated with caution. The following estimates are very approximate and have a large margin of error. This large margin of error is due to uncertainty at several stages of the estimation process, including the impact of particular BMPs on nutrient levels, the costs to producers of adopting BMPs, the value that residents of a watershed place on environmental improvements, and the extrapolation of results from two local areas to provincial and national levels.

Methodology

The report quantifies the costs to producers of certain practices and proposes a payment schedule to offset these costs; it also estimates public administrative costs. The programs are designed to achieve a target level of two environmental benefits: a reduction of phosphorous concentrations in surface water and the maintenance or enhancement of wildlife habitats. The analysis is conducted for two representative watersheds, the Nicolet (East) sub-watershed in Quebec and the Little Saskatchewan River watershed in Manitoba, and aggregated to the provincial and national level. The benefits of BMP adoption are given a dollar value through "benefit transfer" methodology. Total public costs of each policy are compared to the benefits in order to obtain benefit-cost ratios.

Key Results

Improvements in water quality worth approximately $900 million would cost between $500 million and $2.5 billion:

A program focused on decreasing phosphorous loadings in water from agricultural sources across Canada to recommended levels would provide benefits to local populations worth approximately $900 million. These benefits include increased fishing, recreational activity, and less expensive water treatment. The costs of attaining this improvement would be approximately:

- $2.5 billion, if delivered through an annual payment policy;
- $1.2 billion, if delivered through a one-time payment policy;

- $ 900 million, for an optimal mix of annual and one-time payments;
- $ 600 million, if delivered through a reverse auction tool; and
- $ 500 million, if delivered through a water quality trading system.

An EG&S program that improves both wildlife habitat and water quality would provide at least $3.3 billion in benefits and would cost between $1 billion and $2.8 billion:
Increasing wildlife habitat in addition to achieving targeted lower phosphorous levels in water at a national scale could be worth between $3.3 billion and $3.9 billion to the inhabitants of the affected regions in terms of improved recreation, drinking water, flood protection, aesthetics and other public benefits. Achieving these results for Canada would cost approximately:

- $2.8 billion, if delivered through an annual payment policy;
- $1.5 billion, if delivered through a one-time payment policy;
- $1.2 billion, for a mix of annual and one-time payments; and
- $1 billion, if delivered through a reverse auction tool.

Water quality trading cannot be compared to these options because it cannot be used directly to increase wildlife habitat.

Implications

Market-based instruments are much more efficient than uniform payment programs. To obtain similar benefits, programs that use standard payment schedules, such as annual or one-time payments, are two to five times more expensive than market instruments such as auctions and water quality trading.

Water quality trading is the most efficient of the tools examined. However, while suitable for reducing phosphorous loadings, it is not suitable for increasing other ecological services, such as wildlife habitat.

One-time payments are suited to actions that involve an initial investment and low on-going costs, such as grassed buffer strips, conversion to conservation tillage or manure storage facilities. On-going payments are suited to actions that involve significant recurring expenditures, such as wooded buffer strips and seeding winter cover crops. The BMPs that reduce phosphorous levels most efficiently can be supported by one-time payments. This is mainly because the BMP “grassed riparian zones”, which is suited to one-time payments, is much less expensive than “wooded riparian zones”, which are more suited to annual or on-going payments.

Some BMPs are far more efficient than others. For example, the costs of reducing phosphorous in eastern regions are approximately:

- $38/kg for cover crops;
- $183/kg for grassed riparian buffers;
- $402/kg for reduced tillage and no-till; and
- $897/kg for wooded riparian buffers.

The costs of reducing phosphorous in the western regions are about:

- $19/kg for grassed riparian buffers;
- $41/kg for manure storage;
- $224/kg for wooded riparian buffers; and

- $263/kg for cover crops.

In addition, the efficiency of BMPs may vary enormously between regions, as cover crops are very efficient for phosphorous in the east but are inefficient in the west. These differences depend in part on differences in opportunity costs between regions for certain BMPs.

Water quality costs more to improve than wildlife habitat. Based on the value to the public of improvements in water quality and wildlife habitat, it costs much more to obtain reductions in phosphorous levels in water than to obtain equivalent increases in value for wildlife habitat.

Provincial Results for Water Quality Improvements
The benefits and costs of implementing the phosphorous reduction policy described above would be distributed as indicated in the following table (see full report for other provincial results).

Public costs for phosphorus reduction, by province

Province	*Total benefits* ($ millions)	*Costs: ($ millions)*				
		1-time payments	Annual payments	Mix: Annual and 1-time payments	Auctions	Tradable permits
Prince Edward Island	4	18	25	18	14	10
Nova Scotia	27	10	17	10	5	4
New Brunswick	20	14	20	14	9	7
Quebec	229	210	369	213	152	114
Ontario	337	426	735	432	297	223
Newfoundland and Labrador	14	NA	NA	NA	NA	NA
Manitoba	32	78	192	27	19	17
Saskatchewan	28	249	636	69	51	46
Alberta	93	197	454	96	61	55
British Columbia	119	13	23	10	6	5
Canada	903	1 214	2 472	889	613	480

Quantitative Results
Total public costs for all policies and both regions, split by environmental objectives (water quality and wildlife habitat) are summarized in the next table. These costs show that in both regions and for the whole country, the cost of implementing policies based on pre-determined government payments is significantly higher than the cost of implementing market-based instrument policies. Moreover, costs required to reach the water quality improvement target are greater than the costs needed to preserve wildlife habitat.

Aggregated Total Public Costs for Canada

	One-time payments (million $)		**Annual payments** (million $)		**Mixed one-time/annual payments** (million $)		**Auctions** (million $)		**Tradable permits** (for P only) (million $)	
	Central and Eastern Canada	Western Canada	Central and Eastern Canada	Western Canada	Central and Eastern Canada	Western Canada	Central and Eastern Canada	Western Canada	Central and Eastern Canada	Western Canada
Total water costs	677	536	1,166	1,306	687	202	477	136	358	123
Total habitat costs	315	43	317	54	319	61	391	62	-	56
Total costs[1]	**992**	**536**	**1,483**	**1,306**	**1,006**	**202**	**868**	**136**	**358**	**123**
	1,528		**2,789**		**1,208**		**1,004**		**481**	

The results obtained are consistent with economic theory and with research literature on policy efficiency and design. Policies based on market-based instruments (auctions and permit trading systems) are more efficient than direct payment policies (one-time, annual payments and a mixed policy of one-time and annual payments). However, market-based mechanisms entail higher public transaction costs per dollar of payment.

Introduction

Federal and provincial departments of agriculture in Canada are currently examining policy options based on the concept of Ecological Goods and Services (EG&S), also known as ecosystem services and multi-functionality. The definition of EG&S for federal/provincial (F/P) policymakers is derived from the UN Millennium Ecosystem Assessment of 2005:

"*Ecological Goods and Services (EG&S) are the positive environmental benefits that Canadians derive from healthy ecosystems, including clean water and air, and enhanced biodiversity. The EG&S concept includes market goods produced from ecosystems (e.g. food, fibre, fuel, fresh water, generic resources, biochemicals, etc.), the benefits from ecosystem processes (e.g. nutrient cycling, climate regulation, water purification, waste treatment, pollination, etc.) and non-material benefits (e.g. aesthetic values, recreation, etc.) Agriculture is both a beneficiary and a provider of EG&S. For example, farming's viability depends on ecosystem processes like soil renewal, climate regulation, and precipitation. At the same time, well-managed agricultural lands can provide benefits to broader society like fish and wildlife habitat, scenic views, and purification of air and water through natural processes.*"

There are differing opinions among governments on the efficiency and effectiveness of various EG&S policy tools for potential integration into future agri-environmental programming. In the face of pressure from some in the agricultural industry to increase subsidy levels through environmental

[1] In the case of Western Canada, some BMPs that have an impact on water quality also improve the habitat, and there is no BMP specific to habitat that is not taken into account for water quality. This is why total payments equal the payments for water quality improvement.

programming under the heading of EG&S, with strong support from some provinces and equally strong resistance from others, consensus was achieved among F/P Ministers to have officials undertake research on EG&S policy. As a result, the F/P EG&S Working Group was formed.

In late 2006, Ministers directed officials to conduct a cost-benefit analysis (CBA) of potential EG&S options in Canada. The F/P EG&S Working Group formed a sub-committee consisting of five representatives from Agriculture Agri-Food Canada (AAFC) and five provincial members (Manitoba, Ontario, Alberta, Saskatchewan, and Quebec) to handle the CBA contacting process and subsequent monitoring. As a result, ÉcoRessources Consultants and their partners, the International Institute for Sustainable Development (IISD) and the Institut de recherche et de développement en agroenvironnement (IRDA), were awarded the contract to estimate the efficiency of the various EG&S policy tools selected by the F/P Working Group through a cost-benefit analysis.

This report estimates the costs and benefits of five beneficial management practice (BMP) incentive programs: one-time payments, annual payments, mixed one-time and annual payments, auctions and tradable permits. The five programs were designed to achieve a certain target level of environmental benefits. The desired environmental benefits were a reduction of phosphorous concentrations in surface water and the maintenance or enhancement of wildlife habitats. The analysis was conducted for two representative watersheds: the Nicolet (East) sub-watershed in Quebec and the Little Saskatchewan River watershed in Manitoba.

Regarding the analytical methods employed for the study, specific BMPs selected for analysis differ for each watershed and incentive policy. This exercise was carried out using a method that involved quantifying the private costs of certain practices to producers and then designing a payment schedule to offset those costs. Total public costs of each policy were compared to the level of benefits that are given a dollar value via the benefit transfer method. Through this method, a ranking of the five policies, with respect to the benefit-cost ratio generated by each of them, was obtained. Finally, cost and benefits were extrapolated to two regions: Central and Eastern Canada and Western Canada. The ranking of the five policies was re-evaluated at the level of these two regions in order to derive conclusions useful to all Canadian provinces.

Policy Options

This report takes an in-depth look at various types of policies to determine their efficiency in producing least-cost environmental goods and services. These policies consist of one-time payments, annual payments, a mixed policy of one-time and annual payments as well as market-based instruments in the form of auction mechanisms and emissions trading schemes.

The policy scenarios chosen owe much to existing agri-environmental programs such as the federal government's National Farm Stewardship and Greencover Canada programs, Manitoba's Alternative Land Use Services (ALUS) program , Quebec's Farm Income Stabilization Insurance (FISI) and various other provincial on-farm environmental planning programs. We also made use of existing programs in other countries such as the USA's Conservation Reserve Program (CRP), Australia's BushTender and EcoTender programs and France's agri-environmental measures (AEMs).

The primary purpose of these policies is to encourage adoption of beneficial management practices (BMPs) to achieve target environmental goods and services (EG&S). Selecting the portfolios of practices that will qualify users for payments is thus a central part of the policy design process, and policy efficacy will depend on this aspect to a great extent.

One-time Payments
The aim of this policy is to encourage implementation of certain BMPs by one-time payments covering all the net losses incurred by farmers who comply with their contractual commitments. Under this policy, producers undertake to implement BMPs on their farms in exchange for one-time financial compensation.

The BMPs that make up our one-time payment policy portfolio are: grassy riparian buffer strips (without maintenance), cover crops for cereals, conservation tillage and direct seeding, maintaining woodlands and wetlands in agricultural areas, crop reduction on agricultural floodplains, and manure storage. The payment level corresponds to a certain percentage of the value of the investments made up to a predetermined limit. In the case of maintaining woodlands and wetlands in agricultural areas and of crop reduction in agricultural floodplains, the payment level represents the capitalized amount of the opportunity cost associated with use of the land. In terms of technical support, the one-time payment corresponds to the cost of technical assistance for two years.

Annual Payments
The annual payment policy involves awarding financial compensation to program participants for all the net annual expenses incurred by implementing BMPs on their farms. The portfolio of BMPs qualifying for the annual payment program thus consists of practices that involve recurring expenses, i.e., establishing treed buffer strips (with maintenance), cover crops, intercropping, maintaining woodlands and wetlands in agricultural areas, and crop reduction on agricultural floodplains.

As in the case of one-time payments, all farmers are generally eligible for the program for all their owned or leased land. However, in the case of certain practices requiring an initial investment, only owned land qualifies.

The contract period is for three years and can be renewed twice, i.e., up to a total of nine years. In terms of penalties, producers who do not fulfil their contractual commitments will not receive assistance for the year in question, and producers wishing to terminate their contracts before expiry will be required to repay half the annual amount of the remaining years (penalty modelled on the ALUS and Greencover Canada programs). All program participants receive the same payment amounts for given BMPs.

Mixed Policy: One-Time and Annual Payments
In this kind of policy scenario, practices will be remunerated via one-time or annual payments, according to whether they generate high initial investments or recurring expenditures. BMPs are classified according to their environmental effectiveness (costs/EG&S obtained), and the most effective practices will be the first to be prescribed and applied. Practices will be added to the policy’s portfolio until environmental objectives are reached.

The “Auction” System
An auction is a market institution with an explicit set of rules determining resource allocation and prices on the basis of bids from market participants. When specifically applied to obtaining EG&S in agriculture, an auction system operates as follows: producers participating in the program propose the amount of money that they would like to receive for implementing a BMP, and only the best proposals in terms of cost per environmental benefit obtained are selected until the target environmental objectives are achieved.

Identify target BMPs	⇒	Awareness-raising: Perform environmental diagnoses Establish list of BMPs to be implemented	⇒	Farmers: Submit proposals Calculate the value of EBIs	⇒	Select offers on the basis of their cost-effectiveness in achieving the target EG&S (> EBIs are chosen first)	⇒	Implement the BMPs	⇒	Obtain the EG&S

This description implies that the target environmental objectives and their related BMPs are clearly defined. The proposals made by the producers must be analyzed and classified using environmental benefit indicators (EBIs) of varying complexity adapted to the specific characteristics of each case. These indicators express the relationship between the environmental benefit obtained (less phosphorus in water or habitat creation/preservation) and the price of a given proposal.

With auction systems, it is possible to respond to the information challenges that exist in designing agri-environmental policies. Although government decision-makers are more knowledgeable about how BMPs help achieve EG&S, they do not know the actual cost of applying these practices; in contrast, farmers are more knowledgeable about the actual cost of applying practices but do not know how such practices impact the environment. Through auctions, decision-makers inform producers about the environmental impacts of BMPs, while farmers, through their proposals, reveal the cost of implementing the practices to decision-makers.

Auctions reduce private costs because the competition for funds causes participating producers to propose prices as close as possible to their actual costs instead of trying to get as big a payment as possible. This system also enables governments to reach a greater number of farmers systematically and to establish agreements collectively.

Effluent Trading Schemes
Initially developed and applied with respect to air pollution in the United States, such schemes have flourished in the water quality improvement field. For this study, we will consider measures to improve water quality by reducing phosphorus-containing effluent from agricultural operations.

The effluent trading process is based on the fact that the costs of reducing pollution to a given target level are not uniform between system participants. Different pollution sources have different reduction costs, which is the basis for the motivation to trade. In fact, sources with high pollution control costs prefer to buy reductions or effluent permits from lower-cost sources rather than reducing their own effluent. Moreover, sources that had low reduction costs have an incentive to lower their effluent more than their permit requires, since they can then sell their effluent rights at a higher price than their reduction costs. Society thus wins overall because market forces achieve a given environmental objective by reducing effluent where this can be done at the lowest cost.

Despite the difficulties associated with implementing such programs (e.g., uncertainty of the effluent reductions associated with BMPs), their value is constantly growing because of several highly attractive characteristics:

1. This type of instrument is specific and can be adapted to individual situations – it is a decentralized system;
2. The approach is based on innovative procedures;
3. The participation of farmers and their local associations is a fundamental component – these are voluntary systems.

All things considered, the establishment of such systems is justified because of the major environmental challenges society is facing. In fact, this can be achieved where a formal target has been articulated for a particular watershed, and receptivity combined with government will exists at the national level to provide legal, institutional and financial support to such initiatives (pilot projects, etc.).

This study models a "cap and trade" system, which is based on the government's establishment of an absolute upper limit for all sources covered by the program. This limit is based on the target environmental objective. Permission to emit or discharge is then given to the participating sources, with the maximum value of the total number of permits corresponding to this upper limit. These permits can then be traded among participants. Permit trading allows each source to adopt a strategy specific to its particular circumstances and based on the relative costs of the basic option of either introducing practices or technologies to reduce effluent or purchasing permits from another program participant. As a result, the participants with the lowest effluent reduction costs ensure achievement of the target level. Such programs are thus more effective and reduce the total cost of achieving a defined environmental objective. Since the level of pollution is set by an absolute threshold (cap), this is also called a "closed" system.

Complete details on the choice and definitions of policy options are given in *Cost-Efficiency Analysis of Environmental Goods and Services Policy Options - Technical Report*, Section 2.

Choice of Priority Watersheds

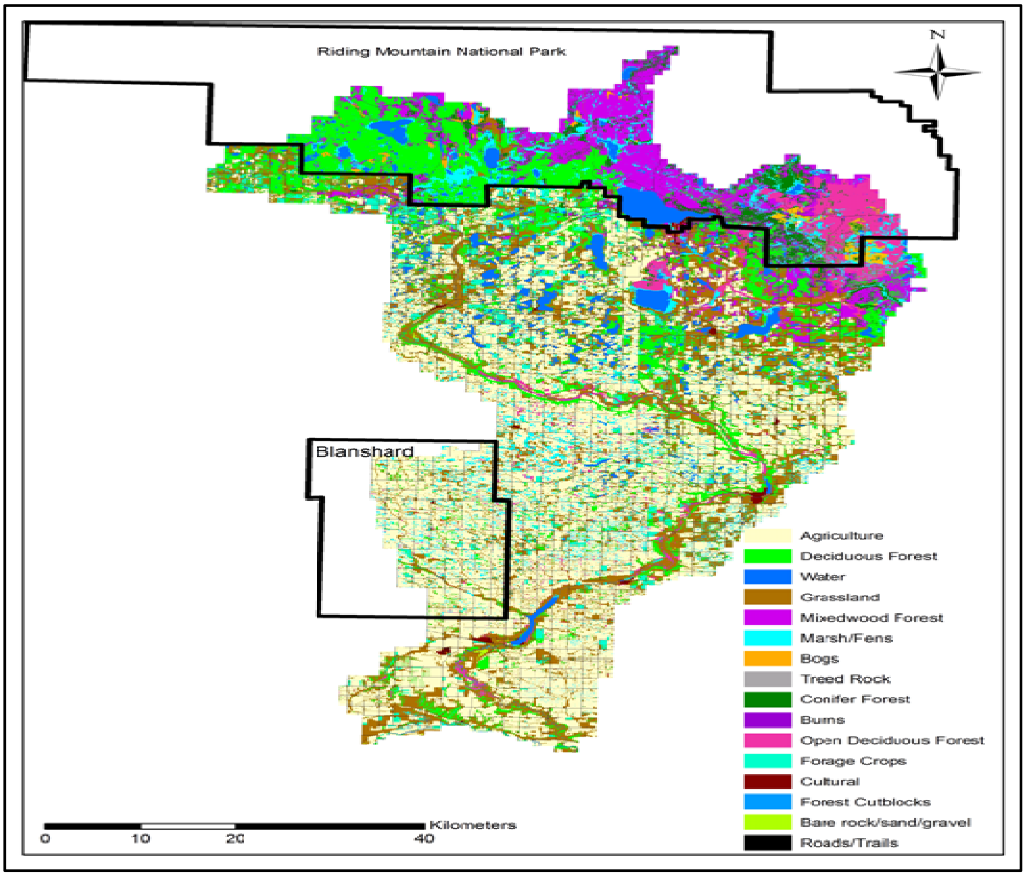
Objectives and Selection Criteria

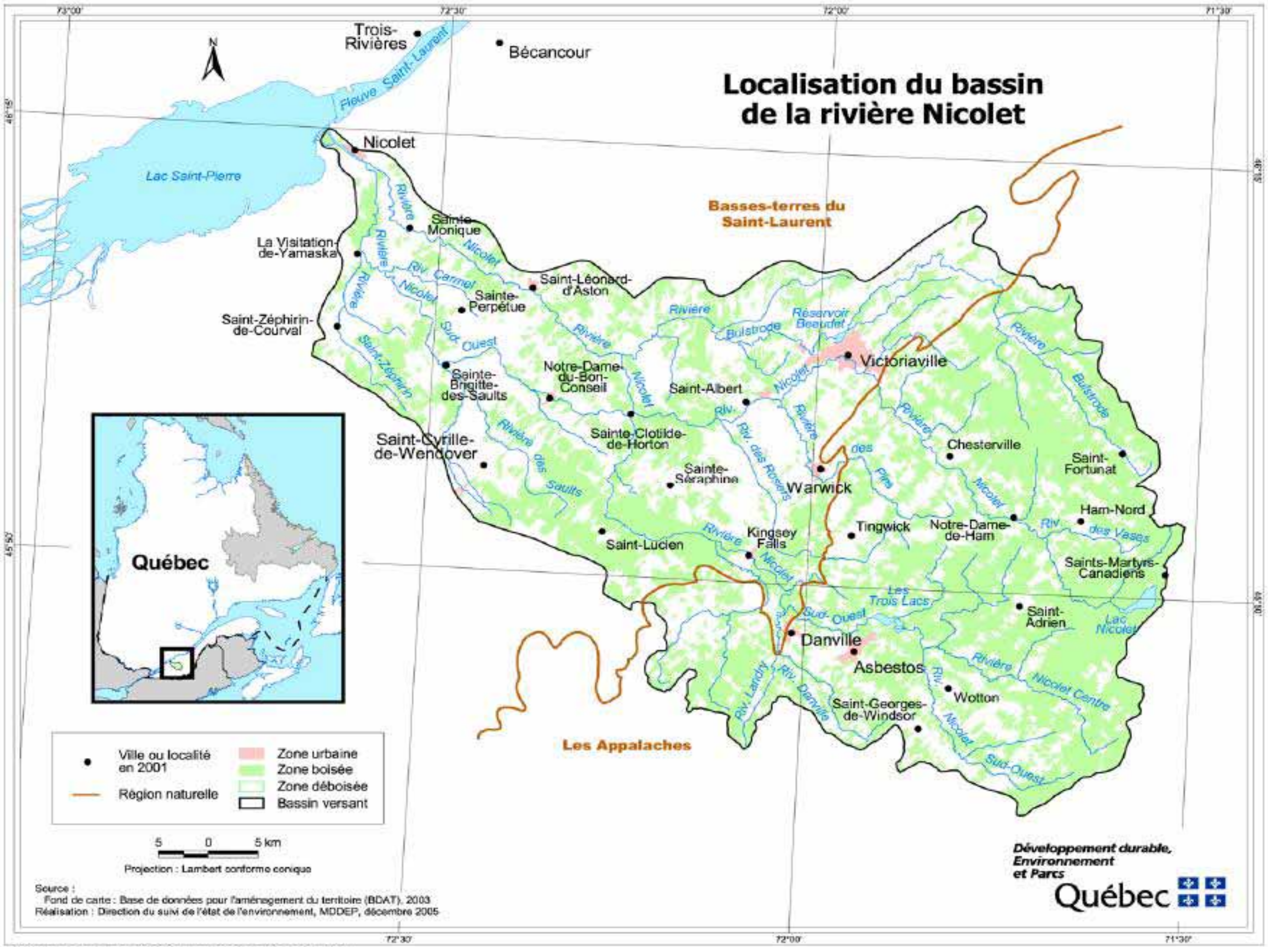
In order to compare the costs and benefits of various policies that promote the production of EG&S and to identify the ones that can achieve the target EG&S level at the lowest cost, our analysis began with the situation in a representative watershed chosen by pre-established evaluation criteria. These criteria cover:

- Watershed's geographic location;
- Only watersheds in major farming regions were considered;
- Watershed size;
- Watersheds less than 1,500 km2 were not considered;
- Watershed's agricultural value;
- More than 30% of the chosen watersheds should be suitable for cultivation;
- Diversity of agricultural practices;
- Shown by the watershed's animal density;
- Presence of agriculture-related environmental problems;
- To produce ecological goods and services, the chosen watershed has to have agriculture-related environmental problems; and
- Available data.
- These criteria are essential if we want to produce an accurate picture and plausible analysis of the territory.

The analysis determined that the two representative watersheds would be the **Little Saskatchewan River watershed in Manitoba** (Western Canada) and the **Nicolet sub-watershed in Quebec** (Central and Eastern Canada).

Little Saskatchewan Watershed





Direction du suivi de l'état de l'environnement, MDDEP, décembre 2005.

Details on the choice of representative watersheds are given *Cost-Efficiency Analysis of Environmental Goods and Services Policy Options - Technical Report*, Section 1.1.

Choice of Priority EG&S

This section identifies a wide range of EG&S and identifies two for use in this study: water quality from lower phosphorus and wildlife habitat.

The table below presents an extensive list of EG&S cited in the literature by various writers. This list includes 27 EG&S categorized according to the ecosystem functions they support. A glance reveals that some EG&S, including crop pollination and climate control, garner unanimous support, while others, such as ecosystem resistance to invasive species, are cited by only one or two writers.

		Daily (1997)	Costanza et al. (1997)	ESA	ESP	EcoValue Project	De Groot et al. (2002)	Firth (2004)
	Regulation Functions							
1	Purification of air	x		x			x	x
2	Climate regulation	x	x	x	x	x	x	x
3	Regulation of atmospheric chemistry		x			x	x	x
4	Protection from the sun's harmful UV radiation	x		x			x	x
5	Regulation of river flows and groundwater levels	x	x	x	x	x	x	x
6	Water supply		x			x	x	
7	Purification of water	x		x	x		(1)	x
8	Regulation of oceanic chemistry							x
9	Soil formation	x	x	x		x	x	
10	Renewal of soil fertility	x		x	x		x	x
11	Erosion control		x	x	x	x	x	x
12	Nutrient regulations and storage	x	x	x		x	x	x
13	Dispersal of seeds	x		x				
14	Waste absorption and breakdown	x	x	x	x	x	x	x
15	Disease control (Regulate disease carrying organisms)			x			x	x
16	Pollination of crops and natural vegetation	x	x	x	x	x	x	x
17	Ecosystem resistance to invasive species							x
18	Biological control of pests and pathogens	x	x	x	x		x	x
	Habitat Functions							
19	Provision of shade and shelter				x			
20	Provision of habitat for various organisms		x		x	x	x	
	Production Functions							
21	Production of food, fiber, turf, and fuel		x				x	x
22	Maintenance of biodiversity and generic resources	x	x	x	x		x	x
23	Medicinal resources						x	
24	Ornamental resources						x	
	Information Functions							
25	Aesthetic and spiritual amenities	x			x	x	x	
26	Recreation		x			x	x	
27	Support of diverse human cultures	x	x		x		x	

(1) De Groot et al.'s (2002) water supply function includes provision of water for consumptive use, which may cover the water purification function.
*Table format adapted from De. Groot et al.'s (2002) function-based taxonomy.

Based on the table, we are able to identify the EG&S likeliest to be influenced by agri-environmental measures. These EG&S are listed for different components of the natural and social environment. It is clear that beneficial management practices directly or indirectly generate a substantial number of EG&S. It thus becomes necessary to identify the EG&S that will be priorities for achieving the objectives of this study. Therefore, eliminating the EG&S seen as non-priority leaves us with the following EG&S as the focus of our analysis:

- Conservation/restoration of physical water quality;
- Conservation/restoration of biochemical water quality;
- Conservation/restoration of moisture balance;
- Conservation/restoration of biodiversity in wetlands and aquatic environments;
- Habitat creation;
- Conservation/restoration of recreational environments;
- Landscape protection.

Clearly, the EG&S listed above are associated with various types of social uses. Relatively readily quantifiable, significantly influenced by the introduction of BMPs and perceptible by the public, these EG&S are seen as priorities for our analytical purpose.

The priority EG&S identified are quantifiable at the biophysical level; the biophysical change is significant and is publicly perceivable. In the absence of data on all prioritized EG&S, we have chosen biochemical water quality and habitat creation. Biochemical water quality will be evaluated by the total phosphorus (TP) concentration (in mg/L) and habitat creation by wetland and woodland areas (in hectares). The table below summarizes these choices.

Priority EG&S chosen for this study	**Parameter**
Conservation/restoration of biochemical water quality	• Phosphorus concentration in water
Habitat creation	• Wetland areas • Woodland areas

Phosphorus Concentration in Water
Total phosphorus in surface water has long been seen as a good indicator of nutrient enrichment in these environments. Only a small portion of the phosphorus in soil is absorbed by plants and other organisms. Another portion is taken to waterways by runoff. Though part of a natural cycle, phosphorus is now in surplus in a number of worldwide aquatic environments, causing numerous surface-water eutrophication problems (algae blooms, massive aquatic plant growth, oxygen deficit, bad odours, fish mortality, etc.). In Quebec, agricultural activity is often cited as the main cause of exceeding environmental criteria for phosphorus concentration in water, while in western Canada, Lake Winnipeg water-quality concerns signal the presence of a similar problem.

In analyzing policies for the effective use of certain BMPs to improve the general condition of the environment and ecosystems, the use of this parameter (total phosphorus concentration in water) will very likely favour longer-term policies. As this element is heavily stored in soils, reductions cannot be measured and reported in the shorter term. Moreover, reducing phosphorus in water may potentially have indirect beneficial effects on other water-quality parameters like cloudiness and suspended solids.

Wetland Areas
Wetlands (marshes, swamps, seasonal ponds and peat bogs) attract a variety of wildlife. Wetlands are inhabited by various rare or threatened species. Their diversity of plant life, extent and depth make them indicators of environmental quality. According to Environment Canada, their degradation and

disappearance entail ecosystem losses and a negative impact on humans with whom they are closely linked. Indeed, wetlands play a role no other ecosystem can fill in terms of natural water-filtration capacity. By absorbing surplus nutrients and pollutants, wetlands not only improve water quality but also play a role in the recycling process for nutrients like nitrogen and phosphorus.

Wetlands also offer numerous socio-economic benefits inasmuch as they can bring economic spin-offs for adjacent communities through ecotourism. Wetlands are also of great interest for scientific research. Our use of this parameter in analyzing policies for the effective use of certain BMPs will promote economic development and the conservation of environmental biodiversity.

Woodland Areas
A number of ecological goods and services are associated with forests. They provide habitat for a number of species of flora and fauna, including some that are rare or threatened. This makes them essential for maintaining biological diversity. In the agri-environment, they can act as windbreaks to reduce wind erosion of soil. They also reduce surface runoff and the water erosion of soil, which improves water quality by reducing fertilizer and suspended-solid loadings. Furthermore, forests greatly assist groundwater replenishment.

Woodlands also play a socio-economic role by contributing to scenery quality and supporting tourism.

Target and Current Levels of Priority EG&S

The analysis acts on the assumption that, given the similarities in provincial agri-environments, in the resulting environmental problems and in BMPs that can be introduced there, the environmental objectives defined in Quebec's programs and policies are typical of the ones to be achieved across Central and Eastern Canada. Those defined in Manitoba's programs and policies are typical of the ones to be achieved across Western Canada.

The target levels for priority EG&S are derived from official environmental criteria. These include policies the Quebec and Manitoba governments have already adopted or Environment Canada guidelines regarding the minimum areas of habitat in a watershed.

	Nicolet (East) – Quebec (Eastern and Central Canada)	**Little Saskatchewan River – Manitoba (Western Canada)**
Water quality		
→ Phosphorus	◦ Target level: 0.036 mg/l (share of agriculture from the general target of 0.03 mg/l) ◦ Baseline: 0.041 mg/l (level of phosphorus at 85% uptake of regulated BMPs) ◦ Current level: 0.052 mg/l	◦ Target level: 0.05 mg TP/L ◦ Baseline/Current level: 0.20 mg TP/L
Wildlife habitat quality		
→ Wetland areas	◦ Maintaining existing wetlands ◦ Expanding the area of wetlands by reducing cropping on floodplains	◦ Expanding the area of wetlands
→ Woodland areas	◦ Maintaining existing woodlands	◦ Expanding the area of woodlands

Details on the priority levels of EG&S are given in *Cost-Efficiency Analysis of Environmental Goods and Services Policy Options - Technical Report*, Section 1.3.

Choice of Beneficial Management Practices (BMPs)

This section identifies and briefly describes all BMPs chosen to achieve the target levels of EG&S. The following table summarizes the various BMPs chosen in the two case studies.

	Water quality (phosphorus)	**Habitat (wetland and woodland)**	
		Wetlands	**Woodland**
Nicolet (East) (Quebec)	• Riparian buffer zones (wooded and grassy, 10 m) • Winter cover crops (for cereals and corn) • Conservation tillage (no-till and reduced till)	• Removing lands prone to flooding from production • Conservation of existing wetlands in agricultural zones	• Conservation of existing forests in agricultural zones
Little Saskatchewan River (Manitoba)	• Wooded riparian buffer zones (10 m) • Converting marginal farmland to wetlands • Winter cover crops • Conservation tillage (no-till) • Manure storage	• Converting marginal farmland to wetlands	• Wooded riparian buffer zones (10 m)

Water Quality (phosphorus)

The choice of suitable BMPs for achieving target EG&S levels was first conditioned by the availability of information on the effectiveness of each practice, especially for phosphorus. Of the existing coefficients of effectiveness in the literature, we settled on those of the South Nation Conservation Authority (2003) for their reduced information requirements and their ease of use. The South Nation coefficients allowed us to evaluate the impact of each BMP on a relatively equitable basis as they are established on the basis of a consensus of several experts from Ontario and a comprehensive review of BMP literature. These coefficients are used under the Total Phosphorus Management program pilot experience of the Ontario Ministry of Environment on water quality trading in the South-Nation watershed.

Closer to the Canadian Prairies, BMP efficiency rates have also been applied by the Idaho Soil Conservation Commission (ISCC) for a water quality trading program in the Lower Boise Watershed (ISCC, 2002). The efficiency rates do not differ significantly from those of South Nation Conservation. Each BMP related to phosphorus and chosen for this study is briefly presented in the following paragraphs.

Manure Storage

Though different storage modes (solid, semi-solid or liquid) affect the amounts of plant nutrients preserved in manure management, this beneficial management practice is heavily influenced by the spreading method and its timing and soil incorporation time. An ideal storage system should prevent nutrient loss during storage and provide enough capacity until the field is safely covered, and spreading should be done in a way that reduces nutrient runoff into ground and surface water.

Riparian Buffer Zones
Riparian buffer zones play an important role, not only in protecting water and habitat quality, but also in regularizing water flows and stabilizing banks. The term "zone" can denote various arrangements bordering bodies of water, such as areas exclusively composed of forage species or more varied vegetation with forage, bushes and trees. As a rule, species have to be suitable, hardy and non-invasive. In some cases, species sown in riparian zones may represent a source of income for the farmers.

Conservation Tillage (Reduced Till and No-till)
Conservation tillage is a beneficial management practice that leaves at least 30% of the soil surface covered by residues (stems, leaves, straw from the previous harvest) after seeding. This practice is divided into two major stages:

- a primary stage in which the soil is broken up or lifted instead of turned over; and
- a secondary stage in which the seed bed is prepared, the soil surface levelled (with one or two passes with an implement), and fertilizers and herbicides are incorporated.

This practice helps water quality in a number of ways, including by limiting water and wind erosion through better coverage and increased organic matter in the soil. Conservation tillage has various non-environmental advantages such as time savings in soil preparation. However, we must realize that the success of this BMP depends on the effective control of crops, weeds and residues.

Cover Crops
Generally speaking, cover crops are put in to offer protection in periods when commercial crops cannot be grown. These cover plants help to limit erosion and runoff. They reduce the amount of soil and nutrients moving toward surface waters. This practice's other advantages include organic soil enrichment and improved soil structure.

Converting Marginal Farmland to Wetlands
This practice involves transforming less productive agricultural land to wetlands so they can serve as habitats for various wildlife species while at the same time decreasing the level of phosphorus that leaches into rivers.

Habitat
In the case of habitat, the choice of BMPS is straightforward in both watersheds. For the Nicolet (East) sub-watershed the proposed BMPs are (1) removing lands prone to flooding from production, (2) conservation of existing wetlands and (3) conservation of existing forests. For the Little Saskatchewan River, they are (1) converting marginal farmland to wetlands and (2) the implementation of wooded riparian buffer zones.

Each BMP related to habitat and chosen for this study is briefly presented in the following paragraphs, except for those that are already presented in the water quality section.

Conservation of Existing Wetlands and Forests in Agricultural Zones
Mainly because they are so fertile, various wetlands and woodlands are cleared and planted every year. Generally speaking, this BMP would involve preserving wetlands and forests in farming areas, since these environments are all crucial for wildlife.

This type of intervention is new to agricultural environmental protection. Manitoba's Alternate Land Use Services (ALUS) project is certainly the most developed program of this kind in Canada at this time. On a case by case basis, it offers farmers compensation by the hectare for preserving a range of natural environments in agricultural districts. For wetlands, the level of compensation varies to reflect use, for example, if no agriculture is practised, if forage is harvested, or if livestock are pastured there. The BMP we used for our analysis is based on the first of these options: the conservation of wetlands and woodlands so that they remain in the wild state.

Removing Lands Prone to Flooding from Production
This practice involves restoring agricultural floodplains to their natural state so they can serve as habitats for various wildlife species. Like the conservation of wetlands and woodlands, the future generalization of this practice will basically be limited to the existing areas in the watersheds.
Details on the choice of BMPs are given in the *Cost-Efficiency Analysis of Environmental Goods and Services Policy Options - Technical Report*, Section 1.4.

BMP Adoption Rates Needed to Attain Environmental Targets

This section briefly reviews the practices that are chosen for each policy, the adoption rates of these practices and the environmental improvements that are achieved.

The selection of BMPs for each policy is based on several principles that are briefly summarized below. Each BMP portfolio reaches the water quality and habitat targets.

For one-time payments, we consider only BMPs that do not involve annual costs, except for opportunity costs. When annual costs are involved, annual payments are automatically used because otherwise producers would have a strong incentive not to respect their obligations while at the same time keeping the one-time payment they already received. Thus, for the Nicolet (East), one-time payments are used for grassed riparian buffers because no annual maintenance is needed, while annual payments are considered appropriate for wooded riparian buffer zones because they involve important annual maintenance. Using the same principle, cover crops should be financed via one-time payments because annual costs of seeding and ploughing are marginal. On the other hand, because the agricultural soils of the Nicolet are considered rich in minerals, producers don't perceive the benefits of this practice and thus do not adopt it even if annual costs are minimal. To help them bypass this barrier, annual payments that cover their annual costs are also considered for this practice, along with an initial payment for technical assistance.

The selection of BMPs for the mixed one-time/annual payments is based respectively on their cost per kilogram of phosphorus eliminated and on their cost per hectare of habitat preserved. Thus, the most efficient BMPs in terms of $ per unit of environmental benefit are chosen until environmental targets are reached. The others are eliminated.

For market-based instruments, BMPs are also selected based on their cost per unit of environmental benefit, but here we consider that producers receive their real cost and not the average one estimated within the incentive program. Thus, adoption rates are different from those found in the mixed policy, even if the BMPs happen to be identical.

Target adoption rates for phosphorus BMPs are chosen on the basis of two factors: (1) some realistic levels we obtained after consulting agronomists from the respective regions and (2) the constraint of achieving the phosphorus target. While the realistic level is respected when enough choice of BMPs is available, we exceed it when no other BMPs are available to achieve the phosphorus target for that policy. This is the case of wooded riparian buffers on the Nicolet (East) watershed. Even if a 60% adoption rate is considered quite realistic for this region, we use 80% because both other available BMPs reach or even exceed their realistic adoption level (80% for cover crops and 20% for intercropping or cover crops for corn).

BMP portfolios by policy for the Nicolet (East) watershed

	Target adoption rates					**Water quality target**	**Habitat target**
	One-time payments	**Annual payments**	**Mixed one-time/ annual payments**	**Auctions**	**Tradable permits**		
Wooded riparian buffers	-	80%	-	-	-	0.036 mg TP/L	-
Grassy riparian buffers	60%	-	60%	50%	50%		
Cover crops for cereals	40%	80%	40%	94%	94%		
Intercropping	-	20%	-	-	-		
Reduced tillage and no-till	70%	-	70%	12%	12%		
Woodland preservation	3%	3%	3%	4.23%	-	-	1,165 ha (825 ha of woodland, 310 ha of wetlands & 30 ha of floodplains) or (1,165 ha of woodland)
Wetland preservation	80%	80%	80%	-	-		
Removing lands prone to flooding from production	80%	80%	80%	-	-		

BMP portfolios by policy for the Little Saskatchewan watershed

	Target adoption rates					Water quality target	Habitat target
	One-time payments	Annual payments	Mixed one-time/ annual p.	Auctions	Tradable permits		One-time & annual payments
Cover crops for cereals	-	8%	-	1.8%	1.8%	0.050 mg TP/L	-
Manure storage	5%	-	6.03%	0.01%	0.01%		
Converting marginal farmland to wetlands	3%	3%	-	-	-		550 ha (of wetlands or terrestrial habitat)
Wooded riparian buffers	-	80%	-	-	-		
Grassy riparian buffers	80%	-	100%	100%	100%		

It is important to mention that both environmental objectives remain constant across policies in both watersheds: 0.036 mg TP/L and 1,165 ha of habitat for Nicolet (East) and respectively 0.05 mg TP/L and 550 ha of habitat for the Little Saskatchewan River. On the other hand, because the habitat objective varies in terms of its composition on both watersheds (e.g., 550 ha of wetlands for one-time and annual payments and 550 ha of terrestrial habitat for the other policies in the Little Saskatchewan case), the associated monetary benefits also vary.

The methodology used to estimate the level of BMP adoption needed to achieve the EG&S targets is described in *Cost-Efficiency Analysis of Environmental Goods and Services Policy Options - Technical Report*, Section 1.5 and Section 2.

Public Costs of Policy Implementation

The following table summarizes the payments needed to implement BMPs to reach EG&S targets for each of the five policies examined.

Total payments of different policies in the Nicolet (East) and the Little Saskatchewan watersheds

	Total payments of different policies in the Nicolet (East) watershed (Million $)	Total payments of different policies in the Little Saskatchewan River (Million $)
One-time payments	1.75	2.55
Annual payments	4.2	6.71
Mixed one-time/annual payments	1.68	0.60
Auctions	1.06	0.35
Tradable permits (for P only in Nicolet)	0.55	0.32

Source: ÉcoRessources Consultants computations.

It is clear that the payment levels for market-based policies (auctions and tradable permits) are lower than payment levels for direct payments policies. The methodology used to estimate these costs is given in *Cost-Efficiency Analysis of Environmental Goods and Services Policy Options - Technical Report*, Section 3.2.1.

The public transaction costs of administering these options are given in the following table as a share of program payments. As a share of payments, one-time payments are the least expensive, while tradable permit systems are the most expensive to deliver.

Public transaction costs of the various policies

Policy	**Public transaction costs (% disbursements)** (Nicolet)	**Public transaction costs (% disbursements)** (Little Saskatchewan River)
One-time payments	9.4	9.4
Annual payments	11.1	11.1
Mixed one-time/annual payments	11.1	11.1
Auction system	11.9	11.9
Tradable permit system	13.8	26

The methodology used to estimate these costs is found in *Cost-Efficiency Analysis of Environmental Goods and Services Policy Options - Technical Report*, Section 3.2.2.

Monetary values of Environmental Targets

This report estimates the monetary value of environmental improvements through the Benefits Transfer method. This method applies econometric results from other similar studies to the specific environmental targets specified in this study. The methodology draws mainly on meta-models developed by Thomassin and Johnston (2008) for surface water quality and Borisova-Kidder (2006) for wetland and terrestrial habitat.

The value of the improvements is based on the willingness-to-pay of residents of the watersheds covered by the studies for improvements in water quality and habitat over the nine-year period of the improvements. Improvements include drinking, fishing and swimming qualities, wildlife viewing and open space for habitat.

The benefit estimates in this study are similar to those of similar studies, such as Olewiler (2004) and Thomassin and Johnston (2008).

For example, improvements in water quality due to meeting the phosphorous targets in this study are valued at about $10 per household per year in the Nicolet (East) watershed and about $19 per household per year in the Little Saskatchewan River watershed. Details on the monetary values of the environmental benefits of the targeted improvements are provided in *Cost-Efficiency Analysis of Environmental Goods and Services Policy Options - Technical Report*, Section 4.

Benefit-Cost analysis of the Different Policies

In this section, we analyze the relationships that exist between the environmental benefits obtained and the total costs of the policies for the two watersheds in question, Nicolet (East) and the Little-Saskatchewan River.

The following table shows the total cost of the policies in the Nicolet (East) watershed and in the Little Saskatchewan River, as well as the proportion of expenditures required to achieve each environmental benefit: water quality improvement and habitat creation. These estimates combine the program payments and the transaction costs given in the previous section.

The table shows that in both cases, the cost of implementing policies based on government payments is significantly higher than the cost of implementing market-based instrument policies. Annual payments policy costs are more than two times higher than those of one-time payments, eight times higher than those of a policy based on tradable permits in the Nicolet (East) watershed but less than the costs of the same policy in the Little Saskatchewan case.

Total cost of policies in the Nicolet (East) and Little Saskatchewan watersheds

	One-time payments	Annual payments	Mixed one-time/annual payments	Auctions	Tradable permits
Nicolet (East) watershed million $					
Total water costs	1.50	5.25	1.51	0.82	0.62
Total habitat costs	0.67	0.61	0.61	0.37	-
Total costs	**2.17**	**5.85**	**2.11**	**1.19**	**-**
Little Saskatchewan watershed million $					
Total water costs	2.82	7.46	0.68	0.40	0.40
Total habitat costs	0.23	0.29	0.32	0.32	0.32
Total costs*	**2.82**	**7.46**	**0.68**	**0.40**	**0.40**

*In the case of Western Canada, some BMPs that have an impact on water quality also improve the habitat, and there is no BMP specific to habitat that is not taken into account for water quality. This is why total payments equal the payments for water quality improvement.

However, a more detailed analysis shows that efforts required to reach the water quality improvement target are greater than the efforts needed to preserve habitats on both watersheds. Moreover, in the case of an auction-based policy, the one-time payments policy and the mixed policy, around two-thirds of the costs go towards reducing phosphorous in Nicolet (East) watercourses, whereas only one-third is needed to achieve the habitat preservation target. In the case of the annual payments policy, 90% of the costs is used to achieve the target of expected reduction in phosphorous, and only 10% is needed to preserve habitats inside the Nicolet (East) watershed.

The next table shows the relationship between the value of environmental benefits obtained and the total cost of the policies in the Nicolet (East) watershed. From the outset, we see that if we consider the total value of the environmental benefits obtained through the various BMPs, establishing all these policies is justified because in each case, the benefit/cost ratio is well over 1.

Ratio of environmental benefits obtained /Total costs in the Nicolet (East) watershed

	One-time payments	**Annual payments**	**Mixed one-time/annual payments**	**Auctions**	**Tradable permits** (for P only)
(G) Benefit/cost ratio - water (A/D)	1.05	0.30	1.04	1.91	2.53
(H) Benefit/cost ratio - habitat (B/E)	4.23	4.68	4.68	6.79	-
(I) Benefit/cost ratio – water & habitat (C/F)	2.03	0.75	2.08	3.43	-

The picture varies, however, according to the type of benefit obtained. Therefore, in terms of water quality improvement, although most of the policies yield net benefits, the annual payment policy presents a situation in which the total benefits represent only 30% of the costs. Therefore, taken separately, the annual payments policy aimed at achieving water quality is not socially profitable.

As for habitat creation — for which the value of benefits is vastly superior to that for water quality improvement — net benefits are achieved with every policy analyzed for this environmental benefit.

In the Nicolet (East) case, market-based instruments have the best results in terms of benefit/cost ratios for each environmental benefit as well as for the two benefits considered together. If we consider both benefits (water quality and habitat creation), the auctions-based policy has the best benefit/cost ratio (3.43), followed by the mixed one-time/annual payment policy (2.08) and the one-time payment policy (2.03). The annual payment policy has the lowest benefit/cost ratio of all policies examined (0.75).

The benefit-cost ratio numbers for the Little Saskatchewan present almost the same outcome as those of Nicolet (East) in the sense that conclusions do not change with respect to the efficiency of the different policies considered. As in the Nicolet (East) case, market-based instruments have the best results in terms of benefit/cost ratios for water quality. If we consider both benefits (water quality and habitat creation), the auctions-based policy has the best benefit/cost ratio (3.85), followed by tradable permits (3.81), mixed payments (2.24) and one-time payments (0.19). The annual payment policy has the lowest benefit/cost ratio of all policies examined (0.07).

Benefit-cost ratios for the Little Saskatchewan River are generally lower than those of Nicolet (East), and this is explained by two factors. First of all, the population of this watershed is much lower than the population of Nicolet (East), generating much lower water quality benefits in spite of the fact that the value per household is higher (because of the higher improvement in water quality). This generates lower benefit-cost ratios for water quality improvement. Only market-based instruments yield net benefits when water quality is the single environmental objective (1.23 and 1.24 respectively). Secondly, because the habitat objective is lower for this watershed, benefit-cost ratios for habitat are also lower but still much higher than 1 for all policies. If we consider both benefits, one-time payments and annual payments are not socially desirable (0.19 and 0.07) because of the impact of low water benefits and high costs.

Ratio of environmental benefits obtained /Total costs in the Little Saskatchewan Watershed

	One-time payments	Annual payments	Mixed one-time/annual payments	Auctions	Tradable permits (for P only)
Ratio					
Benefit-cost ratio - water	0.17	0.07	0.72	1.24	1.23
Benefit-cost ratio - habitat	0.16	0.12	3.27	3.25	3.21
Benefit-cost ratio – water & habitat	0.19	0.07	2.24	3.85	3.81

Extrapolation of Costs and Benefits

In order to generalize the conclusions of this study for all of Canada, we extrapolated the total public costs of the policies and the monetary environmental benefits they generate. Precisely, the costs and benefits estimated for the Nicolet (East) watershed are up-scaled at the level of Central and Eastern Canada (Ontario, Quebec, New Brunswick, Nova Scotia, Prince Edward Island and Newfoundland and Labrador) and those for the Little Saskatchewan River at the level of Western Canada (British Columbia, Alberta, Manitoba and Saskatchewan). Because the necessary data for a detailed extrapolation was not entirely available in the short period of time allocated for this exercise, the results must be carefully interpreted.

Extrapolation of Costs

The total public costs of the policies considered are scaled-up at the level of all agricultural watersheds of the two regions for both water quality and habitat benefits. Ideally, water quality benefits should be extrapolated only at the level of agricultural watersheds that present phosphorus problems, but because this kind of data is not available in time, we use the larger scale of all agricultural watersheds. As a consequence, costs are overestimated.

Basically, we first scale-up the payments that agricultural producers receive for adopting targeted BMPs and afterwards apply the % of public transaction cost to estimate total public costs. For all BMPs, we use a unitary payment per kg of phosphorus together with the South Nation phosphorus coefficient and the total area of cultivated land or manure. Target adoption rates for water quality BMPs remain the same as those used at the watershed level. As a consequence, we implicitly suppose that the target level of phosphorus is achieved at the level of the two regions at these adoption rates. On the other hand, the target for habitat is re-evaluated at the level of the two regions because it is defined in terms of number of hectares.

Several sources of data are used for the scale-up of costs:

1. For water quality BMPs, we use data on crop areas in agricultural watersheds, which are defined as the watersheds that have more than 5% of their area covered by cultivated land. This data is provided by the Agri-Environmental Policy Bureau of Agriculture and Agri-Food Canada.

2. For the manure storage BMP, we use data from the Census of Agriculture 2006 on the number of cattle in Western Canada.

3. For wetland BMPs in Central and Eastern Canada, we use data on the area of wetlands in agricultural watersheds, which is also provided by the Agri-Environmental Policy Bureau of Agriculture and Agri-Food Canada.

4. Finally, for woodland BMPs in Central and Eastern Canada, we use data on the area of forests in agricultural regions of Quebec, compute the percentage of preserved forests on the Nicolet (East) watershed, apply this percentage to the area of forests in Quebec (agricultural regions only) and adjust the area of protected forests for each province as a function of the total area of the province. These computations are necessary because we don't have access in time to data on the area of forests in agricultural watersheds of the two regions.

5. In Central and Eastern Canada, annual payments remain the most expensive ones with a total of $1,334 million. The general ranking does not change either: market-based mechanisms remain the least expensive instruments for achieving environmental targets ($762 million for auctions) followed by mixed one-time/annual payments ($898 million), one-time payments ($898 million) and annual payments. This ranking remains unchanged for Western Canada, as well as for the whole of Canada. In the west, market-based mechanisms are the least expensive ($107 million for tradable permits) followed by mixed one-time/annual payments ($180 million), one-time payments ($4,485 million) and annual payments ($1,175 million).

Aggregated payments for Canada

Central and Eastern Canada (million $)

	One-time payments	Annual payments	Mixed policy	Auctions	Tradable permits
Water quality	613	1,049	613	418	314
Habitat	285	285	285	343	-
Total	**898**	**1,334**	**898**	**762**	**314**

Western Canada ($ millions)

	One-time payments	Annual payments	Mixed policy	Auctions	Tradable permits
Water quality	485	1,175	180	119	107
Habitat	38	48	54	54	48
Total*	**485**	**1,175**	**180**	**119**	**107**

Canada ($ millions)

Water quality	1,098	2,224	793	537	421
Habitat	323	333	339	397	48
Total	**1,421**	**2,557**	**1,132**	**934**	**469**

*In the case of Western Canada, some BMPs that have an impact on water quality also improve the habitat, and there is no BMP specific to habitat that is not taken into account for water quality. This is why total payments equal the payments for water quality improvement.

Total public costs for all policies and both regions, split by environmental objective (water quality and habitat) are summarized in the table below. These costs show that in both regions and for the whole Canada, the cost of implementing policies based on government payments is significantly higher than the cost of implementing market-based instrument policies. Moreover, efforts required to reach the water quality improvement target are greater than the efforts needed to preserve habitats. These results confirm those obtained at the watershed level.

Aggregated total public costs for Canada

	One-time payments (million $)		**Annual payments** (million $)		**Mixed one-time/annual payments** (million $)		**Auctions** (million $)		**Tradable permits** (for P only) (million $)	
	Central and Eastern Canada	Western Canada	Central and Eastern Canada	Western Canada	Central and Eastern Canada	Western Canada	Central and Eastern Canada	Western Canada	Central and Eastern Canada	Western Canada
Total water costs	677	536	1,166	1,306	687	202	477	136	358	123
Total habitat costs	315	43	317	54	319	61	391	62	-	56
Total costs[1]	**992**	**536**	**1,483**	**1,306**	**1,006**	**202**	**868**	**136**	**358**	**123**
	1,528		**2,789**		**1,208**		**1,004**		**481**	

The following table gives provincial estimates of the total costs of implementing the five policy options.

[1] In the case of Western Canada, some BMPs that have an impact on water quality also improve the habitat, and there is no BMP specific to habitat that is not taken into account for water quality. This is why total payments equal the payments for water quality improvement.

Public costs of the different policy options, by province, for both phosphorus reduction and habitat protection

Province	Costs ($ millions)				
	1-time payments	Annual payments	Mix: Annual and 1-time payments	Auctions	Tradable permits
Prince Edward Island	19	27	20	14	10
Nova Scotia	18	25	18	13	4
New Brunswick	30	36	30	19	7
Quebec	347	507	352	344	114
Ontario	542	852	549	426	223
Newfoundland and Labrador	36	37	37	52	0
Manitoba	78	192	27	19	17
Saskatchewan	249	636	69	51	46
Alberta	197	454	96	61	55
British Columbia	13	23	10	6	5
Canada	**1 528**	**2 789**	**1 208**	**1 004**	**480**

Extrapolation of Benefits

The benefits scale-up procedure follows exactly the same steps as the monetary evaluation of benefits at the level of the two watersheds. The majority of variables keep the same values as those used at the watershed level, except for variables representing revenue, number of households, hectares of woodland and wetland preserved and the proportion of wetlands in the province.

In the case of water quality benefits, we consider that all households of a province, not only those living on the watersheds that present phosphorus problems, appreciate the water quality improvement of those watersheds. To compute monetary benefits linked to phosphorus reduction, all data remains identical to the one used at the watershed level, except for the following:

1. The revenue variable is given the value of the median household income before taxes of each province. The data comes from Statistics Canada's 2006 Census of Population (Table 111-0009) and is transformed into 2002 US$.

2. The willingness to pay per household is multiplied by the total number of households of the province (from the 2006 Census of Population).

To compute monetary benefits linked to wetland preservation, all data remains identical to the one used at the watershed level, except for the following:

1. The revenue variable is given the value of the median household income before taxes of each province. The data comes from Statistics Canada's 2006 Census of Population (Table 111-0009) and is transformed into 2003 US$.

2. The variable “Proportion of wetland in the region” receives the value specific to all agricultural watersheds of the province. This data is provided by the Agri-Environmental Policy Bureau of Agriculture and Agri-Food Canada.

3. Finally, to compute the value of the variable “Acres (ln)” (acres of wetland preserved - ln) we compute for each of the two watersheds the percentage of preserved wetland from all wetlands of the watershed, consider this percentage as representative for all provinces of the respective region and apply it to the area of wetlands in agricultural watersheds to obtain the area of wetlands to be preserved at the level of each province. The detailed computations are presented in Appendix 27, after the one-time payments for Central and Eastern Canada.

To compute monetary benefits linked to woodland preservation, all data remains identical to the one used at the watershed level, except for the value of the variable “Acres (ln)” (acres of woodland preserved - ln). As for wetland preservation, (1) we compute for each of the two watersheds the percentage of preserved woodland from all woodlands of the watershed, but because no data is available in time on the area of forests in agricultural watersheds of the two regions, we use this percentage only for the provinces of Quebec and Manitoba respectively to (2) compute the area of preserved woodlands in theses provinces by applying the percentages to Quebec/Manitoba’s forests in agricultural regions and (3) adjust the result for the other provinces as a function of their territory compared to Quebec or Manitoba. The detailed computations are presented in Appendix 27 (after the one-time payments for Central and Eastern Canada).

The habitat benefit for Central and Eastern Canada is different for auctions because the composition of this objective is also different. More specifically, the habitat objective is composed of a mix of wetlands and woodlands for one-time payments, annual payments and mixed payments; it only refers to woodlands for auctions. The composition of the habitat benefit for Western Canada also varies by policy: one-time and annual payments refer to wetlands, and all other policies refer to woodlands. While the composition of the habitat objective is different across policies in both regions, the total number of hectares remains constant in order to maintain the same level of habitat preservation.

Water quality benefits are much higher in Central and Eastern Canada ($632 million) than in Western Canada ($273 million). The difference is explained by the total number of households, which is much higher in the east than in the west. Habitat preservation value is even higher in the east ($2,452 million or $3,257 million) than in the west ($17 million or $257 million) because the habitat objective is much higher in the east (1615 ha versus 500 ha), and one unit of habitat is more valued. These results are similar to those obtained at the watershed level.

Table 1 : Aggregated Benefits for Central & Eastern Canada and Western Canada

	Central & Eastern Canada	Western Canada
	Million $	
	For one-time, annual & mixed payments	For one-time & annual payments
Water quality	**632**	**273**
Habitat (wetland)	**404**	**17**
Habitat (woodland)	**2,048**	**-**
Total	**3,086**	**289**
	For auctions	For mixed payments, auctions and tradable permits
Water quality	**632**	**273**
Habitat (woodland)	**3,257**	**257**
Total	**3,890**	**530**
	For tradable permits	-
Water quality	**632**	
Total	**632**	

Benefit-Cost Analysis of the Different Policies

The conclusions generated by the benefit-cost analysis at the aggregated level of the two regions are very close to those derived from watershed estimations. If we consider the total value of the environmental benefits obtained through the various BMPs, establishing all these policies is justified because in each case, the benefit/cost ratio is well over 1. This result corresponds to the one obtained at the watershed level.

Benefit/cost ratios for Central and Eastern Canada

	One-time payments	Annual payments	Mixed one-time/annual payments	Auctions	Tradable permits (for P only)
Million $					
(A) Water benefits	633	633	633	633	633
(B) Habitat benefits	2,453	2,453	2,453	3,257	-
(C) Total benefits (A+B)	3,086	3,086	3,086	3,890	-
million $					
(D) Total water costs	677	1,166	687	477	358
(E) Total habitat costs	315	317	319	391	-
(F) Total costs (D+E)	992	1,483	1,006	868	-
(G) Benefit-cost ratio - water (A/D)	**0.93**	**0.54**	**0.92**	**1.33**	**1.77**
(H) Benefit-cost ratio - habitat (B/E)	**7.79**	**7.74**	**7.69**	**8.33**	**-**
(I) Benefit-cost ratio – water & habitat (C/F)	**3.11**	**2.08**	**3.07**	**4.48**	**-**

The picture varies, however, according to the type of benefit obtained. Thus in terms of water quality improvement, only market-based instruments yield net benefits (1.33 for auctions and 1.77 for tradable permits). The benefit-cost ratios for one-time payments, mixed one-time/annual payments and annual payments are less than 1, even very close to 1 for the first two policies (0.93 and 0.92 respectively). Therefore, taken separately, these three policies are not socially profitable when their unique target is water quality improvement. This result is different from the one obtained at the watershed level where only annual payments are not socially desirable. On the other hand, the ratios for one-time and mixed payments only slightly surpass 1 at the watershed level, meaning they are very close to those obtained for Central and Eastern Canada.

As for habitat creation — for which the value of benefits is vastly superior to that of water quality improvement — net benefits are achieved with every policy analyzed for this environmental benefit. The tradable permit policy has the best results in terms of benefit/cost ratios for water quality (1.77). If we consider both benefits (water quality and habitat creation), the auction-based policy has the best benefit/cost ratio (4.48), followed by the one-time payment policy (3.11), mixed policy (3.07) and annual payment policy (2.08) which has the lowest benefit/cost ratio of all policies examined. This ranking is almost identical to the one estimated for Nicolet (East).

As in the Central and Eastern Canada case, market-based instruments have the best results in terms of benefit/cost ratios for water quality, habitat and the two environmental objectives considered together. If we consider both benefits (water quality and habitat creation), the tradable permits policy has the highest benefit/cost ratio (4.33), followed by auctions (3.89), mixed payments (2.62) and one-time payments (0.54). The annual payment policy has the lowest benefit/cost ratio of all policies examined (0.22).

The tradable permit policy has the best results in terms of benefit-cost ratios for water quality (2.23). The value of habitat benefits is vastly superior to that for water quality improvement — net benefits are achieved with every policy analyzed for this environmental benefit. All these results are similar to those estimated for Little Saskatchewan River.

Ratio of environmental benefits obtained /Total costs in Western Canada

	One-time payments	Annual payments	Mixed one-time/annual payments	Auctions	Tradable permits
Million $					
(A) Water benefits	273	273	273	273	273
(B) Habitat benefits	17	17	257	257	257
(C) Total benefits (A+B)	289	289	530	530	530
Million $					
(D) Total water costs	536	1,306	202	136	123
(E) Total habitat costs*	43	54	61	62	56
(F) Total costs (D)	536	1,306	202	136	123
(G) Benefit-cost ratio - water (A/D)	**0.51**	**0.21**	**1.35**	**2.00**	**2.23**
(H) Benefit-cost ratio - habitat (B/E)	**0.39**	**0.31**	**4.23**	**4.16**	**4.62**
(I) Benefit-cost ratio – water & habitat (C/F)	**0.54**	**0.22**	**2.62**	**3.89**	**4.33**

*In the case of Western Canada, some BMPs that have an impact on water quality also improve the habitat, and there is no BMP specific to habitat that is not taken into account for water quality. This is why total payments equal the payments for water quality improvement.

Conclusions

Before we present the results of our study, some background information is needed. Firstly, the design of the policy has an impact on its cost. The set of BMPs selected is the key to the effectiveness of the policy in terms of the ecological goods and services derived relative to their cost. Moreover, certain practices are more cost-effective than others in achieving environmental objectives.

Secondly, the distinction between one-time and annual payment policies is fictitious, because in theory, an annual payment can always be converted into a one-time payment and vice versa. Thus for a given adoption rate, it is not the method of payment that distinguishes the two programs, but rather the set of BMPs selected. In the case of Quebec, for instance, the cost difference between the one-time and annual payment policies reflects the choice of BMPs and their effectiveness, not the effectiveness of either of the two payment policies per se.

More specifically, with respect to the policies, the results obtained are consistent with economic theory and with the literature. Indeed, policies based on market-based instruments (auctions and permit trading systems) are more efficient. Government can get better value than in the case of direct payment policies where there is an asymmetry of information between public policy-makers and producers, who have more information about their preferences, costs and opportunities (knowledge of technology) (Godard, 2008). Furthermore, according to Stoneham et al. (Stoneham et al., 2007), in Australia’s experience, market-based instruments (auctions, permit trading systems, etc.) create an economic environment in which agricultural producers are able to make the optimal choice between the production of goods and the creation of ecological goods and services.

However, market-based mechanisms entail higher public transaction costs. Concerning auction, information problems are resolved as policy-makers inform producers of the environmental impacts of BMPs, and through the bids made, producers reveal to policy makers the costs of implementing the practices. Auctions make it possible to reduce costs, because competition for funding leads producers participating in the program to make bids that are as close as possible to their true costs, rather than seeking to maximize the amount received (Eigenraam et al., 2005). However, an increase in public transaction costs can be expected due to the specific needs associated with the implementation of auction systems: development of a specific environmental diagnostic associated with parcels of land or a set of parcels (Australian approach) or the use of environmental benefits indicators (U.S. approach).

Permit trading systems are not universally applicable and require that certain conditions be met before they can be implemented. Tradable permits apply only to contaminants regulated through standards that are the subject of legal authorization. BMPs related to biodiversity (wetlands and forest cover) cannot easily be taken into consideration with a permit trading system. Besides, fewer government resources are needed to achieve the objective than with other policies for a given level of EG&S derived, since part of the payments would come from the private sector (point sources).

Transaction costs are also higher than in the case of direct payment policies, because there is one more intermediary at the watershed level for the issuance of permits. The amortization of system implementation costs must also be taken into account, which is more complex than in the traditional system of subsidies. The implementations costs can be allocated 1) to the institutional and legal adjustments necessary to make the system work 2) to the operational mechanisms needed and 3) to the social acceptability of the system. However, the achievement of the target and, therefore, the benefits, depends on the growth of point sources in a watershed. Thus, a policy likely cannot be based exclusively on the implementation of a permit trading system to achieve a given objective if a specific time line is adopted. It must be integrated with other mechanisms that provide payments for implementing BMPs. It can therefore be designed as a complementary mechanism.

The following conclusions can also be drawn from our analysis:

- The analysis was based on two representative watersheds: the Nicolet (East) sub-watershed in Quebec and the Little Saskatchewan River watershed in Manitoba.

- The desired environmental benefits analyzed in the CBA are: a reduction of phosphorous concentrations to levels close to those of the National Agri-Environmental Standards Initiative (NAESI) and the maintenance or enhancement of wildlife habitats.

- Measurements of the value and cost of ecological services should be treated with caution. The above estimates are very approximate and have a large margin of error. This margin of error is large because of uncertainty at several stages of the estimation process, including the impact of particular BMPs on nutrient levels, the costs to producers of adopting BMPs, the value that residents of a watershed place on environmental improvements and the extrapolation of results from two local areas to provincial and national levels.

- Preliminary results suggest that to achieve the desired environmental benefits for water quality and habitat at a national scale, aggregated total public costs for Canada would be as follows:

    - $2.8 billion, if delivered through an annual payment policy;
    - $1.5 billion, if delivered through a one-time payment policy;
    - $1.2 billion, for an optimal mix of one-time and annual payments;
    - $1 billion, if delivered through an auction based policy tool; and
    - $480 million, if delivered through a tradable permit policy;

- The benefits of achieving the desired environmental goals could be worth up to $3.9 billion to the Canadian public, in terms of increased income and recreation, reduced cleanup costs, and other benefits.

- Indications suggest that annual acreage payments are generally the least economically efficient of the policy tools examined, although they can be equivalent to one-time payments for certain BMPs (Beneficial Management Practices).

- Although market-based mechanisms entail higher public transaction costs, government can still get better value than in the case of direct payment policies where there is an asymmetry of information between public policy-makers and producers, who have more information about their preferences, costs and opportunities.

- Program design will direct the decisions made by the producer in terms of practices to implement and the environmental benefit obtained. The producer will agree to implement the practice only if their opportunity costs are compensated by the policy.

- The cost of the various policies depends on the BMPs selected, on geographic scale (watershed level), on selection mechanisms (auctions, tradable permits, others), and on the established payment level.

- One of the possible options for reducing the cost of the policies is to provide guidance to producers on the choice of practices to be implemented. More specifically:

    - The most effective BMPs should be prescribed first, until the desired environmental objectives are achieved.
    - Relative incentives for specific practices should be determined on the basis of their environmental performance.
    - In the case of practices contributing to the achievement of several EG&S at one time, a value should be assigned to each desired environmental benefit.

- However, these solutions present several disadvantages:

    - Lacking information on problems that are not solved;
    - It is a very normative system based on the implementation of one practice to the detriment of another. This could harm technological innovation, because if regulations are very precise, they could make it impossible to achieve the

objective by different means. Indeed, technological innovations make it possible to achieve and even exceed environmental goals at lower costs, in particular by some means that are unknown at the very moment of the implementation of the policy.

- Finally, it is important to adapt environmental objectives and BMPs to the existing context (legal, hydrological, agricultural, etc.). Moreover, programs should be directed towards the achievement of environmental objectives at the watershed level.

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Price Discovery Mechanisms for Providing Ecological Goods & Services from Wetland Restoration: An Examination of Reverse Auctions

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Executive Summary

This research first developed estimates of the cost of wetland restoration activity in South Tobacco Creek, Manitoba. These costs consist of opportunity cost of lost cropping areas, nuisance costs of manoeuvring machinery around the wetlands, and the actual on the ground costs of restoration. Restoration costs were found to be heterogeneous, both within a watershed, individual producer's lands and among producers.

Knowledge of these costs permitted examination of procurement or reverse auctions as a policy to incent adoption of wetland restoration. Auctions operate by inducing competition among bidders for a limited budget. Hence this instrument is useful for two reasons: 1) it may actually achieve significantly more restoration activity with a fixed budget than current policies; 2) it has the ability to reveal the actual costs of restoration in areas where these are unknown.

We examine two offer selection strategies: maximize acres restored and maximize abatement of phosphorus; and two pricing rules: discriminant where winners are paid what they offered to be paid, and uniform in which all winners are paid the lowest unsuccessful offer. Using experimental economic procedures we find that counter to current practice in which the discriminant pricing approach is typically employed, the uniform pricing rule may allow more efficient use of limited funds for wetland restoration.

Background & Rationale for Investigation

Wetland restoration is a new vehicle for providing ecological goods and services (EGSs) such as wildlife habitat, nutrient abatement, and carbon sequestration to society. Though some programs presently exist to encourage the practice of restoring wetlands, uptake has been low by many producers who could supply wetland areas to be restored. While some producers would provide these services voluntarily, others would bear considerable costs for this provision. Current federal programs involve cost share in which only a portion of the costs of wetland provision up to some maximum level are paid. Many producers claim that these available incentives are not adequate to encourage them to adopt these practices. In order to encourage the retention of existing wetlands or the adoption of wetland restoration, policy makers must understand why current incentives are inadequate and what types and levels of incentives can meet wetland goals.

In the case of wetland retention, many jurisdictions regulate the drainage of water from private lands which could be used to force producers to retain existing wetlands on their land. For the case of restoration, however, there is interest by both government and private agencies to provide incentives to restore drained wetland areas. In order to develop policies that encourage producers to restore, knowledge of the associated costs are required. This information is lacking in the literature.

Many Canadian conservation programs typically implement a practice-based payment that is essentially a flat payment structure with little room to negotiate with landowners over the amounts payable. While the flat payment structure suffers all the disadvantages of the practice-based program when constrained by a fixed budget, it also has higher adverse selection problems where lands that provide low quality environmental benefits drive lands with high quality environmental benefits out of consideration.

An alternative approach is to compensate landowners based on the level of the costs they face for generating environmental improvements by making them reveal their costs. Auctions are one way this can be done. Compensating based on costs allows the policy maker to offer producers the chance to make bids on how cost-effectively they can provide a unit of EGS, and use this information to select them. Such auctions make allocation of scarce public or ENGO funds more cost-effective/efficient. The buyer in these auctions, typically the government (but could be an ENGO), can use indicators of the environmental benefits attached to each land (such as in the Australian Bush Tender; see Stoneham et al. 2003) so that the public can purchase environmental goods or pollution abatement services from those lands that provide the most environmental benefit at the least cost (as budget is usually constrained) or the greatest level of mitigation, or provide the land owner with the least profit/rent.

Objectives

1. Develop preliminary estimates of the costs of restoring wetlands on agricultural lands in the prairie region using land management data from the South Tobacco Creek (STC) Watershed.
2. Use the estimated costs to examine the efficacy of procurement auctions as a means to incent producers to adopt wetland restoration activities.

Funding and Partnerships

This research was mainly funded by the Advancing Canadian Agriculture and Agri-Food Program. However, related BMP research funded by AAFC's Watershed Evaluation of Beneficial Management Practices (WEBS) also had a significant impact on this study. Our partners were the Deerwood Soil and Water Management Association, Ducks Unlimited Canada and Dr Yongbo Lui from the University of Guelph. Colleagues Jim Yarotski, Bill Turner and Mohammed Khakzaban also worked with us in the South Tobacco Creek Watershed in Manitoba.

Methods and Implementation

Development of Cost Functions for Wetland Restoration

In order to evaluate costs, it is necessary to first identify suitable areas for wetland restoration in STC. These were provided by Yang et al. (2009) who used GIS functions and Lidar Digital Elevation Models (DEM) to estimate wetland surface area in the watershed. The DEM was used to identify depression cells, or locations of low elevation on the fields. This information was then used to generate depression polygons with areas from 0.1 to 7.0 acres. These areas are consistent with the size range for Ducks Unlimited Canada (DUC) wetland restoration projects in the watershed (personal communication, Yang, W., 2009). These potential wetland restoration sites were linked by GIS with producers' field boundaries and ownership data provided by the Deerwood Soil and Water Conservation Association (DSWCA). The scenarios were based on 100%, 50%, 25%, and 12.5% restoration of potential wetlands in the area. Each of the scenarios below the 100% level involved a spatial random selection of wetlands from the higher restoration level. This involved the exclusion of some of the full suite of wetlands on each producer's property in order to maintain an equal distribution of wetlands among the producers in the watershed. In each scenario, it was assumed that each producer will restore all potential wetlands and will pay the associated cost for this action.

Yang et al. (2009) also used a SWAT model to estimate abatement of sediment, nitrogen and phosphorous under each wetland scenario. The benefit of wetland restoration for sediment and other pollution abatement is a function of the quality of land that drains into the area. Land characteristics affecting the performance of wetland restoration include slope, soil type, and surface area of the wetland and drainage areas respectively (Yang and Weersink 2004).

Over the watershed, if producers undertook restoration activity on their lands to restore 100% of the wetland areas, this would require the restoration of 1062 potential wetlands. Subsequent restoration scenarios included fewer producers. Yang et al. (in progress) outline how a hydrologic model was connected to the scenarios to estimate abatement of nutrients in run-off from agricultural activities in the watershed. We employ this information in the development of abatement costs below. It should be noted that in much of this report, only the 100% scenario is reported in detail since the other scenarios involve a randomly generated subset of wetlands from the full 100% restoration effort.

The total cost of restoring a given wetland for a specific producer was assumed to be comprised of the following elements: the opportunity cost of the land to be converted to a wetland, the nuisance costs associated with maneuvering machinery around the restored wetland, and the actual restoration costs associated with the construction and restoration of the wetland. The general cost model estimated for STC includes the direct and indirect costs of wetland restoration as well as nuisance costs for each wetland on each field. Figure 1 provides an overview of these costs. These costs would constitute the value of easements paid by agencies like DUC for producers to restore wetlands in perpetuity or for a pre-determined period. Since farms may have a number of potential restoration sites, the restoration costs for each wetland on a farm were aggregated to calculate wetland restoration costs by producer.

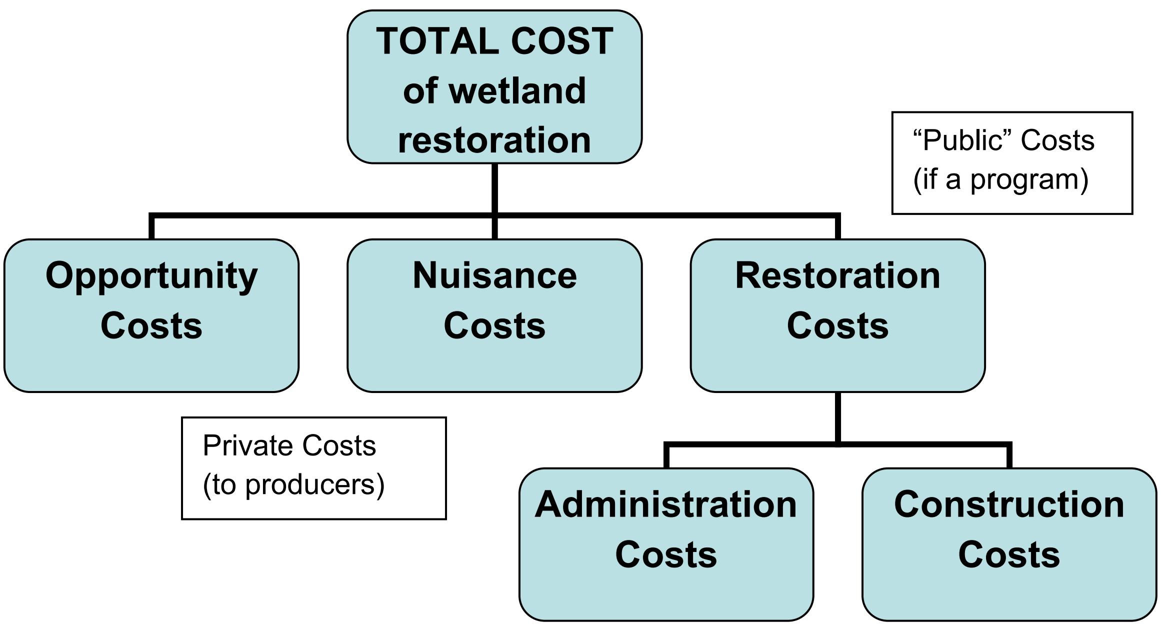

Figure 1: Components of the total costs incurred by landowners for wetland restoration.

The direct restoration cost is the one time cost of restoring a wetland, including administration and physical construction costs. These costs were based upon estimates provided by DUC (Andrews, pers comm. 2008) where a wetland restoration project typically costs $500/project - about $321 per wetland for administration and $156.98/wetland acre for restoration. The restoration cost was considered to be a fixed cost per acre per producer, while the administration cost was a fixed cost for each producer regardless of the number of wetlands they could restore.

The opportunity cost of forgone income due to lost cropping areas was estimated by assuming a baseline scenario where conventional tillage would have been practiced. Where wetlands were restored on forage and pasture fields, the baseline also included net returns from forage and pasture. Forgone net incomes from crops undergoing conventional tillage and from forage are based on historic land use, soil and climate data provided by DSWCA for the period 1991-2006. Yield models based on crop yields over this period were used to forecast foregone yields over a 12 year future rotation (2007-2018).[1] The yield and opportunity cost models are explained in detail in Boxall et al. (2008). Since forage improves soil characteristics like aeration and water holding capacity, the forage model also includes the indirect benefits of boosting the yields of subsequent crops cultivated after forage.

Because each wetland is associated with a specific field, the current and projected historical crops to be grown in this field were ascertained. This involved projecting a specific crop rotation based upon the past crops grown in the field from 1991-2007. When this is coupled with the yield functions and other information[2], the income derived for each field was projected up to 2018. Imposing wetlands on these fields involves reducing the area cropped in future years. Hence, an estimate of the income forgone from this reduction in acreage can be generated for each year until 2018. The total of this income forgone, discounted at 10% over the 12 year period (see below) provides an estimate of the opportunity costs of the wetland restored.

Fields that historically were in pasture were assumed to remain in pasture for the forecast period. The net revenue from pasture was estimated by multiplying the number of animals the pasture could carry by the maximum number of days the pasture could be grazed. Wetlands restored on pasture incur an added cost of installing watering devices and fences to keep livestock away. Boxall et al. (2009) provide details of how these additional costs were calculated.

Nuisance costs arise from the increased costs from maneuvering machinery around restored wetlands. Estimates of these costs were adapted from Cortus (2005) who shows that nuisance cost estimates can be based on the amount of extra time required maneuvering around wetlands, and machinery operating costs. We used his formula and parameters for estimating nuisance costs: *Nuisance Cost = Nuisance Factor * Machinery Operating Costs*. The nuisance factor represents the percent increase in time spent cultivating a quarter section and was determined by considering the size, location, and number of wetlands in each field. Machinery operating costs (e.g. fuel) were derived for each crop type in a given rotation year based on MAFRI (2004) crop budgets. Machine operating costs were not specific to each producer but to crop type, therefore nuisance costs depend on where a producer is in his rotation. Nuisance costs are also directly affected by the size of the farming implements used, which were proxied by the size of the entire farm (e.g. number of quarter sections) for each producer in STC.

Nuisance costs across the fields varied from $0 to $244 per wetland over the twelve years (2007-18). Nuisance costs were assumed to be $0 for wetlands situated in pasture fields.

The opportunity costs and nuisance costs accrue in each year during the 12-year period; thus the costs of the last year are not likely to be treated the same by the producer as costs in the first year. All costs

[1] Note: a twelve year period was selected in order to account for three cereal rotations or a full forage cycle of 7 years followed by a cereal/oilseed rotation.

[2] This land use data was combined with soils data from the 'Manitoba Soil Database' (AAFC, 2002) including soil class, soil texture, and slope, and climate data including temperature and precipitation obtained from, Environment Canada (2005 and 2007), for the meteorological station at Miami Thiesen, Manitoba.. Information on crop prices for crops and forage were obtained as a 10 year average from 1994-2003, to reduce the effect of year-to-year price variation. Prices for crops were obtained from SAF (2003) and for forage from personal communication with Sumach (2007). Boxall et al (2008) provide details.

considered for the restoration of wetlands were discounted at a 10% rate which is commonly used in agricultural finance literature (Unterschultz, pers comm. 2008). The equation below captures the net preset value of the total costs (*TC_i)* of wetland restoration in a field *i* including the portion that is discounted:

$$TC_i = R_i + \sum_{t=1}^{12} \frac{C_i^t}{(1+r)^t},$$

where R_i is the one-time restoration costs for restoring all wetlands in field *i*, C_i^t is the difference in net revenue in each period *t* using average historic commodity prices and costs between having wetlands restored and not, and *r* is the discount rate of 10%. Note that the total cost estimates represent a one-time payment received at the beginning of the 12 year period required to equal the costs a producer would bear for restoration.

Table 1 displays summary statistics for the 100% restored wetland scenario including acreage restored, total cost, and annualized cost per acre at the level of the individual wetland restored. This information illustrates the heterogeneity between producers in terms of the costs of restoring individual wetlands. The average wetland to be restored is less than 0.5 acres. The average total cost for restoring an individual wetland is estimated at about $440, resulting in an annualized cost of $65 for the 12 year period. However, the variation in these costs is high with a SD ($447) similar to the mean cost. The average annual cost per acre to restore wetlands would be about $1,396/acre in STC. Note that the variation around this mean is also high.

Table 1: Descriptive statistics for restored wetland acreage and estimated costs measured at the individual wetland level (100% restoration scenario).

	Wetland Acres	*Total Cost*	*Total Cost/acre*	*Annualized Cost*	*Annualized Cost/Acre*
Mean	0.461	440.25	1395.61	64.6129	204.82
Median	0.282	324.94	1173.86	47.69	172.28
Standard Deviation	0.677	446.82	1085.81	65.58	159.36
Minimum	0.016	99.09	104.13	14.54	15.28
Maximum	8.759	5507.54	9891.22	808.30	1451.67

The wetland restoration scenarios were linked to a SWAT model by Yang et al (2009) in order to provide preliminary estimates of P, N, sediment etc. in run-off with and without wetland restoration at the producer level of aggregation. The difference in nutrient and sediment levels with and without wetland restoration provides estimates of abatement. Table 2 provides estimates of phosphorous abatement and costs using the 100% wetland restoration scenario. These estimates were calculated from restoration activity that involved each producer restoring 100% of the wetlands on their properties. This is a heroic assumption as in the real world producers would each choose a restoration level and an associated payment level. Nevertheless these estimates are instructive as they illustrate full restoration costs and abatement levels at the enterprise level.

Table 2 provides per producer wetland acreage estimates from Yang et al. (2009). On average each farm in STC has about 13 acres of wetland area to fully restore. The SD is quite high (17.25 acres) pointing to considerable heterogeneity across the landscape in terms of wetland coverage to be restored. The SWAT model predicts that at 100% restoration on each farm, the quantities of P abated range from about 0.56 to 261 kg. The associated average costs of restoring all wetlands on average are about $13,000 per producer. The large SD associated with this estimate ($14,931) highlights the heterogeneity of costs among the producers in this watershed, which range from about $650 to $82,000 per producer. The average total cost per kg P abated is about $1900/kg and if paid annually and considering the discount rate, the average annualized abatement cost of P would be $63.21/kg/yr, with a range of $17.34/kg/yr to $234/kg/yr.

Table 2: Descriptive statistics regarding the amounts of costs for phosphorous abatement at the producer level using the 100% restoration scenario.

	Wetland acres	*kg P Abated*	*Total Cost*	*Total Cost/kg P*	*Annualized Cost ($/yr)*	*Annualized Cost/kg P/yr*
Mean	13.33	38.13	12825.84	430.68	1882.36	63.21
Median	10.60	29.36	9540.32	337.20	1400.17	49.49
Standard Deviation	17.25	44.78	14930.78	298.23	2191.29	43.77
Minimum	0.27	0.56	641.79	118.16	94.19	17.34
Maximum	99.16	260.95	82431.19	1596.70	12097.87	234.34

The information in Tables 1 and 2 illustrate significant heterogeneity between restored wetlands and among producers, suggesting that spatial targeting of wetland restoration activities would be important from a cost effectiveness policy perspective.

Wetland Restoration Cost Curves

There are a number of approaches for representing these costs graphically. First we provide a total cost curve for restoring wetland acres in STC at the producer level (Fig. 2). This was constructed based on ranking the total costs by producer for all affected producers in the watershed. This total cost function shows the amount of restored wetland acres possible for a given restoration program cost - one can determine the wetland area that could be restored given a particular budget. For example, with a budget of $150,000 about 115 wetland acres could be restored on the farms of 11 producers. This total cost relationship can also be constructed for the costs of P abatement (see Boxall et al. 2009).

An important economic concept is the marginal costs of supplying EGS's. The marginal cost is the incremental cost of increasing the supply of wetlands by one unit. From a policy perspective, it is important to supply goods if the marginal cost is less than the marginal benefit, i.e. if the benefits of the next unit produced exceed the additional costs. Given the information above we were able to develop marginal cost functions for wetland restoration in either "acre-space" (quantity of acres supplied at a given cost or price) or "abatement-space" (quantity of P abatement supplied for a given cost or price).

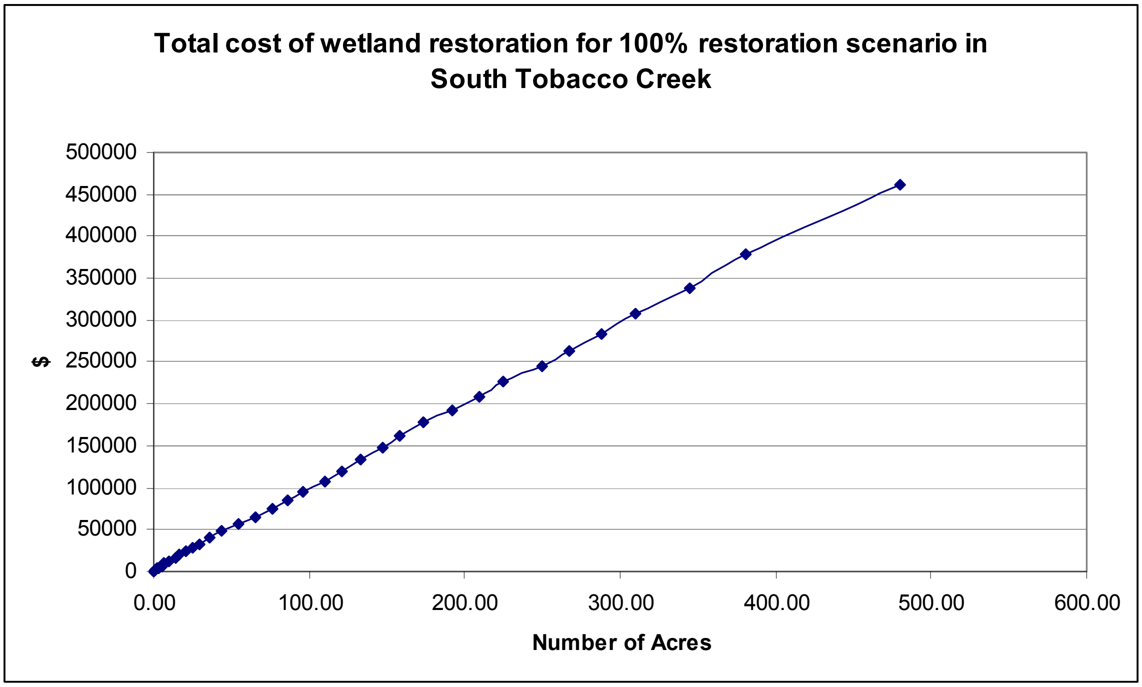

Figure 2: The total costs of restoring wetland acres in South Tobacco Creek

Figure 3 shows the per unit costs associated with supplying restored wetland acres and Figure 4 shows per unit costs for kg P abated annually. Each point in Fig. 3 represents an individual wetland (cf. Table 1) while those in Fig. 4 represent per unit costs borne by an individual producer in STC (cf. Table 2). The information in Fig. 3 suggests that if an agency was willing to pay $2000/acre, about 420 wetland acres in STC could be restored at that price. This supply curve suggests that the majority of wetlands in STC could be restored for under $2000/acre. However, there is a group of low-cost wetlands and one of high costs. Implementing the full 100% restoration scenario is expensive primarily because of the high cost group. Omitting these wetlands from a restoration program, and working only with the lower cost wetlands, could likely achieve cost effective restoration. A similar pattern and story emerges in the supply curve shown in P abatement space in Fig. 4, except that each point represents 100% restoration on an individual producer's property in STC.

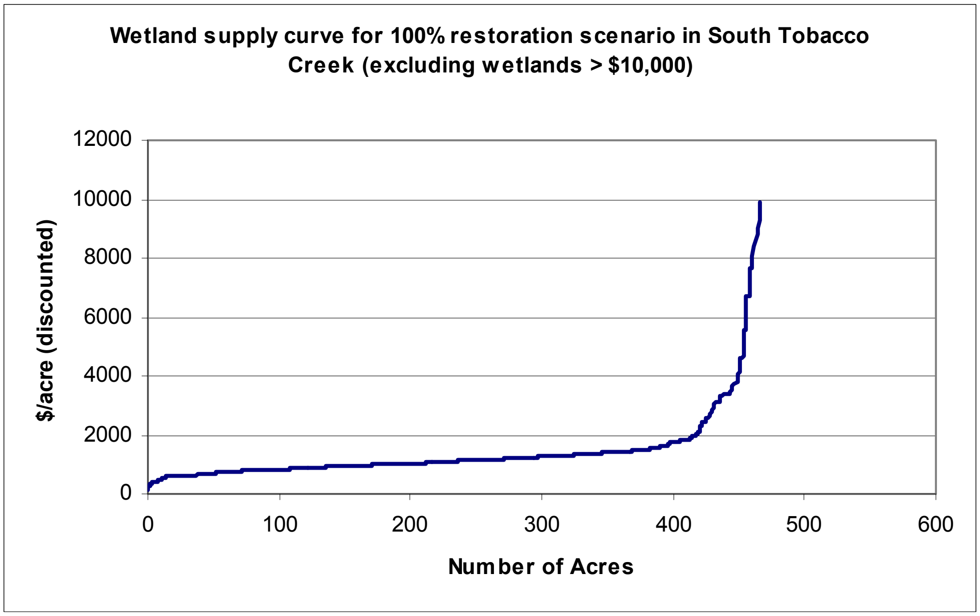

Figure 3: A supply curve for acres of wetland restoration in South Tobacco Creek. Note that each point in this curve represents an individual restored wetland.

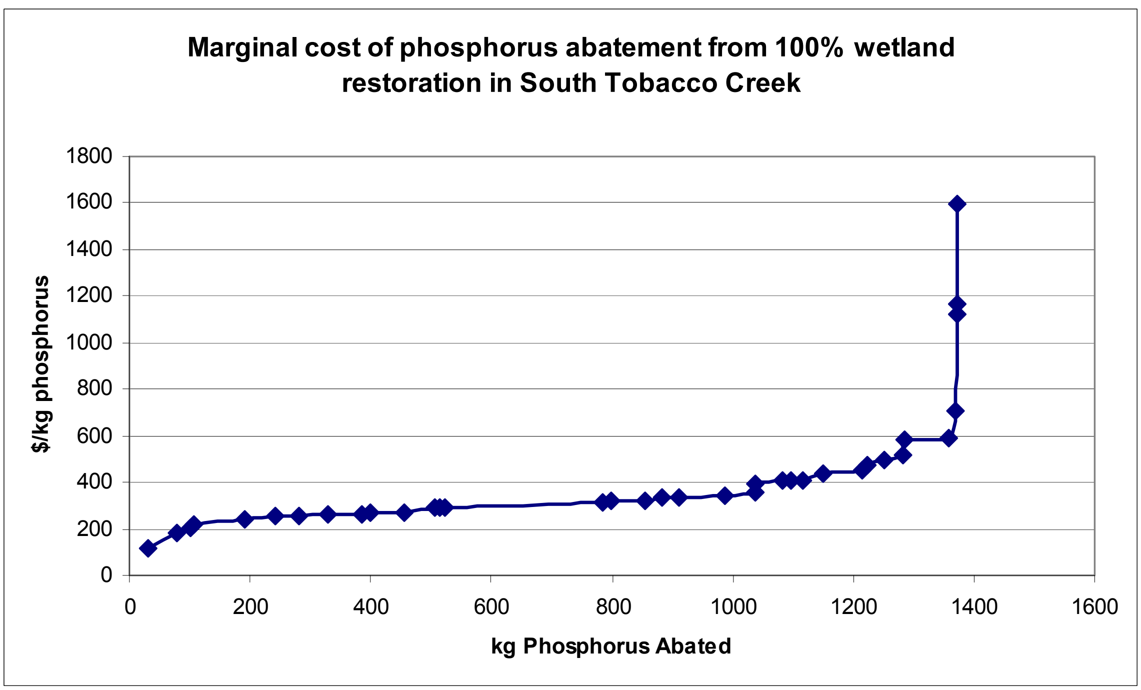

Figure 4: A supply curve for phosphorus abatement using wetland restoration in South Tobacco Creek. Note that each point in this curve represents the costs borne by an individual producer who would restore all wetlands on their farm.

Summary

These estimation procedures provide an understanding of the costs of provision for EGSs from restoring wetlands. In this STC example we considered phosphorous abatement as an EGS; however we could also include nitrogen and sediment abatement as well as flood protection, habitat, and carbon sequestration. This suggests the need to develop weighted environmental benefit indices to assist in a full economic analysis of supplying wetland EGSs.

Knowledge of cost functions allows examination of policy options. Market based instruments may be an effective tool to incent the provision of EGSs, but knowledge of the true costs of provision is instructive in designing appropriate policy instruments. Some market based approaches, such as auctions, can actually develop estimates of producers' true costs and thus provide more appropriate compensation as well as information to conservation agencies. In the next section of this paper, we examine the use of procurement or reverse auctions to achieve wetland conservation objectives using the preliminary wetland restoration cost information from STC. We test alternative auction design options using experimental economics techniques in a laboratory setting.

The Development of Reverse Auctions for Wetland Restoration

In establishing our economic laboratory auctions we were influenced by Cason et al. (2003) and Cason and Gangadharan (2005) (hereafter called the Cason group) who examined auctions for the adoption of beneficial management practices by producers in Australian watersheds. Similar to this Australian research we utilized students as subjects – in our case from a pool of mostly largely undergraduate students recruited from the University of Alberta using ORSEE software (Greiner 2004).

Each of our experiments involved an auction for restoring 100% of the wetlands on individual farms in STC. Subjects made sealed-offers for payments to restore wetlands based on the different costs and qualities outlined in the previous section. The Cason group's research imposed heterogeneity on costs and quality by randomly drawing costs and environmental benefits for each BMP independently for each seller each period. In this research we had detailed cost information for each producer in the watershed as discussed above, as well as abatement information for each producer with and without restoration. This knowledge of the costs and environmental benefits allowed us to exploit the actual heterogeneity found in STC across the subjects in the experiment. This is similar in spirit to Tisdell's (2007) approach of bringing biophysical models into the economic laboratory. Thus, in the experiments each of 12 subjects represented one of the actual producers in the watershed and the farms differed by their associated costs of adoption and pollution abatement levels. The costs for the 12 experimental producers were chosen from the full set of 31 producers to accurately portray the cost function in Figure 4 as well as a similar producer level cost function in "acre-space" not shown in this paper (see Boxall et al. 2009).

An important issue in these experiments is the information about the farms available to each subject, both within and between subjects. Cason et al (2003) found that revealing the levels of the environmental improvements associated with each auction participant resulted in offers that misrepresented the costs of adoption more for "high quality" (in terms of abatement potential) farms. This resulted in lower abatement levels and higher seller profits than similar trials in an absence of this environmental information. Thus, we did not reveal abatement levels associated with each farm in our experiments. We also did not reveal any information about other subjects' costs.

In the Cason group's auctions (and indeed other auctions such as Bushtender) offers provided by bidders were ranked according to their contribution to improving environmental quality. Some of these are measured using indices which assess multiple contributions towards environmental improvements and hence the term Environmental Benefits Index (EBI) is a common term used to describe the assessments. Thus, a common offer ranking approach in these environmental auctions to date has been to maximize EBI (called MAX EBI below).

Since we developed estimates of abatement associated with wetland restoration at each of the 12 farms from the hydrologic model developed by Yang et al. (2009) we were able to follow the MAX EBI offer-ranking strategy. However, we also examined a strategy to select offers based on maximizing the number of acres restored in the watershed. This strategy, called MAX COV, was chosen to see how well it could approximate the abatement levels associated with the MAX EBI approach. Given that a significant level of information and analysis is required to develop estimates of pollution abatement for producers in each watershed in Canada, we decided to examine a strategy that could approximate the MAX EBI approach for those watersheds that had little hydrologic information. While the MAX EBI strategy could possibly be superior in terms of pollution abatement, we feel that very few watersheds in Canada would currently have the information necessary to attempt this procedure.

There are two pricing rules typically used in procurement auctions. The most common is the discriminant-price auction in which winning bidders receive the value of their actual offers as payments. In this pricing format the seller earns no surplus (profits) if he/she submits an offer equal to their costs of restoring wetlands. Thus, there exists an incentive to inflate their offers above their costs. In formulating their offers, producers would trade off gains from winning with an inflated offer to the risks of not winning a contract with an inflated offer (losing a contract to a competitor).

The second pricing rule is the uniform-price auction in which all winners receive the same price. Typically this price is determined by the lowest rejected offer (termed a second price uniform auction). In this pricing approach inflating one's offer serves to decrease the probability of winning because it does not change the payment received. Thus, there is a tradeoff between winning with an inflated offer and losing to a competitor. The draw-back with this pricing rule is that the buyer is guaranteed to pay winning producers prices that are higher than their opportunity costs.

Ferraro (2008) notes that there is not sound theoretical guidance on which pricing rule to use and points out that experiments and agent based models have been employed to examine the implications of the two rules. McKee and Berrens (2001) and Cason and Gangadharan (2005) found that discriminative actions are less costly to the agency than uniform-price auctions for a given environmental objective. Others have employed formats that allow learning by bidders and have achieved opposite conclusions. Because of the lack of guidance in choice of the pricing rule, we employed both in our BMP auctions in order to compare outcomes both on environmental outcomes and economic efficiency metrics.

The two offer-ranking strategies and the two pricing rules led to a 2 X 2 experimental design. Thus, the full design with one repetition involves four separate experiments or treatments. Since it is difficult to generate sound conclusions from experiments with one repetition, we employed multiple repetitions and report measures of central tendency and dispersion of the offers for each treatment. Table 3 summarizes the design and number of repetitions.[1]

[1] Note that given time constraints only 2 replicates were possible for some treatments. Thus, the results reported should be treated as preliminary. We plan to add more (to a maximum of 3) in future research. We also conducted other auctions that we do not report results for. These served as pilots to test experimental procedures and the software, or involved cases where we had computer failures and the results had to be discarded. We also conducted one experiment with a sample of producers but have not analyzed these results yet.

Table 3: Experimental design for testing wetland restoration auctions in South Tobacco Creek.

	Treatment	Number of repetitions	
		Discriminatory pricing	Uniform pricing
Budget Based	Maximize Coverage (MAX COV)	2	3
	Maximize kg P abated (MAX EBI)	2	3

Each experiment involved 12 subjects who submitted sealed offers in each of 15 periods. Prior to the beginning of each experiment subjects viewed a PowerPoint presentation which outlined the rules and procedures of the auction. Subjects were informed that the experimenter purchases the lowest priced items per unit of environmental quality or per acre for the MAX EBI and MAX COV ranking rules respectively. Subjects were not allowed to communicate with each other during the experiment to reduce opportunities for collusion. The impact of allowing communication during these experiments is currently being tested in other auction-related research.

Offers were submitted on computers using the ZTREE experimental economic software system (Fischbacher 2007). Subjects could not see other subjects' offers (hence sealed offers). In each of the 15 periods, offers were collected by the software system and were sorted and ranked according to the ranking strategy employed. Offers were then purchased up until the budget was exhausted. Once this was done the results were reported to the subjects electronically on their computers. The next period then started. This continued until 15 periods had elapsed. During the experiments each round was set using the software to be 1 minute. The average length of each session length was approximately 45-50 minutes, including reading the instructions and determining payments to each subject. For simplicity the producer revenues and costs were presented to the subjects as in smaller scale units so that they could understand their take-home payments which were related to total farm income earned minus the costs of any restoration plus any successful offers.[1] We converted each $100 in "real" costs to $1 in the experiment. Thus, every additional experimental dollar the subjects' farms generated the student took $0.10 home. Subjects earnings ranged from $15 - $35 a session, with an average per subject payment of about $23.

Since these auctions were budget constrained, a budget was developed using payments under the National Farm Stewardship Program (NFSP) (see Boxall et al. 2008). We calculated the amount of money that would have been allocated to pay all of the producers in STC to restore all wetlands on their property as the total auction budget. Under the NFSP, wetland restoration falls under Category 21 (Enhancing Wildlife Habitat and Biodiversity) and 28 (Biodiversity Enhancement Planning) and applicants can receive 50% of their restoration costs (administration and construction costs) up to a total of $25,000 each. A budget was calculated based on 50% of the restoration costs of the 12 producers in the experiment, but this was found to be very low relative to the total costs described above. While it is important to limit the number of winners in an auction in order to induce competition for the budget, having too few winners may discourage participation in the auction. Therefore, the NFSP payments were adjusted to include all costs (opportunity, nuisance, and restoration costs) borne by producers facing

[1] Note that if a subject submitted an offer to restore that was less than his/her costs, then their farm income would decline and their take-home payment would be small. Thus, the experiment was designed such that subjects would make "rational" economic decisions.

wetland restoration. This gave a total auction budget of $62, 218.65 (scaled down to $622.18 in the auction). This budget was small enough to be insufficient to pay every producer in STC to restore wetlands, but was large enough so that some proportion of subjects could “win” a payment.

Table 4 provides some results for the four auction treatments. These values were averaged over the rounds and repetitions for each treatment. To facilitate comparison, U refers to uniform price and D discriminant price. On average the MAX COV-U auctions involved spending the lowest amount of the budget at $53,285 and the MAX EBI-U the highest at $57,056. Spending the remainder of the budget would not have been enough to purchase the next offer. However, there is high variability in these estimates due to the random component of different subjects participating in each auction session. The MAX COV treatments restored more wetland acres, which was to be expected, since this is the goal of the treatment. In terms of the mean amount of phosphorus abated over each treatment, an unlikely result occurred where MAX COV-D was able to abate more phosphorus than the MAX EBI-D auction. It is likely that in the MAX COV-D treatment one player placed a very low bid and more wetland restoration would occur than would be expected.

Table 4: Mean values of budget spent, acres restored, phosphorus abated, $/acre, and $/kg phosphorus for each auction treatment over the 15 rounds. Total maximum values for budget, acres, and kg phosphorus are included for context.

	MAX COV-D	MAX COV-U	MAX EBI-D	MAX EBI-U	Total Available
Mean budget spent	$54,764 (8.78)	$53,285 (9.70)	$55,664 (7.14)	$57,056 (7.07)	$62,218
Mean acres restored	40.83 (1.51)	36.72 (0.44)	33.07 (0.76)	34.79 (0.74)	81.97
Mean kg P abated	263.38 (8.38)	241.77 (2.70)	249.66 (3.90)	271.98 (3.14)	500
$/acre restored	$1341	$1451	$1683	$1640	n/a
$/kg P abated	$208	$220	$223	$210	n/a

Following Cason and Gangdharan (2005), we developed an economic efficiency measure ($/kg P abated) to gauge auction performance. A lower $/kg P value indicates a higher level of efficiency, as more kg P may be abated per dollar. A $/kg P value higher than the expected may also be an indication of rent seeking. Figure 5 illustrates the progression of this efficiency measure ($/kg P) over auction rounds for the 4 treatments in comparison to the expected average, $215/kg P, if subjects offered their actual costs. The averages of the offers were calculated for each period for each treatment, and are all relatively constant among rounds except for MAX EBI-U which in the first 5 rounds the $/kg P values were quite variable and then steadied in the following rounds. This pattern could be the result of some subjects providing erratic offers in the early rounds, and then as learning occurred, their bidding behaviour stabilized in later rounds. The $/kg P measure was generally higher than the value expected if subjects offered their costs of adoption - conversely the $/kg P was generally lower than the expected measure. An interesting observation is that the MAX COV-D measure actually evolved from below to above the expected measure. It is possible that over the course of the multiple rounds participants learned that it was possible to secure profits by bidding higher than their costs (called rent seeking by economists). The reason why the uniform treatments tended to be below the expected efficiency measure is that participants were under-valuing their costs in order to increase their chances of having a successful bid in the auction.

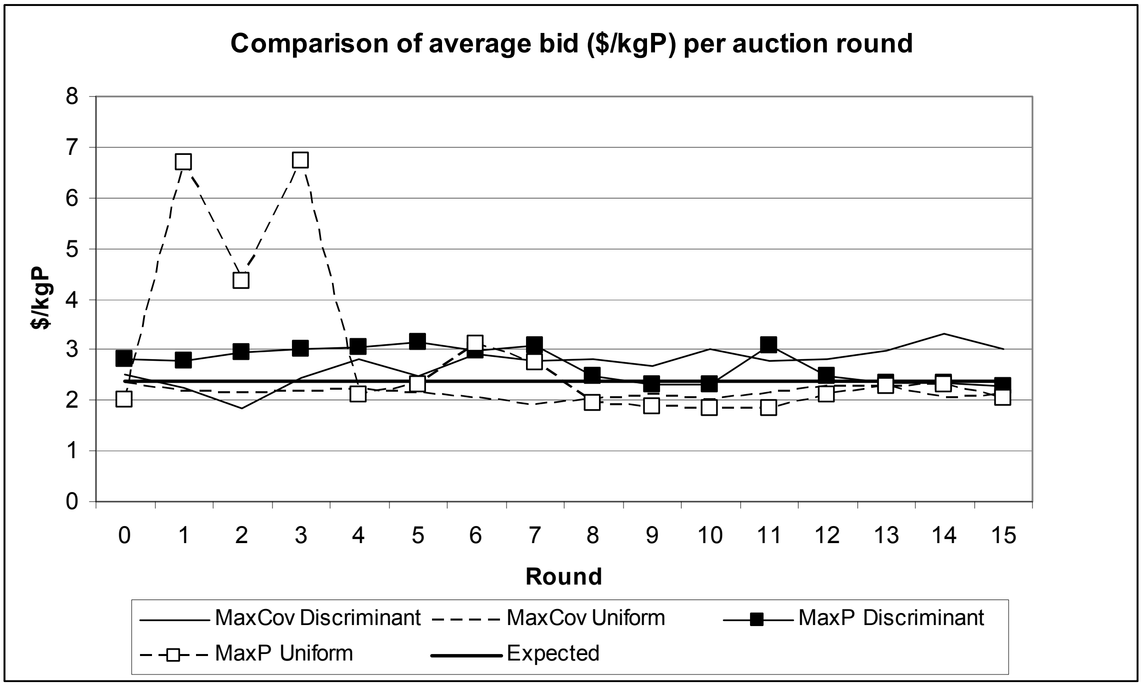

Figure 5: Mean $/kg P for each round of each auction treatment compared with an expected $/kg P if subjects only offered their costs of adopting wetland restoration.

Auction Supply Curves

Jack et al. (2009) point out that since reverse auctions are a price discovery mechanism, their use can essentially generate supply curves associated with the good and service of interest to the agency. Thus, one way to evaluate the performance of specific auction architecture is to develop the underlying supply curve resulting from the offers submitted and compare it to the "real" supply curve, if known. In our experiments, realized supply curves could be generated for each round in each auction. To facilitate presentation, we generated average offers over rounds 1-5, 6-10 and 11-15,[1] but here we present supply curves in which offers are averaged over rounds 6-10.

[1] Rounds 1-5 can exhibit behaviour indicating initial learning of the auction mechanism - offers tend to be variable in the initial rounds. In rounds 6-10 we expect that participants understand the auction mechanism and we find that variability in offers was reduced (Boxall et al. 2008). In rounds 11-15 participants should have a good understanding of the auction mechanism and may start manipulating their offers to rent seek. Variability in offers in rounds 11-15 may also be an indication of fatigue and loss of interest in the task.

We show these supply curves along with the “real” supply curve (from Fig. 4) in Figure 6 for the MAX COV and Figure 7 for the MAX EBI offer ranking strategy. Figure 6 shows that the offers for the discriminant pricing rule are positioned above the real supply curve, while those of the uniform rule lie below. This information supports the notion that the uniform payment method encouraged our subjects to offer values near their actual costs, while in the discriminant approach the opposite occurs where participants tended to provide offers higher than their actual costs. In other words, an agency employing the discriminant pricing rule invites participants to rent seek. Because of this rent seeking behaviour the agency running the auction is spending more of its budget paying for restored wetlands than it should cost.

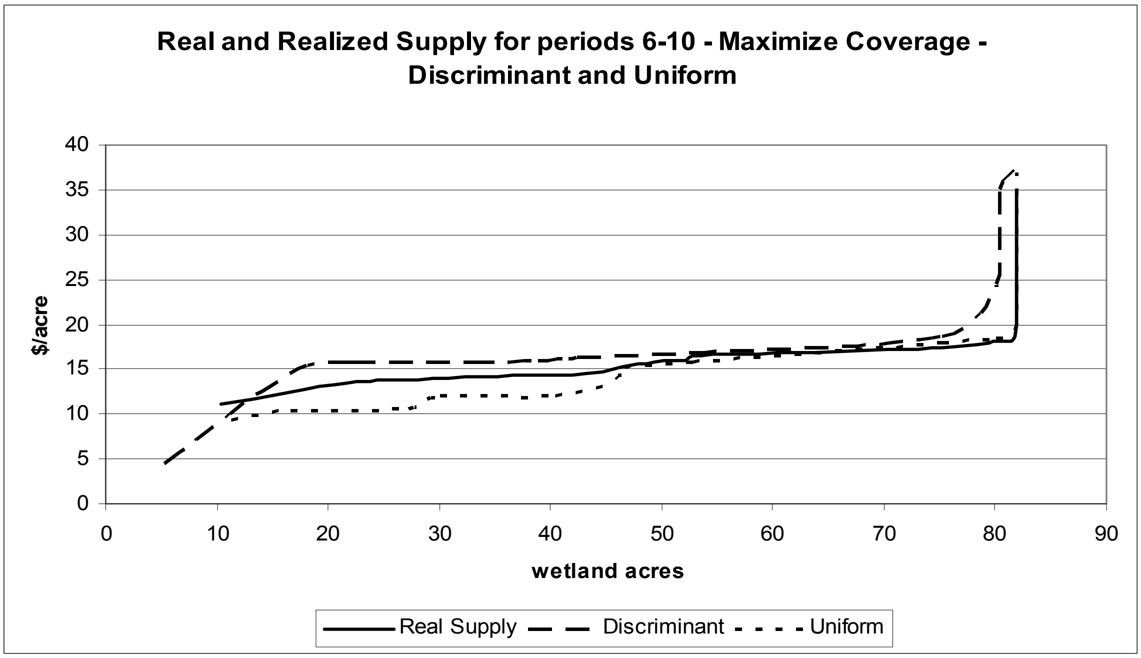

Figure 6: Supply curves developed by averaging offers from experimental rounds 6-10 for the discriminant and uniform pricing rules for the MAX COV offer ranking approach and the underlying “real” supply curve for comparison.

Figure 7 shows similar information for the MAX EBI offer ranking strategy. The results are mostly similar except that at about the 350 kg P level, where the uniform curve rises above the real curve and the discriminant curve lies almost directly on top of it. In the lower cost region (< $2.50/kg) similar findings to those in Fig. 6 are apparent. Since offers in the higher cost region of the supply curve are likely not selected due to budget limitations, we suggest that this information provides similar conclusions to those from the MAX COV strategy.

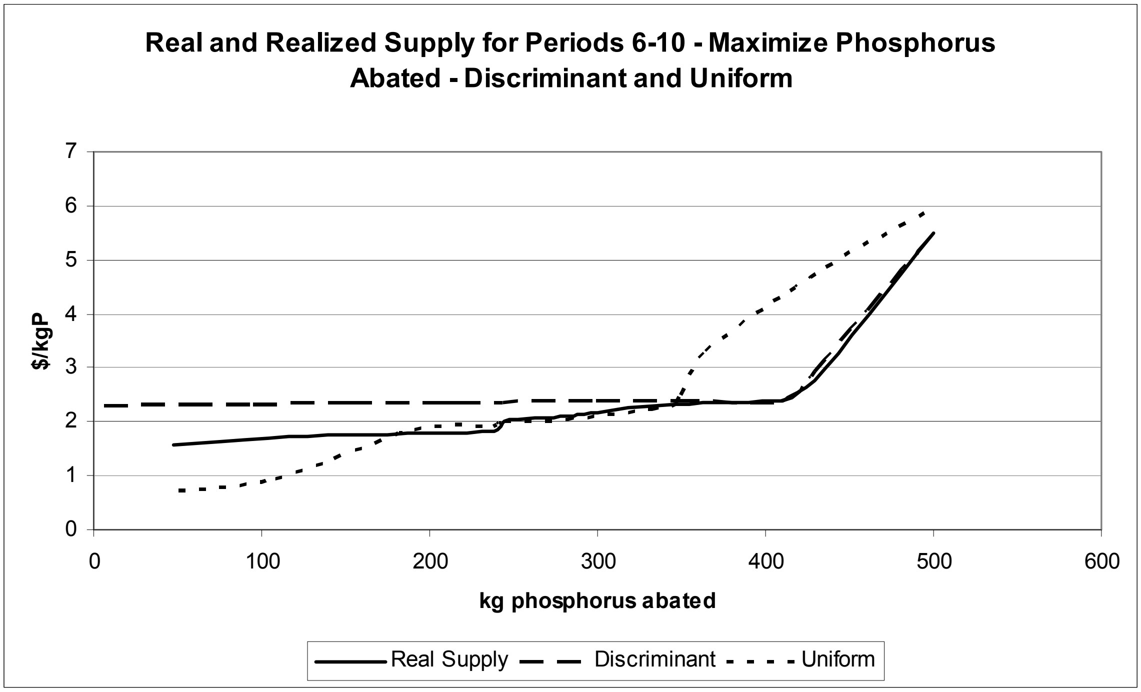

Figure 7: Supply curves developed by averaging offers from experimental rounds 6-10 for the discriminant and uniform pricing rules for the MAX EBI offer ranking approach, and the underlying "real" supply curve used to the develop costs of adoption for the subjects in the experiments.

Conclusions

This research provides a number of important pieces of information about wetland restoration as a strategy to increase EGSs from wetland ecosystems. First, the STC study provides information on what restoration activity costs. This is key information in understanding the low levels of uptake of wetland restoration as a BMP given current policy incentives. While data from STC may not be applicable for the prairie pothole region, the approach used to developing these costs provides a framework for developing estimates in other watersheds.

We found that our estimated restoration costs in STC vary considerably within and between farms. This observation is probably not unique to the STC watershed. This variability suggests, however, that given limited budgets spatial targeting of wetland restoration programs would be an economically efficient approach for wetland managers to pursue. While the need for spatial targeting is not "new" information to economists and environmental policy experts, this study highlights the need for this strategy to be considered in a specific Canadian context. We predict that if restoration cost functions were developed for other watersheds that they would be quite different than the STC functions. In other words, heterogeneity of costs would be exhibited within farm, among farms and among watersheds. This information would suggest a very different suite of policy instruments than those currently employed.

Knowledge of the costs of restoration permitted us to examine reverse auctions as an approach to apply limited budgets to gain resorted wetlands. We used these costs in experimental settings select offers to maximize wetland acres restored or to maximize water quality improvements by abating phosphorus in run-off. Counter to current practice in which the discriminant pricing approach is typically employed (e.g. Bushtender, Stoneham et al. 2003), we found that given limited budgets to pay producers for restoration, employing a uniform pricing rule may allow a more efficient use of limited funds.

An important caveat in this research is that we were forced to employ specific restoration scenarios in examining reverse auction architectures. In our experiments, we developed auction parameters from Yang et al. (2009)'s 100% restoration scenarios. In actual practice, producers would submit offers as well as the number of acres and locations for wetland areas to be restored. Given the limited resources at hand, we could not test both a price and a quantity submission mechanism in the auction. This is fruitful ground for future research.

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The Institute for Agriculture, Forestry and the Environment

Dr. Ken Nicol, Chair
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Executive Summary

The Institute for Agriculture, Forestry and the Environment (IAFE) is a key part of the Alberta Government's (GOA) commitment to managing the environmental pressures resulting from unprecedented economic growth in Alberta.

The IAFE was created with the purpose of recommending to the Government of Alberta a policy framework that will engage a broad set of market instruments to promote environmentally friendly actions while still facilitating the producer's ongoing desires to be innovative and competitive in the marketplace.

The IAFE brings together the two largest working land managers in the province, agriculture and forestry, to find better ways of enhancing the environment, securing markets for their products, and profiting from their actions. As managers of approximately 80% of Alberta's landscape, these industries are uniquely able to play a major role in influencing environmental health in the province.

Appropriate stewardship of agricultural and forest landscapes provides all Albertans with ecosystem services such as abundant food and fibre products, clean air, clean water and biodiversity. The growing consumer demand for "green" products and services offers agriculture and forestry a significant opportunity to increase economic returns from their stewardship practices.

With the right framework of policies, tools and measures in place, the environmental and economic benefits of new products and business opportunities from increased stewardship may be profound. This paper discusses the IAFE and the strategies and processes it is using in developing a recommended policy framework for ecosystem services for the Government of Alberta.

Background & Rationale

The consequence of human activity on the natural environment and the resulting desire to do something about these consequences has resulted in the development of a complex set of policies and regulations. This narrow set of applied instruments is being used to mitigate environmental impacts while sustaining ongoing human activity and economic growth.

In 2008, the Government of Alberta created the IAFE with the purpose of recommending to government a policy framework that will engage a broader set of market instruments to promote environmentally friendly actions while still facilitating their ongoing desires to be innovative and competitive in the marketplace. IAFE creates a unique partnership which brings together four Ministries of the provincial government and the two largest working land managers in Alberta, agriculture and forestry, and the environmental community to find better ways of enhancing the environment, securing markets for their products, and profiting from their actions.

A New Paradigm

The Government of Alberta through this expanded policy framework will shift the focus of ecosystem policy from one where businesses bear the costs of compliance to a policy format that identifies possible revenue streams that may be gained while practicing conservation and ecosystem stewardship. Creating new markets for ecosystem services and helping industry document the ecosystem integrity of their production can increase returns to renewable resource industries while promoting a reputation for excellence in providing society with the products they want and ecosystem integrity embodied in cleaner air, cleaner water and enhanced biodiversity.

The IAFE Mandate

IAFE has four strategic mandate areas:

1. **Market-Based Instruments for Environmental Protection and Enhancement**
   Develop a recommended policy framework to identify and commercialize complimentary ecological goods and services (EGS) through market-based instruments (MBIs).
2. **Branding and Certification**
   Develop recommended approaches to document the environmental footprint of renewable resource products produced in Alberta.
3. **Innovation**
   Identify and recommend worldwide best practices, institutional innovations and management strategies and mechanisms to make Alberta an "aggressive first adopter" of practices and systems that support increased stewardship or diversification into new markets based on the environmental advantage of its renewable resource industries.
4. **Conservation and Stewardship**
   Develop a strategy to enhance Alberta's capacity for conservation and stewardship on public and private lands.

IAFE's actions will:

- Catalyze and coordinate the development of a policy framework that encourages environmentally sustainable agricultural and forestry practices using market-based approaches.
- Act as a champion and coordinating body for a framework which incents stewardship, conservation and efficiency in the agriculture and forestry sectors in their role as managers of both public and private lands.
- Foster dialogue between the forestry and agriculture sectors.
- Work in concert with Alberta's Research institutes, colleges and universities, and the private think tanks involved in public policy research.
- Determine how to incorporate collective efforts and innovative approaches aimed at integrating environmental stewardship and sustainable development in order to advance the environmental agenda and to position Alberta as a global leader in initiating public policy that promotes environmental integrity.

The Government of Alberta's 2008-2011 Strategic Business Plan identifies "Greening Our Growth" as one of three fundamental pillars that underpin government direction toward strengthening and enhancing our environment and our economy. "Greening Our Growth" means *ensuring that our land base is used as efficiently as possible, water resources are effectively managed and competing interests are managed for the benefit of all Albertans.*

Objectives

The four components of the mandate relate to each other in both a functional and policy way. The Conservation and Stewardship mandate outlines the relationship between the various target setting initiatives currently underway within the Government of Alberta including the Biodiversity Strategy, Water for Life Strategy, and Land-use Framework. The Market Based instruments mandate will develop a policy framework to evaluate, select and guide public policy in the selection of policy instruments to achieve these defined targets. The Branding and Certification mandate will identify products produced by the agriculture and forestry sectors that are produced in a way that meets consumer desired environmental standards, and recommend a system for certifying and validating the environmental production standard of the product. And finally, the Innovation mandate will recommend a process to facilitate Alberta's agriculture and forestry sectors are the innovators and early adopters of practices and inputs demanded by consumers to satisfy their ever evolving consumer desire for products embodying appropriate environmental footprints. Figure 1 provides an overview of the IAFE mandates and its linkages with other Government of Alberta strategic policy directions.

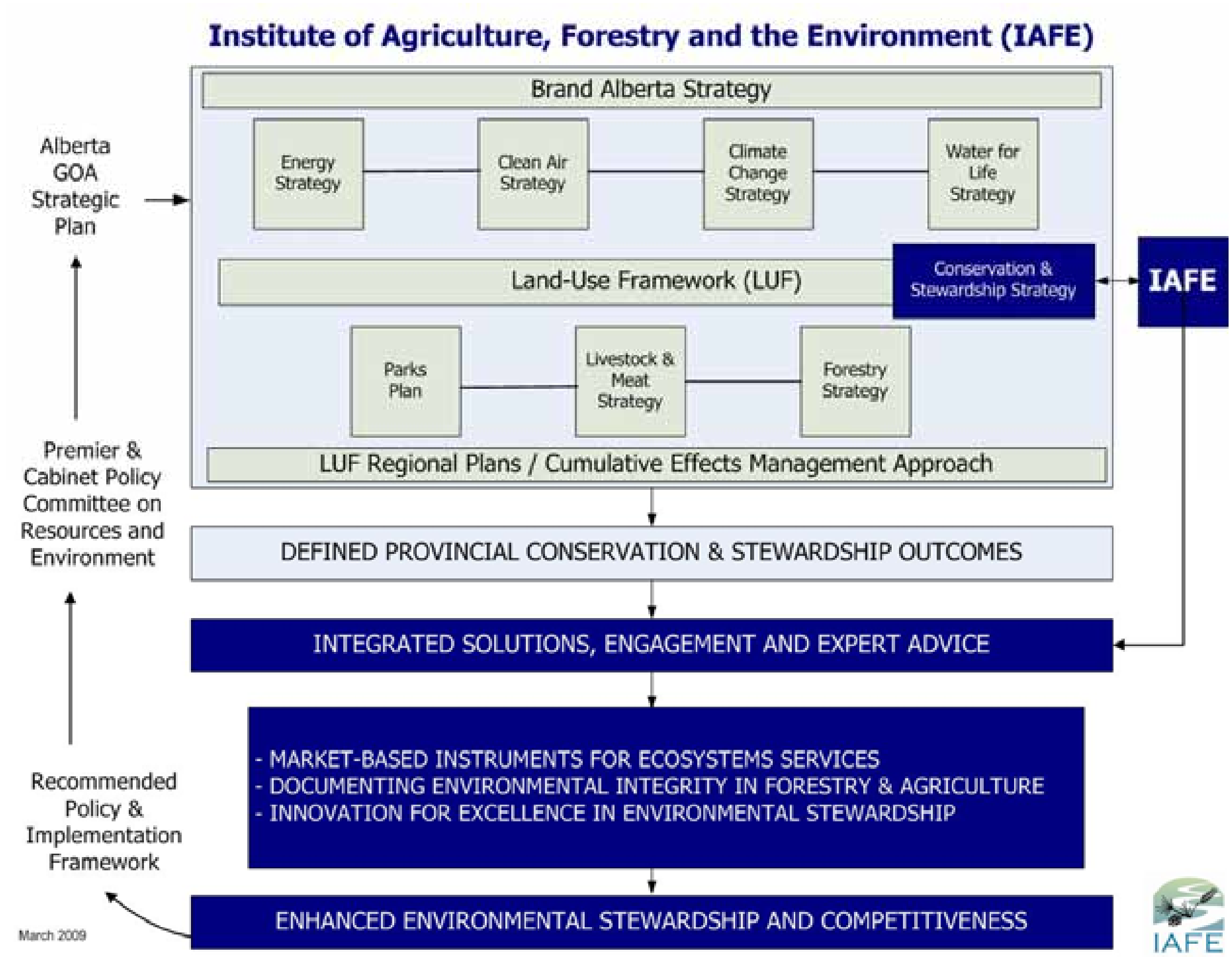

Figure 1

Partnerships
IAFE is developing relationships within and across government, throughout the agriculture and forestry sectors, and with the academic and environmental non-governmental organization (ENGO) communities, see Figure 2.

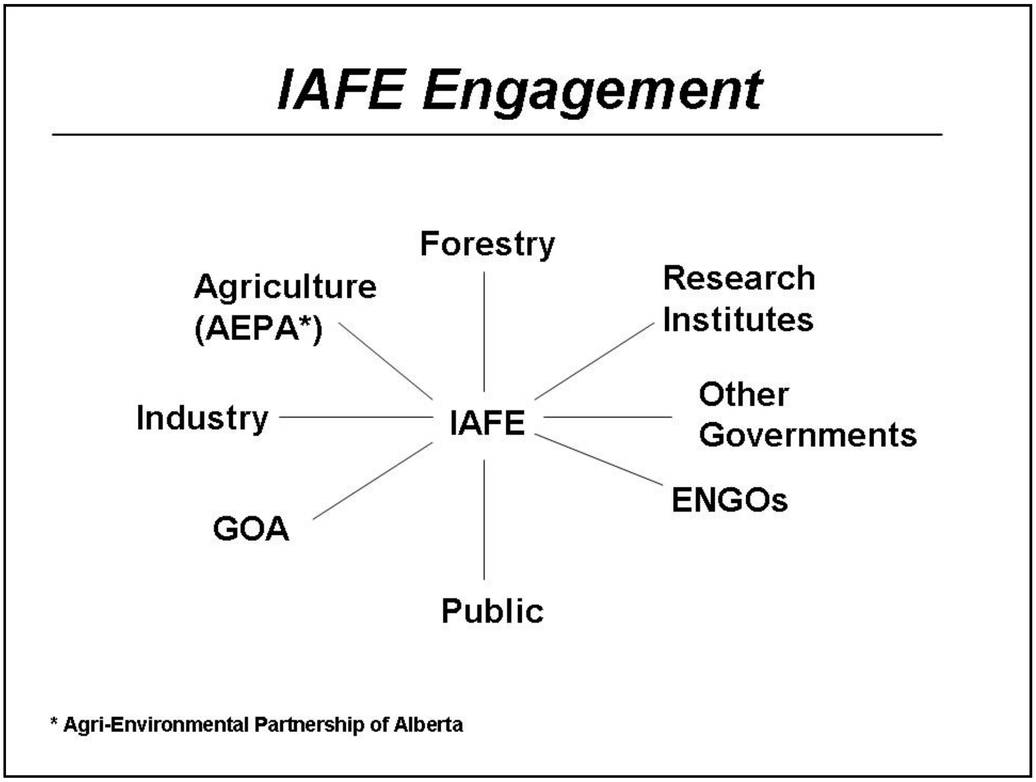

Figure 2

In the process of collecting input to develop the recommendations, IAFE has engaged a number of partners and undertaken a major consultation with individual experts. These partners include: Deloitte and Touché LLP, the Pembina Institute, the Miistakis Institute, Climate Change Central, and the Environmental Law Center. Also, the IAFE organized an International Experts "Think Tank" in February 2009 to discuss:

1. What is the public policy rationale for focusing on EGS?
2. How to move from broad environmental quality objectives to defining EGS products?
3. How do you know you have an EGS "product" that can be associated with changes in land use or management activities?
4. How do you make a *public* good a *private* good?
5. What trends do you see in defining EGS products?
6. What are the primary issues and concerns to be identified and managed in order to move from command and control market mechanisms to market-based instruments in meeting environmental objectives?
7. What trends do you see emerging in the development of markets for EGS and the development of MBIs?

8. Are most successful MBIs tied in as a mix of instruments, e.g. regulatory backstops, information and MBI?
9. What institutional innovations (levers) are required or effective in enabling MBIs for EGS? Why?
10. Can you apply/transfer successes from one area/jurisdiction to others?

The results of the International Think Tank, Deloitte and Touche and Climate Change Central projects are being compiled for analysis and subsequent contribution into IAFE's recommendations to the Government of Alberta.

Implementation: The Framework for Action

The multitude of terms used to define our natural systems and their relationship to the economy needs clarification. When incorporating the business sector into our "environmental" policy we need to envision a production function that begins with our natural capital (land, water, clean air and genetic material) and combines this with human capital and financial and technical capital to produce the spectrum of ecosystem services for society. In this context, **ecosystem services** (ES) as defined by the 2005 Millennium Ecosystem Assessment (MA) provides the most flexible yet encompassing definition that relates to business options and consequence. This ecosystem service definition includes four differentiated output/benefit services or components [1]:

Provisioning services: reflect the totality of goods produced from our ecosystem such as our food, fiber, fresh water, forest products, mining, and genetic resources.

Regulating services: are the benefits we get from ecosystem functions such as regulation of climate and water flows and the maintenance of natural environmental barriers to pests and disease.

Cultural services: include the spiritual enrichment, cognitive development, reflection, recreation, aesthetic experience, knowledge systems and social relations that humans build around and enjoy from ecosystems.

Supporting services: reflect the ecosystems role in biomass production, production of atmospheric oxygen, soil formation and retention, nutrient cycling, water cycling, and generation of natural habitat.

Using this concept allows a true multi-output investigation of the business production process covering all goods and services of value to society and has the potential to expand the market based decision-making of producers beyond the current focus only in provisioning services (food and fiber).

The next definition area clarified broadens the spectrum of policy options useable when changing business's relationship to the ecosystem from the command-control, tax and/or subsidize practices of the past to now include, as an option, the creation of market signals that encourage business to incorporate ecosystem impacts into their bottom line decisions.

The five main **categories of public policy** [5] options available for governments include:

- **Persuasion –** in the form of lobbying, extension and information sharing,
- **Prescription-** through regulation or other command and control actions,
- **Penalties** – such as fees, taxes and licenses,
- **Payment for services rendered** –subsidies and incentives, and

- **Property** – the creation of property, use or commodity rights.

In the functional sense each could be construed as a market-influencing instrument even if not market forming as discussed later. Persuasion voluntarily shifts the cost curve or output level of a business. This subsequently affects the business's competitive position domestically, if not all domestic competitors are persuaded, and for sure globally as it is not logical to assume all jurisdictions will persuade their businesses to simultaneously and correspondingly change their actions. Prescription (regulation), penalties (taxes or fines) and payments (subsidies, or tax deductions) each in their own way affect a business's marginal cost or revenue which translates into indirect influences to alter ecosystem decisions of business. By adding to the options creating or altering property and commodity rights policy makers now have options that, in their own right, become part of the input/output decisions of business as they seek to gain return on assets or enhance cash flow from provisioning services (commodities).

Although the emerging debate about the use of market-based instruments focuses on the property, payment and penalty options, understanding the business impact of the persuasion and prescription options is required to truly evaluate the merits of the various market instruments.

If adopted, the recommendations put forward by the IAFE will allow the Government of Alberta to undertake consistent reviews of the above five different policy options and select the one most likely to give the ecosystem and economic outcomes desired in a way that is consistent with the philosophy of the government.

Incorporating the ecosystem services into the bottom line decision making of business and society requires a consistent and defendable method of **estimating economic values or contributions** arising from the changed ecosystem service.

Not all of the currently discussed "market instruments" being discussed have true price determination capability incorporated. For these a "proxy" economic value needs to be developed so that producers can make production decisions based on some value for all the ecosystem services being considered. An inventory of the methods available to estimate an economic value for the change in relevant ecosystem components is drawn from King and Mazotta (2009) and the IAFE Think Tank (2009):

1. **Market Price Method**
   Estimates economic values for ecosystem products or services that are bought and sold in commercial markets.
2. **Productivity Method**
   Estimates economic values for ecosystem products or services that contribute to the production of commercially marketed goods.
3. **Hedonic Pricing Method**
   Estimates economic values for ecosystem or environmental services that directly affect market prices of some other good. Most commonly applied to variations in housing prices that reflect the value of local environmental attributes.
4. **Travel Cost Method**
   Estimates economic values associated with ecosystems or sites that are used for recreation. Assumes that the value of a site is reflected in how much people are willing to pay to travel to visit the site.

5. **<u>Damage Cost Avoided, Replacement Cost, and Substitute Cost Methods</u>**
   Estimate economic values based on costs of avoided damages resulting from lost ecosystem services, costs of replacing ecosystem services, or costs of providing substitute services.
6. **<u>Contingent Valuation Method</u>**
   Estimates economic values for virtually any ecosystem or environmental service. The most widely used method for estimating non-use, or "passive use" values. Asks people to directly state their willingness to pay for specific environmental services, based on a hypothetical scenario.
7. **<u>Contingent Choice Method</u>**
   Estimates economic values for virtually any ecosystem or environmental service. Based on asking people to make tradeoffs among sets of ecosystem or environmental services or characteristics. Does not directly ask for willingness to pay—this is inferred from tradeoffs that include cost as an attribute.
8. **<u>Benefit Transfer Method</u>**
   Estimates economic values by transferring existing benefit estimates from studies already completed for another location or issue.
9. **<u>Reverse Auction Method</u>**

Estimates economic values based on the buyer soliciting bids for specific land uses or practices from land-managers, based on a pre-set budget and are usually assessed using an environmental benefits index when available.

A critical aspect of using **market-based instruments** is a clear and comprehensive understanding of the role of market initiatives and recognizing the components that need to be available when initiating a market policy. In brief, market instruments can:

1. Encourage behaviour through market signals rather than through explicit instructions regarding pollution controls or methods.
2. Set levies on potentially harmful products to influence purchasing habits and provide funds for recycling programs.
3. Encourage firms and/or individuals to undertake pollution control efforts that are in their own interests and that meet policy goals.
4. Provide financial and near-monetary rewards for conserving biodiversity.
5. Create proxy commodities whose market action directly influences an ecosystem service provision.

For these instruments to operate, clarity is needed in defining the market including:

1. Who are the providers (suppliers)?
2. Who are the beneficiaries (buyers)?
3. How is perceived scarcity measured?
4. How is the value of the service determined?
5. How the willingness-to-exchange is expressed?
6. How does the marketplace operate to determine price and give integrity to the exchange?
7. Are there credible measurement, reporting, compliance monitoring and dispute resolution (market support) systems in place?

The final operational area that needs to be considered includes the understanding of the **impact on the business community** involved. These include how business will respond to:

1. The science-based definitions and responses expected.
2. The consequence for financing and capitalization of rights established.
3. The cash flow consequence of any instrument payment or tax.
4. Property rights and ownership impacts and options.
5. Global and industry competitiveness consequences.
6. Risk mitigation as a result of the expanded market involvement.
7. Implications on lease arrangements for private land.
8. Forest management agreement and grazing lease consequences and implications on public land.
9. Bundling/unbundling options to meet specific market signals.
10. Corporate Social Responsibility analysis (pubic expectations on behaviour).
11. Impact on aboriginal rights, policy and business opportunity.
12. Role of and recognition for pre-compliance by operators.
13. Defining and outlining the role of Duty of Care and its application in relation to compliance payments and property rights.
14. Expropriation override to carry out the public good.
15. What is the ownership or transfer status of offsets upon completion.

Branding and Certification

The third component of the IAFE mandate deals with recognizing the processes and benefits of certifying the integrity of the ecosystem characteristics of commodities produced under the new paradigm. The experts at the International Think Tank addressed this issue and evaluated processes which could contribute to achieving this end. Over all, such processes must incorporate the steps from:

1. Initial scientific development of the criteria.
2. Outline and implement an auditing system.
3. Validating producer feasibility.
4. Continual auditing and validation of compliance at the producer level.
5. Product chain certification, validation and auditing
6. Consumer acceptance validation and auditing.

The Think Tank discussion also raised the issue of an agent to monitor the process itself and certify its compliance and validity. This last step in fact creates believability and trust in the process of certifying and branding the ecosystem legitimacy of the commodity targeted.

Conservation and Stewardship Strategy

The fourth component of the mandate of the IAFE is to work with the Government of Alberta to develop a province wide strategy for conservation and stewardship on public and private lands in Alberta.

The Conservation and Stewardship Strategy will provide a consistent, long-term approach to landscape management that is supported and followed across Government.

The strategy will focus on four elements outlined in the Alberta Government's Land-use Framework report [3], and build in the knowledge gained from IAFE on the following components:

- Identify and develop a toolkit of new best practices, market-based approaches and incentives to provide ecosystem services;
- Develop education and awareness programs;
- Develop action plans for the conservation and sustainable use of Alberta's biodiversity that can be used to support and inform development of regional plans; and,
- Pursue innovative ways to raise both public and private funds to support conservation and stewardship initiatives.

Conclusions

The Institute for Agriculture, Forestry and the Environment's approach to working with the Government of Alberta is transformational in many ways – linking environmental excellence to business success in policy development; using market based instruments to improve environmental performance; bringing Alberta Government ministries together to support an external industry board by aligning, and adding value to the work the Alberta Government is doing for Albertans. This integrated approach will change the way solutions are developed for complex environmental issues and transform business's focus from absorbing the costs of environmental compliance to realizing the benefits of increased competitiveness through greater environmental stewardship and corporate social responsibility.

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Poster Presentation Abstracts

Provision of Ecological Goods and Services as Club Goods: Case Studies from Ontario

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Cornes and Sandler (1998, p. 347) define a club as “a voluntary group of individuals who derive mutual benefit from sharing one or more of the following: production costs, the members’ characteristics, or a good characterized by excludable benefits.” Fox (2008, p.122) extends the definition of clubs to include voluntary groups who derive mutual benefit from sharing a good that is not necessarily characterized by excludable benefits. There are many voluntary associations in North America that provide financial and in-kind support for the provision of Ecological Goods and Services (EG&S) that generate benefits not exclusive to club members. Examples of these benefits include wildlife habitat, nature based recreation opportunities, biodiversity, water filtration and storage, flood control and pollination amongst others. In theory goods are characterized as either entirely private or public but in practice most EG&S fall somewhere in between these two extremes. Preliminary results from research being undertaken at the Department of Food, Agricultural and Resource Economics at the University of Guelph show that some ecological goods and services have been successfully provided as club goods. Under the supervision of Dr. Glenn Fox, three master’s students are examining various approaches to the provision of EG&S in Ontario and the factors that influence their success.

Three case studies by Monika Drozdz explore markets for nature-based recreation and a water quality improvement program. This qualitative study explores financial, institutional and social factors that contribute to the success or failure of markets for EG&S. Two of the cases, a private forest with a member-supported wolf centre and snowmobiling clubs in Ontario, involve EG&S delivered as club goods. Jessica Rosenberg's thesis examines the critical success factors that arise out of the experiences in the Alternative Land Use Services (ALUS) pilot project in Norfolk County, Ontario. An understanding of the critical success factors is an important source of information for the design and extension of this approach of promoting the provision of EG&S in Ontario and Canada. Paul Guerra is undertaking a feasibility study of investment in the provision of EG&S from Ontario farmland by looking at how ALUS could integrate with the current agri-environmental policy framework at the provincial level. The studies employ multi-disciplinary, qualitative and quantitative research strategies that capture the institutional, financial and social influences on the provision of EG&S.

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Transfer of Development Credits – A Tool for Market Based Stewardship of Natural Capital for Sustainable Development in Rural Alberta

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This poster reviews the concept of Transfer of Development Credits (TDC) as a potential policy tool to help municipalities' reconcile the challenges of developing and conserving land. Briefly stated, TDC programs identify areas where increased development is desirable, and areas where it is less appropriate, then assign 'development credits' to each parcel within the program area. Those in the receiving (development) area are required to purchase credits from parcels in the sending (conservation) area before being allowed to increase the density of their development. In addition to traditional zoning, TDC's provide a framework for long-term community planning, using an open-market mechanism where there is financial consideration for conservation. The poster then describes a potential TDC pilot project in Strathcona County in the Beaver Hills of east central Alberta that involves the Beaver Hills Initiative, Alberta Research Council, the Miistakis Institute and Cambridge Strategies. The goals of the pilot project will be to develop a market for TDC's in Strathcona County; then by taking advantage of Strathcona County's protected natural capital expand and create sustainable business opportunities; and to develop a model for other municipalities.

Implementation of Policy Tools to Conserve Wetland Functions in Canada: Case Studies from Saskatchewan and New Brunswick

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Wetlands are some of the most valuable conservation lands in Canada but every year they continue to be lost due to pressure from agriculture, industrial development and urbanization. In Canada, the amount of wetland loss has been reported as 65% for Atlantic coastal salt marshes, 50% for prairie potholes and 80-98% in urban centers (Federal Policy on Wetland Conservation 1991). The greatest single threat to wetlands has historically been drainage for agricultural purposes accounting for 85% of total known conversions. Wetland values and functions such as flood water retention, filtering of pollutants and sediments, biodiversity, carbon sequestration and wildlife habitat are all lost when wetlands are drained and filled in. Concern over wetland loss led to the 1991 Federal Policy on Wetland Conservation and subsequent development of wetland policies in many provinces of Canada. An objective of most wetland conservation policies in Canada is the conservation of wetland functions and wetland area. Most policies also advocate a hierarchical mitigation approach of avoidance, minimization, and as a last resort compensation of negative impacts on wetlands. Although policies are clear in the need for application of the mitigation hierarchy, and in some cases compensatory mitigation, guidance on, how to assess wetland function and compensation requirements is limited. The

twinning of the Trans Canada Highway in Saskatchewan versus New Brunswick resulted in different compensation plans. The Saskatchewan compensation plan resulted in net loss of over 50 hectares of wetlands while the New Brunswick plan protects wetland function by requiring the loss of 24 ha of wetlands to be compensated for by creation of 75 ha of wetland according to provincial policy. Wetlands continue to be impacted by development and other anthropogenic activities and therefore wetland conservation policies need to be developed for all jurisdictions of Canada, and equally important more guidance needs to be developed so the mitigation process is an equitable and transparent process.

A Reverse Auction to Restore Wetlands in Saskatchewan

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In October 2008 a reverse auction to restore drained wetlands on private land and increase waterfowl production was initiated in the Upper Assiniboine River watershed of Saskatchewan. An extensive media and phone campaign was implemented to attract bidders to the auction. Twenty producers submitted bids on 118 quarter sections for a total of 713 wetlands (670 acres). Bids included both cropland and forage, and all bids were for 12-year terms despite the option to submit bids on perpetual conservation easements. Bid values ($/restored acre) varied substantially, but generally were significantly higher for cropland than forage. Preliminary results suggest a) initially considerable effort is required to attract bidders and guide them through the auction process, b) producers would likely become more proficient with future auctions, c) there is significant interest in wetland restoration among cattle producers in this area.

Phosphorus Trading in the South Nation River Watershed

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The South Nation River (SNR) watershed has a regulated water quality trading program. New or expanding waste water dischargers must control all phosphorus (P) loadings into receiving waters, since the SNR exceeds the 0.03 mg/l Provincial Water Quality Objective (PWQO) for P.

To achieve this, dischargers buy P credits from South Nation Conservation (SNC), a community based watershed organization. The Total Phosphorus Management (TPM), allows dischargers to offset increased P loads by controlling P from non-point sources (NPS) using best management practices (BMP's). SNC's long-standing Clean Water Program, a cost-share grant program, is the delivery mechanism for implementing the P reduction BMP's. The quantity of P removed by each BMP is calculated using mathematical formulae derived from primary research.

The amount of P credits that need to be bought depends on two factors. The first is the amount of P that the discharger contributes. The second is the offset ratio required by regulation; in the SNR watershed, an offset ration of 4:1 is mandated. That is, 4 kg of P must be removed from non-point sources for every 1 kg of P that the discharger contributes.

NAESI Standards as Desired Environmental Outcomes: Linkages with Ecological Goods and Services and Other Natural Capital and Environmental Valuation Programs

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There is a growing movement to recognize the ecological goods and services (EG&S) that agriculture provides beyond food production—particularly the ways in which agricultural activity can shape environmental landscapes and supply environmental benefits. Any successful EG&S policy/program should include: clear environmental targets; a system for choosing the right mix of policy instruments; the capacity to measure, interpret and report environmental results; a valuation of EG&S; and citizen and producer engagement.

Environment Canada, in close collaboration with AAFC has recently completed a four year initiative to develop agri-environmental performance standards that describe desired environmental conditions on agricultural landscapes. One of the proposed uses of the National Agri-Environmental Standards Initiative (NAESI) standards is as benchmarks of environmental quality to evaluate policies for their ability to achieve EG&S targets and to help determine the appropriate contribution by society and land owners.

This poster will demonstrate how some of the water and biodiversity NAESI standards could serve as suitable benchmarks for evaluating and monitoring desired environmental outcomes. For example, through NAESI a series of region-specific phosphorus standards have been developed for a variety of waterbody types (streams, rivers, and coastal waters) and sizes. The most appropriate phosphorus standard could be chosen by EG&S program administrators as an environmental outcome against which the current situation could be evaluated and as a way to measure the success and accountability of policies/programs.

EG&S: Estimating Program Uptake & Nature of Costs/Benefits in Agro-Manitoba. A Study by George Morris Centre Prepared for Manitoba Agriculture, Food and Rural Initiatives (2008)

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The main objectives of this study were to determine the nature and extent of EG&S qualifying lands across agro-Manitoba and to describe the potential environmental benefits from an EG&S program and the main environmental practices involved. The eligible landscapes were: wetlands, natural uplands, ecologically sensitive lands and riparian areas. Local stakeholders were consulted on program design scenarios, eligible acres were estimated via GIS analysis and the costs and benefits of each program scenario were estimated using literature land values. The three payment scenarios included: rental rates for marginal and productive land, crop revenues and expenses, and the ALUS pilot project (assuming no agricultural use). Benefit/cost ratios were greater than one for all scenarios in the initial analyses, and were highly dependent on the assumed monetary value of wetlands. Although there may be positive net benefits to Manitobans, a blanket EG&S program covering all of agro-Manitoba would cost several hundred million dollars per year, depending upon program parameters. Opportunity costs seem to drive overall program costs.

Ontario's Wealth, Canada's Future: Appreciating the Value of the Greenbelt's Eco-Services

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Nearly a quarter of Canada's population lives in Southern Ontario's Golden Horseshoe. In the next two decades, the population is projected to increase by another 3.7 million. As a result, unprecedented pressure will be placed on the region. In 2005, the Greenbelt Act established a band of permanently protected area covering more than 730,000 hectares around Hamilton and the Greater Toronto Area. The Greenbelt was designated to safeguard key environmentally sensitive land, watersheds, and farmlands and provide essential ecosystem services. The objective of this study was to profile the importance of the natural capital and ecosystem services provided by Ontario's Greenbelt through an assessment of benefits provided to communities in the Golden Horseshoe. This study provides an account of the land cover types and the region's ecosystems, and quantifies the non-market values provided by the Greenbelt's ecosystems.

The types of ecosystems and land-use within the Greenbelt were determined using land cover data from 2000-2002 Southern Ontario Land Resource Information System (SOLRIS). The Ontario Land Cover (1990-1997) was used for the northern arm of the Niagara Escarpment region. We estimated the value of non-market ecosystem services using avoided cost and replacement cost methods, as well as contingent valuations or willingness-to-pay studies to estimate cultural values. Some of these values were derived using direct analysis and some values were adapted from other studies known as value transfer.

The total annual value of the Greenbelt's non-market ecosystem services is an estimated to be $2.6 billion, or an average of $3,487 per hectare per year. The highest values per hectare are attributed to wetlands and forests. The ecosystem services with the highest values are habitat, flood control, climate regulation, pollination, waste treatment, and control of water runoff. These values are likely conservative estimates due to our incomplete understanding of all the benefits provided by nature, the intrinsic value of nature itself and the likely increase in ecosystem service values over time, as services, such as water supply become increasingly scarce with global warming, for example. The valuations of ecosystem services, however, provide an opportunity to rigorously assess the current benefits of the Greenbelt and the potential costs of human impacts.

Tax Incentive Programs to Encourage Responsible Stewardship – Ontario Ministry of Natural Resources

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Ontario has 14.8 million hectares of privately owned lands. Private lands contribute to the social, economic and environmental well being of the province while adding to all aspects of sustainable resource management. They host some of the most significant natural areas in the province representing 12% of Ontario's productive forest cover. OMNR has developed incentive programs to encourage and promote responsible stewardship on private lands. These incentive programs aim to increase landowner awareness of land stewardship while enhancing efforts to conserve and protect of our natural heritage. These programs are an essential component of the governments' greening initiatives. Tax based incentives encourage landowners to practice good stewardship while contributing to Ontario's healthy natural environment and have proven to be effective resource management tools.

The Conservation Land Tax Incentive Program (CLTIP) is designed to protect highly significant natural heritage features on private lands. Eligible lands are tax-exempt as long as participants demonstrate a commitment to the protection of these features. The Managed Forest Tax Incentive Program (MFTIP) encourages landowners to actively manage forested properties to achieve a range of goals. Eligible lands are taxed at 25% of the residential tax rate. Participation in these programs continues to increase.

Lessons Learned in Alberta's Carbon Market

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The Greenhouse Gases (GHG) Regulatory Framework in Alberta is the first of its kind in North America, and considered a pilot for many other carbon trading initiatives across the continent. Alberta's Specified Gas Emitters Regulation requires companies that emit more than 100,000 tonnes of carbon dioxide equivalents (C02e) annually to reduce their emission intensity by 12 %. If unable to meet this requirement, companies may purchase verified carbon offsets generated by using a government approved ISO 14064-2 conformant protocol. This series of science-based quantification protocols have been used to create carbon offsets around new technology and/or management practices that either remove or reduce greenhouse gases. Key insights into lessons learned from applying an adaptive management framework for the Alberta Carbon Market over the last 18 months will be presented. This larger scale Environmental Goods and Services related Market-Based Instrument has proven successful and further improvements are planned in the next couple of years based on our early learning's.

Growing ALUS in Ontario

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Alternative Land Use Services or "ALUS" is a national landscape conservation concept using the special skills of farmers to deliver ecological goods and services (EG&S). These special skills may be used to maintain and restore natural capital, biodiversity, ecosystem connectivity and habitats, and to manage carbon in the soil. ALUS pays farmers to produce EG&S from their land. Communities and farmers play a direct role in managing the program. ALUS builds on and incorporates existing programs, such as the environmental farm plan, and allows farmers to do more for the environment on their land. Existing farm organizations, like crop insurance are also used to monitor EG&S delivery, and manage a fully accountable program.

- There are no tricks or quick fixes to engaging farmers in providing ecological goods and services from their land. ALUS is a grass- roots approach that provides a social license in the rural community for conservation, because ecological service delivery is planned, implemented and monitored at the community level. EG&S delivery should be voluntary, allow for grass- roots input and allow for decision- making at the community level.
- Involve farmers as solution providers to environmental issues. Use the "farmer to farmer" approach to access land, and have extension capacity to visit farms and reach consensus with the farmer on the specific environmental improvements that are sought by the community, and

those that are compatible with farming operations. Use the special skills of farmers as land and crop managers to deliver solutions.

- EG&S should be delivered in a holistic manner in the community and on individual farms. The “farmer to farmer” approach was only successful within the context of a community- managed approach.
- Build EG&S on current programs for risk management such as the Environmental Farm Plan, and involve the full array of existing programs and interests in the project, from public and private sector partners. Maintain the identity and integrity of individual partner programs in the overall approach.
- Build EG&S as a collaborative of funding partners and project supporters, brought together at the community level. Encourage and build project support from the community, out to the broader levels of interest.
- Flexibility is key to engaging farmers in EG&S delivery and partner support. At the same time, a level of control is warranted to maintain or protect services.
- Build the EG&S program on incremental environmental gains, while recognizing and rewarding good stewardship of existing services.
- Native tall-grass prairie restoration on marginal or sensitive farmland in Norfolk County has many co- benefits, particularly where this rare ecosystem once flourished, including: biodiversity conservation; carbon sequestration; habitat provision to native pollinators, parasitoids and predator insects beneficial to the farm; source of bio-fuel; drought resistant pasture; water filtration, and soil stabilization.
- Natural capital has zero or even negative economic value at the farm gate, a situation that must be changed to maintain or enhance EG&S from farmlands.

Water Quantity and Quality Benefits from Wetland Conservation and Restoration in the Broughton Creek Watershed

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Ducks Unlimited Canada recently completed Phase I of a multiphase research project to determine the impacts of wetland loss and associated drainage activity in the Broughton’s Creek watershed (BCW) in Manitoba (MB). The BCW was selected because land use and wetland loss trends there are representative of southwestern Manitoba. The BCW also feeds into Lake Winnipeg, which is experiencing significant water quality issues. This project confirmed that 5,921 wetland basins in the BCW (70% of its wetlands) were degraded or totally lost due to drainage between 1968 and 2005. Hydrologic models estimated that this loss had the following environmental impacts at a watershed scale: 31% increase in area draining downstream; 18% increase in peak flow following rainfall; 30% increase in stream flow; 31% increase in nitrogen and phosphorus load from the watershed; 41% increase in sediment loading; approximately 34,000 tonnes of carbon released; and 28% decrease in annual waterfowl production. When results from the BCW were extrapolated to all of southwestern MB, it was estimated that wetland drainage since 1968 has resulted in: an increase in total phosphorus loading (114 tonnes/year) to Lake Winnipeg; a release of 5 million tonnes of carbon stored in wetland sediments and plant material; and an increase in area contributing run-off to Lake Winnipeg of 4,518 km^2. The estimated value of wetland ecosystem services associated nutrient removal and carbon sequestration lost since 1968 is $430 million. To replace the ecosystem services lost in MB in 2005 alone would cost approximately $15 million and this will increase to $19 million by 2020 if wetland drainage is not stopped. Although this study focused on Manitoba, it paints a clear picture of the impacts that continued wetland loss will have throughout Canada. The ecological goods and services that are critical to our health and economic well-being are continually being deteriorated, and this research justifies the need for comprehensive and integrated wetland policies to reverse this trend.

Facilitator's Report: Building a Blueprint for the Future of EGS in Canada

Warren Wilson, The Intersol Group

Introduction

An Ecological Goods & Services Technical Meeting was held on April 29-30, 2009 in Ottawa, Ontario. The Meeting sponsors were the Prairie Habitat Joint Venture (PHJV), Eastern Habitat Joint Venture (EHJV) and Agriculture and Agri-Food Canada (AAFC). A full agenda for the meeting is available in Appendix 1.

Approximately 100 invited participants heard technical results from eight Ecological Goods and Services (EGS) pilot projects funded by the Advancing Canadian Agriculture and Agri-Food (ACAAF) program.

The stated objectives of the meeting were:

- Communicate results from ACAAF funded EGS pilots and other studies.
- Foster a national community of practice among key EGS stakeholders.
- Facilitate the documentation and delivery of project results for consideration in the design of environmental programming.

The meeting included a series of presentations from representatives of each of the pilot projects followed by brief plenary question and answer periods. In addition, a poster display provided an opportunity to share additional and complementary information with participants. Rapporteurs were assigned to capture and share "key messages" from presentations as well as the poster display.

During the second day of the meeting, participants engaged in small group (table) and then plenary discussion where they focussed on the future direction of EGS in Canada.

What follows here is a summary report from this meeting. The report is intended as a record of the meeting to be used by the organisers in continuing the discussion on EGS in Canada. The report includes:

- Rapporteur remarks recorded during the session as outlined above. These remarks are summarized in the body of the report. Complete outlines of the rapporteur remarks are contained in the Appendix 2 of the Proceedings document.
- A summary of key messages from the group discussions on day two. In addition the verbatim notes captured during table discussions, which are the basis for the key messages, are in Appendix 3 of the Proceedings document.

Prior to the workshop, summary papers were prepared for each of the pilot projects. In addition full reports from each pilot are currently being compiled. All of this information as well as power point presentations that were presented at the session will be compiled with paper copies and a CD. This information will all be posted to the websites of the meeting sponsors.

Rapporteur Key Messages

The work of the pilots is significant, comprehensive and complex. The following key messages do not capture the specifics of what was learned at each of the sights. Rather, they are an attempt at identifying the higher level messages, as gleaned by the rapporteurs, that may be useful in informing the next steps beyond the pilots. The reader is again referred to the detailed rapporteur summaries in Appendix 2 of the Proceedings document as well as the individual project reports and summaries which will be made available separately.

- There has been a significant and important body of knowledge assembled through the work of the pilots as well as related research (e.g. WEB's). We have learned much about the biophysical science, economic, and social aspects of EGS. While questions remain, there is much to build on.
- Canada's landscape is diverse. Solutions and actions will need to respect that diversity.
- There is an interest in the producer community as well as civil society to pursue EGS in Canada. Attitudes are changing and relatively quickly. The pilots highlighted how in some cases farmers have now "internalized" practices that were considered foreign even 5 years ago.
- EGS is complex (in ecological and financial terms). The challenge will be to translate this complexity into programs and tools that can be understood and applied on the landscape.
- There are numerous existing institutions, mechanisms and programs (e.g. environmental farm planning) that can be leveraged in implementing solutions.
- Producers prefer the "carrot" versus the "stick" approach – stewardship and working cooperatively versus regulation.
- EGS work/research like that undertaken in the pilots is long term. The two year time frame is too short. Producers would prefer longer term programs (to fully understand costs and benefits in the context of their production systems which are longer term).
- There are more than ecological benefits to be derived from implementing BMP's. Biomass is an example of a new economic benefit that can be derived from the use of BMP's (in this case buffer strips).
- EGS is evolutionary not revolutionary – we will not get it perfect right out of the gate. This implies the need for an adaptive management approach.
- The work also raises questions around who pays?
    - Public, industry, producers, Government (and which Branch – Environment, Agriculture, Forestry)?
    - The government in fact has promoted practices in the past that are now considered an issue for the environment. The concept of BMPs has changed – e.g. certain drainage practices.
- Targets need to be set that will balance land use, economics, personal values, wildlife needs.
- Producer and community involvement are key to successful implementation.
- In terms of policy instruments, there is a need to complement & be integrated with other policy tools and services that have the same objectives – to get more BMPs on more farms (education, EFPs, other cost-share programs, extension).

- Quantify impacts of wetland loss and translate into the value of the goods and services provided in order to establish a market price. The pilots illustrated the need for the right combination of financial, institutional and social factors to make this viable.
- There is a need for a suitable benchmark for evaluating and monitoring the effectiveness of policy tools in achieving EGS targets (i.e. NAESI).

Group Discussion – Learning from the pilot projects and future direction for EGS

Following the pilot project presentations, participants engaged in small group (table) and then plenary discussion. Initially groups added additional key messages to those presented by the rapporteurs. The reader is referred to the list of these messages which is significant, in Appendix 2. In addition the following questions were discussed (Again, the verbatim notes captured during table discussions on these questions are in Appendix 2 of the Proceedings document). What follows here is an attempt at summarising the key messages that emerged:

1. What did the pilots tell us about baseline/minimal environmental performance standards?
    - Generally, and conceptually, it was felt to be desirable to set performance standards.
    - However, more research is needed here. There are many questions (see appendix notes). Some pilots focussed more explicitly on standards than others.
    - Because of the diversity of landscapes across the country there will be a need for regional standards – it would be difficult/impossible to set a national standard.

2. What did the pilots tell us about which policy tools would be most effective and efficient?
    - The one key message coming out of this discussion was that there will be a need for a mix or suite of tools in each circumstance that is different – "One size will not fit all".
    - All of the policy tools examined through the pilots have merit.

3. What are the key elements of and EGS agenda, and should it be pursued in Canada? Why? Why not?
    - There was a clear signal from the group that EGS should indeed be pursued in Canada, based on the results of the pilots.
    - Elements of an EGS agenda would include a national policy statement, a vision, flexibility to facilitate the use of a mix of instrument and delivery mechanisms, stewardship as a central tenet – the "carrot", education and outreach, qualitative as well as quantitative analysis).
    - But – we need to get on with it – there is enough information to broaden beyond "pilots" now – this implies an adaptive management "learn as we go" approach.

4. What are your suggestions for specific next steps?
    - Obtain Ministerial commitment to develop a framework for EGS.
    - Establish a vision for EGS in Canada.
    - Document the lessons learned from the pilots.
    - Identify the BMP's that have the most potential, as well as those that will be clearly cost prohibitive.
    - Explore a further role for NGO's.
    - Resolve jurisdictional issues (land use planning, environment, energy etc.).
    - Scale up based on what we have learned – this is a difficult but necessary step.

Learning from the Pilot Projects and Future Direction for EGS

Leloni Scott[1] and Ian Campbell[2]

This workshop provided an extraordinary opportunity to bring together many of the key professionals and stakeholders who have been working hard on improving the functioning of ecological services in Canada's agricultural landscapes over the past five years.

In 2004, federal and provincial ministers of agriculture faced an uncomfortable situation: they recognized that farmers did not receive recognition for the environmental benefits of many farm practices. On the other hand, it was not clear how to support environmentally beneficial practices in ways that were affordable, accountable to the public, and did not distort other market signals. They created our Federal-Provincial EG&S Working Committee to shed light on this dilemma. From the direction given by federal-provincial ministers of agriculture in 2004, we have created an impressive body of work that illuminates many of the key questions about how to develop effective and efficient ecological policy and programs. Some of the many objectives of this working group were to set up research pilot initiatives to support policy development on EG&S, test and validate innovative approaches to EG&S and assess the costs and benefits of different BMPs. Between 2006 and 2009, eight EG&S pilot projects were funded under the Advancing Canadian Agriculture and Agri-Food (ACAAF) program. The results of this work have been showcased during this workshop, and many promising ways of efficiently increasing ecological services have been tested.

While many lessons can be drawn from the material presented in these sessions, a few crucial next steps have been identified during the discussion over the last two days:

1. There is a need to clarify the objectives and outcomes of EG&S policies in order to communicate with both decision makers and stakeholders. While allowing for differences in priorities and approaches, the establishment of clear goals would assist in making a case for new initiatives.

2. We have to identify and address impediments to adoption of EG&S policies in order to focus attention and resources on key gaps. For example, low understanding and acceptability of new program options such as auctions may require attention in spite of their apparent economic efficiency. Other impediments could include gaps in scientific knowledge or administrative institutions.

3. The need for regional flexibility is crucial. One of the recurrent conclusions of the workshop is that the enormous variety in environmental, institutional and other conditions across Canada means that EG&S policies and programs need to be highly flexible across regions.

4. There is a need to test the results of small-scale research in other areas where applicable. Many of the conclusions of the local EG&S pilot projects presented at this workshop likely apply beyond their original area, but further work is needed to confirm which results can be applied in

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different landscapes and jurisdictional situations.

5. The current framework of agricultural programs in Canada appears well adapted to EG&S: broad guidelines established at the federal level apply to program initiatives that are largely delivered at the provincial level. This structure ensures consistency of approaches across the country, while allowing significant provincial flexibility to adapt programs to local conditions and priorities. In addition, it fosters experimentation and sharing of successful approaches between areas with similar circumstances.

6. Stakeholders from beyond the agricultural industry must be drawn into the development of EG&S policies. Most of the agricultural landscapes that would benefit from improved environmental management include urban, rural non-farm, forestry, recreational or other types of land users. Potential partners in other natural resource departments, wildlife groups, municipal governments, and other entities have a role to play as potential beneficiaries, funders, sources of expertise, participants and possibly as leaders of EG&S initiatives.

7. It will be important to get support from high levels within government to advance the development of EG&S policies. Public commitments from ministers of various departments would greatly assist the advancement of EG&S policies in Canada.

Participants in the workshop are eager to further analyze these results and use them to follow up on the crucial next steps identified during the discussion.

Appendices

Appendix 1 – Meeting Agenda

Ecological Goods & Services Technical Meeting
Lord Elgin Hotel, Ottawa, Canada
April 29-30, 2009

Agriculture and Agri-Food Canada
Prairie Habitat Joint Venture & Eastern Habitat Joint Venture
North American Waterfowl Management Plan

Presentation Agenda & Posters **Updated April 16, 2009**

Day 1 – Wednesday, April 29

Time	Activity
7:30 am	**Invitee Registration & refreshments**
Pearson Room	**Day 1 Chair** – Dean Smith, Co-Chair Organizing Committee and Chair, PHJV Policy Committee, Advisor, Federally Managed Assets, Agri-Environment Services Branch, Agriculture & Agri-Food Canada, Regina, SK
8:00	***Introductions*** Eleanor Zurbrigg, Board Member of Eastern Habitat Joint Venture and Manager Population Conservation Section, Ontario Region, Environment Canada, Canadian Wildlife Service, Ottawa ON Bob Carles, Board Member of Prairie Habitat Joint Venture and Vice-President, Vice-President, Stewardship Division, Saskatchewan Watershed Authority, Moose Jaw, SK
	Theme: Background
8:15	***EGS Pilot Projects*** Presenter: Mr Jamshed Merchant, Assistant Deputy Minister, Agri-Environment Services Branch, Agriculture and Agri-Food Canada, Ottawa, ON
	Theme: Valuation of EGS
8:30	***Integration of Watershed Planning and the Agricultural Policy Framework for the Provision of Ecological Goods and Services: A Pilot Watershed Approach For Wetland Restoration & Retention + Estimates of Passive Use Values of Wetland Restoration and Retention in Southern Manitoba*** Institute for Wetland and Waterfowl Research, Ducks Unlimited Canada Presenter: Shane Gabor, Research Scientist, Stonewall, MB

	Dr. Peter Boxall, Professor, Environmental and Rural Economics, Department of Rural Economy, University of Alberta, Edmonton, AB
	Theme: Direct Payment Approach
9:15	***Alternative Land Use Services (ALUS): An Ecological Goods & Services Research Project*** Keystone Agricultural Producers, Manitoba Presenter: Ian Wishart, President, Winnipeg, MB
10:00	Break
10:30	***Prince Edward Island Ecological Goods & Services Pilot Project*** The Souris and Area Branch of the Prince Edward Island Wildlife Federation Presenter: Fred Cheverie, Project Manager, Souris PEI
11:15	**Rapporteur Summary for Day #1 Morning** – Paul Smith, Member of Federal/Provincial EGS Working Group and Environmental Policy Analyst, Ontario Ministry of Agriculture, Food and Rural Affairs, Guelph ON
11:30 am	**Poster Display Set up** at Laurier Room & Pearson Room Foyer / Depart for Ontario Room
11:45	**Buffet Lunch** @ Ontario Room
1:00 pm	**Attended Poster Displays** – Laurier Room & Pearson Room Foyer
	Theme: New Beneficial Management Practices
1:30 pm	***Ecological Goods & Services and Agroforestry (EG&S) : the benefits for farmers and the interests for society*** EcoRessources Consultants Presenter: Jean Nolet, President, Quebec City, QC
2:15	***Farmer Contribution to the Production of Environmental Goods and Services in Targeted Sub-basins of Missisquoi Bay*** Pike River Drainage Basin Community Cooperative Presenter: Richard Lauzier, Agronomist, Bedford Service Centre Quebec Ministry of Agriculture, Fisheries and Food, Bedford, QC

3:00	Break
3:30	***Identification and Assessment of the Provision of Environment Goods and Services by the Primary Agriculture Sector and Determining Societal Expectations of the Farm Community*** The Nova Scotia Federation of Agriculture Presenter: Dr. Bruce Roberts, PAg. Kelco Consulting Ltd., Kentville, NS
4:15	**Rapporteur Summary of Day #1 Afternoon Session** – Patricia Edwards, Coordinator, Eastern Habitat Joint Venture, Environment Canada, Sackville, NB
4:30	Wrap up of Day 1
4:30 – 5:30	**Poster Session**: Cash Bar and Attended Posters @ Laurier Room/Pearson Room Foyer

Day 2 – Thursday, April 30, 2009

Time	Activity
Pearson Meeting Room	**Day 2 Chair** – Ian Campbell, Co-Chair Organizing Committee and Senior Manager, Agri-Environmental Policy and Strategic Priorities, Agri-Environmental Services Branch, Agriculture and Agri-Food Canada, Ottawa, ON
	Theme: Enhancement of Environmental Farm Plans
8:00	***Lower Souris Watershed Ecological Goods and Services Pilot Proposal*** The Lower Souris Watershed Committee Presenter: Sheldon Kyle, Watershed Coordinator, Redvers, SK
8:45	***Investigation of the Use of the Environmental Farm Plan (EFP) as an EG&S Management and Policy Development Tool*** The Eastern Canada Soil and Water Conservation Centre Presenter: Jerome Damboise, Project Coordinator, Saint-Andre (Grand Falls), NB
	Theme: Evaluation of Costs & Benefits
9:30	***Cost Efficiency Analysis of Possible Environmental Goods & Services (EG&S) Policy Options***

	EcoRessources Consultants Ltd Presenter: Claude Sauve, Senior Associate, EcoRessources Consultants Ltd., Quebec City, QC
10:15	Break
	Theme: New Initiatives
10:30	***Price Discovery Mechanisms for Providing Ecological Goods & Services from Wetland Restoration: An Examination of Reverse Auctions*** Presenter: Dr. Peter Boxall, Professor, Environmental and Rural Economics, Department of Rural Economy, University of Alberta, Edmonton, AB
11:15	**Rapporteur Summary for Day #2 Morning Session** – Brook Harker, Manager of Watershed Evaluation of Beneficial Management Practices (WEBS), Agri-Environment Services Branch, Agriculture and Agri-Food Canada, Regina, SK
11:30	Depart to Ontario Room
11:45	**Buffet Lunch** 12:20 pm Speaker Introduction – Bob MacFarlane, Policy Coordinator, Prairie Habitat Joint Venture, Regina, SK Dr. Ken Nicol, Chair, The Institute for Agriculture, Forestry and the Environment, Coalhurst, AB will speak on **The Institute for Agriculture, Forestry and the Environment**
1:00	Depart and regroup at Pearson Meeting Room
	Theme: Next Steps
1:15 pm	**Poster Rapporteur Summary** – Cynthia Edwards, National Manager Industry and Government Relations, Ducks Unlimited Canada, Regina, SK and Maxine Kingston, Technical Director, Ontario Region, Agri-Environment Services Branch, Agriculture and Agri-Food Canada, Guelph, ON
1:15	Group Facilitation Session led by Warren Wilson, The Intersol Group, Ottawa ON **"Building a Blueprint for the Future of EGS in Canada"**
	Informal Break On-Going

3:45	***Learning from the Pilot Projects and Future Direction for EGS*** Presenters: Leloni Scott, Co-Chair Fed & Prov. EGS Working Committee, Director, Agri-Environment Branch, Manitoba Agriculture Food and Rural Initiatives, Carmen, MB; Ian Campbell, Co-Chair Fed & Prov. EGS Working Committee and Senior Manager, Agri-Environmental Policy and Strategic Priorities, Agri-Environmental Services Branch, Agriculture and Agri-Food Canada, Ottawa, ON
4:00	Closing Remarks & Departures

Listing of Posters

Provision of Ecological Goods and Services as Club Goods: Case Studies from Ontario
Glenn Fox and Monika Drozdz
Department of Food, Agricultural and Resource Economics, University of Guelph, Guelph, ON, N1G 2W1
gfox@uoguelph.ca and mdrozdz@uoguelph.ca

Transfer of Development Credits – A Tool for Market Based Stewardship of Natural Capital for Sustainable Development in Rural Alberta
Kimberly Good[1], Brenda Wispinski[2] and Guy Greenaway[1]
[1]Miistakis Institute c/o Environmental Design, 2500 University Drive NW, Calgary, AB T2N 1N4 (kim@rockies.ca)
[2]Strathcona County Corporate Planning and Intergovernmental Affairs, 2001 Sherwood Drive, Sherwood Park, AB T8A 3W7 (wispinsk@strathcona.ab.ca)

Implementation of Policy Tools to Conserve Wetland Functions in Canada: Case Studies from Saskatchewan and New Brunswick
Michael Hill[1] and Alan R. Hanson[2]
[1]Ducks Unlimited Canada, 603-45 St. West, Saskatoon SK, S7L 5W5 (m_hill@ducks.ca).
[2]Canadian Wildlife Service - Environment Canada, P.O. Box 6227, Sackville, NB E4L 1G6 (al.hanson@ec.gc.ca)

A Reverse Auction to Restore Wetlands in Saskatchewan
Glen McMaster[1], Tom Harrison[1], Aron Hershmiller[2], Michael Hill[3], Jeff Olson[1], and Trevor Plews[3].
[1]Saskatchewan Watershed Authority, 420-2365 Albert Street, Regina SK, S4P 4K1. (Glen.McMaster@swa.ca; Tom.Harrison@swa.ca or Jeff.Olson@swa.ca)
[2]Assiniboine Watershed Stewardship Association, 37 3rd Ave N, Yorkton, SK S3N 2W3 (a.hershmiller@assiniboinewatershed.com)
[3]Ducks Unlimited Canada, 603-45 St. West, Saskatoon SK, S7L 5W5 (m_hill@ducks.ca or t_plews@ducks.ca).

Ontario's Wealth, Canada's Future: Appreciating the Value of the Greenbelt's Eco-Services

Faisal Moola[1], Sara Wilson[2] and Kathy MacPherson[3]
[1]David Suzuki Foundation, #219-2211 West 4th Avenue, Vancouver BC V6K 4S2 (fmoola@davidsuzuki.org)
[2]Natural Capital Research and Consulting, 542 Reed Road, Gibsons, BC V0N 1V1 (sarajwilson@dccnet.com)
[3]Friends of the Greenbelt Foundation, Suite 201, 68 Scollard Street, Toronto, Ontario M5R 1G2 (kmacpherson@ourgreenbelt.ca)

Phosphorus Trading in the South Nation River Watershed

Dennis O'Grady & Ronda Boutz
South Nation Conservation, 38 Victoria Street, Finch ON K0C 1K0 (dogrady@nation.on.ca or rboutz@nation.on.ca)

NAESI Standards as Desired Environmental Outcomes: Linkages with Ecological Goods and Services and Other Natural Capital and Environmental Valuation Programs

Elizabeth S. Roberts and Michelle E. Bowerman
Forestry, Agriculture, and Aquaculture Division. Environment Canada, 351 St Joseph Blvd, Gatineau QC K1A 0H3 (elizabeth.roberts@ec.gc.ca or michelle.bowerman@ec.gc.ca)

EG&S: Estimating Program Uptake & Nature of Costs/Benefits in Agro-Manitoba. A Study by George Morris Centre Prepared for Manitoba Agriculture, Food and Rural Initiatives (2008)

Colleen Wilson[1] and Esther Salvano[2]
[1]Manitoba Agriculture, Food and Rural Initiatives, Box 1149, Carman MB, R0G 0J0 (colleen.wilson2@gov.mb.ca)
[2]Manitoba Agriculture, Food and Rural Initiatives, 545 University Crescent, Winnipeg MB R3T 5S6 (Esther.Salvano@gov.mb.ca)

Tax Incentive Programs to Encourage Responsible Stewardship – Ontario Ministry of Natural Resources

Robert Spence and Fiona McKay
Ontario Ministry of Natural Resources, P.O. Box 7000, 300 Water Street, Peterborough, ON K9J 8M5 (robert.spence@ontario.ca or fiona.mckay@ontario.ca)

Lessons Learned in Alberta's Carbon Market

Amanda Stuparyk and Karen Haugen-Kozyra
Climate Change Central, 100-999 8 Street SW, Calgary, AB T2R 1J5
(astuparyk@climatechangecentral.com or karenhk@climatechangecentral.com)

Growing ALUS in Ontario

Kristen Thompson[1], Bryan Gilvesy[2], Bob Bailey[3], and Dave Reid[4]
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[3]Delta Waterfowl Foundation, 125 Otter Lake Road, RR1, Lombardy, ON, K0G 1L0 (robailey@ripnet.com)
[4]Norfolk Land Stewardship Council, Simcoe, ON, NSY 4N5 (dave.j.reid@ontario.ca)

Water Quantity and Quality Benefits from Wetland Conservation and Restoration in the Broughton Creek Watershed

Wanhong Yang[1], Xixi Wang[2], Shane Gabor[3], Lyle Boychuk[4] and Pascal Badiou[3]
[1]Department of Geography, University of Guelph, ON N1G 2W1(wayang@uoguelph.ca)
[2]Department of Engineering and Physics, Tarleton State University (Texas A&M), Box T-0390, Stephenville, Texas 76402 (xwang@tarleton.edu)
[3]Ducks Unlimited Canada, Institute for Wetland and Waterfowl Research, Box 1160 Stonewall MB R0C 2Z0 (s_gabor@ducks.ca or p_badiou@ducks.ca)
[4]Ducks Unlimited Canada, Western Region, P.O. Box 4465, Regina, SK S4P 3W7 (l_boychuk@ducks.ca)

Appendix 2 – Rapporteurs' Key Messages from Meeting Sessions

Session One

Themes Background, Valuation, Direct Payment Approach (Manitoba), PEI Pilot Project

Rapporteur Paul Smith – Ontario Ministry of Agriculture and Food and Rural Affairs.

Key Messages

- Canada's landscape is diverse as shown by the Manitoba and PEI examples. The implication is that "1 size will not fit all" – solutions and actions will need to respect this diversity.
- There is a need to identify specific next steps – Jamshed Merchant indicated he didn't want the reports to sit on the shelf. Federal and Provincial senior managers and Ministers are looking for advice and recommendations.
- The perceived market value of wetlands is zero. In fact agricultural production costs increase as producers avoid wetlands.
- The valuation of EG & S is complex (in ecological terms and in financial terms):
  - The pilots have produced useful models and analysis.
- Technical detail needs to be translated into a language that producers and civil society can understand.
- The notion of "optimizing targeting" has merit. Doing the right thing in the right places pays dividends.
- There is substantial grass roots support for new approaches:
  - Producers willing to change practices.
  - Society willingness to pay for environmental benefits.
- Existing institutions and mechanisms should be leveraged as emphasized in the Manitoba example (e.g. crop insurance agencies). There are existing relationships on the ground that can be built upon.
- Pricing EG & S on the ground in the pilots was not a purely academic exercise:
  - Local producers had input.
  - The per acre compensation levels were closely related to land rents – but the fees were not intended to drive rental rates.
- Producers prefer the "carrot" versus the "stick" approach – stewardship and working cooperatively versus regulation.
- The pilots have shown that innovation can be driven by incentives and knowledge.
- There are several interrelated elements of EG & S (education, incentives, advice, extension etc.) Programming will need to consider all of these elements.
- EG & S work/research like that undertaken in the pilots is long term. The 2 year time frame is too short. Producers would prefer longer term programs (to fully understand costs and benefits in the context of their production systems which are longer term).

Possible Next Steps

- What is the role of targeting?
- How can we match instruments/techniques with regional differences and production practice differences?
  - "One size will not fit all"
  - This may imply further research.

Session Two

Themes New Beneficial Management Practices – EG & S and Agroforestry, Missisquoi Bay Pilot, Producer & Societal Expectations (Nova Scotia)

Rapporteur Tom Goddard – Alberta Agriculture, Food and Rural Development

Key Messages

- The pilot studies provided much useful analysis and information including:
  - How to take into the account the complexities of the ecosystem.
- The studies also raise important questions that may require more work/research to answer:
  - How best to apply the appropriate static and dynamic variables.
  - What is the cost of business as usual – the impacts and costs of not investing in EG&S?
  - The transaction costs of certain BMP programming need to be considered (e.g. engineering assessment in a field)
- The Agroforestry work in Quebec highlighted that there are more than ecological benefits to be derived from this work (e.g. snow clearing, road accidents etc.)
- The work in Missisquoi Bay identified biomass as an example of a new economic benefit that can be derived from the use of BMP's (in this case buffer strips).
- The work in Nova Scotia on perceptions and attitudes again highlighted the diversity across the country around all aspects/elements of EG & S (scale, producer and public awareness, vocabulary, concepts)
- The pilots were short term in nature – the ecosystem is complex and therefore long term analysis is required.
  - This has an implication for monitoring programs and accountability.
- Attitudes are changing and relatively quickly (note the Nova Scotia work and how farmers have now "internalized" practices that were considered foreign even 5 years ago.
- The work also raises questions around who pays?
  - Public, industry, producers, Government (and which Branch – Environment, Agriculture, Forestry)?
  - The government in fact has promoted practices in the past that are now considered an issue for the environment. The concept of BMP's has changed – e.g. certain drainage practices.
- How are decisions made – what is the governance framework:
  - Does the public set expectations?
  - Do landowners decide on BMP's in the end?
  - Are we aiming for consensus?
- EG & S is evolutionary not revolutionary – we will not get it perfect right out of the gate – implies adaptive management approach.
- There have not been a plethora of new regulations introduced across Canada generally – there are many new guidelines however, that will require change.

Session 3

Themes Lower Souris Watershed, Enhancement of EFP's – New Brunswick, Evaluation of costs and benefits - Quebec, New initiatives – Reverse Auctions

Rapporteur Brook Harker – AAFC – Regina

Key Messages

- We need a plan, but we also need a bias for action. The plan will not be perfect – we will need to adapt as we learn.
- Lower Souris Project:
  - Set targets to balance between land use, economics, personal values, wildlife targets.
  - Set targets for the quantity and quality of wildlife habitat.
  - Find ways for multiple land uses to co-exist within the same watershed.
  - Producer surveys are a key instrument – costs and land use are constantly in transition.
  - The pilot provided a very realistic understanding of the opportunities and limits for producers.
- Environmental Farm Planning:
  - Decision makers need to recognize the potential of EG & S considerations in programming.
  - The work illustrated the value of a technical working group with wide expertise and the time to think through the approach.
  - Can we actually measure the EG & S at the farm and can it be verified?
  - Carefully screen BMP's and select those that have the greatest probability of EG & S benefit.
  - Give farmers an EG & S report card – potential benefits and compensation.
- Cost Benefit Analysis (CBA)
  - Completing a CBA in a short period of time, with many variables and unknowns is complex – the real constraint is the lack of data.
  - The work illustrated 27 EG & S possibilities – need to concentrate on the key ones – phosphorus, biodiversity.
  - Important to select the BMP's where we have the most information – could result in different BMP's for provinces and watersheds.
- Reverse Auctions
  - It is very costly to restore wetlands – should we be paying farmers to not drain wetlands in the first place?
  - There are a lot of variables/assumptions that need to be made in developing the auction models.
  - Rely on fixed payments – may have access to very limited EG & S supply.
  - Auctions are a price discovery mechanism – need to ensure that the controlling agency does not change the rules/manipulate the process.

Next Steps

- Continue to consult with producers.
- Continue to calibrate and refine predictive models.
- Need to find a way to value EG & S and compensate those that provide it.
- EFP can be used as an EG & S assessment and program management tool

- Scaling up is risky but necessary.
- There is generally enough public benefit to justify the costs – the key is to pick the most appropriate BMP's.

Poster Session

Rapporteurs Maxine Kingston & Cynthia Edwards

For this report, the rapporteurs considered 3 questions:

1. If you could provide only three concise key messages/lessons learned from your initiative to policy decision makers, what would they be?
2. In a nutshell, what are the implications of these findings for national agri-environmental policy?
3. What has your initiative led you to believe is the most important barrier or challenge to advancing approaches to conserve natural capital and ensure the right flows of important ecosystem services?

Themes

1. **Policy Instruments**
    - Credits
        - Carbon and water quality offsets; development credits
    - Tax incentives
    - ALUS

Lessons Learned

- Need to compliment & be integrated with other policy tools and services that have the same objectives – to get more BMPS on more farms (education, EFPs, other cost-share programs, extension)
- Balance carrots and sticks
- Community and producer involvement
- Partnering with existing delivery organization
- Some tools (i.e. tax incentives) make ownership of natural heritage/natural capital more affordable
- Easy to implement: understandable

Policy Implications

- Silver buckshot no silver bullet
- Diversity in landscape and benefits – no one size fits all
- Regulatory framework is required (backstop)
- Flexible to address society priorities (government issues – i.e. climate change)

Barriers

- Communication of costs, benefits & practices
- Understanding costs on national scale

2. **Science (physical and economics) to support EGS programs and policy**

Lessons Learned

- Quantify impacts of wetland loss and translate into the value of the goods and services provided in order to establish a market price
- Case studies demo need for right combo of financial, institutional and social factors to make this viable
- Integrate practical with academic side
- Targeting to optimize benefits – opportunity costs and benefits need to be understood and factored into any policy decision
- Watershed scale
- Restoration and retention of natural capital both need to be considered

Research Implications

- Science needs to be refined over time and used to improve programs (physical and economics)
- Adaptive management approach

Barriers

- Measurement and scaling-up results

3. **Measuring Performance**

Lessons Learned

- Need a suitable benchmark for evaluating and monitoring the effectiveness of policy tools in achieving EGS targets (i.e. NAESI)
- Developed in partnership with stakeholders
- Clear objectives – linked to targeting
    - Environmental
    - Agricultural
    - Community

Implications

- Accountability
- Consumer confidence:
    - Reporting on outcomes to public/taxpayers or more direct consumers (MBI)
    - Connected with the scientifically – defensible

Barriers

- Implementation and monitoring
- Coordination and responsibility
- Reporting

Appendix 3 – Responses to Discussion Questions: Verbatim Notes from Table Discussions

What additional key messages would you add to the rapporteurs' summaries?

- Pilots were not long enough.
- Pilots suggest there is demand… we must shift from pilots to policy.
- You cannot expect the public to pay for status quo… any payment must be for incremental benefit delivered.
- EGS cannot be seen as replacement of income.
- Certification – Huge audit/support system must be developed. This will/may require large costs.
- Mechanisms to reward landowners who are already participating in programs or voluntary. Compensate.
- Needs to be broader than agriculture. Driven nationally by PMO and provincially at Premier's level – "Hook" "Health of Canadians". Clean water, environmental sustainability.
- Urban/rural lifestyle segments of society are currently missed. Role in EGS – Service provider – Role in "certification" – Consumer requirement – Support for taxation to drive programs other market drivers.
- Environmental farm plans should be required as a trigger for participation in EGS program (no plan, no payment).
- Question: What is a landowner's basic stewardship responsibility? Landowners should maintain some baseline ecological function of their land on their own,
- Municipalities may be responsible for implementation (supported by Federal, Provincial, (Industry?)).
- Effective M&C is required to develop a policy framework for EGS (gov't, landowners, public).
- If there is more policy research – it would be good for researchers to meet and discuss initiatives and issues frequently (annually).
- Awareness of EGS and potential instruments for payments has increased substantially since pilots started.
- Ecological G&S versus obligation not to pollute.
- Need programs to estimate public benefits from private lands. Estimate consensus on need.
- More stressed areas have more impetus for this kind of programming.
- Need to keep working on the landscape on these sorts of programs.
- Where is the threshold between "polluter pay" and enhancement of EG&S.
- What policy instrument to use for mitigating versus those for motivating "over & beyond".
- These sorts of programs take time; long-term programming will (hopefully) bring systemic change.
- Need for adaptive management based on implementation.
- Reverse auction type mechanisms would be applicable in certain context – AB example.
- Large time and resources investment for education and understanding.
- Must keep existing EG&S maintenance in mind. Incremental.
- Upcoming criticism of EG&S is that transfers of problem to others through created market.
- Mix of instruments. Regulatory & MBIs as opposed to one or the other.
- Artificial creation of land prices etc. due to volatility of markets.
- Producers do look at EG&S as income enhancement.
- Transitional nature of some EG&S need to be considered.
- Consider cost of not doing anything.

- Not a one size fits all. Extension capacity investment to reflect the diversity of need.
- Market based instruments seem to be the most cost effective and efficient means for both public and private sectors to share in EG&S costs and benefits.
- The most effective policy may not be the one that we continue to work on.
- Policy must evolve as we learn. Requires leadership on policy signals.
- Many pilots have made significant progress, focused on the tools and approaches rather than the measurable outcomes on the ground.
- Define your ES, define your target and defined your end goal. (Annual incentives, one time payments, market instrument).
- It is going to be challenging to explain what services are being delivered and why that justifies payment to farmers (env. performance standards Q#2).
- Need environmental and agricultural and societal objectives to be clear. Need a well articulated vision for the agricultural sector (in its broadest interpretation, traditional and lifestyle farms) and the landscapes that sustain it.
- Importance of addressing the full hydrology. Surface water was well addressed but also ground water to consider.
- Persuasion/stewardship/has a proven trade record.
- Sustainability – critical to continuing activity and resources and sustain the activity?
- Dollars are scarce. Some kind of partnerships/private sources.
- Monitoring and environmental performance reporting from: 1. Ag Business perspective. 2. Environmental performance.
- Package of programs is important - (say nutrient trading) with biodiversity and Habitat in another and ability to stack Equity. Regional issues and programs can cause equity issues. Balancing the entitlement issue. Balance focused, objective driven programs in one area.
- Each EG&S occurs at a different scale.
- Move away from payments for practice to payments (BMPs) for performance (focused at right scale of EGS), quantification of outcomes (BMP outcomes).
- Need for more analysis to fine tune research.
- Instruments need to be flexible so they can meet needs of environment, community etc. across regions.
- We feel the summaries captured the key messages, have nothing to add from pilot, presentations.
- One size does not fit all. Suite of tools to match conditions.
- Build on existing institutions, legislation.
- Local, community-based delivery. Local formulation of achievable targets based on higher level objectives.
- There is a wide range of land management regulations/standards to be met. This means that the benchmark (and definition of EG&S) changes in each province, because regulation standards are not the same.
- For regulatory bodies, they must ensure that the basic regulations are met by all producers. Otherwise, good work may be undone by the few who do not comply.
- It is important to take into consideration the differences across the country. Values of EG&S could be tied to land values and land rent to reflect the opportunity cost of doing practice change.
- In the context of a policy/program, EG&S must be defined as going beyond the status quo, or basic regulations that may be in place.

- If there is a combination of public and private benefits, a tiered system of payments should be considered to capture the different contributions from the BMP.
- One of the gaps is not so much discussion around community involvement. This is important so that you can educate stakeholders within community so that you can get a change in mind set and potential for additional resources to move things forward.
- How do we manage the expectation, workshops and pilots have raised expectation that government is going to move. If government is going to move forward at what point will it feel that it has enough information to start implementing.

What did the pilots tell us about baseline/minimum environmental performance standards?

- Payments must be incremental benefits, not status quo.
- Consumers will choose least cost so the public purse or private interests must drive the action to avoid cost disadvantage to our food system.
- Baseline must reflect what Canadian want but what level of awareness do Canadians have?
- First answer “not much”.
- Standards – should be set. National – regional and performances measured against these standards.
- Each pilot was different – so difficult to measure overall performance against any “common standard”.
- More research is needed. Draw from other stewardship programs that have existed and provided land owners payments.
- Lacking a lot of information to help us answer this question. Government needs to set baselines (min ecol standards) Set environmental outcome targets.
- Baseline/min ecol standards were not set in many cases. Can’t gauge performance of programs.
- Important to work on WSs with good long term data sets.
- EFPs were abandoned in AB, but EFPs showed baselines and facilitated change.
- MBPs demonstrated the need for scientific data. Some were based on intuition.
- Realization of private benefits from programming.
- Qualitative data as well as econ. & ecol. measurements.
- The eco resources study provided an important analytical framework for establishing that the EGS performance increment is over and above the regulatory standard.
- Reg standards can evolve.
- Different standards would apply to different original environmental issues.
- It was not evident, that this was explicitly discussed in most of the presentations.
- Lots of “hallway” discussions around what is baseline versus what is incremental with regards to standards.
- Governments currently pay for delivery of BMPs (standards). Establishment costs only (typically) not maintenance.
- Absence of biological indicators of environment quality and to establish baseline conditions.
- Not much. Expectations. Need improved environmental performance. Reference levels –can incorporate the Duty of Care; Polluter pays! Principle. What’s the cost of doing business.
- They’re needed – especially if funded with public dollars. Dollars scarce. Needed from the public relations and environmental performance point of view.
- Community and social values play a role along with science in standards.
- If baselines or standards aren’t enforced, they don’t exist and rely on volunteerism or incentives to achieve.

- Are payments required to go beyond baseline?
- Using existing local agencies works well.
- Nothing at broader level (provincial/national). Selected pilots had targets for participation. Implication – it's difficult or weren't' designed that way?
- Diversity of views about what the reference levels should be. Need consensus on levels.
- NB EFP provided interesting example of defining minimum standards based on existing tool.
- NAESI is one input to standards.
- Many pilots suggested that programs should focus on paying for performance.
- Acknowledge that different landscapes will have different baseline/minimum standards (e.g., some wetlands are perfect when left as they are; some need restoration).
- Extremely difficult to get a good baseline. Science just not there for water quality. How do you set targets if you don't know the baseline? In some areas more information than others such as carbon sequestration
- Probably a lot more baseline information on biological entities i.e. waterfowl census rather than physical/chemical baseline. Either way, need to not rely too much on baselines before moving forward. Need to learn as you go.

What did the pilots tell us about which policy tools would be most effective and efficient?

- All have some applicability in different situations.
- Most efficient may not be most appropriate or sensible based on data available.
- Tool will differ by watershed, so one size does not fit all.
- Clearly needs to be a suite of policy tools.
- Carbon seems to have the most promise to mover the agenda forward.
- A clean federal policy on EG&S is needed. Complimentary to existing policy.
- Main policy components – sectors involved EGS to be pursued. Individual community then develops, implements program to fit suite of options.
- Buffers on riparian areas need biophysical considerations, clearly buffers are desirable for EGS. But "one size" will not fit all across the country (or even within a province)
- Reverse auctions. Policy tools have to have a good methodology, scale.
- Carrots work better than sticks.
- Depends on context – must be determined locally. Use a mix to get broad outcomes.
- Mix of instrument may need to be considered. Build on existing programs and instruments.
- On-going measurements of effectiveness and efficiency and adaptive management is key.
- Efficiency of delivery mechanisms need to be considered.
- Messaging is still disjoint around BCPs and cost efficiency.
- Studies like the George Morris study of NVS and eco-resources study need systematic review around assumptions and benefit to explain different results. "Meta-analysis of BCP's and underlying assumptions".
- Very few of the pilots addressed qualitative measures associated with environmental practices or environmental effectiveness, are the selected tools supporting environmental effective solutions?
- Overall policy framework that enables the application of combination of tools to achieve EGS goals.
- Most effective and efficient. What the government likes, what it can afford and what it can handle politically.

- Persuasion and demonstration has been successful in the past. EGS should be built from this. Extension, outreach and education.
- Regulation – settings of minimum standards. Certification has been highly influential in the forestry sector for influencing delivery of EGS.
- Payments for EGS above and beyond the standard is another tool in the tool box. Full suite including tax instruments, cost share incentives. Full suite not really discussed in the pilots.
- Annual payments – least efficient.
- Market instruments work more effectively, but markets allocate scarce resources effectively if they have perfect information. We need to build the information systems like WEBs and the geomatics to support. Use extrapolation tools – proxies, benefit transfer functions to be started. Start somewhere – don't let the perfect. Be the enemy of the good – revise as you go. Start with reverse auctions – collect more information to develop supply curres?? over time. For coincident EG&S – reverse auctions can balance the tradeoffs possible from bundling EG&*S on the same watershed.
- Depends on the outcome and analysis used and the ecosystem.
- Effectiveness and efficiency depends on the goal.
- Market based has a role but a finite??? of tools are needed.
- Nothing explicitly / definitely from pilots because they generally used one tool (no comparisons).
- Implicitly, one message could be that the market based instruments should be explored more. Given the cost of scaling up of any of the pilots, given other presentations (those not about pilots).
- Depends on objective.
- Most of real world pilots did not test different tools.
- Modeling-based pilots favoured trading and auction options "market" based instruments.
- Don McCabe suggested that we may need "silver buckshot". This is true of policy tools. Some will be effective in different parts of the country.
- Keep the policy and program options flexible. Producers want to keep their options open, their timeline can be a long time and needs changes with the changing economic env.
- The concept of layering EG&S on top of effective tools is a good one (e.g. use of environmental farm plan).
- EFP could be a good delivery mechanism in certain areas associated with risk. But EGS goes over and above this because ES&T not always associated with risk. i.e. wetland restoration.
- Reverse auction should be further explored. Need a lot of information for the farmer to decide whether he/she is going to participate. Need to be aware of social implications. Other opinion that there are issues with reverse auction.
- Already market focus in place to set prices. Also producers will quickly learn to manipulate the process to their advantage. Need a variety of tools for price discovery since one size does not fill all.

What are the key elements of and EG&S agenda and should it be pursued in Canada? Why? Why not?

- Must be broadened to affect other rural stakeholders – domestic septage and forestry.
- Yes, it should be pursued.
- Need a policy statement nationally PMD. Or it crosses departments provincially.
- A clear needs and value statement is needed. System is degraded "borrowed against natural capital within Canada for 200 year the system needs to be restored."

- Work is needed on selling the “why” beyond the environmental community as the program will come with costs to society at large.
- Commitment. Understand the problem. Identify the foal. Need M&C support. Must market to landowners, public and government. What are their expectations?
- Develop a framework for policy and price.
- Set baselines and environmental outcome targets.
- Set minimum ecol standards.
- Use pilots to test the “new” policy and program.
- Employ practical metrics – meaningful and measurable
- Employ complex adaptive management.
- Make sure you develop capacity and knowledge.
- Learn from others.
- Bundling of EG&S.
- Continue with analysis and learning and continue landscape ???
- Flexibility and local control and design autonomy based on performance indicators.
- Mix of instrument and delivery mechanisms.
- Private and public benefits. Design of instruments according to beneficiaries.
- Education and outreach particularly between ?? versus local.
- Quality analysis.
- NFSP not inclusive enough tool box – broaden landscape management options. Doesn’t address. Climate adaptation urgency.
- Consider various mechanisms from a cost benefit analysis.
- Minimum performance standards should be included (i.e. consideration of polluter pays principle). Reference levels may change over time.
- “Standard of care” should be considered before rewards are implemented. Standards will evolve over time.
- Equity in terms of innovation and late adapters.
- Long term sustainability will institutionalize the practice to become the new norm.
- EGS is a useful framework rather than merely a market tool for packaging a comprehensive strategy related to agriculture (as for other sectors) and associated environmental performance.
- Need to develop a common understanding of EGS. Sense that making it a “commodity” is worrisome.
- Need to maintain “stewardship” ethic, although not a unanimous view could possibly reserve “EGS’ as a tool for delivering on stuff that should but wouldn’t get done otherwise in residuals. EG Paul Smith’s table comment on focusing on BMPs that have ongoing maintenance costs and thus have lower rates of adoption.
- OIT should be pursued but in a sustainable way (not just taxpayers dollars).
- Clear communication to stakeholders about the objectives of the EG&S program. Outcomes of expectations of Canadians.
- Based on sound scientific and economic evaluations.
- For delivery – Use honest brokers embedded in the community.
- Invest in programs are important – to commitment. Assess effectiveness.
- Use adaptive management.
- Scale WEB results and other proxies. Get started.
- Begin with reverse auctions – collect the data to move to more market based instruments.
- Understanding costs and benefits – at what price is it going to take?

- Federal government – framework and supporting role, pilots to involve policy – Provincial funding.
- Elements: compensation themes, more tech info extension.
- Strategic, landscape targeted to get biggest bang for the buck.
- Watershed based. Local communities have abilities to identify issues, problems and solution. Roles of federal/provincial to provide funding.
- Conservation districts and conservation authorities deliver on the landscape.
- Elements: better identification of the needs of migratory birds and other ecol services.
- What's the goal?? What are you trying to achieve? What issues are you trying to address? We didn't think that is clear yet – nor is it clear there is a commitment. If that is well defined then it is worth pursuing.
- Need better understanding of EG&S services and their values in different contexts. I can then set standards??
- Need better information on what society thinks about??/benefits (but also education to society).
- Address key private costs that impede adoption. These include opportunity costs and maintenance.
- Better understand public costs and benefits.
- Need to build on existing tools, not reinvent tools.
- Continued scientific research to identify costs and benefits.
- Strong leadership is required for EG&S programming (Federal & Provincial governments etc.)
- We must consider other groups affected by EG&S programming (forestry, fishery, etc). They should be at the table, because of the integrated landscape towards multiple impacts.
- Longer timeframes to measuring ecosystem improvements.
- Yes, it should be pursued.

What are your suggestions for specific next steps?

- Define roles of various levels of government – consider the multi-level Fed, Prov, Municipal, watershed and cross (inter) departmental structures. Alberta's experiment may show the way.
- Focus on policy. Another round of pilots to actually run each of the reverse auctions, individual sales (private) effort.
- Canadian association of municipalities should become involved. May be a good body to push the agenda.
- Agriculture should lead engagement with other departments. Value statements. Standards, recommended program components.
- Also the NGO/and other potential support groups need to be engaged.
- Working group needs to be formed to initiate the next steps. Should happen with serious PMO? Made in Canada Green Plan?
- Commitment (Fed/Prov).
- Member(s) must mandate the development of a framework for policy and program for EGS that is sustainable.
- The initiative need to get to a group that deals with multiple ministries (i.e. cabinet subcommittee that deals with environment.
- Wrap-up pilot and scale up either provincially. Involve NGOs (cost sharing is an issue here to consider). There is some scope for municipal funding. Role of landowner NGOs (such as NCC & DUC).
- Province seen as the right scale to scale up.

- More qualitative aspects along with ongoing econ. and ecological analysis.
- True market involve beneficiaries paying – explore.
- Resolve programming level issue- recognizing departmental responsibilities and the fact that EG&S goes beyond AG dep.
- A few elements of EG&S could be decided at federal level and framework could be provincially set – with content specificity and flexibility.
- Bundling of goods need to be recognized and operationalized.
- Great way to stimulate economy in today's economic climate.
- Commitment to implement – Adaptive management implementation framework. Certainty and simplicity not available but that's a very bad reason for resisting progress. "Ecological infrastructure".
- Integration of government ministries that share EGS goals, priorities and outcomes to demonstrate leadership on policy directions. At the outset, in decision making process.
- Demonstrate commitment and leadership from government on the policy direction. We need a clear policy statement and framework.
- Can move and learn as we go.
- Expand the EGS effort to the full complement of the federal family with resources needed to implement it across all sectors including the conservation sector (e.g. Protected areas establishment)
- MC to establish and implement a national program? The investment.
- Committee for the pilot initiative to take reco? to ministries, results, findings.
- More C/B research so we don't need to extrapolate.
- Federal government to enable comm' and disseminate knowledge.
- Engage community through Cons Auth/Cons districts etc (ground level) to develop objectives of EG&S and methods of reaching objective.
- Draw lessons from pilots and document to share with provincial ADMS. More systematically than in rapporteur summaries.
- Define issue(s). If & how EG&S can help achieve existing Agr&Food Canada and provincial goals/objectives/outcomes.
- Develop plan for additional work on market based instruments, including legislative framework to facilitate (if required).
- Then can determine what additional EG&S work should be done.
- Get on with it. But national approach not possible or appropriate.
- Continue strategic research and pilot projects.
- Draw in other partners. EC, DFO.
- We must consider other groups affected by EG&S programming (forestry/woodlots, fishery, etc.).
- We should start thinking beyond the "carbon offset" market, and consider paying for ecosystem benefits (Ecosystem benefit market place).
- Made sure that EG&S linkages to key environmental priorities is communicated to the govt. public. i.e. linkages to climate change – water quality.

Appendix 4 – New Brunswick Environmental Farm Plan (EFP) Workbook

Introduction

There are various definitions of Ecological Goods and Services (EG&S) such as: EG&S are the benefits that human populations derive, directly or indirectly, from healthy functioning ecosystems. Healthy agro-ecosystems can provide numerous EG&S, such as clean water, flood and erosion control, carbon sequestration, wildlife habitat. (Adapted from UN Millennium Ecosystem Assessment (2005)). EG&S represents the capacity of various components and functions of nature to provide "goods and services" useful to humans. (**MAPAQ**, "Remuneration for ecological goods and services produced by agriculture").

The Eastern Canada Soil and Water Conservation Centre (ECSWCC) was awarded a contract to conduct a pilot project *investigation of the use of the Environmental Farm Plan (EFP) as an Ecological Goods and Services (EG&S) management and policy tool.*

This document presents the various BMPs and their related EFP assessment questions which the EG&S pilot project Technical Working Group (TWG) have kept because of their potential to deliver EG&S. The selection process project to select these BMPs and questions is also summarized. This document will be used for the consultation process with the industry and to present at various EG&S information sessions.

Background on EFP questions screening process

The assessment and screening of the 326 EFP questions and related farming practices was carried out by the Technical Working Group through a series of thorough screening exercises. The first exercise was to identify a list of EG&S that might potentially be produced by agricultural operations in New-Brunswick. The list was initially prepared by the Advisory Committee then refined by the TWG. All the EFP assessment questions were evaluated against the EG&S list.

The list of EG&S was further refined by the TWG during their subsequent meetings. The TWG decided to rename and regroup the EG&S identified into 6 categories, the categories being those that provide EG&S related to: Air, Water, Soil, Biodiversity, Climate and Other Societal Benefits. Brief definitions (explanatory texts) were created for each EG&S as follows:

List of EG&S that could potentially be delivered in NB:

Air: On-farm practices that provide EG&S related to air quality

- **Air Purification:** Practices that can augment natural air purification or air cleaning processes to remove impurities such as dust, odors and particulates.
- **Provision of Oxygen:** Practices that increase the release of oxygen into the atmosphere through photosynthesis, such as planting trees, permanent cover, etc.
- **Maintain good air quality:** On-farm practices that help to maintain good air quality

Water: On-farm practices that provide EG & S related to water quality and quantity

- **Water purification:** On-farm practices that can improve surface and groundwater filtration / purification including water treatment through natural processes.
- **Maintain Water Quality:** Practices that can help to conserve or maintain good surface and groundwater quality including practices that can reduce the potential for surface and groundwater contamination or loading by nutrients, agri-chemicals, bacteria, sediments etc.
- **Regulate Water Cycle:** Practices that can help to regulate the hydrological cycle including the maintenance or improvement of the soil water infiltration and holding capacity, reducing field runoff, reducing evapo-transpiration, flood control, stream recharge, etc.

Soil: On-farm practices that provide EG & S related to soil health

- **Regeneration & Renewal of Soil:** Practice that will help build soil and improve soil quality through improved soil structure, enhanced soil life, increased soil organic matter and improved nutrient cycling capacity.
- **Maintain good soil quality:** Practices that reduce soil degradation and soil loss and maintain good and sustainable soil productivity.

Biodiversity: On-farm practices that maintain or enhance biological diversity at the farm

- **Provision of Terrestrial & Aquatic Habitat:** Practices that provide or protect terrestrial and aquatic habitat, including nesting habitat, habit for pollinators and beneficial insects, etc.
- **Maintain & improve Genetic diversity:** Practices that maintain or improve inter-species or intra-species genetic diversity, through diversification of crops, livestock, woodlands, etc.
- **Protect species at risk:** Practices that protect species at risk, through protection of habitat or creation of habitat that can support species at risk, etc.

Definition of Biodiversity:
Biodiversity (or biological diversity) is a term used to describe the variety and variability within and among living organisms and their relationship with each other and with their physical environment. It includes diversity within species (intra-species diversity), between species (inter-species diversity), and within ecosystems (ecosystem diversity).

Climate: On-farm practices that help to regulate climate, reduce greenhouse gas emissions, or sequester carbon in the soil

- **Reduction of greenhouse gas emissions:** Practices that help to reduce greenhouse gas emissions, such as improved manure management, reduced nitrogen fertilizer use, improved ruminant feeding practices, drainage, etc.
- **Sequester carbon:** Practices that help to sequester carbon in the soil, including conservation tillage, improved crop rotation, permanent cover, shelterbelts, etc.

Other Social Benefits: On-farm practices that provide other social benefits including recreational, rural aesthetics, eco/agro-tourism, social acceptability, cultural, etc.

- **Provision of aesthetically valued landscapes:** Practices that provide aesthetically pleasing or valued landscapes such as windbreaks, woodlots, wetlands, or through restoration of heritage buildings, etc.

- **Enhance recreational opportunities**: Practices that provide increased recreational opportunities, including agro/eco-tourism opportunities, hunting, fishing, canoeing, etc.

As a means to further categorize or rank the EFP questions, a set of ***EG&S "Guiding Principles"*** was prepared by the ECSWCC and approved after review by the TWG. As a second evaluation, the TWG members were then asked to evaluation all 326 EFP questions with respect to those EG&S Guiding Principles (Table 1).

Table 1: EG&S "Guiding Principles"

1. No short term net economic benefit
2. May increase production risk
3. May reduce non-point source water pollution
4. Reduce nuisance
5. Enhance fish & wildlife habitat
6. Reduce or regulate flooding
7. Positive EG&S
8. Reduce negative impact on EG&S
9. Exceed acceptable practice
10. Exceptional practice in sensitive / designated areas
11. Requires high non cash and/or maintenance cost
12. High opportunity cost

During the third exercise, the TWG members were asked to re-assess the remaining EFP assessment questions against the revised list of EG&S and determine the highest EFP risk assessment level that would be acceptable for provision of EG&S for each EFP question.

An initial list of the EG&S-related BMPs addressed in each of the EFP questions retained for EG&S purposes had now been created however the TWG were again asked to reassessed the remaining questions and practices to determine their level of measurability that is, are the identified practice measurable and if so, how. The final selection was carried out to determine the level of acceptability of the remaining practices. In total, 64 EFP questions were kept which are grouped into twelve suites of BMPs.

As a result of the on-farm testing and consultation sessions, a final list of 49 EFP questions were kept as having potential to provide EG&S. This EG&S-BMP guide was revised accordingly and distributed to the participants at the final EG&S workshop. The following section give a brief overview of each suite of BMPs, the EG&S that could be delivered through the adoption of these BMPs.

It should be noted that the elimination of 277 out of 326 EFP questions represented a very thorough screening of the EFP questions for those questions that manage EG&S. The remaining 49 questions provide a very complete analysis of farm practices for EG&S in New-Brunswick.

Farmstead Windbreaks

Windbreaks around the farmstead are designed to enhance the micro-climate around the farmstead buildings and/or to act as a living snow fence to trap snow away from the homestead, working area, and roads. Living snow fences have a long life span, compared to conventional snow fences, and provide more snow control and greater storage. When established around a livestock yard, they protect the livestock from heat in the summer and from cold winds in the winter. This protection reduces the impact of climatic extremes on livestock thus improving their health and productivity.

The "Farmstead Windbreaks" BMPs retained from the EFP for their potential to deliver EG&S are mainly related to the presence of windbreaks or living snow fences, their density and uniformity as well as their width and diversity.

EG&S Provided by Farmstead Windbreaks

Water purification and maintain water quality: Windbreaks can filter part of the surface and ground waters that will flow through them at the surface or through their root zone. The filtration effectiveness will vary with species, windbreak width, and volume of water flowing through them. It is a good practice to establish a grassed buffer strip and/or waterway between windbreaks and adjacent fields to filter and/or divert runoff water.

Air purification, maintain good air quality, provision of oxygen, carbon sequestration and reduction of GHG emissions: Farmstead windbreaks improve air quality by screening dust, noise, and odours. Windbreaks can considerably reduce greenhouse gas emissions by decreasing the amount of energy required to heat the buildings in the winter, reducing the energy required for snow removal, and sequestering carbon. Windbreaks established around a livestock yard can reduce greenhouse gas emissions by improving weight gain per unit of feed consumed.

Maintain/enhance biodiversity: Windbreaks and living snow fences can provide food and nesting sites for various species of birds. The diversity of birds in the windbreaks is dependent on the width and diversity of shrubs, trees, and ground cover. Multi-row windbreaks and snow fences with multiple species of trees and shrubs provide added benefits such as reducing the risk of losing the windbreaks due to a pest infestation. Multi-row windbreaks also enhance wildlife habitat and biodiversity.

Provision of Aesthetic landscape: Windbreaks are beneficial to the landscape contributing to the beauty and diversity of the countryside thus increasing the value of the farm. The incorporation of agroforestry species such as fruit or nut bearing shrubs or trees in the windbreaks may also provide added revenue.

Measurability: Farmstead windbreaks can be easily verified however they will need to be inspected through an on-farm visit to verify their density and uniformity and to measure them. The inspection would not need to be carried out on an annual basis. The reference to snow distribution is a secondary means of assessing the efficiency of living snow fences however it is not expected that they should be verified for EG&S program purposes. It should be noted that the farmstead can be sheltered by a woodlot. In such cases, the woodlot should be assessed as in the woodlot sub-section, not as a windbreak.

EFP Questions and Risk Rating kept for EG&S:

Risk Rating **EFP question**	**1** (Low)	**2**	**3**
1. Presence of windbreaks and living snow fences	Area needing protection (e.g. building, working area, road, farmyard, barnyard, feedlot) is sheltered with windbreaks or living snow fences		
4. Density and uniformity	Density is 60 to 80% year round and uniform across length and height of *windbreaks* Density is 80 to 100% and uniform across length and height of *living snow fences* Shrubs provide a uniform density at the bottom of windbreaks No gaps in windbreak(s) Windbreak(s) extends at least 15 m (50 ft) beyond each side of area needing protection or extends into an L shape	Overall density is 60 to 80% but not uniform across length and height of windbreaks and living snow fences Snow distribution not uniform and accumulation occurs in areas along windbreaks but no sign of turbulence or drifting near buildings or farm yard	
5. Wildlife protection and biodiversity	Windbreaks consist of at least ***3 rows*** of trees and shrubs of deciduous and coniferous species of various ages and structure Groundcover at the bottom of windbreaks	Windbreaks consist of at least ***2 rows*** of trees and shrubs of deciduous and coniferous species	Windbreaks consist of ***1 row*** of trees and shrubs of mixed species

Manure Storage & Handling

Livestock manure is a valuable resource because it contains large amounts of nutrients and adds organic matter to the soil. However, it also contains pathogens and can be a source of offensive odours.

Improper manure storage can result in nutrients and bacteria contaminating nearby watercourses. This can have an impact on aquatic habitat and on the quality of drinking water. Odours from manures can cause some complaints from nearby neighbours. In order to prevent any negative impact of manure on the environment, it is important to store and handle it properly.

The BMPs which were kept for EG&S purposes are exceptional practices related to the enclosure of liquid or solid manure storages. These practices require high investment and maintenance costs.

EG&S Provided by Covered Manure Storages

Maintain good air quality: Manure odours are considered a nuisance to many people. Ammonia and hydrogen sulphide are the two principal gases responsible for manure odours. Building a roof over a manure storage prevents the odorous gas from being transported in the wind and may reduce emission of some gases. Composting in an enclosed composter will also considerable reduce odour emissions during the composting process. Since composted manure does not smell, it allows to spread the composted manure closer to neighbours without having to be concerned about complaints.

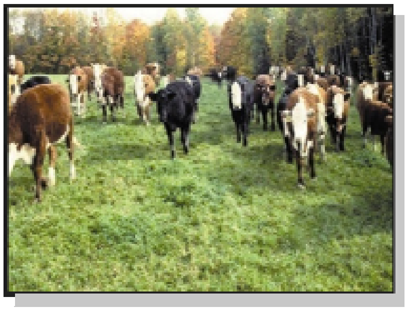
Reduction of GHG emissions: Decomposition of solid manure releases carbon dioxide while decomposition of liquid manure releases nitrous oxide and methane–three potent greenhouse gases. By placing a cover over a liquid manure storage it is possible to capture the methane produced by the manure and use it as a biogas to produce energy. Eliminating the precipitation waters from entering the storage will also reduce the GHG emission during spreading by considerably the number of loads required to empty the storage.

Maintain water quality: Placing a roof over a solid manure storage system or a cover over a liquid system allows to keep the clean precipitation water away from the manure. The runoff water leaving the storage area can then be safely diverted away to nearby storm water disposal outlets such as a ditch or waterway. It also reduce the risk of manure storage overflow during heavy precipitation events therefore reduces risk of water contamination.

Measurability: The structures described in this BMP can easily be identified through a short visit at the farm. Since they are relatively permanent structures, they would not need to be inspected every year. The storage may also need to be measured to determine its capacity if the engineering plan is not available.

EFP Questions and Risk Rating kept for EG&S:

Risk Rating EFP question	**1** (Low)	**2**	**3**
3. Liquid or semi-solid manure storage	Well ventilated, under barn storage system; **or** Permanently covered concrete or glass lined steel tank; **or** Synthetic floating cover over concrete or glass lined steel tank		
4. Solid manure storage system	Dried and stored in an enclosed solid manure storage; **or** Stored in a covered or enclosed in a well ventilated, solid manure storage; **or** Composted in an enclosed composter		



Pasture Management

In New Brunswick, pastures are an important source of livestock feed, especially on beef and sheep farms. Although they are becoming less important on dairy farms, pastures are still commonly used for dry cows, heifers, and calves.

Pasture productivity varies considerably with seasons and between farms and regions. The level of management can have a significant impact on the quantity and quality of forage produced on pastures, on livestock performance, on the environment and on the provision of EG&S.

Limiting the access to watercourses through fencing and improved crossings are the type of pasture management practices that may have the greatest potential to provide EG&S.

EG&S Provided Through Beneficial Pastures Practices

Maintain water quality: When livestock have uncontrolled access to watercourses, they can cause excessive stream bank erosion by trampling the banks. Soil erosion in pastures and stream bank erosion caused by livestock trampling contribute to sedimentation of watercourses and estuaries. Livestock can also affect surface water quality, if they have direct access to it. Although they may not stay in the water for a long period of time, livestock may urinate or defecate directly into watercourses. Nutrient enrichment and pathogens from manure reduce water quality and contribute to algae blooms. Fencing the livestock out of the watercourse will help to reduce stream bank erosion, stream sedimentation and enrichment therefore maintain good surface water quality.

Conserve/maintain good quality soil: Soil compaction, as well as rill and gully erosion, is often observed in heavily grazed pastures. Erosion frequently occurs in areas that are overgrazed and in pathways created by the animals. A well managed pasture through rotational or strip grazing will produce a uniform forage growth across the entire pasture thus reducing the overgrazing and soil compaction. Reducing the livestock travelling distance to water troughs will reduce the pathways which are normally created by livestock who tends to travel in groups when the travelling distance is greater than 150 to 200 meters.

Carbon sequestration and reduction of greenhouse gas emissions: A well managed pasture reduces or removes greenhouse gases. Maintaining productive pastures can increase soil organic matter levels and carbon sequestration. This removes carbon dioxide from the atmosphere. In addition, higher quality forages in a well managed pasture are more easily digested by cattle, resulting in reduced methane emissions.

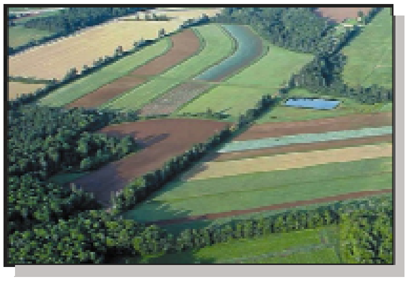
Provision of aesthetic landscape: A well managed pasture is aesthetically pleasing compared to a compacted, muddy or unproductive pastures. The animals are in better physical health and clean. The unproductive steep slopes can be restored into their natural state, reforested or planted in to agroforestry species.

Provision of terrestrial and aquatic habitat: Wildlife habitat and biodiversity can be improved considerably in a well managed pasture. Unproductive steep slopes can be removed from production and restored to their natural state. Sedimentation and loss of stream side vegetation through grazing will eventually degrade fish habitat by creating wide and shallow streambeds, thereby reducing water flow velocity and increasing water temperature. Protection of riparian buffer zones along pastures will not only reduce stream sedimentation, but will enhance biodiversity on the farm by providing shelter and habitats to fish and wildlife.

Measurability: Assessing the pasture condition can be done through on-farm visit however it may be difficult to be consistent from one inspector to the other. A pasture assessment checklist will need to be prepared to ensure consistency. The EFP assessment question #1 could be used as a starting source. The other BMPs related to pasture management such as fencing of watercourses and type of crossings can easily be verified through a farm visit on an annual or unannounced basis. The measurement of the pasture area could be done by aerial photography and a GIS software where available.

EFP Questions and Risk Rating kept for EG&S:

Risk Rating **EFP question**	**1** (Low)	**2**	**3**
1. Pasture condition	Pasture stand contains more than 75% of desirable species Very thick stand of healthy green forages throughout the season Even grazing across pasture and no evidence of over or undergrazing Rapid recovery or regrowth after grazing; sward can be regrazed after 3 to 4 weeks No evidence of soil compaction, slumping, rill or gully erosion No signs of livestock trails	Pasture stand consists of 50% to 75% of desirable species Thick stand but somewhat yellowish green leaves Ungrazed patches cover less than 25% of pasture Sward takes 5 weeks to recover after grazing Some rill erosion confined to steepest areas; no slumping No signs of livestock trails	
3. Access to watercourse	No access to watercourses	Limited access to watercourses through *fenced access ramp* for drinking purposes where permitted by legislation; fence does not cross watercourse	
4. Fencing of watercourses	Fences placed at least 10 m (33 ft) from any watercourse and at least 30 m (100 ft) from protected watercourses	Fences placed at least 5 to 10 m (16 to 33 ft) from any watercourse and at least 15 m (50 ft) from protected watercourses	
6. Watercourse crossing	Well constructed and maintained *culverts or bridge* used everywhere livestock need to cross a watercourse		



Soil Management

The sustainability of food production in Atlantic Canada depends greatly upon the use of soil and crop management practices that enhance healthy, productive soils and protect water resources.

The rolling topography, amount of precipitation, frequency of extreme rainfall events, and intensity of row crop production make Atlantic Canada soils very susceptible to erosion. In places, land can lose between 20 to 50 tonnes of topsoil per hectare in a year, which is not an acceptable rate of loss. Therefore, soil management for crop production and protection of water are the most important challenges facing the farming community in Atlantic Canada.

The potential delivery of EG&S through soil management relates mainly to BMPs which can improve soil organic matter through crop rotation and reduced tillage, and BMPs aimed at reducing soil erosion by water and tillage. The retirement of marginal land from intensive agriculture can also provide EG & S.

EG&S Provided Through Soil Management

Maintain water quality: Good soil management leads to better crop yields and quality while reducing the losses of soil, nutrients, and pesticides associated with runoff. Sound soil management practices can also improve water quality by improving the soil's water infiltration, retention and filtration capacities.

Regulate water cycle: A high level of soil organic matter improves soil structure, water infiltration and retention, and drainage. Organic matter improves the water retention capacity of light soils while improving the infiltration capacity of heavy soils.

Regeneration and renewal of soil: Soil organic matter is one of the key indicators of soil health. A high level of soil organic matter improves populations of soil living organisms, nutrient cycling and availability, soil structure, water infiltration and retention, soil aeration, and drainage.

Conservation and maintain good quality soil: Maintaining a high level of soil organic matter reduces soil structure degradation, soil compaction and soil erosion. It also improves the soils cationic exchange capacity and maintains the soil health.

Provision of terrestrial and aquatic habitat: Good soil management decreases water runoff and soil erosion, which reduces the risks of water contamination of nearby watercourses and helps maintain a healthy aquatic and wildlife habitat.

Maintain and enhance biodiversity: A high level of soil organic matter improves populations of soil living organisms. Maintaining a healthy soil with good soil organic matter levels will improve the diversity of living organisms in the soil.

Carbon sequestration and reduction GHG emissions: Soil management has an influence on carbon sequestration and greenhouse gas emissions. Excessive tillage may accelerate microbial decomposition of organic matter emitting carbon dioxide to the atmosphere. Reduced tillage or zero tillage may build up soil organic matter which sequesters carbon in the soil.

Measurability: Many of the practices kept for their potential of providing EG&S can be verified through on-farm visual inspection however the verification of the farm records will likely be the best method to ensure that the practices were actually carried out. Without such records, EG&S credits will not be awarded. The risk assessment will be required on a field by field basis because of potential differences in field management practices.

EFP Questions and Risk Rating kept for EG&S:

Risk Rating **EFP question**	**1** (Low)	**2**	**3**
1. Soil organic matter level (determined by soil test)	Silty/sandy soils over 3% Silty/sandy loams over 3.5% Loam soils over 4% Clay loams over 5% Clay soils over 6%	Silty/sandy soils 2-3% Silty/sandy loams 2.5-3.5% Loam soils 3-4% Clay loams 4-5% Clay soils 4.5-6%	
4. Crop rotation for soil building	Crops that maintain or increase organic matter and provide a protective groundcover grown at least ***3 years out of 4*** (e.g. perennial forages)	Crops that maintain or increase organic matter and provide a protective groundcover grown ***2 years out of 3***	
12. Management of crop residues	Crop residue (e.g. straw, chaff, stalks, leaves) chopped, evenly spread, and left on the surface Soil surface covered with ***at least 60%*** of crop residue over winter	Crop residue (e.g. straw, chaff, stalks, leaves) chopped, evenly spread, and left on the surface Soil surface covered with ***40 to 60%*** of crop residue over winter	
13. Type of tillage	Tillage practice leaving ***more than 30%*** residue on surface after seeding or planting; **or** No-till	Tillage practice leaving ***20 to 30%*** residue on surface after seeding or planting	
15. Timing of primary tillage	Primary tillage carried out in the spring; **or** Conservation tillage leaving more than 60% of crop residue over winter		

Risk Rating EFP question	**1** (Low)	**2**	**3**
23. Surface drainage outlet (ditch or waterway)	Outlets protected by drop structures or rock chute Outlets discharge in a sedimentation pond, catch basin, or a designed buffer strip		
30. Construction of soil conservation structures	Diversion terraces and waterways constructed as per engineering design and by an experienced contractor Diversion terraces and grassed waterways seeded with a recommended perennial grass mix and stabilized with mulch, erosion control blanket, or netting	Diversion terraces and waterways constructed as per engineering design and by an experienced contractor Diversion terraces and grassed waterways seeded with a recommended perennial grass mix	
31. Maintenance of soil conservation structures	Sediment and debris removed as soon as they accumulate Any damages immediately repaired Vegetation mowed annually Erosion control structures not used as laneways for vehicle or machinery traffic Structures not encroached by tillage	Sediment and debris removed annually Repairs made annually Vegetation mowed annually Light traffic by vehicle or machinery on erosion control structures Structures not encroached by tillage	
32. Winter cover (for fields with low surface residues or following row crops)	Well established over-wintering cover crop (e.g. winter rye or winter wheat) seeded immediately after harvest; **or** Hay or straw mulch applied immediately after harvest	Well established winter cover crop (e.g. winter rye, winter wheat, oats) seeded immediately after harvest on field with slope greater than 2%; **or** Hay or straw mulch applied immediately after harvest on field with slope greater than 2%	

Risk Rating EFP question	**1** (Low)	**2**	**3**
33. Headland management at low end of row crop fields	Permanently established grassed headlands on lower end of row crop fields	Headlands established with grass one year prior to planting a row crop	
37. Practices to reduce tillage erosion	No-till; **or** Land never tilled		
38. Marginal land management (cultivated fields with severe limitations: slope, rocks, drainage, shallow soil,...)	Unimproved land with soil capability classes 5, 6, and 7 retired from agriculture production and planted with a mix of trees and shrubs; **or** **Marginal land allowed to grow naturally and revert to their natural condition**	Unimproved land with soil capability classes 5, 6, and 7 retired from agriculture production and planted with single species of trees or left in permanent cover; **or** Marginal land used within their limitations	

Nutrient Management

The current emphasis on nutrient management planning reflects an increased awareness of the potential impacts of nutrient use on water quality and the need to select nutrient application rates based on both realistically achievable crop production goals and environmental protection objectives.

The purpose of a nutrient management plan is to use organic and/or inorganic nutrients wisely to maximize economic benefits while minimizing contamination of surface and ground water resources and maintaining or improving the physical, chemical, and biological conditions of the soil.

The BMPs retained as having the highest potential to provide EG & S are related to many nutrient management practices found in a Nutrient Management Plan (NMP) such as the method used to determine the rate of nutrient to be applied, the methods of application and cropping practice.

EG&S Provided Through Nutrient Management

Maintain water quality: When nutrients are managed properly, there is a lower risk of contaminating surface and ground waters with nitrogen, phosphorus, or bacteria from organic and inorganic nutrient sources. Excess phosphorus or nitrogen in runoff can contribute to eutrophication of surface waters. Residual nitrogen in the soil may leach into groundwater making it unfit as a drinking water source. At high concentrations in the soil, phosphorus may leach into tile drainage waters. Bacteria from manure or other organic amendments may move with runoff water to watercourses or leach into groundwater contaminating these water sources.

Regeneration and renewal of soil: Additions of organic amendments such as manure and compost will help to build soil organic matter over the long-term and favour the growth of the soil microbial population.

Conservation and maintain good quality soil: Careful management of all nutrient sources on the farm will assist in improving the soil's organic matter, soil structure, water holding capacity, nutrient retention, nutrient cycling and biological activity.

Maintain and enhance biodiversity: Organic amendments to the soil may favour the growth and diversity of the living organisms in the soil. For example, earthworm, bacteria, and fungal populations may increase after manure application. Good nutrient management practices can increase crop yields, increase crop residue in the soil, and consequently increase soil biological activity and biodiversity.

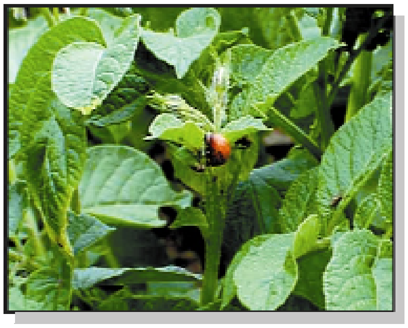
Reduction GHG emissions: Nutrient application should be managed to reduce GHG emissions. Under some circumstances, use of manure and nitrogen fertilizers can result in the emission of methane or nitrous oxide which are two potent greenhouse gases.

Maintain good air quality: Careful management of manure application will reduce emissions of offensive odours.

Measurability: Verification of the record keeping system required for Nutrient Management Planning should provide most of the needed information. This could be complemented with on-farm inspection of some practices such as the rotation and the equipment. Risk assessment will be required on a field by field basis because of potential differences in field nutrient management practices.

EFP Questions and Risk Rating kept for EG&S:

Risk Rating **EFP question**		**1** (Low)	**2**	**3**
1	**Nutrient management plan**	Nutrient management plan ***completed, implemented, and updated annually*** Plan prepared and/or certified by a professional agrologist who has completed a *Nutrient Management Planning* course; **or** Plan prepared by farm staff who have completed a *Nutrient Management Planning* course in the region and has met requirements to become Nutrient Management Planners	Nutrient management plan ***completed, implemented, and updated every 3 years*** Plan prepared and/or certified by a professional agrologist who has completed a *Nutrient Management Planning* course; **or** Plan prepared by farm staff who have completed a *Nutrient Management Planning* course in the region	



Pest Management

Every year, millions of dollars are spent on controlling pests such as weeds, insects, and diseases which affect the yield and quality of crops. Since their introduction in the early 1940s, pesticides have contributed significantly to increased crop productivity, quality, and profitability. However, during the same period, many agricultural producers have intensified their production by relying heavily on pesticides. This has led to concerns related to the impact of pesticides on the environment, food safety, and pest resistance.

Management practices are being developed to better manage crop pests and reduce the use of pesticides. Integrated Pest Management (IPM) which was developed in Nova Scotia in the mid 40s is now being practiced around the world on many crops. It involves pest monitoring and using a combination of cultural, mechanical, and biological control measures including pesticides when necessary.

The BMPs retained for their potential to provide EG&S are mostly related to IPM practices which minimize the potential for soil, water and air contamination while supplying safe food and safe habitat for wildlife and fish.

EG&S Provided by Beneficial Pest Management Practices

Maintain water quality: Pesticides can find their way to various water sources through runoff, subsurface drain outlets, leaching, drift, atmospheric depositions, and spills. Runoff, leaching and spills are the most important pathways. If pesticides are managed properly, there is a low risk of contaminating surface and ground waters. Although pesticides have been detected in ground waters of many intensively cropped areas, the levels are usually below established guidelines developed for drinking water. Care must be exercised to avoid any groundwater contamination through spills or during the cleaning of sprayers. Pesticide contamination of surface waters has been occasionally reported after heavy rainfalls shortly after pesticide application. Integrated pest management objectives are to reduce pesticide use and potential for water contamination while maintaining optimum production of a quality crop.

Conservation and maintain good quality soil: Pesticide contamination of agricultural soils is normally not a problem since the most persistent pesticides have been banned for use in Canada since the mid 1970s. The persistence of pesticides in the soil varies with the chemical properties of the pesticide and the capability of the soil to filter, degrade, and immobilize pesticides. Soil organic matter, soil clay content, pH, CEC, and permeability are all soil properties that play an important role in pesticide adsorption or retention. Integrated Pest Management includes the use of a sound rotation system and the use of green manure crops to control certain pests. These crops will also help in maintaining or increasing the level of organic matter and improve soil structure.

Maintain and enhance biodiversity: The presence of pesticides in the environment can have adverse ecological effects ranging from fish to wildlife kills as well as having an impact on reproduction. Pesticides may have negative impacts on biodiversity. Their impacts vary with their levels of toxicity and selectivity. Continuous use of the same pesticide may also contribute to the development of pesticide resistance and increasing populations of pest not controlled by the pesticide. However, soil organisms can negatively be affected by repeated and intense pesticide use.

Maintain good air quality: Exceeding minimum separation distances, reducing pesticide drift and frequency of pesticide use through alternative pest management practices are important means of reducing air contamination with pesticides.

Measurability: As for Nutrient Management Plans, Integrated Pest Management practices require that the producers keep a very good set of records. The verification of these records should provide most of the needed information. Producers' records will need to document that they are practicing IPM for all the pests on a field by field basis or document their status in terms of organic certification.

EFP Questions and Risk Rating kept for EG&S:

Risk Rating **EFP question**		**1** (Low)	**2**	**3**
1	**Pest management**	Principles of IPM ***understood and followed:*** • preventative and sanitation measures • scouting for pests and natural enemies • control decision based on economic or action threshold • sound crop management practices • combines mechanical, biological, or chemical control **or** ***Certified organic farm or in transition to become an organic farm***		

Field Windbreaks

Properly designed and managed field windbreaks are effective in controlling wind erosion, distributing snow uniformly, improving water use efficiency, and reducing wind damage to crops. As a result, crop yield and quality improve.

The ideal field windbreak system consists of a series of multi-row windbreaks perpendicular to prevailing winds. The distance between the windbreaks should not exceed 15 times the expected tree height and the density should be maintained at approximately 50%. Trees and shrubs selected for field windbreaks should be adapted to the climate and resistant to diseases, insects, rodents, and to potential pesticide drift. If windbreaks are located near salt water shorelines or roads, salt tolerant species should be selected.

The effectiveness of field windbreaks in terms of field protection, crop productivity and provision of EG&S is dependent upon their height, density, length, width spacing, orientation and diversity of species within the windbreak. The "Farmstead Windbreaks" BMPs retained from the EFP for their potential to deliver EG&S are related to the presence of windbreaks or living snow fences, their orientation, density and uniformity as well as their width and diversity.

EG&S Provided by Field Windbreaks

Conserve and maintain good soil quality: Windbreaks can be used as a sole wind erosion control measure; however, their effectiveness can be greatly improved when combined with other measures such as residue management, crop rotation, strip cropping, and conservation tillage. A lower density windbreak can be used to distribute snow uniformly over a distance as much as 25 times the height of the trees. This provides winter cover to perennial crops and reduces the risk of soil erosion during snow melt. Windbreaks benefit the soil in a strip cropping system by reducing runoff and providing permanent markers to guide producers in maintaining the orientation of their strips. A field windbreak system should be designed in a way that complements water management systems where soil erosion by water is a concern.

Water purification and maintain water quality: The positive impact that windbreaks have on water conservation outweighs any competition that may occur between windbreaks and adjacent crops for soil moisture. Better snow distribution reduces runoff and retains more water for crops. By reducing wind velocity, field windbreaks reduce evapotranspiration, thus conserving soil moisture. Windbreaks can filter surface and ground waters and the filtration effectiveness will vary with the species and their root system, windbreak width, and volume of water flowing through the windbreak.

Air purification, maintain good air quality, provision of oxygen and carbon sequestration: Established windbreaks improve the off-farm environment by reducing pesticide drift and by acting as odour, dust, and sound barriers. A well designed windbreak can reduce dust and noise by 30%. Windbreaks can play an important role for reducing greenhouse gases on the farm by sequestering carbon and by improving productivity.

Provision of terrestrial & aquatic habitat, maintain/enhance biodiversity: In many intensively farmed areas, windbreaks may be the only meaningful habitat for wildlife. Windbreaks provide shelter, food, travel corridors, reproductive, and nesting sites for wildlife. The diversity of wildlife in the windbreak is dependent on the width and diversity of the shelter and the integration or connection of the windbreak with other wildlife habitats (e.g. forests, woodlots or old fields).

Provision of aesthetic landscape and enhance recreational opportunities: Windbreaks are beneficial to the landscape contributing to the aesthetic beauty of the countryside thus increasing the value of the farmstead and the farmland. The incorporation of agroforestry species such as fruit or nut bearing shrubs or trees in the windbreaks may also provide added revenue. Windbreaks may enhance recreational activities such as game and bird hunting.

Measurability: The management practices related to field windbreaks can be easily verified however the windbreaks will need to be inspected through an on-farm visit to verify their density and uniformity. Aerial photos could be used to measure their length or they could be measure on site with a GPS or measuring wheel. The inspection would not need to be carried out on an annual basis.

It should be noted that fields can be sheltered by a woodlot. In such cases, the woodlot should be assessed as in the woodlot sub-section, not as a windbreak.

EFP Questions and Risk Rating kept for EG&S:

Risk Rating **EFP question**		**1** (Low)	**2**	**3**
1	**Presence of field windbreaks**	Windbreaks spaced at 10 to 15 times their height at maturity	Windbreaks spaced at 15 to 20 times their height at maturity	Windbreaks spaced at a distance greater than 20 times their height at maturity
2	**Orientation**	Windbreaks oriented at a right angle (90^o) to the most troublesome prevailing wind; **or** Windbreaks on all sides of the field; **or** On field where soil erosion by water is a concern, windbreaks are integrated into a soil conservation system (e.g. installed across the slope or following field contour)		

Risk Rating EFP question		**1** (Low)	**2**	**3**
3	**Density and uniformity**	Density is 40 to 60% and uniform across length and height of windbreaks Shrubs provide a uniform density at the bottom of windbreaks No gaps on the entire length of windbreaks except where frost pockets are a problem		
4	**Wildlife protection and biodiversity**	Windbreaks consist of at least 3 rows of trees and shrubs of deciduous and coniferous species of various ages and structure Windbreaks interconnected to each other or to other wildlife habitats (e.g. woodlots and wetlands) Groundcover at the bottom of windbreaks and between windbreaks and field	Windbreaks consist of at least 2 rows of trees and shrubs of deciduous and coniferous species Windbreaks not interconnected to each other or to other wildlife habitats (e.g. woodlots and wetlands) but still allow safe passage	

Peatlands, Dykelands & Floodplains

Wetlands play an important role in water filtration, flood control, groundwater recharge, and in wildlife habitat. Since European settlement, many wetlands in Atlantic Canada have been converted from their natural states to agricultural purposes. Some of the types of wetlands converted to cultivation in Atlantic Canada include peatlands, dykelands, and floodplains.

Peatlands are comprised of about 93 to 97% organic matter. They are formed by the accumulation of organic matter in poorly drained areas over thousands of years. Peatlands differ from other wetlands as they only receive water from precipitation. They have a limited life span when developed because the rate of peat formation is much lower than the rate of loss.

Dykelands are tidal salt water marshes that have been drained by dykes, ditches, aboiteaux, and land forming. These lands are also very rich in nutrients and were first drained in the Maritimes by Acadians.

Floodplains are low-lying areas adjacent to watercourses that are subject to flooding and naturally dissipate flood water. As the land floods, water deposits fine soil particles, enriching the soil with nutrients.

Peatlands, Dykelands and Floodplains have potential to provide EG & S if they are not intensively farmed. Therefore the BMPs related to these sensitive land bases are mainly related to their farming intensity.

EG&S Provided by Peatlands, Dykelands & Floodplains

Maintain water quality and regulate water cycle: When left undisturbed, peatlands, dykelands and floodplains can play an important natural role of filtering incoming water thus maintaining or improving water quality. Natural wetlands can also retain a great deal of water which helps to protect adjacent areas from flooding during wet periods and then provides water to maintain the water table or stream flow in dry periods.

Conserve/maintain good soil quality: If peatlands, dykelands or floodplains used for agriculture are not tilled, or are only infrequently tilled for re-seeding, then the root mass of the grasses or forages grown on those lands should increase the organic matter content of those soils and that should help to maintain or improve soil quality.

Provision of terrestrial & aquatic habitat: Peatlands, dykelands or floodplains used for agriculture can still provide considerable terrestrial and aquatic habitat if the land-use is not intensive. For example, fields in permanent forage or pasture will provide terrestrial habitat for birds and some smaller animals. Vegetated buffers along field ditches provide terrestrial habitat, as well as protecting aquatic habitat.

Maintain/enhance biodiversity: In their natural state, peatlands, marshlands, and floodplains can have a fairly diverse population of wildlife species, including some species at risk. Completely draining such lands can result in loss of habitat for some species, thereby reducing biodiversity of those lands. However, it is possible to manage those lands in ways to continue to provide habitat and thus maintain or enhance the biodiversity of those lands. Reducing or eliminating tillage on these fields will provide terrestrial habitat for birds and some smaller animals which would maintain or improve the biodiversity of those fields. The increase in organic matter content of those soils resulting from the reduced tillage would improve the biodiversity of organisms in those soils. Vegetated buffers along field ditches provide terrestrial habitat, as well as protecting aquatic habitat thus maintaining or improving the biodiversity of those fields.

Enhance recreational activities: Peatlands, marshlands, and floodplains left in their natural state or with only limited use for agriculture can provide recreational activities such as bird watching and hunting.

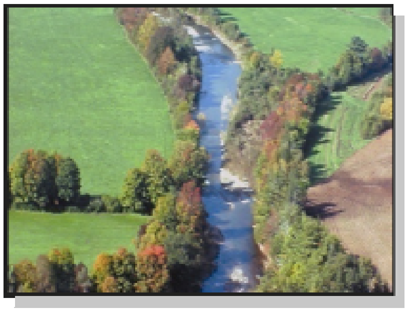
Carbon sequestration: Wetland cultivation can accelerate organic matter decomposition and thus, release carbon dioxide emissions. In some cases, natural wetlands can also be a source of methane emissions. However, peatlands, dykelands and floodplains can be very productive even if not intensively farmed. Reduced tillage or zero-tillage of these peatlands, marshlands and floodplains could maintain or improve the organic matter in these soils thereby sequestering carbon in the soils. Therefore there may be potential to sequester more carbon in those soils than is released.

Measurability: The management practices for peatlands, dykelands and floodplains on farms can easily be verified because the EFP questions related to EG&S mostly have to do with the presence, absence or intensity of use of peatlands, dykelands and floodplains. It may be possible to verify simple presence or absence from aerial photos, farm plans, or maps. However, intensity of use, tillage and other practices may need to be inspected and/or measured, as required, through an on-farm visit. The on-farm record keeping system could also be used to verify the management practices.

EFP Questions and Risk Rating kept for EG&S:

Risk Rating **EFP question**		**1** (Low)	**2**	**3**
1	**Presence and use of peatlands**	No peatlands on the farm; **or** Peatlands left in their natural state	Peatlands not intensively cropped (e.g. row crop production once every 3 years or less)	
17	**Presence and use of dykelands**	No dykelands on the farm **or** **Dykelands not cultivated or are managed for wildlife**	Dykelands used for rotational grazing; **or** Dykelands used for cereal and perennial forage production	
20	**Dykeland drainage- Ditch buffer**	3 m (10 ft) vegetated buffer between ditch and field		
26	**Presence and use of floodplains**	No floodplains; **or** Floodplains remain in or restored to their natural state	Floodplains used for forage production	

Risk Rating **EFP question**		**1** (Low)	**2**	**3**
27	**Floodplain management - tillage**	Floodplains never reseeded; **or** No-till seeding		



Riparian Buffer Zones

A riparian buffer zone is a strip of permanent vegetation located between a watercourse and any potential source of contamination. The health of riparian buffers can easily be determined by evaluating the conditions of the watercourse and by assessing surface water quality.

Ideally, a riparian buffer consists of three zones each of which have distinct functions. The zone at the edge of the watercourse is designed to protect the streambank from erosion and is primarily composed of densely rooted moisture-loving trees and shrubs. The zone along the fields or other potential sources of contamination should be composed of dense perennial grasses which filter sediments and other contaminants in the runoff water. The intermediate zone is composed of larger and deeper rooted trees and shrubs which filter the remaining surface and shallow ground waters.

The BMPs identified as having potential to provide EG&S relate to the presence and width of the buffers along the stream and ditches as well as their composition. The condition of the stream is used as a benchmark to assess the effectiveness of the practices being implemented.

EG&S Provided by Riparian Buffer Zones

Air purification, provision of oxygen, carbon sequestration and reduction of greenhouse gas emissions: Since riparian buffer zones are permanently vegetated areas, the plants in the buffer can play a role in carbon sequestration, provide oxygen through photosynthesis, and may possibly aid in purification of the air. The plants in the riparian buffer zone can also take up nitrogen from filtered runoff water or the soil, thus nitrous oxide emissions may be reduced. Also, any potential pesticide drift through the air may be prevented from reaching the watercourse by the presence of a healthy riparian buffer zone.

Water purification, maintain water quality and regulate water cycle: Riparian buffer zones can be effective in filtering surface runoff and shallow groundwater and are designed to complement sound land management practices. The filtration of surface runoff begins with the grassed zone which slows runoff, enhances water infiltration, and physically intercepts most of the sediments and the attached contaminants. The intermediate zone also filters any runoff water that has not been filtered by the grassed strip as well as shallow groundwater. A well managed riparian buffer therefore helps prevent nutrients, pesticides, and other contaminants from reaching the watercourse and groundwater, thus maintaining high quality water.

Conserve/maintain good soil quality: Some of the best quality agricultural land base is located near watercourses. Proper riparian zone maintenance and farm field runoff control will help to reduce streambank erosion and conserve this good quality soil from being eroded. Streambank erosion normally occurs during heavy flows such as during spring thaw and after severe storms. Stream banks can be eroded by the action of stream flow and/or by uncontrolled runoff water flowing over the banks. Streambank erosion also contributes a considerable amount of sediment and attached contaminants to watercourses thereby degrading water quality.

Provision of terrestrial and aquatic habitat: Riparian buffer zones have a mixture of grass, shrub and tree vegetation. As a result, riparian buffer zones can provide different terrestrial habitats to suit a wide range of species of terrestrial plants and animals. Buffer zones harbour beneficial insects and birds which help keep pests under control. Mammals use the riparian zone for shelter, food, and as travel corridors to move between different habitats. The most humid areas of the riparian buffer zone, often the areas of a riparian buffer zone closest to the watercourse, can also provide habitat for aquatic plant species. The overhanging trees and vegetation in a riparian zone will keep water in the stream cool thus providing suitable aquatic habitat for many fish and other aquatic species. As well these trees can be an important feed source for many aquatic species which are feeding from falling debris and insects. Riparian buffer zones also filter runoff thus maintaining the quality of the nearby aquatic habitat.

Maintain/enhance biodiversity: Riparian buffer zones have a mixture of terrestrial, transitional (semi-aquatic) and aquatic habitats. This variety of habitats allows riparian zones to support a diverse variety of species of terrestrial and aquatic plants and animals. Thus Riparian zones can maintain or enhance the biodiversity of an area through the provision of a wide variety of habitats.

Provision of aesthetic landscape: The mixture of grass, shrub and tree vegetation and their proximity to a watercourse often means that riparian zones provide a very visually appealing landscape. The aesthetic value of this visually appealing landscape to residents of the area and to the general public is an EG&S provided to the public through the maintenance of the riparian zone.

Enhance recreational activities: A healthy riparian ecosystem includes a diversity of vegetation and wildlife (e.g. fish, insects, birds, mammals), because it is a transition between aquatic and terrestrial habitats. Also, the presence of a healthy riparian zone can directly or indirectly enhance and provide access to many leisure activities such as fishing, hunting, bird watching, or canoeing.

Measurability: Aerial photos can be used as the initial assessment of the riparian buffer zone (RBZ) however on-site inspection and measurement will be required to assess the width and composition of the buffer zone. A GPS unit and RBZ assessment software would greatly simplify the task. Due to the difficulties in assessing watercourse conditions, it was decided to remove questions 6 “Condition of watercourse” for EG&S purposes. Also, if a forested RBZ is wider than 75 m, the area exceeding the 75 m will be assessed as a woodlot.

EFP Questions and Risk Rating kept for EG&S:

Risk Rating EFP question		**1** (Low)	**2**	**3**
1	**Width of riparian buffers along watercourses**	Between 30 to 75 m along all natural watercourses (streams, rivers, ponds, lakes, and wetlands).	Between 15 to 30 m (50 to 100 ft) of maintained natural vegetation.	Between 5 to 15 m (17 to 50 ft) of vegetated buffer between field and edge of watercourse; **or** Buffer width meets legislation
2	**Buffer strips for drainage and road ditches**	More than 5 m (17 ft) of grass strip between field and ditch (high water mark)	Between 3 to 5 m (10 to 17 ft) of grass strip	

Risk Rating EFP question		**1** (Low)	**2**	**3**
3	**Watercourse crossings**	Well designed, constructed, and maintained bridges Road approaches prevent water from draining directly into the watercourse		
4	**Vegetation**	Streambank vegetated with deep binding root mass, moisture-loving trees, shrubs, and grasses; no maintenance required Intermediate forested zone composed of deep rooted trees, shrubs, and grasses; regular maintenance and harvesting allow various age groups Grass buffer strip composed of dense perennial grasses; mowing and/or controlled grazing in dry conditions	Streambank and forested zones composed of unmanaged stand of trees and shrubs Grass buffer strip composed of perennial grasses and forbs	
5	**Habitats**	Trees and shrubs provide 50 to 70% shade to the stream Wide variety of plant species that provide shelter and food to wildlife	Trees and shrubs provide 25 to 50% shade to the stream Wide variety of plant species that provide shelter and food to wildlife	

Wetlands

Natural wetlands (marshes, shallow water, fens, bogs, and swamps) can be generally described as any area of land that is regularly covered or saturated with water. They can be found on many farms and can range from thousands of hectares to less than one hectare in size. Some wetlands have permanent open water ponds while others are entirely vegetated and may only be saturated with water for a few weeks annually. Wetlands play an important role in water purification and storage, shoreline protection, and flood control.

Constructed wetlands are manmade, shallow aquatic systems designed to capture and filter effluents from feedlots and manure storages, milkhouse wastewater, and agricultural runoff. These constructed wetlands are designed to filter water by the same processes found in a natural wetland. Constructed wetlands can effectively filter bacteria, nutrients, and sediments thus reducing the threat to surface or ground water.

The EFP assessment questions kept to assess the potential to provide EG&S are related to the presence and restoration of natural wetland and the presence of constructed wetlands. The quality of water being discharge into the natural wetlands and the quality of water being discharged from the constructed wetlands are also important considerations.

EG&S Provided by Wetlands

Regulate water cycle: Wetlands are important reservoirs for the recharge of surface and ground waters. Many communities depend on wetlands for continued access to high quality drinking water. Wetlands act like a sponge and have the ability to absorb and store excess water which prevents flooding. Climatologists are predicting that extreme weather events such as hurricanes will occur more often in the future which means that we will be more dependent upon wetlands for flood prevention. Protecting agricultural land from flooding will reduce nitrate loss, soil compaction, runoff, and soil erosion.

Maintain water quality and water purification: Wetlands play a critical role in protecting the quality of surface and ground waters by filtering water flowing from agricultural fields or other sources of contamination. This water may contain sediments, nutrients, bacteria, or other compounds that can potentially contaminate water. The natural ecological processes of a wetland help to remove these contaminants resulting in improved water quality. Constructed wetlands designed for wastewater treatment can be an inexpensive way to filter contaminated water. Wetlands can be used as a water recharge system for irrigation or livestock watering ponds thereby eliminating the cost of drilling wells.

Provision of terrestrial and aquatic habitat; maintain/enhance biodiversity: Wetlands provide some of the most productive and diverse habitat for wildlife. By maintaining quality wetlands, farmers contribute to diverse ecosystems and support up to 600 species of plants and animals. Some common wetland vegetative species include cattails, sphagnum, and larch. Wetlands also shelter a wide variety of insects, crustaceans, molluscs, fish, reptiles, amphibians, birds, and mammals. Many species cannot exist without wetlands. In fact, several species at risk take refuge in wetlands. All species in wetlands are closely interlinked and if one species disappears, the whole food web can be altered.

Enhance recreational opportunities: Wetlands reduce the negative impacts caused by flooding (e.g. damage to farm structures and cropland and delayed planting times). On some farms, wetlands can provide a diversified source of income such as wood harvesting, fur trapping, or hunters paying for access to wetlands. Wetlands can add to the aesthetic value of the farm and provide good places for bird watching or fishing.

Measurability: Aerial photos with GIS wetland layer overlaid can be used as an initial step in identifying natural wetlands however special skills (wetland biologist) are required to properly identify the type of wetlands and their delimitations. In most cases, on-farm inspection and on-site measurement preferably with a GPS unit may be required. However constructed wetlands are easier to locate and measure. In most case, constructed wetlands would have been built with the use of an engineering plan. In these cases, the engineering plan could be used.

EFP Questions and Risk Rating kept for EG&S:

Risk Rating **EFP question**		**1** (Low)	**2**	**3**
1	**Presence of natural wetlands**	Surveyed farm property to locate and map all wetlands	Used GIS maps where available or aerial photos to locate and map all wetlands on the farm	
2	**Wetland restoration/ alteration**	No wetlands have been in-filled or drained	Altered wetlands identified and restored according to a plan prepared by a specialist	
4	**Discharge into natural wetlands**	No direct discharge of contaminated water from ditches, barnyards, feedlots, etc. into natural wetlands		
7	**Wetland construction**	Wetland constructed according to approved engineering design All permits obtained		
11	**Outflow of water from constructed wetland**	Outflow diffused through a well vegetated riparian buffer zone of at least 30 m (100 ft) before entering a watercourse or natural wetland		

Woodlots

Canada is often referred to as a forest nation. In fact, approximately 42% of Canada's land mass is covered by forests and Canada is the largest exporter of forest products worldwide. Though forests are important for economic reasons, they also provide a multitude of environmental and social benefits.

Farm woodlots are usually natural forests that are variable in size and often isolated in an agricultural environment. Many farmers use their woodlots to generate supplemental income. Many people enjoy the recreational activities that woodlots offer such as hiking, bird watching, camping, and hunting. Woodlots provide food and shelter to a wide variety of wildlife.

Woodlots are important for conserving the quality of air and water. Trees produce oxygen and capture carbon dioxide. Shallow ground water and runoff can be filtered as they flow past the root system.

A well-managed woodlot can generate income and provide many EG&S such as protection of soil and water resources, and provision of wildlife habitat. The EFP questions retained are related to the presence and use of the woodlots and their diversity.

EG&S Provided by Woodlots

Water purification, maintain water quality and regulate water cycle: Woodlots act like a sponge and can prevent flooding and erosion of adjacent fields. Woodlots can be used as a soil conservation measure to prevent neighbouring runoff from causing erosion on the farm. Flood prevention and erosion control will reduce nutrient loss and soil compaction. When woodlots are situated near fields, the trees protect crops against strong winds and reduce wind erosion.

Woodlots store excess water and help maintain the water table level. They also improve groundwater quality as they filter excess nutrients and chemicals applied to farmlands. In fact, they are sometimes used for the safe disposal of surface runoff. By reducing wind velocity, woodlots provide a higher relative humidity in the fields and reduce evapotranspiration. This conserves soil moisture and increases crop productivity while reducing the requirement for irrigation. Woodlots also protect the water quality of nearby streams, rivers, and lakes.

Air purification, provision of oxygen, maintain good air quality and carbon sequestration: Trees play an important role in reducing greenhouse gas emissions by sequestering carbon dioxide from the air. Trees also conserve air quality by producing oxygen and by acting as a barrier to dust particles, odours, and other gaseous pollutants. Trees can affect the local climate and influence the amount of precipitation and growing degree days in an area.

Provision of terrestrial and aquatic habitat, maintain/enhance biodiversity: Woodlots support a variety of plants and animals. The proximity of a woodlot to other natural habitats (e.g. forests, riparian buffer zones, wetlands) allows wildlife to safely travel in search of food and shelter. In certain cases, forest corridors (e.g. windbreaks) are required to link woodlots with other natural habitats.

Provision of aesthetic landscape, enhance recreational activities: A well managed woodlot can generate various products such as maple syrup, wood for heating and wood for construction. When situated near a field, woodlots can increase crop yields by reducing evapotranspiration stress and soil erosion and by acting as a barrier to the transmission of diseases between fields. Woodlots can add to the aesthetic value of the farm and provide good places for bird watching or hunting. Woodlots may also allow farmers to generate additional income through agri-tourism.

Measurability: Aerial photos could be use as an initial assessment tool to measure the woodlots left on the farm however verification of the forest management plan provides most of the required information. An on-site verification may be needed to assess woodlot diversity and the buffer zone. Occasional on-farm verification should be carried out. Farm woodlots are usually natural forests that are variable in size and often isolated in an agricultural environment. Any area covered mostly of trees can be considered as part of the farm woodlots. Areas covered mostly of bushes can be assessed as marginal land.

EFP Questions and Risk Rating kept for EG&S:

Risk Rating **EFP question**		**1** (Low)	**2**	**3**
1	**Woodlot area**	Woodlots occupy land capability classes 3 to 7	Woodlots occupy land capability classes 4 to 7	
2	**Woodlot use**	Woodlot conserved for wildlife habitat and recreational use	Woodlot used to diversify income on the farm, such as: selective tree harvesting, maple syrup production, Christmas wreath production, etc.	
3	**Forest management plan**	Forest management plan prepared for woodlot within last 5 years that includes: • owners' objectives • woodlot inventory and map • annual woodlot operating plan		
7	**Buffer zone**	More than 100 m (330 ft) along all watercourses (streams, rivers, ponds, lakes) and wetlands Necessary permits obtained prior to wood harvest in buffer zone	More than 50 m (165 ft) along all watercourses (streams, rivers, ponds, lakes) and wetlands Necessary permits obtained prior to wood harvest in buffer zone	
9	**Woodlot diversity**	Woodlot consists of several hardwood and softwood stands of various ages and sizes Highly diverse ground cover Woodlot directly connected to other natural habitats (e.g. large forests, wetlands, riparian buffer zones)	Woodlot consists of several stands of either hardwood or softwood of various ages and sizes Highly diverse ground cover Woodlot connected to other natural habitats (e.g. large forests, wetlands, riparian buffer zones) through wide travel corridors without interruption	

Species at Risk

Canada is fortunate to have a rich diversity of flora and fauna. Experiences with wildlife enrich Canadians lives and enhance their emotional, spiritual, and social well being. In addition, wildlife plays a vital role in essential ecological and biological processes, is important for the preservation of genetic diversity, and boosts Canada's economy. However, in the past century, many changes to the land have taken place, which have an impact on wildlife. Human activities are threatening the survival of many species by disrupting their habitat, contaminating their environment, introducing invasive species, and by excessive hunting and trapping.

EG&S Provided by Species at Risk

Provision of terrestrial & aquatic habitat, maintain/enhance biodiversity, protect species at risk: It is important to protect sensitive wildlife areas which are consistently used for breeding, feeding, birthing, or nesting. White-tailed Deer, for example, return to the same wintering grounds year after year. Since any destruction or disruption of these grounds could negatively impact the health of the herd, great care must be taken to ensure that these areas are protected. Species at Risk are present on landowners land because of their good management of natural resources. In addition, many management tools for species recovery are also beneficial to livestock production. It is in everyone's best interest to protect Species at Risk.

Provision of aesthetic landscape, enhance recreational activities: The conservation of natural habitats provides landscapes that are more aesthetic and can also enhance recreational activities such as bird watching. There are opportunities to create agri-tourist activities in areas where species at risk are found as long as precautions are taken not to disturb the species.

Measurability: An on-site inspection will be required to verify the specific actions undertaken to preserve species at risk at the farm or to conserve the natural habitat.

EFP Questions and Risk Rating Kept for EG&S:

Risk Rating EFP question		1 (Low)	2	3
2	**Agricultural practices modification for Species at Risk**	Personal records of Species at Risk spotted on the property Modified practices to ensure Species at Risk on land are not harmed or harassed and habitat is managed according to the needs of the species		
3	**Habitat conservation**	Natural habitats on the farm managed according to wildlife needs Wildlife habitat increased by converting or allowing marginal and sensitive lands to revert towards their natural condition	Natural habitats on the farm managed according to wildlife needs Unproductive and highly erodible crop land seeded to forage Poorest land fenced out and allowed to revert toward natural condition	

Appendix 5 – List of Attendees

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