Socio-Economic and Environmental Assessment of Beneficial Management Practices:

- Alternative Watering Systems to Manage Livestock (1001)
- Riparian Buffer Establishment (1002)
- Irrigation Management (1801)
- Wildlife Damage Prevention (2302)

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Executive Summary

Between June 2011 and March 2012 a project team from the Resource and Environmental Management Program at Simon Fraser University was contracted by the British Columbia Ministry of Agriculture to conduct a socio-economic and environmental assessment of agri-environmental beneficial management practices (BMPs) promoted through the *Canada-British Columbia Environmental Farm Plan Beneficial Management Practices Program* (BMP Program). The project was supported by *Growing Forward,* a federal-provincial initiative that supports provincial agricultural programs, such as the Environmental Farm Plan and BMP Programs.

The specific objectives for this project were to:

- Develop a methodology to conduct a socio-economic and environmental impact assessment of BMPs on BC farms; and to
- Evaluate the social, economic and environmental outcomes of four BMPs cost-shared through the BMP Program.

The four BMPs reviewed in this report include:

- Alternative Watering Systems to Manage Livestock (practice code 1001);
- Riparian Buffer Establishment (practice code 1002);
- Irrigation Management (practice code 1801); and
- Wildlife Damage Prevention (practice code 2302).

To conduct the assessment, the project team developed four BMP evaluation surveys (one for each BMP assessed). Surveys were administered through personal interviews with BMP adopters from across British Columbia as well as through paper surveys mailed to a sample of adopters via post in the fall of 2011. The survey collected both baseline and social, economic and environmental BMP impact data.

Results of the project highlight both the impacts of the BMP to individual farm operations as well as the overall impact of the BMP program to society. The results also indicate where the program and specific BMPs have been successful as well as where there is room for improvement. The report critically analyzes each BMP using a SWOT (strengths, weaknesses, opportunities and threats) analysis as well as makes recommendations for the future of each BMP.

With the completion of this report, it is hoped that Ministry of Agriculture staff, EFP program administrators and producers will have better information about agri-environmental BMPs in practice on BC farms. By understanding who, how and why producers are adopting specific BMPs, the program may be better tailored to the needs of the producer and in turn promote BMP uptake. In addition, the information contained in this report will aide in:

- Demonstrating BMP effectiveness to funding agencies;
- Promoting the BMPs to producers; and
- Effectively allocating limited program funding.

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1.0 Introduction

This project is supported by *Growing Forward,* a federal-provincial-territorial initiative that supports provincial agricultural programs, such as the Canada-British Columbia Environmental Farm Plan Program (EFP) and Beneficial Management Practices Programs (BMP Program). In British Columbia, the EFP Program, launched in 2004, was designed to raise awareness and to complement and enhance the current environmental stewardship practices of agriculture producers. Programs were developed based upon a risk assessment of regional issues concerning air, soil, water and biodiversity and Beneficial Management Practices (BMPs) needed to address the issues. Encouraging the adoption of BMPs such as those reviewed in this reprt contributes to improved environmental stewardship. Since 2005, the BMP Program has encouraged the adoption of BMPs by cost-sharing the implementation costs of the practices with producers who adopt agri-environmental BMPs.

To date the Ministry of Agriculture has not conducted a formal evaluation of practices that have been funded through the BMP Program. This report is the first step in assessing the socio-economic and environmental impact of four agri-environmental BMPs cost-shared through the BMP Program:

- Alternative Watering Systems to Manage Livestock (practice code 1001);
- Riparian Buffer Establishment (practice code 1002);
- Irrigation Management (practice code 1801); and
- Wildlife Damage Prevention (practice code 2302).

The objectives of this project were to:

1. Develop a methodology to conduct a socio-economic and environmental impact assessment of BMPs on BC farms; and to
2. Evaluate the social, economic and environmental outcomes of four BMPs cost-shared through the BMP Program.

The specific research questions addressed in this report are:

- What was the adoption between 2005 and 2010 for the BMP and what factors are contributing to this level of adoption?
- What are the social, economic and environmental impacts of each BMP?
- Is the BMP effectively targeting the environmental risks it is intended to address?

With the completion of this report, it is hoped that Ministry of Agriculture staff, EFP program administrators and producers will have better information about agri-environmental BMPs in practice on BC farms. By understanding who, how and why producers are adopting specific BMPs, the program may be better tailored to the needs of the producer and in turn promote greater BMP adoption. In addition, the information contained in this report will aid in:

- Demonstrating BMP effectiveness to funding agencies;
- Promoting the BMPs to producers; and
- Effectively allocating limited program funding.

2.0 BMP Assessment Methodology

This project is the first socio-economic and environmental assessment of BMPs conducted by the BC Ministry of Agriculture (AGRI). It is expected that at least one similar BMP assessment that focuses on different BMPs will take place in the subsequent program year. Several important factors contributed to the BMP assessment methodology that was developed:

- At the time of the initial assessment, limited information had been collected about BMP projects. In addition, no information about the state of the environmental risks prior to BMP adoption was available in order to establish a baseline level of environmental risk;
- The methodology had to be cost-effective and able to be completed within an eight-month timeframe. Thus environmental testing and monitoring over time was not possible; and
- The general assessment methodology needed to be replicated over time and across BMPs to allow for monitoring of the impacts and to compare the BMPs to one another.

The remainder of this section will outline the methodology used to conduct the socio-economic and environmental assessment of BMPs.

The four BMPs reviewed in this report are:

- Alternative Watering Systems to Manage Livestock (practice code 1001);
- Riparian Buffer Establishment (practice code 1002);
- Irrigation Management (practice code 1801); and
- Wildlife Damage Prevention (practice code 2302).

Literature Review

The first step was a review of government publications and academic literature. The focus of the literature review was to determine how the methodologies of other environmental monitoring programs, economic evaluations and indicator-based studies could be applied to BMP assessment in BC. The literature review is attached in Appendix I and contains many studies that were helpful in developing the methodology.

Creating Social, Economic and Environmental Indicators and the Assessment Survey

To evaluate the environmental impact of agri-environmental BMPs on farms, a set of environmental indicators for the individual farm operation were developed based on the specific environmental risk that the BMP is intended to address. Agri-environmental indicators are used as a proxy for the actual environmental impact of a specific BMP without the need for direct measurement. The indicators were assessed either by a site assessment and/or by survey questions posed to the farmer.

To determine the financial impact of the agri-environmental BMP to the farm operation, both costs and benefits prior to and post BMP adoption were considered.

To determine the economic impact of the agri-environmental BMP to society, a Cost-Benefit Analysis (CBA) was conducted[1]. The CBA framework was developed based on the Canada Treasury Board Secretariat[2] methodology and analyzed according to their generally accepted guidelines. These guidelines were initially developed to evaluate federal regulations but they are also applicable at other levels of government. According to the 'Canadian Cost-Benefit Analysis Guide' five main steps are followed when conducting a cost-benefit analysis:

1. Identify the issues, risks, and the baseline scenario;
2. Set objectives;
3. Develop alternative regulatory and non-regulatory options;
4. Assess the benefits and costs (using a variety of possible techniques); and
5. Prepare an accounting statement.

As an additional step, we added a sensitivity analysis to these five recommended steps.

Data used to conduct the cost-benefit analyses came from both BMP Program data and data collected during the assessment. In some cases, the sample sizes used to calculate either cost or benefit data were small relative to the overall population of adopters. Low sample sizes are acknowledged as a potential limitation to the representativeness of the cost-benefit analyses results. The detailed methodology followed to conduct the CBA is outlined in Appendices II through IV.

To understand the motivations, barriers and social implications of BMP adoption, a set of social assessment questions were developed. The social impact assessment included social indicators pertinent to the goals of the BMP Program, for example, increasing environmental awareness amongst agricultural producers.

Data Sources and Data Collection Methodology

The data for this project came from three sources:

1. A sample of BMP project application files were supplied by BC Agricultural Research and Development Corporation (ARDCorp) for each BMP assessed in this study.

ARDCorp acts as the delivery agent for both the Environmental Farm Plan and BMP Programs in BC. When a farm applies for BMP project funding, they submit an application form to ARDCorp. The BMP project file data was collected from paper archives by photocopying files and entering relevant data into a database. The data that was obtained from the program files included the contact information for adopters, the total number of adopters (N), the specific city/region where the BMP was adopted, the date the BMP was completed, and the total cost of the infrastructure both paid by the agencies and by the producer. The data files selected from ARDCorp included all adopters of 1001 (N=69), 1002 (N=42) and a random

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[1] Cost benefit analyses are used by governments to determine the economic efficiency of alternative policies (i.e. government intervention) for solving a specific problem (e.g. water pollution). Governments at varying levels around the world have adopted this decision tool for assessing new or existing policies — indeed it is one of their "key analytical tools".

[2] Treasury Board of Canada Secretariat. (2007). Canadian Cost-Benefit Analysis Guide: Regulatory Proposals. Ottawa, ON: Government of Canada. Retrieved on January 22, 2012 from: http://www.tbs-sct.gc.ca/ri-qr/documents/gl-ld/analys/analys00-eng.asp

sample of 200 each of 1801 and 2302 for the time period of 2005 to 2010. ARDCorp also supplied the electronic data files for all adopters of 1801 (N=619) and 2302 (N=318) which included BMP location and implementation cost data.

2. A survey instrument was developed to conduct the socio-economic and environmental assessment.

For each BMP, a separate survey instrument was developed to assess the socio-economic and environmental impact. Questions were designed to capture the indicators developed during the previous steps as well as based on recommendations made by the project team and AGRI steering committee. Data was collected in two ways:

1. Personal interviews with producers, and
2. A mail out to producers who did not participate in an interview.

A target of 60 interviews (15 for each BMP) was set. Interviews were conducted between September and December 2011 and focused on key areas of BMP adoption across the Province including:

- The Fraser Valley and Metro Vancouver;
- The South Okanagan – Similkameen;
- The Thompson – Nicola Region;
- The Cariboo;
- Prince George and Vanderhoof areas;
- The Peace region; and
- The Kootenay regions.

A total of 51 interviews were completed. Interviews were arranged by telephone and email prior to visiting the regions. All areas but the Kootenays were visited in person. Phone interviews were conducted with adopters in the Kootenays, after a planned trip had to be cancelled due to poor weather. One member of the project team conducted the majority of the interviews with some assistance (when interview appointments overlapped). In most cases, when the producer had time, interviews corresponded with a site visit. Riparian Health Assessments were conducted where possible for Livestock Watering and Riparian Buffer BMP projects. Table 1 contains a summary of interviews conducted.

Figure 1. Conducting personal interviews with BMP adopters helped to gain insight into the motivations, challenges and benefits associated with BMP adoption.

Table 1. Summary of Interviews Conducted.

BMP	# Interviews/Site Visits Conducted
1001	15
1002	10
1801	12
2302	14
Total	**51**

A survey was mailed to the sample of adopters who did not participate in an interview. Surveys were sent at the beginning of October with a return deadline of November 15th. A total of 430 surveys were mailed out (some addresses from ARDCorp files were out of date, reducing the sample) and 78 completed surveys were returned. Response rates for each BMP will be discussed in the BMP sections below. All participants who did not return a survey by the deadline received one follow-up phone-call. Several producers indicated that they never received the survey, although their address information was correct. In these cases a second survey was sent; however, very few were returned. Non-respondents indicated several reasons for not returning surveys:

- Lack of time to fill out the survey;
- Unwillingness to participate; and
- An inability to remember the answers to questions.

3. Data from relevant literature sources was used, particularly to value environmental benefits for the purposes of the CBA.

Some environmental benefits could not be valued monetarily within the scope and timeframe of this project. In order to conduct the cost-benefit analysis, values for environmental benefits were gathered from relevant literature sources. This methodology, termed "value transfer" or "benefit transfer" is elaborated upon in Appendix III.

Data Analysis

The survey results collected through personal interviews and mail surveys were combined and analyzed jointly for each BMP. Select questions were analyzed across all four BMPs in aggregate.

SWOT Analysis, Conclusions and Recommendations

To organize the main findings of the assessment as well as present some anecdotal findings from interviews, a SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis was conducted for each BMP. Finally, conclusions and recommendations, based on the findings of the BMP assessment were made for each BMP.

3.0 Socio-Economic and Environmental Impact of Four Beneficial Management Practices

This section will report the findings of the socio-economic and environmental assessment of four BMPs that were evaluated between September and December 2011. The four BMPs included in this assessment are Alternative Livestock Watering Systems to Manage Livestock (1001), Riparian Buffer Establishment (1002), Irrigation Management for Nursery, Greenhouse, Tree Fruit, Grapes and Berry operations (1801) and Wildlife Damage Prevention (2302).

Each of the four BMPs reviewed in this document was evaluated separately. However, it is important to recognize that BMPs are often adopted as a suite of practices. For example, a producer who adopts a Livestock Watering BMP may also restore the vegetation in the riparian area and reinforce the streambank at the same time. These practices likely act together to reduce the farm's impact on the environment.

3.1 Alternative Livestock Watering Systems to Manage Livestock (Practice Code 1001)

The Alternative Livestock Watering Systems to Manage Livestock BMP (herein referred to as the Livestock Watering BMP) is intended to address environmental risks associated with livestock drinking directly from surface water sources. These risks include contaminating water with urine and manure, spawning bed trampling, streambank trampling and removal of riparian vegetation through trampling and grazing.[3]

The BMP cost-shares the implementation of livestock watering systems that either restrict livestock access to surface water sources, provide an off-stream water source or a combination of both. Restricting access to surface waters and/or providing an off-stream water source reduces risks to riparian habitat and water quality and can also improve livestock health and safety as well as provide a reliable year round water source for livestock[4]. Off-stream watering systems can help ranchers distribute animals across the rangeland more effectively, resulting in a more efficient use of forage and aiding in rotational grazing.

The BMP funding may be allocated to pumps, water storage, power set up from existing power lines, waterlines, construction costs and both temporary and permanent livestock exclusion fencing. The BMP emphasizes the use of alternative power sources such as solar, gravity fed and wind systems as an alternative to fossil fuel powered systems.

Figure 2. A solar powered portable livestock waterer can be moved from pasture to pasture, facilitating rotational grazing.

3.1.1 Environmental Objectives of the Livestock Watering BMP

The specific environmental objectives that the Livestock Watering BMP is intended to address include:

- Enhancing riparian health; and
- Reducing the impacts of livestock on water quality.

The environmental objectives addressed by the Livestock Watering BMP have a larger impact on the overall health of ecosystems by improving habitat for both land

[3] BC Ministry of Agriculture and Lands. (2006). *Watering Directly From Watercourses: Livestock Watering Factsheet.* Retrieved from *www.agf.gov.bc.ca/resmgmt/publist/500Series/590302-1.pdf*
[4] National Farm Stewardship Program. (2006). *Beneficial management practices descriptions.* Ottawa, ON: Agriculture and Agri-Food Canada.

and fish species, filtering nutrients, chemicals and sediments from runoff water, sequestering carbon and filtering air.

3.1.2 Survey Response

A total of 14 interviews and site visits were conducted. 23 surveys were returned totaling 37 respondents. The survey response rate was 53%.

3.1.3 Livestock Watering BMP Provincial Statistics

This section will report the BMP adoption and distribution statistics for the period between 2005 and 2010. The data sources for this section include the ARDCorp program files as well as data collected through the BMP assessment survey.

Cost-Share, Cap Structure and Average BMP Project Cost

The Livestock Watering BMP was cost-shared at 50% of total eligible items up to $25,000. Between May 2006 and March 2008, Ducks Unlimited topped up the amount of money available to adopters by providing 10% of the total eligible cost, bringing the cost-share level up to 60%.

The average cost of a Livestock Watering BMP project, taking into account only the eligible costs is $14,262.

Distribution of Adoption

A total of 69 livestock watering BMP projects have occurred across BC between 2005 and 2010. The BMP has been adopted by just under 2% of the cattle ranches reported by Statistics Canada in BC.[5]

Table 2. Distribution of the Livestock Watering BMP by Regional District.

Regional District	# BMPs Adopted
Alberni-Clayoquot	1
Bulkley-Nechako	6
Cariboo	14
Central Kootenay	4
Columbia-Shuswap	6
Comox Valley	2
East Kootenay	1
Fraser Valley	1
Fraser-Fort George	2
Kootenay-Boundary	3
Nanaimo	1
North Okanagan	5
Okanagan-Similkameen	2
Peace River	16
Thompson-Nicola	5

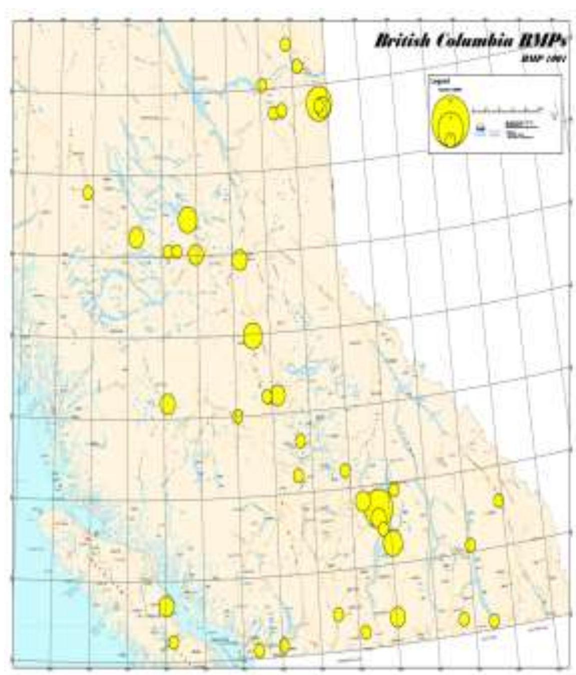

Figure 3. Geographic Distribution of the Livestock Watering BMP Adoption Between 2005 and 2010

[5] Ministry of Agriculture. (2010). Fast Stats 2010. Agriculture, Aquaculture and Food. Retrieved from http://www.agf.gov.bc.ca/stats/ on January 28, 12.

By Commodity

The cattle ranching industry has adopted the majority of the BMP projects in this category to date (90%). Other adopters of this BMP include horse operations (3%), dairy farms (2%) and other farms, classified as forage operations that have a small herd of livestock (5%). None of the survey respondents indicated that they were certified organic.

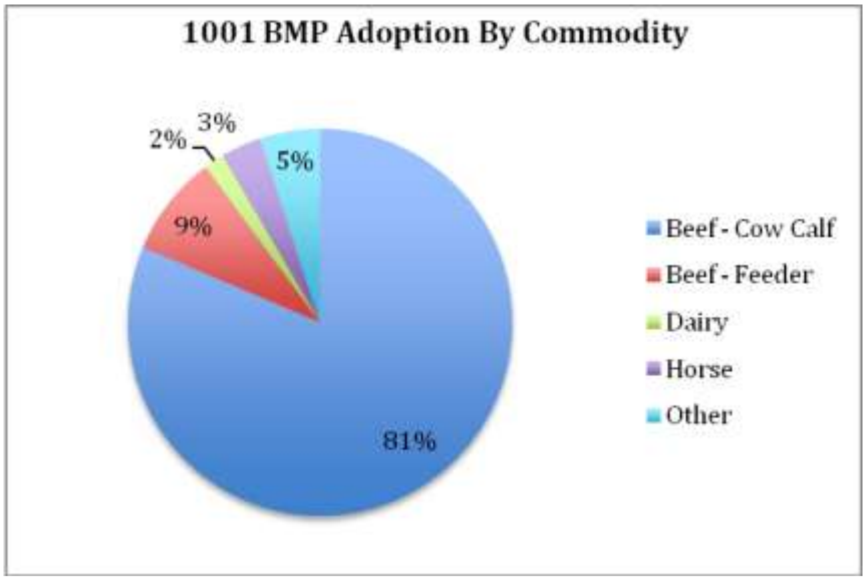

Figure 4. Livestock Watering BMP adoption by commodity.

Adoption Over Time

Adoption of the Livestock Watering BMP peaked in 2007 and 2008. Since 2008, adoption has dropped to approximately 6 projects per year. The reasons for the differences in adoption rates by year were not explicitly assessed in this study, however, the decline in adoption may be explained by a combination of the following reasons:

- The BMP has captured most of the likely "early adopters" and other potential adopters are not being captured by the program;
- A lack of awareness of the EFP/BMP program since the restructuring of the program administration in 2009;
- Decreased total amount of funding available when Ducks Unlimited top-up funding ended in 2008; and
- Increased scrutiny of BMP Projects after the change in administrative structure in 2009.

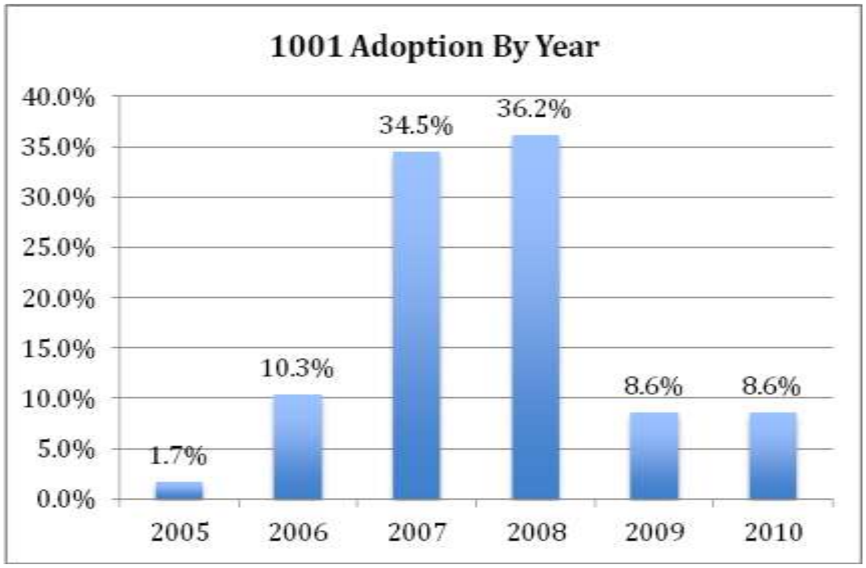

Figure 5. Temporal distribution of Livestock Watering BMP adoption.

Livestock Watering BMP Adopter Characteristics

Understanding the characteristics of the average livestock watering BMP adopter compared to the average population of farmers across BC will provide insight into the unique characteristics of the producers and farms who choose to adopt this BMP. The following adopter characteristics and socio-demographic information are compared to Statistics Canada 2006 Census of Agriculture information where possible. [6]

Average Farm Adopting the Livestock Watering BMP

The average size of ranch that has adopted the Livestock Watering BMP is 307 hectares. Each ranch has an average of 178 livestock[7], of which, 156 are beef cattle.

Table 3. Descriptive Statistics of Livestock Watering BMP Adopters.

	# Livestock	Ranch Size (ha)
Average	178	307.6
Median	123	126.7
Min	5	1.2
Max	552	1861.6

[6] Statistics Canada. (2006). Census of agriculture: farm data and operator tables. Retrieved from http://www.statcan.gc.ca/pub/95-629-x/2007000/4182411-eng.htm#gfr on January 15, 2012.
[7] Note that poultry were not included in this calculation because they skew the average number of livestock. Beef cattle, dairy cows, horses and other livestock such as sheep and goats were included in the calculation.

Farm Gate Sales

Farm gate sales of the BMP adopters compared to the farm gate sales for farmers across BC reveal that more adopters fall into the middle range farm gate sales than farms across BC.

Table 4. Farm Gates Sales of Livestock Watering BMP Adopters compared to the average BC Farmer.

Farm Gate Sales	% of BMP Adopters in 2010	% of BC Farmers in 2006 Census
Less than $10,000	22.6%	47.7%
$10,000-$24,999	16.1%	16.1%
$25,000-$49,999	16.1%	10.3%
$50,000-$99,999	32.3%	8.0%
$100,000-$249,999	9.7%	7.7%
$250,000 and over	3.2%	10.2%

Age of Adopters

The average age of Livestock Watering BMP adopters is higher than the BC average for farmers reported in the 2006 Census of Agriculture[8]. 48.6% of BMP adopters fall into the age category of 55 and above compared to 40.7% of BMP adopters falling into 55 and above across BC. The pattern may reflect a more senior demography of ranchers specifically.

Table 5. Age of Livestock Watering BMP adopters compared to the BC farmer average

Age Category	BMP Adopters	Farmers in BC
18-34	5.7%	9.1%
35-54	45.7%	50.2%
55 and above	48.6%	40.7%

Farming Experience

The average number of years that adopters of the livestock watering BMP have farmed is 23 years with the minimum of 3 years and the maximum of 50 years. Respondents were also asked how many years they have farmed on the property where the BMP was adopted. The average time farmed on the property was 19 years with the minimum of 3 years and the maximum of 40 years.

Ownership

Respondents were asked whether the land where the BMP was adopted was privately owned, leased or provincially owned. 100% of respondents indicated that the land that the BMP was implemented on was privately owned.

[8] Statistics Canada. (2008). Farm operators by age in BC. 2006 Census of Agriculture. Retrieved from http://www40.statcan.gc.ca/l01/cst01/agrc18a-eng.htm

3.1.4 The Livestock Watering BMP in Practice

This section gives a brief overview of the how the Livestock Watering BMP has, in general, been implemented on farms and ranches. The BMP funding may be allocated to pumps, water storage, power set up from existing power lines, waterlines, construction costs and both temporary and permanent livestock exclusion fencing.

Practice Prior to BMP Implementation

- 65% of respondents indicated that they were watering directly from a watercourse with no fencing or restrictions to access for livestock.
- 35% of respondents indicated that they previously watered livestock directly from a watercourse with some restrictions to access (see Figure 6).

Figure 6. Example of a watering system where livestock drink directly from the source but access is restricted by fencing.

Type of BMP Implemented

- 81% of respondents indicated that they installed an off-stream watering system and restricted access to the watercourse/waterbody;
- 17% of respondents indicated that they installed an off-stream watering system and still allow access to the watercourse; and
- 3% indicated that they restricted access to the watercourse but did not install an off-stream waterer.

Type of Watercourse

The majority of respondents indicated that livestock were drinking from natural surface water sources (80%) whereas 20% of respondents watered livestock from constructed sources such as dugouts and ditches.

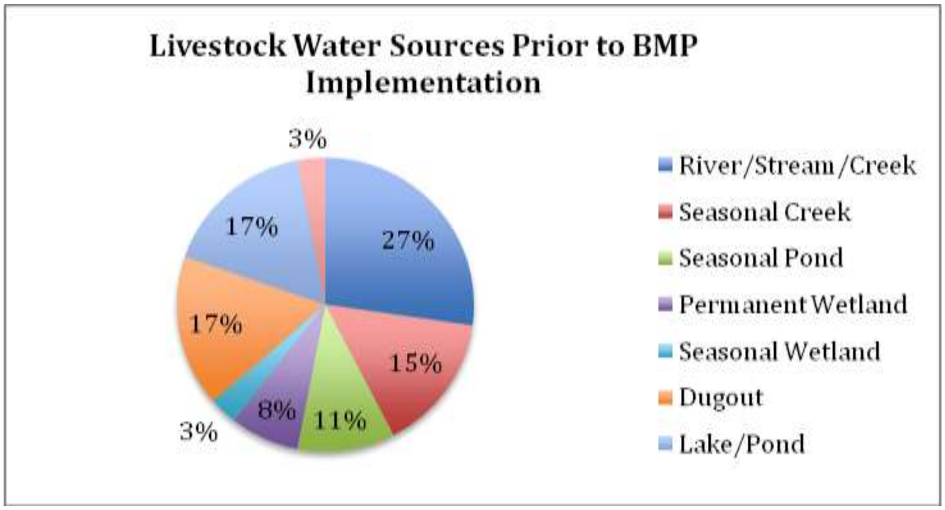

Figure 7. Sources of Livestock Water Prior to BMP Implementation.

The source of water for livestock prior to BMP adoption is synonymous with the type of watercourse and riparian area that the Livestock Watering BMP has reduced or prevented livestock from accessing.

> At a test ranch for off-stream livestock waterers along the South Thompson River, researchers found that livestock who have a choice between an off-stream waterer and unrestricted access to a natural watercourse will choose the off-stream waterer up to 80% of the time. Researchers also learned that cows are opportunistic and will choose the drinking water source that is more readily accessible.
>
> Source: BC Ministry of Agriculture and Lands. (2006). *Livestock Watering Factsheet: Off-stream Watering to Reduce Livestock Use of Watercourses and Riparian Areas.* Retrieved from *www.agf.gov.bc.ca/resmgmt/publist/500Series/590302-3.pdf*

Livestock Access to Watercourse

Note that restricting access to the watercourse/waterbody does not necessarily mean that livestock are prohibited from accessing the watercourse. 30% of respondents indicated that livestock still have access to the watercourse in some way. One respondent indicated that although livestock have a choice between the off-stream waterer and accessing the watercourse, livestock choose the off-stream waterer over 90% of the time.

Interviewees also indicated that although they may have completely restricted livestock access to the watercourse/waterbody, they do allow some controlled grazing to help manage the vegetation within the riparian area.

Use of Livestock Waterers

Respondents were asked to indicate how many animals are typically watered from the BMP that was installed. The livestock watering system BMPs are used for an average of 155 animals per farm.

Table 6. Species and use of Livestock Watering System

Type of Animal Using System	Average # of Animals
Cow/Calf Pairs	68
Cows	65
Horses	4
Other	18
Total # Per Farm	155

Respondents were also asked which area(s) of the farm/ranch the livestock watering system BMP is used. 48.6% of respondents indicated that the Livestock Watering BMP is used in winter feeding/grazing areas. The majority of respondents (77%) indicated that they use the livestock watering system that they installed for more than one season per year.

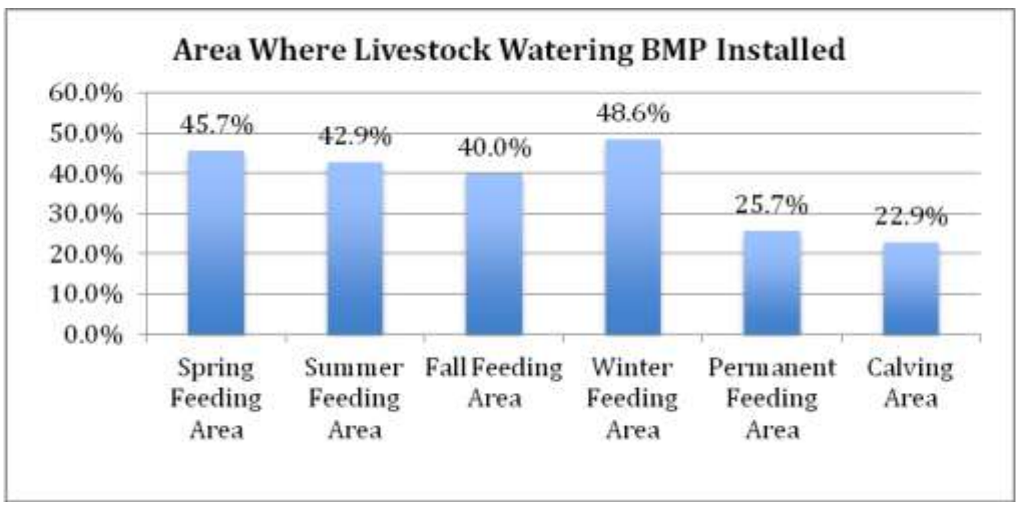

Figure 8. The areas of the farm that the Livestock Watering BMP services.

3.1.5 Environmental Impact of the Livestock Watering BMP

The above sections provide insight into how the livestock watering BMP has been implemented in practice, whereas this section provides insight into the environmental impact that the BMP has had between the time of implementation and 2011 based on data collected through the assessment survey. Note that a baseline level of riparian health was not assessed with the BMP assessment survey[9]. In the

[9] Respondents were asked to indicate whether or not they had completed a Riparian Management Plan and RHA in the survey. Recall bias was evident – most mailout survey respondents indicated that they had done an RHA, whereas most interviewees indicated that that had not. In the authors opinion, most mailout respondents did not understand what was meant by a Riparian Management Plan.

future, establishing a baseline level of riparian health using Riparian Health Assessments (which are required as a precondition to receiving BMP Program funding for riparian projects as of 2010) will allow for the environmental impact of the BMP to be more accurately assessed.

Environmental Indicators for the Livestock Watering BMP

The indicators used to assess the environmental impact of the Livestock Watering BMP were:

- Riparian area conserved due to reduced livestock presence; and
- Change in the health of the riparian vegetation and area.

Both of these indicators are proxies for the actual environmental impact that limiting livestock access to the watercourse and riparian area can have.

Area of Riparian With Reduced Livestock Presence

Respondents were asked a series of questions to determine the length of watercourse/waterbody and total riparian area that the Livestock Watering BMP reduces livestock presence within. The average area of riparian that is conserved[10] on farms that have adopted the Livestock Watering BMP is 1.3 hectares. Provincially, approximately 86 hectares of riparian area have been conserved due to Livestock Watering BMP projects between 2005 and 2010. A total of 72.1 kilometers of shoreline have been conserved due to the adoption of the Livestock Watering BMP.

Table 7. The dimensions of the riparian areas conserved by the adoption of the Livestock Watering BMP.

Riparian Area Dimensions	Value
Average Riparian Area Length (meters)	1045.3
Average Width of Riparian Area (meters)	12.0
Average Riparian Area (hectares)	1.3
Total Length of Watercourse Conserved (km)	72.1
Total Riparian Area Conserved by Adopters (hectares)	86.4

Health of the Riparian Area

The change in the health of the riparian area since installing the Livestock Watering BMP was assessed in two ways. First, respondents were asked a series of survey questions to assess the change in various aspects of vegetative health. Because no baseline information on the health of the riparian area was available, respondents were asked to indicate how riparian vegetation had responded since installing the Livestock Watering BMP. Second, where possible, Riparian Health Assessments were conducted on farms and ranches where the producer was available for interviews.

[10] The term 'conserved' here refers to the reduction of livestock presence within the riparian area and therefore a mitigation of the negative environmental impacts that livestock can have.

The majority of respondents indicated that percent cover on the streambank/shoreline, seedling and sapling recruitment and vegetative percent cover of native vegetation in the riparian area have all increased since implementing the Livestock Watering BMP. Note that the time between BMP adoption and the assessment is not accounted for in the assessment of the change in riparian vegetation.

Table 8. Summary of Responses for Change in Riparian Vegetation

	Streambank/ Shoreline Cover	Seedling/Sapling Recruitment	Native Vegetation Cover
Increased	77.1%	54.8%	63.3%
Decreased	0.0%	0.0%	0.0%
No Change	17.1%	45.2%	36.7%

Respondents were also asked to indicate the current "state" of the riparian vegetation. Because no baseline data was available, the following results indicate a snapshot in time for riparian health:

- Two thirds of respondents indicated that there is currently 90% or more vegetative cover on the streambank/shoreline whereas one third indicated that there is between 75% to 90% cover;
- 44.7% of respondents indicated that over 50% of the vegetation in the riparian area are trees and shrubs, 44.7% indicated that between 25%-50% of the vegetation in the riparian area are trees and shrubs and 10.5% indicated below 25% trees and shrubs.

A total of 7 riparian health assessments (RHA)[11] were conducted at sites where the Livestock Watering BMP was adopted. The average score was 63%. The lowest score was 40% and the highest score 84%. Again because there is no baseline riparian health data, these scores merely provide a snapshot in time.

Figure 9. Picture of a riparian area at a ranch along the Chilako River where a Livestock Watering BMP was installed. The bank lacks stability and in the years since installing the off-stream waterer and livestock exclusion fencing has been washed away during freshet events. This reach scored a 42.1% (only a small portion is shown here). Examples such as this show that sometimes one BMP implemented in isolation will not achieve the environmental objectives it is meant to. This particular rancher indicated that peak flows and risks of flooding have increased due to the pine beetle management harvests in the area.

[11] Riparian Health Assessments were conducted using the Assessment tool in the Riparian Management Field Workbook.

3.1.6 Economic Impact of Livestock Watering BMP Adoption

This section will present the business and operational objectives that motivate farmers and ranchers to adopt the Livestock Watering BMP. To assess the economic impact of the BMP to society a cost-benefit analysis was conducted. The results of the cost-benefit analysis are presented below in this section.

Operational Objectives of the Livestock Watering BMP

Farmers and ranchers generally adopt the Livestock Watering BMP for business or operational reasons with the understanding that this BMP will somehow enhance their farm operation or increase efficiency. In order to explore these reasons further, a series of survey questions aimed at assessing the costs and benefits experienced by farmers and ranchers due to the adoption of the BMP were created. The following sections present the results of these survey questions. Note that many of these costs and benefits are included as values in the cost-benefit analysis.

Livestock Health and Safety

Where livestock health and safety is at risk due to various reasons, the Livestock Watering BMP can help mitigate concerns. Producers were asked if their livestock had experienced a change in health and safety since implementing their BMP. 41% of farmers and ranchers indicated that livestock health had improved where as 56% indicated that there has been no change in livestock health and safety. Of those who indicated that livestock health had improved, the reasons offered included:

- Increased water consumption leading to improved calf weight for beef cows and increased milk production for pasture-raised dairy cows;
- Removed the risk of cows falling through the ice in winter-feeding areas; *Note that one respondent indicated that between 2 – 7 mortalities used to occur annually due to cattle falling through ice;*
- Improved hoof health due to livestock not standing in water for extended periods of time; and
- Improved drinking water quality for livestock.

One respondent indicated that livestock health had declined since installing the Livestock Watering BMP, but offered no explanation.

Year Round Watering

When asked if the Livestock Watering BMP enabled year round watering in the area where it was installed, approximately half of respondents indicated that it did (51%). This result corresponds with the number of farmers and ranchers who indicated that they use the Livestock Watering BMP for livestock watering during the winter. From the interviews and site visits conducted, it became clear that often Livestock Watering BMP adoption was associated with a change in grazing management practices (elaborated upon below). Therefore ranchers may have changed where they over-winter their cattle, enabling year round watering in another location.

Labour Requirements

It may seem intuitive that adoption of the Livestock Watering BMP results in labour savings for the farmer or rancher, as the systems are mostly automatic and low maintenance. However, this is not necessarily the case for every adopter. In some cases the Livestock Watering BMP requires more labour due to the need to maintain the system and check the waterer more frequently than before. In situations where the previous winter watering practices involved breaking ice or hauling water to winter-feeding areas, the Livestock Watering BMP offers labour savings.

Respondents were asked to indicate how many hours of labour annually they spent previously watering livestock, and how many hours annually they spend now watering livestock. 45% of respondents indicated that they experienced an increase in labour requirements due to BMP adoption. Reasons for the increase in labour include:

- Repair and maintenance on the system and fence; and
- Checking to make sure the system is running properly.

55% of respondents indicated that they experienced a decrease in labour requirements due to the Livestock Watering BMP. Reasons for the decrease in labour include:

- No need to break up ice in the wintertime;
- No need to haul water in the wintertime. *Note that one respondent indicated a labour savings of 400 hours per year now that they are not hauling drinking water.*[12]

On average, adopters experienced a 62-hour per year decrease in annual labour requirements due to BMP adoption.

Marketing and Communications

14% of respondents indicated that they use the EFP/BMP Program for marketing purposes. Of those, three indicated that they put the EFP sign on their driveway. One indicated that the EFP label is used on their direct-marketed beef to give their "natural" brand more credibility. One indicated that they have had articles published in provincially distributed magazines about the environmental work they did through the EFP and BMP Programs.

Beneficial Grazing Management Practices

Grazing practices facilitated by the installation of the Livestock Watering BMP were not specifically assessed using the survey that was developed. However, it became evident through the interviews and survey comments that the Livestock Watering BMP is often implemented in conjunction with a change in grazing management practices. One interviewee commented that the Livestock Watering BMP allowed them to initiate a rotational grazing program, resulting in more efficient use of pasture and enabling an expansion of their herd. Another respondent commented that they adopted this BMP to "deliver water to livestock in areas of

[12] Note that this respondent was considered an outlier and therefore was not included in the calculation.

marginal grazing which will allow [them] to improve soils and plant diversity while sustainably increasing [their] carrying capacity".[13]

Livestock Watering BMP Cost-Benefit Analysis

To understand the economic impact of BMP adoption to society, a cost-benefit analysis (CBA) was conducted. See Appendix II for a detailed methodology of the cost-benefit analysis that was conducted. Appendix IV contains a summary of the average costs and benefits that were used to calculate the Livestock Watering BMP CBA. The majority of net present values calculated for the Alternative Livestock Watering Systems BMP are positive which suggests that the benefits of this BMP to society outweigh its costs. The BMP appears to have economic justification. Details of the three net present value calculations are provided below in Tables 9 to 11.

Net Present Value of the Program to Date

Depending on the specification of the discount rate and ecosystem service values, aggregate benefits (i.e. benefits summed across all adopters of the Livestock Watering BMP) ranged from a low of $1,294,910 to a high of $3,782,689, while the costs ranged from a low of $1,123,635 to a high of $1,452,916. The net present values calculated for the program to date were mostly positive. They ranged from a low of -$8,245 in the case of a lower bound ecosystem service value[14] and 8% discount rate to a high of $2,329,773 in the case of an upper bound ecosystem service value and an 8% discount rate. Depending on the discount rate, the net present value of the program to date ranged from $1,160,764 to $1,219,100 when calculated using the point estimate of ecosystem service value.

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[13] Quote was taken directly from a respondent's survey.

[14] A lower bound ecosystem service value is one that estimates the value of benefits from a riparian area most conservatively, whereas the upper bound is a much more liberal estimate of ecosystem service values.

Table 9. Benefit, Cost, and NPV of the Program to Date[a]

Discount Rate	Ecosystem Service Estimates		
	Lower	Upper	Point
Benefit			
0 %	$1,294,910	$3,390,559	$2,342,735
3 %	$1,349,153	$3,532,586	$2,440,869
8 %	$1,444,671	$3,782,689	$2,613,680
Cost			
0 %	$1,123,635	$1,123,635	$1,123,635
3 %	$1,239,031	$1,239,031	$1,239,031
8 %	$1,452,916	$1,452,916	$1,452,916
Net Present Value			
0 %	$171,275	$2,266,924	$1,219,100
3 %	$110,121	$2,293,555	$1,201,838
8 %	-$8,245	$2,329,773	$1,160,764

[a] Values are in 2011 Canadian dollars.

Net Present Value over the Expected Life of the Program

Depending on the specification of the discount rate and ecosystem service values aggregate benefits ranged from a low of $4,257,538 to a high of $14,996,704, while the costs ranged from a low of $1,321,714 to a high of $1,578,615. The net present values calculated for the program over its expected lifetime were all positive. They ranged from a low of $2,678,923 in the case of a lower bound ecosystem service value and 8% discount rate to a high of $13,674,990 in the case of an upper bound ecosystem service value and a 0% discount rate. Depending on the discount rate, the net present value over the program's expected life ranged from $6,124,067 to $9,040,382 when calculated using the point estimate of ecosystem service value.

Table 10. Benefit, Cost, and NPV over the Expected Life of the Program[a]

Discount Rate	Ecosystem Service Estimates		
	Lower	Upper	Point
Benefit			
0 %	$5,727,488	$14,996,704	$10,362,096
3 %	$5,041,475	$13,200,466	$9,120,970
8 %	$4,257,538	$11,147,826	$7,702,682
Cost			
0 %	$1,321,714	$1,321,714	$1,321,714
3 %	$1,404,031	$1,404,031	$1,404,031
8 %	$1,578,615	$1,578,615	$1,578,615
Net Present Value			
0 %	$4,405,774	$13,674,990	$9,040,382
3 %	$3,637,444	$11,796,435	$7,716,939
8 %	$2,678,923	$9,569,210	$6,124,067

[a] Values are in 2011 Canadian dollars.

Net Present Value of Adding one Farmer in 2011
Depending on the specification of the discount rate and ecosystem service values, aggregate benefits ranged from a low of $47,366 to a high of $217,344, while the costs ranged from a low of $18,086 to a high of $21,628. The net present values calculated for adding an agricultural producer today were all positive. They ranged from a low of $29,804 in the case of a lower bound ecosystem service value and an 8% discount rate to a high of $198,188 in the case of an upper bound ecosystem service value and a 0% discount rate. Depending on the discount rate, the net present value of adding an agricultural producer to the program today ranged from $68,132 to $131,020 when calculated using the point estimate of ecosystem service value.

Table 11. Benefit, Cost, and NPV of Adding One Farmer to the Program in 2011[a]

Discount Rate	Ecosystem Service Estimates		
	Lower	Upper	Point
Benefit			
0 %	$83,007	$217,344	$150,175
3 %	$66,062	$172,976	$119,519
8 %	$47,366	$124,023	$85,695
Cost			
0 %	$19,155	$19,155	$19,155
3 %	$18,398	$18,398	$18,398
8 %	$17,563	$17,563	$17,563
Net Present Value			
0 %	$63,852	$198,188	$131,020
3 %	$47,664	$154,577	$101,121
8 %	$29,804	$106,461	$68,132

[a] Values are in 2011 Canadian dollars.

3.1.7 Social and Motivating Factors of BMP Adoption

This section will present the results of a series of questions about various personal and social aspects of BMP adoption to try to understand the following:

- The personal and business motivations behind the Livestock Watering BMP adoption (some of which have been discussed above);
- The adopter's perception of the benefits to society that the BMP provides; and
- The barriers to adoption of the Livestock Watering BMP by other farmers or ranchers.

Motivating Factors for Adoption of the Livestock Watering BMP

Respondents were asked to rate on a scale of 1 to 5 (not important to very important), the reasons why they chose to adopt the Livestock Watering BMP from a list of possible motivations. Interestingly, the factors that mostly relate to farm or ranch operations were rated lower than those related to environmental or stewardship factors. Limiting the farm's impact on the environment was the highest rated motivating factor, scoring a 4.6. The second highest rated motivating factor was a desire to improve the long-term sustainability of the farm operation. This motivating factor could encompass both business (i.e. financial) considerations as well as social and environmental factors.

Table 12. Average Rating of Motivating Factors for BMP Adoption Organized from Highest to Lowest.

Motivation	Score
Limit the farm's impact on the environment	4.6
Improve the long-term sustainability of the operation	4.4
Demonstrate stewardship	4.3
Contribute to a positive industry image	3.3
Secure a reliable source of water for livestock	3.2
Improve livestock health	3.2
Improve the profitability of the operation	2.9
Reduce the need for riparian fencing	2.3
Avoid regulatory action	2.2

Respondents were also asked to indicate any other motivating factors in a comment line. Responses included:

- Labour savings; and
- Public perception and awareness of cows in the creek.

Several respondents re-iterated that their primary motivating factors were stewardship-based including desires to create natural and riparian habitats on their properties and that adopting this BMP is the “environmentally right thing to do”.

Social Benefits Provided by the BMP

Respondents were asked whether or not they feel that their Livestock Watering BMP provides a benefit to society. 86% of respondents indicated that they feel the BMP provides a benefit. A summary of the benefits to society provided by the BMP include:

- Improved water quality for other users of the water source;
- Improvements to wildlife and fish;
- Stewardship and better/more ethical treatment of land;
- Improved livestock health meaning better food for people;
- Improves tourism values of area; and
- Providing environmental goods and services.

Barriers to Adoption of the Livestock Watering BMP

Similar to the motivation question described above, respondents were asked to rate on a scale from 1 to 5 (not a barrier to a large barrier) a set of barriers to Livestock Watering BMP adoption. The exact wording of the question was “In your opinion, what are the barriers to adoption of the Livestock Watering BMP by other producers in your industry”. Not surprisingly, cost was listed the biggest barrier to BMP adoption with a score of 3.8. The next highest barriers included a lack of awareness of environmental impacts resulting from farm practices and a lack of understanding about how the BMP will benefit their operation (both scored a 3.1).

Table 13. Barriers to the Livestock Watering BMP Adoption

Barriers	Score
Costs associated with BMP adoption	3.8
A lack of awareness of risks to the environment from farm practices	3.1
A lack of understanding about *how* the BMP will benefit their operation	3.1
Barriers to accessing funding through the BMP Program	3.0
A lack of time or labour	3.0
A lack of understanding about *which* BMP will benefit their operation	2.7
No succession plan for their farm	2.6
A lack of support from public agencies	2.4
A lack of industry pressure	2.3
Logistically not feasible	2.1
Other environmental priorities take precedent	2.0
A lack of public pressure	2.0

Respondents were also asked to indicate any other barriers to adoption that they felt weren't included in the list. The barriers indicated (or reiterated in some cases) by respondents include:

- The age of the farming population/lack of succession;
- A lack of education and awareness amongst farmers;
- High costs of projects with too low of a category cap; and
- Red tape associated with the EFP/BMP program.

3.1.8 Livestock Watering BMP SWOT Analysis

A brief SWOT (Strength, Weaknesses, Opportunities, Threats) Analysis is presented in this section to organize some of the main findings of the BMP assessment as well as present anecdotal information that may not be presented in the report for the Livestock Watering BMP above. Note that this is only the preliminary step in a SWOT analysis and further steps including a detailed analysis and development of an action plan are often conducted in order to direct policy.

Strengths

- In most cases, the BMP has positive net environmental results as indicated both by the area of riparian conserved as well as improvements in riparian health.
- In some cases the BMP has had a positive effect in the overall health of livestock (to varying degrees). The BMP can eliminate the risk of cattle breaking through ice in the winter months (drastically reducing the risk of mortality) as well as promote overall health by promoting increased water consumption.

- The BMP facilitates beneficial grazing management practices (rotational grazing, swath grazing) resulting in it being taken up when a rancher decides to change their grazing practices.

Weaknesses

- The current uptake of the BMP has been relatively low compared to the population of ranchers in BC. There are likely multiple reasons for this including:
  - The cost of adopting the BMP (especially for large operations)
  - Category caps on riparian categories resulting in large operations capping out. One respondent recommended to "have farm caps, not category caps. We would do lots of other riparian work on our farm that would be extremely beneficial but we tapped out [of funds]."
  - A lack of motivation to change a method of watering that is generally "working". As a respondent indicated, "If you have water, you're not going to put in any waterer".
  - Time constraints of getting the work finished by the cut-off time, especially in Northern BC where the weather is a barrier.

Opportunities

- The now required Riparian Management Planning process will help to prioritize riparian BMPs to minimize risk of livestock watering BMPs, fencing, and riparian plantings being washed away in flooding events.
- The positive feedback from producers could help to "sell" the BMP based on its operational and environmental merits.
- Other programs, such BC Cattlemen's Farmland – Riparian Interface Stewardship Program (FRISP), could and are promoting the uptake of this BMP.

Threats

- Environmental change, such as flooding events and climate change, can impact the effectiveness of the BMP performance beyond the program or adopters control.
- As several respondents noted, the aging population of farmers is a barrier to the adoption of this BMP.

3.1.9 Conclusions and Recommendations for the Livestock Watering BMP

This section provides an overview of the main conclusions derived from the BMP assessment. Recommendations will also be provided where appropriate. Note that these conclusions and recommendations are based on the authors' opinions and reflect both qualitative and quantitative information collected during the assessment.

Is the BMP having the impact it was designed to have?

To recap, the Livestock Watering BMP is intended to address environmental risks associated with livestock drinking directly from surface water sources. These risks include contaminating water with urine and manure, spawning bed trampling, streambank trampling and removal of riparian vegetation through trampling and grazing.

In the authors' opinion the livestock watering BMP is generally achieving the intended impacts that it was designed to have based on the environmental indicators used to assess the environmental impacts as well as the site visits and anecdotal information provided by interviewees. In general, respondents indicated that riparian vegetation had improved since installing the BMP and livestock are either now restricted from accessing surface water or are choosing to drink from off-stream waterers, reducing the frequency of livestock drinking from surface water. Over the lifetime of the Livestock Watering BMP, (assumed to be 15 years for the purposes of this assessment project), the environmental outcomes related to the BMP will likely change as the riparian area adjusts to less livestock presence.

In some cases, external environmental pressures such as freshet events and climate change prohibit the BMP from realizing the intended effects. *To minimize the risk of such events, it is recommended that more guidance in risk assessment, BMP design and prioritizing BMPs be provided to adopters when choosing which riparian BMPs to adopt (including the Livestock Watering BMP).*

Does the BMP meet the expectations of adopters?

Producers generally are satisfied with the impact of the Livestock Watering BMP on their operation and in the authors' opinion the BMP is having the intended impact according to adopters. As described in section 3.1.6 there are several operational motivations leading to adoption of the BMP in addition to the environmental benefits provided by the BMP. These are:

- Improved grazing management;
- Improved livestock health and safety; and
- Labour savings associated with chopping ice and hauling water in the winter.

Is there justification for continued support of the BMP?

Based on the following criteria the authors recommend *continued support* of the Livestock Watering BMP. The criteria used to come to this conclusion include:

Does the BMP mitigate the environmental risk(s) it was intended to?

- Based on the environmental indicators described in this report, the BMP generally has a positive impact on the riparian area.

Does the BMP provide the expected benefit to the adopter?

- Based on the results of the BMP assessment survey as well as anecdotal information, the BMP generally has a positive impact on the farm operations where the BMP has been adopted.

Does the BMP provide a benefit to society?

- The BMP has a positive Net Present Value indicating that the BMP provides a benefit to society.

3.2 Riparian Buffer Establishment (Practice Code 1002)

The Riparian Buffer Establishment BMP (herin referred to as the Riparian Buffer BMP) is intended to address a variety of environmental risks associated with a lack of or no riparian buffer area between farming operations and watercourses and/or waterbodies. These risks include impacts of farming practices to water quality and quantity, soil erosion and wildlife (including flora and fauna).

The benefits of riparian buffer establishment include: a filtering effect for contaminants, nutrients and sediment particles that could potentially enter watercourses; providing habitat for wildlife; creating primary productivity and associated CO_2 sequestration; the potential to generate revenue from agro-forestry products; and enhancing the aesthetic value of the landscape and farm.

The BMP funding may be allocated towards pre-planting site preparation, weed control, irrigation, temporary fencing to exclude livestock and/or wildlife, plant purchase and planting costs for grasses, forbes, shrubs and trees and maintenance of those plants for one year post-planting as well as consultant services for riparian buffer planning.

3.2.1 Environmental Objectives of the Riparian Buffer BMP

The specific environmental objectives that the Riparian Buffer BMP is intended to address include:

- Providing erosion control for streambanks and shorelines;
- Invasive plant management by promoting the establishment of native plant species;
- Providing a filtering structure to mitigate the flow of nutrients, pesticides or sediments into watercourses and/or waterbodies, mitigating the risk of causing eutrophic conditions;
- Promoting water infiltration;
- Enhancing biodiversity and providing habitat for flora and fauna; and
- Carbon sequestration (as long as the total biomass is held constant).

3.2.2 Survey Response

A total of 10 interviews and site visits were conducted and 6 surveys were returned totaling 16 respondents. A total of 41 surveys were administered and the response rate was 39%.

3.2.3 Riparian Buffer BMP Provincial Statistics

This section will report the BMP adoption and distribution statistics from the period between 2005 and 2010. The data sources for this section include the ARDCorp program files as well as data collected through the BMP assessment survey.

Cost-Share, Cap Structure and Average BMP Project Cost

The Riparian Buffer BMP was cost-shared at 50% of total eligible costs up to $25,000 (note that the current cost-share level is 60% through the BMP Program). Between May 2006 and March 2008, Ducks Unlimited topped up the amount of money available to adopters by providing 10% of the total eligible cost, bringing the cost-share level up to 60%. The average cost of a Riparian Buffer BMP project, taking into account only the eligible costs is $9898.

Distribution of Adoption

A total of 42 Riparian Buffer BMP projects have occurred across BC between 2005 and 2010 (approximately 1% of the total farms in BC reporting watercourses on their properties).[15]

Table 14. Distribution of the Riparian Buffer BMP by Regional District.

Regional District	# BMPs Adopted
Alberni-Clayoquot	1
Bulkley-Valley	3
Capital Regional District	1
Central Kootenay	5
Columbia-Shuswap	10
Comox Valley	1
Cowichan Valley	1
Fraser Valley	4
Metro Vancouver	3
Nanaimo	4
North Okanagan	3
Okanagan Similkameen	3
Thompson-Nicola	3

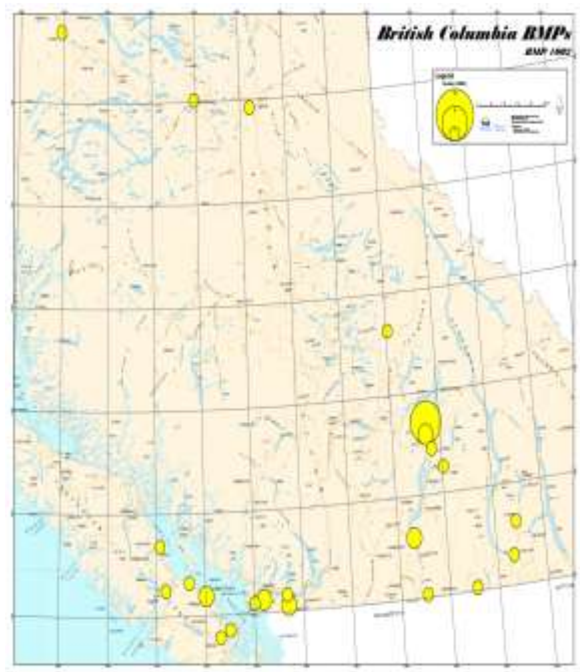

Figure 10. Geographic Distribution of Riparian Buffer BMP Adoption Between 2005 and 2010

By Commodity

The Riparian Buffer BMP has been adopted by a range of commodities, with the largest group being ranchers (44%). The next largest groups of adopters include the dairy industry (8%) and forage producers (8%). A summary of all adopters by commodity is displayed in Figure 11. One of the survey respondents indicated that they are certified organic.

[15] A total of 3835 farms in BC (approximately half of all farms) reported waterways in the 2006 FEMS survey. Agriculture and Agrifood Canada. (2006). Farm Environmental Management Survey Data Tables.

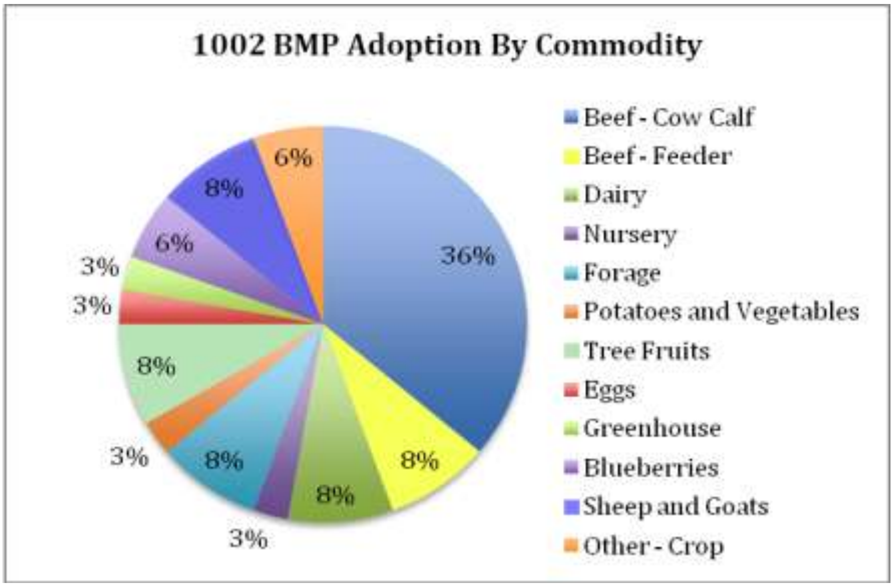

Figure 11. Riparian Buffer BMP adoption between 2005 and 2010 by commodity.

Adoption Over Time

Adoption of the Riparian Buffer BMP was at its highest in 2008 when 54% of all adopters completed BMP projects. In other years, BMP adoption has been relatively low with between 1 and 6 farms per year adopting this BMP. The reasons for the differences in adoption rates by year were not explicitly assessed in this study, however, the decline in adoption may be explained by a combination of these reasons:

- The BMP has captured most of the likely "early adopters" and other potential adopters are not being captured by the program;
- A lack of awareness of the EFP/BMP program since the restructuring of the program administration in 2009;
- Decreased total amount of funding available when Ducks Unlimited top-up funding ended in 2008;
- The "risks" and "costs" associated with the adoption of this BMP are not accurately reflected in the level of cost-share/cap available;
- Increased scrutiny of BMP Projects after the change in administrative structure in 2009; and
- The challenges and threats associated with adoption of this BMP are acting as a barrier to adoption by producers across BC (see section 3.2.8).

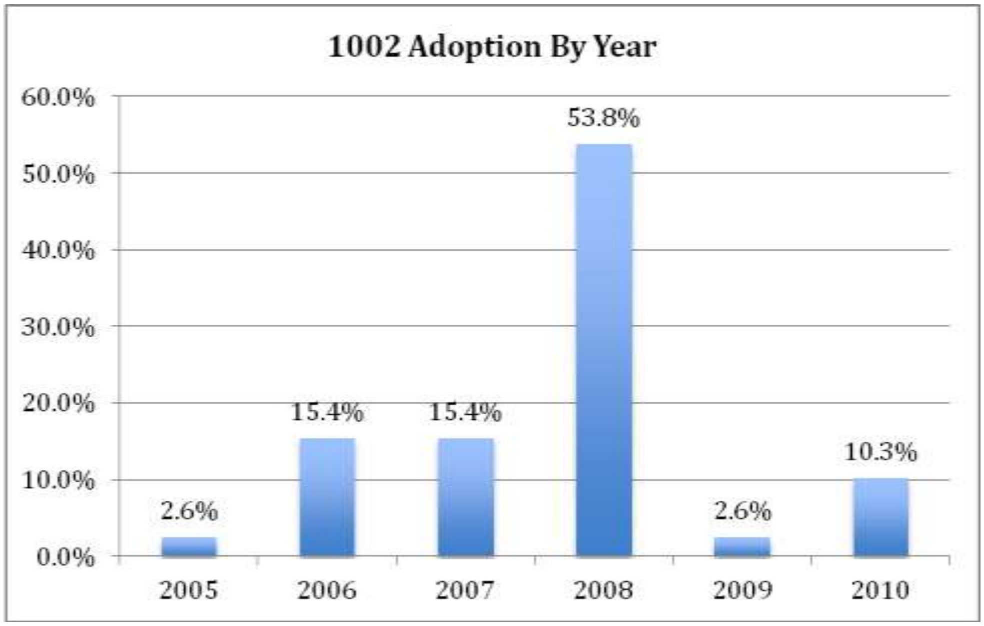

Figure 12. Temporal distribution of Riparian Buffer BMP Adoption

Riparian Buffer BMP Adopter Characteristics

Understanding the characteristics of the average Riparian Buffer BMP adopter compared to the average population of farmers across BC will provide insight into the unique characteristics of the farms who choose to adopt this BMP. The following farm characteristics and socio-demographic information are compared to Statistics Canada 2006 Census of Agriculture information where possible. [16]

Characteristics of the Average Farm Adopting the Riparian Buffer BMP

The average size of farm that has adopted the Riparian Buffer BMP is 73 hectares. Each farm has an average of 28 livestock[17]. Table 1 contains the descriptive statistics for the size of farm and number of livestock.

Table 15. Descriptive Statistics of Farms that Have Adopted the Riparian Buffer BMP.

	# Livestock	Farm Size (ha)
Average	28	73.4
Median	5	15.4
Min	0	0.6
Max	6000	809.4

Farm Gate Sales

Farm gate sales of the Riparian Buffer BMP adopters compared to the farm gate sales for farmers across BC reveal that farms that adopt the BMP are generally in

[16] Statistics Canada. (2006). Census of agriculture: farm data and operator tables. Retrieved from http://www.statcan.gc.ca/pub/95-629-x/2007000/4182411-eng.htm#gfr on January 15, 2012.
[17] Note that poultry were not included in this calculation as they skew the average. Also, a large cattle operation (6000 head) was not included in the calculation as it was an outlier.

a mid-range farm gate sales bracket. There are fewer farms with low farm gate sales adopting this BMP, compared to the provincial population of farms.

Table 16. Farm Gates Sales of Riparian Buffer BMP Adopters compared to the averages for BC Farmers.

Farm Gate Sales	% of Survey Respondents in 2010	% of BC Farmers in 2006 Census
Less than $10,000	15.4%	47.7%
$10,000-$24,999	15.4%	16.1%
$25,000-$49,999	38.5%	10.3%
$50,000-$99,999	7.7%	8.0%
$100,000-$249,999	0.0%	7.7%
$250,000 and over	23.1%	10.2%

Age of Adopters

The average age of the Riparian Buffer BMP adopters is higher than the BC average for farmers reported in the 2006 Census of Agriculture[18]. 68.8% of BMP adopters fall into the age category of 55 and above compared to 40.7% falling into 55 and above across BC.

Table 17. Age of Riparian Buffer BMP adopters compared to age distribution of farmers across BC.

Age Category	Percentage of BMP Adopters	Farmers in BC
18-34	0.0%	9.1%
35-54	31.3%	50.2%
55 and above	68.8%	40.7%

Farming Experience

Respondents were asked to indicate how many years they have farmed as a proxy for how much experience they have with farming. The average number of years that adopters of the Riparian Buffer BMP have farmed is 18 years with a minimum of 4 and a maximum of 37. Respondents were also asked how many years they have farmed on the property where the BMP was adopted. The average time farmed on the property was 13 years with a minimum of 4 and a maximum of 30.

Ownership

Respondents were asked whether the land where the BMP was adopted was privately owned, leased or provincially owned. 100% of respondents indicated that the land that the BMP was implemented on was privately owned.

3.2.4 Riparian Buffer BMP in Practice

This section gives a brief overview of the how the Riparian Buffer BMP has, in general, been implemented in practice. The BMP funding may be allocated to:

[18] Statistics Canada. (2008). Farm operators by age in BC. 2006 Census of Agriculture. Retrieved from http://www40.statcan.gc.ca/l01/cst01/agrc18a-eng.htm

- Pre-planting site preparation;
- Weed control;
- Irrigation;
- Temporary fencing to exclude livestock and/or wildlife;
- Plant purchase and planting costs for grasses, forbes, shrubs and trees and maintenance of those plants for one year post-planting; and
- Consultant services for riparian buffer planning.

Riparian Health Prior to BMP Implementation

Respondents were asked to indicate the characteristics of the riparian area prior to implementing the Riparian Buffer BMP. A series of indicator-based questions were posed to the respondents to assess the "health" of the riparian area. This was done in order to establish a proxy for a baseline level of riparian health to better understand the level of impact that adoption of the BMP has had. Respondents were asked to indicate if their riparian area contained the following characteristics prior to implementing their BMP:

- The banks of the waterbody/watercourse showed signs of damage (e.g. exposed soil, bank slumping and/or livestock hoof action);
- The area had greater than 15% exposed soil;
- The area had few trees and shrubs present (less than 15% of the total plant cover);
- The area had non-native plant species present (i.e. Canada thistle, blackberries and Kentucky blue grass); and
- The area showed signs of livestock grazing.

Responses indicated that:

- 88% of streambanks/shorelines showed signs of damage prior to BMP adoption;
- 56% of riparian areas had greater than 15% exposed soil;
- 38% of riparian areas had few trees and shrubs present;
- 50% of riparian areas had non-native plant species present; and
- 25% of riparian areas showed signs of livestock grazing.

Respondents also provided comments about their riparian area prior to BMP adoption. Three respondents indicated that there were problems with streambanks being washed away prior to BMP adoption. One respondent indicated that they had lost approximately .4 hectares of land to streambank erosion.

In the project teams' opinion, this was a rudimentary method for determining a baseline level of riparian health. The results here are not comparable to Riparian Health Assessment scores, where a trained assessor scores the riparian health on a set of weighted indicators. Note that the requirement for Riparian Management Plans as a pre-condition to receiving BMP funding was only implemented in 2010; therefore, Riparian Health Assessment scores were not available as a baseline. In the future, the Riparian Health Assessment score for the riparian area prior to BMP implementation could be used as a standardized proxy for the baseline level of riparian health.

Type Riparian BMP Implemented

Respondents were asked which features of the Riparian Buffer BMP were implemented.

- 81% indicated that they planted trees, shrubs grasses and/or forbes;
- 62% indicated that they did site preparation activities;
- 56% indicated that they installed a temporary fence to protect the riparian area;
- 43% indicated that they hired a professional consultant to help with the riparian restoration/enhancement;
- 38% indicated that they implemented weed and vegetation control; and
- 25% indicated that they implemented irrigation for the riparian area.

Type of Watercourse

Respondents were asked to indicate which type of watercourse or waterbody the riparian buffer was installed adjacent to. The majority of respondents (56%) indicated that they installed the buffer next to a permanent stream, river or creek. Respondents from the Lower Mainland indicated that they installed the riparian buffer next to a constructed ditch. Figure 13 provides more detail on the type of watercourse adjacent to the enhanced riparian areas.

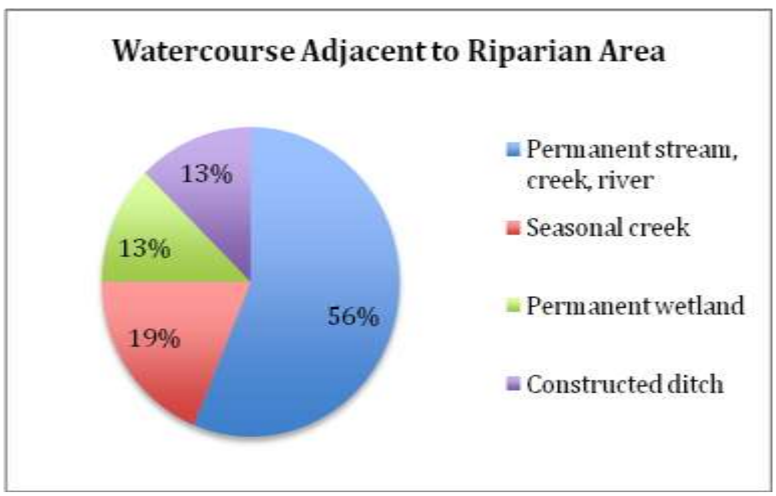

Figure 13. The type of watercourse adjacent to the riparian area that was enhanced.

Area Adjacent to Riparian Area

Respondents were asked to indicate what the area adjacent to the riparian area that was enhanced is used for. 44% of respondents indicated that the riparian BMP was implemented next to a grazing area and an equal amount indicated that the BMP was implemented next to cropland. Other land uses included a large greenhouse and poultry barns.

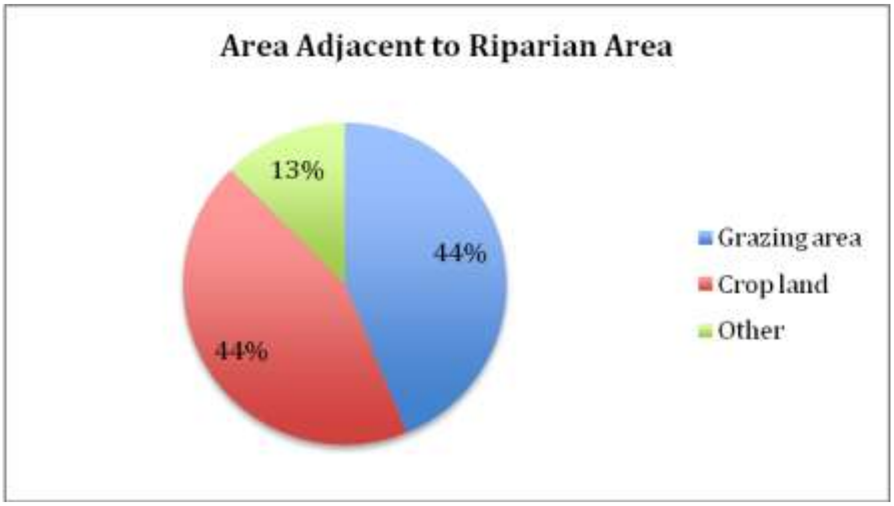

Figure 14. The area adjacent to the riparian area that was conserved

Livestock Access to Watercourse

Respondents were asked to indicate if livestock had access to the riparian area before the BMP was implemented. All of the farms that have livestock indicated that livestock had access to the riparian area prior to BMP adoption. Of those seven respondents, two still allow a small amount livestock to access the riparian area (6.3 meters on average). Three adopters indicated that they allow flash grazing of the riparian area and also use the riparian area to extend their grazing season.

Registered Covenants for Riparian Areas

Respondents were asked to indicate whether or not the riparian area that they enhanced is protected by restrictive covenant. This question was asked as an indicator of the potential longevity of the benefits of the Riparian Buffer BMP. 25% of respondents indicated that they had some sort of restrictive covenant to protect the riparian area. The types of covenants include a building set back distance (5 meters and 60 meters), an agreement with Ducks Unlimited as well as a contract and security deposit with the local government.

3.2.5 Environmental Impact of the Riparian Buffer BMP

The above sections provide insight into how the Riparian Buffer BMP has been implemented in practice, whereas this section provides insight into the environmental impact that the BMP has had between 2005 and 2010 based on data collected through the assessment survey.

Environmental Indicators for the Riparian Buffer BMP

The indicators used to assess the environmental impact of the Riparian Buffer BMP were:

- Riparian area conserved due to reduced livestock presence; and
- Change in the health of the riparian vegetation and area.

Both of these indicators are proxies for the actual environmental impact that creating a riparian buffer area can have. Note that these are the same indicators used to assess the environmental impact of the Livestock Watering BMP except for the median area restored was calculated instead of the average area.[19]

Area of Riparian Enhanced by the Riparian Buffer BMP

Respondents were asked a series of questions to determine the total riparian area that the Riparian Buffer BMP enhances. The median area of riparian that is enhanced on farms that have adopted the Riparian Buffer BMP is .30 hectares. Provincially, approximately 12.7 hectares of riparian area have been conserved due to Riparian Buffer BMP projects between 2005 and 2010. Approximately 15.9 kilometers of shoreline have been conserved due to the adoption of the Riparian Buffer BMP in BC.

Table 18. The dimensions of the riparian areas enhanced by the adoption of the Riparian Buffer BMP.

Riparian Area Dimensions	Value
Median Riparian Length (meters)	378.6
Median Width of Riparian Area (meters)	8.0
Median Riparian Area (hectares)	0.30
Total Length of Watercourse Conserved (km)	**15.9**
Total Riparian Area Conserved by Adopters (hectares)	**12.7**

Health of the Riparian Area

The change in the health of the riparian area since installing the Riparian Buffer BMP was assessed in two ways. First, respondents were asked a series of survey questions to assess the change in various aspects of vegetative health. Because no baseline information on the health of the riparian area was available, respondents were asked to indicate how riparian vegetation has responded since implementing the Riparian Buffer BMP. Second, where possible, Riparian Health Assessments were conducted on farms and ranches that made themselves available for interviews.

Overall, 100% of respondents indicated that the vegetative cover along the streambanks and shoreline had increased since the Riparian Buffer BMP was adopted. The majority of respondents indicated that both seedling and sapling recruitment and native vegetation cover had increased since adopting the BMP. Note that the time between BMP adoption and the assessment is not accounted for in the assessment of the change in riparian vegetation.

[19] The median values were calculated rather than average values in order to more accurately reflect the critical areas that the Riparian Buffer BMP targets that are not necessarily representative of the entire reach of a watercourse on a farm or ranch.

Table 19. Summary of responses for the change in riparian vegetation after the Riparian Buffer BMP was adopted

	Streambank/ Shoreline Cover	Seedling/Sapling Recruitment	Native Vegetation Cover
Increased	100.0%	73.3%	75.0%
Decreased	0.0%	0.0%	8.3%
No Change	0.0%	26.7%	16.7%

Respondents were also asked to indicate the current "state" of the riparian vegetation. 67% of respondents indicated that the streambank and shoreline has 90% or more plant cover. 48% of respondents indicated that their riparian area had more than 50% vegetative cover in trees and shrubs. Table 20 indicates the current level of riparian vegetation. Because no baseline data is available, the results presented in this report indicate a snapshot in time for riparian health. It is likely that in some cases, the level of riparian vegetation will increase over time as the riparian vegetation becomes more established.

Table 20. Current level of riparian vegetation in enhanced areas

Plant Cover on Streambank/Shoreline	
90% or More	66.7%
75% to 90%	13.3%
75% or less	20.0%
Percent Cover of Trees and Shrubs	
More than 50%	46.7%
25% - 50%	20.0%
Less than 25%	33.3%

A total of 10 riparian health assessments (RHA)[20] were conducted at sites where the Riparian Buffer BMP was adopted. The average score was 69%. The lowest score was 40% and the highest RHA score 87%. Again because there is no baseline riparian health data, these scores merely provide a snapshot in time.

[20] Riparian Health Assessments were conducted using the assessment tool in the Riparian Management Field Workbook.

Figure 15. Example of a Riparian Buffer BMP along the Salmon River in the Thompson-Nicola region where rapid streambank erosion was occurring prior to planting willows and other vegetation along the banks. The producer indicated that the planting, along with structural reinforcement of the streambank has greatly improved the erosion problem. This particular riparian area scored a 75%.

Figure 16. Example of a Riparian Buffer BMP along a constructed ditch that drains into a fish-bearing stream. The planted riparian vegetation is healthy; however, the riparian buffer was planned with only 1.5 m from the top of bank to edge of buffers. Two heavily used roadways flank each side of the buffer. This particular riparian area scored a 40%.

Wildlife Values Provided by the Riparian Buffer BMP

Respondents were asked to indicate the wildlife species that they have noticed living in their riparian areas. This question was asked as a proxy for the actual biodiversity values provided by the Riparian Buffer BMP. On average the riparian buffers support:

- 3 species of birds;
- 1 species of fish;
- 3 species of mammals; and
- 5 species of amphibians.

Although this is a rough indicator of biodiversity that only takes into account fauna, and is merely a baseline as no other data has been collected to date, it is important to note the broader impact of the Riparian Buffer BMP. Interestingly, this question had a 100% response rate indicating that these farmers and ranchers are “in tune” with the biodiversity values of their riparian area.

Figure 17. Kokanee running downstream from a Riparian Buffer BMP near Adams Lake.

3.2.6 Economic Impact of Riparian Buffer BMP Adoption

This section will present the operational objectives that motivate farmers and ranchers to adopt the Riparian Buffer BMP as well as the costs that they incur when doing so. To assess the economic impact of the BMP to society a cost-benefit analysis was conducted. The results of the cost-benefit analysis are presented below in this section.

Business/Operational Objectives of the Riparian Buffer BMP

The specific business reasons that Riparian Buffer BMP adopters consider when deciding to implement the BMP are not straightforward. In order to explore these reasons further, a series of survey questions aimed at assessing the costs and benefits experienced by farmers and ranchers due to the adoption of the BMP were created. The following sections present the results of these survey questions. Note that many of these costs and benefits are included as values in the cost-benefit analyses presented below.

Mitigation of Streambank Erosion/Flooding

Producers weren't specifically asked if this was the reason that they adopted the Riparian Buffer BMP; however, several respondents (25%) indicated that this was their primary reason for adopting this particular BMP. In a couple of cases this BMP was adopted in addition to the Livestock Watering BMP and other BMPs to create a comprehensive riparian management strategy to manage erosion and further damage to the riparian area. One respondent indicated that they had already lost an acre of land to erosion.

It is hard to put a price on the loss of farmland, as it is something that is irreversible in the timeframe of a human life. However, there is a cost associated with erosion to either the farmer or rancher as well as to society that should be noted here. In future studies it may be appropriate to try to quantify the benefits of streambank erosion mitigation.

Extension of the Grazing Season

Respondents were asked if the implementation of the Riparian Buffer BMP allowed them to extend their grazing season. Three respondents indicated that it did for an average of 7 weeks per year. Based on an average cost of feeding 1 cow for 1 week of $8.41[21] the average benefit for each livestock farmer who extends his or her grazing season using the Riparian Buffer BMP is $118.84 annually.

Enhancing Public Perception and Tourism Value

Two respondents indicated that their main reasons for adopting the Riparian Buffer BMP was to either enhance the public perception of their farm or to increase the aesthetic value of their farm property for their agri-tourism operation. Both respondents indicated that this particular BMP was adopted as a package with other BMPs such as Livestock Watering and that they wouldn't have completed this BMP in isolation for these purposes alone.

Marketing

31% of respondents indicated that they use the EFP and BMP Programs for marketing purposes. Of those, two indicated that they put the EFP sign on their driveway for their direct market stands. Three indicated that the EFP label is used to enhance their brand via their website, brochures and/or at the farmers market.

Labour Requirements

Respondents were asked to indicate how many hours of labour annually they spent maintaining the riparian area that was enhanced previously, and how many hours annually they spend maintaining it now. 36% of respondents indicated that they experienced an increase in labour requirements due to BMP adoption. Reasons for the increase in labour include:

- Fixing the temporary fencing;
- Maintaining undesirable vegetation by mowing and weeding.

21% of respondents indicated that they experienced a decrease in labour requirements since adopting the Riparian Buffer BMP. Reasons for the decrease in labour include:

- Less labour sandbagging;
- No need to move fencing during freshet anymore.

43% of respondents either experienced no change in labour requirements or do not spend any time maintaining their riparian area. On average, adopters experienced a 16-hour per year increase in annual labour requirements due to BMP adoption.

Respondents were also asked in a separate question if they maintain their riparian area by removing unwanted vegetation. 73% of respondents indicated that they do perform some maintenance work on their riparian area annually.

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[21] The cost of feeding one cow was calculated assuming 1 cow eats 3.5 tons of feed/year and the cost of feed is $125/ton. Based on www.agf.gov.bc.ca/busmgmt/budgets/.../2007hay_kamloops.pdf and http://www.agf.gov.bc.ca/busmgmt/budgets/beef.htm

Riparian Buffer BMP Cost-Benefit Analysis

To understand the economic impact of BMP adoption to society, a cost-benefit analysis was conducted. See Appendix II for a detailed methodology of the cost-benefit analysis that was conducted. See Appendix IV for a summary of the costs and benefits used in the Riparian Buffer CBA. Though all of the net present values calculated for the Riparian Area Management BMP using low monetary values are negative, the remaining estimates are positive. This analysis provides evidence that the benefits of this BMP are larger than the costs. The Riparian Area Management BMP appears to have economic justification.

Inestimable Costs of the Riparian Area Management BMP

Several costs were not able to be included in the cost-benefit analysis for Riparian Area Management as they could not be estimated within the scope of this project, and may not be a factor for all farms that adopt the Riparian Management BMP. These costs may also be considered "risks" that producers take on when they restore or enhance riparian areas on their farm. These costs and risks include:

- Potential for increased wildlife interactions or damage in agricultural areas;
- Potential for increased risk of food safety concerns due to increased wildlife/crop interaction;
- An increase in the width of buffer as per pesticide label requirements to buffer for potential drift between crop areas and non-crop areas when spraying pesticides; and
- Federal, provincial or local government regulatory requirements and authorizations directed to restrict activities in and around riparian areas in British Columbia.

Details of the three net present value calculations are provided below in Tables 21 to 23.

Net Present Value of the Program to Date

Depending on the specification of the discount rate and ecosystem service values aggregate benefits ranged from a low of $144,397 to a high of $564,172, while the costs ranged from a low of $599,820 to a high of $742,491. The net present values calculated for the program to date were all negative. They ranged from a low of -$581,912 in the case of a lower bound ecosystem service value and 8% discount rate to a high of -$92,501 in the case of an upper bound ecosystem service value and an 8% discount rate. Depending on the discount rate, the net present value of the program to date ranged from -$380,116 to -$273,961 when calculated using the point estimate of ecosystem service value.

Table 21. Benefit, Cost, and NPV of the Program to Date[a]

Discount Rate	Ecosystem Service Estimates		
	Lower	Upper	Point
Benefit			
0 %	$144,397	$507,319	$325,858
3 %	$150,261	$527,920	$339,091
8 %	$160,579	$564,172	$362,376
Cost			
0 %	$599,820	$599,820	$599,820
3 %	$650,116	$650,116	$650,116
8 %	$742,491	$742,491	$742,491
Net Present Value			
0 %	-$455,422	-$92,501	-$273,961
3 %	-$499,855	-$122,196	-$311,026
8 %	-$581,912	-$178,319	-$380,116

[a] Values are in 2011 Canadian dollars.

Net Present Value over the Expected Life of the Program

Depending on the specification of the discount rate and ecosystem service values aggregate benefits ranged from a low of $606,257 to a high of $3,860,037, while the costs ranged from a low of $1,301,812 to a high of $1,797,431. The net present values calculated for the program over its expected lifetime were mostly positive. They ranged from a low of -$698,755 in the case of a lower bound ecosystem service value and 0% discount rate to a high of $2,062,606 in the case of an upper bound ecosystem service value and a 0% discount rate. Depending on the discount rate, the net present value over the program's expected life ranged from $66,313 to $681,926 when calculated using the point estimate of ecosystem service value.

Table 22. Benefit, Cost, and NPV over the Expected Life of the Program[a]

Discount Rate	Ecosystem Service Estimates		
	Lower	Upper	Point
Benefit			
0 %	$1,098,676	$3,860,037	$2,479,357
3 %	$843,752	$2,964,398	$1,904,075
8 %	$606,257	$2,129,994	$1,368,125
Cost			
0 %	$1,797,431	$1,797,431	$1,797,431
3 %	$1,520,441	$1,520,441	$1,520,441
8 %	$1,301,812	$1,301,812	$1,301,812
Net Present Value			
0 %	-$698,755	$2,062,606	$681,926
3 %	-$676,689	$1,443,957	$383,634
8 %	-$695,556	$828,182	$66,313

[a] Values are in 2011 Canadian dollars.

Net Present Value of Adding one Farmer in 2011

Depending on the specification of the discount rate and ecosystem service values aggregate benefits ranged from a low of $11,170 to a high of $91,906, while the costs ranged from a low of $23,985 to a high of $42,796. The net present values calculated for adding an agricultural producer today were mostly positive. They ranged from a low of -$16,637 in the case of a lower bound ecosystem service value and a 0% discount rate to a high of $49,110 in the case of an upper bound ecosystem service value and a 0% discount rate. Depending on the discount rate, the net present value of adding an agricultural producer to the program today ranged from $1,222 to $16,236 when calculated using the point estimate of ecosystem service value.

Table 23. Benefit, Cost, and NPV of Adding One Farmer to the Program in 2011[a]

Discount Rate	Ecosystem Service Estimates		
	Lower	Upper	Point
Benefit			
0 %	$26,159	$91,906	$59,032
3 %	$18,220	$64,015	$41,118
8 %	$11,170	$39,243	$25,206
Cost			
0 %	$42,796	$42,796	$42,796
3 %	$32,833	$32,833	$32,833
8 %	$23,985	$23,985	$23,985
Net Present Value			
0 %	-$16,637	$49,110	$16,236
3 %	-$14,613	$31,182	$8,284
8 %	-$12,815	$15,258	$1,222

[a] Values are in 2011 Canadian dollars.

3.2.7 Social and Motivating Factors of Riparian Buffer BMP Adoption

This section will present the results of a series of questions about various personal and social aspects of BMP adoption to try to understand the following:

- The personal/business motivations behind the Riparian Buffer BMP adoption (some of which have been discussed above);
- The adopter's perception of the benefits to society that the BMP provides; and
- The barriers to adoption of the Riparian Buffer BMP by other farmers or ranchers.

Motivating Factors for Adoption of the Riparian Buffer BMP

Respondents were asked to rate on a scale of 1 to 5 (not important to very important), the reasons why they chose to adopt the Riparian Buffer BMP from a list of possible motivations. Similar to the responses for this question for the Livestock Watering BMP, the stewardship motivations such as "limiting the farm's impact on the environment" are rated higher than the business or operational motivations. These responses correspond with the findings presented in the above economic impact section, which indicates that adopters of this BMP are primarily motivated by environmental and stewardship reasons; whereas the business or operational reasons for adoption vary on a farm-by-farm basis.

Table 24. Average rating of motivating factors for Riparian Buffer BMP adoption organized from highest to lowest.

Motivation	Score
Limit the farm's impact on the environment	4.3
Demonstrate stewardship	3.8
Contribute to a positive industry image	3.6
Improve the long-term sustainability of the operation	3.5
Enhance biodiversity on my farm	3.0
Improve the profitability of the operation	2.9
Enhance the aesthetics of my operation	2.6
Avoid regulatory action	2.5
Improve livestock health	2.3
Enhance the branding of my operation	2.1
Produce marketable products	1.3

Respondents were also asked to indicate any other motivating factors that were not included in the list of motivations. Responses included:

- Protecting the streambank/shoreline from erosion;
- Stewardship/ethical motivations;
- DFO required the producer to enhance the riparian area on their property; and
- To enhance public perception of the ranch.

Responses indicate that adopters of this BMP were for the most part, passionate about the environment. One respondent indicated that their motivation was to "make it a better place as a gift for their grandson…and to reduce [their] footprint on the land for the future".

Social Benefits Provided by the BMP

Respondents were asked whether or not they feel that their Riparian Buffer BMP provides a benefit to society. 75% of respondents indicated that they feel the BMP provides a benefit. A summary of the benefits to society provided by the BMP include:

- Protecting wildlife and fish species;
- Water quality and stream improvements;
- Providing sustainable/ethical food; and
- Enhancing the aesthetics of the area.

Barriers to Adoption of the Riparian Buffer BMP

Similar to the motivation question described above, respondents were asked to rate on a scale from 1 to 5 (not a barrier to a large barrier) a set of barriers to Riparian Buffer BMP adoption. The exact wording of the question was "In your opinion, what are the barriers to adoption of the Riparian Buffer BMP by other producers in your industry". Similar to the Livestock Watering BMP, the largest barrier indicated by respondents is cost (4.1). The next largest barrier is a lack of time or labour (3.6).

Table 25. Barriers to Riparian Buffer BMP Adoption

Barriers	Score
Costs associated with BMP adoption	4.1
A lack of time or labour	3.6
A lack of understanding about *how* the BMP will benefit their operation	2.9
Other environmental priorities take precedent	2.9
A lack of awareness of risks to the environment from farm practices	2.7
Barriers to accessing funding through the BMP Program	2.7
A lack of industry pressure	2.6
A lack of understanding about *which* BMP will benefit their operation	2.4
No succession plan for their farm	2.4
A lack of support from public agencies	2.4
Logistically not feasible	2.1
A lack of public pressure	2.0

The top barriers to adoption could indicate that among the group of farmers who will potentially adopt this BMP, it is likely that environmental awareness is higher than for other BMPs like the Livestock Watering BMP; however, the cost of adopting the Riparian Buffer BMP including monetary and labour costs are a deterrent for some potential adopters. Other barriers indicated in the comment section include:

- The mentality/lack of long-term thinking amongst some farmers;
- Distrust of government; and
- Pressure to be productive on farmland.

3.2.8 Riparian Buffer BMP SWOT Analysis

A brief SWOT (Strength, Weaknesses, Opportunities, Threats) Analysis is presented in this section to organize some of the main findings of the BMP assessment as well as present anecdotal information that may not be presented in the report for the Riparian Buffer BMP above. Note that this is only the preliminary step in a SWOT analysis and further steps including a detailed analysis and action plan are often conducted in order to direct policy.

Strengths

- The BMP has had a positive effect on mitigating streambank erosion and enhancing riparian vegetation.
- Adopters of this BMP appear to have a high environmental ethic, likely ensuring the longevity of riparian buffer enhancement projects.
- The buffer provides aesthetic value, important to agri-tourism operations.

Weaknesses

- The current uptake of the BMP has been relatively low (1% of the total possible farms in the province). There are likely multiple reasons for this including:
    - The cost of adopting the BMP (especially for large operations).
    - Limited obvious on-farm businesses reasons for adopting the BMP (especially in the short term).
    - A lack of awareness amongst non-adopters about the environmental risks and long-term benefits of riparian buffer enhancement.
- A lack of BMP implementation and maintenance standards may be leading to varying quality of Riparian Buffer BMPs. This weakness was apparent in the range of quality of riparian areas visited during the interview process.
- There is no ongoing requirement to keep buffers in place. Environmental benefits of the BMP may never be realized if a BMP is not kept or maintained for a certain amount of time.

Opportunities

- The Riparian Management Planning process could help to create standards for riparian buffer establishment, producing higher quality riparian buffer projects.
- Riparian Buffer BMPs are supported by other agencies (DFO, municipalities, industry organizations and environmental groups), which could help to enhance adoption.

Threats

- The average age of adopters of this BMP is much higher than the provincial average for farmers. It appears that almost no younger farmers are adopting this BMP. As the farms that have adopted the BMP change hands due to retirement, the riparian buffer may not remain intact.
- Environmental change and pressures, such as flooding events, climate change can impact the effectiveness of the BMP performance beyond the program or adopters control.
- Potential for increased wildlife interactions or damage in agricultural areas.
- Potential for increased risk of food safety concerns due to increased wildlife/crop interaction.
- An increase in the width of buffer as per pesticide label requirements to buffer for potential drift between crop areas and non-crop areas when spraying pesticides; and
- Federal, provincial or local government regulatory requirements and authorizations directed to restrict activities in and around riparian areas in British Columbia.

3.2.9 Conclusions and Recommendations for the Riparian Buffer BMP

This section provides an overview of the main conclusions derived from the BMP assessment. Recommendations will also be provided where appropriate. Note that these conclusions and recommendations are based on the authors' opinions and reflect both qualitative and quantitative information collected during the assessment.

Is the BMP having the impact it was designed to have?

To recap, the Riparian Buffer BMP is intended to address environmental risks associated with a lack of or no riparian buffer area between farming areas and watercourses and/or waterbodies. These risks include impacts of farming practices to water quality and quantity, soil erosion and wildlife (including flora and fauna).

In the authors opinion the Riparian Buffer BMP is *in some cases* achieving the intended impacts that it was designed to have based on the environmental indicators used to assess the environmental impacts as well as the site visits and anecdotal information provided by interviewees. *In some cases* due to inadequate BMP design, lack of maintenance, and/or environmental pressures, there is evidence that the BMP is not and will not have the impacts it is intended to. *To minimize the risk of such events, we recommended that more guidance in risk assessment, BMP design and prioritizing BMPs be provided to adopters when choosing which riparian BMPs to adopt (including the Riparian Buffer BMP).*

Does the BMP meet the expectations of adopters?

Producers are generally enthusiastic and positive about the impacts that the Riparian Buffer BMP had on their farms and ranches. In cases where the BMP is mitigating the risk of streambank erosion, adopters are generally satisfied with the performance of the BMP. It is apparent that in some cases, this BMP is adopted for ethical or stewardship reasons. In these cases, as long as the BMP is performing its environmental objectives (or moving towards performing its environmental objectives), adopters are satisfied with results. In other cases the BMP is adopted as a suite of riparian BMPs and the expectations of adopters are satisfied due to the overall impact of the riparian enhancement projects acting as a suite of BMPs.

In a few cases, producers expressed dissatisfaction with the lack of vegetative growth, need to replace young trees and level of maintenance required to maintain the buffer. Based on visual inspection, it was clear that in these cases, the BMP had not been properly maintained and it is likely that the environmental benefits of the riparian buffer will not be realized (at least without some intervention). *To help producers overcome the initial challenges associated with riparian buffer establishment and maintenance; we recommend that a follow up visit and/or check-in be conducted with adopters to troubleshoot any issues and to visually inspect the success of the Riparian Buffer BMP projects. It may also be useful to assess the need for continued funding for maintenance of the BMP beyond the first year after planting.*

Is there justification for continued support of the BMP?

Based on the following criteria the authors recommend *continued support* of the Riparian Buffer BMP with a re-evaluation of cost-share levels, more stringent design requirements and/or a follow up check in/site visit to help with successful riparian buffer establishment. The criteria used to come to this conclusion are as follows:

Does the BMP mitigate the environmental risk(s) it was intended to?

- Based on the environmental indicators described in this report as well as visual inspections of Riparian Buffer BMP projects, the BMP *in some cases* addresses the environmental risks that it is intended to, whereas in some cases, the BMP may be failing to address environmental risks.

Does the BMP provide the expected benefit to the adopter?

- Based on the results of the BMP assessment survey as well as anecdotal information, the BMP generally met the expectations of adopters. However, it is important to note here that the BMP is often adopted for ethical or stewardship reasons, and in some cases provides little positive impact on day-to-day farm operations. Because of this we recommend re-assessing the level of cost-share provided for this BMP.

Does the BMP provide a benefit to society?

- Over the life of the program (assumed to be 15 years in the case of the Riparian Buffer BMP) the BMP has a positive Net Present Value. However, the program to date has yielded negative Net Present Values. This indicates that the non-private benefits of the Riparian Buffer BMP are realized only after the buffer is maintained for a number of years. *A requirement to maintain the buffer for a certain amount of time after establishment may provide a mechanism to increase the benefits of the Riparian Buffer BMP to society over the long-term.*

3.3 Irrigation Management for Nursery, Greenhouse, Tree Fruit, Grape and Berry Operations (Practice Code 1801)

The Irrigation Management BMP is intended to address environmental risks associated with excess water use for irrigation by providing an incentive to use efficient irrigation systems (i.e. the use of trickle or drip systems vs. sprinklers). Benefits provided by this BMP include water conservation; decreased impacts of irrigation on watercourses and species that depend on the function of the watercourse; as well as reduced nutrient loss to runoff by means of fertilizer injectors for fertigation systems.

The BMP funding may be allocated towards drip irrigation lines, emitters and filters, controllers and electrical equipment, injection equipment for fertigation. Installation of controllers, electrical and fertigation equipment may only be installed if the whole system gains at least 15% water efficiency.

3.3.1 Environmental Objectives of the Irrigation Management BMP

The specific environmental objectives that the Irrigation Management BMP is intended to address include:

- Water conservation by:
    - Improving irrigation system efficiency; and
    - Increasing irrigation scheduling and climate monitoring;
- Mitigation of surface and groundwater withdrawal and subsequent impacts on streams; and
- Improvement of the efficiency of fertilizer inputs, reducing the loss of nutrients into groundwater and streams.

3.3.2 Survey Response

A total of 12 interviews and site visits were conducted and 24 surveys were returned totaling 36 respondents. A total of 200 surveys were administered and the response rate was 18%.

3.3.3 Irrigation Management BMP Provincial Statistics

This section will report the BMP adoption and distribution statistics from the period between 2005 and 2010. The data sources for this section include the ARDCorp program files as well as data collected through the BMP assessment survey.

Cost-Share and Cap Structure and Average BMP Project Cost

The Irrigation Management BMP was cost-shared at 30% of total eligible costs up to $10,000 between 2005 and 2008, and up to $15,000 in 2009 and 2010. Between May 2006 and March 2008, Ducks Unlimited topped up the amount of money available to adopters by providing 20% of the total eligible cost, bringing the cost-share level up to 50%. The average cost of an Irrigation Management BMP project, taking into account only the eligible costs is $18,070.

Adoption Distribution

A total of 619 Irrigation Management BMP projects have occurred across BC between 2005 and 2010. The majority of projects have occurred in the Fraser Valley and the Okanagan-Similkameen areas[22] corresponding with berry, grape and tree fruit production. The BMP has also been adopted, to a much lesser extent, on Vancouver Island and elsewhere in BC.

Table 26. The number of BMPs that have been adopted in each Regional District.

Regional District	# of BMPs Adopted
Fraser Valley	221
Okanagan-Similkameen	171
Metro Vancouver	120
Central Okanagan	34
North Okanagan	19
Capital Regional District	8
Comox Valley	6
Thompson-Nicola	5
Central Kootenay	5
Kootenay-Boundary	3
Cowichan	2
Nanaimo	1
Alberni-Clayquot	1
East Kootenay	1

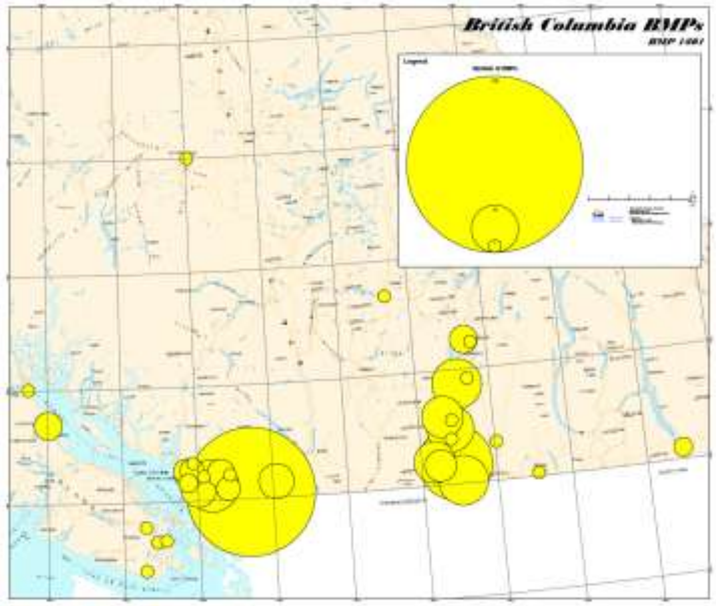

Figure 18. Geographic Distribution of Irrigation Management BMP Adoption Between 2005 and 2010.

Adoption By Commodity

The Irrigation Management BMP has been adopted by a range of commodities, with the largest group being blueberry growers (37%). The next largest groups of adopters include grape (27%) and tree fruit growers (18%). A summary of all adopters by commodity is displayed in Figure 19. No greenhouses turned up in the sample of ARDCorp data. 11% of the survey respondents indicated that they are certified organic.

A scan of agricultural resources in 1998-99 was conducted and reported in the "State of Resources Report" by the BC Ministry of Agriculture. At that time, approximately 33% of tree fruit growers and 23% of berry growers in the province were using drip/trickle lines to irrigate. Assuming that the number of farms has remained relatively constant since then, the BMP Program has increased the percentage of farms using trickle/drip lines by approximately 24% of berry operations to a total of 47% of berry farms and by 14% of tree fruit operations to a total of 47% of tree fruit farms. Note that these percentages do not reflect farms that may have adopted drip/trickle lines on their own.

Source: Bertrand, R. State of Resources Report. 1999. BC Ministry of Agriculture, Abbotsford, and survey data.

[22] Note that the "Fraser Valley" here encompasses both the FVRD and Metro Vancouver regional districts and the Okanagan-Similkameen encompasses RDOS, RDCO and RDNO regional districts.

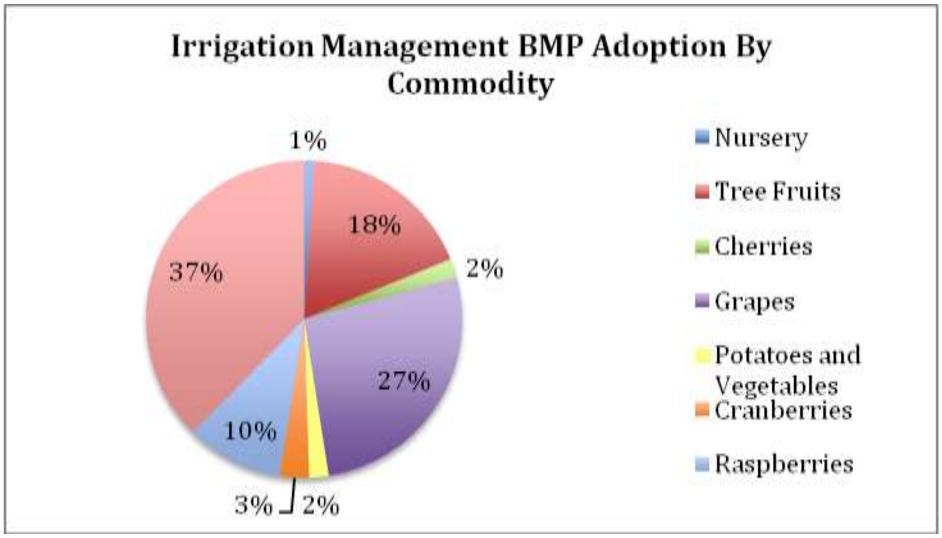

Figure 19. Irrigation Management BMP adoption between 2005 and 2010 by commodity.

Adoption Over Time

Adoption of the Irrigation Management BMP grew steadily until adoption was at its highest in 2008 when approximately 200 farms completed BMP projects. In 2009 and 2010, relatively few farms adopted the BMP compared to the three past years. The reasons for the differences in adoption rates by year were not explicitly assessed in this study; however, the decline in adoption may be explained by a combination of these reasons:

- The BMP has captured most of the likely "early adopters" and other potential adopters are not being captured by the program;
- The majority of the industries targeted by this BMP have already adopted more efficient irrigation systems, (i.e. these systems have become the industry standard);
- A lack of awareness of the EFP/BMP program since the restructuring of the program administration in 2009;
- Increased scrutiny of BMP Projects after the change in administrative structure in 2009; and
- Decreased total amount of funding available when Ducks Unlimited top-up funding ended in 2008.

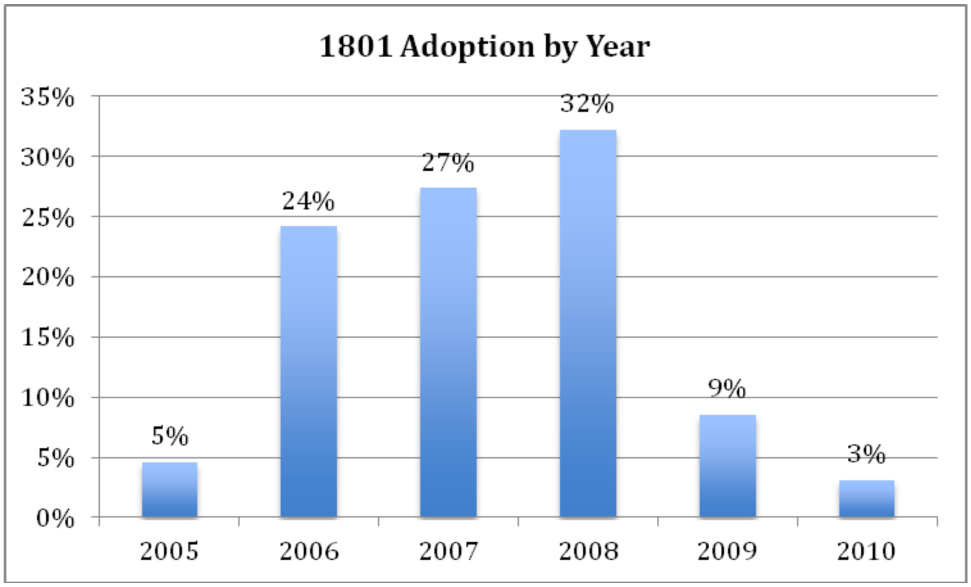

Figure 20. Temporal distribution of Irrigation Management BMP adoption.

Irrigation Management BMP Farm Characteristics

Understanding the characteristics of the average Irrigation Management BMP adopter compared to the average population of farmers across BC will give insight into the unique characteristics of the producers and farms who choose to adopt this BMP. Where there are considerable differences in the characteristics of adopters in the Fraser Valley and adopters in the Okanagan-Similkameen, the characteristics will be reported both separately and in aggregate. The following farm characteristics and socio-demographic information are compared to Statistics Canada 2006 Census of Agriculture information where possible.[23]

Size of the Average Farm Adopting the Irrigation Management BMP

The average size of farm that has adopted the Irrigation Management BMP in the Fraser Valley is 17.6 hectares with an average of 9.2 irrigated hectares. The average size of farm in the Okanagan is 6.9 hectares with an average of 4.6 hectares irrigated. Aggregately, the average area of farms that adopt the Irrigation Management BMP is 12.8 hectares with an average of 6.4 hectares irrigated.

Farm Gate Sales

Farm gate sales of the Irrigation Management BMP adopters compared to the farm gate sales for farmers across BC reveal that farms that adopt the BMP are generally weighted more heavily at the $50,000 and above brackets for farm gate sales. However, 22.6% of respondents indicated that their farm gate sales in 2010 were less than $10,000. This is likely due to a portion of adopters who adopt the BMP do so during the start up phase of their farm or after a major crop renovation or switch over. This point will be elaborated upon in sections below.

[23] Statistics Canada. (2006). Census of agriculture: farm data and operator tables. Retrieved from http://www.statcan.gc.ca/pub/95-629-x/2007000/4182411-eng.htm#gfr on January 15, 2012.

Table 27. Farm Gates Sales of Irrigation Management BMP Adopters compared to the average farm gates sales for farms across BC.

Farm Gate Sales	% of BMP Adopters in 2010	% of BC Farmers in 2006 Census
Less than $10,000	22.6%	47.7%
$10,000-$24,999	12.9%	16.1%
$25,000-$49,999	6.5%	10.3%
$50,000-$99,999	25.8%	8.0%
$100,000-$249,999	22.6%	7.7%
$250,000 and over	12.9%	10.2%

Age of Adopters

The average age of the Irrigation Management BMP adopters is similar to the BC average for farmers reported in the 2006 Census of Agriculture[24].

Table 28. Age of Irrigation Management BMP adopters compared to the average for BC Farmers.

Age Category	Percentage of BMP Adopters	Farmers in BC
18-34	2.9%	9.1%
35-54	57.1%	50.2%
55 and above	40.0%	40.7%

Farming Experience

Respondents were asked to indicate how many years that they have farmed as a proxy for how much experience they have with farming. The average number of years that adopters of the Irrigation Management BMP have farmed is 18 years with the minimum of 2 years and the maximum of 50 years. Respondents were also asked how many years they have farmed on the property where the BMP was adopted. The average time farmed on the property was 12 years with the minimum of 1 years and the maximum of 34 years.

Ownership

Respondents were asked whether the land where the BMP was adopted was privately owned, leased or provincially owned. 85% of respondents indicated that the land that the BMP was implemented on is privately owned. 15% of respondents indicated that the BMP was implemented on land that is leased.

3.3.4 Irrigation Management BMP in Practice

This section gives a brief overview of the how the Irrigation Management BMP has, in general, been implemented in practice. The BMP funding may be allocated to:

- Drip irrigation lines;
- Drip emitters;

[24] Statistics Canada. (2008). Farm operators by age in BC. 2006 Census of Agriculture. Retrieved from http://www40.statcan.gc.ca/l01/cst01/agrc18a-eng.htm

- Filters; and
- Controllers and electrical equipment, injection equipment for fertigation.

Irrigation Equipment Prior to BMP Implementation

Respondents were asked to indicate the type of irrigation system being used prior to adopting the BMP. The majority of adopters (77%) from the Fraser Valley were irrigating using a travelling gun prior to BMP adoption. BMP adopters from the Okanagan-Similkameen Region were using a range of irrigation equipment prior to BMP adoption.

Table 29. The type of irrigation systems used by adopters prior to BMP implementation

Fraser Valley Previous System	Percentage Used
Overhead solid set	7.7%
Drip irrigation (Nursery)	7.7%
Travelling gun	76.9%
Stationary gun	7.7%

Okanagan-Similkameen Previous System	Percentage Used
Overhead solid set	42.9%
Under-tree solid Set	28.6%
Handmove sprinklers	9.5%
Drip irrigation (greenhouse)	4.7%
Solid set gun	4.7%
None	9.5%

Type of Irrigation Equipment Implemented

Respondents were asked to indicate which particular irrigation, fertigation and timing equipment were implemented when the Irrigation Management BMP was adopted. The majority of adopters (89%) switched to a drip system. Approximately a third of respondents indicated that they installed irrigation-timing equipment. Just under half of respondents indicated that they installed fertigation equipment.

Table 30. Percentage of eligible irrigation equipment that was adopted through the Irrigation Management BMP

BMP Equipment Adopted	% of Adopters
Drip Irrigation (field crops)	88.6%
Drip Irrigation (greenhouse/nursery)	2.9%
Microspray Irrigation	8.6%
Timing Equipment	31.4%
Fertigation Equipment	42.9%

Source of Water for BMP

Respondents were asked to indicate what the source of irrigation water is on the farm. 43% of respondents indicated that irrigation water is supplied either by a municipal or water purveyor source. 29% of respondents indicated that irrigation water is supplied by a private groundwater source.

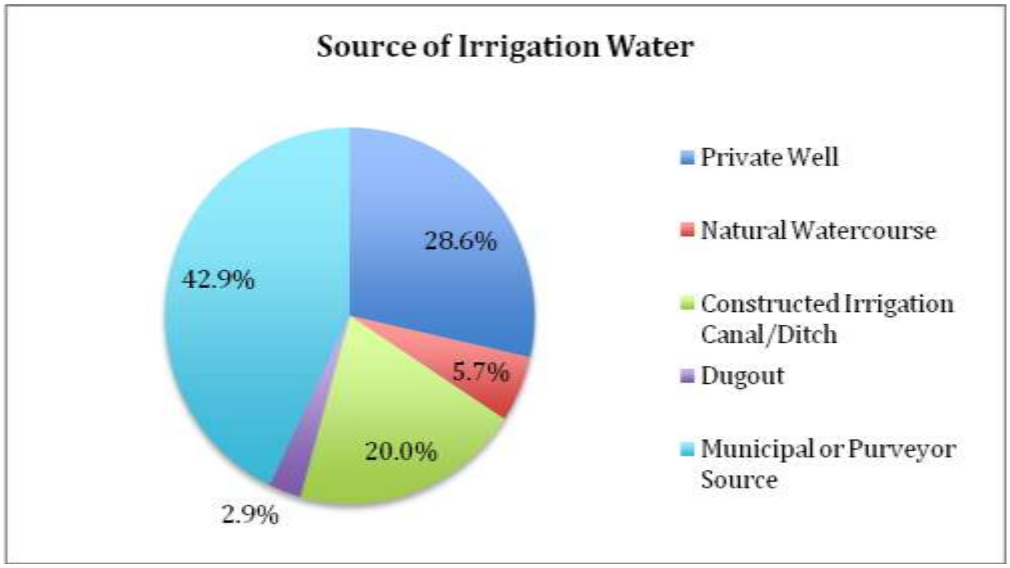

Figure 21. Source of irrigation water systems implemented through the Irrigation Management BMP.

Crops Produced Prior and Post BMP Adoption

Respondents indicated the crops that were produced prior to BMP adoption and post BMP adoption. Results are presented in Figure 22 below. The graph indicates that the Irrigation Management BMP is often associated with change in the crop produced. For example, the results indicate that the BMP has been adopted in the Okanagan-Similkameen in conjunction with a switch into grape production.

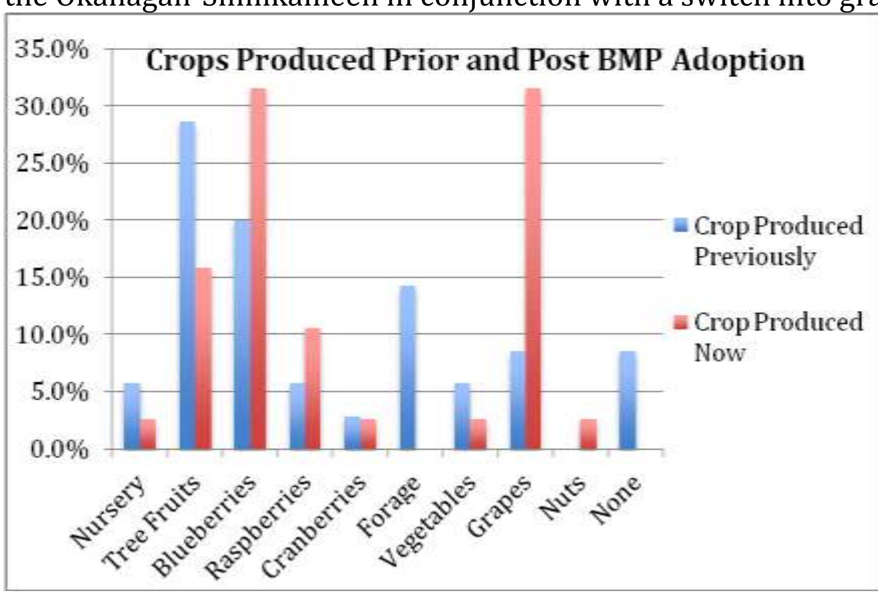

Figure 22. The crops produced on the land where the BMP was installed prior to and post BMP adoption.

Figure 23. A vineyard in the RDOS that chose to adopt the Irrigation Management BMP when the field was switched into grape production from forage production. The grapes have not reached full production yet. During interviews, it became apparent that the adoption of this BMP often comes with a crop switch or major field renovation. At other times in the growing cycle, it may not make economic sense to switch irrigation systems for a more efficient one.

Area Impacted by Irrigation Management BMPs

The average crop area that the Irrigation Management BMP covers per farm in the Fraser Valley is 7.8 hectares and the average area in the Okanagan-Similkameen is 3.3 hectares. The total crop area covered by the Irrigation Management BMP is 2604 hectares in the Fraser Valley and 929 hectares in the Okanagan-Similkameen. The total area across BC is 3533 hectares.

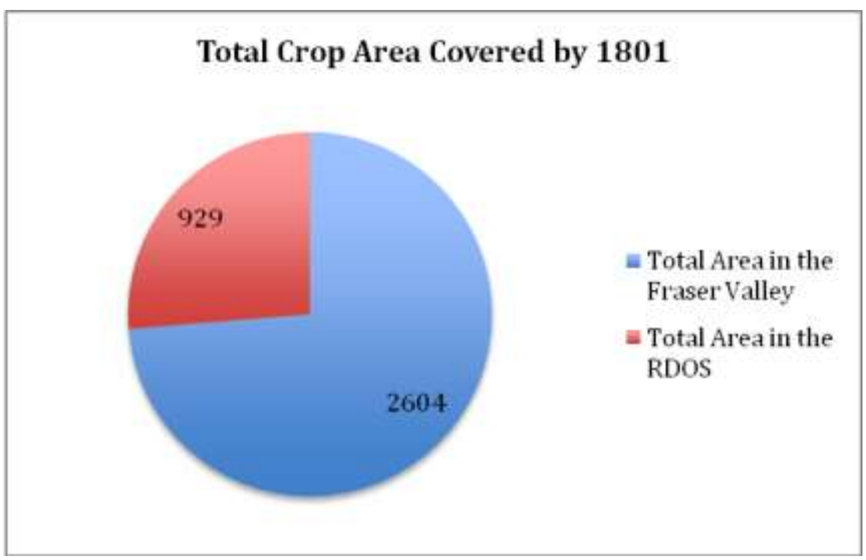

Figure 24. Total crop area covered by the Irrigation Management BMP in hectares.

3.3.5 Environmental Impact of the Irrigation Management BMP

The above sections provide insight into how the Irrigation Management BMP has been implemented in practice, whereas this section provides insight into the environmental impact that the BMP has had between 2005 and 2010 based on data collected through the assessment survey. The benefits provided by this BMP include water conservation; decreased impacts of irrigation on watercourses and species that depend on the function of the watercourse; as well as reduced nutrient loss to runoff by means of fertilizer injectors for fertigation systems.

Environmental Indicators for the Irrigation Management BMP

The indicator used to assess the environmental impact of the Irrigation Management BMP is:

- The water conservation due to BMP adoption.

This indicator is also used as a proxy for the mitigation of ground and surface water withdrawls for irrigation purposes and subsequent impacts on streamflow. The sections below will present the water conservation achieved by the Irrigation Management BMP. Note that assumptions made when calculating the irrigation water efficiency gains are provided in the Appendix VI.

Water Conservation Due to the Irrigation Management BMP

Using survey data provided by respondents, program uptake data supplied by ARDCorp and water requirements and irrigation efficiency factors, water savings due to BMP adoption was calculated. The average farm in BC conserves 4.1 acre-feet of water annually due to the adoption of the Irrigation Management BMP. The average water use efficiency gained by adopting the Irrigation Management BMP is 25%. In 2010 the annual amount of water conserved by all BMP adopters to date topped 2531 acre-feet water savings annually. Table 31 provides a summary of the water conservation achieved on an annual basis by the BMP.

Table 31. Annual water savings due to the adoption of the Irrigation Management BMP.

Annual Water Savings	Acre Feet
Average Water Savings Per Farm Fraser Valley	4.0
Average Water Savings Per Farm Okanagan	4.2
Average Water Savings Per Farm BC	4.1
Annual Water Savings due to BMP Adoption in Fraser Valley (2010)	1333.9
Annual Water Savings due to BMP Adoption in Okanagan (2010)	1194.8
TOTAL Annual Water Savings due to 1801 Adoption in BC (2010)	**2528.7**

On an annual basis, since 2005, total annual water savings has increased due to more growers adopting the Irrigation Management BMP. Between 2008 and 2010 the annual increase in total water savings has begun to level off as less farms have adopted this BMP. Figure 25 displays the annual total water savings per year between 2005 and 2010.

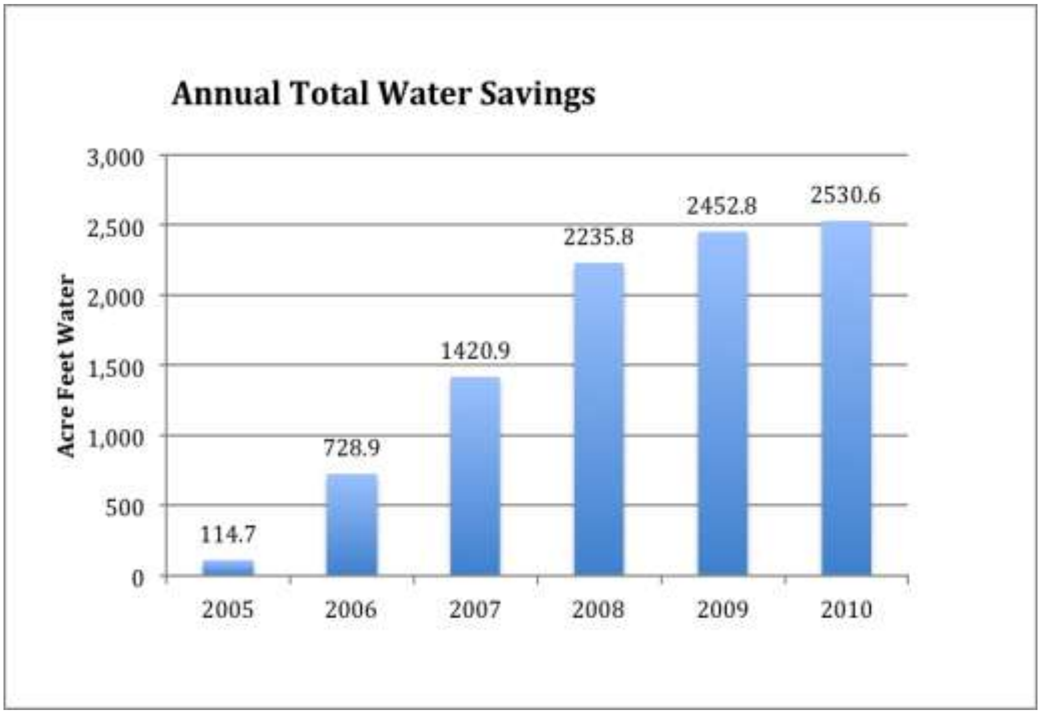

Figure 25. Annual total water savings by year

The total volume of water conserved by the Irrigation Management BMP from 2005 to 2010 was 9483 acre-feet of water. Note that these calculations assume that every farm that adopted the Irrigation Management BMP between 2005 and 2010 continued to use their irrigation BMP from the time adopted through til the end of 2010. It also assumes that farms were at full production during that same time period.

Change in Drainage

Respondents indicated whether there had been a change in the water drainage in their crop area since implementing the Irrigation Management BMP. 37% of respondents indicated that the drainage in their fields had improved since adopting the BMP. Other respondents indicated that they saw no change in field drainage since adopting the BMP. Note that some adopters may have not had any problem in the past with poor drainage and thus may have not noticed a difference.

Change in the Risk of Soil Erosion

A question about the impact of BMP adoption soil erosion was not specifically asked; however, interviewees from the Okanagan-Similkameen indicated that in some cases the risk of soil erosion in the alleys between rows has increased with the adoption of efficient irrigation systems that place water more precisely in the crop root zone. Some interviewees indicated that they have a hard time keeping a cover crop alive without overhead sprinklers. To mitigate soil erosion, some growers have installed some overhead sprinklers in addition to drip irrigation to irrigate in-between rows specifically. Note that this irrigation water use was not included in the water conservation calculations above.

3.3.6 Economic Impact of Irrigation Management BMP Adoption

This section will present the operational objectives that motivate farmers and ranchers to adopt the Irrigation Management BMP as well as the costs that they incur when doing so. To assess the economic impact of the BMP to society a cost-benefit analysis was conducted. The results of the cost-benefit analysis are presented below in this section.

Business/Operational Objectives of the Irrigation Management BMP

There is currently little incentive or regulatory mechanisms in BC to promote water conservation amongst farmers. That is not to say that farmers do not care about water conservation; however, there are other business/operational objectives that farmers consider when adopting the Irrigation Management BMP. In order to explore these reasons further, a series of survey questions aimed at assessing the costs and benefits experienced by farmers due to the adoption of the BMP were created. The following sections present the results of these survey questions. Note that many of these costs and benefits are included as values in the cost-benefit analysis presented below.

Crop Quality and Yields

Respondents were asked if they have noticed a change in crop quality since adopting the Irrigation Management BMP. Approximately half of respondents (54%) indicated that they have noticed an improvement in crop quality, whereas the rest of respondents who were growing the same crop on their land as they were prior to BMP adoption did not notice any change in crop quality. One grape grower noted that vines could potentially become less vigorous due to less rooting depth and reach associated with drip irrigation.

Respondents were also asked to indicate if they had experienced a change in crop yields since adopting the BMP. 62% respondents who are growing the same crop now as they were prior to BMP adoption indicated that they had experienced an increase in yields since adopting the BMP. Of that 62%, the average farm gate value of the increase is $4919/hectare annually. The average value of the yield increase per farm is $9271 annually. Two respondents indicated that they were able to get a crop off (apples and nursery) an entire year earlier due to better irrigation and fertilizer management.

Weed Pressure

Respondents were asked to indicate if the weed pressure in their fields had changed since adopting the Irrigation Management BMP. 58% of growers indicated that they did not notice any change in the weed pressure in their fields. 31% indicated that they had reduced weed pressure in their fields since adopting the Irrigation Management BMP and 12% indicated that weed pressure had increased.

Marketing

23% of respondents indicated that they use the EFP/BMP Program for marketing purposes. Of those, three indicated that they put the EFP sign on their driveway for their direct market stands. Another respondent indicated that their wholesaler uses their Irrigation Management BMP as an example to other farms.

Labour Requirements

Respondents were asked to indicate how many hours of labour annually they spent maintaining the irrigation system that was replaced, and how many hours annually they spend maintaining the irrigation BMP. 49% of respondents indicated that they experienced a decrease in labour requirements due to BMP adoption. Reasons for the decrease in labour include:

- Not having to reel out wheel line sprinklers;
- A decrease in time to set up the system at the beginning of the season;
- Less passes on the tractor to spread fertilizer; and
- Automated systems require little manual operation.

14% of respondents indicated that they experienced an increase in labour requirements since adopting the Irrigation Management BMP. Reasons for the increase in labour include:

- Cleaning driplines and filters;
- Watering more often with Irrigation BMP.

On average, adopters experienced a 66-hour per year decrease in annual labour requirements due to BMP adoption.

Irrigation Management BMP Cost-Benefit Analysis

To understand the economic impact of BMP adoption, a cost-benefit analysis methodology was used. See Appendix II for a detailed methodology of the cost-benefit analyses that was conducted. Appendix IV contains a summary of the average costs and benefits used to calculate the Irrigation Management CBA. Though all of the net present values calculated for the Irrigation Management BMP to date are all negative, the estimates of net present value over the life of the program (7 years) and for adding a new producer are all positive. The negative net present values of the program to date are likely due to the large number of agricultural producers who joined the program in recent years. Therefore the infrastructure implementation costs have been incurred, but benefits have only been accruing for a few years. Overall this analysis suggests that the benefits of this BMP are larger than the costs. These results suggest that the Irrigation Management BMP has economic justification. Details of the three net present value calculations are provided below in Tables 32 to 34.

Net Present Value of the Program to Date

Depending on the specification of the discount rate aggregate benefits ranged from a low of $16,917,284 to a high of $18,121,785, while the costs ranged from a low of $23,473,848 to a high of $28,455,761. The net present values calculated for the program to date were negative. They ranged from a low of -$10,333,976 in the case of an 8% discount rate to a high of -$6,556,564 in the case of a 0% discount rate.

Table 32. Benefit, Cost, and NPV of the Program to Date[a]

Discount Rate	Benefit	Cost	Net Present Value
0 %	$16,917,284	$23,473,848	-$6,556,564
3 %	$17,362,069	$25,263,744	-$7,901,675
8 %	$18,121,785	$28,455,761	-$10,333,976

[a] Values are in 2011 Canadian dollars.

Net Present Value over the expected Life of the Program
Depending on the specification of the discount rate aggregate benefits ranged from a low of $43,112,189 to a high of $47,816,432, while the costs ranged from a low of $23,473,848 to a high of $28,455,761. The net present values calculated for the program over its expected lifetime were all positive. They ranged from a low of $14,656,428 in the case of an 8% discount rate to a high of $24,342,584 in the case of a 0% discount rate.

Table 33. Benefit, Cost, and NPV over the Expected Life of the Program[a]

Discount Rate	Benefit	Cost	Net Present Value
0 %	$47,816,432	$23,473,848	$24,342,584
3 %	$45,803,675	$25,263,744	$20,539,931
8 %	$43,112,189	$28,455,761	$14,656,428

[a] Values are in 2011 Canadian dollars.

Net Present Value of Adding one Farmer in 2011
Depending on the specification of the discount rate aggregate benefits ranged from a low of $57,454 to a high of $77,248, while the costs were invariant at $37,922. The net present values calculated for adding an agricultural producer today were all positive. They ranged from a low of $19,532 in the case of an 8% discount rate to a high of $39,326 in the case of a 0% discount rate.

Table 34. Benefit, Cost, and NPV of Adding One Farmer to the Program in 2011[a]

Discount Rate	Benefit	Cost	Net Present Value
0 %	$77,248	$37,922	$39,326
3 %	$68,754	$37,922	$30,832
8 %	$57,454	$37,922	$19,532

[a] Values are in 2011 Canadian dollars.

3.3.7 Social and Motivating Factors of Irrigation Management BMP Adoption

This section will present the results of a series of questions about various personal and social aspects of BMP adoption to try to understand the following:

- The personal/business motivations behind the Irrigation Management BMP adoption (some of which have been discussed above);
- The adopter's perception of the benefits to society that the BMP provides; and
- The barriers to adoption of the Irrigation Management BMP by other farmers or ranchers.

Motivating Factors for Adoption of the Irrigation Management BMP

Respondents were asked to rate on a scale of 1 to 5 (not important to very important), the reasons why they chose to adopt the Irrigation Management BMP from a list of possible motivations. Business or operational motivations scored higher than the stewardship motivations with the highest motivation being to improve the profitability of the farm operation (3.9). Water conservation was also listed as a higher priority as (3.8) which is a motivating factor that benefits both the farm and society. The top motivations for adoption of the Irrigation Management BMP are opposite those of both riparian BMPs, where the highest motivating factors were based on stewardship reasons.

Table 35. Average rating of motivating factors for Irrigation Management BMP adoption organized from highest to lowest.

Motivation	Score
Improve the profitability of the operation	3.9
To conserve water	3.8
Improve the long-term sustainability of the operation	3.6
Improve crop yields	3.4
To increase the reliability of water for irrigation	3.1
Limit the farm's impact on the environment	3.0
Demonstrate stewardship	2.6
Contribute to a positive industry image	2.6
To help my farm adapt to climate change	2.4

Respondents were also asked to indicate any other motivating factors that were not included in the list of motivations. All responses provided were based on business objectives such as:

- Cost effectiveness;
- Labour savings;
- Better control over irrigation amount and timing;
- Food safety; and
- Water efficiency.

Social Benefits Provided by the BMP

Respondents were asked whether or not they feel that their Irrigation Management BMP provides a benefit to society. 86% of respondents indicated that they feel the BMP provides a social benefit. Responses to the type of social benefit provided by the BMP include:

- Water conservation (approximately 50% of respondents);
- Producing high quality food/food safety;
- Less pressure on infrastructure; and
- Supports the water allocation discussion by showing that farms are doing their part to reduce water consumption.

Barriers to Adoption of the Irrigation Management BMP

Similar to the motivation question described above, respondents were asked to rate on a scale from 1 to 5 (not a barrier to a large barrier) a set of barriers to Irrigation Management BMP adoption. The exact wording of the question was "In your opinion, what are the barriers to adoption of the Irrigation Management BMP by other producers in your industry". Overall, scores for barriers were lower than both riparian BMPs evaluated above, indicating that there are perhaps less barriers to adoption for this BMP relative to the riparian BMPs. Responses indicate the largest barrier is cost (3.3) although the average score was lower than for the riparian BMPs. This hypothesis is reflected in the BMP adoption statistics relative to the other BMPs evaluated in this report.

Table 36. Barriers to Irrigation Management BMP Adoption

Barriers	Score
Costs associated with BMP adoption	3.3
A lack of understanding about *how* the BMP will benefit their operation	3.1
Barriers to accessing funding through the BMP Program	2.7
A lack of understanding about *which* BMP will benefit their operation	2.6
A lack of support from public agencies	2.6
A lack of time or labour	2.5
Other environmental priorities take precedent	2.4
A lack of industry pressure	2.4
A lack of public pressure	2.4
No succession plan for their farm	2.3
A lack of awareness of risks to the environment from farm practices	2.1
Logistically not feasible	1.9

Comments regarding barriers in the comment line include:

- Farmers are unlikely to replace their system if they already have one in place, it doesn't make economic sense to do so;
- Lack of awareness of the program;
- Difficulties completing projects within the timelines of the BMP program;
- Leasing land is a barrier to adoption; and
- There are no real barriers, most people in the industry are already using this system.

3.3.8 Irrigation Management BMP SWOT Analysis

A brief SWOT (Strength, Weaknesses, Opportunities, Threats) Analysis is presented in this section to organize some of the main findings of the BMP assessment as well as present anecdotal information that may not be presented in the report for the Irrigation Management BMP above. Note that this is only the preliminary step in a SWOT analysis and further steps including a detailed analysis and development of an action plan are often conducted in order to direct policy.

Strengths

- The BMP has had high uptake by the blueberry, nursery and tree fruit sectors.
- The BMP makes clear business sense for these industries and there are many positive operational motivations expressed by those who have adopted this BMP.
- The cost of adoption does not seem to be as strong of a barrier, and some adopters indicated that their entire industry is moving towards efficient irrigation already.

Weaknesses

- There has been low uptake of this BMP by the nursery and greenhouse industry. From the responses received, it is not clear why this is so.
- The BMP funding has in some cases funded the adoption of irrigation systems where there was not one previously. In these cases, the BMP has facilitated increased use of water by agriculture.

Opportunities

- Adoption of efficient irrigation systems could be achieved by allowing new operations to access BMP funding. If this were to be the case, funding levels should be reassessed to investigate the optimal level of cost-share and cap.
- The modernization of the Water Act and associated regulations may provide the regulatory framework to require adoption of efficient irrigation.
- Increased water metering and price of water could help to increase the adoption of this BMP.

Threats

- The risk of increased soil erosion, specifically in the Southern Interior regions is a potential negative environmental impact of this BMP.
- Adoption of this BMP is closely tied to replanting, field renovations and crop change over. Those who already have a system in place and are not likely to make changes in the near future are probably less likely to adopt this BMP.
- For the benefits of water conservation to be realized, the BMP must be in use for a certain length of time. The berry/tree fruit/grape sectors experience relatively high change over as well as pressures to sell their land, which is in high demand for non-farm uses. There is the potential for the BMP to become non-operational before the irrigation system needs to be replaced as well as a chance that the irrigation system is installed before it was needed in order to take advantage of the BMP funding that is available.

3.3.9 Conclusions and Recommendations for the Irrigation Management BMP

This section provides an overview of the main conclusions derived from the BMP assessment. Recommendations will also be provided where appropriate. Note that these conclusions and recommendations are based on the authors' opinions and reflect both qualitative and quantitative information collected during the assessment.

Is the BMP having the impact it was designed to have?

To recap, the Irrigation Management BMP is intended to mitigate the environmental risks associated with excess water use for irrigation by providing incentive to use efficient irrigation systems (i.e. the use of trickle or drip systems vs. sprinklers). Benefits provided by this BMP include water conservation; decreased impacts of irrigation on watercourses and species that depend on the function of the watercourse; as well as reduced nutrient loss to runoff by means of fertilizer injectors for fertigation systems.

In the authors' opinion the Irrigation Management BMP is effective in achieving the intended impacts that it was designed to *when it is implemented on farms that were using a less efficient irrigation system prior to BMP adoption.* In 91% of cases, the BMP was adopted on farms where an increase in efficiency was realized (an average of 25% efficiency gain). In 9% of cases, the farm did not have an irrigation system prior to BMP adoption. In these cases, the BMP helped to increase the total water use attributed to agriculture. *To reduce the instances where this BMP is being adopted in areas where no previous irrigation system existed, it is recommended that proof of the previous system in the form of pictures be required with all Irrigation Management BMP applications to ARDCorp.*

Anecdotally, producers indicated that that mature plants were able to take up nutrients better with the use of the fertigation system for fertilization vs. other spraying techniques. From this we can infer that crops are using nutrients more effectively and less are lost to runoff into the surrounding ecosystem.

In some cases, respondents indicated that the adoption of the BMP increased the risk of soil erosion on their properties. Soil erosion was not specifically evaluated in the BMP assessment survey. *To address the risk of soil erosion due to adoption of the Irrigation Management BMP, we recommend that adopters should be required to indicate in their BMP application how they will maintain adequate soil cover in the alleys of orchards/vineyards given less irrigation water.*

Does the BMP meet the expectations of adopters?

In almost all cases, the BMP has met the expectation of adopters. Respondents to both the mailout survey and interview surveys indicated that there is a positive operational impact associated with this BMP. These benefits include:

- Labour savings due to reduced manual operation (49%); and
- Increased yields (62%).

In the opinion of the authors, the benefits of drip irrigation systems on berry, grape and tree fruit operations are widely recognized by their respective industries. If farms are considering a switch in their irrigation system (due to the depreciation of irrigation equipment or field renovation) it is likely that they will choose an efficient irrigation system regardless of cost-share levels or BMP funding availability. These sentiments were echoed by interviewees and in the survey respondent comments. Note that this does not necessarily mean that all adopters of efficient irrigation systems will adopt fertigation equipment.

Is there justification for continued support of the BMP?

Based on the following criteria the authors recommend *continued support* of the Irrigation Management BMP with a re-evaluation of cost-share levels to determine the optimal level, ensuring that the majority of potential adopters are captured and BMP funding is used effectively. The criteria used to come to this conclusion are as follows:

Does the BMP mitigate the environmental risk(s) it was intended to?

- Based on the environmental indicators described in this report the BMP results in water efficiency gains for almost all farms that adopt the BMP. It is likely that fewer nutrients are being lost to runoff for farms that have also adopted fertigation equipment.

Does the BMP provide the expected benefit to the adopter?

- Based on the findings of the BMP assessment as well as anecdotal information, the BMP is achieving the expected impacts for adopters.

Does the BMP provide a benefit to society?

- Although the Net Present Value of the BMP to date is negative, in future years it is likely that a benefit to society will be realized as the costs associated with the BMP transition from implementation costs to maintenance and repair costs. Arguably, the economic value assigned to water in this report ($0.60/1000 m^3) could increase as water becomes increasingly scarce in the province.

3.4 Wildlife Damage Prevention (Practice Code 2302)

The Wildlife Damage Prevention BMP is intended to reduce both the impacts that wildlife can have on farm operations and the impacts that farms can have on wildlife. The BMP provides cost-sharing for the installation of wildlife fencing to mitigate or eliminate agriculture-wildlife conflicts particularly involving stored feed, irrigation lines and crops. The benefits provided by this BMP include reduction in financial losses to the farm operation as well as reducing the occurrence of wildlife conflict events by restricting access to agricultural food sources.

The BMP funding has not been available since the 2008-2009 program year; however when funding was available it cost-shared fencing materials and installation.

3.4.1 Environmental Objectives of the Wildlife Damage Prevention BMP

The specific environmental objectives that the Wildlife Damage Prevention BMP is intended to address include:

- A reduction of agriculture – wildlife conflicts including:
  - Restriction of unnatural food sources for wildlife species in efforts to maintain a stable population;
  - Reduction of wildlife mortalities related to ag-wildlife conflicts; and
- Conservation of wildlife biodiversity by facilitating a manageable relationship between agriculture and wildlife.

3.4.2 Survey Response

A total of 15 interviews and site visits were conducted and 24 surveys were returned totaling 39 respondents. A total of 200 surveys were administered and the response rate was 19.5%.

3.4.3 Wildlife Damage Prevention BMP Provincial Statistics

This section will report the BMP uptake and distribution statistics from the period between 2005 and 2009. The data sources for this section include the ARDCorp program files as well as data collected through the BMP assessment survey.

Cost-Share and Cap Structure and Average BMP Project Cost

The Wildlife Damage Prevention BMP was cost-shared at 30% of total eligible costs up to $10,000 until March 2008. The average cost of a Wildlife Damage Prevention BMP project, taking into account only the eligible costs is $14,031. The average cost of a BMP project to protect stored feed (and not crops) is $7,200.

Adoption Distribution

A total of 318 Wildlife Damage Prevention BMP projects have occurred across BC between 2005 and 2009. The majority of projects have occurred in the Fraser Valley, the Okanagan-Similkameen regions and Vancouver Island. A smaller amount of projects have also occurred in the Kootenays, Cariboo and Peace Regions. This BMP has the largest geographic spread of all of the BMPs that are assessed in this report, which is possibly an indicator of the spread of the agriculture-wildlife conflicts across the province.

Table 37. The number of BMPs that have been adopted in each Regional District.

Regional District	# of BMPs Adopted
Okanagan Similkameen	101
Central Okanagan	40
Capital Regional District	24
Fraser Valley	19
North Okanagan	17
Peace River	14
Comox Valley	13
Cowichan Valley	13
Metro Vancouver	10
Central Kootenay	8
Kootenay Boundary	7
East Kootenay	5
Nanaimo	5
Bulkley-Nechako	4
Columbia-Shuswap	4
Thompson-Nicola	4
Alberni Clayquot	2
Squamish-Lilloet	1

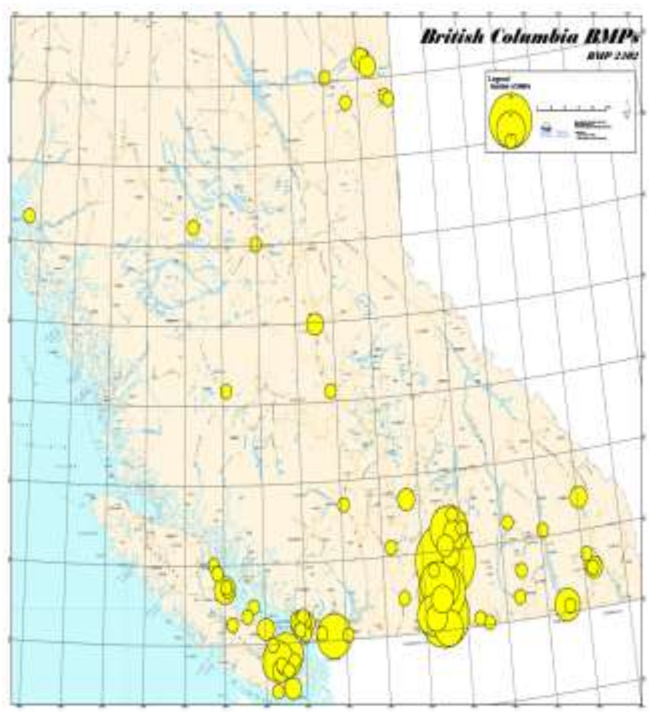

Figure 26. Geographic Distribution of Wildlife Damage Prevention BMP Adoption Between 2005 - 2009.

Adoption By Commodity

The Wildlife Damage BMP has been adopted by a range of commodities, with the largest group being tree fruit growers (35%) and grape growers (28%) in the Okanagan-Similkameen. 9% of respondents indicated that they are certified organic.

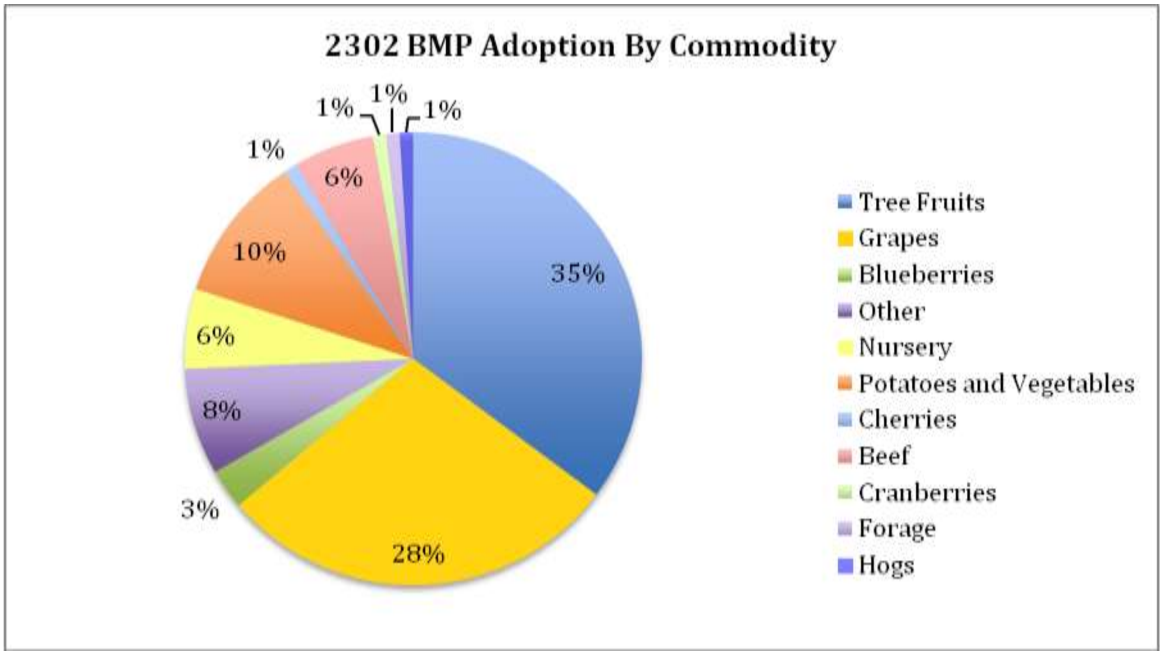

Figure 27. Wildlife Damage Prevention BMP adoption between 2005 and 2009 by commodity.

Adoption Over Time

Adoption of the Wildlife Damage Prevention BMP grew steadily until adoption was at its highest in 2008 when approximately 139 farms completed BMP projects. After the 2008-2009 project year, the BMP was no longer offered through the BMP Program. The reasons for the differences in adoption rates by year were not explicitly assessed in this study; however, it appears that adoption rates were steadily increasing by year prior to this BMP being cut from program funding.

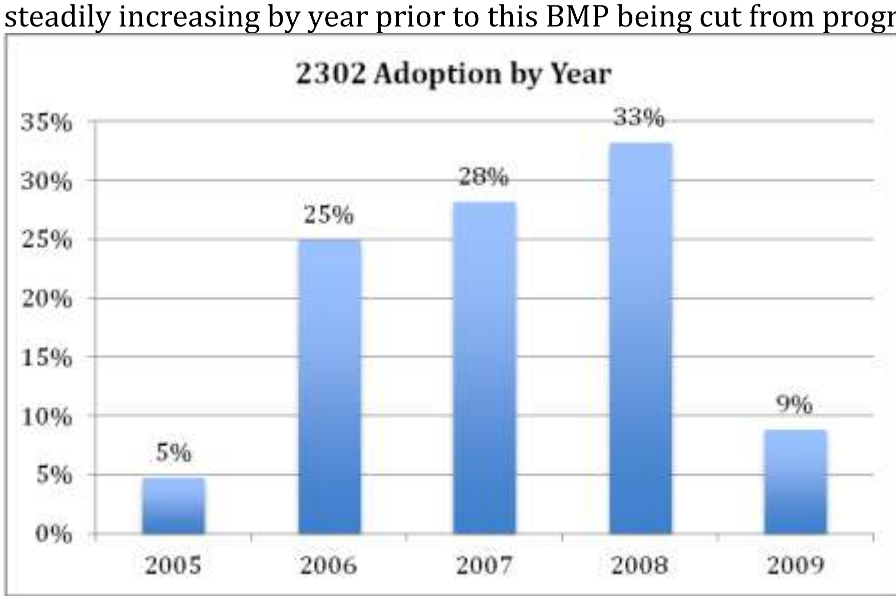

Figure 28. Temporal distribution of Wildlife Damage Prevention BMP adoption

Wildlife Damage Prevention BMP Farm Characteristics

Understanding the characteristics of the average Wildlife Damage Prevention BMP adopter compared to the average population of farmers across BC will give insight into the unique characteristics of the farms that choose to adopt this BMP. Where appropriate, statistics for farms that adopted the BMP to protect crops will be reported separately from farms that adopted the BMP to protect stored forage. The following farm characteristics and socio-demographic information are compared to Statistics Canada 2006 Census of Agriculture information where possible. [25]

Size of the Average Farm Adopting the Wildlife Damage Prevention BMP

The average size of farm that adopts the Wildlife Damage Prevention BMP to protect stored feed is 286 hectares. They have an average of 233 livestock of which the majority are beef cows (average of 204 beef cows per ranch). The average size of farms that adopt this BMP to protect ground crops is 13.2 hectares.

Table 38. Farm size and number of livestock on farms that adopt the Wildlife Damage Prevention BMP

	Stored Feed - # Livestock	Stored Feed - Farm Size (ha)	Crop – Farm Size (ha)
Average	233	286.0	13.2
Median	83	207.4	8.2
Min	1	46.5	1.6
Max	750	775.7	42.4

Farm Gate Sales

The farm gate sales in 2010 for adopters of the Wildlife Damage Prevention BMP indicate that adopters of this BMP are less heavily weighted in the minimal farm gate sales bracket and more heavily weighted in the $50,000-$99,000 bracket when compared to all BC farmers farm gate sales in 2006.

Table 39. Farm Gates Sales of Wildlife Damage Prevention BMP Adopters (both crops and stored feed) compared to the average BC Farmer

Farm Gate Sales	% of BMP Adopters in 2010	% of BC Farmers in 2006 Census
Less than $10,000	22.6%	47.7%
$10,000-$24,999	25.8%	16.1%
$25,000-$49,999	9.7%	10.3%
$50,000-$99,999	19.4%	8.0%
$100,000-$249,999	6.5%	7.7%
$250,000 and over	6.5%	10.2%

[25] Statistics Canada. (2006). Census of agriculture: farm data and operator tables. Retrieved from http://www.statcan.gc.ca/pub/95-629-x/2007000/4182411-eng.htm#gfr on January 15, 2012.

Age of Adopters

The average age of the Wildlife Damage Prevention BMP adopters is higher than the BC average for farmers reported in the 2006 Census of Agriculture[26]. Table 40 reports the age distribution of Wildlife Damage Prevention BMP adopters compared to the age distribution of farmers in BC.

Table 40. Age of Wildlife Damage Prevention BMP adopters compared to the average for BC Farmers

Age Category	Percentage of BMP Adopters	Farmers in BC
18-34	0.0%	9.1%
35-54	40.6%	50.2%
55 and above	59.4%	40.7%

Farming Experience

Respondents were asked to indicate how many years they have farmed as a proxy for how much experience they have with farming. The average number of years that adopters of the Wildlife Damage Prevention BMP have farmed is 24 years with a minimum of 4 and a maximum of 56. Respondents were also asked how many years they have farmed on the property where the BMP was adopted. The average time farmed on the property was 16 years with a minimum of 3 and a maximum of 56.

Ownership

Respondents were asked whether the land where the BMP was adopted was privately owned, leased or provincially owned. 94% of respondents indicated that the land that the BMP was implemented on is privately owned. 6% of respondents indicated that the BMP was implemented on land that is leased.

3.4.4 Wildlife Damage Prevention BMP in Practice

This section gives a brief overview of the how the Wildlife Damage Prevention BMP has, in general, been implemented in practice as well as the nature of the wildlife damage. When it was available, the BMP funding was allocated to:

- Fencing and gate materials; and
- Installation costs.

Species of Wildlife Causing Damage

Respondents were asked to indicate what specie(s) were (and in some cases still are) causing damage on their farm. The majority of respondents (94%) indicated that deer cause damage to either crops or stored feed on the farm. Other species that

[26] Statistics Canada. (2008). Farm operators by age in BC. 2006 Census of Agriculture. Retrieved from http://www40.statcan.gc.ca/l01/cst01/agrc18a-eng.htm

were listed include coyotes, black bears, elk, sheep and moose. Figure 29 summarizes the main species that cause damage on farms in BC.[27]

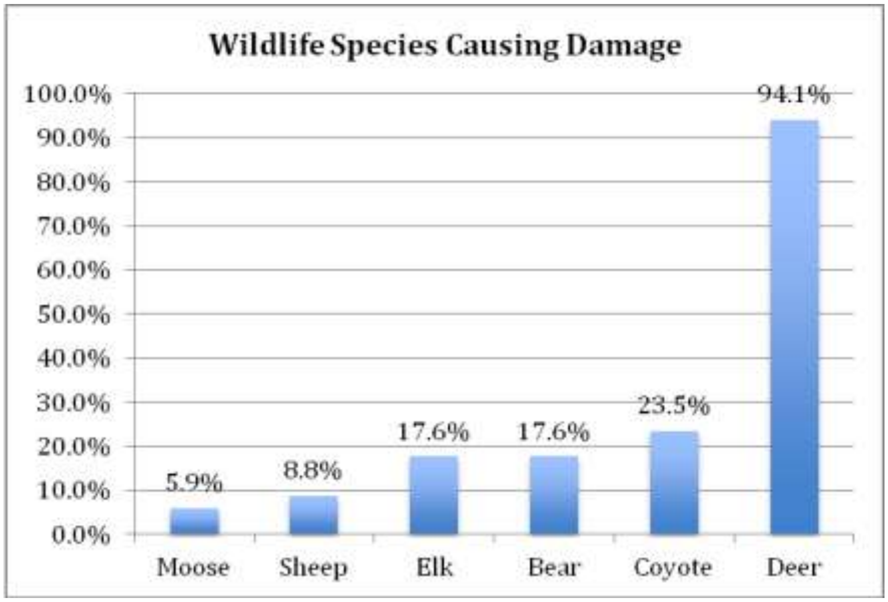

Figure 29. Species that cause(d) damage to farms that adopted the Wildlife Damage Prevention BMP.

Type and Cost of Damages

Respondents indicated the nature of the damages that were being caused by wildlife and what the annual value of damage (farm gate value) was prior to BMP adoption. The majority of respondents (88%) indicated that wildlife were damaging their crops at an average cost of $5,454 annually. 29% of respondents indicated that coyotes were damaging their irrigation lines at an average cost of $820.

15% of respondents indicated that wildlife were damaging stored feed at an average cost of $10,200 per farm or ranch. Interviewees indicated that it is mostly elk, moose and deer that cause damage to stored feed. The damage that occurs in a stackyard often takes place in a short period of time (over one or two nights) and can have devastating effects on feed stores as wildlife not only eat feed, but ruin it by defecating, urinating and trampling it. Table 41 provides a summary of the type of damage and average annual cost to producers prior to BMP adoption.

Table 41. The type of damage and annual value of the damage per farm caused by wildlife species prior to BMP adoption.

Type of Damage	Percentage of Respondents	Average Annual Value of Damage
Stored Feed	15%	$10,200
Irrigation	29%	$820
Crops	88%	$5,454
Other	18%	$1,000

[27] Note that although some respondents indicated that birds and small mammals cause damage on their farm, those species weren't included in the analysis.

Other types of damages experienced by adopters include black bears damaging honeybees and young trees. One respondent indicated that they have an issue with elk breaking through trellises and irrigation lines.

Figure 30. A large herd of mule deer feeding on stored hay over winter in the Peace Region. These deer became residents moving back and forth between the stackyard and winter feeding areas prior to the wildlife fence being installed.

Area Fenced by Wildlife Damage Prevention BMP

The average crop area fenced by the Wildlife Damage Prevention BMP is 4.5 hectares. The average area fenced to protect stored feed is 0.8 hectares. Two respondents indicated that they had fenced their entire forage field as well as their stored feed averaging 53.5 hectares fenced in total.

Damages Post BMP Adoption

Respondents were asked to indicate the value of damages (if any) that they experienced after adopting the Wildlife Damage Prevention BMP. For the most part, the wildlife fencing results in complete protection of crops and stored feed. Some respondents indicated that they are still experiencing coyote damage to irrigation lines; however, the annual value of the damage is low at $78/farm.

In a separate question, respondents were asked if any "new" damages are occurring since installing the wildlife fence. Two forage/beef producers indicated that pressure on standing forage crops has increased in recent years. Both ranchers are experiencing an average cost of $18,750 annually in damages to standing forage and swath grazing pastures.

One interviewee in the Peace region indicated that the mobility of wildlife has increased with the growth in the road network due to oil and gas expansion. The increased mobility combined with convenient food sources has led to population explosions and even more pressures on stored and standing forage.

3.4.5 Environmental Impact of the Wildlife Damage Prevention BMP

The above sections provide insight into how the Wildlife Damage Prevention BMP has been implemented in practice, whereas this section provides insight into the environmental impact that the BMP could have based on data collected through the assessment survey.

Figure 31. Cows grazing on alfalfa, sharing their food with deer in the background in the Peace Region.

Impact on Wildlife Habitat

The installation of a fence on agriculture land has the effect of reducing the amount of habitat available for wildlife species. Without discussing whether or not farms should provide habitat for wildlife, a brief analysis of the impact of the Wildlife Damage Prevention BMP will be presented.

2365 hectares of agricultural land have been fenced out from wildlife between 2005 and 2009 due to the adoption of the Wildlife Damage Prevention BMP. Relative to the amount of forested and other native lands in the province the area that has been fenced out is small. However, respondents in both interviews and surveys indicated that adoption of wildlife fencing is only pushing the wildlife onto other people's farms, ranches and residential properties. The concentrated pressures of deer and other wildlife on both crops, stored feed and standing forage are so high in some parts of the province that respondents indicated that farms in their area cannot continue viably without fencing.

Respondents were asked to indicate whether or not they provide some wildlife habitat on their farm. 50% of respondents indicated that they do provide some habitat for wildlife on their property. Beef and forage producers provide an average of 179 hectares of wildlife habitat on their properties. Other crop producers provide an average of 6.2 hectares of wildlife habitat on their farms.

Further studies are needed to determine what the actual impact of this BMP has been on wildlife habitat, species survival and migration.

Impact on the Adoption of Other Agri-Environmental BMPs

As reported above, the cost that farm operations can incur from damages to their operation from wildlife can be high. This begs the question about whether or not farmers can afford to adopt other agri-environmental BMPs without first installing a wildlife fence to protect their current farm assets and sources of revenue.

This sentiment was expressed by several interviewees as well as resonated in the comments provided in surveys. Adoption of the Wildlife Damage Prevention BMP increases the viability of the farm operation therefore having a positive impact on the adoption of other agri-environmental BMPs. In future studies, it may be beneficial to test this hypothesis to see if adopters of this BMP are in fact adopting others as well.

3.4.6 Economic Impact of Wildlife Damage Prevention BMP Adoption

This section will present the additional operational objectives that motivate farmers and ranchers to adopt the Wildlife Damage BMP as well as the costs that they incur when doing so. To assess the economic impact of the BMP to society a cost-benefit analysis was conducted. The results of the cost-benefit analysis are presented below in this section.

Business/Operational Objectives of the Wildlife Damage Prevention BMP

Mitigation of the damages to crops, stored forage and irrigation lines by wildlife were discussed in the above sections and are the primary economic motivation for the adoption of the Wildlife Damage Prevention BMP. However, other operational impacts occur due to the adoption of the BMP. The following sections will present some of the impacts experienced by adopters of the Wildlife Damage Prevention BMP.

Other Wildlife Deterrent Practices

Respondents were asked to indicate the practices they used to deter wildlife prior to BMP adoption as well as what practices they use to deter wildlife post BMP adoption. Results indicate that other wildlife deterrent practices generally decreased with the adoption of the Wildlife Damage Prevention BMP. Practices prior to and post BMP adoption are presented in Figure 32.

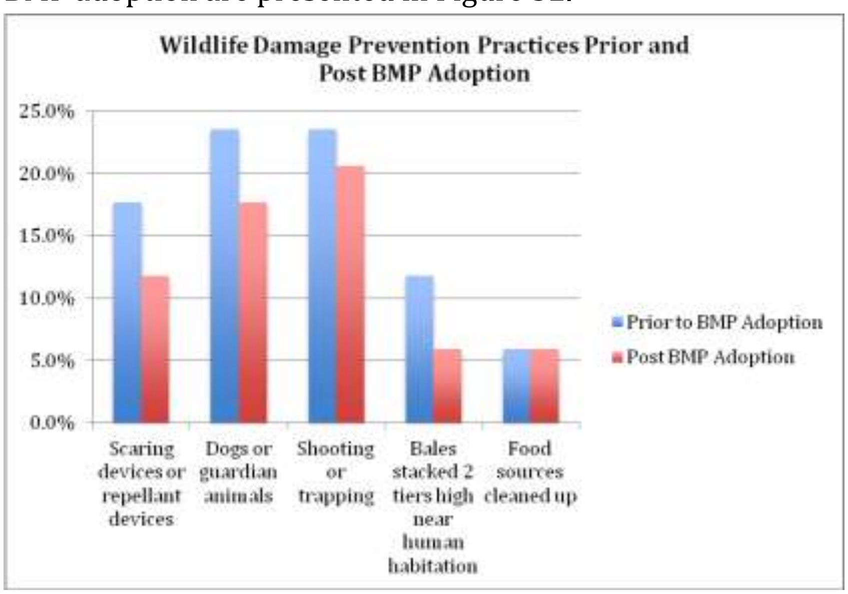

Figure 32. Wildlife damage prevention practices employed prior and post BMP adoption.

The average cost of damage prevention practices prior to BMP adoption was $378 per farm annually. The average cost of other damage prevention practices employed now is $18 per farm annually.

Marketing

29% of respondents indicated that they use the EFP/BMP Program for marketing purposes. Of those, seven indicated that they put the EFP sign on their road or driveway. One respondent advertises the EFP program on their website.

Labour Requirements

Respondents were asked to indicate how many hours of labour annually they spent previously deterring wildlife, and how many hours annually they spend deterring wildlife now that the wildlife fence has been installed. 44% of respondents indicated that they experienced a decrease in labour requirements due to BMP adoption. Reasons for the decrease in labour include:

- Less clean up in the silage pit/stackyard;
- No need to wrap stacks each fall to protect them over the winter;
- Less time spent replanting damaged trees; and
- Less time spent deterring wildlife using the practices described above.

20% of respondents indicated that they experienced an increase in labour requirements since adopting the Wildlife Damage Prevention BMP. Reasons for the increase in labour include:

- Having to haul hay to the yard and then out to feed in the winter;
- Routine maintenance on the fence;
- Checking the fence for holes and wildlife breaches.

On average, adopters experienced a 43-hour per year decrease in annual labour requirements due to BMP adoption.

Figure 33. A stackyard in the Peace region after wildlife had been feeding and bedding in it. Cleaning up a mess such as this can be very labour intensive in addition to the cost of lost feed.

Figure 34. The now fenced stackyard eliminates the cost of damaged stored feed as well as decreases the amount of labour needed to deter wildlife and clean up damaged feed.

Wildlife Damage Prevention Cost-Benefit Analysis

To understand the economic impact of BMP adoption to society, a cost-benefit analysis was conducted. See Appendix II for a detailed methodology of the cost-benefit analyses that was conducted. Appendix IV contains a summary of the average costs and benefits used in the Wildlife Damage Prevention CBA. The data is presented by first showing an analysis for stored feed and crop protection separately, and then in aggregate.

Wildlife Damage Prevention for Stored Feed CBA

Net Present Value of the Program to Date

Depending on the specification of the discount rate aggregate benefits ranged from a low of $1,090,066 to a high of $1,231,270, while the costs ranged from a low of $181,885 to a high of $242,869. The net present values calculated for the program to date were all positive. They ranged from a low of $908,181 in the case of a 0% discount rate to a high of $988,401 in the case of an 8% discount rate.

Table 42. Benefit, Cost and NPV of Program to Date[a]

Discount Rate	Benefit	Cost	Net Present Value
0 %	$1,090,066	$181,885	$908,181
3 %	$1,140,921	$203,084	$937,837
8 %	$1,231,270	$242,869	$988,401

[a] Values are in 2011 Canadian dollars.

Net Present Value over the Expected Life of the Program

Depending on the specification of the discount rate aggregate benefits ranged from a low of $3,316,241 to a high of $4,333,999, while the costs ranged from a low of $196,293 to a high of $252,129. The net present values calculated for the program over its expected lifetime were all positive. They ranged from a low of $3,064,111 in the case of an 8% discount rate to a high of $4,137,706 in the case of a 0% discount rate.

Table 43. Benefit, Cost, and NPV over the Expected Life of the Program[a]

Discount Rate	Benefit	Cost	Net Present Value
0 %	$4,333,999	$196,293	$4,137,706
3 %	$3,857,874	$215,151	$3,642,723
8 %	$3,316,241	$252,129	$3,064,111

[a] Values are in 2011 Canadian dollars.

Net Present Value of Adding one Farmer in 2011

Depending on the specification of the discount rate aggregate benefits ranged from a low of $112,414 to a high of $197,000, while the costs ranged from a low of $8,547 to a high of $8,922. The net present values calculated for adding an agricultural producer today were all positive. They ranged from a low of $103,868 in the case of an 8% discount rate to a high of $188,078 in the case of a 0% discount rate.

Table 44. Benefit, Cost and NPV of Adding One Farmer to the Program in 2011 [a]

Discount Rate	Benefit	Cost	Net Present Value
0 %	$197,000	$8,922	$188,078
3 %	$156,785	$8,744	$148,041
8 %	$112,414	$8,547	$103,868

[a] Values are in 2011 Canadian dollars.

Wildlife Damage Prevention for Crops CBA

Net Present Value of the Program to Date

Depending on the specification of the discount rate aggregate benefits ranged from a low of $4,022,983 to a high of $4,560,735, while the costs ranged from a low of $6,093,271 to a high of $8,010,647. The net present values calculated for the program to date were all negative. They ranged from a low of -$3,449,911 in the case of an 8% discount rate to a high of -$2,070,288 in the case of a 0% discount rate.

Table 45. Benefit, Cost and NPV of Program to Date[a]

Discount Rate	Benefit	Cost	Net Present Value
0 %	$4,022,983	$6,093,271	-$2,070,288
3 %	$4,216,348	$6,759,717	-$2,543,369
8 %	$4,560,735	$8,010,647	-$3,449,911

[a] Values are in 2011 Canadian dollars.

Net Present Value over the Expected Life of the Program

Depending on the specification of the discount rate aggregate benefits ranged from a low of $12,040,457 to a high of $15,627,335, while the costs ranged from a low of $8,978,047 to a high of $9,870,063. The net present values calculated for the program over its expected lifetime were all positive. They ranged from a low of $2,170,394 in the case of an 8% discount rate to a high of $6,649,288 in the case of a 0% discount rate.

Table 46. Benefit, Cost, and NPV over the Expected Life of the Program[a]

Discount Rate	Benefit	Cost	Net Present Value
0 %	$15,627,335	$8,978,047	$6,649,288
3 %	$13,947,242	$9,178,762	$4,768,480
8 %	$12,040,457	$9,870,063	$2,170,394

[a] Values are in 2011 Canadian dollars.

Net Present Value of Adding one Farmer in 2011

Depending on the specification of the discount rate aggregate benefits ranged from a low of $30,127 to a high of $52,795, while the costs ranged from a low of $24,696 to a high of $30,331. The net present values calculated for adding an agricultural producer today were all positive. They ranged from a low of $5,431 in the case of an 8% discount rate to a high of $22,464 in the case of a 0% discount rate.

Table 47. Benefit, Cost and NPV of Adding One Farmer to the Program in 2011 [a]

Discount Rate	Benefit	Cost	Net Present Value
0 %	$52,795	$30,331	$22,464
3 %	$42,018	$27,652	$14,366
8 %	$30,127	$24,696	$5,431

[a] Values are in 2011 Canadian dollars.

All Wildlife Damage Prevention BMPs Combined CBA (both stored feed and crops)

Net Present Value of the Program to Date

Depending on the specification of the discount rate aggregate benefits ranged from a low of $8,150,816 to a high of $9,238,056, while the costs ranged from a low of $5,460,593 to a high of $7,347,987. The net present values calculated for the program to date were all positive. They ranged from a low of $1,890,068 in the case of an 8% discount rate to a high of $2,690,222 in the case of a 0% discount rate.

Table 48. Benefit, Cost and NPV of Program to Date[a]

Discount Rate	Benefit	Cost	Net Present Value
0 %	$8,150,816	$5,460,593	$2,690,222
3 %	$8,541,807	$6,115,194	$2,426,613
8 %	$9,238,056	$7,347,987	$1,890,069

[a] Values are in 2011 Canadian dollars.

Net Present Value over the Expected Life of the Program

Depending on the specification of the discount rate aggregate benefits ranged from a low of $24,421,938 to a high of $31,712,391, while the costs ranged from a low of $5,747,551 to a high of $7,532,913. The net present values calculated for the program over its expected lifetime were all positive. They ranged from a low of $16,889,025 in the case of an 8% discount rate to a high of $25,964,840 in the case of a 0% discount rate.

Table 49. Benefit, Cost, and NPV over the Expected Life of the Program[a]

Discount Rate	Benefit	Cost	Net Present Value
0 %	$31,712,391	$5,747,551	$25,964,840
3 %	$28,297,844	$6,355,803	$21,942,040
8 %	$24,421,938	$7,532,913	$16,889,025

[a] Values are in 2011 Canadian dollars.

Net Present Value of Adding one Farmer in 2011

Depending on the specification of the discount rate aggregate benefits ranged from a low of $56,906 to a high of $99,725, while the costs ranged from a low of $17,553 to a high of $18,074. The net present values calculated for adding an agricultural producer today were all positive. They ranged from a low of $39,353 in the case of an 8% discount rate to a high of $81,650 in the case of a 0% discount rate.

Table 50. Benefit, Cost and NPV of Adding One Farmer to the Program in 2011 [a]

Discount Rate	Benefit	Cost	Net Present Value
0 %	$99,725	$18,074	$81,650
3 %	$79,367	$17,826	$61,541
8 %	$56,906	$17,553	$39,353

[a] Values are in 2011 Canadian dollars.

3.4.7 Social and Motivating Factors of Wildlife Damage Prevention BMP Adoption

This section will present the results of a series of questions about various personal and social aspects of BMP adoption to try to understand the following:

- The personal/business motivations behind the Wildlife Damage Prevention BMP adoption (some of which have been discussed above);
- The adopter's perception of the benefits to society that the BMP provides; and
- The barriers to adoption of the Wildlife Damage Prevention BMP by other farmers or ranchers.

Motivating Factors for Adoption of the Wildlife Damage Prevention BMP

Respondents were asked to rate on a scale of 1 to 5 (not important to very important), the reasons why they chose to adopt the Wildlife Damage Prevention BMP from a list of possible motivations. Business or operational motivations scored higher than the stewardship motivations with the highest motivations being to reduce the damage that wildlife cause to the farm (4.6) and to improve the profitability of the operation (4.1).

Table 52. Average rating of motivating factors for Wildlife Damage Prevention BMP adoption organized from highest to lowest.

Motivation	Score
Reduce damages wildlife cause to the farm	4.6
Improve the profitability of the operation	4.1
Improve the long-term sustainability of the operation	3.8
Limit the farm's impact on the environment	3.0
Demonstrate stewardship	3.0
Contribute to a positive industry image	2.8
Limit the farm's impact on wildlife	2.8
To avoid regulatory fines	1.9

Respondents were also asked to indicate any other motivating factors that were not included in the list of motivations. Responses included:

- Facilitated the existence of more wildlife;
- Creating an environmentally responsible farm; and
- That they saw it as the only solution to managing agriculture-wildlife conflict.

Social Benefits Provided by the BMP

Respondents were asked whether or not they feel that their Wildlife Damage Prevention BMP provides a benefit to society. 64% of respondents indicated that they feel the BMP provides a social benefit. Responses to the type of social benefit provided by the BMP include:

- Encouraging wildlife to forage as they are intended to do in nature;
- Protection of wildlife; and
- Increased food production, supply of local food to the market and farm viability.

Barriers to Adoption of the Wildlife Damage Prevention BMP

Similar to the motivation question described above, respondents were asked to rate on a scale from 1 to 5 (not a barrier to a large barrier) a set of barriers to Wildlife Damage Prevention BMP adoption. The exact wording of the question was "In your opinion, what are the barriers to adoption of the Wildlife Damage Prevention BMP by other producers in your industry". Overall, scores for barriers were similar to those indicated by adopters of the Irrigation Management BMP. Responses indicate the largest barrier is cost (4.0). The rest of the barriers scored relatively low, indicating that cost is generally the primary deterrent for anyone who hasn't already adopted this BMP either through the program, or on their own. Echoing the sentiments expressed by respondents, "Other environmental priorities take precedent" was rated as the lowest barrier. This indicates that wildlife damage is a top priority amongst those impacted by it and takes precedent over other environmental concerns.

Table 53. Barriers to Wildlife Damage Prevention BMP Adoption

Barriers	Score
Costs associated with BMP adoption	4.0
A lack of time or labour	2.9
Barriers to accessing funding through the BMP Program	2.8
A lack of understanding about *which* BMP will benefit their operation	2.6
A lack of support from public agencies	2.6
A lack of understanding about *how* the BMP will benefit their operation	2.4
A lack of industry pressure	2.3
A lack of public pressure	2.3
A lack of awareness of risks to the environment from farm practices	2.2
No succession plan for their farm	2.1
Logistically not feasible	1.9
Other environmental priorities take precedent	1.8

Comments regarding barriers in the comment line included:

- Negative impact on aesthetics;
- The cost of fencing large areas such as forage fields; and
- The lack/shortage of funds through the BMP Program.

3.4.8 Wildlife Damage Prevention BMP SWOT Analysis

A brief SWOT (Strength, Weaknesses, Opportunities, Threats) Analysis is presented in this section to organize some of the main findings of the BMP assessment as well as present anecdotal information that may not be presented in the report for the Wildlife Damage Prevention BMP above. Note that this is only the preliminary step in a SWOT analysis and further steps including a detailed analysis and development of an action plan are often conducted in order to direct policy.

Strengths

- The BMP had relatively high uptake by the impacted sectors.
- There are very obvious operational motivations to adopting this BMP, aiding in the uptake.
- The BMP allows farmers to produce food viably. In some cases, respondents indicated that they would not be in business without a fence. Food production in the province is a clear benefit to society.

Weaknesses

- The BMP adoption has been mostly concentrated across the Southern portion of BC. Less BMP projects were adopted in Central and Northern BC while the funding was available.
    - As some respondents indicated there are almost no grape or tree fruit producers without a wildlife fence; they wouldn't be able to farm without one.
    - The benefits of the BMP funding are currently not available to farmers in the North who indicate that they are experiencing increased wildlife pressures.
- The BMP funding does not differentiate between the different needs of farms and ranches across the province. The cost to adopt a fence for a stackyard is less than to protect a crop of grapes; however, the value of damage prevention for a stackyard is higher than that of crops. The funding levels and incentives do not reflect this difference.
- Ranchers in the North indicated that the increased wildlife pressures combined with the lower price of beef, relative to pre-BSE prices, leaves little room in the budget to implement other environmental BMPs.

Opportunities

- If the Wildlife Damage Prevention BMP is considered for BMP funding again, there is an opportunity to target the BMP specifically for Northern areas, or specifically to protect stored feed.
- Some ranchers would like to see BMP funding to prevent wildlife damage to standing forage.
    - The Peace River Forage Association promotes the uptake of three dimensional (3D) fencing as a low cost alternative to traditional wildlife fencing. 3D fencing may be used to fence in larger areas such as around the perimeter of a forage field or swath grazing area, as it is less costly than fencing used around stackyards. Trials in the Peace region have shown that 3D fencing is effective at protecting standing and stored forage from wildlife. For more information visit the Peace River Forage Association's website (http://www.peaceforage.bc.ca).

Threats

- Although no clear evidence is available, it is possible that the Wildlife Damage Prevention BMP has decreased wildlife habitat and disrupted habitat continuity in some areas of the province.
- Wildlife pressures in some areas are increasing, (based on anecdotal information). It is possible that adopting the Wildlife Damage Prevention BMP is diverting the wildlife pressures to those who have not or cannot adopt this BMP. Thus providing a positive impact for the individual adopter, but a having a negative impact on those who do not have a fence. This is the case for some respondents who indicated that the pressures on neighbours crops and stored feed have increased due to their fence.
    - In the authors' opinion, wildlife fencing is only part of the solution to managing agriculture-wildlife conflict.
    - A more comprehensive management system that employs innovative solutions to the agriculture-wildlife conflict may be beneficial in the long-term.
    - Farmers and ranchers have innovative ideas about how to manage wildlife and are a valuable resource if there is a desire create a more comprehensive wildlife management strategy in the province. For example, ranchers in the North at the time of this project were passionate about increasing the capacity for guided hunts on their ranches – enhancing tourism, generating income and managing wildlife populations at a reasonable level.

3.4.9 Conclusions and Recommendations for the Wildlife Damage Prevention BMP

This section provides an overview of the main conclusions derived from the BMP assessment. Recommendations will also be provided where appropriate. Note that these conclusions and recommendations are based on the authors' opinions and reflect both qualitative and quantitative information collected during the assessment.

Is the BMP having the impact it was designed to have?

To recap, the Wildlife Damage Prevention BMP is intended to address both the impacts that wildlife can have on farm operations and the impacts that farms can have on wildlife and biodiversity by installing physical barrier between wildlife and farm operations.

In the authors' opinion the Wildlife Damage Prevention BMP is, generally, having the impact that it was designed to on the farms where it was installed (note that the majority of BMP projects occurred in the Southern portion of BC between 2005-2009). In almost all cases, the wildlife that were causing damage prior to adoption are no longer causing damage to the area that was excluded by the fence (either stored feed or crop areas). However, in some cases the BMP has not completely eliminated the issue of wildlife damage to all farm operations (e.g. forage producers are still experiencing damage to standing forage). There are also some adopters who still practice shooting and trapping to prevent wildlife damage post-BMP adoption.

Therefore, the fence isn't completely eliminating the certain types of agriculture-wildlife conflict amongst a small portion of the adopters (~20%).

In addition, while the BMP may mitigate the environmental risk for the farm that has adopted the BMP, the BMP may be displacing the problem and effectively increasing the wildlife pressure on those who have not installed a wildlife fence. In areas where adequate wildlife habitat is provided on ranches and elsewhere, the issue of displacement may not be as much of a concern. *If this BMP is considered for BMP funding in the future, we recommend that regional wildlife experts as well as producers/ranchers be engaged to determine the best means of structuring the BMP to achieve a reduction of agriculture-wildlife conflicts across the landscape in addition to reduction at the individual farm and ranch level.*

Does the BMP meet the expectations of adopters?

The results of the BMP assessment survey as well as anecdotal information provided by interviewees indicate that the BMP is meeting the expectations of those who were able to adopt the BMP while it was cost-shared through the BMP Program.

Is there justification for continued support of the BMP?

Based on the following criteria the authors recommend *reinstating support* of the Wildlife Damage Prevention BMP with emphasis on fencing to protect stored feed in the highly-impacted areas of the province. The criteria used to come to this conclusion are as follows:

Does the BMP mitigate the environmental risk(s) it was intended to?

- Based on the environmental indicators described in this report, the Wildlife Damage Prevention BMP is mitigating the risks on farms where it was adopted. However, in certain areas of the province where the BMP was not widely adopted while BMP funding was available, the risk of agriculture-wildlife conflicts has not been adequately prevented by the BMP (i.e. in the Peace Region and other interior regions were damages to stored feed are a major concern amongst ranchers).

Does the BMP provide the expected benefit to the adopter?

- Based on the results of the BMP assessment survey as well as anecdotal information, the BMP has met the expectations of those who have adopted it.

Does the BMP provide a benefit to society?

- The BMP has a positive Net Present Value indicating that the BMP is a benefit to society.

4.0 Additional Assessment Questions

This section reports the results of three social impact of BMP adoption questions analyzed across all four BMPs. Finally, a question that explores the preferred information channels for agri-environmental BMPs is presented.

Impact on Personal Pride for Farm Operation

Respondents were asked to indicate whether or not adopting their agri-environmental BMP increased their personal pride in their farm operation. 84% of respondents indicated that adopting a BMP increased their pride, 9% of respondents indicated that their pride did not change as a result of BMP adoption and 7% did not know.

Motivation to Adopt Additional BMPs

Respondents were asked to indicate whether they would be more likely or less likely to adopt additional BMPs after their experience with the BMP they adopted. 83% of respondents indicated that they would be more likely to adopt agri-environmental BMPs after their experience with the BMP Program. 3% indicated they would be less likely to adopt more BMPs and 15% were neutral.

Sharing of Environmental Farm Plan Program/BMP Program Experience

Respondents were asked to indicate whether or not their farming peers or neighbours have recognized that they completed an Environmental Farm Plan or adopted a BMP on their farm. 66% of respondents indicated that they had shared their EFP/BMP experience in some way with their neighbours or peers. Some interviewees indicated that groups of neighbours have all done EFPs. Some indicated that they have held tours of their BMP projects to interested peers.

Preferred Information Sources

Respondents were asked to indicate which information channels they prefer to receive information about environmental farm practices from. The majority of respondents (53%) indicated that that they prefer to read about environmental farm practices in agricultural magazines. The Internet and newsletters are preferred by approximately 40% of respondents. A summary of the preferred information channels is reported in Table 54.

Table 54. The information channels preferred by BMP adopters.

Source of Information	% Preferred
Agricultural Magazines	53.0%
Internet Websites	46.2%
Newsletters	42.7%
Farm Demos and Field Tours	29.1%
Classes/Workshops	23.9%
Supply Companies	23.9%
Government Publications	22.2%
Peers	21.4%
Newspapers	16.2%
TV	10.3%
Books	8.5%
Mobile Media	4.3%
Social Media Websites	3.4%

Other preferred information channels indicated by respondents include:

- Industry associations;
- Planning Advisors;
- Veterinarian;
- Email lists; and
- The Ministry of Agriculture.

5.0 Recommendations for Future BMP Assessment Studies

Based on initial experiences conducting the BMP assessment in 2011-2012, the authors have assembled a list of suggestions for how to improve the assessment methodology for subsequent projects.

- *Continue to conduct both interviews and mail-out surveys:*
    - The project team recognized that the data collected through personal interviews is sometimes of better quality and in context versus the data collected through mail-out surveys. However, in order to capture the experiences of a larger sample of adopters, it is likely that a mail-out survey will always be necessary.

- *Allow for more time to conduct interviews and collect survey responses by initiating the survey development and contact period earlier in the program year.*
    - The project team encountered challenges arranging the specified interview targets within the two-month time period budgeted for interviews. Allowing more flexibility in the timing of interviews could allow for a larger sample of interviews/site visits. By extending the survey period, the interviewers will have time to strategically arrange interviews based on the farming season.

- *Conduct assessments multiple times and closer to the time of adoption:*
    - In the project team's opinion, it could be useful to conduct an assessment of the BMPs evaluated in this report at least one more time in the future to measure the impact of the BMP over time to see if the intended effects are achieved over the lifespan of the BMP.
    - If the initial interview/assessment process could be conducted closer to the time of adoption, it could serve a dual purpose, both assessing the effectiveness of the BMP as well as troubleshooting any issues or complications that the producer has encountered. Furthermore, recall bias may be less of an issue amongst the respondents.

- *Collect some baseline data either through the BMP application form or through a separate form completed by the Planning Advisor.*
    - Simple baseline data such as the type of irrigation system used previously and the type of crop being grown on the land prior to BMP adoption (in the case of 1801) would allow for the collection of baseline data on the farms that adopt BMPs. In the future this baseline data could be used as a more accurate means to assess the impact of BMP adoption over time. Furthermore, the current BMP Program data may be supplied electronically by ARDCorp rather than in paper form

as all information required from the files is available through ARDCorp's electronic database.

- *Set program targets/goals to work towards:*
    - To be able to measure the "effectiveness" of a BMP towards achieving the intended impact province-wide, it may be useful to specify targets for each BMP either per program year, or over a set period of time. BMP targets would allow for monitoring of the progress of the BMP adoption towards specified program goals.

As a final note, the project team recognizes that the methodology employed to conduct this initial BMP assessment is not a replacement for more rigorous environmental monitoring programs such as those conducted by the Watershed Evaluation of Beneficial Management Practices project (WEBs) or other environmental monitoring projects that collect data over time. Nor does the methodology replace a more rigorous assessment of BMP adoption, such as an adoption model study would provide. In the authors' opinion, the BMP assessment study methodology demonstrated here is strongest when used as one of several tools employed by program-managers to monitor the impact and effectiveness of agri-environmental BMPs on BC farms.

Appendix

I. Socio-Economic and Environmental Assessment of Beneficial Management Practices: Literature Review

1. Introduction

Grounding a study in relevant literature is an important step when conducting research in order to place the study in the context of existing information. A literature review also serves to identify the research gap that you hope to fill by doing the research. To develop the approach and context for the Socio-Economic and Environmental Assessment of Beneficial Management Practices Project (herein referred to as the BMP Assessment Project) several key pieces of literature have been reviewed. Due to the wide scope of the project, a broad scan of literature was undertaken including literature from the federal government, provincial governments, international organizations, peer reviewed journals and agricultural organizations. The scan was guided by the following topics:

- BC agri-environmental programs;
- Federal agri-environmental monitoring programs and indicator development;
- International agri-environmental monitoring programs and indicator development; and
- Methodologies to assess beneficial management practice (BMP) impacts including:
    - Environmental Assessment;
    - Social Assessment;
    - Cost-benefit analysis.

The methodology that will be developed for the BMP Assessment Project must broad enough so that it effectively assesses the wide range of BMPs that are promoted through the Canada-British Columbia Environmental Farm Plan Beneficial Management Practices Program (BMP Program). To this end, it is important that the survey instrument that we develop is flexible enough to assess a broad set of BMPs yet yields data useful for on-farm decision-making and policy direction. Another aspect of the BMP Assessment survey is that we are interested in capturing the socio-economic and environmental *impact* that the BMP has had on the farm since adoption. In order to do this, we must gain an understanding of how the socio-economic and environmental conditions on the farm have changed since the agri-environmental BMP was adopted. All literature reviewed in this report was considered based on its relevancy to this study and suggestions will be made throughout this report regarding the application of the literature to the objectives of the BMP Assessment Project.

2.0 Background

2.1 Framing the Research Context – Baseline Information

Prior to the initiation of the Canada - British Columbia Environmental Farm Plan Program and Beneficial Management Practices Program in 2003, the Province commissioned studies to assess the state of and priorities for agri-environmental resources in British Columbia (BC). The State of Resources Report was developed by the Resource Management Branch of the BC Ministry of Agriculture (Bertrand, 1999). The study objectives were to gather baseline information about the state of agri-environmental resources in the province at that time by examining farming practices. The information gained from this study provides limited but important baseline data for which to compare the current state of resources given the increased adoption of BMPs. For example, findings from Bertrand (2009) show that at the time only 23% of berry producers in the province were using efficient irrigation systems (drip/trickle). This information could be compared with data collected through the assessment of the irrigation management BMP.

Prior to the development of the BMP Program, the Province contracted Golder and Associates to conduct a province-wide consultation to assess the actual and potential environmental risks within the regions of BC (Golder and Associates, 2003). This information was gathered through several workshop consultations with industry and public agencies across BC. The information collected was used to inform the development of the initial BMPs and funding allocation for BMPs promoted through the BMP Program. The results of the consultation ranked environmental priorities and the concerns of farmers for each region. The information reported by Golder and Associates (2003) will be useful to reference when establishing conclusions and recommendations stemming from the BMP Assessment. Has and does the BMP Program continue to address these issues and concerns?

2.2 Other Provincial Studies on the Environmental Farm Plan/BMP Programs

The BMP Assessment project will be the first of it's kind to be undertaken by the Growing Forward partners in British Columbia. However, researchers have conducted studies on the equivalent Environmental Farm Plan (EFP)/BMP programs in other provinces. These studies were somewhat different in their research objectives, but help to shed light on the research gaps that have been identified with respect to the EFP/BMP programs.

Robinson (2006) evaluated Ontario's Environmental Farm Plan by conducting informal interviews with farmers and studying program data. The study focus was a broad scan of several aspects of the EFP program to try to evaluate its performance since it commenced in 1993. Among several findings regarding the uptake and geographical spread of the program, Robinson (2006) identified several barriers to entry and factors that have an effect on the uptake of the Ontario EFP program including:

- Financial situation of the farm;
- Farm household characteristics and whether or not the farm has a successor;
- The quality of information provided by the program;

- Peer pressure;
- The ability of the program to fit with the farm management practices;
- The farmer's perception of environmental issues; and
- The farmer's perception costs of environmental actions.

The findings by Robinson (2006) could inform the development of similar study questions that focus on the social factors and barriers that relate to BMP adoption in BC.

Robinson (2006) also identified several future research areas that could help with EFP program promotion and development. These areas include research into the environmental impacts of BMPs to verify the effectiveness of the program in reaching its intended environmental goals. This noted research gap verifies the importance of assessing the impacts of agri-environmental programs including the actual environmental impacts of BMPs.

Yiridoe et al., (2010) conducted a study that investigated the farmer and farm characteristics that determine participation in the Nova Scotia (NS) Environmental Farm Plan. Researchers found that several factors increase the likelihood of a farm participating in the program including:

- Livestock production (vs. crop production, which has a lower uptake in NS);
- Large scale of farm (vs. small or medium scale);
- High farm income; and
- Specialized knowledge and training regarding environmental practices.

Interestingly, formal education levels, age and years of experience in farming did not significantly affect participation.

Yiridoe et al. (2010) also studied the information streams that farmers prefer when gathering information about the EFP program and relevant agri-environmental practices. Farmers in NS prefer to receive information through interpersonal sources such as their peer group and farming organizations as well as the provincial agricultural department. In terms of information type, printed information sources are preferred to online sources.

The findings of Robinson (2006) and Yiridoe et al. (2010) could inform research questions that pertain to the social factors related to the likelihood of adoption of BMPs on BC farms. Futhermore, Robinson (2006) indicated that more research is needed on the environmental impact of BMP adoption on farms, which provides justification to the BMP Assessment Project.

3.0 Agri-Environmental Assessment and Monitoring Programs

Agri-environmental monitoring programs are used around the world to assess the state of agri-environmental resources (Organization for Economic Co-Operation and Development, 2008). In many cases the assessment occurs on repeated intervals to assess the change in the state of the environment and the impact that agricultural practices are having over time. The Organization for Economic Co-Operation and Development (OECD) has been integral in developing agri-environmental indicators that are used in various monitoring and assessment programs around the world. In Canada there are three federal agri-environmental monitoring programs that currently exist: The National Agri-Environmental Health Analysis Reporting Program

(NAHARP), the Farm Environmental Management Survey (FEMS) and the Watershed Evaluation of Beneficial Management Practices (WEBs). This section will highlight the work of the OECD agri-environmental monitoring program, as well as the three federal agri-environmental programs, and discuss their relevancy to the BMP Assessment Project.

3.1 The Organization for Economic Co-Operation and Development of Agri-Environmental Indicators

The OECD monitors and reports on agri-environmental resources in member countries around the world using a methodology based on agri-environmental indicators (Organization for Economic Co-Operation and Development, 2008). The indicators assess the impact of farm management practices and inputs used in farming (e.g. fertilizers and pesticides) on the environment, over time (Organization for Economic Co-Operation and Development, 2001). Indicators are tested based on data supplied by each member country. OECD efforts to assess agri-environmental resources worldwide have resulted in a fairly consistent, populated dataset on the state of agri-environmental resources for many countries.

In addition to the monitoring data that the OECD has reported, they have also made considerable efforts to develop and refine agri-environmental indicators to assess various aspects of the agriculture-environment dynamic. These indicators are generally science-based measures of environmental quality and/or practice based measures of environmental impact. The indicators are generally assessed on a regional or national scale (Organization for Economic Co-Operation and Development, 2001).

So far the methodology employed by the OECD to monitor agri-environmental change has not incorporated social or economic factors. Furthermore, the agri-environmental indicators that are used, rely on data collection techniques beyond the scope of the BMP Assessment Project and generally provide baseline data for which to compare and monitor environmental change over time. However, the indicators developed by the OECD, used to assess the state of the environment and resources, can be used to inform the development of environmental indicators that assess the environmental impact of BMPs. The potential contribution of the OECD agri-environmental indicators to this project is elaborated upon in section 4.1.2.

3.2. Canadian Agri-Environmental Monitoring Programs

The federal government has three programs that monitor and report on agri-environmental health. The FEMS and NAHARP programs monitor agri-environmental health using farm environmental management data and other agri-environmental indicators. The WEBS program monitors the environmental and economic impacts of on-farm BMPs on watersheds across Canada.

3.2.1. Farm Environmental Management Survey (FEMS)

The Farm Environmental Management Survey is conducted by Statistics Canada and Agriculture and Agri-Food Canada (AAFC) on an irregular basis (the last survey was conducted in 2006, and the next is planned for 2011). The goal of the survey is to monitor farm practices and the resulting environmental impacts of farming operations (Statistics Canada, 2006). The survey results indicate areas of environmental priority and help to inform policy and program development in Canada (Statistics Canada, 2007).

The FEMS questionnaire contains a section on environmental farm planning and BMP adoption. In 2006, respondents were asked to indicate if they had done or are doing an EFP for their operation and if so, to what extent BMPs were adopted. This information is useful baseline data to monitor overall BMP adoption across Canada; however, the results are too general to determine the impact of any specific BMP or category of BMP.

The survey questions included in the FEMS study could help to inform the questionnaire development for the BMP Assessment Project. The contribution of the FEMS survey to this project is elaborated upon in section 4.1.2.

3.2.2. The National Agri-Environmental Health Analysis Reporting Program (NAHARP)

The National Agri-Environmental Health Analysis Reporting Program is an initiative of AAFC to monitor and report agri-environmental health and risks across Canada (Eliers et al., 2010). There has been three reports published to date and agri-environmental indicators have been revised and refined over time to reflect increased understanding and knowledge of how to effectively monitor agri-environmental health (Eliers et al., 2010; Lefebvre et al., 2005; McRae et al., 2000).

The reports are formulated using data gathered from the FEMS program (described above) and other scientific monitoring techniques and is displayed geographically, on a provincial or regional scale, using agricultural landscape data. The data and information synthesized by NAHARP allows policy makers and industry to:

- Monitor the environmental performance of agriculture;
- Determine how the environmental performance of agriculture has changed over time;
- Assess the impact of adopting beneficial management practices;
- Evaluate the effectiveness of agricultural policies and programs (Eliers et al., 2010).

NAHARP also links the science of agri-environmental health monitoring to economic impacts using a integrated economic modeling. The NAHARP weighs the costs and benefits of agri-environmental health using several techniques, including: public willingness-to-pay for ecological goods and services (EG&S) provided by the agricultural community and benefits transfer methodologies[28]. Economic models are in the pilot stage of development and are drawing from methodologies used around the world to calculate the costs and benefits of EG&S provided by agriculture (Eliers et al., 2010).

[28] Willingness-to-pay studies ask the public how much they would be willing to pay for a program to improve the environment. Benefits transfer methodologies use calculated values from other studies to determine the value of environmental goods and services (Eliers et al., 2010).

3.2.3. Watershed Evaluation of Beneficial Management Practices (WEBs)

The WEBs program was initiated in 2004 to evaluate the impact of BMPs on nine watersheds across Canada, including the Salmon River Watershed in BC (Agriculture and Agri-Food Canada, 2011b). WEBs measures the biophysical and hydrological impacts of on-farm BMP adoption on watersheds as well as evaluates the costs and benefits associated with the BMP.

The methods employed by WEBs include a blend of technical monitoring, using surface water quality data as the main indicator of the BMPs' environmental impact. WEBs also uses five different methods to gauge the economic impact of BMP adoption, both on farm and to society (Agriculture and Agri-Food Canada, 2009).

The preliminary findings of WEBs economic evaluations have found that up to 75% of BMPs studied could contribute to increased financial gains to the farmer (Agriculture and Agri-Food Canada, 2011c). For example, in a study that looked at controlled tile drainage (CTD) in Ontario, researchers found that a 3% yield increase was experienced by farms that adopted CTD (Agriculture and Agri-Food Canada, 2011a). Furthermore, the WEBs program is currently developing a farm economic-behavioural model, that will investigate some of the socio-economic factors that affect BMP adoption (Agriculture and Agri-Food Canada, 2011b).

3.3 Application of Agri-Environmental Monitoring Programs to the BMP Assessment Project

The current international and national agri-environmental monitoring programs, described above, assess agri-environmental health and the impacts of agriculture on a regional or national basis over time by conducting the evaluation multiple times and comparing results to previous studies. The methodologies employed by these monitoring programs, with the exception of the FEMS program which is centered around a farm practices questionnaire, generally rely on scientific data and require environmental testing to indicate the impact that agricultural practices have on the environment. Due to the timeframe and scope of the BMP Assessment Project, the methodologies employed by the OECD programs and Canadian federal agri-environmental monitoring programs cannot be used directly for our purposes. Furthermore, social and economic assessment components of these programs are in the early stages of development, but may provide useful data for which to compare the results of the BMP Assessment Project social and economic impact assessment to.

The BMP Assessment Project methodology will build on the agri-environmental monitoring methodology developed by these programs. We can use the information regarding environmental risks and indicators of agri-environmental health as a foundation for a specialized set of indicators to assess the socio-economic and environmental impacts of BMP adoption on farms in BC. The foundation of the methodology and approach is further elaborated upon in section 4.

4.0 Developing the BMP Assessment Instrument

The following sections highlight key literature that pertains to the development of a new socio-economic and environmental BMP Assessment Survey instrument. Note that the actual methodology is not described here, merely how the literature will be applied to the development of the survey instrument.

4.1 Foundation for the Environmental Assessment Instrument

Vilain et al. (2007) established a straightforward methodology for determining appropriate indicators to assess environmental sustainability on farms in France. Although the indicators established by Vilain et al. (2007) are not applicable to the BMP Assessment Project, the general steps to developing appropriate indicators are useful for our purposes. These steps are as follows:

- Step 1: clearly identify the objectives that you would like to assess;
- Step 2: build a matrix that lays out the objectives with the indicators that characterize them;
- Step 3: formulate an initial hypothesis that will be tested by the indicators;
- Step 4: develop the content of the indicators and associated scale and describe each indicator in detail.

These four steps can inform the development of indicators to assess the environmental performance of BMPs on farms. The following three sections describe how this approach could be informed by the existing literature on BMPs and agri-environmental programming in BC.

4.1.1. Identifying BMP Environmental Objectives

The first step in developing the environmental indicator assessment portion of the BMP survey instrument is to identify the environmental risks that the BMPs funded through the BMP program are intended to address (Pervanchon et al., 2002). The Environmental Farm Plan Program Reference Guide and associated management guides can inform the development of a matrix of objectives that the BMPs are intended to achieve (BC Ministry of Agriculture, 2010). For example, the establishment of a riparian buffer (practice code 1002) is intended to:

- Reduce erosion by:
  - Trapping sediment;
  - Building and maintaining streambanks;
  - Storing water and energy during floods;
  - Reducing and dissipating energy along streambanks;
- Recharge aquifers by storing and releasing water;
- Reduce contaminants that enter watercourses by filtering and buffering water;
- Maintain biodiversity; and
- Create primary productivity (BC Ministry of Agriculture and Lands, 2005).

The OECD has also created similar matrices to describe the environmental risks attributed to agricultural practices (Organization for Economic Co-Operation and Development, 2001). The OECD publications may be used to supplement information on agri-environmental risks and BMP objectives published by the Canada-British Columbia Environmental Farm Plan Program.

4.1.2. Creating Environmental Impact Indicators for BMPs

After the environmental objectives of the BMPs are established, a specialized set of indicators to assess these objectives should be created. Because the timelines and scope of the BMP Assessment Project do not permit the use of scientific monitoring techniques, such as used in the WEBs program, to evaluate the performance of BMPs, it is more likely that farm management practices could be used as indicators for environmental performance. Farm practice indicators may be informed by the generally accepted measures of agri-environmental health established by the NAHARP and WEBs programs (Eliers et al., 2010; Agriculture and Agri-Food Canada, 2011b).

The FEMS approach could inform the development of these indicators in the sense that in the FEMS questionnaire, producers and growers are asked to describe their farm environmental management practices, which researchers then use as indicators for the environmental impact of agriculture (Statistics Canada, 2007). The FEMS survey also asks producers how their practices have changed over time in order to determine the change in environmental impact of farms. There is little existing baseline information regarding the environmental impact of farm practices before the commencement of the EFP/BMP Programs. Therefore, it is likely that the BMP assessment instrument developed will contain questions to determine how farmers have *changed* their practices due to the adoption of BMPs on farms.

4.1.3. Developing the Environmental Assessment Survey Instrument

Behnam et al. (2005) developed a set of survey tools to assess the quality of 16 agri-environmental BMPs implemented both through the Virginia's Agricultural Best Management Practices Implementation Program and by farmers themselves. The survey included a farmer self-assessment component and a BMP observation component performed by an interviewer. Indicators of BMP quality were developed on the basis of how well the indicator related to the quality and thus the performance of the BMP, and how quickly and easily observed the indicator was. The categories of BMP quality that Benham et al. (2005) assessed were:

- BMP design;
- Site selection;
- Implementation; and
- Maintenance quality.

The approach taken by Benham et al. (2005) to develop a self-assessment of BMP quality could help inform the BMP Assessment tool. The self-assessment approach is also justified by Vilain et al. (2007) who indicate that their farm sustainability methodology may be implemented both as a self-assessment and by a third party assessor.

4.2 Foundation for the On-Farm Social Assessment

Methodologies that include a specific social evaluation component are scarce in most socio-economic and environmental evaluations of agri-environmental practices and programs. In some studies that claimed to include a social impact evaluation component, the authors, in practice, tied the social component directly to the economic evaluation (Toma, 2002; Namibiar et al., 2001). For example, Namibiar et al., (2001), used farm economic output as a measure of social impact in their assessment of agricultural sustainability in China. In a paper that reviews agri-environmental program evaluation methodologies from both Europe and Asia, van der Werf and Petit (2002) found that only one of ten methodologies aimed at assessing sustainability of farms encompassed social evaluation criteria.

However, there are a few methodologies that were found which attempt to integrate a social assessment component in an on-farm agri-environmental evaluation. For example, The Genuine Progress Index (GPI) Atlantic developed an indicator-based approach to assessing the sustainability of farms in Nova Scotia (Scott & Coleman, 2008). Social indicators were developed by means of farmer focus groups and were based on the social dimensions of human capital, social capital and farm community viability. For example, the indicator "increased opportunities for learning about ecological agriculture" is a human capital dimension that is valuable as a proxy for assessing the farmer knowledge base of agri-environmental practices. The study by Scott and Coleman (2008) will prove useful in defining areas of social impact relevant to the evaluation of agri-environmental practices on BC farms.

4.2.1 Social Impact of BMP Adoption and the EFP Program Generally

The methodology for developing indicators related to the on-farm social impact of adopting BMPs could be established using the methodology employed by Vilain et al. (2007) described above in section 4.1. Using this approach, the social objectives of the EFP/BMP Program would be defined, and indicators would be developed to perform an on-farm assessment of the social impact of BMP adoption. For example, one goal of the EFP/BMP Program is to increase the pride or satisfaction in one's farm operation (Agricultural Research and Development Corporation, 2010). A relevant survey question could be: "*Has implementing (an) agri-environmental BMP(s) increased the pride you have for your farm operation?* Yes ☐ No ☐'

4.2.2 Social Factors that Impact BMP Adoption

Both Yiridoe et al. (2010) and Robinson (2006) studied social factors that contribute to EFP program participation and BMP adoption and found that there are a variety of social factors that contribute to whether or not a farmer is more likely to adopt agri-environmental BMPs. These researchers included a socio-demographic component to their surveys as well as a suite of questions aimed at identifying social barriers to BMP adoption. In order to assess the social factors that lead to BMP adoption, a similar suite of questions could be included in the BMP Assessment Survey.

4.3 Foundation for the BMP Cost-Benefit Analysis

WEBs researchers, among others, have recognized that it is important to relay to the farming community the potential costs and benefits of adopting BMPs in order to encourage adoption of agri-environmental practices (Agriculture Agri-Food Canada, 2009; Eliers et al., 2010; Robinson, 2006). To this end, it is important that an economic impact component is included in the BMP Assessment Project.

It is relatively straightforward to estimate the on-farm costs associated with BMP adoption, however, estimating the value of benefits to both the farmer and to society is somewhat more difficult (Agriculture and Agri-Food Canada, 2009). The NAHARP has begun to investigate the valuation of environmental goods and services provided by agri-environmental landscapes and practices in order to gain a better understanding of the value that agri-environmental BMPs provide to society (Eliers et al., 2010). Methods used by other researchers to estimate on-farm benefits include measuring increases in yields due to BMP adoption (Agriculture and Agri-Food Canada, 2011a; Ajayi, 2009); and econometric modeling to determine the economic impact of BMP adoption on the whole farm operation including costs and benefits (Monaghan et al., 2008; Agriculture and Agri-Food Canada, 2009).

Despite a growing body of literature on the topic of estimating both on-farm and societal benefits from BMP adoption, there are still challenges that result in an inability to estimate all benefits. An example of a relevant challenge includes an inability to directly attribute an ecosystem good or service to BMPs due to the complex nature of ecosystems (Agriculture and Agri-Food Canada, 2009). WEBs researchers have found that because of this, on-farm cost-benefit analyses of some BMPs yield results showing that BMPs are not economically profitable to the farm operation (Agriculture and Agri-Food Canada, 2009).

In an effort to depict qualitative information about benefits that cannot be quantified in a cost-benefit analysis, Ziller and Phibbs (2003) created a methodology to compare qualitative data with quantitative data in a matrix. Their objective was to put benefits that are not quantifiable on a level playing field with quantitative cost and benefit data. For the cost-benefit component of the BMP Assessment project, it is likely that some benefits will not be quantifiable. Describing non-estimable benefits qualitatively and displaying them such as Ziller and Phibbs (2003) describe will help create a balanced assessment of costs and benefits associated with BMP adoption on farms and to society.

The Treasury Board of Canada Secretariat (2007) published the 'Canadian Cost-Benefit Analysis Guide' to direct the development of cost-benefit analyses of regulatory proposals to the federal government. The guide outlines distinct steps to follow when conducting any cost-benefit analysis. These are as follows:

1. Identify the issues, risks, and the baseline scenario;
2. Set objectives for the cost-benefit analysis (i.e. are they purely economic or should they include social and environmental factors);
3. Describe the alternatives to the baseline scenario;
4. Assess the benefits and costs (using a variety of possible techniques);
5. Prepare an accounting statement.

The Treasury Board of Canada Secretariat (2007) also outlines steps to account for non-quantifiable factors in the cost-benefit analysis. The guide states that in the case that non-monetized benefits or costs are believed to be important factors in a cost-benefit analysis, the researcher should describe all such benefits and/or costs qualitatively, describe the timing and likelihood of such events and describe why the benefits or costs can not be valued quantitatively.

Several studies have evaluated agricultural best management practices (BMP) using cost-benefit analysis. These studies can be divided into two groups. The first group includes studies that focus on assessing on-farm benefits and costs using market prices, avoiding an analysis of off-farm societal impacts. These studies include analyses of the profitability of: agroforestry and conventional farming systems in Zambia (Ajayi et al. 2009); erosion control practices on German farms

(Aurbacher and Dabbert 2009); best management practices implemented by New Zealand dairy farms aimed at improving stream health; and various cropping systems as well as conventional, integrated, and organic management practices on Californian farms (Ogbuchiekwe and McGiffen 2004). Yang et al. (2010) avoid monetizing benefits altogether in their assessment of flow diversion terraces for reducing sediment yields in a New Brunswick watershed since they conduct a cost-effectiveness analysis. The benefits considered by this group of studies largely focussed on increases in revenue or savings that may accrue to farmers. The cost considered by this group of studies included: establishing and maintaining the BMP; changes in farm production (e.g. additional capital or labour required, field operation inefficiencies, etc.); and changes in output (e.g. forgone income). Information for estimating the benefits and costs was obtained mainly from farmer surveys, but also from existing literature and field experiments.

The second group includes studies that involve an analysis of off-farm societal benefits. These studies include analyses of the costs and benefits of: modifying agricultural land use to improve the provision of five ecosystem services in an irrigated region of Australia (Crossman et al. 2010); eight agricultural BMPs in two Prince Edward Island watersheds (Lantz et al. 2009); five BMPs aimed at controlling nitrate contamination of groundwater in a Minnesota watershed (Yadev and Wall 1998); and four management practices for reducing soil erosion in an agricultural watershed in Iowa (Zhou et al. 2009). The benefits considered by these studies mainly included improvements in ecosystem services such as water quality, agricultural production, and recreation but also included any savings accruing to farmers. These improvements were valued using a few different techniques: market prices in the case of agricultural production and water delivery cost savings (Crossman et al. 2010, Zhou et al. 2010); value transfer (Crossman et al. 2010, Zhou et al. 2010); avoided cost (Yadev and Wall 1998); and choice experiments (Lantz et al. 2009). The costs considered by these studies were similar to those in the first group. Information for estimating costs was obtained from interviews, past programs, and existing literature.

5.0 Review of Literature Findings and Conclusions

By means of a thorough review of the literature on BMP assessment and agri-environmental monitoring programs, it may be concluded that there is no existing methodology that can be taken directly and applied, as is, for the purposes of the BMP Assessment Project on BC farms. However, the methodologies and approach of several key pieces of literature, reviewed in this document, may be blended to create an appropriate BMP assessment methodology that highlights the social, economic and environmental impacts of BMP adoption on farms.

There is a wealth of literature regarding measures of agri-environmental health and the environmental impacts of BMPs and we can likely adapt existing indicators to meet the needs of an environmental assessment for agri-environmental BMPs. On the other hand, the social and economic BMP assessment methodology is not as well developed, and these areas may require more creative development when it comes to developing a survey instrument to measure relevant social and economic aspects of BMP adoption on BC farms.

The importance of monitoring, evaluating and reviewing agri-environmental programs is evident in the body of literature that exists on the topic. The ability to learn from BMP adopters is an important step in developing effective agri-environmental programs that are widely adopted by farmers. Furthermore, interest in the economic and social evaluation of such programs is increasing amongst researchers in Canada and worldwide. By conducting a socio-economic and environmental assessment of BMPs funded through the Canada-British Columbia Environmental Farm Plan Beneficial Management Practices Program, Growing Forward partners will have a greater understanding of the on-farm and societal implications of agri-environmental practices adopted by BC farmers.

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II. Detailed Cost-Benefit Analysis Methodology

STEP 1: IDENTIFY THE ISSUE, RISKS, AND THE BASELINE SCENARIO

The first step involves documenting the details of the issue or problem and any related risks. This step also involves identifying and projecting what may happen given the status quo situation (i.e. the baseline scenario with no policy intervention).

1.1 Issue

The important details of the issue should be clearly identified and defined. The general issue addressed by the BMPs that are part of our review are environmental impacts associated with agricultural operations in British Columbia. However, each BMP is targeted at specific issues.

Table 1: The issues targeted by each BMP

BMP	Issues
Alternative Livestock Watering Systems	Risks to riparian habitat and water quality related to livestock drinking directly from surface water.
Riparian Buffer Establishment	Risks to water quality and quantity, soil erosion, as well as flora and fauna related to farming practices.
Irrigation Management	Risks to water quality and quantity, soil erosion, as well as flora and fauna related to irrigation.
Preventing Wildlife Damage	Risks to the farm operation related to conflicts with wildlife (e.g. destroying stored feed, irrigation lines, crops, and livestock).

1.2 Baseline Scenario

The benefits and costs of a policy are determined by contrasting the baseline scenario with the scenarios that include government intervention. As such, correctly identifying and projecting the baseline scenario is of utmost importance. Projection of the baseline scenario should attempt to account for any changes that might be expected to occur without the policy intervention. This may include the adoption of environmentally friendly farming practices due to changes in the market (e.g. consumer preferences), innovation, or advances in technology.

For the purposes of our study we assumed that agricultural producers in British Columbia would not have adopted a BMP without the help of the Canada-British Columbia Environmental Farm Plan Program. We also assumed that agricultural producers would not have adopted practices that would cause further environmental degradation. Therefore, the baseline scenario reflects the situation before each farmer adopted their BMP. We determined the baseline scenario using a survey of participating farmers, as well as farm visits.

1.3 Risk Assessment

A dynamic risk assessment is often required when dealing with environmental issues. Such an assessment involves identifying and evaluating any risks and uncertainties associated with the issue and baseline scenario.

A risk assessment for each agricultural operation was not completed as this was beyond the scope of our resources.

STEP 2: SETTING OBJECTIVES

This step involves setting objectives for the policy intervention. For example, are the goals of the proposed policy intervention purely economic or do they include social and environmental factors? Consultation with the stakeholders can be helpful at this stage. The goals of the proposed policy should be clearly identified and defined in such a way so that progress toward the goal can be evaluated. As such some level of measurability, such as a set of criteria, should be identified as part of the policy-making process.

The overall objective of the Canada-British Columbia Environmental Farm Plan Program is to help agricultural producers in British Columbia manage environmental risks associated with their farming operations by enhancing their stewardship practices. However, each BMP has specific objectives.

Table 2: The objectives of each BMP

BMP	Objectives
Alternative Livestock Watering Systems	Address environmental risks associated with livestock drinking directly from surface water sources.
Riparian Buffer Establishment	Address the environmental risks associated with a lack of riparian buffers between farming areas and watercourses and/or wetlands.
Irrigation Management	Address environmental risks associated with excess water use for irrigation by providing incentives to use efficient irrigation systems.
Preventing Wildlife Damage	Address the impacts that wildlife can have on farm operations by providing incentives to manage wildlife away from potential problem areas.

STEP 3: DEVELOPING ALTERNATIVE REGULATORY AND NON-REGULATORY OPTIONS

This step involves identifying the alternative policy interventions that may be used to address the issue. Several tools can be used for this purpose, including regulatory and non-regulatory instruments or a combination of these approaches. These instruments seek to change consumer or producer behaviour in order to achieve a policy's objective. Regulatory instruments involve the government setting mandatory standards that stakeholders are required to meet. They seek to change stakeholder behaviour using a command and control approach. On the other hand, non-regulatory instruments are voluntary tools. They generally rely on market forces (i.e. market-based instruments) to modify a stakeholder's behaviour, but may also involve education and information campaigns, or voluntary standards. Several market-based instruments have been developed, including: tradable permits; taxes or charges; subsidies or tax incentives; and deposit-refund schemes. When initially selecting among alternative tools a preliminary analysis should be conducted based on the characteristics of each instrument. It may also be useful to examine experiences with the alternative options in other jurisdictions. A chief concern when selecting among alternative instruments is their efficiency or cost-effectiveness. Additional concerns include: stringency; stakeholder compliance; timing; international and regional issues; size of stakeholders; and enforcement.

The Canada-British Columbia Environmental Farm Plan Program is a non-regulatory market-based instrument since the program provides subsidies to agricultural producers for adopting certain BMPs. The subsidy covers a certain percentage of eligible costs associated with the BMP up to a certain level of funding (i.e. it's a cost-share program). The BMPs that are part of this evaluation are described in Table 3.

Table 3: Details of each BMP

BMP	Description	Cost-Share	Program Life[29]
Alternative Livestock Watering Systems	Providing an off-stream water source for livestock.	60% up to $25K	15 years
Riparian Buffer Establishment	Establishing or planting vegetation in riparian areas.	60% up to $25K	25 years
Irrigation Management	Modification or improvement of irrigation equipment.	30% up to $10K	7 years
Preventing Wildlife Damage	Keeping wildlife away from potential problem areas.	30% up to $10K	15 years

STEP 4: ASSESS THE BENEFITS AND COSTS

The main part of a cost-benefit analysis is assessing the benefits and costs of each alternative policy. This step involves identifying the impacts of the policy and then measuring the associated benefits and costs.

[29] The program life was estimated based on the nature of the BMP, depreciation of equipment and input from the Project Steering Committee.

4.1 Identification of significant impacts

Identifying the significant impacts involves defining and quantifying the impacts of each alternative policy and then projecting these impacts over the policy's expected life. Consulting with experts at this stage can be helpful. Three activities are involved in identifying and projecting the impacts: 1) identifying the potential direct or indirect impacts of each alternative; 2) relating these potential impacts to variables, such as economic growth or technological change, that may modify an impact's magnitude over time; and 3) using projections of these variables to forecast the impacts over the life of each alternative policy. Often this proceeds by using an environmental impact assessment or life cycle analysis.[30] The forecasted impacts of each alternative are then contrasted with the baseline scenario in order to determine the incremental impact of each policy. To facilitate the CBA, the identified impacts should be classified by stakeholder. Qualitative descriptions should be provided for any impacts that cannot be quantified.

General descriptions of the potential impacts of each of the BMPs that are part of our analysis are provided below in Tables 4 to 7.

Table 4: The potential impacts of the Alternative Livestock Watering System BMP

Impact Category	Specific Impacts
Environmental risk addressed	1. Riparian habitat damage from livestock 2. Streambank erosion 3. Reduced water quality related to livestock presence
Additional benefits	1. Year round watering for livestock 2. Improved livestock health 3. Potential climate change adaptation with use of alternative energy sources
Cost	1. Ongoing maintenance costs 2. Land taken out of production 3. Ongoing cost of energy

[30] Pearce, D.W., G. Atkinson, and S. Mourato. (2006). Cost-benefit analysis and the environment: recent developments. Paris: Organisation for Economic Co-operation and Development.

Table 5: The potential impacts of the Riparian Buffer Establishment BMP

Impact Category	Specific Impacts
Environmental risk addressed	1. Run-off from nutrients, pesticides or sediments 2. Soil and streambank erosion 3. Habitat destruction from farming practices 4. Invasive plants 5. Eutrophication
Additional benefits	1. Improved infiltration 2. Increased biodiversity 3. Carbon sequestration 4. Potential revenues from agro-forestry products
Cost	1. Ongoing maintenance costs 2. Land taken out of production

Table 6: The potential impacts of the Irrigation Management BMP

Impact Category	Specific Impacts
Environmental risk addressed	1. Water shortages and associated impacts to groundwater and surface water systems 2. Run-off/soil erosion caused by excess irrigation water 3. Loss of nutrients to groundwater and streams
Additional benefits	1. Improved crop quality 2. Improved yields 3. Increased reliability of water source 4. Less energy needed to run irrigation 5. Reduced weeds in fields due to more directed irrigation
Cost	1. Ongoing maintenance costs (including inspection of drip lines) 2. Additional infrastructure to install system 3. Installation of irrigation more susceptible to damage (wildlife and equipment)

Table 7: The potential impacts of the Preventing Wildlife Damage BMP

Impact Category	Specific Impacts
Environmental risk addressed	1. Wildlife causing economic damage to stored feed 2. Wildlife causing economic damage to crops 3. Wildlife causing economic damage to irrigation lines 4. Wildlife causing damage to livestock
Additional benefits	1. Reduced attraction to farming areas 2. Maintenance of habitat in other areas of the farm property without impeding on production activities 3. Other wildlife damage mitigation measures become more effective
Cost	1. Potential displacement of wildlife to other areas of the farm, or other farms in the surrounding area 2. Ongoing maintenance costs of fencing 3. Wildlife corridors are disturbed

While environmental impact assessments and life-cycle analyses are the preferred means of identifying and projecting the impacts of each BMP we did not have sufficient resources to complete them. Instead, since the Canada-British Columbia Environmental Farm Plan Program has existed for several years we were able to use a survey, sent to a sample of program participants, along with visits to farms to help determine the impacts of each BMP. The survey was developed in consultation with the literature, farmers, and ministry experts. As highlighted by the literature review, surveys have been used to identify the impacts (i.e. costs) imposed on agricultural producers. However, surveying farmers has rarely been used to help ascertain the benefits of BMPs. The survey we developed was used to determine the impacts of each BMP on an agricultural producer's management of their farm (e.g. areas of vegetated riparian buffer restored as part of BMPs 1001 and 1002). These impacts were then used to determine the relevant benefits and costs. A more rigorous approach to assessing benefits would have been to determine the impacts of changing management practices on indicators of water quality, habitat, etc. This, however, was beyond the scope of our resources as it would have required modeling or linking any changes in the environment that have occurred directly to each BMP. However, the information that was gathered can be used to get an estimate of some of the relevant benefits. Note that the impacts were not related to key variables when making projections over the life of the program — annual impacts were assumed to remain constant.

4.2 Measurement of benefits and costs

After identifying the incremental impacts of each alternative policy it is possible to determine the associated benefit and cost in monetary terms, which provides a common metric. There are several different types of benefits and costs to consider when analyzing agricultural beneficial management practices (see Table 8). A monetary value is assigned to each benefit and cost by estimating the maximum willingness to pay or minimum willingness to accept of stakeholders. Willingness to pay is the amount of money a stakeholder would pay in order to obtain an increase — or avoid a decrease — in the quantity or quality of a good or service, while willingness to accept is the amount that they would require to forgo an increase — or to endure a decrease — in quantity or quality. These measures are capable of capturing the total economic value of a policy's impacts.

Table 8: Different types of costs and benefits[a]

Costs	Benefits
• Compliance costs e.g. new equipment • Government regulatory costs[b] e.g. monitoring • Transitional social costs[b] e.g. unemployment	• Environmental improvements e.g. ecosystem services • Commodity quality e.g. Livestock health • Reduction in operating expenses e.g. irrigation efficiencies

[a] Double counting of costs or benefits should be avoided. Caution is advised when dealing with transfers between stakeholders. For example, if producers increase prices to cope with an increase in farming costs they are passing on these costs to consumers. These costs should only be counted once.
[b] Information on government regulatory and transitional costs was not available and were assumed to be zero.

Several techniques can be used to determine willingness to pay or accept. For impacts that affect marketed goods or services (e.g. agricultural output), it is possible to use market prices as inputs into the cost-benefit analysis. However, in many cases it is not possible to use prices since the impacts of a policy affect goods and services whose values are not reflected in the market (i.e. there is no price). As such, economists have developed a series of non-market valuation techniques to elicit willingness to pay or willingness to accept. These techniques can be classified into three main groups: 1) revealed preferences; 2) stated preferences; and 3) value transfer. Revealed preference techniques use information obtained indirectly from observing stakeholder choices in markets related to the good or service being valued. Several techniques are part of this group, including: hedonic pricing; travel cost; averting behaviour; replacement cost; cost of illness; and production function approaches. Stated preference techniques use information obtained directly from stakeholders by asking about their willingness to pay or accept using surveys. These techniques include contingent valuation and choice experiments. The choice of which technique to use depends on many factors. For example, stated preferences are able to capture a wider range of values than revealed preferences, though they are subject to several biases.

When the resources required for eliciting willingness to pay or accept using revealed or stated preferences are prohibitive, it is possible to use value transfer (a.k.a. benefit transfer). Value transfer, which is a commonly used technique, involves assigning monetary values to non-market goods and services using estimates from previous studies in similar contexts. Values can either be transferred as unit values (i.e. means or medians) or functions (i.e. a function relating WTP or WTA to certain independent variables). Three basic guidelines should be followed when conducting a value transfer: 1) the context of the studies that are the source of the transferred values should be similar to the context of the current study; 2) the source studies should be of good quality; and 3) the source studies should use the same welfare measure as the current study (i.e. WTP or WTA).

While it is possible to monetize many benefits and costs, it is likely not be possible to monetize all of them. In these cases it is still important to qualitatively document the features of these benefits and costs. An additional concern is double counting which occurs when a benefit or cost is counted twice. Double counting should be avoided. Also, financial transfers among stakeholders or between stakeholders and the government should not be counted as either benefits or costs.[31]

We used a mix of techniques for our analysis (see Table 9). Where possible, market prices were used. However, incremental impacts to non-market goods and services were assigned a value using unit value transfer following similar analyses by Troy and Wilson[32] in Massachusetts, Washington, and California, Troy and Bagstad[33] in Ontario, and Schmidt et al.[34] in Washington. Monetary values of the ecosystem services supplied by riparian areas as part of BMPs 1001 and 1002 were obtained from Schmidt et al. The specific unit benefit and cost amounts used in the analysis are provided in Appendix IV

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[31] However, we used the transfer of funds from the government to agricultural producers to determine the costs of constructing infrastructure related to implementing each BMP.

[32] Troy, A. & M.A. Wilson. (2006). Mapping ecosystem services: Practical challenges and opportunities in linking GIS and value transfer. *Ecological Economics*. 60: 435-449.

[33] Troy, A., & K. Bagstad. (2009). Estimation of Ecosystem Service Values for Southern Ontario. Ontario Ministry of Natural Resources. Retrieved from www.ontla.on.ca/library/repository/mon/23011/296833.pdf on January 22nd, 2012.

[34] Schmidt, R., D. Batker, J. Harrison-Cox. (2011). Nature's Value in the Skykomish Watershed: A Rapid Ecosystem Service Valuation. Earth Economics, Tacoma, WA. Retrieved on January 22, 2012 from: http://www.eartheconomics.org/Page12.aspx

Table 9: Monetizing costs and benefits

BMP	Costs	Benefits
Alternative Livestock Watering Systems	▪ Infrastructure (Market price) ▪ Maintenance (Market price)	▪ Ecosystem services from riparian area (Value transfer) ▪ Savings due to less fencing required (Market price) ▪ Savings due to less labour required (Market price)
Riparian Buffer Establishment	▪ Infrastructure (Market price) ▪ Maintenance (Market price) ▪ Labour (Market price) ▪ Opportunity cost of land taken out of production (Market price)	▪ Ecosystem services from riparian area (Value transfer) ▪ Grazing season extension (Market price)
Irrigation Management	▪ Infrastructure (Market price)	▪ Increased yield (Market price) ▪ Water savings (Rental rate) ▪ Savings due to less labour required (Market price) ▪ Savings due to less maintenance required (Market price)
Preventing Wildlife Damage	▪ Infrastructure (Market price) ▪ Maintenance (Market price)	▪ Damage avoided (Market price) ▪ Damage prevention avoided (Market price) ▪ Savings due to less labour required (Market price)

4.3 Aggregating Benefits and Costs

The present values of each policy intervention can be calculated once benefits and costs are estimated in each time period for individual stakeholders. This involves aggregating individual average values across the population of stakeholders as well as aggregating values across time.

4.3.1 Across Stakeholders

Aggregating average estimates of benefits or costs over the relevant populations is fairly straightforward. A simple approach is to multiply the mean or median estimates of benefits and costs calculated for individual stakeholders by the total number of stakeholders. More complicated approaches involve accounting for differences in stakeholders (e.g. location, producer type, etc.) using adjustments or functions.[35]

[35] Bateman IJ, Carson RT, Day B, Hanemann M, Hanley N, Hett T, Jones-Lee M, Loomes G, Mourato S, Özdemiroğlu E, Pearce DW, Sugden R, Swanson J. (2002). Economic Valuation with Stated Preference Techniques: A Manual, Edward Elgar, Northhampton, MA.

We used the simple approach to aggregate average estimates to the relevant population of agricultural producers.

4.3.2 Across Time: Discounting

Aggregating benefits and costs over time can be complicated. It requires discounting benefits and costs to account for the effect that time has on the value of money, as well as accounting for any future changes in unit benefits or costs (e.g. if a good becomes more scarce in the future, then the price will increase). Discounting involves converting future values of benefits and costs into present monetary values[36] using a discount rate. This rate reflects the time value of money (return on private investment or the rate at which individuals are willing to trade consumption over time). Values that occur in future time periods are essentially weighted less than values that occur in — or nearer to — the current time period. The formula for calculating the present value is:

$$PV = \frac{FV}{(1+r)^t} \qquad [\mathbf{1}]$$

Where: *PV* is the present value
FV is the future value
r is the discount rate
t is the number of time periods

Since discounting essentially weights the future less than the present it is the somewhat controversial. As such several approaches to discounting have been developed, including: using one positive discount rate (the common approach); using a discount rate of zero; and using time declining discount rates. The Treasury Board of Canada Secretariat[37] advises the use of one positive discount rate. The selection of a discount rate is also controversial since higher discount rates weight the future less than lower rates. Three approaches to calculating discount rates are common: 1) the social time preference rate; 2) the opportunity cost of forgone investments; or 3) a combination of these approaches. Regardless, the Treasury Board of Canada Secretariat recommends the use of an 8% discount rate. However, they suggest that the social time preference rate is closer to 3%. The same rate should be used for discounting both benefits and costs.

Since the Environmental Farm plan has been operating for several years there are benefits and costs that have occurred in the past time periods. In this case these past values were converted into future values using the discounting process. The same

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[36] The reference year for our analysis is 2011 as farmers were surveyed at this time.

[37] Treasury Board of Canada Secretariat. (2007). Canadian Cost-Benefit Analysis Guide: Regulatory Proposals. Ottawa, ON: Government of Canada. Retrieved on January 22, 2012 from: http://www.tbs-sct.gc.ca/ri-qr/documents/gl-ld/analys/analys00-eng.asp

formula used to calculate the present value was used for this process. However, the time period was set as a negative number. For example, if the year of a benefit was 2005, then t was set at -6 (i.e. 2005-2011). This process brings costs and benefits occurring in past years to the current time period and is consistent with the approach taken by the Environmental Protection Agency in the United States in their cost-benefit analysis of the Clean Air Act.[38] Doing so will have the effect of magnifying past cost and benefit values (similar to future values being weighted less when calculating the present value of future benefits or costs).

We used discount rates of 0%, 3%, and 8%. We assumed that the BMP implementation costs occurred in the first year, with annual costs and benefits occurring each following year until the end of the BMP's life. The stream of benefits and the stream of costs were separately converted into present values using Equation 1.

4.4 Criteria / Decision Rule

Once the values are estimated for the benefits and costs and they have been discounted to present values the decision rule can be applied. There are three criteria that are often used: 1) net present value rule; 2) benefit-cost ratio; and 3) internal rate of return. Net present value is calculated by subtracting the present value costs from the present value benefits. For this criterion, a policy intervention should proceed if the net present value is larger than zero. If choosing among several different policy interventions the most efficient alternative has the largest net present value (i.e. select the alternative with the largest NPV). The benefit-cost ratio is calculated by dividing the present value costs by the present value benefits. A policy intervention should proceed if the benefit-cost ratio is larger than 1. If choosing among several different policy interventions the most efficient alternative has the largest benefit-cost ratio. The internal rate of return is calculated by determining the discount rate at which the net present value equals zero. The internal rates of return calculated for competing policy interventions can then be contrasted.

We used the net present value criterion since the Treasury Board of Canada Secretariat recommends this criterion as the benefit-cost ratio and internal rate of return are problematic. Among the issues are that the benefit-cost ratio conceals the scale of benefits and costs, while several internal rates of return can be calculated from the same set of data.

Three different net present value analyses were performed for each BMP:

1. Determining the net present value of the program to date (until 2011);
2. Determining the net present value over it's expected life; and

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[38] United States Environmental Protection Agency. (1997). The Benefits and Costs of the Clean Air Act, 1970 to 1990. Retrieved on January 22, 2012 from: http://yosemite.epa.gov/EE/epa/eerm.nsf/vwRepNumLookup/EE-0295?OpenDocument

3. Determining the net present value of adding one farmer to the program in 2011.

4.5 Annualizing net present value

Annualizing net present values involves adjusting the overall net present value so that it is expressed as a constant annual amount. Annualizing net present values can be helpful when comparing policies that have different lifetimes. For example, BMP A has a large net present and a long lifetime, while BMP B has a smaller net present value and shorter lifetime. Comparing these two BMPs without adjusting for the differing time periods is problematic and the net present values should be annualized. The following equation is used to annualize net present values:

$$AV = \frac{NPV \times r}{1-(1+r)^{-n}} \qquad [2]$$

Where: *AV* is the annualized value
NPV is the net present value
r is the discount rate
n is the policy's lifetime

4.6 Cost-effectiveness analysis

If an economic value cannot be determined for the benefits of a policy intervention it may be possible to conduct a cost-effectiveness analysis instead of a cost-benefit analysis. This type of analysis can be used to identify the least cost approach (i.e. most efficient) for solving a particular problem. It proceeds by dividing the present value costs of a policy intervention by a quantitative measure of the related present value benefits. The resulting ratio represents the cost to achieve a unit of benefit. Lower ratios indicate more efficient policy alternatives.

We did not complete a cost-effectiveness analysis as part of our study.

4.7 Impacts on stakeholders

Economic efficiency is likely one of several criteria being used to evaluate a policy intervention. Equity is another common criterion and a policy's distributional impacts can also affect the success of its implementation. Therefore, it is important to identify the impacts of a policy intervention on each of the stakeholders involved. These stakeholders include impacts on industry, employment groups, consumers and individuals, governments, and others. Distributions between regions and generations may also be of concern.

We did not complete a stakeholder impact analysis as part of our project.

STEP 5: SENSITIVITY ANALYSIS

Sensitivity analysis is an important step in any cost-benefit analysis as it provides an opportunity to deal with uncertainty. Though mentioned in the 'Canadian Cost-

Benefit Analysis Guide', sensitivity analysis is not presented as an explicit step in this guidebook. However, following Hanley and Barbier[39], we included sensitivity analysis as a distinct step in this document. Uncertainty is incorporated into the cost-benefit analysis as part of this step by first modifying the values of certain parameters (e.g. the variables that help predict impacts over time or the discount rate) and then recalculating benefits, costs, and decision criteria. Thus, we get an idea of how varying key parameters impacts the conclusion of the cost-benefit analysis.

For our analysis, we completed a brief sensitivity analysis by examining the effect of varying the discount rate (0%, 3%, and 8%) and benefit estimates for ecosystem services (least, upper, and point).

STEP 6: PREPARE AN ACCOUNTING STATEMENT

The results of the cost-benefit analysis should be presented in an accounting statement. The intention of an accounting statement is to present all of the relevant details of the exercise, including: monetized and non-monetized benefits and costs; criteria; as well as impacts on stakeholders. Accounting statements should also incorporate the results of the sensitivity analysis. The 'Canadian Cost-Benefit Analysis Guide' provides templates that can be used to prepare an accounting statement.

[39] Hanley, N. and E. B. Barbier. (2009). Pricing Nature: Cost-Benefit Analysis and Environmental Policy. Northhampton, MA: Edward Elgar.

III. Estimating the Benefits of Restoring Riparian Buffers: An Ecosystem Services Approach

Author: Ryan Trenholm

A simple approach to valuing the restoration of riparian buffers is to assign a monetary value to the ecosystem services supplied by a unit area (e.g. hectare) of buffer via value transfer. This approach to valuing ecosystem services, based on the method used by Troy and Wilson[40], Troy and Bagstad[41], and Schmidt et al.[42], follows 5 steps. This approach is based on the idea that an area of natural capital (e.g. a hectare of vegetated riparian buffer) supplies a flow of ecosystem services (e.g. water purification) which provide a benefit society.

Step 1: Identify the area of riparian buffer that has been restored by the Environmental Farm Plan Program and determine the baseline land cover

We identified the area of riparian buffer restored by the Environmental Farm Plan program using a survey and site visits. Respondents were asked to describe the area of vegetated riparian buffer restored as part of the program as well as the prior condition of this area. The baseline land cover was assumed to be agricultural land.

Step 2: Identify the ecosystem services supplied by the restored riparian buffer as well as the ecosystem services supplied by the baseline land cover

The ecosystem services expected to be supplied by the restored riparian buffer and the baseline land cover were identified from Schmidt et al. As seen in Table 1 vegetated riparian buffers and agricultural lands supply several ecosystem services.

[40] Troy, A. & M.A. Wilson. (2006). Mapping ecosystem services: Practical challenges and opportunities in linking GIS and value transfer. *Ecological Economics*. 60: 435-449.

[41] Troy, A., & K. Bagstad. (2009). Estimation of Ecosystem Service Values for Southern Ontario. Ontario Ministry of Natural Resources. Retrieved from www.ontla.on.ca/library/repository/mon/23011/296833.pdf on January 22nd, 2012.

[42] Schmidt, R., D. Batker, J. Harrison-Cox. (2011). Nature's Value in the Skykomish Watershed: A Rapid Ecosystem Service Valuation. Earth Economics, Tacoma, WA. Retrieved on January 22, 2012 from: http://www.eartheconomics.org/Page12.aspx

Table 1: Ecosystem services supplied by riparian buffers and agricultural land

Ecosystem Service Category	Riparian Buffer	Agricultural Land
Aesthetic & Recreational	✓	✓
Biological Control	✓	✓
Disturbance regulation	✓	✓
Food Provisioning	✓	✓
Gas & Climate Regulation	✓	✓
Genetic Resources	✓	✓
Habitat Refugium & Nursery	✓	✓
Medicinal Resources	✓	✓
Nutrient Cycling	✓	✓
Pollination	✓	✓
Raw Materials	✓	✓
Science and Education	✓	✓
Soil Erosion Control	✓	✓
Soil Formation	✓	✓
Waste Treatment	✓	✗
Water Regulation	✓	✓
Water Supply	✓	✓

✓ indicates that ecosystem services are supplied by the land cover
✗ indicates that the ecosystem service are not supplied by the land cover

Step 3: Identify the total value of the ecosystem services supplied by a unit area (e.g. hectare) of restored riparian buffer and for the baseline land cover.

Determining values for ecosystem services often proceeds using one of the valuation techniques described in Section 4.2 of Appendix II. However, we used value transfer to determine the value for the ecosystem services supplied by a hectare of riparian buffer and agricultural land. We sourced annual per hectare value estimates from Appendix B of Schmidt et al. who used value transfer to assign a monetary value to the ecosystem services provided by several different land covers in the Skykomish watershed which empties into Puget Sound. While this area may not represent all of British Columbia, the area is located in the Pacific Northwest, and the database of source studies the authors used for their value transfer is extensive and up to date.

Schmidt et al. list the lowest and highest annual per acre values reported in several source studies for different categories of ecosystem services, classified by land cover. We reviewed the source studies used by Schmidt et al. and found them to be reasonable for use in a British Columbian context. Note that future analyses of the benefits of ecosystem services supplied by an area of natural capital may be able to use the SERVES (Simple and Effective Resource for Valuing Ecosystem Services) database to obtain source studies. SERVES is currently in development.[43]

[43] For an overview of SERVES see www.eartheconomics.org/Page150.aspx

Following Troy and Bagstad's "average of averages" approach, annual per hectare values for each category of ecosystem services were calculated according to the following steps:

1) A lower bound estimate of value for each type of ecosystem service was calculated by taking the mean of the low values reported for the source studies within each ecosystem service category;
2) An upper bound estimate of value for each type of ecosystem service was calculated by taking the mean of the high values reported for the source studies within each ecosystem service category;
3) A single point estimate of value was calculated by taking the mean of the average lower and upper bound estimates within each ecosystem service category; and
4) An estimate of the total value of the ecosystem services supplied by a hectare of vegetated riparian buffer or agricultural land was calculated by summing the values calculated for each ecosystem service category. These values can be added together since each service provides a different type of benefit to society (i.e. they are separable).

This "average of averages" approach results in a conservative estimate of the value of the ecosystem services supplied by a hectare of vegetated riparian buffer or agricultural land. Though this approach limits the influence of extreme values on the lower, upper, and point estimates, two source studies that reported very high per hectare estimates were removed from the analysis.

Since the values of many ecosystem services supplied by riparian buffers and agricultural lands have not been published in the literature it was impossible to assign a value to each service listed in Table 1. Therefore we have likely underestimated the economic value of riparian buffers and agricultural lands. To account for some of the uncertainty in the magnitude of the per hectare values we included the lower and upper bounds, in addition to the point estimate, in the cost-benefit analysis. These annual per hectare values are reported in Table 2.

Table 2: The value[a] of ecosystem services provided by riparian buffers and agricultural lands

Ecosystem Service Category	Riparian Buffer			Agricultural Land		
	Lower	Upper	Point	Lower	Upper	Point
Aesthetic & Recreational	$1,440.17	$3,167.66	$2,303.91	$76.88	$76.88	$76.88
Biological Control				$39.67	$39.67	$39.67
Disturbance regulation	$21.15	$659.01	$340.08	$5.60	$5.60	$5.60
Food Provisioning[b]						
Gas & Climate Regulation	$256.89	$2,568.88	$1,412.88	$47.20	$194.26	$120.73
Genetic Resources						
Habitat Refugium & Nursery	$44.92	$1,058.57	$551.75			
Medicinal Resources	$31.09	$995.35	$513.22			
Nutrient Cycling				$23.54	$23.54	$23.54
Pollination				$539.84	$539.84	$539.84
Raw Materials						
Science and Education						
Soil Erosion Control				$16.89	$16.89	$16.89
Soil Formation				$11.48	$11.48	$11.48
Waste Treatment						
Water Regulation	$103.59	$511.23	$307.41			
Water Supply	$1,530.72	$1,722.63	$1,626.67			
TOTAL	**$3,428.52**	**$10,683.33**	**$7,055.92**	**$761.12**	**$908.18**	**$834.65**

[a] All values are per hectare per year and have been converted into 2011 Canadian dollars

[b] The food provisioning service of agricultural land has been accounted for separately using survey responses to determine the opportunity cost of removing land from production (see Table B.2)

Step 4: Multiply the total value per hectare of riparian buffer and agricultural land by the average number of hectares per farm restored as part of the Environmental Farm Plan program.

This step results in the average annual value of ecosystem services supplied by vegetated riparian buffers and agricultural lands per farm. For example, if on average the Environmental Farm Plan program resulted in the restoration of 2 hectares of riparian buffer per farm, then the total value per hectare of riparian buffer and agricultural land in Table 2 are multiplied by 2.

Table 3: The value[a] of ecosystem services provided by vegetated riparian buffers and agricultural lands per farm

Ecosystem Service	Riparian Buffer			Agricultural Land		
	Lower	Upper	Point	Lower	Upper	Point
Aesthetic & Recreational	$2,880.34	$6,335.31	$4,607.83	$153.76	$153.76	$153.76
Biological Control				$79.34	$79.34	$79.34
Disturbance regulation	$42.30	$1,318.02	$680.16	$11.20	$11.20	$11.20
Food Provisioning						
Gas & Climate Regulation	$513.78	$5,137.76	$2,825.77	$94.40	$388.52	$241.46
Genetic Resources						
Habitat Refugium & Nursery	$89.85	$2,117.15	$1,103.50			
Medicinal Resources	$62.17	$1,990.70	$1,026.44			
Nutrient Cycling				$47.08	$47.08	$47.08
Pollination				$1,079.68	$1,079.68	$1,079.68
Raw Materials						
Science and Education						
Soil Erosion Control				$33.78	$33.78	$33.78
Soil Formation				$22.96	$22.96	$22.96
Waste Treatment						
Water Regulation	$207.17	$1,022.47	$614.82			
Water Supply	$3,061.43	$3,445.25	$3,253.34			
TOTAL	**$6,857.03**	**$21,366.65**	**$14,111.84**	**$1,522.24**	**$1,816.36**	**$1,669.30**

[a] All values are per farm per year and have been converted into 2011 Canadian dollars.

Step 5: To identify the incremental value per farm of the ecosystem services supplied by the restored riparian buffers, subtract the values obtained for agricultural land in Step 4 from those obtained for riparian buffers.

This step helps identify the per farm value of changing from agricultural land cover to a vegetated riparian buffer. This incremental value is calculated by subtracting the value of the ecosystem services supplied by agricultural land from the value of the ecosystem services supplied by vegetated riparian buffers (in Table 3). Continuing with the example from Step 4, the estimates in Table 4 represent the economic value per farm of the change in the flow of ecosystem services that results from the implementation of a vegetated riparian buffer on 2 hectares of agricultural land. These values are used in the cost-benefit analysis to calculate the total benefits of restoring vegetated riparian buffers as part of the Environmental Farm Plan program.

Table 4: The value[a] of restoring riparian buffers on a parcel of farmland

Ecosystem Service	Value Lower	Upper	Point
Aesthetic & Recreational	$2,726.57	$6,181.54	$4,454.06
Biological Control	-$79.35	-$79.35	-$79.35
Disturbance regulation	$31.09	$1,306.81	$668.95
Food Provisioning			
Gas & Climate Regulation	$419.38	$4,749.24	$2,584.31
Genetic Resources			
Habitat Refugium & Nursery	$89.85	$2,117.15	$1,103.50
Medicinal Resources	$62.17	$1,990.70	$1,026.44
Nutrient Cycling	-$47.07	-$47.07	-$47.07
Pollination			
Raw Materials			
Science and Education			
Soil Erosion Control	-$33.78	-$33.78	-$33.78
Soil Formation	-$22.96	-$22.96	-$22.96
Waste Treatment			
Water Regulation	$207.17	$1,022.47	$614.82
Water Supply	$3,061.43	$3,445.25	$3,253.34
TOTAL	**$5,334.80**	**$19,550.30**	**$12,442.55**

a All values are per farm per year and have been converted into 2011 Canadian dollars.

IV. Cost-Benefit Analysis Assumptions and Limitations

Key Assumptions

1. We assumed that the initial infrastructure costs occurred in the first time period and that annual benefits and costs started to occur in the following time period.

2. We assumed that the annual benefits and costs were constant throughout the life of each program. This may not be the case, especially for ecosystem services since it may take several years for vegetated riparian buffers to become established. Maintenance and labour costs may also increase over the life of a BMP as infrastructure may begin to deteriorate at a faster rate.

3. We assumed that each hectare of vegetated riparian buffer supplied the same type and level (i.e. quantity or quality) of ecosystem services. The same assumption was made for agricultural land.

4. We assumed that the baseline and BMP scenarios were not impacted by changes in key variables (e.g. population or technological changes). We did not complete a detailed forecast of the baseline or scenario.

5. We assumed that enrolment in the BMP programs would not change from current levels when completing the cost-benefit analysis over the program's lifetime.

6. We assumed that transitional and government regulatory costs were zero. In the case of transitional costs it is likely safe to assume that they are "small and can be ignored"[44]. However, government regulatory costs are likely not zero (e.g. administration costs associated with the EFP program). However, we did not have any information on these costs.

7. We assumed that the context of the studies from which the ecosystem service values were obtained was similar to that of British Columbia. The values we obtained were used in a value transfer exercise in northwest Washington State.

8. We assumed that the information obtained from the survey and ARDCorp used to determine benefits and costs was representative of the larger population of BMP adopters. For example, average maintenance costs calculated from survey responses were applied to the population of BMP adopters.

[44] Treasury Board of Canada Secretariat. (2007). Canadian Cost-Benefit Analysis Guide: Regulatory Proposals. Ottawa, ON: Government of Canada. Retrieved on January 22, 2012 from: http://www.tbs-sct.gc.ca/ri-qr/documents/gl-ld/analys/analys00-eng.asp

Key Limitations

1. We could not quantify all of the benefits or costs. This is especially evident in the case of BMP 2302 (Preventing Wildlife Damage) as we were only able to capture private benefits and costs. There may be other benefits of this BMP that we're not assessed. For example, many respondents indicated that they would likely have to stop farming altogether if they weren't able to install wildlife fencing. This may have impacts on the rural lifestyle, culture, and communities as well as domestic food production, which British Columbians value. On the other hand wildlife fencing likely has negative impacts on the amenity or aesthetic value of the agricultural landscape.

2. We were not able to complete a rigorous analysis of the impacts of each BMP on the environment on or near each farm. This is especially difficult to complete for a program such as the Environmental Farm Plan since agricultural producers are distributed throughout the province. This makes monitoring difficult as information on the change in environmental characteristics such as soil erosion or water quality is difficult and costly to obtain. An additional complication is that it may be difficult to link changes in management practices to any changes observed in the environment. A further issue is that the environmental impacts of management practices on one farm may be negligible, but cumulative impacts of implementing BMPs on many farms may be substantial.

3. We did not complete a dynamic risk assessment.

4. We did not complete a detailed stakeholder impact analysis.

5. We could not complete an original valuation study to assign a monetary value to the ecosystem services supplied by a vegetated riparian buffer or agricultural land. Instead we relied on a simple value transfer, which has several limitations including:

   a) Estimates of economic value obtained in other locations may not be representative of those in the areas under study.
   b) Estimates of economic value were not available for all ecosystem services supplied by vegetated riparian buffers or agricultural land. There are many gaps in the literature as values have not been estimated for many ecosystem services using original research.
   c) Estimates of economic value are subject to the limitations of the primary valuation study from which they were sourced.

V. Data Sources for Benefits and Costs Used in the Cost-Benefit Analysis

- All values are per farm (or per farm per year) except in the case of water savings resulting from the Irrigation Management BMP.
- Negative cost indicates a benefit.
- All values are in 2011 Canadian dollars.

Table 1: Alternative Livestock Watering Systems

BMP	Impact	Amount	Source
Benefits	Ecosystem services	See Table 2 in Appendix III	Schmidt et al. (2011)
	Savings due to less fencing required	$925.68 per year	Survey
Costs	Infrastructure:		
	Provided by the EFP program	$6,821.75	ARDCorp
	Provided by outside funders	$618.96	ARDCorp
	Provided by the farmer	$6,821.75	ARDCorp
	Additional infrastructure cost	$1,183.47	Survey
	Maintenance	$247.29 per year	Survey
	Labour	-$1,247.20 per year	Survey

Table 2: Riparian Buffer Establishment

BMP	Impact	Amount	Source
Benefits	Ecosystem services	See Table 2 in Appendix III	Schmidt et al. (2011)
	Grazing season extension	$59.42 per year	Survey
Costs	Infrastructure:		
	Provided by the EFP program	$4,846.26	ARDCorp
	Provided by outside funders	$352.56	ARDCorp
	Provided by the farmer	$4,700.05	ARDCorp
	Additional infrastructure cost	$67.85	Survey
	Maintenance	$414.59 per year	Survey
	Labour	$319.20 per year	Survey
	Opportunity cost of land out of production	$579.38 per year	Survey

Table 3: Irrigation Management

BMP	Impact	Amount	Source
Benefits	Increased yield	$9,271.93 per year	Survey
	Water savings (water supply)	$0.60 per 1000m^3 per year	BCMOE (2011)[45]
Costs	Infrastructure:		
	Provided by the EFP program	$5,421.12	ARDCorp
	Provided by the farmer	$12,649.29	ARDCorp
	Additional infrastructure cost	$19,851.80	Survey
	Maintenance	-$436.05 per year	Survey
	Labour	-$1,324.40 per year	Survey

Table 4: Preventing Wildlife Damage: Crops & Feed

BMP	Impact	Amount	Source
Benefits	Damage avoided	$5,421.10 per year	Survey
	Damage prevention avoided	$359.60 per year	Survey
Costs	Infrastructure:		
	Provided by the EFP program	$4,209.35	ARDCorp
	Provided by the farmer	$9,821.81	ARDCorp
	Additional infrastructure cost	$446.41	Survey
	Additional fence installed	$2,381.94	Survey
	Maintenance	$80.97 per year	Survey
	Labour	-$867.60 per year	Survey

Table 5: Preventing Wildlife Damage: Crops

BMP	Impact	Amount	Source
Benefits	Damage avoided	$3,510.22 per year	Survey
	Damage prevention avoided	$9.45 per year	Survey
Costs	Infrastructure:		
	Provided by the EFP program	$4,209.35	ARDCorp
	Provided by the farmer	$9,821.81	ARDCorp
	Additional infrastructure cost	$198.18	Survey
	Additional fence installed	$2,977.35	Survey
	Maintenance	$80.97 per year	Survey
	Labour	$874.97 per year	Survey

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[45] [BCMOE] British Columbia Ministry of the Environment. (2011). Annual Rental Rates for Water Licence Purposes by Sector. Retrieved on January 22, 2012 from: http://www.env.gov.bc.ca/wsd/water_rights/water_rental_rates/cabinet/new_rent_structure_revised_august-2011.pdf

Table 6: Preventing Wildlife Damage: Feed

BMP	Impact	Amount	Source
Benefits	Damage avoided	$11,983.33 per year	Survey
	Damage prevention avoided	$0.00 per year	Survey
Costs	Infrastructure:		
	Provided by the EFP program	$2,404.68	ARDCorp
	Provided by the farmer	$4,809.44	ARDCorp
	Additional infrastructure cost	$833.33	Survey
	Additional fence installed	$0.00	Survey
	Maintenance	$58.33 per year	Survey
	Labour	-$1,150.00 per year	Survey

VI. Water Efficiency Calculation

The assumptions made when calculating the annual water savings due to 1801 adoption were:

- That adopters were either in the Fraser Valley (including MetroVan and FVRD) or Okanagan Regions (including RDOS, Central and North Okanagan Regional Districts);
- That all BMP adopters in the Fraser Valley switched from a travelling gun to drip irrigation;
- That all BMP adopters in the Okanagan switched from using overhead solid set sprinklers to drip irrigation;
- That all BMP adopters were producing an irrigated crop over either blueberries in the Fraser Valley or Grapes or Tree Fruits in the Okanagan (weighted to the actual uptake by commodity).
- Values for annual water requirements, irrigation efficiency factors and crop adjustment factors were retrieved from *BC Ministry of Agriculture and Lands. (2005). Determining Actual Annual Water Use of Sprinkler Irrigation Systems. Water Conservation Factsheet Series* and *BC Ministry of Agriculture and Lands. (2005). Determining Actual Annual Water Use of Trickle Irrigation Systems. Water Conservation Factsheet Series.*

Table 1. Fraser Valley Irrigation Water Efficiency Calculation					
Water Consumed before BMP	**Value**	**ft3**	**Depth, ft**	**Depth, in**	**volume**
	Liters	**litre/ft3**	**ft2/acre**		**acft**
		28.32	43560	12	43560
Annual Water Requirements Per Acre Annually	722363.87	25507.1988	0.585564711	7.026776529	
Efficiency factor for travelling guns	0.65				
Crop Adjustment Factor FV	0.78				
Average Annual Water Use Fraser Valley per Acre previously	871281.96	30765.60593	0.706281128	8.475373535	
# of 1801 adopted in FV	334				
Average Acres BMP Covered	19.25				
Average Annual Water use Fraser Valley per Farm Previously	16772177.76	592237.9153			13.59591174
Total Annual Water use FV Previously	5606268140	197961445.6			4544.569458
Water Consumed After BMP Adoption					
Annual Water Requirements Per Acre Annually	722363.87	25507.1988	0.585564711	7.026776529	
Efficiency factor for drip system Crop Adjustment Factor FV	0.92 0.78				
Average Annual Water Use Fraser Valley per acre NOW	615579.65	21736.56956	0.499002974	5.988035692	
# of 1801 adopted in FV	334.26				
Average Acres BMP Covered	19.25				
Average Annual Water use Fraser Valley per Farm NOW	11849908.2	418428.9619			9.605807205
Total Annual Water use FV NOW	3960950316	139864064.8			3210.837117
Average Efficiency Gain FV					0.293478261
Annual Water Savings due to BMP Adoption in Fraser Valley	1645317824	58097380.78			1333.732341

Table 2. Okanagan Irrigation Water Efficiency Calculation					
Water Consumed before BMP	**Value**	**ft3**	**Depth, ft**	**Depth, in**	**volume**
	Liters	**litre/ft3**	**ft2/acre**		**acft**
		28.32	43560	12	43560
Annual Water Requirements Per Acre Annually	2565706.97	90596.99753	2.07982088	24.95785056	
Efficiency factor for overhead solid set	0.72				
Crop Adjustment Factor OK	0.83				
Average Annual Water Use Okanagan per acre previously	2954126.5	104312.3764	2.394682654	28.73619185	
# of 1801 adopted in OK	284				
Average Acres BMP Covered	8.06				
Average Annual Water use Okanagan per Farm Previously	23808852.86	840708.0812			19.30000186
Total Annual Water use OK Previously	6779332763	239383219			5495.482531
Water Consumed After BMP Adoption					
Annual Water Requirements Per Acre Annually	2565706.97	90596.99753	2.07982088	24.95785056	
Efficiency factor for drip system	0.92				
Crop Adjustment Factor OK	0.83				
Average Annual Water Use Okanagan per acre NOW	2311925.09	81635.77295	1.874099471	22.48919365	
# of 1801 adopted in OK	284.74				
Average Acres BMP Covered	8.06				
Average Annual Water use OK per Farm NOW	18633015.28	657945.4548			15.10434928
Total Annual Water use OK NOW	5305564771	187343388.8			4300.812415
Annual Water Savings due to BMP Adoption in Okanagan	1473767992	52039830.22			1194.670115
TOTAL Annual Water Savings due to 1801 Adoption in BC	3119085816	110137211			2528.402456

Table 3: Summary Table					
Average Water Savings Per Farm FV	4922269.56	173808.9534			3.990104531
Average Water Savings Per Farm OK	5175837.58	182762.6264			4.195652581
Average Water Savings Per Farm BC	5049053.57	178285.7899			4.092878556
Efficiency Gain					
Total Annual Water Use Previously	12385600903	437344664.6			10040.05199
Total Annual Water Use Now	9266515087	327207453.6			7511.649533
Average Efficiency Gain	**0.25**				

VII. Summary of Respondent Comments

Respondents were asked to provide any comments about their experience adopting the BMP or any comments and suggestions about the BMP Program in general:

1001

It costs too much money to make things happen and correct what the previous owners did with the property. As of 2011 we will only be selling hay and fixing up the ranch slower. No cattle until set up is complete, years down the road.
It was a good program
The installation of the watering system provided in partnership with our EFP is a part of BMP that we have chosen to develop at our own cost and by our own desire. The sum of all the improvements that have been made significantly improved our operation. Environment, water, livestock health and labour requirements etc. have all improved.
Continue with financial support so farmers can continue to make improvements to the environment
The length of time from application (if you can get an EFP planner to attend) to permission to start even purchasing equipment is usually considerably longer than the length of time left in the calendar year to implement the BMP and hand in reimbursement receipts. This has reportedly been a significant problem for large BMPs. Both of our BMPs would have been implemented regardless of funding just because they were so beneficial so the financial help is greatly appreciated, but the time from approval to completion could be a deterrent for some producers and was stressful for us.
It is difficult to develop a project and get it approved, completed by Dec 31st when program doesn't start til April, you need an energy assessment, it took over 6 months to get mine done, and still hope to do a project prior to freeze up not being able to incur any expenses prior to approval makes it difficult
When we had help from the program to install a water project on crown land, it gave us the information and incentive to install on our private land
I think its a great tool for the ranching community and has brought a lot of environmental awareness. I hope there is further help as we have doubled our operation and would like to update to handle it an in environmentally friendly way.
Very enjoyable project. Our water system includes 7 troughs made from used tires (very tough and cheap and recycled). Welcome to come see
Cost sharing goes a long way to implementation of BMPs. In my case they cost money to implement with ongoing costs - other members of my community are the beneficiaries. I doubt that a business case can be made for most BMPs. Otherwise they would have already been implemented. Make it less painful to do the right thing.
A very rewarding experience

Funding levels and amounts should be increased. Proactive projects should be allowed. Projects for protection from, and the eradication of invasive species such as transplanted ELK should be implemented. So called conservation groups and BC Wildlife Federation and Rocky Mountain Elk Foundation should be required to pay the agriculture producers for the lost production, damage and spread of invasive plants that are spread by the introduction of non-indigenous species. EFP funding should cover 100% of stackyard fencing projects where elk have been introduced.
I feel that the BMP Program is one that greatly benefits farmers that want to improve their farms and make them more environmentally sustainable. I hope the program will continue and thus enable more farms and ranchers to adopt practices that will improve the land on which they operate. One suggestion to improve the program and perhaps draw more people into it would be to extend deadlines to a more practical time line especially when the project is large and therefore time consuming. Large projects are often hard to complete in one season especially in light of the fact that all the regular farm work still has to be done at the same time.
The time frame between funding delivery and December 31st has been too short in two of the three years we participated
The program is very convenient for farmers. The Planning Advisor did a lot of work they couldn't have done it without his help.
Make the application easier. Sometimes there are programs I don't know about, make information more available to the public/easier to access
Clarify the red tape
Great program, farmers really are trying to help the environment and social aspect of country living

1002

A biologist was a great help
Once I found out who to talk to I was given great information and support by the people involved in the BMP and its consultants
All went smoothly, it was a worth while endeavor and I would recommend other farmers to do the same
My personal feeling is that the EFP program helped us to fulfill our responsibility toward and stewardship of our lands. The EFP seems to be effectively managed and thoroughly scrutinized.
Having the advisor was very helpful.
Great program. Would improve by reducing requirements for paid consultants to do management plans before we can do projects. A motivated farmer who is paying 50% to 80% is going to spend rationally without incurring added expense and hassle.
Often requires jumping through hoops - practical means to put the theories in play
Beavers are taking out all of the trees that were planted through the EFP

1801
I think it's a great program. The government should come up with programs for younger farmers to utilize their property to its best potential.
Should be a bit more easy to access
Worked out well for us
Generally good but the timing requirements were unreasonable. By the time we know if funding is available in the spring we have already started projects so its too late to apply
I see a great deal of water being wasted. If these users could be persuaded to use more efficient water delivery systems through the BMP program it would benefit everyone.
A new irrigation system required when I pulled out the apples and replanted with grapes. The BMP reduced my costs for the new system. I would have installed a drip irrigation system with or without BMP
Follow-up with a visit 1 year after implementation with an expert to review installation/sewage/maintenance and issues in order to maximize the benefit of the improvement to the farmer and provide feedback for the BMP program. I forgot most of the requested details now.
The EFP was beneficial to us as we developed our vineyard. There always seems to be uncertainty as to whether the program is still funded or note. Lots of magazine ads, but no money. To be honest, I was very reluctant to participate in any survey by SFU. The SFU sponsored HIRA Report was an embarrassment and has done tremendous disservice to our industry. Just an FYI, winter may be a better time to get feedback from producers.
More contact with growers through newsletters
Excellent program
Good program
After he installed his irrigation system all of the neighbours around him did the same. All commented on his irrigation BMP.
Nothing negative. Has been a good program to date will continue in the future
Had good things to say about Planning Advisor
We love the program
Without the irrigation we would not be able to farm at all. We typically go 9-12 weeks in the summer without rain. We do pastured poultry and need irrigation to have pasture. We also did our fencing through the program and would like to see the fencing program come back to benefit other farmers. The deer on the island are out of control. Because of the variety of crops and livestock that we do, the versatility of our system is so important.
Would like to see flail mowers and deer fences come back

2302
This program to exclude wildlife from stored feed should be reinstated, plus standing crop fencing should be added
Advisor very helpful. Final expense verification confusing. BMP funding gave me incentive to do some work I would not have found time for. The fencing project in this case has had a big influence on wildlife movement in this area. If I were not in retiring from farming mode, I would have done more. BMP funding was helpful in implementing what I thought was marginally beneficial to the operation. Turned out to be good for wildlife and for the farm. Might be useful to have a wildlife expert assess or study areas where protective fences have been built
We feel we got burned in the process
Showed us how much we were losing to deer. Paid for itself in the first year
If there could be some mail out to inform farmers of programs available to them. It is hard to find out what is out there. The government does not advertise it so we need to be informed
We had a most awesome planner to work with, he knows the area, the local farmers and the issues. He was patient with our questions and was a very valuable resource. I wish more farmers could take advantage of this and I hope that fencing comes back into the program. This questionnaire should have been sooner because it is so easy to forget all the details. We have been so busy getting the farm established
Keep paper work and red tape to a minimum. Provide information, classes, and seminars providing environmental benefits on other topics. We also installed drip irrigation prior to the BMP program and the benefits are many
Waste of time, non-effectual
A very good experience. Program administrators were very understanding and accommodating with our deadline drew near with 3 feet of snow where the fence was to go but the definition of substantially complete really saved our team
Certainly benefitted from the EFP. Would be interested in more if funding stayed available.
The strategy of offering a financial incentive to producers to implement positive environmental changes is a good idea (cost sharing)
Our planning advisor is amazing
We should encourage a way to provide buffers for wildlife by using private lands - i.e. granting large tax benefits by maintaining habitat in strategic areas.