Social, Economic and Environmental Evaluation of Agri-Environmental Beneficial Management Practices

by

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B.Sc. (Hons.), University of British Columbia, 2007

Research Project Submitted in Partial Fulfillment
of the Requirements for the Degree of
Master of Resource Management

in the
School of Resource and Environmental Management
Faculty of Environment

Project No.: 540

SIMON FRASER UNIVERSITY

Fall 2012

Approval

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Degree: Master of Resource Management

Project No.: 540

Title of Project: Social, Economic and Environmental Evaluation of Agri-Environmental Beneficial Management Practices

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Abstract

In British Columbia, the *Canada-British Columbia Environmental Farm Plan Beneficial Management Practices Program* (*BMP Program*) encourages the adoption of agri-environmental practices on farms. The *BMP Program* is a voluntary and confidential program, which is jointly funded by the BC Ministry of Agriculture and Agriculture and Agri-Food Canada. Since 2005 the *BMP Program* has provided funding to farmers to adopt agri-environmental Beneficial Management Practices (BMPs) and during this time no evaluation of the program has occurred resulting in a lack of program feedback to program directors. The specific objectives for this project were to (1) develop a methodology to conduct a social, economic and environmental outcome evaluation of BMPs adopted on BC farms; (2) evaluate the social, economic and environmental outcomes of four BMPs and; (3) make policy recommendations to the Ministry of Agriculture to allow for adaptive management of the *BMP Program* using the evaluation methodology. The four BMPs evaluated for this study included *Alternative Watering Systems to Manage Livestock, Riparian Buffer Establishment, Irrigation Management,* and *Wildlife Damage Prevention*. The evaluation was undertaken for four BMPs with partially overlapping surveys, which were administered with a sample of BMP adopters in the fall of 2011 with in-person interviews as well as with mail surveys. The surveys collected both baseline and social, economic and environmental BMP outcome data. Results show that environmental outcomes are positive but in some cases depend on on-going maintenance and upkeep of certain BMPs. Generally adopters of the *Riparian* BMPs are motivated by stewardship and environmental factors whereas adopters of the *Irrigation Management* and *Wildlife Damage Prevention BMPs* are motivated by on-farm benefits offered by the BMPs. The largest barrier to adoption for all BMPs appears to be cost; however, barriers are overall lower for both the *Irrigation Management* and *Wildlife Damage Prevention BMPs*, which is reflected in the adoption levels to date. Results of the study highlight both the outcomes of the BMP to individual farm operations, and the overall impact of the *BMP Program* to society and also provides critical feedback to program directors.

Keywords: Environmental Farm Plan; agricultural beneficial management practices; British Columbia agriculture; program evaluation

Acknowledgements

I would first like to thank my senior supervisor, Dr. Wolfgang Haider, for his guidance, encouragement and support throughout this project. Wolfgang's expertise and supportive nature are a big reason why this project has been successful. I would also like to thank Dr. Duncan Knowler for lending his expertise and guidance throughout this project and my time at REM. Thank you to Ryan Trenholm, PhD Student, for his contribution to the project, particularly the cost-benefit analyses that he conducted, which are presented in Chapter 4 and discussed in Chapter 5 and 6 as well as in Appendices V and VI.

I would like to thank the BC Ministry of Agriculture for providing the funding for this project and providing me with the opportunity to learn and progress as a student of agricultural resource management. Thank you also to Mark Raymond, Geoff Hughes-Games, Mark Robbins and Dave Trotter from the BC Ministry of Agriculture, Heather Carriere from the Agricultural Research and Development Corporation (ARDCorp) and Gary Telford from Agriculture and Agri-Food Canada for your support and expertise throughout the project.

I am also very thankful to the farmers who spent time speaking openly with me, showing me their operations and being so welcoming during the interview process as well as to those who took the time to respond to the survey. Thank you very much to my fellow peers and professors at REM as well as to Iris, Laurence and Elissa for all of your help throughout my time at REM.

Last but not least, thank you to my family, friends and especially to Patrick for providing your love, support and farm labour while I focused on this project.

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Chapter 1: Introduction

Agricultural practices have an impact on the environment by altering natural ecosystems and ecosystem processes (McRae et al., 2000). In British Columbia (BC) only 5% of the total area of the province is suitable for agriculture. Agriculture and agri-environmental impacts are highly concentrated in narrow river valleys (Hanna, 1997). Furthermore, a high level of urban-agricultural interface in these narrow river valleys implies that agri-environmental impacts potentially affect the majority of BC's population (British Columbia Ministry of Agriculture and Lands, 2006). Examples of current agri-environmental issues in which the BC public has a large stake are:

- In Abbotsford, the drinking water supply of over 100,000 residents is compromised by nitrate contamination due to fertilization practices of farms over the aquifer (Chesnaux et al., 2007);
- In Northern BC, grazing of cattle on wetland habitat results in impacts on biodiversity and the ecosystem services of the wetland (Forest Practices Board, 2002);
- In the Lower Mainland, burning of crop residues and use of biomass boilers to heat greenhouses results in air contamination, having an impact on the sensitive airshed and the millions of people who breathe within it (Leithead et al., 2006).

1.1 Overview and Policy Context of Agri-Environmental Programming in BC

The main legislation regulating environmental pollution from agriculture is the provincial *Agricultural Waste Control Regulation (AWCR),* (B.C. Reg. 131/92), which is administered by the BC Ministry of Environment under the *Environmental Management Act,* (SBC 2003). The *AWCR* imposes fines on farms that are causing pollution, but does not provide incentives for farmers to proactively adopt specific farm practices that minimize the impact of agriculture on the environment (British Columbia Ministry of Environment, 1992). Furthermore, few other pieces of legislation currently encourage proactive adoption of environmental practices (British Columbia Ministry of Agriculture, 2010).

To promote the adoption of agri-environmental Beneficial Management Practices (BMPs) on farms as a means to reduce the environmental impact of agriculture in BC, the federal and provincial governments, in partnership, developed the *Canada-BC Environmental Farm Plan (EFP) Program* (Agricultural Research and Development

Corporation, 2010).[1] The *EFP Program* guides farmers through a whole-farm environmental risk assessment process that identifies environmental priority areas and helps farmers to create a plan of action to mitigate environmental risks (Agricultural Research and Development Corporation, 2008). The *EFP Program* is funded by the *Growing Forward* federal-provincial funding agreement; however, the provincial Ministry of Agriculture (AGRI) is mostly responsible for developing the program content and making decisions regarding program-funding allocation to specific BMPs (Mark Raymond, Personal Communication, March 11, 2011).[2] The *EFP Program* is voluntary, confidential, and delivered through a third party, the Agricultural Research and Development Corporation (ARDCorp), who operates independently of the provincial and federal governments.

Once farmers have completed the *EFP Program*, they have access to the *Beneficial Management Practices Program* (*BMP Program*) where they can apply for cost-sharing funding to implement the BMPs identified through the EFP process. Funding available to farmers ranges from $1,000 to $30,000 for over 60 different BMPs that fall under categories such as ‘Improved Manure Storage and Handling’, ‘Riparian Area Management’ and ‘Irrigation Management’ (Agricultural and Research Development Corporation, 2011). An example of a BMP is the establishment of riparian buffers between the farm operation and watercourses, for which the farm may receive up to $70,000 or 60% of the total project cost.

The *EFP Program* is delivered through contracted ‘Planning Advisors’ who meet one-on-one with farmers to complete the risk assessment and create action plans. Planning Advisors are also often involved with helping farms to submit applications for BMP project funding, although this is not a requirement. To apply for BMP funding, farmers complete an application form that is submitted to ARDCorp, containing contact information, basic farm information as well as a brief overview of the project proposal. ARDCorp is responsible for approving projects and administering funds as well as

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[1] A beneficial management practice (BMP) is defined as an agri-environmental practice which minimizes the impact of the farm on the environment as compared to the alternative practice. For example, livestock producers may water livestock directly from a natural watercourse, resulting in a risk to water quality and riparian health. An alternative BMP to watering directly from a watercourse is to install off-stream waterers and pump water away from the watercourse.

[2] The Growing Forward Agricultural Policy Framework is a 60:40, federal/provincial cost-sharing arrangement for agricultural programming across the Canadian provinces and territories.

collecting and storing *EFP* and *BMP Program* data. ARDCorp is also responsible for reporting limited aggregated *EFP* and *BMP Program* statistics annually (Mark Raymond, Personal Communication, March 11, 2011).

1.2 Development of the Environmental Farm Plan and Beneficial Management Practices Programs

Prior to the initiation of the *EFP* and *BMP Programs* in 2003 and 2005 respectively, the Province commissioned studies to assess the state of and priorities for agri-environmental resources in British Columbia (BC). The 'State of Resources Report' gathered baseline information about the state of agri-environmental resources in the province at that time by examining farming practices (Bertrand, 1999). The information gained from this study provides limited baseline data for which to compare the current state of resources given the increased adoption of BMPs. The Province also contracted Golder and Associates to conduct a province-wide consultation to assess the actual and potential environmental risks due to farming activities within the various regional districts 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 also ranked environmental priorities and the concerns of farmers for each region.

1.3 Problem Statement

Although the *BMP Program* started in 2005, to date, no evaluation of program outcomes has occurred. The lack of evaluation has resulted in little, if any information about the environmental outcomes of BMPs and the overall effectiveness of the *BMP Program* to date. Without this information, program directors have little means to: demonstrate to farmers that agri-environmental practices can be cost-effective and beneficial to their operations, demonstrate net benefits of the program to funding agencies and inform the allocation of limited program funding amongst BMP projects. Furthermore, program directors have little means for adaptive management of the *BMP Program* due to a lack of information about program effectiveness, successes and weaknesses to date. To overcome the current challenges, program directors requested an evaluation of the social, economic and environmental outcomes of eight agri-environmental BMPs between 2011 and 2013 (Mark Raymond, Personal Communication, March 11, 2011).

1.4 Research Objectives

In addition to serving as my REM 699 project, the research reported in this document was funded and conducted on behalf of the BC Ministry of Agriculture (see Suess et al., 2012). The research objectives for this project were:

- To develop a methodology for evaluating the social, economic and environmental outcomes of agri-environmental BMPs adopted by BC farms through the *BMP Program*;
- To test the methodology by evaluating four BMPs currently funded through the *BMP Program* in 2011-2012 including: *Alternative Livestock Watering Systems to Manage Livestock*, *Riparian Buffer Enhancement*, *Irrigation Management* and *Wildlife Damage Prevention*;[3] and
- To make policy recommendations to the Ministry of Agriculture to allow for adaptive management of the *BMP Program* using the evaluation methodology.

1.5 Organization of the Study

In Chapter 2 I review the literature on program evaluation and agri-environmental program monitoring and evaluation in Canada and elsewhere. The study methodology is described in Chapter 3. In Chapter 4 I present the results of the evaluation for each BMP in the order of *Alternative Livestock Watering Systems to Manage Livestock*, *Riparian Buffer Establishment*, *Irrigation Management*, and *Wildlife Damage Prevention*. In Chapter 5 I present a SWOT analysis of each BMP and make policy recommendations to the Ministry of Agriculture. In Chapter 6 I discuss the results of the evaluation in the context of other research and in Chapter 7 I conclude the report with final thoughts.

[3] For an overview of the BMPs evaluated for this project, see Appendix IV.

Chapter 2: Literature Review

The following literature review grounds this study in the context of the program evaluation literature and reviews previous evaluations. The literature review also identifies the research gap that is filled by the evaluation of BMPs funded through the *BMP Program*. Due to the scope of this study, a broad scan of literature was undertaken including program evaluation literature from the federal government, provincial governments, international organizations, peer reviewed journals and agricultural organizations, as well as academic literature on program evaluation. The literature review was guided by the following research questions:

- How does program evaluation improve environmental programming?
- What are the common methods of program evaluation and how and when are they best applied?
- How does the BMP evaluation fit within the context of environmental program evaluation?
- Could other program evaluation studies or projects provide insight into the evaluation of BMPs?

2.1 Introduction to the Policy Cycle and Evaluation

Public policy is broadly defined as the action or inaction taken towards a problem by public authorities (Pal, 2005). The three major elements of a policy include a definition of a problem, goals that are to be achieved and instruments or means to address the problem at hand. Policies are often developed in response to a public issue. For example, the federal and provincial governments established the *Canada-British Columbia Environmental Farm Plan and Beneficial Management Practices Programs* as a program to help mitigate the impact of agriculture on the environment.

Public policy is cyclical in nature whereby policies are developed, implemented, evaluated and amended. The policy cycle is described in more detail by the following major steps written in sequential order (1) an agency develops a policy in response to a problem; (2) the policy is implemented; (3) behavioral changes are made by firms and individuals; (4) environmental, health and other outcomes are experienced; (5) program or policy evaluation occurs; (5) evaluation leads to deliberation and decision making; (6) the policy is amended, replaced or implemented, and the cycle repeats (Bennear & Coglianese, 2005; Pal, 2005).

2.2 Policy and Program Evaluation

Evaluation is a critical step in the policy cycle to indicate whether or not a program or policy is effective and whether it is worthwhile to continue to support it. Policy and program evaluation uses social and scientific research methods to investigate the effectiveness of policy instruments in order to inform future actions and to improve any program shortfalls (Pal, 2005; Rossi et al, 2004).

A program evaluation facilitates adaptive management by monitoring program outcomes, testing assumptions, and initiating double loop learning (Stem et al., 2005). This type of planned, retrospective evaluation can inform policy deliberations and improve the formulation and delivery of government policies and programs, ultimately having positive outcomes (Bennear & Coglianese, 2005).

Despite the positive effect that evaluation can have on the outcome of a policy or program, it is rarely adopted as a regular aspect of government program management (Pal, 2005; Bennear & Coglianese, 2005; Clark, 2002). The lack of evaluation of programs and policy may be due to the fact that it can be expensive, difficult to do, politically unpopular and sometimes inconclusive (Pal, 2005). Furthermore, when an evaluation is implemented, results are rarely widely disseminated, especially in the environmental conservation domain (Pullin & Knight, 2001).

Despite the issues with program evaluation described above, the Canadian federal government has encouraged policy evaluation at the Treasury Board level in recent years. In 2009, a “Policy on Evaluation” was implemented pursuant to the *Financial Administration Act* to determine the ‘value for money’ of federal government programs. The goal of the policy is to provide credible, timely and neutral information on the ongoing relevance and performance of direct program spending to ministers, central agencies, and deputy heads to support evidence-based decision-making on policy, expenditure management and program improvements as well as to support government accountability (Treasury Board of Canada Secretariat, 2012).

2.3 Agri-Environmental Program Evaluation in Practice

This study is the first evaluation of agri-environmental BMPs funded through the *BMP Program* in BC. However, programs similar to BC’s *Environmental Farm Plan* and *BMP Programs* have been the subject of evaluations elsewhere, providing insight into the type of information that program evaluators are often interested in. The Ontario

Environmental Farm Plan Program, which is similar to the *BC EFP Program*, was evaluated once for its performance in 2006 (Robinson, 2006). The Alberta *Cows and Fish Program* conducts ongoing evaluation on various aspects of their programs aimed to decrease the impact of ranching on riparian areas (Alberta Riparian Habitat Management Society, 2012). Evaluators of both these programs are interested in program environmental outcomes, entry barriers to the programs as well as education and awareness of the program amongst the target population (i.e. farmers).

The *Watershed Evaluation of Beneficial Management Practices* (WEBS) 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, 2011d). Unlike the *Ontario EFP* and *Cows and Fish Program* evaluations, WEBS is interested in measuring the biophysical and hydrological impacts of on-farm BMP adoption as well as evaluating the costs and benefits associated with the BMP. The methods employed by WEBS include a blend of technical monitoring and economic analysis, using surface water quality data as the main indicator of the BMPs' environmental impact.

Outside of Canada and on a larger program scale, the European Union's (EU) Common Agricultural Policy (CAP) framework provides subsidies to farmers through agri-environmental programs.[4] Generally, the CAP evaluations are interested in program impact, program effectiveness and value for money of programs. Although the CAP programs have been in place for over a decade and legislation requires the evaluation of agri-environmental programming, few evaluations of program outcomes have occurred and spending on evaluation is only approximately 4% of the overall programs budgets (Finn et al., 2009; Kleijn & Sutherland, 2003; Wilson & Hart, 2001). Challenges with the evaluation of agri-environmental schemes in the EU include lack of clarity about the environmental objectives of the programs, absence of environmental monitoring and lack of information about the relative priority of environmental objectives (Finn et al., 2009).

2.3.1 Agri-Environmental Monitoring Schemes

Agri-environmental monitoring programs differ from environmental program evaluation as they monitor and measure changes in the state of the environment across a landscape that result from a variety of pressures, instead of evaluating the impacts or

[4] Note that the programs vary from country to country but share the common objective of reducing the impact of agriculture on the environment.

outcomes of a single program. 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 some cases the monitoring efforts guide policy and have resulted in program implementation, such as the *EFP* and *BMP Program*s (Agriculture and Agri-Food Canada, 2011b).

Examples of agri-environmental monitoring programs include the Farm Environmental Management Survey (FEMS) and the National Agri-Environmental Health Analysis Reporting Program (NAHARP). 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 2011, but results were not available at the time of writing). 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 National Agri-Environmental Health Analysis Reporting Program (NAHARP) is an initiative of AAFC to monitor and report agri-environmental health and risks across Canada (Eilers et al., 2010). Three reports have been 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 (Eilers et al., 2010; Lefebvre et al., 2005; McRae et al., 2000).

2.4 Approaches to Program Evaluation

Program evaluation involves a description of the performance of the entity being evaluated and an evaluation involving some standards or criteria for judging the performance of the entity. Program evaluation is conducted to inform five different aspects of either a program’s development, implementation or effectiveness including (1) the need for the program; (2) the program’s design; (3) the implementation and service delivery; (4) the program’s impact or outcomes; and (5) the program’s economic efficiency (Rossi et al., 2004). Because the *BMP Program* has already been designed and implemented, and AGRI is interested in learning about the outcomes of BMP adoption, the first three levels of program evaluation do not apply for the purposes of this study.

2.4.1 Process Evaluation

Process Evaluation assesses the breadth and effectiveness of a program's implementation. The types of information delivered by a program *Process Evaluation* include, for example, how many people the program influenced, when, throughout the life of the program participation occurred and what the outcomes of the program were (Pal, 2005). *Process Evaluation* is the most frequent form of evaluation and it is often undertaken in conjunction with *Impact Assessment*, described below (Rossi et al., 2004). The information and knowledge provided by a *Process Evaluation* is critical to manage a program for high performance (Rossi et al., 2004).

Two tools used in *Process Evaluation* are meta-analysis and scorecards. In meta-analysis, evaluators review the literature on similar program evaluations and use each case study to build evidence for the likely outcomes of a similar program (Pal, 2005). The information gained through literature review may be examined quantitatively using a meta-regression analysis framework, which results in a more objective analysis of findings (Stanley & Jarrell, 1989). The use of scorecards to track outcomes on a site or project allows the evaluator to ask consistent, replicable evaluation questions that can be answered repeatedly, over time (Benham et al., 2005; Stem et al., 2005). The scorecard can be used to monitor outcomes and give direct feedback for management decisions.

Outcome monitoring is also a form of *Process Evaluation*, which involves the continual measurement and reporting of indicators that relate to program outcomes. Appropriate indicators for outcome monitoring include those that are responsive to program effects and those that only the program can affect to any appreciable degree, to reduce the chance of confounding factors affecting results. Measuring indicators prior to program implementation and post-program implementation can provide a low-cost alternative to measuring impact however, with less reliable results than those resulting from *Impact Assessment*, described below (Rossi et al., 2004).

Difficulties often arise when attempting to find an indicator where changes may be directly attributed to the program, and not to any other confounding factor. On that note, outcome monitoring is limited in the reliability of the information that it provides as it does not provide empirical evidence that the program is having any given impact, it only generates correlation between the program and changes in indicators. Thus, outcome monitoring is a technique for gaining feedback on a program and tracking outcomes attributed to the program, not measuring impact. The information gained from outcome monitoring is varied and it is often up to a program manager or analyst to interpret the results. Integral in this step is having some framework or threshold to determine what constitutes a change in outcomes (Rossi et al., 2004).

2.4.2 Impact Assessment

Similar to *Process Evaluation*, *Impact Assessment* is a method of evaluation that investigates the outcomes of a program. However, *Impact Assessment* employs experimental or quasi-experimental design methodology and as such can elucidate causal relationships between a program and outcomes, where as *Process Evaluation* cannot (Rossi et al., 2004). The type of information gained through an *Impact Assessment* includes assessment of whether the desired outcomes have been attained and whether or not the program has resulted in unintended side effects (Rossi et al., 2004).

Integral to *Impact Assessment* is the design of the study, which must be capable of establishing the status of program participants compared to their status, had they not participated in the program (i.e. the counterfactual situation). The "gold standard" for *Impact Assessment* methodology is a controlled, random experiment where the mean of an outcome of one group that has received the treatment is compared to the mean of an identical group that does not receive the treatment (Frondel & Schmidt, 2005; Rossi et al., 2004). However, this standard is hard to achieve due to challenge of identifying a control group. Instead, often a quasi-experimental design is employed, where a non-randomized treatment and control groups are compared out of necessity (Frondel & Schmidt, 2005; Rossi et al., 2004). One less rigorous alternatives to a random experimental design is the comparison of time series data or of pre-program and post-program outcomes (Pal, 2005).

Impact Assessment is a costly and time-consuming endeavor, suitable for programs that have been subject to prior *Process Evaluations*. *Impact Assessments* often occur after major program revisions or changes in funding to determine how the changes have impacted program outcomes (Rossi et al., 2004). Some researchers have indicated that *Impact Assessment* is an essential undertaking for programs aiming to improve environmental conditions, in order to proof that the program has the intended effect (Ferraro, 2009; Frondel & Schmidt, 2005 Kleijn & Sutherland, 2003). However, some researchers indicate that because of the time, expense and challenges associated with *Impact Assessment*, it has little place in a government program evaluation context (Dumaine, 2012).

2.4.3 Economic Efficiency Assessment

An *Economic Efficiency Assessment* gauges the relationship between a program's costs and outcomes and/or impact (i.e. the program's benefits). *Economic Efficiency Assessment* is usually conducted after a *Process Evaluation* or *Impact Assessment,* once the outcome of the program is known or reasonably estimated. The two methods of efficiency assessment are cost-benefit analysis or cost-effectiveness analysis (Rossi et al., 2004). Cost-benefit analysis monetizes and discounts benefits and costs over a specified amount of time and then constructs a decision rule, such as Net Present Value (NPV), to assess performance. Cost-effectiveness does not attempt to monetize benefits as it is assumed that the benefits are constant across the alternatives being considered. Many considerations besides economic efficiency are important in program delivery, but economic efficiency is almost always critical in order to determine value for money (Canada Treasury Board Secretariat, 2012; Rossi et al., 2004).

Estimating the private costs associated with BMP adoption is relatively straightforward. However, estimating the broader value of benefits 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 (Eilers et al., 2010). Methods used by other researchers to estimate private benefits focus on increases in yields due to BMP adoption, and econometric modeling to determine the economic impact of BMP adoption on the whole farm operation including costs and benefits (Agriculture and Agri-Food Canada, 2011a; Ajayi, 2009; Agriculture and Agri-Food Canada, 2009; Monaghan et al., 2008).

Despite a growing body of literature on the topic of estimating both on-farm benefits and benefits to society from BMP adoption, an inability to estimate all benefits attributed to a BMP is a limitation of the methodology (Turner et al., 2010). An example of a relevant challenge includes a lack of ability 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 some benefits cannot be monetized, results of Cost-Benefit Analyses of some BMPs show that they are not financially profitable to the farm operation (Agriculture and Agri-Food Canada, 2009).

2.4.4 Summary and Comparison of Program Evaluation Approaches

Process Evaluation, *Impact Assessment* and *Economic Efficiency Assessment* differ in their methods employed and objectives achieved, although all three approaches are useful for yielding information required to effectively direct programming. *Process Evaluation* may take place at any stage during the life of a program and is often conducted on an ongoing basis for monitoring purposes. On the other hand, *Impact Assessment* and in some cases *Economic Efficiency Assessment* are more useful when conducted on mature programs, or those that are earmarked for major changes to structure or funding (Rossi et al., 2004). The three approaches also differ in the time and average resources required. Specifically, *Impact Assessment* is often a more costly and time-consuming endeavor than *Process Evaluation* and *Economic Efficiency Assessment*. The evaluation approaches are further summarized and compared in Table 1 below.

Table 1. Summary and comparison of program evaluation approaches[5]

Type of Evaluation	Methods	Information Yielded	Objectives	Cost	Time
Process Evaluation	Variable: Can include quantitative and qualitative data. Typically not experimental design. Can include interviews, surveys, meta analysis, self assessments.	Variable: Breadth of program impact, program outcome information, feedback from participants, ongoing program monitoring	Variable but can include: Investigation of the outcomes of a program, investigate the breadth of the program and gain feedback from participants and target population	Low - Medium	Variable: Can be ongoing
Impact Assessment	Experimental (preferred) or quasi-experimental design	The impact of a program vs. the status quo	To determine the impacts that can be directly attributed to a program	Medium - High depending on design	Often a long process
Economic Efficiency Assessment	Either a Cost-Benefit Analysis or Cost-Effectiveness Analysis	The value of a program vs. the status quo or alternative OR the cost of a program versus the status quo or alternative	To determine the value for money of a program or to compare costs of a program versus the	Variable: (depending on approach and data availability)	Variable: Can be short if impact or outcome data available

[5] Table contents adapted from Bardach, 2011; Pal, 2005; Rossi et al., 2004; and Clark, 2002.

2.4.6 Agri-Environmental Practice Adoption Studies

Adoption of agri-environmental practices and technologies has been the subject of several empirical studies that seek to understand the reasons why a practice is or isn't adopted by farmers (Knowler & Bradshaw, 2006). For example, Yiridoe et al. (2010) conducted a choice experiment to investigate the farmer and farm characteristics that determine participation in the Nova Scotia Environmental Farm Plan. Researchers found that several factors increase the likelihood of a farm participating in the program including livestock production, large-scale farms, high farm income, and specialized knowledge and training regarding environmental practices. Similarly, Wandel and Smithers (2000) found that adoption of conservation tillage by Ontario farmers was most affected by factors relating to farm size and scale as well as the nature of the farming system itself rather than personal and attitudinal factors. Studies have identified few universal variables, which explain the adoption or non-adoption of conservation agriculture across several different locations. Therefore, to assume that the findings of other adoption studies are applicable to the unique situation of another particular location is not realistic. Rather, to understand the factors that influence adoption of BMPs and to create policy and programming to effectively promote adoption, tailored research and programming is likely necessary (Knowler & Bradshaw, 2006; Stonehouse, 1996).

2.5 Best Practices in Evaluation Data Collection

Some of the literature reviewed for this report presents "best practices" for the collection of data for program evaluation. These best practices are useful for the purposes of the development of the BMP evaluation methods and process. The following commentaries is a summary of the best practices that lead to effective program evaluation:

- Know the program well, including administrative and institutional details;
- Know the facts about the context of the program, including community statistics and population characteristics;
- Economize on data collection (which can be time consuming and costly by) only collecting data that can be turned into evidence and supplementing formal data collection with information from literature review and other informal sources; and
- Where establishing causal relationships is not possible, trusting intuition and the experience of key informants is a reasonable means of establishing conclusions (Bardach, 2011; Ravillion, 2001).

2.6 Bias and Pitfalls Common to Program Evaluation

Common to all types of evaluation are issues associated with interpreting evaluation data in the absence of other types of information. For example, to interpret the results of an *Economic Efficiency Assessment*, it is critical to understand the *impact* or *outcomes* of the program. Furthermore, to understand the results of an *Impact Assessment*, it is helpful to have a clear idea of the administration and breadth of the program (Pal, 2005; Stem et al., 2005; Rossi et al., 2004). A common issue with both *Impact* and *Economic Efficiency Assessment* is the failure to consider either social or cultural factors when conducting an evaluation (Stem et al., 2005).

Process Evaluation is subject to specific biases. *Process Evaluation*, which does not adopt a random experimental design methodology does not account for other factors that are correlated with the impact of the program. Therefore, an outcome may be erroneously attributed to a program when the true impact is actually due to a confounding factor (Ravillion, 2001). Pitfalls associated with outcome monitoring over time with indicators include but are not limited to a tendency for program managers to pay extra attention to indicators once established as well as a tendency to pad the indicator to make it look better than it is actually performing (Rossi et al., 2004).

Finally, particularly relevant to the evaluation of the *BMP Program* is that voluntary programs are subject to self-selection bias (Borck & Coglianese, 2009; Ravillion, 2001). Therefore, participants in these programs may be more likely to adopt environmental management practices anyways and perhaps would have done it in the absence of the program and results of the outcome evaluation, where this is not controlled for may be biased.

2.7 Synthesis of the Literature Review

Environmental programming is improved by program evaluation, which closes the policy loop and creates a mechanism for feedback on and knowledge about the program. In the case of the *BMP Program*, program directors lack any direct feedback on the program and are unable to adequately adapt to the changing context of agriculture and changing needs of the program participants. By adding a regular evaluation component to the program, decision-makers will gain the knowledge necessary to manage the program in a way so that it remains relevant to the needs of the future. Furthermore, adding a regular program evaluation component to the *BMP Program* will aid in federal program evaluation requirements, helping to provide the information necessary to promote the continued funding of the program in British Columbia.

The common methods of *ex-post* program evaluation include *Process Evaluation*, *Impact Assessment* and efficiency assessment. Each type of evaluation yields different types of results, however no one monitoring and evaluation approach fits all program evaluation scenarios (Stem et al., 2005). As the *BMP Program* has never been evaluated before, it is likely that a *Process Evaluation* would be a necessary first step before attempting an impact and efficiency assessment. Ongoing monitoring of program outcomes using *Process Evaluation* would likely yield the information decision-makers lack: information on the effectiveness of the program to express the need for continued funding of agri-environmental programs and information on the experiences of program participants to relay to non-adopters to help show that agri-environmental BMPs may be beneficial to their operations. Ongoing monitoring would also help to inform the adaptation of the program over time to meet the changing needs of program participants and the environment.

Chapter 3: BMP Evaluation Methodology

Several considerations contributed to the BMP evaluation methodology. At the time of this project, 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 relatively low-cost and be able to be completed within an eight-month timeframe to meet the funders' requirements. Thus environmental testing and monitoring over time was not possible. Finally, the general evaluation methodology was to be designed so it could be replicated in the future and across several BMPs to allow for monitoring of the outcomes and to compare the BMPs to one another.

The evaluation methodology was informed by a literature review, summarized in the previous chapter. The literature review revealed that program evaluation of government programs is not widely practiced on a regular basis, although increased emphasis has been placed on evaluation at the federal level in Canada (Dumaine, 2012). Although researchers have identified that there is a need to evaluate the *EFP* and *BMP Programs,* little efforts have been made to date (Robinson, 2006). Because the evaluation needs of AGRI were unique, and broad in scope, there were no evaluation programs in existence that could be replicated to evaluate the BMPs funded through the *BMP Program*. Furthermore, doing so would likely compromise the effectiveness of delivering useful information to decision-makers (Knowler & Bradshaw, 2006; Stonehouse, 1996). Rather, the BMP evaluation methodology was developed for the specific context of the *BMP Program* in BC. For the purposes of this study a *Process Evaluation* approach using mixed methods was selected, as well as an *Economic Efficiency Analysis* (cost-benefit analyses) (Johnson & Onwuegbuzie; 2004; Rossi et al., 2004).[6] These methods are described in more detail in section 3.1; whereas the remainder of this section will justify the approach selected for the BMP evaluation.

The literature described three distinct possible evaluation frameworks for which to base the BMP evaluation on: *Process Evaluation, Impact Assessment* and *Economic Efficiency Assessment* (Pal, 2005). In addition, technology adoption studies were also reviewed but were considered to be too narrow in scope for the purposes of the initial

[6] Mixed methods research integrates both quantitative and qualitative research methods in order to look at a problem statement in multiple ways, often yielding more useful results than if investigated with one single method only (Johnson & Onwuegbuzie, 2004).

BMP evaluations (Yiridoe et al., 2010; Wandell & Smithers, 2001). *Process Evaluation* delivers a range of information that may be collected from various sources and includes both quantitative and qualitative data (Stem et al., 2005; Greene, 2001). The type of information delivered by a *Process Evaluation* is broad and can include the outcomes of a program, the level of participation, the experiences of program participants and the spread of the program adoption (Rossi et al. 2004). Furthermore, *Process Evaluation* may be conducted at any time during the life of a program may be replicated over time and across BMPs, satisfying the ongoing evaluation needs of the program directors. Because AGRI was interested in gaining a range of performance, experiential and adoption based information about the *BMP Program* for a relatively low-cost, over a short time frame *Process Evaluation* was selected as the basis for developing the BMP evaluation methodology.

On the other hand, *Impact Assessment* is generally most useful when conducted on mature programs or after a major program revision has occurred (Rossi et al., 2004). For example, the *Watershed Environmental Best Management Practices Evaluation* (WEBS) Program employs an *Impact Assessment* framework to measure environmental impacts of BMPs on specific watersheds across Canada by measuring specific indicators within the watershed (Agriculture and Agri-Food Canada, 2011). Although *Impact Assessment* generally employs experimental design, and delivers more reliable results than *Process Evaluation,* there are several reasons why *Impact Assessment* was not appropriate for the evaluation of BMPs funded through the BC *BMP Program* including: narrow scope of evaluation focus, high-cost and long timelines associated with experimental design, and an inability to compare pre-program status to post-program status of BMP adopters as baseline information was not gathered prior to adopting BMPs (Dumaine, 2012; Frondel & Schmidt, 2005; Ravillion, 2001).

Economic Efficiency Assessment (i.e. Cost-Benefit Analyses) was also selected for the evaluation methodology. CBA results help to deliver a better understanding of the value for money of the *BMP Program*, and specific BMPs. It was expected that the CBA results would allow AGRI to prioritize limited funding as well as demonstrate the value of the *BMP Program* to the federal government (Canada Treasury Board Secretariat, 2012; Dumaine, 2012).

3.1 Data Sources and Pilot Evaluation of Four BMPs

The data for this project originated from three sources:

- A sample of BMP Program project application files which were supplied by ARDCorp for each BMP that was evaluated for this project;
- Survey instruments which were developed to conduct the social, economic and environmental evaluation of each BMP and administered via mail or via personal interviews with adopters; and
- Qualitative information, which was gained during interviews with BMP adopters was used to provide context to the information gathered using the survey instruments.

3.1.1 BMP Program Project File Data

The BMP project file data was collected from ARDCorp's paper archives. The data obtained from the program files included the contact information for adopters, the total number of adopters (N), the region where the BMP was adopted, the date the BMP was completed, and the total cost of the infrastructure both paid by the funding agencies and by the producer. The data files selected from ARDCorp included all adopters of the *Livestock Watering BMP* (N=69) and the *Riparian Buffer BMP* (N=42) and a random sample of 200 each of the *Irrigation Management* and *Wildlife Damage Prevention BMP* for the time period of 2005 to 2010.[7] ARDCorp also supplied the electronic data files for all adopters of the *Irrigation Management* (N=619) and the *Wildlife Damage Prevention BMP* (N=318), which, included BMP location, and implementation cost data but not contact information.

3.1.2. BMP Evaluation Survey and Survey Administration

Using information gathered through the literature review and in consultation with the AGRI project steering committee, four separate BMP evaluation surveys were developed and designed to capture environmental outcomes, financial outcomes (i.e. on-farm costs and benefits related to BMP adoption) and social factors of BMP adoption.[8] Indicators were used as a proxy for actual measurement of BMP outcomes and the survey

[7] Funding for the *Wildlife Damage Prevention BMP* ended in 2009, therefore only those who adopted the BMP between 2005 and 2009 were surveyed.

[8] The AGRI project steering committee consisted of subject matter experts from the Ministry of Agriculture, ARDCorp and Agriculture and Agri-Food Canada.

questions elicited information related to each indicator (Agriculture and Agri-Food Canada, 2011b; Vilain et al., 2007; National Farm Stewardship Program, 2006). See Appendix III for a summary of the environmental indicators selected for each BMP. Survey formats and techniques were informed by Dillman (2007) as well as though recommendations from my REM supervisory committee (see Appendix I for a sample survey). Prior to the survey administration, the survey tool was pretested with both students and farmers. Survey data was collected in two ways:

- Personal interviews with adopters of the BMP; and
- A mail out to BMP adopters who did not participate in an interview.

Interviews were conducted between September and December 2011 and focused on areas where BMP adoption was concentrated across the Province including the Fraser Valley Regional District, Metro Vancouver; the Regional District of the Okanagan – Similkameen, The North Okanagan Regional District, The Thompson – Nicola Region; The Cariboo Region; Prince George and Vanderhoof areas; The Peace River Region; and The Central and East Kootenay Regions (see Appendix II for maps depicting areas of BMP adoption).

A total of 52 interviews were completed. Interviews were arranged by telephone and email prior to visiting the regions. All areas with the exception of 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. I conducted the majority of the interviews with some assistance from one additional interviewer, when interview appointments overlapped. In most cases, when the producer had time, interviews corresponded with a BMP project site visit. The interviews were 2 to 3 hours in length and were generally informal, although the BMP evaluation survey was used as an interview guide.

A survey was mailed to the sample of adopters who did not participate in an interview.[9] Surveys were sent at the beginning of October with a return deadline of November 15th. A total of 430 surveys were mailed out and 77 completed surveys were returned (Table 2). The overall response rate was 25%, which is a similar response rate to previous studies conducted on *Environmental Farm Plan* participants in Ontario and Nova Scotia (Yiridoe et al., 2010; Atari et al., 2009). All participants who did not return a

[9] Note that in this case, the sample included the population of adopters of the *Livestock Watering* and *Riparian Buffer BMP* and a sample of 200 adopters of each of the *Irrigation Management* and *Wildlife Damage Prevention BMPs*.

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 including a lack of time to fill out the survey, an unwillingness to participate, and an inability to remember the answers to questions.

BMP	# Surveys Administered	# of Personal Interviews Conducted	# of Mail Surveys Returned	Response Rate
Livestock Watering	69	15	23	55%
Riparian Buffer	42	10	6	38%
Irrigation Management	200	12	24	18%
Wildlife Damage Prevention	200	15	24	19.5%
Total	**511**	**52**	**77**	**25%**

Table 2. Summary of response rates

3.1.3 Qualitative and Experiential Information

Often producers who were interviewed provided commentary about their experience adopting the BMP or information about the regional barriers to participation in the *BMP Program*. Qualitative information helps to provide context to the results of the evaluation and in some instances can help to explain why outcomes or participation rates are the way they are (Rossi et al, 2004; Greene, 2001). My personal experiences working with the *Environmental Farm Plan* and *BMP Programs* as a Professional Agrologist prior to conducting this project as well as a farmer were useful for comprehending the qualitative information offered by BMP adopters in interviews.

3.2 Data Analysis and Reporting

Results of the BMP evaluation surveys were analyzed and reported in aggregate. Descriptive statistics were used to highlight the major findings of the evaluation.

On-Farm Environmental Outcome Evaluation

Average environmental outcomes of BMP adoption, as expressed by select indicators, were calculated for each farm during the visits and extrapolated across the population of adopters to estimate the total environmental outcomes across the province.

Financial Outcome Evaluation

To understand the financial effects of the BMP to farm operations, several survey questions captured expenses and also monetary benefits associated with the BMP implementation by each individual farm operation. In some cases, where it was not possible to monetize costs or benefits, on-farm costs and benefits were described qualitatively. This information, together with value-transfer data provided the background data for a cost-benefit analysis.

Economic Efficiency Assessment

Results of the CBA are reported in this document to illustrate how an *Economic Efficiency Assessment* allows comparison of BMPs to one another, demonstrates the benefits of the program to funding agencies and assist in allocating limited program funding (Rossi et al., 2004).[10][11] The private costs and benefits captured by the BMP evaluation surveys were used to partially populate the CBAs.

The Treasury Board of Canada Secretariat (2007) guidelines for conducting cost benefit analyses were followed for the economic analysis. The first step was to identify the issues that the BMPs were intended to address as well as establish a status quo scenario. For the purposes of the BMP evaluation, it was assumed that the BMP would not have been adopted without the cost-share funding from the *BMP Program.* The status quo scenario was determined using the evaluation survey. The second step was to determine the specific objectives of each BMP. This was accomplished through literature review and in consultation with subject matter experts from the BC Ministry of Agriculture (National Farm Stewardship Program, 2006).The third step was to define the alternative (i.e. the implemented BMP) to the status quo. This included establishing a "program life" for each BMP as well as determining the characteristics of each BMP (Table 3).

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[11] The Cost-Benefit Analyses reported in this document were conducted by Ryan Trenholm, PhD candidate in the School of Resource and Environmental Management, on behalf of the BC Ministry of Agriculture (see Suess et al, 2012).

Table 3. Definition of each BMP for CBA

BMP	Description	Cost-Share	Program Life[12]
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

The fourth step was to assess the costs and benefits of both the status quo and the implemented BMP. Costs and private benefits were assessed using the results of the evaluation survey and project cost data supplied by ARDCorp. For some BMPs, public benefits were assessed using value transfer following similar analysis by Troy and Bagstad (2009) and Schmidt et al. (2011). The specific costs and benefits used in the analysis are documented in Appendix V. Benefits and costs were aggregated across the population of adopters for each BMP and discounted across time using a range of discount rates (0%, 3% and 8%). The fifth step was to apply a decision rule, net present value (NPV), to determine if the BMP funding is of benefit. Using NPV the BMP provides a benefit if the net present value is larger than zero. Three different net present value analyses were performed for each BMP including: determining the net present value of the program to date (until 2011), determining the net present value over it's expected life; and determining the net present value of adding one farmer to the program in 2011.

Social and Motivating Factors of BMP Adoption

To gain some understanding of the factors leading to adoption of BMPs, Likert scale questions were designed to capture the main motivations and barriers to BMP adoption (Yiridoe et al., 2010; Robinson, 2006). The motivation and barrier scores were averaged, and allowed for ranking of motivations and barriers. A principle component analysis (PCA) was conducted for the Livestock Watering System BMP motivation and barrier questions to further explore the data; however for other BMPs, such additional analysis

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

was limited by low sample size.[13] PCA reduces the number of variables by grouping possibly interrelated variables into unrelated components (Jolliffe, 2002). Components were extracted using the Varimax with Kasier Normalization method.

Societal Outcome Evaluation

Adoption of agri-environmental BMPs on-farm often results in off-farm benefits to society (Stonehouse, 1997). The benefits of agri-environmental BMP adoption to society were evaluated using information gathered during through the literature review, BMP adoption data, the results of a cost-benefit analysis and by aggregating survey results. Societal outcomes were described both qualitatively and quantitatively, where appropriate.

SWOT Analysis, Recommendations and Conclusions

To organize the main findings of the BMP evaluation surveys as well as qualitative information offered by interviewees, a SWOT analysis was conducted for each BMP. SWOT analysis framework highlights the characteristics of a policy or program and organizes the findings into strength, weaknesses, opportunities and threats. It provides information to decision makers if they should allow a program to evolve and leverage strengths, take advantage of opportunities as well as address weaknesses and threats (Pride & Farrell, 2000). Atari et al. (2009) used a SWOT framework to highlight the characteristics of the *EFP Program* and to present strategies to decision makers to improve the program in their study on determinants of participation in the Nova Scotia *EFP Program.*

Finally, conclusions and recommendations, based on the findings of the BMP evaluation were made for each BMP. Generally, if through the evaluation process, a problem with the current program is found, then often the role of the evaluator is to seek, assess and recommend alternatives (Pal, 2005). Recommendations were formulated based on the SWOT analysis as well as informed by the steps to making effective policy recommendations outlined by Clark (2002). For example, Clark (2002) considers the following criteria when formulating policy recommendations:

- The dependability of the facts presented by the evaluation;
- Comprehensiveness of information known about the problem;

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[13] A PCA was conducted only for the *Livestock Watering BMP* motivations and barriers to adoption, as the response rate for the other surveys was considered too low to achieve reliable results.

- How selective the evaluation was when targeting the appropriate groups; and
- The timeliness of the intervention provided by the alternative (and the urgency of the need for intervention).

The Ministry of Agriculture identified three broad questions that they hoped to answer with the results of the evaluation. Bardach (2011) advises that it is often the role of the client (in this case, the Ministry of Agriculture) to determine relevant policy questions for the evaluator. These questions, which helped to guide the synthesis of evaluation results and indicated which specific information AGRI was interested in, were:

- Does the BMP meet the expectations of adopters?
- Does the BMP provide a benefit to society?
- Is there justification for continued support of the BMP?

The criteria used to determine whether there is justification for continued support of the BMP included:

- Whether or not the BMP effectively mitigates the environmental risk it is intended to;
- Whether or not the BMP provides the expected benefits to the adopter; and
- Whether or not the BMP demonstrates net benefits to society.

These criteria were formulated based on the stated goals of the *EFP* and *BMP Programs* and were chosen to reflect the "effectiveness" of the individual BMP at achieving the program goals (Agricultural Research and Development Corporation, 2011; Agricultural Research and Development Corporation, 2010; Mark Raymond, Personal Communication, July 5th, 2012). Note that current adoption levels were not used as criteria here as there was insufficient information about the total potential for BMP adoption by BC farms to make any judgment.

Chapter 4: Results of The Beneficial Management Practice Evaluations

The following chapter presents the results of the evaluation of four BMPs funded through the *BMP Program* including *Alternative Livestock Watering Systems to Manage Livestock; Riparian Buffer Establishment; Irrigation Management for Nursery, Greenhouse, Tree Fruit, Grape and Berry Operations;* and *Wildlife Damage Prevention*.

4.1 Alternative Livestock Watering Systems to Manage Livestock

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 (BC Ministry of Agriculture and Lands, 2006).

4.1.1 Livestock Watering BMP - Provincial Statistics

In this section I report the BMP adoption and distribution from available statistics for the period between 2005 and 2010. A total of 69 *Livestock Watering BMP* projects have occurred across BC between 2005 and 2010.[14] The BMP has been adopted by just under 2% of the cattle ranches reported by Statistics Canada in BC (BC Ministry of Agriculture, 2011). Adoption generally corresponds with the distribution of cattle ranches across the province (see Appendix II for maps displaying the geographic distribution of adoption).

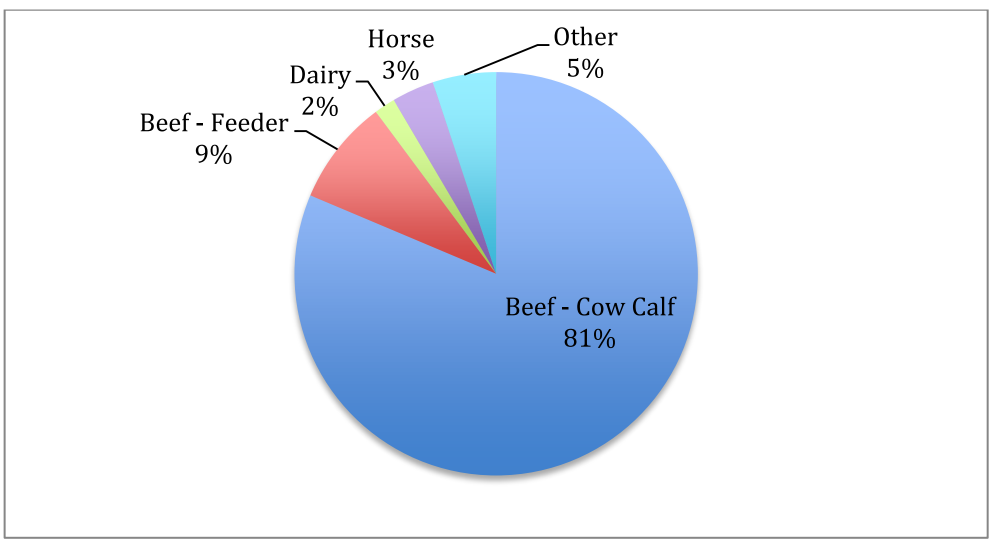
[14] A BMP 'Project' was defined as a single BMP approved and funded by ARDCorp. Using this definition, an individual farm operation may have adopted one or more distinct BMP projects on one or multiple farm properties.

Table 4. The number of Livestock Watering BMPs adopted in each 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

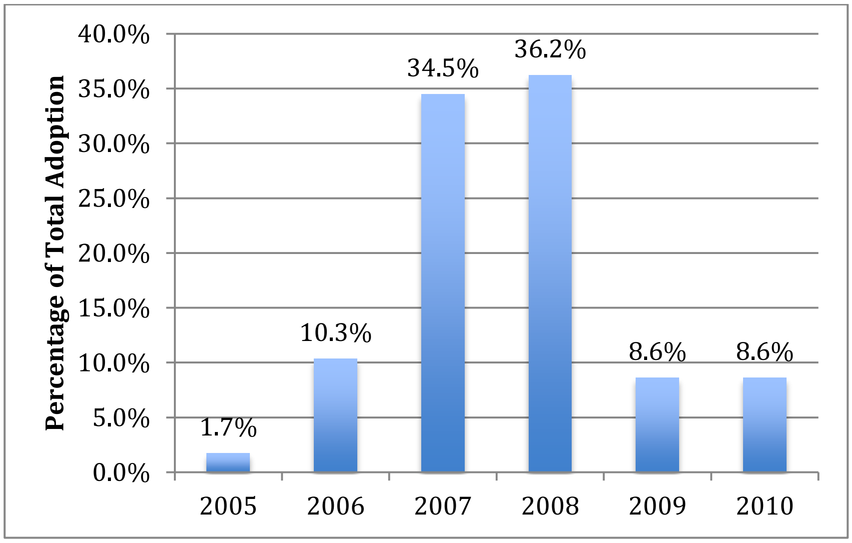
The cattle ranching industry has adopted the majority of the BMP projects in this category to date (90%). Other adopters of this BMP include horse operations (3%), dairy farms (2%) and other farms, classified as forage operations that have a small herd of livestock (5%) (Figure 1).

Figure 1. Livestock Watering BMP adoption by commodity



Adoption of the *Livestock Watering BMP* peaked in 2007 and 2008. Since 2008, adoption has dropped to approximately six projects per year (Figure 2).

Figure 2. Adoption of the Livestock Watering BMP over time



4.1.2 Characteristics of Adopters of the Livestock Watering BMP

The average size of ranches that have adopted the *Livestock Watering BMP* is 307 hectares, which is smaller than the BC industry average of 434 hectares (BC Cattlemen's Association, 2012). The median ranch size (126.7 ha) indicates that adopters of the BMP are generally smaller ranch operations. Each ranch has an average of 178 livestock, of which, 156 are beef cattle (Table 5).[15]

Table 5. Characteristics of farms adopting the Livestock Watering BMP

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

Farm gate sales of the BMP adopters reveal that more adopters fall into the middle range farm gate sales (Table 6).[16]

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[15] 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.

[16] Farm gate sales refer to the gross value of the product produced on a farm annually.

Table 6. Farm gate sales in 2010 of farms that adopted the Livestock Watering BMP

Farm Gate Sales	Percentage of BMP Adopters
Less than $10,000	22.6%
$10,000-$24,999	16.1%
$25,000-$49,999	16.1%
$50,000-$99,999	32.3%
$100,000-$249,999	9.7%
$250,000 and over	3.2%

Approximately half (48.6%) of BMP the adopters fall into the age category of 55 and above, whereas a minimal amount of adopters fall into the age category of 18 – 34 (Table 7). The pattern may reflect a more senior demography of ranchers specifically.

Table 7. Age of farmers who adopted the Livestock Watering BMP

Age Category	Percentage of BMP Adopters
18-34	5.7%
35-54	45.7%
55 and above	48.6%

The average number of years that adopters of the *Livestock Watering BMP* have farmed is 23 years with a minimum of 3 years and a maximum of 50 years. The average time they farmed on the property was 19 years with the minimum at 3 years and the maximum at 40 years.

4.1.2 Environmental Outcomes of the Livestock Watering BMP

In this section the environmental outcomes of the *Livestock Watering BMP* adoption are described, based on the findings of the evaluation survey.

Area of Riparian With Reduced Livestock Presence

The average riparian area that is conserved 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 8).

Table 8. The dimensions of the riparian areas conserved by the adoption of the Livestock Watering BMP

Average Riparian Area Dimensions Per Farm	Value	Standard Deviation
Average Riparian Area Length in m	1045.3 m	979.3
Average Width of Riparian Area in m	12.0 m	9.8
Average Riparian Area in ha	1.3 ha	0.9
Total Riparian Area Conserved in BC		
Total Length of Watercourse Conserved in km	72.1 km	
Total Riparian Area Conserved by Adopters in ha	86.4 ha	

Adopters were asked to describe the current state of their riparian vegetation. Two thirds of respondents indicated that their streambank or shoreline had over 90% vegetative cover at the time of the evaluation. Approximately half (44.7%) of respondents indicated that over 50% of the vegetation in the riparian area is trees and shrubs, 44.7% indicated that between 25%-50% of the vegetation in the riparian area is trees and shrubs and 10.5% indicated below 25% trees and shrubs.[17]

The majority of respondents indicated that vegetative cover on the streambank/shoreline, seedling and sapling recruitment and vegetative cover of native vegetation in the riparian area have all increased since implementing the *Livestock Watering BMP* (Table 9).

Table 9. Summary of responses for the change in riparian vegetation after the Livestock Watering BMP was implemented

	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%

Note that the time between BMP adoption and the evaluation is not accounted for in results presented in Table 9. However when the results are analyzed by year, responses generally indicate that over time, streambank/shoreline vegetative cover improved.

A total of seven Riparian Health Assessments (RHAs) were conducted at sites where the *Livestock Watering BMP* was adopted (BC Ministry of Agriculture and Lands, 2005). The average score was 63% (i.e. healthy but with problems). The lowest score

[17] Trees and shrubs are considered to be desirable riparian vegetation versus grasses or other herbaceous plants that are not deeply rooted (BC Ministry of Agriculture and Lands, 2005).

was 40% (i.e. unhealthy) and the highest score 84% (i.e. healthy). Because no baseline riparian health data had been collected prior to BMP adoption, these scores merely provide a snapshot of riparian health in time. Visually, some BMPs appeared to be more effective than others due to superior design and implementation. In some cases, *Livestock Watering BMPs* were not effective at mitigating streambank erosion and riparian damage as flooding events had occurred post BMP adoption, washing away large portions of streambanks.

Figure 3. A photo of a riparian area at a ranch along the Chilako River near Prince George 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% in a RHA (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.

4.1.3 Operational Outcomes 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. The outcomes of the BMP on the farm operation presented in this section include:

- Livestock health and safety;

- Year round livestock watering;
- Change in labour requirements;
- Change in grazing practices; and
- Marketing and communications.

Where livestock health and safety was at risk for reasons related to drinking from surface water, the *Livestock Watering BMP* generally helped to mitigate concerns. Responses indicated that 41% of adopters had experienced an improvement in livestock health whereas 56% indicated that no change in livestock health and safety has occurred. The reasons for improvement in livestock health included:

- Increased water consumption leading to improved calf weight for beef cows and increased milk production for pasture-raised dairy cows;
- Elimination of the risk of cows falling through the ice in winter-feeding areas;
- 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.

Approximately half of respondents (51%) indicated that adoption of the *Livestock Watering BMP* facilitated year round watering of livestock in an area where it was not possible previously (typically due to surface water freezing or lack of water during specific times). 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 their location for over-wintering their cattle due to the adoption of the *Livestock Watering BMP*, enabling year round watering at that location.

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, labour savings are not necessarily experienced by 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 for watering livestock, and how many hours annually they spend now for watering livestock. Approximately half (45%) of all respondents indicated that they experienced an increase in labour requirements due to BMP adoption. Reasons for the increase in labour included repair and maintenance on the system and fence and a need to check the system periodically to ensure it is running properly. Over half (55%) of all respondents indicated that they experienced a decrease in labour requirements. Reasons for the decrease in labour include:

- Elimination of the need to break up ice in the wintertime;
- Elimination of the 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.*[18]

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

Grazing practices facilitated by the installation of the *Livestock Watering BMP* were not specifically evaluated 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 marginal grazing which will allow [them] to improve soils and plant diversity while sustainably increasing [their] carrying capacity".[19]

Fourteen percent 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*.

4.1.4 Economic Outcomes of the Livestock Watering BMP

The net present values calculated for the program over its expected lifetime (15 years) were all positive (Table 10). 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. Aggregate BMP benefits ranged from a low of $4,257,538 to a high of $14,996,704, while the costs

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

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

ranged from a low of $1,321,714 to a high of $1,578,615 depending on the specification of the discount rate and ecosystem service values.[20] [21]

Table 10. Benefit, cost, and NPV of the Livestock Watering BMP over the expected lifetime 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.

The costs and benefits assessed in the Livestock Watering BMP CBA include both private and public costs and benefits including ecosystem services provided by riparian area conservation. The results of the CBA for the Livestock Watering BMP show that regardless of the discount rate used, the BMP provides a benefit to society.

4.1.5 Social and Motivating Factors of Livestock Watering BMP Adoption

Respondents were asked to rate on a Likert 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 (Table 11). Interestingly, factors which related 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 out of 5. 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 financial considerations as well as social and environmental factors.

[20] See Trenholm, 2012 in Suess et al., 2012 for a description of the benefit transfer methodology used to derive ecosystem service values.

[21] See Appendix V for a description of the costs and benefits used to conduct the *Livestock Watering BMP* CBA. See Appendix VI for additional CBA results including the NPV of the *Livestock Watering BMP* to date and the NPV of one additional BMP project.

Table 11. Rating of motivating factors for adopting Livestock Watering BMPs

Motivations	Mean Score	Standard Deviation
Limit the farm's impact on the environment	4.6	.82
Improve the long-term sustainability of the operation	4.4	1.27
Demonstrate stewardship	4.3	1.12
Contribute to a positive industry image	3.3	1.34
Secure a reliable source of water for livestock	3.2	1.67
Improve livestock health	3.2	1.38
Improve the profitability of the operation	2.9	1.46
Reduce the need for riparian fencing	2.3	1.53
Avoid regulatory action	2.2	1.46

These respondents were also asked to add any other motivating factors as comments. Responses included labour savings and responding to the negative public perception of the impacts of livestock in and around watercourses. 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.”[22]

A principle component analysis (PCA) on the motivations for adopting the *Livestock Watering BMP* (Tables 12 and 13) exposed relationships between the individual motivation items. The three components extracted accounted for 72% of the variance amongst variables. The first component named “industry image” is made up of industry “well-being” motivations including maintaining a positive industry image, avoiding regulatory fines, and providing water for livestock. The second component named “environment and sustainability” combines motivations related to reducing impacts of farm operations on the environment and enhancing the sustainability of the farm or ranch operation. The third component named “on-farm benefits” consists of demonstrating stewardship, improving livestock health and reducing the need for fencing on the farm operation. The components indicate that operational benefits of the BMP are common motivations for adoption amongst a group of respondents. Stewardship motivations are also a common motivating factor for a group of respondents. Limited sample size

[22] Quote taken directly from a survey respondent.

prevents any further analysis; however, PCA and regression analysis may allow evaluators to investigate differences between groups of adopters.

Table 12. Motivating factors for adopting the Livestock Watering BMP – principle component analysis

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.701	33.761	33.761	2.381	29.768	29.768
2	2.036	25.453	59.215	1.971	24.637	54.405
3	1.029	12.859	72.073	1.413	17.668	72.073
4	0.759	9.491	81.565			
5	0.525	6.563	88.128			
6	0.474	5.926	94.055			
7	0.278	3.471	97.526			
8	0.198	2.474	100			

Table 13. Motivating Factors For Adopting the Livestock Watering BMP - rotated component matrix.

	Component		
	Industry Image	**Environment and Sustainability**	**On-Farm Benefits**
Avoid regulatory action	**0.869**	-0.171	0.08
Contribute to a positive industry image	**0.774**	0.042	-0.152
Secure a reliable source of water for livestock	**0.74**	0.33	-0.139
Limit the farm's impact on the environment	-0.135	**0.903**	0.12
Improve long term sustainability of operation	0.219	**0.842**	0.123
Demonstrate stewardship	-0.153	0.217	**0.783**
Improve livestock health	0.36	0.397	**0.565**
Reduce the need for riparian fencing	0.51	0.32	**-0.635**

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. Cost was listed as the largest barrier to BMP adoption with a score of 3.8. The next largest 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 14. Rating of barriers to the adoption of the Livestock Watering BMP

Barriers	Mean Score	Standard Deviation
Costs associated with BMP adoption	3.8	1.57
A lack of awareness of risks to the environment from farm practices	3.1	1.42
A lack of understanding about *how* the BMP will benefit their operation	3.1	1.64
Barriers to accessing funding through the BMP Program	3.0	1.71
A lack of time or labour	3.0	1.71
A lack of understanding about *which* BMP will benefit their operation	2.7	1.62
No succession plan for their farm	2.6	1.54
A lack of support from public agencies	2.4	1.47
A lack of industry pressure	2.3	1.36
Logistically not feasible	2.1	1.43
Other environmental priorities take precedent	2.0	1.01
A lack of public pressure	2.0	1.20

Respondents were also asked to indicate any other barriers to adoption that they felt weren't included in the list. Additional barriers (or in some cases reiterated) included 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 funding cap; and the red tape associated with the *EFP/BMP Programs,* which should be interpreted as overload of paperwork and program eligibility criteria.

A principle component analysis (PCA) on these barriers to the *Livestock Watering BMP* adoption (Tables 15 and 16) explained approximately 70% of the variance in three components. Results of the PCA show that approximately 70% of the variance can be explained by three components. The first component named "logistics" accounts for 29% of the variance and consists of logistical type barriers such as high costs of BMPs, lack of labour, and incompatibility with the unique situation of the farm. The second component named "education and awareness", which explains 26% of the variance consists of educational barriers such as a lack of understanding of the benefits of the BMP, challenges choosing which BMP to implement as well as barriers to accessing funding. The third component named "understanding and planning", which explains 15%

of the variance, includes barriers related a lack of understanding the environmental risks that current farm practices pose to the environment and not having a succession plan for the farm.

Table 15. Barriers to adoption of the Livestock Watering BMP – principle component analysis

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.597	46.644	46.644	3.482	29.019	29.019
2	1.620	13.501	60.146	3.085	25.705	54.724
3	1.154	9.614	69.760	1.804	15.036	69.760
4	.839	6.992	76.752			
5	.722	6.013	82.765			
6	.482	4.016	86.781			
7	.420	3.502	90.283			
8	.380	3.170	93.453			
9	.231	1.924	95.377			
10	.201	1.679	97.056			
11	.185	1.544	98.600			
12	.168	1.400	100.000			

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Table 16. Barriers to Adoption of the Livestock Watering BMP - rotated component matrix

	Component		
	Logistics	Education and Awareness	Understanding and Planning
Logistically not feasible	**.815**	.085	-.186
Costs associated with BMP adoption	**.729**	-.015	.130
Lack of time or labour	**.736**	.388	.226
Other environmental priorities take precedent	**.675**	.506	.015
A lack of support from public agencies	**.650**	.432	.239
A lack of industry pressure	**.580**	**.559**	.303
Barriers to accessing funding through the BMP Program	.255	**.667**	-.278
A lack of understanding about *how* the BMP will benefit their operation	.028	**.852**	.200
A lack of understanding about *which* BMP will benefit their operation	.345	**.767**	.328
Lack of awareness of risks to the environment from farm operations	-.276	.384	**.576**
No succession plan for their farm	.245	-.048	**.842**
A lack of public pressure	.458	.512	.536

4.2 Riparian Buffer Establishment

The *Riparian Buffer Establishment BMP* (hereafter 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).

4.2.1 Riparian Buffer BMP Provincial Statistics

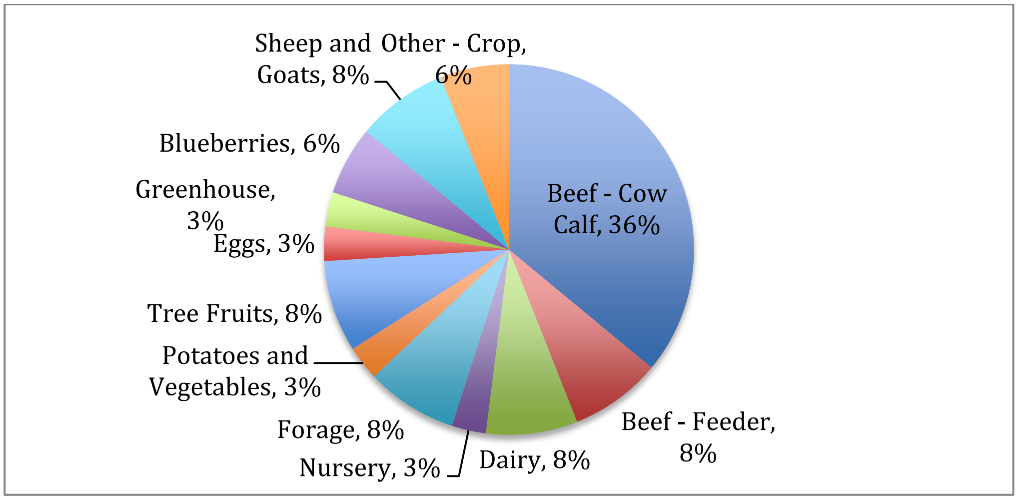
A total of 42 *Riparian Buffer BMP* projects occurred across BC between 2005 and 2010 (Table 17). This represents approximately 1% of the total farms in BC reporting watercourses on their properties (Agriculture and Agri-Food Canada, 2006).

Table 17. The number of Riparian Buffer BMPs adopted in each 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

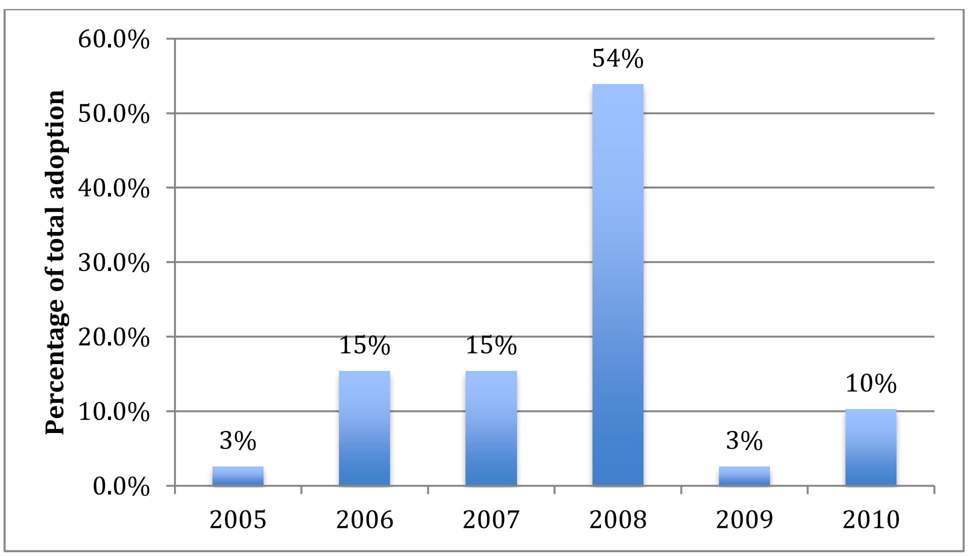
Different commodity groups have adopted the *Riparian Buffer BMP*, with the largest group being ranchers (44%). The next largest groups of adopters include the dairy industry (8%) and forage producers (8%). A summary of all adopters by commodity is displayed in Figure 4.

Figure 4. Riparian Buffer BMP adoption by commodity



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 (Figure 5).

Figure 5. Adoption of the Riparian Buffer BMP over time



4.2.2 Characteristics of Adopters of the Riparian Buffer BMP

The average size of farms that have adopted the *Riparian Buffer BMP* is 73 hectares and has an average of 28 livestock (Table 18).[23]

Table 18. Characteristics of farms adopting 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 of the *Riparian Buffer BMP* adopters reveal that farms that adopt the BMP are generally in a mid-range farm gate sales bracket (Table 19).

Table 19. Farm gate sales in 2010 of farms that adopted the Riparian Buffer BMP

Farm Gate Sales	Percentage of Survey Respondents
Less than $10,000	15.4%
$10,000-$24,999	15.4%
$25,000-$49,999	38.5%
$50,000-$99,999	7.7%
$100,000-$249,999	0.0%
$250,000 and over	23.1%

The majority (68.8%) of BMP adopters fell into the age category of 55 and above whereas no adopters of this BMP fell into the 18-34 age category (Table 20).

Table 20. Age of farmers who adopted the Riparian Buffer BMP

Age Category	Percentage of BMP Adopters
18-34	0.0%
35-54	31.3%
55 and above	68.8%

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. The average time farmed on the property was 13 years with a minimum of 4 and a maximum of 30.

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[23] 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.

4.2.3 Environmental Outcomes of the Riparian Buffer BMP

In this section the environmental outcomes of the *Livestock Watering BMP* adoption are described based on the findings of the evaluation survey. Note that the same indicators were used to assess the environmental outcomes of the *Livestock Watering BMP* except for the *Riparian Buffer BMP* the median area restored was reported instead of the average area.[24]

The median area of riparian that has been 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 21).

Table 21. The dimensions of the riparian areas restored by the adoption of the Riparian Buffer BMP

Riparian Area Dimensions	Value
Median Riparian Length in m	378.6 m
Median Width of Riparian Area in m	8.0 m
Median Riparian Area in ha	0.30 ha
Total Length of Watercourse Conserved in km	**15.9 km**
Total Riparian Area Conserved by Adopters in ha	**12.7 ha**

Overall, 100% of respondents indicated that the vegetative cover along the streambanks and shoreline had increased since the *Riparian Buffer BMP* was adopted (Table 22). The majority of respondents indicated that both seedling and sapling recruitment and native vegetation cover had increased since adopting the BMP.

Table 22. Summary of responses for the change in riparian vegetation after the Riparian Buffer BMP was implemented

	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%

[24] 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 such as the *Livestock Watering BMP* targets.

The majority (67%) of respondents indicated that the streambank and shoreline has 90% or more plant cover. Approximately half (48%) of respondents indicated that their riparian area had more than 50% vegetative cover in trees and shrubs. Table 23 indicates the current level of riparian vegetation. Because no baseline data is available, the results in this report simply indicate a snapshot in time for riparian health. In some cases, it is likely that the level of riparian vegetation will increase over time as the riparian vegetation becomes more established.

Table 23. Current characteristics of riparian vegetation in restored 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) were conducted at sites where the *Riparian Buffer BMP* was adopted (BC Ministry of Agriculture and Lands, 2005). The average score was 69%. The lowest score was 40% and the highest RHA score 87%. Again because no baseline riparian health data was collected prior to BMP adoption, these scores merely provide a snapshot in time for riparian health.

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 three species of birds; one species of fish; three species of mammals; and five species of amphibians that adopters are aware of.

Figure 6. 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 7. 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%.

4.2.4 Operational Outcomes of Riparian Buffer BMP Adoption

The operational objectives that *Riparian Buffer BMP* adopters consider when deciding to implement the BMP are not straightforward. The outcomes of the BMP to the farm operation, presented in this section include:

- Mitigation of streambank erosion and/or flooding;
- Extension of the grazing season;
- Enhancing farm aesthetics, public perception and tourism value;

- Marketing and communications; and
- Change in labour requirements.

Producers weren't specifically asked if mitigation of streambank erosion and/or flooding 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 some 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.

Three respondents indicated that adoption of the Livestock Watering BMP allowed them to extend their grazing season by an average of 7 weeks per year. Based on an average cost of feeding one cow for one week of $8.41 the average benefit for each livestock farmer who extends his or her grazing season using the *Riparian Buffer BMP* is $118.84 annually.[25]

Two respondents indicated that their main reasons for adopting the *Riparian Buffer BMP* were 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.

Approximately a third (36%) of respondents indicated that they experienced an increase in labour requirements due to BMP adoption. Reasons for the increase in labour include a need to fix the temporary fencing and maintaining undesirable vegetation by mowing and weeding. Twenty-one percent (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 need for labour for sandbagging or moving fencing during freshet events. Forty-three percent (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.

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[25] 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 (BC Ministry of Agriculture and Lands, 2007a; BC Ministry of Agriculture and Lands, 2007b).

Approximately a third (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.

4.2.5 Economic Outcomes of the Riparian Buffer BMP

The net present values calculated for the program over its expected lifetime (assumed to be 25 years) were mostly positive (Table 24). 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. 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 (Suess et al., 2012).[26]

Table 24. Benefit, cost, and NPV of the Riparian Buffer BMP over the expected lifetime 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.

The costs and benefits assessed in the Riparian Buffer BMP CBA include both private and public costs and benefits including ecosystem service benefits provided by riparian area restoration. The results of the CBA for the Riparian Buffer BMP show that over the

[26] See Appendix VI for additional CBA results including the NPV of the *Riparian Buffer BMP* to date and the NPV of one additional BMP project.

expected life of the program, the NPV is positive when calculated using the point estimate for ecosystem services indicating that the BMP provides a benefit. However, the NPV of the program to date is negative, indicating that the benefits of this BMP are not realized until the BMP has been in place over a longer period of time (see Appendix VI).

4.2.6 Social and Motivating Factors of the Riparian Buffer BMP Adoption

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 (Table 25).

Table 25. Rating of motivating factors for adopting the Riparian Buffer BMP

Motivations	Mean Score	Standard Deviation
Limit the farm's impact on the environment	4.3	1.40
Demonstrate stewardship	3.8	1.37
Contribute to a positive industry image	3.6	1.74
Improve the long-term sustainability of the operation	3.5	1.82
Enhance biodiversity on my farm	3.0	1.50
Improve the profitability of the operation	2.9	1.38
Enhance the aesthetics of my operation	2.6	1.59
Avoid regulatory action	2.5	1.86
Improve livestock health	2.3	1.81
Enhance the branding of my operation	2.1	1.57
Produce marketable products	1.3	.79

Other motivations included:

- Protecting the streambank/shoreline from erosion;
- Stewardship/ethical motivations;
- The Department of Fisheries and Oceans required one producer to enhance the riparian area on their property (i.e. regulatory action); 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 generations".

Similar to the *Livestock Watering BMP*, the largest barrier to adoption indicated by respondents is cost (4.1) (Table 26). The next largest barrier is a lack of time or labour (3.6).

Table 26. Rating of barriers to the adoption of the Riparian Buffer BMP

Barriers	Mean Score	Standard Deviation
Costs associated with BMP adoption	4.1	1.30
A lack of time or labour	3.6	1.54
A lack of understanding about *how* the BMP will benefit their operation	2.9	1.68
Other environmental priorities take precedent	2.9	1.75
A lack of awareness of risks to the environment from farm practices	2.7	1.48
Barriers to accessing funding through the BMP Program	2.7	1.49
A lack of industry pressure	2.6	1.65
A lack of understanding about *which* BMP will benefit their operation	2.4	1.55
No succession plan for their farm	2.4	1.55
A lack of support from public agencies	2.4	1.31
Logistically not feasible	2.1	1.14
A lack of public pressure	2.0	1.46

The largest barriers to adoption may 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 included:

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

4.3 Irrigation Management for Nursery, Greenhouse, Tree Fruit, Grape and Berry Operations

The Irrigation Management for Nursery, Greenhouse, Tree Fruit, Grape and Berry Operations BMP (hereafter referred to as 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. overhead 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.

4.3.1 Irrigation Management BMP Provincial Statistics

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 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 27).[27]

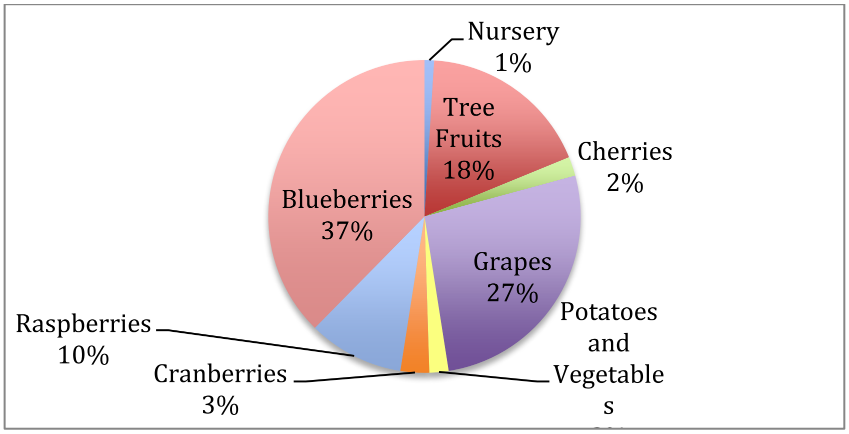
Table 27. The number of Irrigation Management BMPs adopted in each Regional District

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

[27] 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.

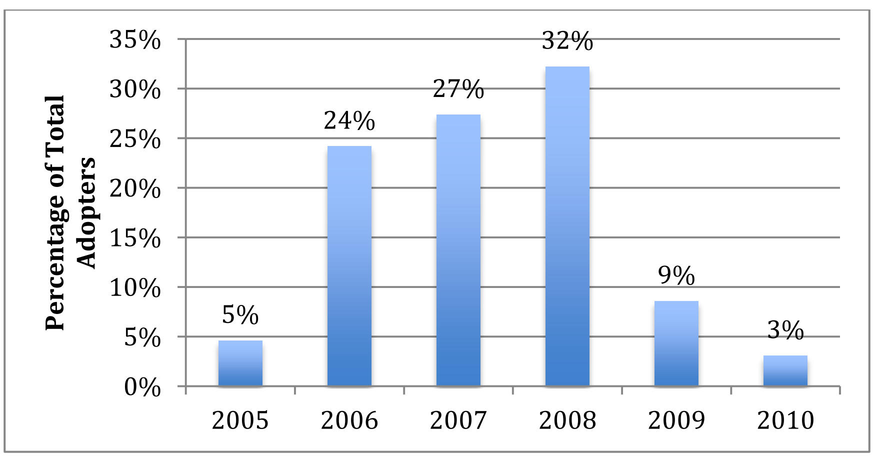
Different commodity groups have adopted the *Irrigation Management BMP*, with the largest group being blueberry growers (37%) and the next largest groups of adopters include grape (27%) and tree fruit growers (18%). A summary of all adopters by commodity is displayed in Figure 8. The sample did not include any greenhouses. Eleven percent (11%) of survey respondents indicated that they are certified organic.

Figure 8. Irrigation Management BMP adoption by commodity



Adoption of the *Irrigation Management BMP* grew steadily until 2008 when approximately 200 farms completed BMP projects. In 2009 and 2010, relatively few farms adopted the BMP compared to the three past years (Figure 9).

Figure 9. Adoption of the Irrigation Management BMP over time



4.3.2 Characteristics of Adopters of the Irrigation Management BMP

The average size of farms that have 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 adopted the *Irrigation Management BMP* is 12.8 hectares with an average of 6.4 hectares irrigated.

Farm gate sales of the *Irrigation Management BMP* adopters reveal that farms that adopt the BMP are generally weighted more heavily in 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 (Table 28).

Table 28. Farm Gates Sales in 2010 of farms that adopted the Irrigation Management BMP

Farm Gate Sales	Percentage of BMP Adopters
Less than $10,000	22.6%
$10,000-$24,999	12.9%
$25,000-$49,999	6.5%
$50,000-$99,999	25.8%
$100,000-$249,999	22.6%
$250,000 and over	12.9%

The majority of the adopters of the Irrigation Management BMP fell into the 34-54 an 55 and above age categories (Table 29).

Table 29. Age of farmers who adopted the Irrigation Management BMP

Age Category	Percentage of BMP Adopters
18-34	2.9%
35-54	57.1%
55 and above	40.0%

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. The average time farmed on the property was 12 years with the minimum of 1 years and the maximum of 34 years.

4.3.3 Environmental Outcomes of 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 (BC Ministry of Agriculture and Lands, 2005). The average farm in BC conserves 4.1 acre-feet of water annually due to the adoption of the *Irrigation*

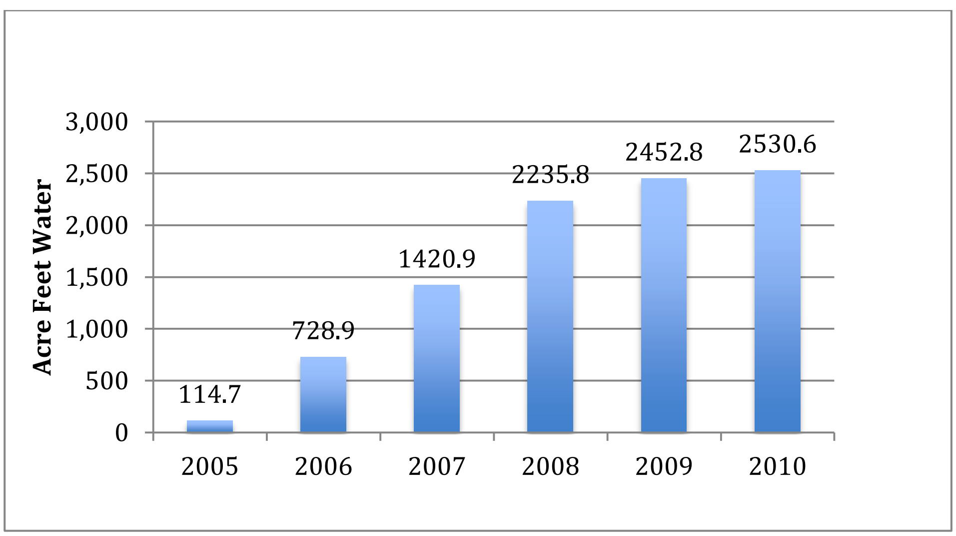
Management BMP. The average water use efficiency gained by adopting the *Irrigation Management BMP* is 25%. In 2010 the annual amount of water conserved by all BMP adopters to date topped 2531 acre-feet water savings annually. Table 30 provides a summary of the water conservation achieved on an annual basis by the BMP.

Table 30. Annual water savings due to the adoption of the Irrigation Management BMP

	Acre-Feet of Irrigation Water Conserved
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 BMP 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 fewer farms have decided to adopt this BMP (Figure 10).

Figure 10. Annual total water savings by year due to adoption of the Irrigation Management BMP



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 until the end of 2010. It also assumes that farms were at full production during that same time period.

Respondents indicated whether there had been a change in the water drainage in their crop area since implementing the *Irrigation Management BMP*. Thirty-seven percent (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.

4.3.4 Operational Outcomes of the Irrigation Management BMP

The outcomes of the BMP on the farm operation presented in this section include:

- Change in crop quality and yields;
- Change in weed pressures;
- Change in labour requirements; and
- Marketing and communications.

Approximately half of all respondents (54%) indicated that they have noticed an improvement in crop quality since adopting the BMP. some grape growers noted that vines could potentially become less vigorous due to less rooting depth and reach associated with drip irrigation.

The majority (62%) respondents who are growing the same crop at the time of evaluation 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 harvest a tree crops (apples and nursery) one year earlier due to better irrigation and fertilizer management.

Approximately half (58%) of growers indicated that they did not notice any change in the weed pressure in their fields. Approximately a third (31%) indicated that weed pressure in their fields had declined since adopting the *Irrigation Management BMP* while 12% indicated that weed pressure had increased.

A minority of respondents (23%) 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.

Approximately half (49%) of respondents indicated that they experienced a decrease in labour requirements due to adoption of the *Irrigation Management BMP*. 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 a reduction in the time needed to operate the system due to increased automation. A minority (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 the need to clean driplines and filters and the need to irrigate more frequently with the drip irrigation system. On average, adopters experienced a 66-hour per year decrease in annual labour requirements due to BMP adoption.

4.3.5 Economic Outcomes of the Irrigation Management BMP

The NPVs calculated for the program over its expected lifetime (7 years) were all positive (Suess et al., 2012). 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. 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 (Table 31).[28]

Table 31. Benefit, Cost, and NPV of the Irrigation Management BMP over the expected lifetime 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.

The costs and benefits assessed in the Irrigation Management BMP CBA include both private and public costs and benefits including the public benefit of water conservation. The results of the CBA for the Irrigation Management BMP show that over the expected life of the program, the NPV is positive indicating that the BMP provides a benefit. However, the NPV of the program to date is negative, indicating that the benefits of this BMP are not realized until the BMP has been in place over a longer period of time (see Appendix VI).

[28] See Appendix VI for additional CBA results including the NPV of the *Irrigation Management BMP* to date and the NPV of one additional BMP project.

4.3.6 Social and Motivating Factors of Irrigation Management BMP Adoption

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 factor that benefits both the farm and society (Table 32). The most important motivations for adoption of the *Irrigation Management BMP* are opposite to those of both riparian BMPs, where the highest motivating factors were based on stewardship reasons.

Table 32. Rating of motivating factors for adopting the Irrigation Management BMP

Motivations	Mean Score	Standard Deviation
Improve the profitability of the operation	3.9	1.47
To conserve water	3.8	1.59
Improve the long-term sustainability of the operation	3.6	1.66
Improve crop yields	3.4	1.62
To increase the reliability of water for irrigation	3.1	1.76
Limit the farm's impact on the environment	3.0	1.78
Demonstrate stewardship	2.6	1.63
Contribute to a positive industry image	2.6	1.70
To help the farm adapt to climate change	2.4	1.66

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.

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) (Table 33).

Table 33. Rating of barriers to the adoption of the Irrigation Management BMP

Barriers	Mean Score	Standard Deviation
Costs associated with BMP adoption	3.3	1.55
A lack of understanding about *how* the BMP will benefit their operation	3.1	1.52
Barriers to accessing funding through the BMP Program	2.7	1.55
A lack of understanding about *which* BMP will benefit their operation	2.6	1.41
A lack of support from public agencies	2.6	1.40
A lack of time or labour	2.5	1.29
Other environmental priorities take precedent	2.4	1.36
A lack of industry pressure	2.4	1.31
A lack of public pressure	2.4	1.29
No succession plan for their farm	2.3	1.49
A lack of awareness of risks to the environment from farm practices	2.1	1.33
Logistically not feasible	1.9	1.40

Additional comments regarding barriers included that:

- Farmers are unlikely to replace their system if they already have one in place, it doesn't make economic sense to do so;
- Farmers have difficulties completing projects within the timelines of the *BMP Program*;
- Leasing land is a barrier to adoption; and
- No barriers to adoption of the *Irrigation Management BMP* exist; most people in the industry are already using an efficient system.

4.4 Results of the Wildlife Damage BMP Evaluation

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 by providing funding for wildlife fences to protect crops and stored feed. Because of the differences in the nature of protection of crops versus the protection of stored feed, this section reports the results of the evaluation separately and aggregately where appropriate.

4.4.1 Wildlife Damage Prevention BMP Provincial Statistics

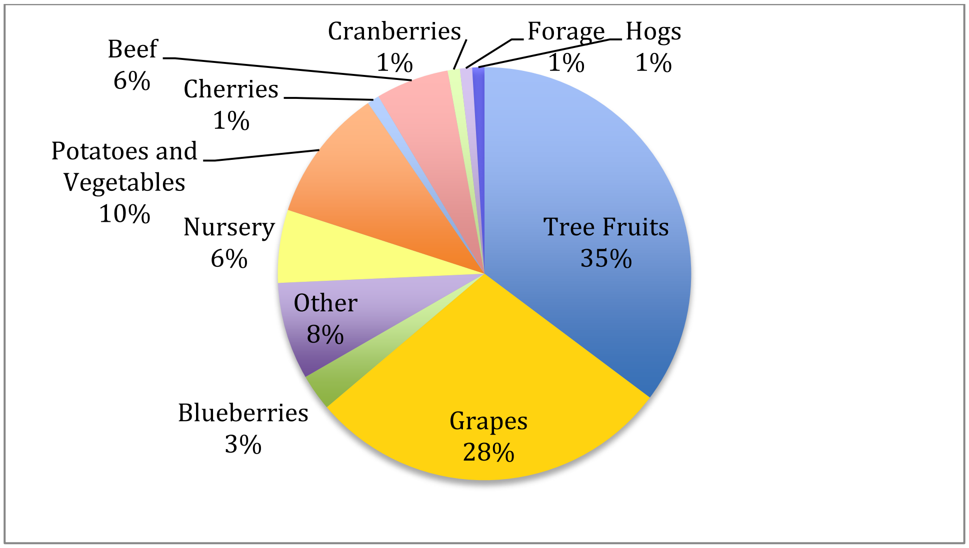
A total of 318 *Wildlife Damage Prevention BMP* projects have been supported across BC between 2005 and 2009. The majority of projects have occurred in the Fraser Valley, the Okanagan-Similkameen regions and Vancouver Island. Fewer projects have also occurred in the Kootenays, Cariboo and Peace Regions (Table 34).

Table 34. The number of Wildlife Damage BMPs adopted by 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

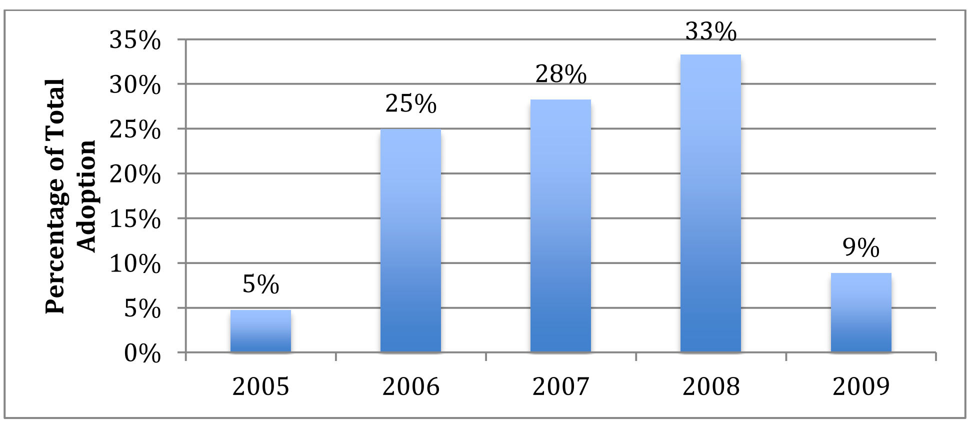
Different commodity producers have adopted the *Wildlife Damage Prevention BMP*, with the largest group including tree fruit growers (35%) and grape growers (28%) in the Okanagan-Similkameen (Figure 11). A minority (9%) of respondents indicated that they are certified organic.

Figure 11. Wildlife Damage Prevention BMP adoption by commodity



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* (Figure 12). 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 12. Adoption of the Wildlife Damage Prevention BMP over time



4.4.2 Characteristics of Adopters of the Wildlife Damage Prevention BMP

The mean size of farms that adopted the *Wildlife Damage Prevention BMP* to protect stored feed is 286 hectares. They hold an average of 233 livestock of which the majority are beef cows (average of 204 beef cows per ranch). The mean size of farms that adopt this BMP to protect ground crops is 13.2 hectares (Table 35).

Table 35. Characteristics of farms adopting the Wildlife Damage Prevention BMP

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

The farm gate sales in 2010 for adopters of the *Wildlife Damage Prevention BMP* indicate that adopters of this BMP are more heavily weighted in the minimal farm gate sales bracket and in the $50,000 to $99,000 range (Table 36).

Table 36. Farm Gates Sales in 2010 of farms that adopted the Wildlife Damage Prevention BMP

Farm Gate Sales	Percentage of BMP Adopters
Less than $10,000	22.6%
$10,000-$24,999	25.8%
$25,000-$49,999	9.7%
$50,000-$99,999	19.4%
$100,000-$249,999	6.5%
$250,000 and over	6.5%

The average age of the *Wildlife Damage Prevention BMP* adopters is most heavily weighted in the 55 and above range (Table 37).

Table 37. Age of farmers who adopted the Wildlife Damage Prevention BMP

Age Category	Percentage of BMP Adopters
18-34	0.0%
35-54	40.6%
55 and above	59.4%

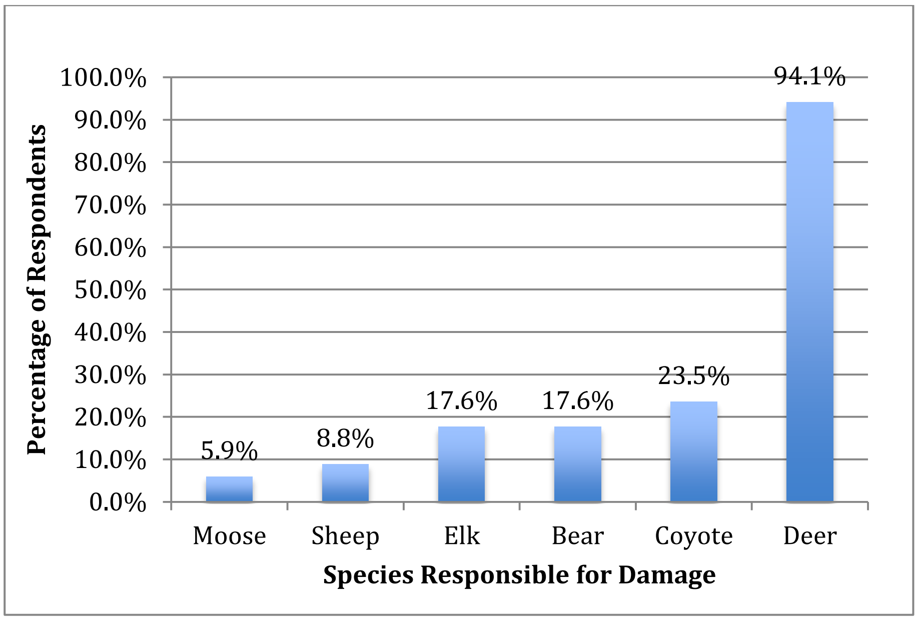
The average number of years that adopters of the *Wildlife Damage Prevention BMP* have farmed is 24 years with a minimum of 4 and a maximum of 56 years. The average time farmed on the property was 16 years with a minimum of 3 and a maximum of 56.

4.4.3 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.

Respondents were asked to indicate which specie(s) were 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 were listed include coyotes, black bears, elk, sheep and moose. Figure 13 summarizes the main species that cause damage on farms in BC. [29]

Figure 13. Wildlife species that caused damage to farms that adopted the Wildlife Damage Prevention BMP



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 (Table 38). The majority of respondents (88%) indicated that wildlife damaged their crops at an average cost of $5,454 annually. Some respondents (29%) indicated that coyotes were damaging their irrigation lines at an average cost of $820 annually.

[29] Note that although some respondents indicated that birds and small mammals cause damage on their farm, those species weren't included in the analysis as they are not prevented by wildlife fencing.

Some respondents (15%) indicated that wildlife damaged 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 feed 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 38. The type of damage and annual value of the damage *per farm* caused by wildlife prior to BMP adoption

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

Respondents indicated that they also experienced black bears damaging honeybees and young trees. One respondent indicated that they have an issue with elk breaking through trellises and irrigation lines.

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.

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 the wildlife fence was installed. 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.

Figure 14. 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.

4.4.4 Environmental Outcomes of the Wildlife Damage Prevention BMP

The installation of a fence on agricultural 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 aggregate outcome of the *Wildlife Damage Prevention BMP* will be presented.

Approximately two thousand (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 this is a very small area at the moment. However, respondents in both interviews and surveys indicated that adoption of wildlife fencing is displacing the wildlife to other people's farms, ranches and residential properties. This leads to concentrated pressures of deer and other wildlife on crops, stored feed and standing forage in some parts of the province, and some respondents indicated that farms in their area couldn't continue to be viable without fencing

Respondents were asked whether they provide some wildlife habitat on their farm. Half (50%) of respondents indicated that they did provide some habitat for wildlife on their property. Beef and forage producers provide an average of 179 hectares of wildlife habitat on their properties. Crop producers provide an average of 6.2 hectares of wildlife habitat on their farms. Further studies are needed to determine what the actual effect of this BMP has been on wildlife habitat, species survival and migration.

4.4.5 Operational Outcomes of the Wildlife Damage Prevention BMP Adoption

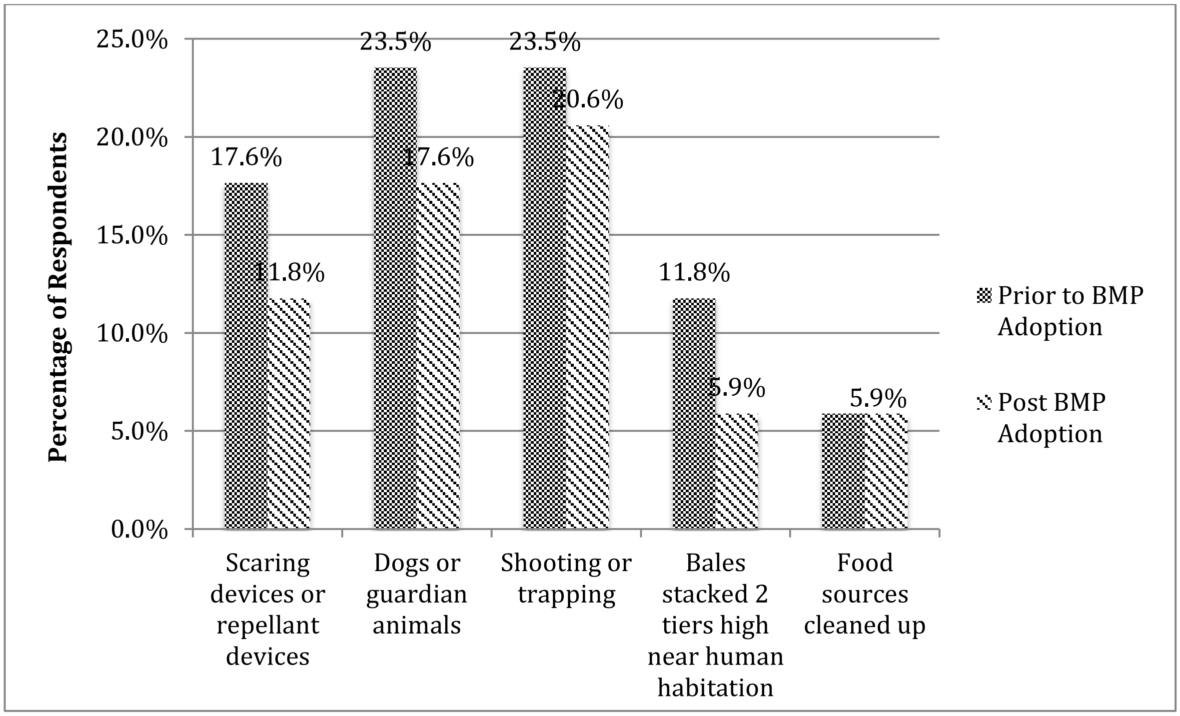
Mitigation of wildlife damages to crops and stored feed constituted the primary on-farm benefit due to the adoption of the *Wildlife Damage Prevention BMP*. However, other operational outcomes have occurred due to the adoption of the BMP including:

- Change in the other practices used to deter wildlife;
- Change in labour requirements; and
- Marketing and communications.

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 the need for 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 15.

Figure 15. Wildlife damage prevention practices employed before and after 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.

Approximately half (44%) of respondents indicated that they experienced a decrease in labour requirements due to BMP adoption. Reasons for the decrease in labour included:

- 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.

Some respondents (20%) 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, and 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.

A minority (29%) of respondents used 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.

Figure 16. 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. The now fenced stackyard (below picture) eliminates the cost of damaged stored feed as well as decreases the amount of labour needed to deter wildlife and clean up damaged feed.

4.4.6 Economic Outcomes of the Wildlife Damage Prevention BMP

The CBA results are presented by first showing an analysis for stored feed and crop protection separately, and then in aggregate (Suess et al., 2012). The expected life of the program is 15 years.[30]

Wildlife Damage Prevention for Stored Feed CBA

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 39). 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.

Table 39. Benefit, cost, and NPV of the Wildlife Damage Prevention of Stored Feed BMP over the expected lifetime 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.

Wildlife Damage Prevention for Crops CBA

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 40). 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.

[30] See Appendix VI for additional CBA results including the NPV of the *Wildlife Damage Prevention BMP* to date and the NPV of one additional BMP project.

Table 40. Benefit, cost, and NPV of the Wildlife Damage Prevention BMP for Crops over the expected lifetime 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.

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

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 41). 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.

Table 41. Benefit, cost, and NPV of the Wildlife Damage Prevention BMP over the expected lifetime 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.

The costs and benefits assessed in the Wildlife Damage Prevention BMP CBAs include both private and public costs and only private benefits, as public benefits of the BMP could not be estimated within the scope of this study. The results of the CBA for the Wildlife Damage Prevention show that over the expected life of the program, the NPV is positive indicating that the BMP provides a benefit; however, it is unclear if this benefit is to society or to the adopters only.

4.4.7 Social and Motivating Factors of Wildlife Damage Prevention BMP Adoption

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 42).

Table 42. Rating of motivating factors for adopting Wildlife Damage Prevention BMPs

Motivations	Mean Score	Standard Deviation
Reduce damages wildlife cause to the farm	4.6	1.72
Improve the profitability of the operation	4.1	1.69
Improve the long-term sustainability of the operation	3.8	1.71
Limit the farm's impact on the environment	3.0	1.61
Demonstrate stewardship	3.0	1.71
Contribute to a positive industry image	2.8	1.65
Limit the farm's impact on wildlife	2.8	1.61
To avoid regulatory fines	1.9	1.55

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

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

Overall, scores for barriers were similar to those indicated by adopters of the *Irrigation Management BMP*. Cost was identified as the single largest barrier (4.0) (Table 43). The remaining 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 in interviews, "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 43. Rating of barriers to the adoption of the Wildlife Damage Prevention BMP

Barriers	Mean Score	Standard Deviation
Costs associated with BMP adoption	4.0	1.329
A lack of time or labour	2.9	1.573
Barriers to accessing funding through the BMP Program	2.8	1.414
A lack of understanding about *which* BMP will benefit their operation	2.6	1.391
A lack of support from public agencies	2.6	1.540
A lack of understanding about *how* the BMP will benefit their operation	2.4	1.365
A lack of industry pressure	2.3	1.218
A lack of public pressure	2.3	1.276
A lack of awareness of risks to the environment from farm practices	2.2	1.347
No succession plan for their farm	2.1	1.195
Logistically not feasible	1.9	.978
Other environmental priorities take precedent	1.8	.870

Comments regarding barriers included that the fences have a negative effect on aesthetics and that the cost of fencing large areas such as forage fields is not affordable.

Chapter 5: SWOT Analysis of BMPs

To synthesize the evaluation results, and present qualitative evaluation data about each BMP, Strength, Weaknesses, Opportunities, and Threats (SWOT) analyses were conducted for each BMP (Atari et al., 2009; Pride & Farrell, 2000). Following each SWOT analysis, conclusions and recommendations for each BMP are made. A summary table of recommendations pertaining to each BMP is presented at the end of this chapter. Criteria used to determine whether or not continued funding of the BMP was justified included:

- Whether or not the BMP effectively mitigates the environmental risk it is intended to.
- Whether or not the BMP provides the expected benefits to the adopter.
- Whether or not the BMP demonstrates net benefits to society.

5.1 Livestock Watering BMP SWOT Analysis, Conclusions and Recommendations

Strengths

- In most cases, the BMP has positive net environmental results as indicated both by the riparian area 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 facilitating increased water consumption.
- The BMP facilitates beneficial grazing management practices (i.e. rotational grazing, and swath grazing) creating an incentive for ranchers to adopt the BMP.
- In aggregate the Net Present Value of the BMP over the lifetime of the project is positive.

Weaknesses

- So far, the acceptance of the BMP has been relatively low compared to the population of ranchers in BC (approximately 2% of all ranchers). Possible reasons for the low adoption of this BMP include: (1) the cost of adopting the BMP, especially for large operations, if they need to deliver water to remote areas; (2) funding caps on riparian BMPs has resulted in large operations receiving insufficient BMP funding to adequately compensate producers for adopting the large or extensive BMPs; (3) a lack of motivation to change a method of watering that is generally "working." (4) time constraints of getting the work finished by the program funding deadlines, especially in Northern BC where a long period of frozen ground constitutes an additional barrier to completing BMP projects.

Opportunities

- The Riparian Management Planning process, which was implemented in 2010 as a required precursor to BMP project approval, will help to prioritize riparian BMPs to minimize the risk of *Livestock Watering BMP*s, fencing, and riparian plantings being washed away in flooding events or being implemented improperly, as has occurred in some cases.
- The positive feedback about this BMP in practice could help to "sell" the BMP based on its operational and environmental merits via marketing and communication materials.
- Other programs, such BC Cattlemen's *Farmland – Riparian Interface Stewardship Program (*FRISP), could and are promoting the uptake of this BMP (British Columbia Cattlemen's Association, 2012).

Threats

- Environmental events and change, such as freshet flooding events and climate change, could negatively impact the effectiveness of the BMP performance beyond the program or adopters control.
- As several respondents noted, the aging population of farmers and lack of long-term plans for the farm is a barrier to the adoption of this BMP.

The remainder of this section provides an overview of the main conclusions of the *Livestock Watering BMP* evaluation.

Is the BMP achieving the outcomes it was designed to have?

The *Livestock Watering BMP* appears to be achieving the intended outcomes that it was designed for environmental evaluation 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 now either 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 evaluation 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 may prohibit the BMP from realizing the intended effects. *To minimize the risk of such events, it is recommended that more guidance in riparian risk assessment, BMP design and prioritizing BMPs be provided to adopters by Planning Advisors 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 outcomes of the *Livestock Watering BMP* on their operation and the BMP appears to have the intended outcomes according to adopters. Several operational motivations leading to adoption of the BMP were evident. In addition to the environmental benefits provided by the BMP, motivations for adoption included 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 (i.e. funding) of the BMP?

Based on the following reasoning, I recommend continued support of the Livestock Watering BMP through the BMP Program.

- Based on the environmental indicators described in this report, the BMP generally has positive affects on riparian areas.
- Based on the results of the BMP evaluation survey as well as anecdotal information, the BMP generally has positive outcomes on the farms where the BMP has been adopted.
- The BMP has a positive NPV over the lifetime of the BMP, (assumed to be 15 years, but likely longer as long as vegetation is kept intact), indicating that the BMP provides a benefit. Note that the NPV calculation includes both private and off-farm benefits and costs.

5.2 Riparian Buffer BMP SWOT Analysis, Conclusions and Recommendations

Strengths

- The BMP has generally had a positive effect on mitigating streambank erosion and enhancing riparian vegetation.
- Adopters of this BMP appear to have a high environmental ethic, increasing the likelihood that Riparian Buffer Enhancement projects are maintained in the future.
- The buffer provides aesthetic value, which is important to agri-tourism operations and the character of rural areas.

Weaknesses

- The acceptance of the BMP was relatively low between 2005 and 2010 (1% of all farms in the province reporting watercourses). Possible reasons for the low adoption included: the cost of adopting the BMP relative to the on-farm benefits; limited obvious on-farm benefits associated with adopting the BMP (especially in the short term; and a lack of awareness amongst non-adopters about the environmental risks and long-term benefits of riparian buffer enhancement.
- A lack of standards and assistance with BMP implementation and maintenance may be leading to sub-standard quality of *Riparian Buffer BMP*s. This weakness was apparent in the range of quality of riparian areas visited during the interview process.

- The *BMP Program* has no policy, which would require adopters 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 now required 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 if efforts are made to work collaboratively with these agencies.

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 which have adopted the BMP change ownership due to retirement, the riparian buffer may not remain intact.
- Environmental change and pressures, such as freshet flooding events and climate change can affect the effectiveness of the BMP performance beyond the program or adopters control.
- Several regulatory and other factors may be acting as barriers to adoption including: a requirement to increase the width of the buffer for potential drift between crop areas and non-crop areas when spraying pesticides; federal, provincial or local government regulatory requirements and authorizations directed to restrict activities in and around riparian areas in British Columbia; potential for increased wildlife interactions or damage in agricultural areas may be attributed to *Riparian Buffer BMP* adoption; potential for increased risk of food safety concerns due to increased wildlife/crop interaction may be attributed to BMP adoption.

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

The *Riparian Buffer BMP* is in some *cases* achieving the intended outcomes that it was designed for. In some cases due to inadequate BMP design, lack of maintenance, and/or environmental pressures, evidence shows that the BMP is not and will not have the outcomes it is intended to. *To minimize the risk of such events, I recommend 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). I also recommend that adopters be required to maintain the buffer for a specified period of time in order for the benefits of the buffer to be realized.*

Does the BMP meet the expectations of adopters?

Producers are generally positive about the effects of the *Riparian Buffer BMP* on their farms and ranches. In cases where the BMP is effectively mitigating the risk of streambank erosion, adopters are generally satisfied with the performance of the BMP.

In some cases, this BMP is adopted for ethical or stewardship reasons. In these cases, as long as the BMP is achieving its environmental objectives, or moving towards achieving 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, the need to replace young trees and the 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*, I 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 appropriate 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 reasoning, I recommend continued support of the Riparian Buffer BMP with a re-evaluation of cost-share levels to determine whether current levels are appropriate incentive for the acceptance of the BMP, more stringent design requirements and/or a follow up site visit to help with successful riparian buffer establishment.

- 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.
- Based on the results of the BMP evaluation survey as well as anecdotal information, the BMP generally met the expectations of adopters. However, this BMP is often adopted for ethical or stewardship reasons, and in some cases provides little private benefit to the individual adopter. Therefore, *I recommend re-evaluating the level of cost-sharing provided for this BMP.*
- Over the life of the program (assumed to be 25 years in the case of the *Riparian Buffer BMP*) the BMP has a positive Net Present Value. Note that the NPV calculation is based on both private and off-farm costs and benefits. However, the program to date has yielded negative NPV (see Appendix VII for additional CBA results reported in Suess et al., 2012) indicating that the off-farm benefits of the *Riparian Buffer BMP* are realized only after the buffer is maintained for a number of years.

5.3 Irrigation Management BMP SWOT Analysis, Recommendations and Conclusions

Strengths

- The *Irrigation Management BMP* has had a high acceptance by the blueberry, nursery and tree fruit sectors.
- The BMP makes clear business sense based on the private benefits associated with adoption.
- The cost of adoption did not seem to be a barrier, and some adopters indicated that their entire industry is moving towards efficient irrigation regardless of *BMP Program* funding.

Weaknesses

- The nursery and greenhouse industries have not had high acceptance of this BMP. From the responses received, it is not clear why this is so.
- The BMP funding has in some cases been used to support the replacement of an already existing irrigation system, leading to increasing use of water by agriculture, which is not the intention of the program.

Opportunities

- Adoption of efficient irrigation systems could be achieved by allowing new operations to access BMP funding, ensuring that all new operations are selecting the most efficient equipment available. If this were to be the case, funding levels should be reassessed to investigate the optimal level of cost-share and cap relative to the on-farm benefits.
- The modernization of the *Water Act* and associated regulations may provide the regulatory framework to require adoption of efficient irrigation (Province of British Columbia, 2012).
- Increased water metering and increasing pricing of water could help to increase the adoption of this BMP.

Threats

- The risk of increased soil erosion due to less broadcast irrigation, and less vegetative ground cover, specifically in the Southern Interior regions is a potential negative outcome 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. The potential for the BMP to become non-operational before the expected life of the irrigation system is surpassed is a threat to the long-term net benefits of this BMP.

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

The *Irrigation Management BMP* appears to be effective at achieving the intended outcomes that it was designed to have where it has been 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 actually facilitated an increase in the total water use attributed to agriculture. To reduce the instances where this BMP is being adopted on farms where no previous irrigation system existed, *I recommended that proof of the previous system in the form of pictures be required with all Irrigation Management BMP applications to ARDCorp or the program is redesigned to allow new systems to be funded*.

In some cases, respondents indicated that the adoption of the BMP increased the risk of soil erosion on their properties. To address the risk of soil erosion due to adoption of the *Irrigation Management BMP*, *I recommend that adopters be required to plan for the maintenance of adequate soil cover in the alleys of orchards/vineyards given less irrigation water (e.g. additional sprinklers may be required to maintain row cover).*

Does the BMP meet the expectations of adopters?

In almost all cases, the BMP has met the expectation of adopters. Respondents to both the mail out survey and interview surveys indicated private benefits are associated with this BMP. These benefits include labour savings due to reduced manual operation and increased crop yields.

It appears that 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.

Is there justification for continued support of the BMP?

Based on the following reasoning, I recommend *continued support* of the *Irrigation Management BMP* with a re-evaluation of cost-share funding to determine the optimal level, ensuring that the majority of potential adopters are captured and BMP funding is used effectively.

- Based on the environmental indicators described in this report the BMP results in water efficiency gains for almost all farms that adopt the BMP.
- Based on the findings of the BMP evaluation as well as anecdotal information, the BMP is achieving the expected outcomes for adopters.
- The Net Present Value of the *Irrigation Management BMP* over the life of the program (assumed to be seven years) is positive indicating that the BMP provides a benefit. Note that the NPV calculation is based on both private and off-farm costs and benefits. Water conservation is an important issue in BC and agriculture, which currently accounts for up to 70% of water use in some municipalities, has a responsibility to conserve where possible (Province of British Columbia, 2011). The *Irrigation Management BMP* helps the agriculture industry to reduce its water use and adapt to increasingly scarce availability of water.

5.4. Wildlife Damage Prevention BMP SWOT Analysis, Recommendations and Conclusions

Strengths

- The BMP had a relatively high acceptance by the industries in Southern BC, which are most likely to be impacted by wildlife.
- In all cases, adopters of this BMP experience net private benefits.
- The BMP allows farmers to produce food viably. In some cases, respondents indicated that they would not be in business without a wildlife fence. Food production in the province is a clear benefit to society.

Weaknesses

- 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 and did not access the funding while it was available.
- The BMP funding does not differentiate between the different needs of farms and ranches across the province. The cost to adopt a fence to protect 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 Northern BC 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. Generally, the state of an industry at any given time could effect the adoption of BMPs.
- The BMP only protects stored feed, and does not protect standing forage crops which are also vulnerable to damage by wildlife.

Opportunities

- If the *Wildlife Damage Prevention BMP* is considered for BMP funding again, funding may be directed to funding to areas of special concern, or specifically to protect stored feed on ranches in Northern BC.

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) and in some cases the *Wildlife Damage Prevention BMP* may be diverting the wildlife pressures to those who have not or cannot adopt this BMP. Thus providing private benefits 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.

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

The *Wildlife Damage Prevention BMP* is, generally, having the outcome that it was designed to on the farms where it was adopted. In almost all cases, the wildlife that was causing damage prior to adoption are no longer causing damage to the areas that were 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). Furthermore, some adopters still practice shooting and trapping to prevent wildlife damage post-BMP adoption. Therefore, in some cases (~20%) a fence does not completely eliminate all agriculture-wildlife conflict.

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, *I recommend that regional wildlife experts as well as producers/ranchers be consulted regarding 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 evaluation 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 reasoning*, I recommend reinstating support of the Wildlife Damage Prevention BMP with emphasis on fencing to protect stored feed in the highly-effected areas of the province as a short term solution to the current wildlife pressures.* In the long term, more study is needed on the impact of fencing on wildlife and to investigate alternative solutions to manage wildlife populations in a manner that minimizes agriculture wildlife conflict.

- 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 where damages to stored feed are a major concern amongst ranchers).
- Based on the results of the BMP evaluation survey as well as anecdotal information, the BMP has met the expectations of those who have adopted it.
- The BMP has a positive Net Present Value over the life of the program (15 years) indicating that the BMP is a benefit. However, the NPV is based only on private costs and benefits as no off-farm benefits were estimable within the scope of this study. Therefore it is not clear whether or not the BMP provides a benefit to society. More research is needed to determine the true impact that fencing has on wildlife populations.

5.5 Summary of BMP Recommendations

The following table summarizes the recommendations for each BMP discussed in the above sections.

Table 44. Summary of recommendations pertaining to each BMP

	Livestock Watering BMP
1	More guidance should be provided in risk assessment, BMP design and prioritizing riparian BMPs to minimize the risk of poor BMP design and outside threats (i.e. flooding events) reducing the Livestock Watering BMP effectiveness.
2	The Livestock Watering BMP funding should be continued in future program years.
	Riparian Buffer BMP
3	More guidance should be given in risk assessment, BMP design and prioritizing riparian BMPs to minimize the risk of poor BMP design and outside threats (i.e. flooding events) reducing the Riparian Buffer BMP effectiveness.
4	Adopters should be required to maintain the buffer for a specified period of time in order for the benefits of the buffer to be realized.
5	To help producers overcome the initial challenges associated with riparian buffer establishment and maintenance; I 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.
6	The Riparian Buffer BMP funding should be continued in future program years pending a re-assessment of the cost-share level to determine whether the funding provided is adequate to entice producers to adopt the BMP.
	Irrigation Management BMP
7	To reduce the instances where this BMP is being adopted in areas where no previous irrigation system existed, I recommend that proof of the previous system in the form of pictures be required with all Irrigation Management BMP applications to ARDCorp or the program is redesigned to allow new systems to be funded.
8	To address the risk of soil erosion due to adoption of the Irrigation Management BMP, I recommend that adopters should be required to plan for how they will maintain adequate soil cover in the alleys of orchards/vineyards given less irrigation water (e.g. additional sprinklers may be required to maintain row cover).
9	The Irrigation Management BMP funding should be continued in future program years pending 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.
	Wildlife Damage Prevention BMP
10	If this BMP is considered for BMP funding in the future, I recommend that regional wildlife experts as well as producers/ranchers be consulted regarding 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.

11	The Wildlife Damage Prevention BMP funding should be reinstated in future program years with emphasis on fencing to protect stored feed in the Northern areas of the province as a short-term solution to the current wildlife pressures. In the long term, more study is needed on the impact of fencing and to investigate alternative solutions to manage wildlife populations in a manner that minimizes agriculture wildlife conflict.

Chapter 6: Discussion and Synthesis of Results Across the Four BMPs

The research objectives for this project were:

- To develop a methodology for evaluating the social, economic and environmental outcomes of agri-environmental BMPs adopted by BC farms;
- To test the methodology by evaluating four BMPs currently funded through the *BMP Program* in 2011-2012; and [31]
- To make policy recommendations to the Ministry of Agriculture to allow for adaptive management of the *BMP Program* using the evaluation methodology.

The results of the BMP evaluation provided insights about the outcomes associated with BMPs that have been adopted between 2005 and 2010. The objective of the evaluation was to provide AGRI with this type of information so they can promote the *BMP Program* more efficiently to farmers and funders and to adaptively manage the *BMP Program* with its limited resources. The evaluation yielded novel information about environmental outcomes attributed to the program between 2005 and 2010, the financial outcomes of the BMPs on farms, the economic value of the BMP projects to society and the motivations and barriers to adoption of BMPs. A summary of the main findings is presented in Table 45.

[31] For a description of the BMPs evaluated for this project, see Appendix IV.

Table 45. Summary of the evaluation results for the four BMPs

		BMPs			
		Livestock Watering	**Riparian Buffer**	**Irrigation Management**	**Wildlife Damage**
Adoption	**Numbers**	A small percentage of the ranching industry has adopted this BMP (2%). After 2008, adoption by year dropped off drastically.	Adoption of this BMP has been low province wide. Approximately 1% of all farms reporting watercourses have adopted this BMP.	Adoption of this BMP has been good with 619 BMP projects occurring between 2005 and 2010. The berry, grape and tree fruit industries account for most of the adoption.	Adoption of this BMP was good with 318 projects province wide between 2005-2009.
	Geographic Range	Adoption to date has been spread across the province corresponding with the location of cattle ranches. Approximately 50% adoption has occurred in the Peace River and Cariboo Regional Districts.	Adoption of this BMP has been spread across BC with the most BMPs occurring either in the Columbia/Shuswap or along the southern border of the province.	Adoption of this BMP has been concentrated in the Lower Mainland and in the Okanagan, corresponding with berry, grape and tree fruit production.	Adoption of this BMP has been concentrated mostly in the Okanagan with some projects on Vancouver Island, the Lower Mainland and scattered along the Southern portion of BC. While BMP funding was available, very few projects occurred in Northern BC.
Environmental Outcomes	**Positive**	Approximately 86 ha or riparian area and 72 km of watercourse conserved to date. Most respondents indicated positive improvement in riparian vegetation.	Approximately 13 ha of Riparian Area and 15.9 km of watercourse have been enhanced due to this BMP. Most respondents indicated that they have a positive improvement in their riparian vegetation.	This BMP has been very effective at achieving its environmental outcomes. The BMP achieves an average of 25% water savings per project.	Wildlife is effectively excluded from crop areas and stored feed, mitigating unnatural wildlife population growth associated with abundant food supply from agriculture.
Environmental Outcomes	**Negative**	In a small number of cases, poor planning, design, and BMP management has lead to minimal achievement of environmental outcomes.	In some cases the expected environmental outcomes of this BMP have not been achieved due to outside environmental pressures (e.g. flooding), and/or poor planning of BMPs.	In some cases, BMPs have been adopted where an irrigation system was not in place previously. In these cases the BMP has facilitated an increase in water use by agriculture.	The environmental outcomes of this BMP are not clear. It is possible that fencing wildlife away from farms is resulting in a diversion of the problem to other areas. A more focused study is needed to evaluate the true impact of wildlife fencing on wildlife populations.

Table 45 continued

		BMPs			
		Livestock Watering	**Riparian Buffer**	**Irrigation Management**	**Wildlife Damage**
Financial Outcomes	**Positive**	Adoption of this BMP has generally resulted in a positive outcome to the individual producer. In some cases, benefits include improved livestock health, year round access to water, decreased labour and improved grazing practices.	The biggest private benefit of this BMP is a reduction in streambank erosion. Otherwise, little financial reasons exist to adopt this BMP.	Generally this BMP results in a decrease in labour requirements and an increase in crop quality and in some cases yield.	The mitigation of crop and stored feed damage is the primary reason that this BMP is adopted and the mean annual value of the crop that is saved per farm by fencing is approximately $5000 and $10,000 for stored feed.
	Negative	45% of adopters indicated that they experience an increase in labour.	Some adopters (36%) have experienced an increase in labour since adopting this BMP.	In some cases (14%) adoption of this BMP has resulted in an increase in labour requirements.	Few, if any, “costs" are associated with this BMP other than implementation costs.
Social Factors of Adoption	**Motivations**	Adopters are primarily motivated by environmental stewardship reasons; financial objectives are of secondary importance.	Adopters are primarily motivated by environmental stewardship reasons; financial objectives are of secondary importance.	Adopters are primarily motivated by the desire to increase the profitability of their operations. Secondary motivations include conserving water and improving the long-term sustainability of the farm.	Adopters are primarily motivated to adopt this BMP to protect of crops and stored feed and improve the profitability of their operation.

Table 45 continued

		BMPs			
		Livestock Watering	**Riparian Buffer**	**Irrigation Management**	**Wildlife Damage**
Financial Outcomes	**Positive**	Adoption of this BMP has generally resulted in a positive outcome to the individual producer. In some cases, benefits include improved livestock health, year round access to water, decreased labour and improved grazing practices.	The main private benefit of this BMP is a reduction in streambank erosion. Otherwise, little financial reasons exist to adopt this BMP.	Generally this BMP results in a decrease in labour requirements and an increase in crop quality and yield.	The mitigation of crop and stored feed damage is the primary reason that this BMP is adopted and the mean annual value of the crop that is saved per farm by fencing is approximately $5000 and $10,000 for stored feed.
	Negative	A slight minority (45%) of respondents indicated that they experience an increase in labour.	Some adopters (36%) have experienced an increase in labour since adopting this BMP.	In some cases (14%) adoption of this BMP has resulted in an increase in labour requirements.	Few, if any, “costs" are associated with this BMP other than implementation costs.
Social Factors of Adoption	**Motivations**	Adopters are primarily motivated by environmental stewardship reasons; financial objectives are of secondary importance.	Adopters are primarily motivated by environmental stewardship reasons; financial objectives are of secondary importance.	Adopters are primarily motivated by the desire to increase the profitability of their operations. Secondary motivations include conserving water and improving the long-term sustainability of the farm.	Adopters are primarily motivated to adopt this BMP to protect of crops and stored feed and improve the profitability of their operation.

Table 45 continued

		BMPs			
		Livestock Watering	**Riparian Buffer**	**Irrigation Management**	**Wildlife Damage**
Social Factors of Adoption	**Barriers**	The largest barrier to adoption is cost, with a lack of awareness and understanding as a secondary barrier to adoption.	The largest barrier to adoption is the cost of the BMP and the next largest barrier is a lack of time or labour to complete the project.	Cost is the largest barrier to adoption for this BMP. Many respondents indicated that there are few other barriers to adoption, as evidenced by the widespread uptake of this BMP both through the *BMP Program* and privately	By far the largest barrier to the adoption of this BMP is the implementation cost. No other barriers were commonly identified by adopters.
Cost-Benefit Analysis		The NPV of the program over its expected life (15 years) is positive and ranges from $6,124,067 to $9,040,382 depending on the discount rate.	The NPV of the program over its expected life (25 years) is positive and ranges from $66,313 to $681,926 depending on the discount rate. The NPV of the program to date however is negative and ranges from -$273,961 to -$380,116 depending on the discount rate.	The NPV of the program over its expected life (7 years) is positive and ranges from $14,656,428 to $24,342,584 depending on the discount rate. The NPV of the program to date however is negative and ranges from -$10,333,976 to -$6,556,564 depending on the discount rate.	The NPV of the program over its expected life (15 years) is positive and ranges from $16,889,025 to $25,964,840 depending on the discount rate.

Overall, the results of the BMP evaluation show that the BMPs are achieving their environmental objectives, albeit to varying degrees. The *Livestock Watering* and *Riparian Buffer BMPs* both offer some environmental benefits to riparian areas as they reduce livestock presence in and around watercourses and either directly or indirectly re-establish riparian vegetation. In cases where livestock are not specifically excluded from riparian areas, the *Livestock Watering BMP* still offers some benefit by providing a drinking water source away from riparian areas (BC Ministry of Agriculture and Lands, 2006). At the same time, the outcomes of both BMPs face challenges in some cases due to inadequate planning, design, implementation and maintenance. The *Irrigation Management BMP* has been effective at achieving water conservation on farms, with an average of 25% water savings attributed to the installation of the BMP. Generally, the environmental outcome findings are novel, unique to the BC *BMP Program* and will provide a benchmark for comparison of environmental outcome data over time.

The environmental outcomes of the *Wildlife Damage Prevention BMP* adoption remain unclear. The BMP has been effective at mitigating wildlife damage to farm property, but may result in a reduction of wildlife habitat (2365 hectares have been excluded from wildlife habitat to date), impacts to habitat connectivity and an unnatural concentration of wildlife in areas (Hayward & Kerley, 2009; Jaeger & Fahrig, 2004). Further study to determine the impact of fencing of agricultural areas to wildlife may yield information that might ultimately lead to further improvements to the conflict situation between agriculture and wildlife in BC.

Further to the environmental outcomes of the *Wildlife Damage Prevention BMP,* 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 effect 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.

With the exception of the *Riparian Buffer BMP*, the BMPs evaluated for this project generally provide a financial benefit to farms that adopt them. On-farm benefits are often in the form of labour savings, improved yield or reduction in damages in the case of the

Wildlife Damage Prevention BMP. These results are consistent with the findings of several studies that found that conservation agriculture often results in financial gains to the adopter (Knowler & Bradshaw, 2006; Stonehouse, 1997). The level of on-farm benefits offered by the BMP appear to be tied to the level of adoption of the BMPs. For example, the *Riparian Buffer BMP* does not yield many direct on-farm benefits, and has been adopted by relatively few farms. On the other hand, the *Irrigation Management BMP* results in several on-farm benefits including labour savings and crop quality improvements and has been adopted by many farms (619 between 2005 – 2010). WEBs researchers have shown that because of an inability to estimate some benefits of BMPs, for example mitigation of soil erosion in the case of the *Riparian Buffer BMP*, results of some financial analyses show that BMPs are not financially profitable to the farm (Agriculture and Agri-Food Canada, 2009). As valuation methods improve, financial analyses of BMPs may indicate that some BMPs are in fact beneficial on-farm.

The cost-benefit analyses show that the Net Present Value of the *BMP Program* over the lifetime of the program varies but are positive for all BMPs (Suess et al., 2012). The *Wildlife Damage Prevention BMP* has the highest NPV over the expected life of the program with values between $16,889,025 to $25,964,840 depending on the discount rate. The *Riparian Buffer BMP* yields the lowest NPV over the lifetime of the program with values ranging between $66,313 to $681,926.[32] However, the NPV of both the *Riparian Buffer BMP* and *Irrigation Management BMP* to date, including all completed projects, is negative (See Appendix VI). This indicates that benefits of these BMPs are not realized until after the project has been in place for some years. The NPV of adding an additional BMP project, reported in Appendix VI, shows that the NPV of each BMP project completed in 2011 ranges from between $1,222 to $16,236 on the low side for the *Riparian Buffer BMP* to between $103,686 to $188,078 on the high side for the *Wildlife Damage Prevention BMP for Stored Feed.* The results of the CBAs are novel; over time as more evaluations are conducted on the *BMP Program*, these results will provide the basis for comparison with other CBAs.

The results of the CBAs should aid in program reporting to the federal government who requires that all federal government programs be evaluated for “value for money” to society under the *Financial Administration Act* (Canada Treasury Board Secretariat,

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[32] Note that these values are tied to the number of adopters for each BMP between 2005 – 2010 and therefore should not be used to compare the NPV of individual BMPs to one another across BMP categories.

2012; Dumaine, 2012). Using *Impact Assessment* data that more accurately reflects the true impact of the BMP may help with refining the cost-benefit analysis approach. For example, the Watershed Evaluation of Beneficial Management Practices (WEBs) program is in the preliminary stages of including a cost-benefit analysis component to the watershed-based Impact Assessments that it conducts across Canada, including the Salmon River watershed in BC (Agriculture and Agri-Food Canada, 2011c). Over time, and across evaluations, the economic efficiency data will allow AGRI decision makers to prioritize limited funding to specific BMPs based on value for money in order to maximize the value of the *BMP Program* to society (Dumaine, 2012; Rossi et al., 2004).

Generally, adopters of the riparian BMPs were motivated by stewardship or environmental reasons, whereas adopters of the *Irrigation Management* and *Wildlife Damage Prevention BMPs* were primarily motivated by the potential to increase profitability and the viability of their businesses. The motivations indicated by adopters of the riparian BMPs were consistent with the findings of both Atari et al. (2009) and Robinson (2006) who found that participants in the Nova Scotia and Ontario *Environmental Farm Plan Programs* are primarily motivated by a desire to be good stewards. Barriers to adoption were similar across BMPs and included obvious barriers such as cost as well as lack of awareness and understanding about the environmental impact of farm practices. These barriers are consistent with the findings by Robinson (2006) who indicated that the perceived cost of BMPs was the biggest barrier to adoption in Ontario through the equivalent provincial *BMP Program*. The average scores for barriers were generally lower for both the *Irrigation Management BMP* and *Wildlife Damage Prevention BMP* than the riparian BMPs, indicating that perhaps less barriers to adoption are present for these BMPs and funding levels through the *BMP Program* should be set accordingly. Understanding of these motivations and barriers brings context to the evaluation and allows decision makers to interpret the adoption levels (Rossi et al., 2004; Greene, 2001). It also sheds light on potential areas for improvement of the BMP Program by determining some common barriers to adoption.

The principle component analysis presented in the *Livestock Watering BMP* results section allowed for further exploration of the data and allowed for a better understanding of common motivations and barriers to adoption of the BMP (Jolliffe, 2002).[33] Small populations and low response rates limited analysis of the other BMPs using PCA.

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[33] The motivations for and barriers to adoption *Livestock Watering BMP* was selected for further analysis as the sample represented over 50% of the population of adopters.

However in future evaluations, PCA and further analysis for example, using regression analysis, may allow for a better understanding of the differences between groups of adopters and what motivations and barriers are common amongst these groups (Yiridoe et al., 2010).

Socio-demographic information collected in the evaluation survey allowed for aggregate characterization of the BMP adopters and provided a baseline comparison to the overall population of farmers. Results show that generally, the four BMPs evaluated for this study program do not attract a proportionate amount of farms in the lowest ($24,999 and below) farm gate sales bracket relative to the population of BC farmers (Statistics Canada, 2006). These results are consistent with other researchers who have found that adoption of agri-environmental practices increases with an increase in farm gate sales (Yiridoe et al., 2010, Wilson, 1997). Adopters of the *Livestock Watering, Riparian Buffer and Preventing Wildlife Damage BMPs* are on average older than the average age of BC farmers with a higher proportion in the 55 and above age bracket when compared to the BC average. The BMPs, in general, attract a smaller proportion of farmers in the 18-34 age category when compared to the BC average. Further study is needed to determine why this is so.

Adoption rates varied depending on the BMP. The *Riparian BMPs* have been less widely adopted than the *Irrigation* and *Wildlife Damage Prevention BMPs*. This is likely due to more on-farm benefits attributed to the latter two BMPs, ineffective program targeting or funding levels and/or other barriers or challenges with the *Riparian BMPs*. In all cases, BMP adoption rates declined after the 2008 program year. The evaluation did not provide any further explanation; however, based on information gained in the interview process and from program directors, the decline in recent adoption may be explained by a change in program administration in 2009 and increased scrutiny of BMP projects, a decrease in the total amount of funding available to farmers and/or a lack of awareness of the program amongst the farming community (Mark Raymond, Personal Communication, March 3rd, 2012).

6.1 Discussion and Critique of Methods

The *Process Evaluation* approach used in this evaluation project is one of several described by the program evaluation literature and was selected based on the context of the evaluation and needs of the program directors (Bardach, 2009; Pal, 2005; Rossi et al, 2004). Pr*ocess Evaluation* allowed us to gather critical program feedback from participants and to derive outcomes attributed to BMP adoption. An *Economic Efficiency Assessment* was also conducted to determine the benefits of the specific BMPs and to demonstrate the value of the *BMP Program* to program funders as well as allow decision makers to prioritize limited BMP funding.

The methodology incorporated the collection and interpretation of qualitative data such as experiential information and observation in addition to quantitative data. Qualitative data can be difficult to analyze, but provides rich understanding of the program that is subject to evaluation (Greene, 2001). This type of data collection does not often follow an experimental design, but instead focuses on case studies, open-ended interviews, on-site observation, participant observation and literature review. The manner in which qualitative information is interpreted and reported often depends on the judgment and biases of the researcher, which is certainly a limitation of the BMP Evaluation project and others that take a similar approach (Greene, 2001). Despite interpretation bias, qualitative, experiential information is often critical to the understanding and interpretation of outcome evaluation (Rossi et al., 2004).

Photographs of BMP projects, taken during interviews provided context to the results of the evaluation. These photos were presented to AGRI to help them understand the variation in both the implementation and quality of various BMPs. Photos allowed the *BMP Program* managers to draw from their expertise to create their own conclusions about the quality and outcomes of the BMPs as well as provided a “check” on the surveyors conclusions.

Despite *Process Evaluation* being the most appropriate framework to conduct the initial BMP evaluations, the methodology had several limitations. As only adopters were surveyed, the results do not measure the true impact of the program, as they do not take into account outside factors that influence the outcomes. In order to measure the impact of a program accurately, an *Impact Assessment* that utilizes a random experimental design is considered to be the “gold standard” for measuring outcomes attributed to a program or policy (Frondel & Schmidt, 2005). In the absence of *Impact Assessment* using random experimental design, baseline data is helpful to compare pre-program status to post-program status.

The collection of baseline data prior to the participants receiving a treatment allows the evaluator to conduct an unbiased *Impact Assessment* on both the treated and untreated group (Ravillion, 2001). However, baseline data is not always collected before the program treatment is applied and thus the use of baseline data in evaluation is limited. Unfortunately, no baseline information was available to compare outcomes to, and thus we attempted to gather baseline information about the state of the environment prior to BMP adoption during the evaluation. Furthermore, the *BMP Program* has not set targets for adoption levels or thresholds for environmental outcomes to measure BMP effectiveness. Therefore evaluators have basis for which to compare evaluation results to or to determine if the *BMP Program* has been effective in achieving its goals . *In future program years, I recommend that the Ministry of Agriculture begin to collect baseline data on the state of the indicators that are to be measured prior to the implementation of the BMP project as well as attempt to set program targets* (Rossi et al., 2004; Ravillion, 2001). When the *EFP/BMP Program* undergoes revision in 2013, it may be possible to start collecting baseline data as well as to set program targets.[34]

The methodology employed for the BMP Evaluation did not capture the group of non-adopters likely resulting in biased results. Limiting the sample to adopters of BMPs only can result in bias particularly with respect to the data on motivations and barriers to adoption. In future studies, capturing the preferences of non-adopters using a discrete choice experiment or other stated preference method would help to tailor the program to meet the needs of those who have not already adopted the BMPs funded through the *BMP Program* (Yiridoe et al., 2010; Louviere et al., 2000).

Process Evaluation does not provide a holistic understanding of all factors that affect adoption of agri-environmental BMPs across BC that a specific agri-environmental BMP adoption study would provide (Knowler & Bradshaw, 2006). For example, the current economic climate and practical considerations such as land configuration are potential factors affecting adoption that were not considered in this evaluation but have been identified in other studies as barriers to adoption (Smithers et al., 2004; Gayler, 2003; Lobley & Potter, 1998; Wilson, 1997). Furthermore, currently AGRI does not know how many BMPs have been adopted relative to all potential adopters. Nor is it known how many farms have adopted BMPs without the use of funding from the *BMP Program* as the current national environmental farm survey only records certain environmental practices (Agriculture and Agri-Food Canada, 2006).[35]

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[34] The current funding agreement between the Provincial and Federal government ends in March 2013, at which time a new agreement and potentially updated versions of the *EFP* and *BMP Programs* will be implemented.

[35] The Farm Environmental Management Survey is conducted on a periodic basis to understand the farm management practices used by producers across Canada.

In order to investigate and understand the factors that determine adoption rates for agri-environmental BMPs on BC farms, a study that investigates adoption factors within the local context is required (Yiridoe et al., 2010; Knowler & Bradshaw, 2006; Feder et al., 1985). An adoption modeling study would more accurately depict current BMP adoption relative to total potential adoption levels. For example, it is possible that the BMP has captured most of the likely “early adopters” and that it needs to be redesigned to target the majority of producers. With better understanding of factors affecting adoption, programing could be better targeted to specific groups along the adoption curve (Marra et al., 2003). A study that explicitly models the adoption process may also result in better understanding of the dynamic adoption *process*, unique to the BC context (Abadi Ghadim et al., 2005; Feder et al., 1985).

Low response rates, particularly for certain BMPs including the *Irrigation Management* and *Wildlife Damage Prevention BMPs* limited further analysis and affected the reliability of results. When discussing the results of the evaluation, it is important to understand that the conclusions here are not based on statistically significant data. Low response rates may be due to the time of year that farms were surveyed (during the fall harvest time) as well as an inability to recall information about BMPs they adopted several years prior and therefore a lack of willingness to participate.

A *Process Evaluation*, characteristically, does not adequately capture unforeseen outcomes of a program (Rossi et al., 2004). To capture unexpected outcomes in the BMP evaluation, an open ended question asked respondents to indicate if the BMP had any additional impacts on their operation. For example, a question about the impact of BMP adoption on 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 had a hard time keeping a cover crop alive without overhead sprinklers. Although some unforeseen outcomes were captured, it is possible that some outcomes of BMP adoption may not be captured in the evaluation, which is a limitation to the methodology.

Some respondents experienced challenges with recalling information when responding to certain questions. Recall bias was particularly evident when comparing the difference in responses collected in personal interviews as opposed to those collected via mailed survey. In interviews, respondents could be prompted and reminded of specific aspects of BMP adoption that they may have otherwise forgotten. An inability to recall answers to survey questions may have also reduced response rates, as adopters did not feel they could accurately fill out the evaluation survey. *To minimize recall bias in future evaluations, I recommend that AGRI conduct evaluations closer to the time of BMP adoption (for example between one to two years post-adoption).* Further bias may be present due to the voluntary nature of the *EFP* and *BMP Programs*. Voluntary programs are subject to their own set of biases as program participants often consist of the most willing participants or perhaps the least-likely “offenders” (Bennear & Coglianese, 2005; Ravillion, 2001). Volunteer bias may restrict the applicability of results to other groups of potential adopters particularly with respect to environmental outcomes and motivations and barriers to adoption described by respondents.

Another limitation to the methods was that certain costs and benefits could not be estimated within the scope of this project. For example, a major benefit to farms adopting the *Riparian Buffer BMP* is the mitigation of streambank erosion. Costs to both the farmer as well as to society are associated with erosion; however, these costs could not be estimated within the scope and timeframe of this project. In future studies it may be appropriate to try to quantify the benefits of streambank erosion mitigation to more accurately report the benefits of the *Riparian Buffer BMP* and to promote the BMP to potential adopters. Although CBA portrays the value of BMP projects to funding agencies, on-farm costs and benefits were not portrayed in a manner useful for on-farm decision-making. In future evaluations, a discounted cash-flow analysis could portray on-farm financial outcomes of BMP adoption in a more practical way (Lazarus & Rudstrom, 2012).

In future BMP evaluations, adaptation of the methodology presented in this project may improve results. My recommendations to improve the scope and usefulness of evaluations include:

- Implement a web survey in addition to the paper survey to test whether response rates increase;
- Conduct evaluations closer to the time of BMP adoption (for example between one to two years post-adoption) to minimize recall bias;
- Use a discounted cash-flow analysis methodology to portray on-farm costs and benefits in a manner that is useful for on-farm decision-making;
- Collect some baseline data either through the BMP application form or through a separate form completed by the Planning Advisor at the time that the BMP project is approved;
- Set program targets/goals 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;

- Study the characteristics and needs of the group of non-adopters who are not surveyed in this evaluation study to understand how to target the program more effectively;
- Conduct a study to investigate when producers adopt agricultural BMPs and the factors leading to adoption; and
- Implement a regular self-evaluation component to the *BMP Program* that feeds regular evaluation data back to ARDCorp to facilitate monitoring. On-farm self-assessment using a scorecard may provide a low cost, broad applicability monitoring framework for on-going *BMP Program* monitoring (Benham et al., 2005).

6.2 Policy Implications of the BMP Evaluation Project

The policy cycle typically involves a program or policy evaluation component (Bennear & Coglianese, 2005; Pal, 2005). Until this BMP Evaluation project, no evaluation of BMPs funded by the BC *BMP Program* had occurred and program directors were lacking program feedback and outcome data. By including a program evaluation component to the *BMP Program*, decision makers will improve their ability to adapt the program to the changing needs of agriculture, the changing ecological landscape and changes in the social and cultural context of farming in BC. *Process Evaluation* may be adopted as a regular monitoring and evaluation scheme for a relatively low cost in the next iteration of the *EFP* and *BMP Programs* in BC, which will be implemented in Spring 2013.

The federal government is currently in the process of implementing an economic evaluation component to all federally funded programs (Treasury Board of Canada Secretariat, 2012). By 2013 all programs must conduct evaluations that demonstrate the 'value for money' of the program. By conducting cost-benefit analyses, the *EFP* and *BMP Program* directors can demonstrate the net benefits of agri-environmental incentive programs for farmers, making the economic case for continued federal funding (Dumaine, 2012).

In time, it would also be useful to incorporate periodic *Impact Assessments* on specific BMPs funded through the *BMP Program*. A combination of evaluation approaches will ensure that a breadth of information about the *BMP Program* is available to decision-makers; however, considering the current levels of government funding in Canada, the likelihood of adopting a comprehensive evaluation scheme involving a random experimental design is low.

The results of the BMP Evaluation will aid AGRI program directors in:

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

Chapter 7: Study Conclusions

The world's population is growing and the need to increase food production to meet the needs of future generations is becoming increasingly important. At the same time, the land base available for agriculture is finite and in some cases is decreasing due to urban pressures (Androkovich, 2013). In some cases, land degradation and water scarcity may reduce the productivity of agriculture in previously productive areas (de Fraiture et al., 2010; Kissinger & Rees, 2009). Agriculturalists will need to adapt their current practices to produce food in a manner that does not degrade the resources it depends upon, and in a manner that is compatible with urban neighbours. Agri-environmental programming, such as the *Canada-British Columbia Environmental Farm Plan Beneficial Management Practices Program* plays a role in helping farms adapt to changing environmental conditions, reducing their impact on the environment and enhancing ecosystems where possible.

The objectives of this project were to create a methodology to evaluate agri-environmental BMPs funded through the *Canada-British Columbia Environmental Farm Plan Beneficial Management Practices Program* and use the methodology to evaluate the social, environmental and economic outcomes of four BMPs funded through the program. The methods and pilot evaluation project that I reported here demonstrate how a relatively straightforward evaluation and monitoring program can deliver critical program outcome information and feedback from participants to program directors.

The results of the evaluation assists in the *BMP Program* delivery by: (1) gathering feedback on program experiences from adopters allowing the program to be better tailored to the needs of the farmers who will potentially adopt BMPs; (2) evaluating program outcomes to determine how well the *BMP Program* is meeting its specified goals; (3) obtaining formal data and anecdotal information about the benefits of BMP adoption to farms which can be used to promote the adoption of agri-environmental BMPs to potential adopters; (4) demonstrating the value-for-money of the program to federal funding agencies; (5) delivering ongoing information about changes in the context of the *BMP Program* and needs of the farming community, to allow the program to be adaptively managed over time in order to remain relevant and effective.

As a final note, in my opinion, the BMP evaluation conducted in this study is not a replacement for more a rigorous environmental *Impact Assessment* or other environmental monitoring programs that collect data on BMP effectiveness over time.

Nor does the *Process Evaluation* approach presented here replace a more rigorous assessment of BMP adoption, such as an adoption model study would provide. Rather, the BMP evaluation methodology employed here is strongest when used as one of several evaluation tools for program-managers to monitor the outcomes and effectiveness of agri-environmental BMPs on BC farms.

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Appendices

Appendix I. Example Survey

Growing Forward

Survey of Your Experience Adopting On-Farm Environmental BMPs

Riparian Area Management
Beneficial Management Practice

Canada ardcorp Growing Forward SFU British Columbia

Introduction to the Riparian Area Management Beneficial Management Practice Survey

The purpose of this survey is to obtain insight into the social, economic and environmental effects when farms adopt riparian area beneficial management practices (BMPs). You have been selected for this survey because you have participated in the *Canada – BC Environmental Farm Plan BMP Program* and have experience adopting the Riparian Area Management BMP on your farm.

The survey is divided into seven sections and should take you approximately 15 to 20 minutes to complete. First you will be asked to describe your farming practices prior to implementing your BMP. In the subsequent sections, you will be asked questions related to environmental, economic and social aspects of your farm practices since adopting your BMP. You do not need to answer every question in order to participate.

If you have restored a riparian area on multiple land holdings, or on multiple areas of your farm, please select and refer to ONE restored riparian area that was ***cost-shared through the BMP Program*** *when answering the following questions.*

Thank you very much in advance for your time and valuable input!

SECTION A.
Background on your Farm and Previous Practices

1. **In which municipality, city or town is your farm located?**

 ____

2. **What are the main products that your farm produces?**

 ____

 2a. Is your farm certified organic?
 - ☐ Yes
 - ☐ No

1

2b. Please indicate the total number of livestock *on the farm where the BMP was implemented* in the table below:

Beef	Dairy	Poultry	Horses	Other Livestock	Total Livestock
|_____| +	|_____| +	|_____| +	|_____| +	|_____| =	|_____|

2c. Please indicate the area of various land uses *on the farm where the BMP was implemented* in the table below.

Annual Crop (acres)	Horticulture/ Greenhouse (acres)	Tame Forage (acres)	Native Forage (acres)	Other Acres (acres)	Total Acres
|_____| +	|_____| +	|_____| +	|_____| +	|_____| =	|_____|

3. What is the ownership status of the land where the BMP was implemented?
Please check all that apply.
- ☐ Land that is owned by the producer
- ☐ Private land that is leased
- ☐ Crown land

4. Which characteristics below *best* describe your riparian area *prior* to implementing your BMP?
Please check all that apply.
- ☐ The banks of the waterbody showed signs of damage (e.g. exposed soil, bank slumping and/or livestock hoof action)
- ☐ The area had greater than 15% exposed soil (areas with no plant cover)
- ☐ The area had few trees or shrubs present (less than 15% of the total plant cover)
  - ☐ *Trees and shrubs do not naturally grow in my area*
- ☐ The area had non-native plant species present (i.e. Canada thistle, blackberries and kentucky blue grass)
- ☐ The area showed signs of livestock grazing

4a. Additional comments about your previous riparian area ______________________________________

____

5. Did livestock have access to the riparian area prior to implementing your BMP?
- ☐ Yes
- ☐ No
- ☐ n/a - I don't have livestock on the property

SECTION B. Your Riparian Area Management BMP

6. In which year did you complete your Riparian Area Management BMP project?

____

7. Which of the following features/practices did you implement in your riparian area when you installed your BMP?
Please check all that apply.
- ☐ Temporary fencing to exclude livestock or other sources of disturbance from the riparian area
- ☐ Planting of trees, shrubs, grasses and/or forbes
- ☐ Site preparation
- ☐ Weed or vegetation control
- ☐ Temporary irrigation
- ☐ Professional consultative services (i.e. a Biologist)
- ☐ Other (*please specify*)____________________________

7a. Additional comments about the riparian area that you restored____

____

8. If you implemented a temporary fence to exclude livestock from the riparian area what length of waterbody/ watercourse do livestock *now* have access to?
If access is prohibited, please indicate 0.

__________meters *or* ________ feet

9. In which area of the farm did you install your Riparian Area Management BMP adjacent to?
(Eg. crop land, summer grazing area, calving area, etc.)

____

10. Which type of waterbody/watercourse is adjacent to the the riparian area that you restored?
Please check one of the following options.
- ☐ Permanent stream/creek/river
- ☐ Seasonal creek
- ☐ Seasonal pond
- ☐ Permanent wetland
- ☐ Seasonal wetland
- ☐ Lake
- ☐ Pond
- ☐ Dugout
- ☐ Constructed ditch
- ☐ Other (*please specify*)___________________________

11. Did you complete a Riparian Management Plan (RMP) through the Environmental Farm Plan Program?
- ☐ Yes
- ☐ No (*skip to Section C*)

11a. Was the Riparian Area Management BMP recommended by a RMP?
- ☐ Yes
- ☐ No

11b. What were your reasons for competing a RMP?

____

____

____

11c. What was the total score?

________ points / 57 possible total points

Or if you don't recall the score, please indicate the rating of the riparian area that was identified through the RHA:
- ☐ Healthy
- ☐ Healthy with problems
- ☐ Unhealthy
- ☐ I don't know

SECTION C. Environmental Impact of your BMP

In the following questions we are trying to estimate the dimensions of the riparian area that has been restored by your BMP. Please report in either acres, meters or feet.

12. What is the total riparian area that was restored?
If you restored the riparian area on both sides of the watercourse or waterbody, please report the area of both sides added together. If you can not estimate the total area of riparian that was restored, skip to question 13.

_______ acres *or* ______ square meters *or* ______ square feet

13. What is the total length of the riparian area that you restored?
If you restored the riparian area on both sides of a watercourse/ waterbody, please report only the length of one side.

__________meters *or* ________ feet

On ☐ one side *or* ☐ both sides of the watercourse/waterbody

14. What is the average width of the riparian area that you restored?
Please report the distance from the waterline to one side of the outer edge of the riparian area.

__________meters *or* ________ feet

15. What is the average distance from the waterline to the top of the stream bank or shoreline?

__________meters *or* ________ feet

16. Do you maintain your riparian area by removing invasive or unwanted plant species?
- ☐ Yes
- ☐ No

17. Have you noticed a change in water drainage in and around the riparian area since implementing your BMP?
- ☐ The drainage in the area has improved
- ☐ The drainage in the area has worsened
- ☐ I have not noticed a change in drainage

*A riparian area is the transitional zone between the aquatic area and surrounding upland area. It is characterized by a presence and abundance of water and lush vegetation that survives well in abundant water.

18. Has the amount of plant cover along the streambank/ shoreline changed since implementing your BMP?
To help you answer this question, please consider the amount of bare soil that is present in the area now vs. prior to implementing your BMP.
- ☐ The amount of plant cover has increased
- ☐ The amount of plant cover has decreased
- ☐ There has been no change in the amount of plant cover
- ☐ I don't know

18a. How much plant cover is there currently along the streambank/shoreline?
- ☐ 90% cover or more (10% bare soil)
- ☐ 75% to 90% cover (10% - 25% bare soil)
- ☐ 75% cover or less (25% or more bare soil)

19. Has the number of trees and/or shrubs seedlings or saplings (young plants) in the riparian area changed since implementing your BMP?
- ☐ The number of seedlings and/or saplings has increased
- ☐ The number of seedlings and/or saplings has decreased
- ☐ There has been no change in the amount of seedlings and/or saplings
- ☐ I don't know
- ☐ Trees and/or shrubs do not naturally grow in my area (*skip to Question 20*)

19a. What percentage of the total plant cover in the riparian area are trees and shrubs (of any size)?
- ☐ More than 50%
- ☐ 25% to 50%
- ☐ Less than 25%

20. Have you noticed a change in the amount of native plant cover in the riparian area since implementing your BMP?
- ☐ Native plant cover has increased
- ☐ Native plant cover has decreased
- ☐ There has been no change in native plant cover
- ☐ I don't know

6

21. Please list all animal species that you have noticed living in your riparian area.

Birds____________________

Fish____________________

Mammals____________________

Amphibians____________________

22. Is your riparian area protected by a restrictive covenant or other permanent protective measure?
- ☐ Yes
- ☐ No (*skip to Section D*)

22a. If yes, please indicate the protective measure________

____

SECTION D. Impacts On Your Farm Operation

23. Do you produce any potentially marketable products in your riparian area?
- ☐ Yes
- ☐ No (*skip to question 24*)

23a. If yes, do you sell any of these products?
- ☐ Yes
- ☐ No (*skip to question 24*)

23b. If yes, what products do you sell from your riparian area?____________________

23c. If yes, what is the total annual value of products produced in the riparian area?

$_________ /year

24. Has this BMP allowed you to extend your grazing season by allowing managed grazing in the riparian area?
- ☐ Yes
- ☐ No (*skip to Question 25*)
- ☐ n/a - No livestock graze in the area (*skip to Question 25*)

24a. If yes, approximately how many more weeks per year do you graze your livestock in the riparian area?

_________weeks/year

7

25. If there has been any other impacts to your farm operation since restoring your riparian area, please describe them here____________________

____

____

SECTION E. Cost of the BMP to your Farm Operation

Please estimate your annual maintenance costs before and after implementing the BMP. If there was/is no cost, indicate $0. Please don't include any capital purchases in your response.

26. What were your average costs per year for maintenance of the riparian area *prior to restoration*?

$_________ /year

27. What are your average costs per year for maintenance of the riparian area that you restored?

$_________/year

27a. What are the major maintenance costs?

____

Please estimate your annual labour requirements before and after implementing the BMP. Include both family and hired labour. If no labour was/is required, please indicate 0 hours.

28. How many hours of labour per year *were* needed to maintain the riparian area previously?

________ hours/year

29. How many hours of labour per year are *now* needed to maintain the restored riparian area?

________ hours/year

30. If the BMP has required more or less labour, please indicate why____________________

____

8

31. Did you take land out of production permanently in order to implement this BMP?
- ☐ Yes
- ☐ No (*skip to question 31*)

31a. How much land was removed from production?

_______acres *or* ______ square meters *or* ______ square feet

31b. What type of crop *were* you producing?

____

32. Did you install any additional infrastructure (i.e. livestock waterers, concrete pad for watering, stream crossings, culvert or permanent fencing) in order to protect the riparian area that you restored?
- ☐ Yes
- ☐ No (*skip to question 33*)

32a. If yes, what additional infrastructure did you install?

____

32b. What was the total cost of the infrastructure?

$____________

32c. Did you receive funding through the BMP Program for this additional infrastructure?
- ☐Yes
- ☐No

33. Did you incur any other costs when restoring your riparian area that were not "cost-shared" by the BMP Program?
Please list the items and the cost here.

Item	Cost
______________	$____________
______________	$____________
______________	$____________
______________	$____________

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SECTION F. Social Aspects of BMP Adoption

34. Why did you choose to adopt the Riparian Area Management BMP? *For each statement below, please circle the number that reflects your answer.*

	Not important		Somewhat important		Very important
To demonstrate stewardship	1	2	3	4	5
To improve livestock health	1	2	3	4	5
To avoid environmental regulatory fines	1	2	3	4	5
To improve the long-term sustainability of my operation	1	2	3	4	5
To limit the farm's impact on the environment	1	2	3	4	5
To contribute to a positive industry image	1	2	3	4	5
To produce marketable products in the riparian area	1	2	3	4	5
To enhance the aesthetics of my operation	1	2	3	4	5
To improve the profitability of my operation	1	2	3	4	5
To enhance the branding of my operation	1	2	3	4	5
To enhance biodiversity on my farm	1	2	3	4	5

If you had other reasons for adopting this BMP, please describe them here______________________________

____

____

35. In your opinion, what are the barriers to adoption of the Riparian Area Management BMP by other producers in your industry? *For each statement below, please circle the number that reflects your answer.*

	Not a barrier				A large barrier
A lack of awareness of risks to the environment from farm practices	1	2	3	4	5
Costs associated with BMP adoption	1	2	3	4	5
Barriers to accessing funding through the BMP program	1	2	3	4	5
Other farm priorities take precedent	1	2	3	4	5
A lack of time or labour	1	2	3	4	5
A lack of industry pressure	1	2	3	4	5
A lack of public pressure	1	2	3	4	5
A lack of support from public agencies	1	2	3	4	5
A lack of understanding about *how* the BMP will benefit their operation	1	2	3	4	5
A lack of understanding about *which* BMPs will benefit their operation	1	2	3	4	5
No succession plan for their farm	1	2	3	4	5
Logistically not feasible	1	2	3	4	5

If you can think of other barriers to adoption for this BMP please list them here______________________________

____

36. Do you believe that your Riparian Area Management BMP provides a benefit to society?
- ☐ Yes
- ☐ No (*skip to question 37*)
- ☐ I don't know (*skip to question 37*)

36a. If yes, please describe the benefits to society that your BMP provides______________________________

____

____

37. Are you more likely or less likely to implement environmentally friendly management practices since adopting your Riparian Area Management BMP?
- ☐ More likely
- ☐ Less likely
- ☐ No change

38. Has adopting the Riparian Area Management BMP increased your personal pride in your farm operation?
- ☐ Yes
- ☐ No
- ☐ I don't know

39. Have you used your participation in the Environmental Farm Plan (EFP)/BMP Program to market your products?
- ☐ Yes
- ☐ No (*skip to question 40*)

39a. If yes, please describe how you use the EFP/BMP Program to market your product____________________

____

40. Have other farmers recognized that you have completed an EFP and/or restored a riparian area on your farm in some way (e.g. commented or visited)?
- ☐ Yes
- ☐ No

41. Which information channels do you prefer for gathering information about environmental farm practices?
Please check all that apply.
- ☐ Newsletters
- ☐ Agricultural magazines
- ☐ Farm demonstrations and field tours
- ☐ Social media websites (e.g. Facebook, Twitter)
- ☐ Mobile media (e.g. iPhone apps.)
- ☐ Peers
- ☐ Internet websites
- ☐ Newspapers
- ☐ Classes/workshops
- ☐ Agricultural supply companies
- ☐ Government publications
- ☐ Books
- ☐ Television
- ☐ Other (*please specify*)______________________________

SECTION G. About You

42. What is your relationship to the farm?
- ☐ I am an owner of the farm
- ☐ I am an employee of the farm
- ☐ Other (*please specify*) ______________________________

43. For how many years have you been farming?

_________ years

44. For how many years have you been farming on the property where the BMP was implemented?

_________ years

The following two questions will help us to understand how farmers in BC who adopt BMPs compare to the general population of farmers. As with all other questions, this information will be analyzed and reported in aggregate.

45. Please indicate your age category:

- □ 18 to 34 years
- □ 35 to 44 years
- □ 45 to 54 years
- □ 55 to 64 years
- □ 65 years and above

46. Please indicate the farm gate receipts reported in 2010 from the farm operation:

- □ $9,999 or less
- □ $10,000 to $24,999
- □ $25,000 to $49,999
- □ $50,000 to $99,999
- □ $100,000 to $249,999
- □ $250,000 to $499,999
- □ $500,000 and over

47. Is there anything that you would like to tell us about your experience implementing your BMP or comments and suggestions about the BMP Program in general?
Please attach additional sheets if required.

____
____
____
____
____
____
____
____
____
____

Thank you for completing this survey! Your input and opinions are greatly valued. Please return the survey by enclosing it in the pre-paid postage envelope and dropping it into the mail by November 15th, 2011 in order to have your input included in this study and to be eligible for the $100 Visa Gift Card draw.

If you would like to be included in the draw for one of three $100 Visa Gift Cards, please indicate an email address or phone number where you can be reached:

Email______________________________

Phone number__________________________

Appendix II. Regional BMP Adoption Maps

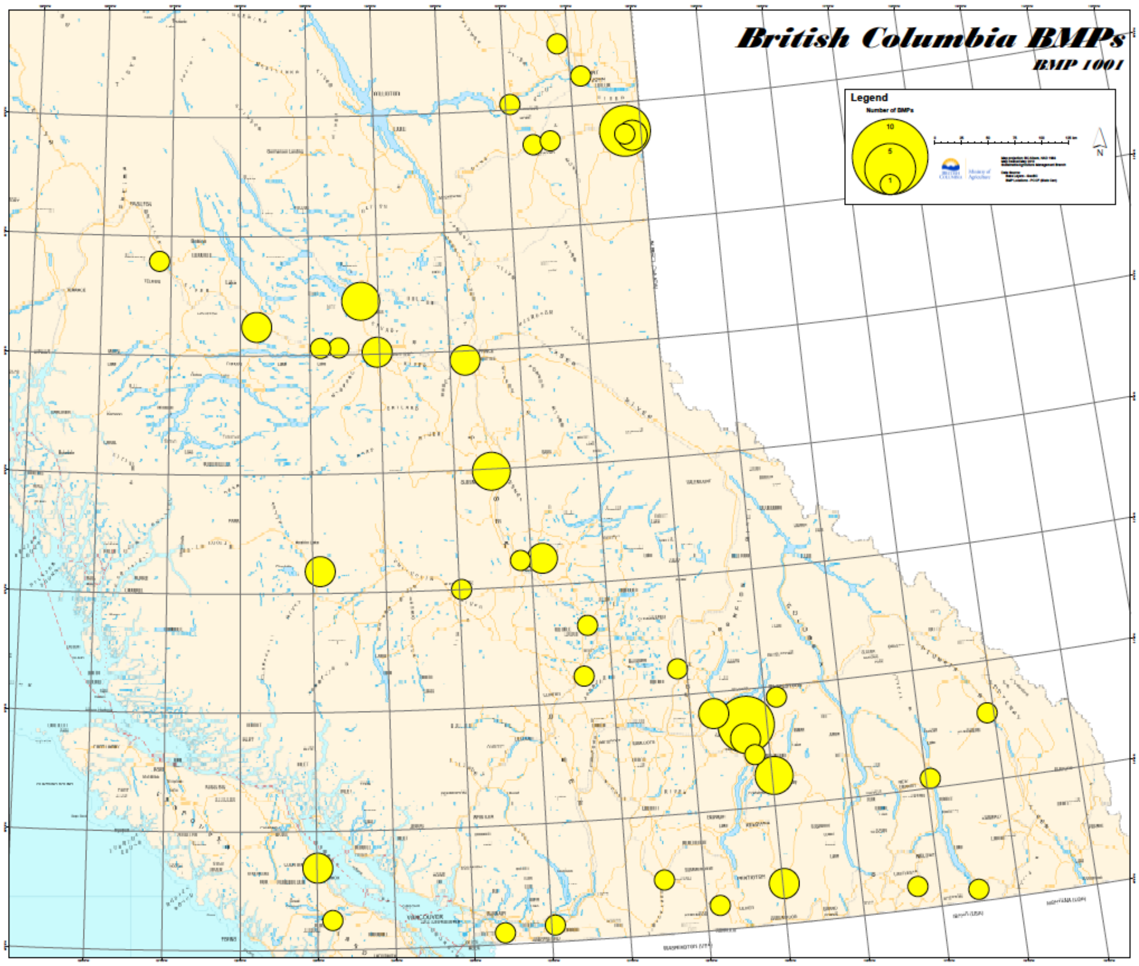

Figure 17. Map of Livestock Watering BMP Adoption Between 2005 - 2010

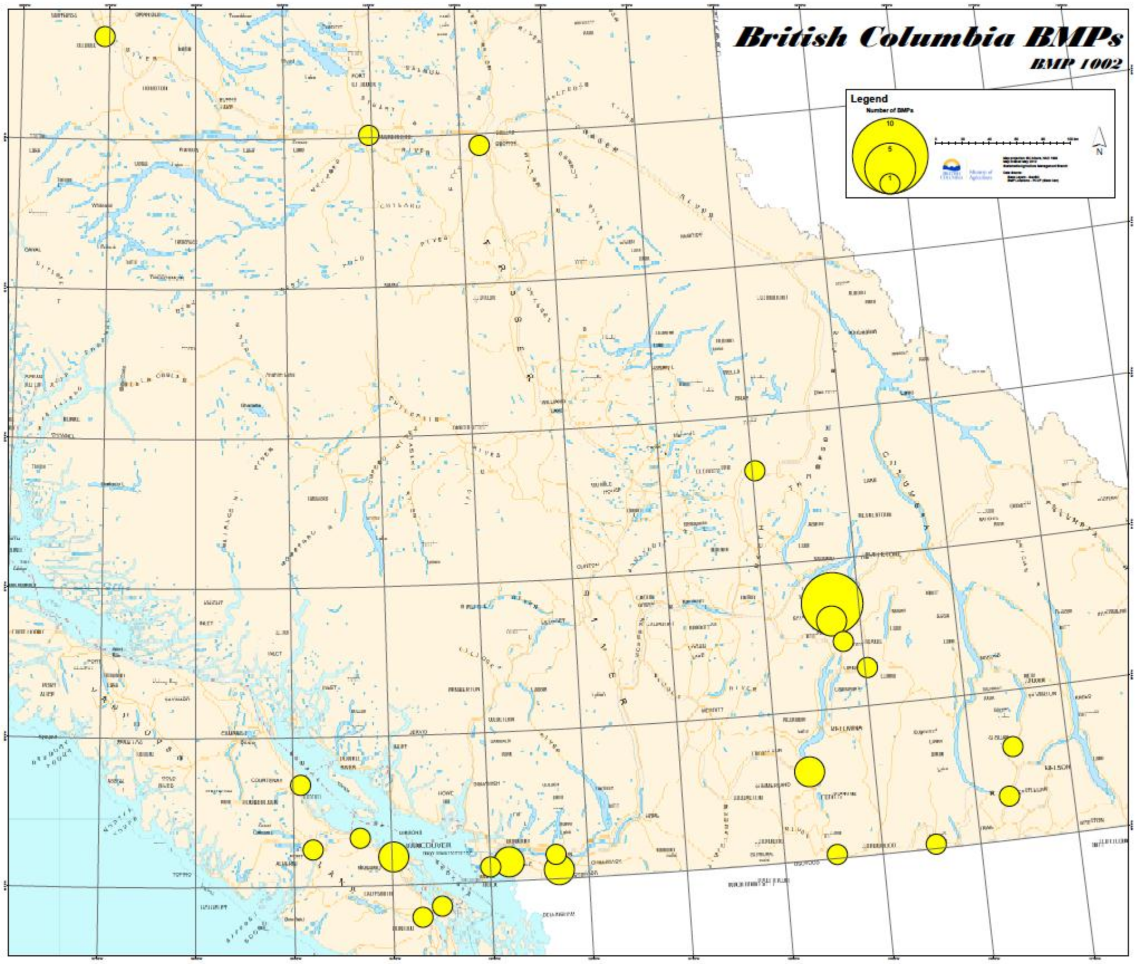

Figure 18. Map of Riparian Buffer BMP Adoption Between 2005 - 2010.

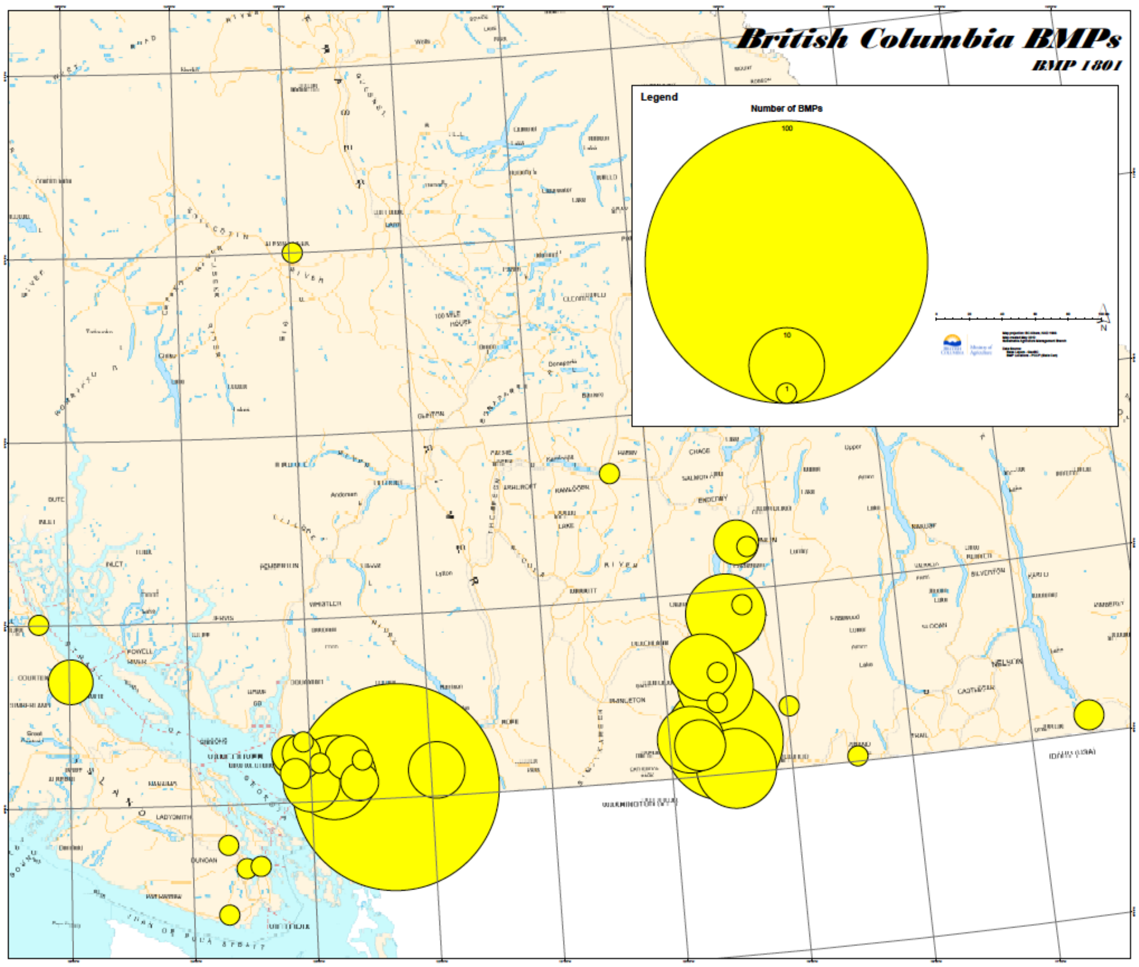

Figure 19. Map of Irrigation Management BMP Adoption Between 2005 - 2010.

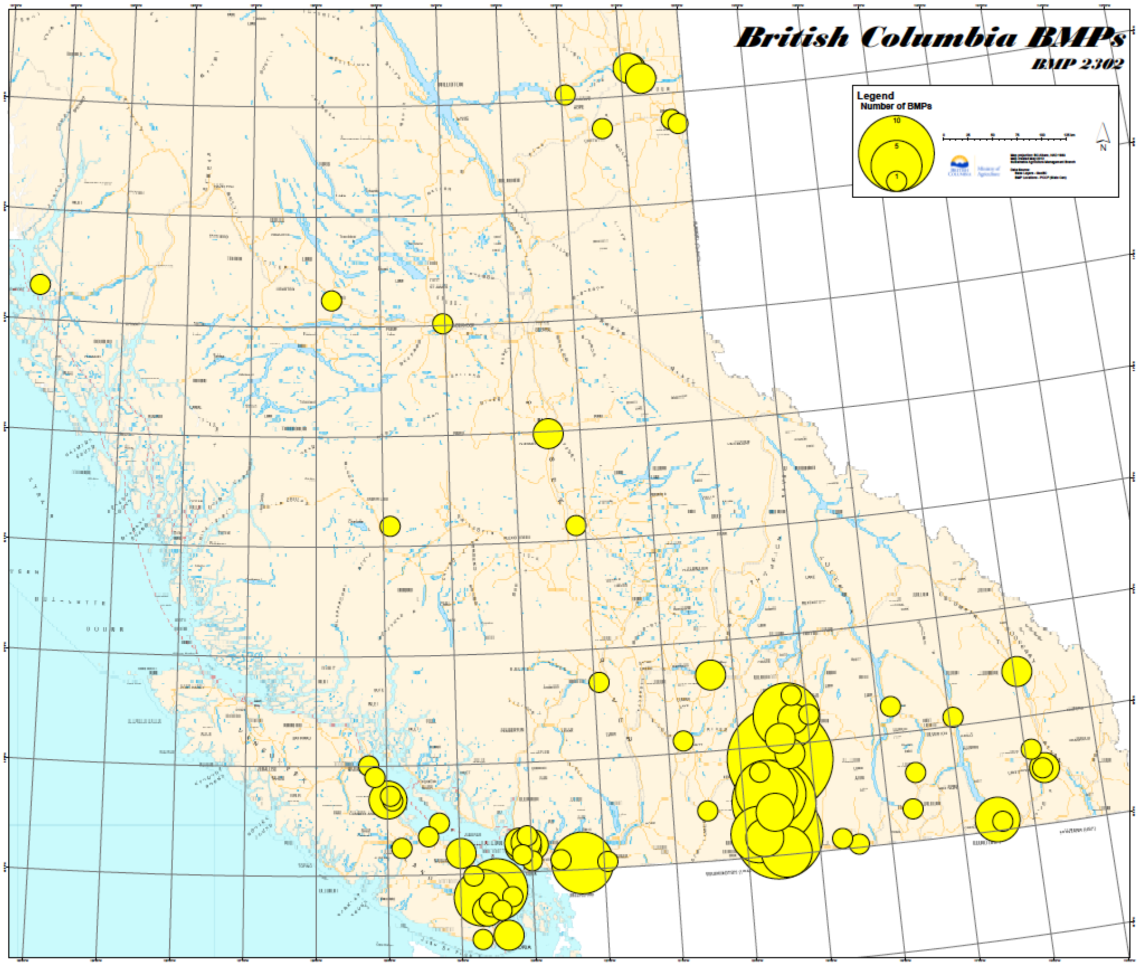

Figure 20. Map of Wildlife Damage Prevention BMP Adoption Between 2005 - 2009.

Appendix III. Environmental Indicators Selected for Evaluation

BMP	Environmental Risk Addressed	Indicator of Risk Mitigation	Indicator Type
Alternative Watering Systems to Manage Livestock: *this BMP gives money for pumps, storage, power setup, waterlines, construction, protective fencing or portable panels to install either off-stream watering or restrict livestock access to the watercourse*	1. Riparian Habitat Damage from Livestock	Amount of riparian area with reduced livestock presence due to watering system (area)	Practice: survey question/visual inspection
		Change in riparian vegetation	Outcome: survey question/Riparian Health Assessment
	2. Streambank Erosion	Amount of streambank with reduced or no livestock presence due to watering system (area)	Practice: survey question/visual inspection
		No or little evidence of erosion	Outcome: visual inspection
	3. Reduced Water Quality related to Livestock Presence	Water test (i.e. has producer noticed improvements in water tests?)	Outcome: Survey question
Riparian Buffer Establishment: *This BMP funds the establishment of adaptable, hardy, permanent native or non-invasive species of grasses, forbes, trees and shrubs. Eligible costs include: preplanting site prep, plant purchase costs, weed control, irrigation (trickle or drip), temporary fencing, purchase/planting/establishment costs for grasses, forbes, shrubs, trees for year of planting and one year afterwards, consultant services*	1. Run-off from nutrients, pesticides or sediments	Amount of riparian habitat created (area)	Practice: survey question/visual inspection
		Average width of buffer	Practice: survey question/visual inspection
	2. Soil and streambank erosion	Amount of riparian habitat created (area)	Practice: survey question/visual inspection
		No evidence of erosion	Outcome: visual inspection
		Presence of well rooted plants and no bare soil	Outcome: Riparian Health Assessment
	3. Habitat destruction from farming practices	Riparian area contains features such as: stand diversity, shade for fish and other aquatic species, woody debris, stable banks	Outcome: Riparian Health Assessment
		Livestock are restricted from riparian area via grazing management or physical restriction resulting in maintenance of habitat values	Practice: survey question
	4. Invasive plants	Plant species composition of riparian area	Practice/outcome: survey question/Riparian Health Assessment
		Management for invasive species	Practice: survey question

BMP	Environmental Risk Addressed	Indicator of Risk Mitigation	Indicator Type
Irrigation equipment modification/improvement to increase water and nutrient use efficiency for nursery, greenhouse, berries, grapes and tree fruits: *This BMP funds the upgrade of pre-existing irrigation systems to gain at least 15% efficiency saving over the old system. Specific aspects funded include drip irrigation, controlling equipment, fertilizer injection equipment*	1. Water shortages and associated effects to groundwater and surface water systems	Efficiency gains from new system	Outcome: survey question
		Region within BC and associated state of water resources	State: Surveyor to assess the effect of efficiency gains by comparing different regions in BC and current and future availability of water
	2.Run-off/soil erosion caused by excess irrigation water	No evidence of erosion	Outcome: visual inspection
	3.Loss of nutrients to groundwater and streams	Reduced nutrient inputs	Practice: survey question
Preventing Wildlife Damage: *Strategic fencing to prevent wildlife/bird damage to stored feed, concentrated livestock, high value crops, drip irrigation systems, and other critical agricultural activities from protected or managed wildlife species. The goal of category 23 is to strike a balance between farming and biodiversity values.*	1. Wildlife causing economic damage to stored feed	Amount of damage to feed that fencing has reduced	Outcome: survey question
	2. Wildlife causing economic damage to crops	Amount of damage to feed that fencing has reduced	Outcome: survey question
	3. Wildlife causing economic damage to irrigation lines	Amount of damage to irrigation that fencing has reduced	Outcome: survey question
	4. Wildlife causing damage to livestock	Amount of damage to livestock that fencing has reduced	Outcome: survey question

Appendix IV. Overview of BMPs Evaluated in this Study

This appendix provides an overview of the four BMPs that were selected for evaluation, the reasons they were selected for evaluation by the Ministry of Agriculture and the environmental risk that they are intended to mitigate (Mark Raymond, Personal Communication, July 5th, 2011; BC Ministry of Agriculture, 2010).

A. Alternative Watering Systems to Manage Livestock

The Alternative Livestock Watering Systems BMP is intended to address environmental risks associated with livestock drinking directly from surface water sources, trampling and grazing riparian vegetation and defecating in and around surface water. The BMP provides funding to install an off-stream water source(s) or to restrict livestock access to surface waters. 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.

Installation of off-stream watering systems can also improve livestock health and provide a year round drinking water source. This BMP was selected for evaluation because AGRI and other agencies had an interest in learning more about the effectiveness of this BMP in practice.

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.

Figure 21. Example of a Livestock Watering BMP where the producer installed a frost-free watering system to deliver water upstream from the creek.

B. Riparian Buffer Enhancement

The *Riparian Buffer Enhancement BMP* is intended to address a variety of environmental risks associated with a lack of buffers between farming areas and watercourses and/or wetlands. These risks include impacts of farming practices to water quality and quantity, soil erosion and wildlife (including flora and fauna). Benefits of riparian buffer enhancement 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 Riparian Buffer Establishment BMP* has not been adopted widely over the life of the program. Therefore, there was interest in learning about how and why the BMP had been adopted in the few cases that it has, well as about the barriers to adoption.

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.

The *Riparian Buffer BMP* was cost-shared at 50% of total eligible costs up to $25,000 (although the current cost-share level has increased to 60% in 2011). 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.

Figure 22. Example of a Riparian Buffer BMP project where the producer has installed a planting of willow saplings to mitigate rapid streambank erosion.

C. Irrigation Management for Nursery, Greenhouse, Tree Fruit, Grape and Berry Operations

The Irrigation Management for Nursery, Greenhouse, Tree Fruit, Grape and Berry Operations BMP is intended to address 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.[36] The *Irrigation Management BMP* was selected for evaluation because it has had high adoption over the life of the program and AGRI had an interest in learning about the motivations behind adoption as well as if the funding levels could be changed over the coming years of the program.

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.

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

[36] A fertigation system allows soluble fertilizer to be applied through the irrigation system, resulting in a more accurate placement of nutrients around the crop rooting zone and more efficient nutrient uptake.

50%. The average cost of an *Irrigation Management BMP* project, taking into account only the eligible costs is $18,070.

Figure 23. Example of an Irrigation Management BMP project on a new planting of grapes.

D. Wildlife Damage Prevention

The *Wildlife Damage Prevention BMP* is intended to reduce the impacts that wildlife can have on the farm operation by providing funding to construct a wildlife fence around potential problem areas such as stored feed, irrigation lines and crops. The benefits provided by this BMP include reduction in economic losses to the farm operation as well as reducing the occurrence of wildlife conflict events by restricting access to 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. In recent years, farmers, particularly in Northern BC, have asked for AGRI to reinstate funding for this BMP. AGRI selected this BMP for evaluation in order to better understand the agriculture wildlife conflict situation and needs of farmers.

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.

Figure 24. Example of a Wildlife Damage Prevention BMP project where a fence was erected around an apple orchard to eliminate deer damage to trees.

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

Prepared by Ryan Trenholm

- 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	Outcome	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	Outcome	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	Outcome	Amount	Source
Benefits	Increased yield	$9,271.93 per year	Survey
	Water savings (water supply)	$0.60 per 1000m^3 per year	BCMOE (2011)[37]
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	Outcome	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	Outcome	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

[37] [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	Outcome	Amount	Source
Benefits	Damage avoided	$10,200 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

Appendix VI. Additional CBA Tables

1.0 Livestock Watering BMP

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[38] 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.

Table 1. 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 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.

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38 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 2. 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.

2.0 Riparian Buffer BMP

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 3. 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 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 4. 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.

3.0 Irrigation Management BMP

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 5. 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 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 6. 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.

4.0 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 7. 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 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 8. 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.

5.0 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 9. 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

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 10. 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.

6.0 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 11. 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 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 12. 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.