A Study of Canadian Conservation Offset Programs

Lessons Learned from a Review of Programs, Analysis of Stakeholder Perceptions, and Investigation of Transactions Costs

Sustainable Prosperity

RESEARCH PAPER

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September 12, 2014

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This research project was funded by Sustainable Prosperity. However, the views and findings expressed in this paper should be attributed to its authors. They do not necessarily reflect the views and positions of Sustainable Prosperity.

Contents

List of Acronyms

AARD – Alberta Agriculture and Rural Development
ACA – Alberta Conservation Association
AESRD – Alberta Environment and Sustainable Resource Development
BBOP - Business and Biodiversity Offsets Programme
DFO – Department of Fisheries and Oceans
DUC – Ducks Unlimited Canada
EBI – Environmental Benefits Index
ES – Ecosystem Services
HADD – Harmful Alteration, Destruction or Disruption [of fish habitat]
INFFER - Investment Framework for Environmental Resources
MBI – Market Based Instrument
NGO – Non-Government Organization
PES – Payment for Ecosystem Services
PPBF - Public-Private Benefits Framework
RLP – Revolving Land Purchase
SEACOP – Southeastern Alberta Conservation Offset Pilot
SNC – South Nation Conservation
TC - Transactions Costs

Summary

The use of conservation offsets[1] to achieve environmental goals is becoming more prominent, both in Canada and around the world. In order to build new, effective programs, it is useful to evaluate current programs for the lessons that can be learned. Much of the existing literature focuses on evaluating offset programs from a biological perspective *or* an economic perspective. To fully evaluate a program, elements of both disciplines should be used. The following paper develops a framework using existing criteria from both the biological and economic literature. The framework is then applied to several Canadian and one international case study to identify what lessons can be learned. Interviews with key stakeholders in the design of existing offset programs are used to expand the discussion on the lessons learned. The paper concludes with a discussion of lessons that are learned through the literature review, application of the framework, and interview responses.

Introduction

There is increasing recognition that humans benefit directly from services provided by nature, yet these services are not always recognized in market processes (US EPA 2009). While some changes in ecosystem services (ES) directly affect agricultural crops and timber, and are thereby reflected in market value, other ES affect outdoor recreation experiences, wildlife habitat, or scenery and are difficult to capture in market values. In the latter cases the services may be underprovided since there is no direct incentive to generate improvements in their levels of provision. As public or quasi-public goods, the market will likely fail to provide these types of ecosystem benefits in sufficient quantity, which results in the need for policy tools that affect the provision or maintenance of these goods and services. As a corollary, the true costs or scarcity value of declines in these services, from land conversion or other development, will also not be reflected in market values. These non-market benefits and costs have led to a host of policy responses including conservation offsets, in which a loss in services must be offset by an equivalent gain in that service to maintain a non-declining level of ES provision, or possibly an increase in ES provided.

[1] Note that conservation offsets may also go by other names including biodiversity offsets.

Conservation Offset Use

Conservation offsets are typically part of a hierarchy of "avoid, mitigate, rehabilitate / restore, and offset" (BBOP, 2010). In this hierarchy, agents who are affecting ES are required to attempt to first avoid losses in these services, then mitigate them, then rehabilitate other areas to reduce losses, and finally offset the remaining losses by creating or purchasing new habitats that are equivalent to the losses in services from development. While an agent can internally offset such impacts, often they purchase such offsets from others – either directly or through an agency responsible for creating or verifying the generation of offsetting services. In this way the offset mechanism provides for the possibility of cost effective conservation – achieving conservation targets like no-net-loss at least cost. Landowners who wish to participate in the creation of offsets may provide increased services by restoring wetlands or converting cropland to grassland as examples. Such a program is a direct mechanism that provides incentives for ES provision (Ferraro and Kiss 2002) and is viewed as a payment for ES (PES) approach. Many conservation offset programs use ratios (or quality adjustments) to capture the difference in services provided between "impacted" and "created" ecosystems. The use of ratios allows a program to account for heterogeneity in ecosystems, and the services they provide; by requiring a net increase in habitat area (e.g. 1 hectare of wetland loss may be offset with 3 hectares of restored wetlands elsewhere) that takes into account quality differences between the area lost and the area created.

An example of an offset scheme, where firms or individuals who disturb an ecosystem create new ecosystems somewhere else to compensate society for the loss in ecosystem function, is the Alberta Conservation Association's (ACA) Conservation Offsets Framework (Croft et al 2011). This program can be used to outline the components of conservation offsets. A typical set of requirements for offsets are that they be additional, permanent, and equivalent (Croft et al 2011). These three terms indicate that offsets must:

1. Create *new* habitat
2. Exist for at least the duration of the impact
3. Provide equivalent "value" (ecological and/or economic) to the services lost by the development activity

It is not recommended that the costs in these three categories be summed to arrive at a single figure. They measure conceptually different things and should be seen as three ways of looking at the question of the cost of pollution.

In addition, an offset obtained at least cost, by finding the most inexpensive provider of the services, will result in cost effectiveness. Cost effective conservation offset programs can be found using market based instrument[2] programs in which agents who seek offsets (e.g. developers) are facing market-based costs of purchasing the offset, while agents who are selling offsets are being provided with incentives to increase the provision of habitat or ES. The existence of a constraint, such as a no-net-loss constraint, generates the negative incentive on developers and the consequent positive incentive for suppliers of offsets. A market based mechanism if appropriately designed will facilitate the provision of cost effective offsets and construct an effective scarcity signal of the value of the ES.

Challenges of Implementing Conservation Offsets

Many offset programs offset habitat loss or ecosystem function, rather than the ES provided (see case study 3: Alberta's wetland offsets). While offsetting habitat loss is more easily accomplished than accounting for ES, it does not necessarily reflect the loss of ES. Ecological function and ES can overlap, however the function is the natural process and the service is what the function can provide to humans (De Groot et al 2002). An example of the difference between ecological functions and ES is soil retention from plant roots (function) and the preservation of arable land (service) (De Groot et al 2002). It is also important to note that "biodiversity" is increasingly not viewed as an ES. Biodiversity may better reflect the function, while services such as wildlife (viewing or existence values), potential pharmaceutical provision or other such items are the services.

Offset programs can be quite complex as a number of issues arise from the attempt to generate offsetting habitats or ES. Such complexities include the metrics used to assess equivalence,[3] the extent to which offsets must be permanent or if they can be temporary and revolving, the monitoring and verification of offsets, and the use of cost effective mechanisms to secure the offsets. Other issues in offset design include considerations of multiple interdependent services; the effect that offsetting one service may have on related ES. There are also questions regarding the potential for offset programs to "crowd out" voluntary environmental behavior and the possibility that high transactions costs (TCs)[4] associated with offset programs will result in low participation rates or economically inefficient projects. Nevertheless there is considerable interest

[2] See Poulton, D. 2014, for an excellent overview of conservation offset design principles and comparisons of offset programs in other countries.

[2] See Appendix C for a discussion on equivalence and ratios.

[3] See Poulton, D. 2014, for an excellent overview of conservation offset design principles and comparisons of offset programs in other countries.

[4] See Appendix C for a discussion on equivalence and ratios.

[5] TCs are the costs of developing, implementing, and maintaining a program.

in the use of conservation offset schemes, by industry, government and NGOs. An illustration of government interest is the inclusion in Alberta's Land Stewardship Act of conservation offset programs and the provision to support pilot projects on such market based instruments. Industry may be interested in such mechanisms as a cost effective approach to achieving regulatory outcomes, such as no-net-loss, and they may appreciate increased certainty around mechanisms to deal with environmental impacts of projects.

However, there are only a few examples of conservation offset programs in Canada. By exploring the few existing offset programs, new programs can be designed to be more effective; both from an economic efficiency view and the environmental benefits realized. The objective of this project is to describe the "lessons learned" from conservation offset programs in Canada and elsewhere. In addition, lessons learned from other offset programs, such as carbon offsets, will be considered. The analysis will be conducted in two ways. First, a framework for "successful" conservation offsets (a "gold standard"), will be presented. This framework is a compilation of frameworks and criteria that can be found in the current literature. The framework will provide a benchmark from which existing or new programs can be compared. The examination of emerging programs against a benchmark has been used in other contexts (Collie et al 2013) and provides a mechanism for assessment and guides future implementation. Second, this report will explore several "local" (Canadian) case studies in detail. These case studies will be evaluated through a combination of: literature reviews, existing assessments of the programs, results from the program, and a survey of individuals involved in offset programs. In the case studies there will be additional emphasis on the TCs associated with the design and implementation of conservation offset programs as there are relatively few detailed quantitative assessments of TCs associated with participating in conservation offset programs.

Paper Layout

The paper proceeds as follows. First we outline the role and importance of TCs in program design. TCs are included as one of the criteria for evaluation of programs, but because of the importance of TCs in new program design we highlight this aspect of conservation offsets. Next we introduce a framework for assessing conservation offsets. We then provide a summary of the results of the application of this framework to a set of conservation (and other) offset programs in Canada as well as one program in Australia. In the discussion section that follows we summarize the issues raised in the evaluation and in our surveys of stakeholders. We conclude the report with a set of 7 key "lessons learned" from our investigation.

A Digression –Transactions Costs

TCs are an important component in decision making. Whenever a market transaction takes place, there exists a cost to both the buyer and the seller to complete the transaction. This concept was illustrated in considerable detail by Coase (1937), who stated that market transactions implicitly determine how production will be carried out. These market transactions will inherently be influenced by TCs; therefore TCs will impact how and what is produced. When applied to environmental programs such as offsets, the importance of understanding TCs becomes clear; higher TCs will lead to fewer environmental goods and services being provided with a fixed budget. Additionally, high TCs may deter landowners from participating, resulting in an economically inefficient conservation program. Because more money, and time (a deterrent to landowner participation identified by Simpson et al 2013), is tied up in the transaction, fewer benefits are realized, which will make the program less efficient.

While minimizing TCs is important to provide more ES at a lower cost, it is also important to explore transactions cost economics in a broader context. Fox (2007) provides an interpretation of Coase (1937, 1960) regarding how TCs will shape the institutions that allow externalities to be addressed. In a world where TCs exist, institutions will arise to minimize TCs. Individuals may choose to pay a landowner to bring about a land use change (e.g. restoring a wetland on agricultural land), however there will likely be high TCs associated with this method of addressing an externality. In this example, there is the potential for a reorganization of transactions to minimize TCs. Fox (2007) contends that when TCs are present (as is observed in reality), there is the potential for government action to change property to higher value uses where individual transactions would be inefficient because of high TCs. Several of the programs reviewed below represent a reorganization of institutions and the emergence of new institutions to address PES in a way that minimizes TCs.

Quantifying Transactions Costs

The Public-Private Benefits Framework (PPBF) set out by Pannell et al (2012) and described in detail in the "Economic Considerations" section below, illustrates the importance of TCs. High TCs will result in fewer incentive based programs (such as offsets) being socially valuable (a socially valuable program has net public benefits large enough to warrant a program as opposed to "no action"). As shown in Figure 2 below, "no action" becomes the most appropriate choice for more combinations of public and private benefits, relative to no or low TCs cases, because the TCs adjust for potentially overstated benefits (Pannell 2008).

Pannell et al (2012) propose that activities be undertaken until the point where marginal TCs are equal to the marginal environmental outcomes, where these benefits can be measured[5]. Including TCs in the decision making process about whether or not to begin an environmental project will better capture the costs associated with it. In other words, estimated TCs should be used to help identify appropriate programs and instruments, including offset programs.

Coggan et al (2010) list three main factors regarding the good/market that will influence TCs. These are: specificity of the good, temporal aspects, and the institutional framework in which the program will exist (Coggan et al 2010). Several examples of studies that quantify TCs can be found. McCann and Easter (2000) describe a system which can be used to measure the costs borne by the government/public agency in establishing and carrying out a soil conservation project. Given the data available for their study, the authors were constrained and could not examine private TCs. However, they do calculate the planning and application costs of a project by utilizing the salary of a conservationist and a technician respectively and find average TCs (including both private and public agents) of $12.52/ac (McCann and Easter 2000).

Mettepenningen et al (2009) quantify private TCs for European landowners who participated in a conservation program. Using both a survey and a detailed 1-year pilot study the authors gather data on the TCs borne by landowners. An important finding of their study is that the TCs experienced by private agents, in this case farmers, can be quite large, up to 15% of the cost of a program in their analyses (Mettepenningen et al 2009). Landowner TCs will affect program participation and efficiency. This last point may be particularly important as what landowners *perceive* TCs to be is more important in the decision making process than the realized TCs (Mettepenningen et al 2009, Buckley and Chapman 1997).

Santos et al (2014) provide a review of payment for ES scheme, including estimates of TCs. In a case study from Costa Rica, the authors find that using a simple proxy for the ES will have the lowest TCs and allow for application of the program to other areas; however detailed information on the services provided may be lost in a proxy (Santos et al 2014).

Pannell et al (2012) also describe a framework for evaluating environmental policies and TCs. The authors suggest that TCs for government agencies (the designer of the offset program) can be reduced by screening projects with stakeholders before doing a detailed planning phase. Additionally, a properly designed study with selective data requirements may lower TCs for the landowner (Mettepenningen et al 2009).

[6] Pannell et al (2012) recommend this approach to find an appropriate balance between the sophistication of the program and making the program accessible to users. Increasing the complexity of a program will not yield ever increasing net benefits because the TCs associated with this complexity will begin to outweigh the additional benefits (Pannell et al (2012).

Understanding the role of TCs in decision making and accurately quantifying them is important not only to search for efficiencies in program design, but also in the assessment of choice of policy instrument. Because the supply of offsets from private land is typically voluntary, it is necessary to recruit willing landowners. Assuming the landowner is a rational agent, he/she will expect to receive compensation for his/her participation in the conservation or offset program equal to at least the cost of participation, assuming no private benefit is gained from participating.

A successful program will therefore offer compensation at least equivalent to foregone income and TCs, and minimizing the variable TCs will allow for efficiency gains.
One must also note, however, that when evaluating pilot programs, like the Southeastern Alberta Conservation Offset Pilot (SEACOP) program, the TCs as a percentage of the program may be quite high and they would benefit from economies of scale in a broader program.

While TCs vary across programs, Libecap (2014) identifies four factors that influence TCs associated with programs addressing global environmental externalities. Although they are identified for larger geographic areas than the offset and conservation programs presented in this report, they can be used to provide additional insight into the TCs of conservation offset programs. The following four factors increase TCs (Libecap 2014):

- Scientific uncertainty
- Varying preferences and perceptions (see section 3.1.3 for an example of varying perceptions by stakeholder group)
- Asymmetric information
- Lack of compliance

Measuring or estimating TCs involves further steps. Using the breakdown of the elements of TCs laid out by McCann et al (2005), it is possible to systematically determine the TCs of a program. In addition to the actual costs of a transaction, it is also important to consider the costs of researching and establishing a payment for ES program (McCann et al. 2005), described above as learning costs. TCs can be broken down into 7 components, with some taking place at different times (see McCann et al. 2005 for a more thorough explanation). The 7 components are:

- Research and Information
- Enactment or Litigation
- Design and Implementation
- Support and Administration
- Contracting
- Monitoring, Detection, and Conflict Resolution

- Prosecution and Enforcement

In the case study section below, the Southeastern Alberta Conservation Offset Pilot [6](SEACOP, Case 4) is used as an example of the measurement of the TCs. As the pilot program is in the process of being developed, information on costs will be identified[7], through examining proposed budgets, surveys, and interviews (McCann et al 2005). If the analysis was *ex post* it would also be possible to utilize financial reports. Using interviews with government agencies, as well as the oil and gas producers and the landowners involved, it should be possible to determine the labour inputs into this program. Once the approximate time spent by all parties involved is established, it will be possible to estimate the expense of the program using pay scale information. The breakdown given above of TC elements will be used to guide the estimation of costs. Given that the project is still in development stages, some of the costs will not be known. However, they can be estimated using other incentive based programs as guidelines (if the information is available). Additionally, the costs of contracting should be available through estimates provided by other similar programs (e.g. the Alberta Conservation Association (ACA)), who have already undertaken several native range re-seeding projects in the area.

Analysis of TCs in existing programs reveals a large amount of heterogeneity, where newer, international, and developing country programs have higher TCs than established, more localized programs (Alston et al 2013). Localized programs may have an opportunity for lower TCs than national or international programs because they generally involve fewer parties (Alston et al 2013). The nature of the good and particularly how this interacts with property rights can also influence TCs, which should be considered when planning an offset program (Alston et al 2013). The conservation reserve program (CRP) in the United States has TCs estimated at 1% (calculated as TCs as a percentage of the overall program expenditure), the Countryside Stewardship Program in the UK has TCs of 18%, and a program of payments for carbon in Mexico has TCs between 30% and 50% (TCs reported here are total TCs for the program) (Alston et al 2013). Because TCs increase with program size and complexity, it is not surprising that an international program, involving multiple national governments, has higher TCs than an established national program, such as the CRP in the US which involves only one national government. As will be discussed in the summary of case studies, there is interest from the National Energy Board to use offsets as part of approvals for new oil and gas sites (NEB 2013). These one-time offsets will likely suffer from high TCs because they cannot take advantage of existing programs or institutions that have emerged to operate with lower TCs (Fox 2007).
A recent pilot in Florida that paid ranchers for water management services had a budget of $7 million for a small number of ranchers (10 projects were submitted for consideration) (Shabman

[7] SEACOP is a voluntary pilot program where industrial developments that disturb native grasslands can be offset by paying a farmer to take land out of cultivation and return the land to native grass for a finite contract period.
[8] TCs are estimated to be between 72% and 83% of the total program expenditure.

and Lynch 2013). The Florida pilot, similar to other pilots, identifies high learning costs as an issue (Shabman and Lynch 2013). A large budget will help overcome these costs with enough money left over to spend on the actual projects. A small budget for creating offsets has been listed as a concern for the SEACOP program. TCs, including learning costs, can be very high for pilots, therefore future pilots will benefit from larger budgets and/or larger scale to provide ES or ecological function and test market mechanisms. We return to the investigation of TCs in the SEACOP program under the case studies discussed below.

A Framework for Assessing Conservation Offsets

In this section the biological and economic literature on offsets and related programs are synthesized to create a framework for evaluating conservation offsets. This framework will then be applied to five case studies.

Biological Considerations

A review of the literature on frameworks for offset programs revealed documents outlining a general framework for offsets or standards for developing and implementing conservation offsets. For example, the BBOP (2012) report on biodiversity offset standards outlines 10 principles for offset design and accompanying criteria and indicators for each principle (see Table 1). The BBOP principles, summarized below, outline the goals of a conservation offset program in terms of achieving biological outcomes, transparency and equity. Somewhat surprisingly there is relatively little discussion of economic or financial aspects of offset design or consideration of cost effectiveness. For resources or ES that are very scarce the assessment of economic and financial aspects may not appear to be as important, as the social value is likely to be high and initial offset "providers" may be willing to supply them for a low payment. But as the application of offsets grows these conditions may not hold. Furthermore, if conservation offset programs are intended to provide signals of the value of ES as a way to integrate ES into market decision making contexts, then considerations of efficiency and cost effectiveness will be important.

Table 1: Summary of BBOP (2012) Principles for Design and Implementation of Biodiversity Offsets

1. Does the program follow the mitigation hierarchy?
2. Does the program have a risk analysis for residual impacts that cannot be offset?
3. Does the program have a broad scale, landscape context?

4. Does the program adhere to the principle of no net loss and incorporate offset equivalence?
5. Are the conservation outcomes additional?
6. Is there stakeholder participation?
7. Do all stakeholders have an equitable role?
8. Does the program have a long-term plan?
9. Is the program transparent?
10. Does the program utilize proven science and traditional knowledge?

Similarly, the recent contribution by Pilgrim et al (2013) describes "offsetability" in terms of whether an asset (habitat, etc.) can be offset in biological terms using considerations of risk of impact or extinction, available offset options, and likelihood of success. Their conclusions suggest that there is a tradeoff between the degree of biodiversity concern (risk) and the likelihood of success of the offset program and that offsets are most suitable for cases with low biodiversity concerns and high likelihood of offset success. However, these dimensions are largely viewed in biological terms. Likelihood of success is based on biological potential rather than whether landowners will successfully adopt and maintain lands enrolled in programs and whether such programs can be implemented cost effectively.

Economic Considerations

The BBOP (2012) and Pilgrim et al (2013) studies do provide very good summary guidance for issues like additionality, equivalence, and other very important components of an offset program. However, as a framework for assessment they are missing more detailed economic components. Economic considerations can be found in other literature. The Pannell Public-Private Benefits Framework (PPBF) (Pannell 2008) describes instrument choice (e.g. extension[8], positive incentives, negative incentives, or the choice to not implement any policy instrument) in the context of the size of net public and private benefits arising from an action. This relatively simple framework generates several interesting insights, particularly in the case of conservation offsets, and thus is explained in some detail here.

Figure 1 illustrates the Pannell framework. If a development project, such as an energy sector development or a residential sub-division (assumed to produce positive private net benefits) also produces significant negative public net benefits[9] through the loss of habitat – a negative incentive is the optimal policy response (the lower half of the south-east quadrant in Figure 1). Note that the loss in net public benefits must be greater than the gain in net private benefits for

[9] Where extension is "technology transfer, education, communication, demonstrations, support for community network" (Pannell 2008, p226).

[10] Where the net public benefits include the net benefits to everyone except the private land manager

this policy response to be warranted. In the case of a conservation offset this negative incentive is the requirement to offset the impact. Thus the development agent must pay for another landowner to construct an offsetting project. This occurs in north-west quadrant of the diagram. A landowner would experience a negative private net benefit from undertaking the offset project (e.g. converting cropland to native grassland, restoring a wetland). Assuming that the gain in net public benefits offsets the loss associated with the development project one can identify the location of the net private / public benefits point and assess whether a policy instrument such as a positive incentive (e.g. PES) is best.

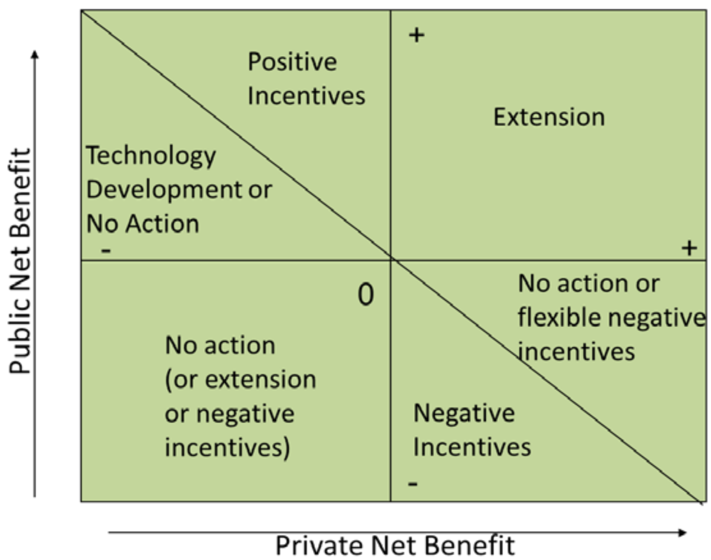

Figure 1: Pannell Public Private Benefit Framework (Pannell 2008, page 228)

The PPBF has been modified to include TCs. Figure 2 illustrates this situation for the offset program. If TCs are significant it is more likely that “no action” or “flexible” incentives are used rather than direct positive or negative incentives. Another potential expanded use of the framework is the fact that the negative incentive on the developer (requirement to offset) constitutes a “willingness to pay” for a type of input into the development project. For the landowner the payment for ES is effectively a “willingness to accept” context. Large willingness to accept amounts may reduce the possibility that a positive incentive is optimal (opting instead for a less direct mechanism or no action outcome). These insights from the PPBF illustrate the importance of TCs and mechanism design on the choice of instrument and approach. Offsets evaluated purely in ecological terms may not generate sufficient net benefits to warrant a policy instrument; as a result “no action” may be the correct decision if economic components are not considered. In contrast to the analysis presented by Pilgrim et al (2013), it is more likely that high value ES (e.g. scarce habitat resources), if they can be established, will generate sufficient public net benefits to justify an offset scheme. In cases with low value ES, TCs in particular may be significant enough to render offset programs as an economically inefficient solution.

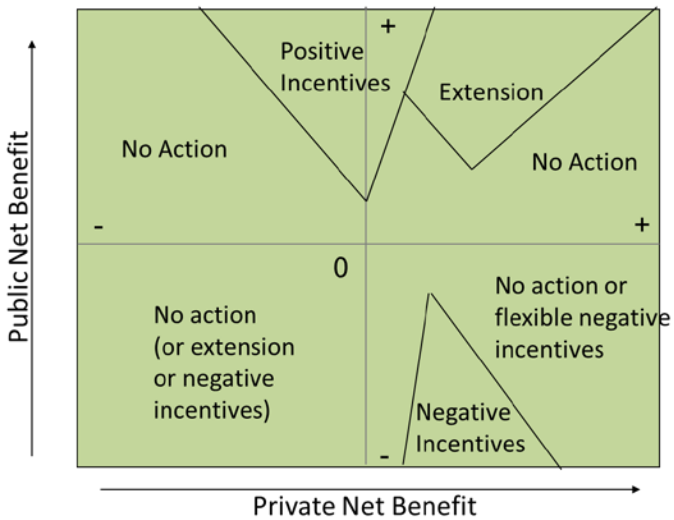

Figure 2: Pannell Public Private Benefit Framework with Transactions Costs (Pannell 2008, Page 228)

In a series of papers Pannell and colleagues have outlined a process for evaluation of environmental projects that is aligned with the PPBF. The INFFER (Investment Framework for Environmental Resources) employs a benefit-cost approach to assess which "projects" to include in a conservation initiative (INFFER 2014). This can be viewed as determining which projects to include given a budget for offsetting activities (noting that this budget is endogenous / negotiable). A key relation in the INFFER framework is that projects should be compared on the basis of their benefit cost ratio (BCR)

$$BCR = \left(\frac{V * W * A * P}{C}\right) * \left[\frac{1}{(1+r)^L}\right]$$

Where V is value, W is the proportional improvement arising from the project, A is the adoption rate, P is the probability of success, C represents costs, r is the discount rate and L is the time lag before benefits occur. The main insights from this framework are that the evaluation of an offset program should include consideration of the adoption rates (by landowners) and the probability of success, as well as accounting for the time lags and appropriately discounting flows of resources. The latter is a factor that is often not discussed in offset analyses, yet is a key component in habitat equivalency analysis as employed in natural resource damage assessments (e.g. Chapman 2004). The inclusion of success probability and adoption rates is somewhat analogous to the likelihood of success criteria in Pilgrim et al (2013), but this INFFER framework includes social, behavioral, and economic aspects as well as ecological elements.

Evaluating Offset Programs

An important issue in evaluating offset programs is the assessment of the mechanism used to generate the offsets. The mechanism on the demand side of the offset (requiring firms to obtain offsets) may be voluntary or mandatory; clearly a mandatory mechanism is more effective (Kollmuss et al 2008). The mechanisms on the supply side are more complex. For example, in the context of ecosystem service offsets – how are landowners encouraged to generate the offset?[10] A variety of mechanisms including voluntary programs, regulated or mandatory programs, negotiations, cost-sharing programs, the development of offset banks, and a range of different types of payments for ecosystem service programs have emerged. Many have argued that direct payments, such as payments through a reverse auction or conservation tender, are most effective (Ferraro and Kiss 2002). However, each of these programs needs to be evaluated in terms of how cost effective it is, particularly when TCs are included in the evaluation. Kinzig et al (2011) raise additional concerns about offset or PES programs including "thin markets" (especially in the context of auction like mechanisms), leakage, unintended consequences arising from payments for only one ecosystem service in a system with multiple interrelated ES, and design flaws such as attempts to achieve multiple goals with a single instrument (e.g. ecosystem service provision and farm income support or poverty alleviation).

Offset programs must deal with the inherent risk in attempting to create equivalent services. Mainly these risks are dealt with through the use of "ratios" or in some cases identification of certain habitat types that are not "offsetable". The development of ratios (e.g. 3 hectares restored for every hectare developed) raises significant questions from biological and economic standpoints in terms of the measurement of equivalence. However, an additional motivation for ratios greater than 1 has been outlined by Horowitz and Just (2013). They suggest that the trading ratio should be above one, even in cases with perfectly measured equivalence, as the ratio operates as a policy tool to reduce non-additionality from the providers of offsets[11]. Using a ratio gives policy makers another tool to achieve emissions reductions in addition to adjusting the baseline against which reductions are measured (Horowitz and Just 2013). An offset ratio greater than 1:1 may also be used as an insurance policy if an offset fails or is not retained in the long run. An alternative to a trading ratio is to offer a subsidy to offset providers, along with a

[11] In some contexts the entity that generates the environmental impact can internally generate an offset. But the cost effectiveness of this type of offset can be questioned as there may be other less costly providers of offsets. In addition the TCs may be significantly higher as the entity generating the offset may not have the capacity or be able to benefit from economies of scale in offset provision. Opportunities for ecological benefit from larger scale offsets may also be lost.

[12] This conclusion arises in part from the expectation that suppliers who benefit from the definition of a baseline will be more likely to participate in a market relative to those who do not benefit from the defined baseline, where the baselines are typically defined at an aggregate or regional level, while the individual supplier has private information about their conditions.

reduction in the baseline used to calculate offsets, as a way to reduce non-additionality. The policy maker employs two tools – the setting of the baseline and the ratio or subsidy – to achieve an optimal outcome. These findings have not been recognized in the policy literature and further consideration is necessary. The appropriate choice of either a ratio or a subsidy (and the accompanying change in the baseline) remains an issue for research. In terms of the framework for evaluation of offset policies, the Horowitz and Just paper suggests careful assessment of the relationship between baselines, ratios (even in cases of complete certainty), and potential subsidies for offset provision.

An area of exploration in conservation offsets that could increase the ES provided is the incorporation of stacking. The concept behind stacking is that one unit of land (grassland, wetland, etc.) can provide multiple ES. In order to account for these multiple services, it may be best to separate the services (and therefore credits) being provided so that the landowner can sell their credits in a way that reflects the true value of what is being provided (Fox 2008)[12].

Allowing for stacking can potentially increase the value of conserved land to private landowners because they can sell credits for multiple services, which could increase their participation in offset programs. However, buyers may also change their behaviour and offer less per unit, resulting in an indeterminate outcome. While allowing for credit stacking can increase the potential participation and more accurately reflect the value of conserved land, there are some challenges surrounding the practice. The first issue is one of TCs. When multiple buyers and sellers are exchanging credits for different ES, the TCs will increase (Weber et al 2011). So while there is the potential for better matching the needs of buyers with sellers with respect to offset type, there is also the potential for an inefficient trading system (Weber et al 2011).

The second issue with stacking is that of ‘double dipping.’ This occurs when the same offset is being sold to multiple buyers, therefore not providing any additional ES after the first payment (Fox 2008). If double dipping occurs, the principle of additionality may be violated. The extent of double dipping will depend on how easily the goods and services can be separated, where more easily disaggregated goods and services can be stacked (Fox 2008). Additionally, stacking will be more effective when one offset agency or exchange is involved for all the credits, as opposed to multiple exchange agencies (Fox 2008). An example of multiple ecosystem service crediting has been developed by the Willamette Partnership (Willamette 2013).

An alternative aspect of multiple ES in offset programs is that unintended negative consequences may arise for an ecosystem service that is not the direct target of the offset protocol. One

[13] Bundling is another way that multiple ES can be captured. The payment is for a bundle that embodies multiple ES, such as a wetland or other composite habitat or process.

ecosystem service should not be protected or increased at the expense of another. For example, planting trees along a river bank to reduce runoff may negatively impact the habitat of bank dwelling animals, and therefore the services they provide. Such potentially negative outcomes may be addressed by including constraints within the targeted offset protocol (e.g. monitoring for no adverse effects on related non-target ES). Designing programs at a broader landscape scale may help limit the potential for one ES to be increased at the expense of another.

Leakage, another consideration in offset design, is the concept that regulating or using a conservation tool in one area will simply transfer the harmful activity to another location. This can be split into two subcategories: primary and secondary leakage (Aukland et al 2003). Primary leakage occurs when the harmful activity is merely shifted to another location (by the same agent); while secondary leakage can take the form of market effects (Aukland et al 2003). An example of a market effect is reducing carbon emissions by halting deforestation, which increases the price of timber, thereby encouraging logging firms in other areas to increase harvest (Aukland et al 2003). If either form of leakage occurs, even on a small scale, the overall benefit of the offset program will be overstated. While tracking and quantifying secondary leakage is difficult, programs can be developed to minimize the potential for primary leakage (contracts, monitoring, establishing accurate baselines) (Aukland et al 2003).

Within the literature on market based instruments there is concern that incentives for conservation may crowd out voluntary conservation initiatives. This issue may be best illustrated with an example. On an international scale, the Reduced Emissions from Deforestation and forest Degradation (REDD) program allows developed countries to offset emissions by paying developing countries to halt deforestation (Alpizar et al 2013). The design of the REDD program leaves countries that have voluntarily reduced deforestation ineligible to benefit from payments for reductions, a factor that may have an adverse effect on conservation outcomes (Alpizar et al 2013). On a smaller scale, landowners who wish to participate, but are not selected because of cost, may change their conservation behaviour (less likely to conserve, or reducing voluntary conservation actions) (Alpizar et al 2013; Kits 2011; Kits et al 2014). Both crowding out and exclusion need to be managed appropriately in order to achieve optimal environmental outcomes when using an offset mechanism.

A method for rewarding landowners who have been voluntarily conserving is employed in the Montana sage grouse program, which pays landowners of existing habitat to maintain it (NRCS 2013). While the Montana sage grouse program may not be additional, it offers landowners an incentive to maintain existing habitat. Paying landowners who are already providing voluntary conservation can also happen in the Australian BushBroker program (BushBroker 2013). Learning from how these programs reward landowners already undertaking voluntary conservation is important, as the issue of how to account for these landowners in new programs is often discussed.

One major issue that is not often discussed in the evaluation of offset programs is the possibility of conducting a formal program evaluation of the program itself. Offset programs include discussions of monitoring – typically compliance monitoring to ensure that created offsets proceed as planned. But program evaluation is a broader concept that includes assessment of the entire program in a before-after, treatment-control type of framework. Many offset programs are designed as "pilot" programs to promote learning by doing and other experiential outcomes. However, the formal incorporation of opportunities for program evaluation would significantly improve the potential to learn from offset pilots. Ideally any conservation offset program should include a design that permits evaluation. Such designs include considerations of "controls" or identifiable matching cases that can be used to assess the efficacy of the program. A recent example is Zhang et al (2013) and the evaluation of a PES program for water quality and quantity improvement in China. This program is evaluated using a matching protocol and the ecological and economic outcomes from the program are assessed against the control groups.

Proposed Framework for Assessing Conservation Offsets

The discussion above leads us to construct a new framework for the evaluation of offset programs. This framework includes criteria identified in more ecologically focused sources such as BBOP (2012) but also integrates the economic literature on program design and evaluation. The key elements of the framework are listed below with the source of the criterion identified in brackets following the item.

Criteria for Evaluation of Offset Programs:

1. Mitigation hierarchy approach employed. (BBOP)
2. Incorporates or assesses risk of inability to offset impacts, probability of failure and low adoption (BBOP, Pilgrim et al, Pannell, Horowitz and Just).
3. Landscape scale (BBOP, Pilgrim et al.)
4. Adheres to the principle of no net loss, or other well defined target, and identifies equivalence (BBOP, Pilgrim et al, Kinzig et al)
5. Additionality occurs (BBOP, Pilgrim et al, Kinzig et al).
6. Incorporates stakeholders in design (BBOP)
7. Includes equity considerations in design (BBOP, Kinzig et al – alternate / dissenting view)
8. Focuses on long term conservation (BBOP, Pilgrim et al, Kinzig et al)
9. Transparency (BBOP, Kinzig et al).

10. Employs the best available science and/or traditional knowledge (BBOP, Pilgrim et al, Kinzig et al)
11. Is cost effective or efficient, and includes consideration of TCs, leakage, discounting of temporal service flows and crowding out (Kinzig et al, Pannell)
12. Addresses multiple ecosystem services, or accounts for potential unintended consequences on non-target ES (Kinzig et al)
13. Integrates effective monitoring and enforcement into the program (Pannell, Kinzig et al).
14. Incorporates methods for program evaluation (Zhang et al, Pannell)

Case Studies

The following are examples of Canadian[13] programs, as well as an exploration of the lessons learned from Australia's experience with market based instruments and offset programs. Four Canadian programs examined in terms of the extent to which they appear to be consistent with the elements of the framework developed above include: (a) the offsets created under the Harmful Alteration, Destruction or Disruption of Fish Habitat (HADD) provision of the *Fisheries Act*, (b) Alberta's wetland policy, (c) Alberta's carbon offset protocols, and the (d) SEACOP program and (e) the Australian BushBroker program. A few other case studies are examples of market based instruments in practice and not technically offset programs, and therefore will not be examined using the evaluation framework but will be included in this discussion as they provide interesting insights into conservation offset programs. While the focus is on offsets that generate (ES) or habitat, examples of other programs will be discussed as their design and implementation can aid in the discussion of designing new offset programs that learn from past experiences.

Figure 3 provides a summary of the analysis of the case studies, indicating whether the program appears to address the criterion (+) or if it does not appear to meet the criterion (-)[14]. N/A means the criterion is not applicable to that program, 0 means the criterion is partly fulfilled, and blank spaces mean it is unknown if the criterion is satisfied or not as that information is not available to us. For the more subjective criteria, a criterion is considered satisfied if there is evidence that it is addressed in the policy, or in other literature. The information used to evaluate if a program satisfies is collected from existing literature, program websites, and policy documents. Following Figure 3 is a description and analysis of each program.

[14] A case study not covered here is the Beaver Hills Initiative (BHI 2010), which uses transferable development credits.

[15] For a detailed explanation of how the framework was applied to each program, see appendix A.

		Program				
		HADD	Alberta's Carbon Offsets	Alberta's Wetland Offsets	SEACOP	BushBroker
Criteria	1. Mitigation hierarchy employed	+	N/A	+		+
	2. Incorporates risk of program failure	-	+	+	+	+
	3. Landscape scale	-	N/A	+	+	
	4. No net loss or explicit target	+	+	+	+	+
	5. Additionality	+	+	+	+	+
	6. Stakeholders aid in design		+	+	+	+
	7. Equity considerations in desgin			+	+	
	8. Long term focus	+	+	+	-	
	9. Transparency	-	+	+		+
	10. Employs best available science/traditional knowledge	+	+	+	+	+
	11. Economic efficiency/cost effectiveness	-	0	-	+	+
	12. Addresses multiple ecosystem services	-		+	+	+
	13. Effective monitoring and enforcement	+	+	+	+	+
	14. Incorporates program evaluation		N/A	0		+

+ yes - no 0, balanced N/A, not applicable blank, unknown

Figure 3: A Summary of Selected Case Studies Evaluated with the Developed Framework.

In Figure 3 HADD refers to offsets for the harmful alteration, destructions or disruption of fish habitat and SEACOP refers to the Southeastern Alberta Conservation Offset Pilot.

Generally, the programs follow a mitigation hierarchy, use the best available science, and generally satisfy the other “biological” criteria. However, two criteria (supported by the survey results discussed below) are more likely to have room for improvement. These are criteria 11 (cost effectiveness, leakage, etc.) and 14 (program evaluation). Perhaps it is not surprising that cost effectiveness concerns are not paramount in pilot programs and initial investigations. The main concerns seem to focus on the equivalence of the outcomes or the maintenance of environmental quality. In addition, striving for cost effectiveness may increase TCs. However, ignoring cost effectiveness and the associated economic aspects of offset programs means that resources may be inefficiently used and effective scarcity signals may not be generated. Furthermore, the resulting high costs of offsets may result in reduced interest in the use of offset mechanisms and other market based instruments without providing a “fair” test of their efficacy. In almost all cases there appears to be a need for formal program evaluation since such

evaluations seldom occur. While the programs are evaluated to a degree using available information, it will be difficult to know with certainty if any of the criteria are met without a more formal program evaluation. More importantly, it will not be known if a program has been successful at achieving its stated goals without a program evaluation, which underscores the need to build a system for ongoing evaluation into the offset program.
Several important findings or lessons emerge from our examination of the individual programs using the evaluation criteria. A full description of each program is included in the appendix, but the highlights from these assessments are described below.

Case 1: Harmful Alteration, Destruction or Disruption of Fish Habitat

The Harmful Alteration, Destruction of Disruption of Fish Habitat (HADD) program is an offset program in that it requires that impacts on fish habitat be offset by equivalent construction of additional habitat or other approved methods (artificial propagation, like for unlike habitat) (Harper and Quigley 2005). Recently, changes to the *Fisheries Act* have changed the nature of the HADD provision to protect species of commercial and recreational importance (DFO 2012). However, the lessons learned from the operation of the HADD offsets can still be analysed. In Canada, under the *Fisheries Act* section 35(2), there is the opportunity for damage (harmful alteration, destruction or disruption; HADD) to fish habitat to be compensated by an offset and therefore gain approval for the development project (Harper and Quigley 2005). Beginning in 1986, the stated goal of the Department of Fisheries and Oceans (DFO) was to have no net loss (NNL) when it comes to fish habitat (DFO 1986).

The HADD program as a whole has led to an overall increase in fish habitat (in this time frame, Harper and Quigley 2005). Based on the evaluation with the framework (Appendix A), the program could be improved by following a mitigation hierarchy, considering multiple ES (rather than "habitat"), and considering impacts on a landscape level. While the program was not designed to provide a cost effective way to address habitat alteration, it could be made more economically efficient by incorporating mechanisms to generate cost effective habitat provision.

Case 2: Alberta's Carbon Offset Programs

Greenhouse gases (GHG), most notably carbon dioxide, are widely accepted to be the cause of climate change. These GHG emissions therefore create an externality which an offset program as a type of market based instrument (MBI) may help correct in a cost effective fashion. In contrast to wetland and other biodiversity offsets, which are difficult to measure and are local in scale, carbon offsets are more easily defined (e.g. tonnes of carbon dioxide emissions) and do not have the spatial focus that habitat and biodiversity do. The difference between carbon and conservation offsets means that not all of the features of a carbon offset can be applied to conservation offsets. However the carbon offset scheme's protocols and its use of a market based instrument (MBI) may still provide helpful insights into the development of cost-effective conservation offset programs. Because there are limited examples of MBIs and protocols surrounding trading environmental goods in Canada, it is important to review as many cases as are available. While carbon trading is done in several markets around the world, this case study will focus on the Alberta program.

The policy used in Alberta (Specified Gas Emitters Regulation) to regulate carbon dioxide emissions is targeted towards large emitters; those who contribute over 100 000 tonnes per year of carbon dioxide (AESRD 2013a). The program is based on intensity targets,[15] where the goal is to decrease carbon dioxide emissions per unit of output (AESRD 2013a). If these large emitters do not meet their targets (12% by intensity from July 1, 2007), they can either purchase offsets within Alberta, or pay a $15/tonne tax (AESRD 2013a). The offsets can be purchased from an aggregator who works with landowners to use low carbon technologies, such as zero till seeding. This reduction in carbon emissions in one sector can be sold to regulated large emitters as an offset. Other activities can also be undertaken by large emitters to receive credit for reduction such as enhanced oil recovery or using biofuels (a complete list of activities that will give credit for emission reductions along with their protocols can be found at AESRD 2013a). The detailed protocols developed for activities that can receive credit for emissions reductions provide a valuable lesson in credit accounting and insuring additionality. While these other emission reducing activities exist, the discussion in Appendix A will focus on offsets provided by agricultural practices as agriculture is in a unique position to provide carbon sequestration (AARD 2005).

The Alberta carbon offset/tax program works as a negative incentive for large emitters and a positive incentive program for landowners. There is a provincially regulated target, and while options for industry to meet this target are flexible, there are clear negative incentives that exist for emitting firms (contribute to a fund, buy an offset, reduce emissions, or use performance enhancement credits) (AESRD 2013).

Case 3: Wetland Offsets in Alberta

Water in Alberta, including wetlands, is regulated by the provincial government under the *Water Act*, specifically section 36. In addition to the Act, wetlands are also managed by the newly

[16]Intensity targets are calculated using the amount of GHGs emitted to produce a certain level of output. In effect, the efficiency of production (in terms of GHG emissions) is increasing, however overall GHG emissions are still rising.

released Alberta Wetland Policy (AESRD 2013b). The wetland policy does not describe the use of a market based instrument (MBI) directly; however NGOs such as Ducks Unlimited have used MBIs to find willing landowners (see the Assiniboine Wetland Reverse Auction case study for an example, as well as other Ducks Unlimited projects, such as their revolving land purchase program (DUC 2013)). While Alberta's wetland policy is not an offset program *per se*, offsets may be used to satisfy the goal of no net loss.

Alberta's wetland policy meets many of the criteria outlined above, but it does not appear to meet the criteria of cost effectiveness (see the discussion in Appendix A). An important lesson to be drawn from Alberta's wetland offset programs is the usefulness of the resource equivalency analysis principle of service-to-service offsets (Roach and Wade 2006). The policy does allow for varying offset ratios based on the distance between the impacted site and the offset, which is a promising component. However, the program could likely benefit from a more systematic approach to offset ratios that includes the value of the services provided by the wetland. A varying ratio based on distance from the impacted and restored sites is used, but this doesn't necessarily capture the service loss to service gain associated with offsetting a wetland (AESRD 2007). The use of a dynamic offset ratio scheme would allow for a more efficient mechanism that offsets the true value of the service. In the recent policy release, a new offset matrix was developed that accounts for different quality of wetlands (however it is based on "function", not the services provided), and establishes the offset ratios between different types (AESRD 2013b). The ratios in the new policy are intended to capture the variation in wetland quality; a step towards approaching a service-to-service offset suggested by Roach and Wade (2006).

Recently, likely because of the costs associated with securing permanent easements on parts of farming operations, and / or the costs associated with repeated temporary easements, Ducks Unlimited has been experimenting with a revolving land purchase program (RLP) as a mechanism for restoring and retaining wetlands. In the RLP program land is purchased, wetlands are restored, a permanent easement is placed on the wetlands, and the land is resold using an online auction (DUC 2013). This program is hoped to improve upon current methods used to achieve permanent conservation easements, and challenges with recurring temporary easements. Appendix (B) provides a financial analysis of the RLP program compared to temporary easements. A preliminary analysis reveals that the RLP is more cost effective than renewable easements when a low discount rate is used. However, under other conditions there appears to be a premium being offered for the security of the permanent easement, and the ability to avoid future TCs from re-negotiating the easement.

Case 4: Southeastern Alberta Conservation Offset Pilot

The motivation for building a lessons learned document, as described above, is to help design more efficient future programs. In the case of the South East Alberta Conservation Offset Pilot (SEACOP) the program is currently under development. This pilot program, which is described in the following case study (and is formally referenced in the South Saskatchewan Regional Plan) (SSRP 2013) provided the opportunity to monitor the development of an offset pilot from its initial stages. As such, it provides a unique opportunity to examine the challenges associated with designing a conservation offset program. In addition, the opportunity to examine the program from its beginnings allows for a more detailed analysis of the TCs associated with program design. Therefore, this case study will centre largely on TCs, which are the costs associated with building and maintaining the program.

In order to conserve net habitat in Southeastern Alberta, an offset program has been proposed. Under this program, oil and gas producers as well as other industrial entities that disturb native grasslands can offset their impact by creating new grasslands elsewhere in the region. These are the buyers in the system. The sellers are landowners, who voluntarily submit parcels of currently cropped land to be converted to grasslands, along with a bid price. By submitting this bid, they are offering to take that land out of production and re-seed it with native grasses, and not cultivate it again for the duration of the contract (likely 10 years). Through the exchange of money, the industry agent offsets their activity via the landowner's creation of new grassland.

The process of offsetting a disturbance may warrant an offset ratio greater than one; that is, one acre of disturbed grassland must be offset by more than one acre of new grassland. The pilot program has adopted a system of varying offset ratios based on the sensitivity of the disturbed site. Therefore, sites that are more environmentally significant or sensitive will require greater offset ratios (for example, instead of 3:1, sensitive areas may require 5:1). These offset ratios are currently determined based on consensus from industry stakeholders and government employees.

While the pilot program is currently voluntary, some stakeholders believe that offset programs like this one will become regulatory as part of Alberta's Regional Plans, in this case the South Saskatchewan Regional Plan (SSRP 2013). Because it may become mandatory to offset impacts, there is incentive for industry stakeholders to begin participating voluntarily to earn credit towards future programs, to learn by doing and potentially aid in future program design. A further complicating factor in the region is that there are multiple species at risk, which require special planning and operations procedures (under the *Species at Risk Act [SARA]*). When critical habitat for species listed under SARA is involved, the offset program must be designed in a way that satisfies SARA, a factor that may increase TCs. The potential for high TCs arises from multiple agencies, laws, and policies involved at different levels of government. Unlike the other programs evaluated so far, SEACOP has consideration for cost effectiveness built in (Figure 3). A complete description of the application of the framework is available in Appendix A.

During the design phase, the SEACOP group decided that in order to best achieve the goal of increasing the area of native grasslands, it would be better to use funds[16] provided by the Land Use Secretariat (under the *Alberta Land Stewardship Act* [ALSA]) to begin establishing an offset bank, potentially using a reverse auction, rather than proceeding directly to an offset scheme. The rationale for not proceeding with an auction for the offset mechanism is that with only a small budget, only a few landowners would be paid, which may lead to a loss of voluntary conservation actions by landowners whose bids were rejected. This means that the pilot will provide information on the development of concepts of equivalence, program implementation and other ecological elements, but there will be little information on price discovery or cost effectiveness.

From the SEACOP program so far, a few lessons can be demonstrated. The first is the importance of developing consistent and meaningful offset ratios that can be understood by landowners and industry stakeholders. This will make the offset process more transparent and encourage participation, while at the same time ensure that additional, equivalent offsets are created. The second lesson is the importance of legislative support and jurisdictional cooperation. Where multiple agencies and levels of government and NGOs have a claim in the project it is important to have effective communication strategies.

Case 5: Australian Case Studies

Australia has more experience than Canada with conservation offsets and using MBIs to provide ES. Recently, a series of studies (Blackmore et al 2013, Blackmore and Doole 2013, Doole et al 2013) were completed evaluating these programs, and as a result there is an opportunity to learn from existing Australian programs. The two different types of Australian programs, conservation tenders and biodiversity[17] offsets, represent different conservation methods. Conservation tenders allow landowners to receive payment for preserving or restoring an ecosystem, while biodiversity offsets allow for the creation of new ecosystems in exchange for impacting existing ones through a market mechanism (Blackmore et al 2013). All of the case studies reviewed above (except for ACA's Landowner Habitat Program) fall into the category of

[17] SEACOP is funded from a variety of government departments as part of ALSA, to test offset tools.

[18] Note that here "biodiversity offset" is used rather than "conservation offset" because the Australian programs refer to their offsets as "biodiversity offsets" (Blackmore et al 2013, Blackmore and Doole 2013, Doole et al 2013).

creating additional habitat (or sequestering carbon), potentially through restoring a degraded ecosystem service, rather than programs that focus on retention or protection. As such they are more in line with offset schemes that will require creation of habitat or offsetting ES features.
In the Australian review of programs, surveys were administered to landowners and non-landowners who were associated with either conservation tenders or biodiversity offsets (Blackmore and Doole 2013, Doole et al 2013). Particular importance was placed on evaluating the cost effectiveness of these programs, which can aid in minimizing TCs (Blackmore et al 2013). The results of the Blackmore et al (2013) study focus on conservation tenders, however the factors perceived to be the most important may be applicable to designing cost effective (low transaction cost) biodiversity offsets. For the non-landholder participants, the most important factors for successful offset programs determined by Blackmore et al (2013) were:

- Taking advantage of the efficiency of large programs, which may benefit from experience with past programs, or "learning by doing"
- Allowing flexibility in the design, implementation, and location of tenders
- Have the landowner self-monitor to keep costs low, and through this develop a relationship of trust between the landowner and the regulating agency

Blackmore et al (2013) determined that for landowners, the following conclusions could be drawn with respect to conservation tenders:

- Allow governments to buy tenders to spur more conservation activities and reveal cost data
- Give landowners easy access to the agency information, including direct staff contacts
- Reduce the amount of administrative work for landowners
- Establish joint monitoring by landowner and agency
- Establishing appropriate contract length is important to achieve environmental goals (~10 years) and landowners must be able to break the contract (with conditions in the agreement)

Next, for biodiversity offsets; Blackmore et al (2013) claim the following were important:

- Establish an efficient trading process, with as little government involvement as possible
- Reduce time lag between injury and restoration
- Have contracts last for the length of the impact that is being offset
- Ensure that the offsets are additional
- Give landowners education on these programs

As can be seen in the lessons learned from Australia above, there is a common theme of reducing administrative inefficiencies, designing a trading system that works without much intervention, using well-designed contracts, and offering education programs to landowners. The desire for administrative clarity may be particularly important in Canadian cases because offsets can involve multiple ministries at a provincial level, and sometimes additional federal jurisdiction can be involved. Thus there is need for a streamlined system that lowers costs. The second lesson of relevance to Canada is landowner education. This could take the form of online extension tools that introduce landowners to the terminology, implementation, and potential effectiveness of conservation offsets. Such web-based programs could be bolstered by in-person workshops or other extension activities.

There are multiple offset-like programs in Australia. To reduce complexity we apply the evaluation framework described above to BushBroker – which is a representative Australian program (see Appendix A). As seen in Figure 3, BushBroker does better in terms of economic efficiency and formal program evaluation than the Canadian programs largely because of the use of auctions and trading platforms to improve cost effectiveness.

Additional Case Studies

The following four case studies are examples of small scale offset programs. Because these programs are technically not offsets at a program or resource scale (e.g. carbon offsets), and may not employ market based instruments, they are not evaluated using the framework developed above.

Case 6: Alberta Conservation Association Conservation Offset Programs

The Alberta Conservation Association (ACA) has implemented various voluntary conservation programs. In a published framework for conservation offsets, they suggest guidelines for successful offset programs in Alberta. These can be used to add to the discussion of what lessons can be learned from past programs, as the report is based on their experiences (Croft et al 2011). The major points stressed in the development of an offset framework are ensuring additionality, making the offset permanent if it is on private land, and using an ecological scale (ecological system approach) to deal with equivalency (Croft et al 2011). In the case of like-for-like offsets, a 1:1 offset ratio is advocated (Croft et al 2011). Aside from the 1:1 offset ratio used, the ACA programs do not deviate from the literature or what has been described above in terms of the biological criteria.

The ACA also operates a landowner conservation program where landowners can be compensated for preserving ecosystems. This is known as the Landowner Habitat Program (LHP). In the LHP a price and contract length is negotiated. In an evaluation of the program the number of acres enrolled in the LHP is declining over time (from 2008 to 2013), thought to be because of the low per acre rate paid (ACA 2013). Because of declining number of acres enrolled, the effectiveness of this tool for long term conservation goals may be low. Increasing the flat rate paid per acre of enrolled land or implementing joint monitoring may increase participation and therefore the effectiveness of providing long term conservation.

Case 7: Assiniboine Wetland Reverse Auction

The Assiniboine wetland auction demonstrates the use of a market based instrument in the provision of wetlands. This auction is not included in Figure 3 because it was a one-time program. This region of Saskatchewan has had a marked increase in improved farmland since 1956 and consequently high rates of wetland drainage (Hill et al 2011). In 2008-2009, a pilot project testing a reverse auction[18] mechanism was conducted in the Assiniboine river watershed. Landowners submitted bids for restoring wetlands, and the parcels of land were then evaluated using an environmental benefits index (EBI)[19] (Hill et al 2011). By ordering the bids by lowest cost per unit of EBI, it was possible to spend the fixed budget to maximize the benefit per dollar. Note that the reverse auction is based on an EBI and not just an area basis of wetland habitat.

An important objective of this pilot was demonstrating that a reverse auction can work in Canada (Hill et al 2011). From a transaction cost perspective, the authors estimate that they spent $39 000 on "administration" ("staff time, plotting maps, supervising ditch plug construction, and advertising") costs (Hill et al 2011), which includes items that can be attributed to TCs as defined by McCann et al (2005). This represents a value of approximately 16% of the $240 000 allocated to the program for purchasing wetlands (Hill et al 2011). Another feature of this auction that could be applied to future programs is using a fair market value to select bids. Initially, if a bid was more than what it would cost to buy the land at market value; the bid was rejected (Hill et al 2011). The rejection criterion was later extended to include any bid that was more than 50% of the market value of the land (Hill et al 2011). Using this method will help provide restored wetlands in an efficient manner, because when the bids approach market values,

[19] A reverse auction is a method used to pay for ES. It works by having landowners submit an amount they would like to be paid to provide an ES. These bids are usually then ranked in terms of lowest cost per unit of ES. The projects are then selected according to the program budget. In the Assiniboine auction, bids were received to provide wetland restoration, rather than an ES.

[20] An EBI is different from ratios and quality adjusted area measures in that an EBI uses multiple environmental elements to value the land, including soil capability, wildlife habitat/migration, hydrologic function, etc. These benefits can be combined to make a single index for the area to be offset.

a program like Ducks Unlimited's (DU) Revolving Land Purchase (RLP) program may be more efficient. Additionally, the pilot gives a clear framework for implementing a reverse auction (advertising, developing an EBI, ground truthing the size and location of wetlands, etc.). While not necessarily the case here, through a well-designed EBI, a reverse auction can yield low cost positive environmental outcomes, and therefore increase the ES provided by the restored habitat.

Case 8: Dennis Lake Conservation Auction

This auction took place in 2012 and early 2013 in the East Interlake Conservation District (EICD) of Manitoba. It is not a formal conservation offset scheme, but the use of a market based instrument to generate increased ecosystem service provision in this case allows for an assessment of lessons learned from this aspect of conservation offsets. The identified ecological goods and services provided by the watershed are: drinking water quality, surface water quality, wildlife and fish habitat, and soil and shoreline maintenance (Packman 2013). An environmental benefits index (EBI) was developed, and bids were ranked based on their cost per unit of EBI (Packman 2013). The decision of which projects to fund was influenced by the EBI ranking; however local knowledge was also considered (Packman 2013).

Some landowners who participated in this auction were interviewed using structured interviews via telephone (see Noga, 2014 for details). The landowners supported the idea of running future conservation auctions and agreed they were an appropriate use of EICD's funds. An element to improve upon that was revealed in the interviews is effective and timely communication with landowners.

As identified in a report on the conservation auction, the most important lesson to be learned is how to use an auction with an environmental benefits index to achieve cost-effectiveness. Additionally, through the mechanism private costs were revealed and other information about the landscape was shared, which will be useful for developing new management tools in the area. The information gathered regarding private costs of providing an ecological function can be used in a cost-benefit analysis of the provision of ecological function and possibly used as estimates of the costs of providing ecosystem functions (or ideally) services in other jurisdictions. The information about the landscape can be used to identify sensitive areas and target future conservation work. The landscape information may also reveal areas that have a high risk of conversion, and are therefore the most efficient areas to target for conservation.

Case 9: South Nation Conservation Offsets

South Nation Conservation (SNC) is an example of a water quality offset program from Ontario. Under SNC's program, point source phosphorus polluters can offset their emissions by paying landowners to abate non-point source pollution through a variety of approved practices where each type of approved practice is credited for a different amount of phosphorus abated based on the effectiveness of the project (O'Grady 2011). While the SNC program uses offsets, it is not a market based system[20]; instead the SNC program is identified as a cap and tax program (Shortle and Horan 2013). A cap and tax program places a limit on emissions from point source polluters, and emissions in excess of this limit are "taxed", in the SNC case through point source polluters paying non-point source polluters to undertake a management practice that will reduce the phosphorus in the water (O'Grady 2011, Shortle and Horan 2013). From 2000 to 2009, SNC has abated 11 843 kg/year of phosphorus emissions (O'Grady 2011). An additional component of program evaluation is that over 80% of landowners said participating in the program has increased their land value (O'Grady 2011).

Emerging Offset Programs

While there are only a few formal offset programs in Canada, the principle is being considered by other agencies. The National Energy Board (NEB) has suggested the use of "habitat offsets" as a mitigation strategy in the application of new energy projects (NEB 2013). There is little discussion in the guidelines of how these offset will be deployed, and what metrics will be used to establish impact-offset equivalence, and how security or permanence will be achieved, however the inclusion of offsets as a recognized practice demonstrates that new offset schemes are being considered.

Another federal government program in Canada that allows for the use of conservation offsets is Environment Canada's (EC) "conservation allowances" framework (EC 2012). Under the conservation allowance framework, any activity undertaken on federal land (or other land that falls under the jurisdiction of Environment Canada) that may negatively impact the environment can be offset with a conservation allowance (EC 2012). The framework states that the conservation allowances should only be used if the impact cannot be avoided or minimized; following the mitigation hierarchy (EC 2012). The framework does not explicitly discuss the use of a market to generate allowances; instead the document focuses on the biological considerations associated with conservation offsets (EC 2012). As a result, EC's conservation allowance framework is not evaluated as a case study; however it does provide another example of the use of offsets, and therefore reinforces the importance of evaluating existing programs.

[21]SNC is not an MBI because the offset price is set by the trading authority and farmers do not directly participate in trading (Shortle and Horan 2013).

Both the National Energy Board and Environment Canada's approach to conservation offsets appear to be at a "project" level rather than at a natural resource or environmental service level. That is, offset projects such as wetland offsets in the U.S. have aimed at sector wide no-net-loss while the NEB and EC approach appear to be relevant to project approvals.

A Survey of Offset Participants and Stakeholders

To explore the lessons learned from existing and developing offset programs and other applications of MBIs, an in-person survey was developed and completed by multiple stakeholders[21]. Stakeholders include members of conservation groups, landowners, government ministries, and industry. Five different versions of the structured interview were created to reflect the different information available from the various stakeholder groups. The survey included several individuals involved in the SEACOP program (either directly or indirectly) as well as individuals involved in other pilots or programs in Alberta and other provinces.

The survey includes questions regarding time and effort invested in a program (including expected time and effort), perceptions on the cost effectiveness of offset programs, and open ended questions about the participants' experiences, leading into what lessons can be learned. The versions of interviews used with industry representatives, government staff, consultants, and conservation groups include Likert scale questions on the participant's perception on the cost effectiveness of conservation offsets and how well they encourage participation from landowners and industry members (see Figure 4). The cost of designing and implementing a conservation offset program is determined by asking those involved in the process how much time they have spent on the program as well as the time invested in the program by other staff in their department (see Tables 3 and 4). Several questions included in the survey paralleled questions used in the Australian review of offset programs (Blackmore and Doole 2013, Doole et al 2013) to allow for comparisons across the countries.

Participants were recruited for the interviews in a variety of ways. Government staff and non-government staff who are working on the SEACOP program were identified based on project meetings. Landowners were invited to participate at a town hall meeting in Medicine Hat. All participants were initially contacted by phone or email, and upon receiving consent were sent an information letter, including research ethics informed consent forms, and a copy of the questions before the interview. The questions were sent in advance to respondents who had an opportunity to prepare comments and answers. Before each interview began the purpose of the study and confidentiality considerations were discussed and oral consent was obtained. The interviews lasted on average around 30 minutes, although some were closer to an hour.

[22] For more detail on the interview results see Noga (2014).

Handwritten notes were augmented by a typed version of the participant's responses. A number of interesting and important insights into offset programs in the Canadian context have been observed.

Government staff involved in such projects have generally found that the process of designing and implementing an offset program takes more time and effort than was expected. Those with experience in designing other conservation or offset programs found that the time required was about what they expected. An element that nearly all government and third party consultant respondents mentioned was the preference for regulation. Participants believe that having a mandatory offset program will increase the ES provided through the program. Most government staff and consultants agree that conservation offsets are cost effective and encourage participation of both landowners and industry more effectively than voluntary initiatives.

Some participants felt that MBIs may not be capable of providing ES. These stakeholders also state a preference for the offset to exist in perpetuity (to ensure long term conservation outcomes); SEACOP is using finite term contracts to reflect the temporary nature of well site disturbance. Thus there is a tension between the desire to obtain permanent offsets, and the practical issue of participation in offset programs by landowners (see Table 2 for a summary of stakeholder opinions on elements of offset programs). The preference for temporary or flexible offsets by landowners implies relatively high costs of permanent offsets. But the desire for permanence may be reflected in relatively high premia in terms of agency willingness to pay for such contracts. A program like the DUC revolving land purchase scheme appears to reflect this tension. Rather than engaging in shorter term easements for wetland conservations, DUC is experimenting with land purchase and re-sale, with permanent easements (Appendix B).

Many stakeholders generally agree that conservation offsets encourage participation from both landowners and industry more effectively than voluntary initiatives. Government, consultants, and conservationists generally agree that the time required to participate in an offset program is not a deterrent to participation for either landowners or industry (see Figure 4). Because the time required to participate is not viewed as a deterrent the implication is that (perceived) TCs are low.

Landowners prefer short term contracts to allow them to react to changing land and crop prices. Additionally, landowners in contexts like SEACOP are hesitant to participate because of the potentially relatively high profits on cropland[22] (compared to native grassland) and a general

[23] Canola, Barley, and Spring Wheat have been increasing in value from 2008 to 2012, although Spring Wheat saw a slight decrease in value from 2011 to 2012 (AARD 2013d).

disbelief that energy producers (the “buyers” in this case) will be willing to pay enough to compensate landowners for the lost income. There is also a concern expressed in the landholder community that conservation groups, energy producers, and other outside groups will enter the market and buy land to retire or use as offsets (rather than paying a landowner to convert to grassland from cultivation). It is unclear why landowners are concerned about land being removed from agricultural production (or having reduced intensity of production). Some appear to be concerned about the ability of the sector to provide for growing global food demands. Others may be concerned about potential land price increases that may affect their opportunities for expansion, the ability for their children to enter the agricultural sector, and / or the impact on the local community tax base.

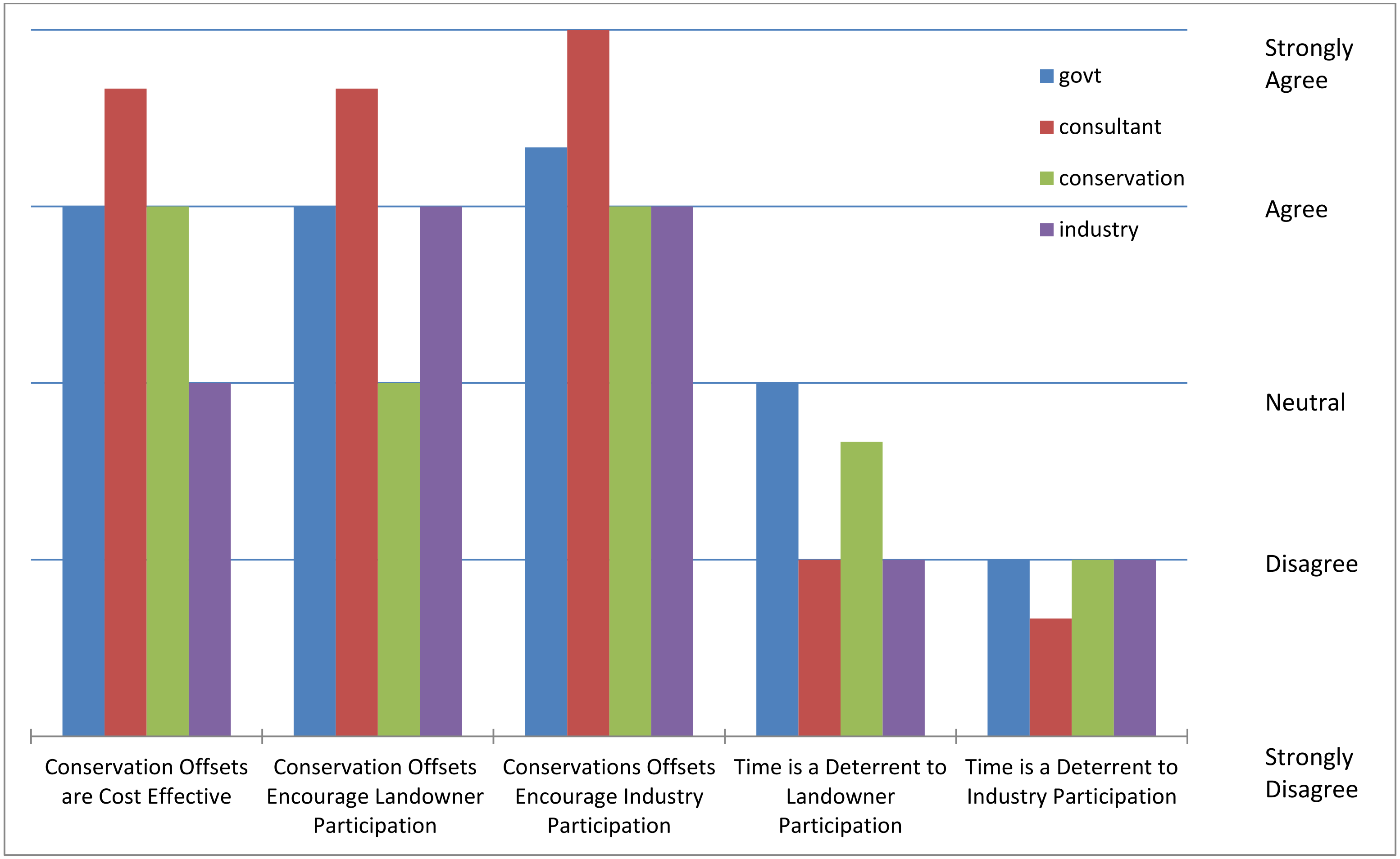

Figure 4: Average Rating of Perceptions on Conservation Offsets Sorted by Stakeholder Group

Table 2: Summary of Stakeholder Views on the Structure of Conservation Offsets

	Stakeholder				
	Landowners	Conservation	Government	Consultant	Industry
Does the stakeholder group favour regulated offsets	No	Yes	Yes	Yes	No, but believe it is coming
Permanence	Prefer temporary, ability to adjust to changing market	Prefer permanent offsets	Designed program to be temporary for a temporary disturbance	N/A	Prefer temporary because the disturbance is temporary, but because the site is reclaimed, some question why offset at all.
Does the stakeholder group support conservation offsets?	No	Yes, if it preserves habitat	Yes	Yes	Yes, because of belief it will become mandatory

Table 3: Sensitivity Analysis of the Estimated Costs of Labour for the Southeastern Alberta Conservation Offset Pilot (SEACOP) Program to Fall 2013 based on Interview Results[a]

		Assumed Salary (per year)		
		$87,095	$102,465	$117,835
Days	781.9	$261,927	$308,150	$354,372
	919.9	$308,150	$362,529	$416,908
	1057.9	$354,372	$416,908	$479,445

[a]"Days" is the total number of working days spent on SEACOP to Fall 2013, with a 15% sensitivity analysis on the number of days. "Salary" is the assumed average salary of each employee (ALIS 2013), with a 15% sensitivity analysis.

Table 3 above shows the in-kind costs of labour invested in the SEACOP program. A range of assumed salaries, using $102 465[23] per year as an average, with a 15% sensitivity analysis, as well as the actual time calculated to be invested (~920 days), with a 15% upper and lower estimate on this time. These costs are then added to the program expenditure of $100 000 to be spent on the actual offsets, and the TCs as a percentage of program expenditure can be calculated (see Table 4 below).

Table 4: Sensitivity Analysis of the Transactions Costs (TCs) as a Percentage of Total Program Expenditure to Fall 2013 based on Interview Results[b]

		Assumed Salary (per year)		
		$87,095	$102,465	$117,835
Days	781.9	72%	76%	78%
	919.9	76%	78%	81%
	1057.9	78%	81%	83%

[b]"Days" is the total number of working days spent on SEACOP to Fall 2013, with a 15% sensitivity analysis on the number of days. "Salary" is the assumed average salary of each employee (ALIS 2013) with a 15% sensitivity analysis.

The values in Table 4 above are obtained by dividing the TCs from the first figure by the total program expenditure (TCs+ $100 000). As can be seen, the TCs may range from 72% up to 83% with a sensitivity analysis of time spent and average salary. For the actual time spent (919.9 days) TCs estimates range from 76% to 81%. In all of the cases, TCs represent a substantial component of total program expenditure. While the costs appear to be quite high, it is important to remember that SEACOP is a pilot program. Many of the background and design phase costs are onetime costs that will not continue if the program had a larger implementation budget. If

[24] $102 465 per year is the average salary of government managers – economic analysis, policy development and program administration in 2013 dollars (ALIS 2013).

SEACOP had a larger implementation budget, the TCs as a percentage of total program expenditure would decline, increasing the cost effectiveness of the conservation offset program. Another element increasing the TCs for the SEACOP program is the size of the area expected to be enrolled in the program. From interviews, the program was initially expecting to convert 1000 acres of land to native grassland. This estimate changed to 160 acres to 320 acres during the design phase. In either case, the amount of land to be converted (size of the program) may be increasing the TCs, as a larger land change will likely require more research into measuring the value of these sites and the mechanism used to obtain the land to be converted.

At the time of the interviews, SEACOP was still in the design phase. As a result, the time (and therefore TCs) reported in Table 3 is the time spent on both the background (information gathering, designating target area) and design phases. Future TCs will include the time spent on implementation and once the program is operational, monitoring and enforcement costs. Government employees have spent the most time working on SEACOP, followed by conservation groups, consultants, and industry partners in descending order of time invested in the project at the date of the interviews. The time spent by landowners was lowest, however their time involvement will likely rise once they are asked to submit an expression of interest. The government employees had the greatest amount of time invested in SEACOP likely because they are designing and administering the program.

At the time the interviews were conducted landowners had not yet submitted expressions of interest or bids, therefore the time required to participate in a functioning program is not known. In interviews with landowners, participants were asked to estimate the time they believe would be required to design and submit a bid. Responses ranged from a full day to a week (not full days all week, but a week because of waiting to hear from contacts). The cost of landowner participation may prove important because if the time required to participate is too high, landowners may chose not to participate (see Simpson et al 2013). In addition to time requirements, landowners were also asked if they would require paid outside help or the use of new software. The landowners said they would likely talk to other people, but not hire a consultant and would not update software explicitly to submit a bid for the offset program. As a result, the cost of landowner participation appears to be solely a function of the time required to participate. A second component of landowner participation is the perceived time requirements (Mettepenningen et al 2009, Buckley and Chapman 1997). The estimates provided by landowners for time requirements reflect the perceived time required to participate. None of the landowners indicated that the time required to participate would be a deterrent to their submitting a bid.

An additional component to consider in the SEACOP TCs is the opportunity for protocols and lessons learned from the pilot to be applied to other programs. If the lessons learned in this pilot can be used in another program to decrease the costs (both "real" and TCs), then the TCs represented above may also be overstated.

Summary and Conclusions

The case studies above demonstrate that in some cases conservation offset programs have the potential to achieve environmental goals. However, there are lessons that can be learned from a review of existing and pilot programs that can provide valuable insights for designing new programs. Through the examination of case studies, interviews, and the existing literature, a set of lessons learned has been developed.

1. There appear to be different opinions of offset programs in Canada and the criteria by which offset programs are developed and evaluated. In some contexts, offsets are considered at the project level in the sense that an individual project is asked or required to offset specific environmental impacts. This “project level” approach effectively employs offsets as a mechanism for mitigating environmental impacts without a focus on the broader landscape scale of the services and the potential for developing cost-effective offsets and signals of ecosystem service scarcity through a market mechanism. Such an approach will not be able to take advantage of economies of scale in design or improved conservation benefits from larger scale offsets. In other contexts offsets are viewed as a way to achieve a conservation objective for a region at least cost. The scarcity is at the regional level (rather than the firm or project) and offsets are considered a market based instrument or cost effective way of achieving a goal. These different views of offset programs helps explain why many of the case studies evaluated have little consideration of the cost effectiveness of the program. SEACOP is attempting to include measures to make the program cost effective. For an offset program to achieve its full potential of being able to achieve environmental quality targets in a cost effective fashion, consideration of costs, price discovery, market structure, and related elements should be included as part of the construct. To get the price of ES correct, the offsets need to be efficient, including the cost of providing the offset. The “market based instrument” aspects of offset programs are not fully being taken advantage of. Another issue related to offset scope is what is targeted. Nearly all offset programs target “habitat” with little assessment of impact on other ecological functions and services (water quality/quantity, carbon, effects on non-target wildlife). Without consideration of multiple services, offsets may create unintended adverse effects on other services, or they may generate beneficial outcomes that should be recognized within the policy framework.

2. Transactions costs appear to be high – but these high costs are often associated with the development phase of the project. In many cases, TCs are high because the program is a pilot, and TCs would fall if the program could take advantage of economies of scale through larger, ongoing programs (Shabman and Lynch 2013, SEACOP). Preliminary

survey results show that offset programs are expensive to build because of the TCs associated with time and effort. Perceived operating TCs of suppliers of offsets, however, are low, although our sample of responses on this topic is quite small.

3. Landowners may see high TCs as a deterrent to participating. Australian landowners wanted more readily available information (Blackmore et al 2013). Providing information to landowners can be aided by education programs (Blackmore et al 2013, Blackmore and Doole 2013, Doole et al 2013). Therefore, offset programs should be designed in a way that encourages landowner participation, including low TCs for the landowner.

4. Implementing permanent easements on private lands appears to be expensive. Alberta landowners are concerned about how easements will affect property values and other aspects of the agricultural system. Ducks Unlimited is experimenting with ways to address the issue using their revolving land purchase program (DUC 2013). Nevertheless, there may be a significant premium for permanent easements. These premia may arise from thin markets (selectivity), landowner's preference for short term options, or a divergence between willingness to accept (for a permanent easement) and willingness to pay (for land with permanent easements). The RLP program attempts to address some of these issues and it appears to be more cost effective than renewable easements if a low discount rate is used and the land is rented to agricultural producers during the restoration phase. High premia on permanent offsets suggests that additional consideration of temporary offsets may be required, recognizing that temporary offsets also present significant challenges in terms of renewal and permanence.

5. While additionality is a concern, it is also important not to crowd out voluntary conservation initiatives. The Montana Sage Grouse program and BushBroker attempt to avoid crowding out voluntary conservation by rewarding landowners for good stewardship (NRCS 2013, BushBroker 2013).

6. Regulation, or at least the threat of regulation, appears to be necessary for an effective offset program. Interviewed government and conservation group participants generally answered that regulation would increase the effectiveness of offset programs. This issue relates to point 1 in that the regulatory structure will have to coincide with the scale of the offset program.
7. A formal program evaluation component is lacking in most programs (Figure 3, Appendix A). One of the elements that most existing programs lack is a structure for formal program evaluation that is built into the program design, rather than being conducted ad hoc once the program begins. All of the programs reviewed have a well-

defined goal, but success cannot be established without a formal evaluation process. In addition, reviews of programs from other countries indicate that these programs undergo significant revisions over time. Formal program evaluation would help structure the evaluation and revision of programs in a continuous improvement framework. Program design that would facilitate evaluation, such as identification of reference regions or areas as part of the program, would facilitate evaluation. Alternately, evaluation like the quasi-experimental study of the effectiveness of PES programs done by Zheng et al (2013) would be beneficial.

Future programs can benefit from the lessons learned by current offset schemes. The review presented in this paper reveals a common theme of reducing administrative inefficiencies, designing a trading system that works without much intervention, using well-designed contracts, and offering education programs to landowners The largest gains appear to be from making programs more cost effective, tying programs to regulation, and addressing the unintended consequences of multiple services, leakage, and crowding out. By building on the strengths and learning from the weaknesses of past programs, future conservation offset programs can be more effective at delivering environmental goods and services.

Acknowledgements

Funding for this research was provided by Sustainable Prosperity. We would like to thank all of the interview participants, those listed here and the anonymous respondents. Glen McMaster, Water Security Agency. Shane Petri, AESRD. Ron McNeil, LandWise Inc. Rob Dunn, AARD. Karen Raven, AARD. Marian Weber, Alberta Innovates- Technology Futures. Tom Goddard, AARD. Tracy Scott, Ducks Unlimited Canada. Kevin Redden, Medicine Hat Gas. We also thank Michelle Brownlee for extensive constructive comments and suggestions.

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Appendix A

Below are the detailed applications of the developed framework to selected case studies.

Case 1: HADD

1. *[Mitigation hierarchy employed]* The HADD program emphasizes a mitigation hierarchy approach, where compensation is the last resort for unavoidable impacts (Harper and Quigley 2005, Quigley and Harper 2006).
2. *[Incorporates risk of program failure]* Harper and Quigley (2005) found that the offset ratio does not change between critical, important, or marginal habitat, suggesting no accounting for risk in terms of high value habitat. The use of financial securities may be used to cover the risk of compensation failure; however these have never been cashed (Harper and Quigley 2005).
3. *[Landscape scale]* There is no evidence of considering offsets above a case by case basis.
4. *[No net loss or explicit target]* NNL is explicitly stated, and is met in approximately 75% of the projects (Harper and Quigley 2005).
5. *[Additionality]* In an audit, the majority of the offsets either created new habitat or increased the productivity of existing habitat, therefore creating additional conservation outcomes.
6. *[Stakeholders aid in design]* It is unclear which stakeholders were included in the design.
7. *[Equity considerations in design]* It is unclear if equity is included in the design.
8. *[Long term focus]* The "offsets" are permanent; providing long term conservation.
9. *[Transparency]* In order to compensate for the loss of fish habitat, several options are available to industry, with a preference given to like-for-like compensation, which if done correctly should be a long term conservation offset (Harper and Quigley 2005). However, several other options are more short term in nature (e.g. Artificial propagation), and may not meet the criteria of long term conservation. The HADD program has been shown to have inconsistent decisions on impacts and compensation, as well as poor record keeping leading to a lack of transparency (Harper and Quigley 2005).
10. *[Employs best available science / traditional knowledge]* There is no evidence of traditional knowledge being used, but there is evidence of knowledge of fish breeding and habitat requirements being accounted for (Harper and Quigley 2005).
11. *[Economic efficiency / cost effectiveness]* It is unclear if the HADD program is cost effective. However, because it is done on a case by case basis, it is likely there could be efficiency gains if an approach that allowed for the most cost effective offset location / approach was taken. While the offsets are established on a case by case basis, offset ratios

are designed to account for the temporal lag between impact and offset (Quigley and Harper 2006).

12. *[Addresses multiple ecosystem services]* There is no evidence that multiple species or services are considered; while the program identifies different habitat types, in only 48% of HADD reports was the fish species affected listed (Harper and Quigley 2005).
13. *[Effective monitoring and enforcement]* Over 90% of HADDs reviewed by Harper and Quigley (2005) required post-construction monitoring.
14. *[Incorporates program evaluation]* It is unclear if the program has a system built in for review, however the Harper and Quigley (2005) (and Quigley and Harper 2006) report is a detailed evaluation process.

Case 2: Alberta's Carbon Offsets

1. *[Mitigation hierarchy employed]* A mitigation hierarchy approach cannot easily be applied to carbon offset program. The nature of the program is such that large emitters have an option of either reducing emissions (internally) or purchasing offsets and as such the emissions levy provides an incentive for them to reduce emissions directly.
2. *[Incorporates risk of program failure]* Offset factors (ratios, risk factors) are calculated for each activity conservatively according to a set of carefully designed protocols (AESRD 2013a). The risks associated with different offset activities are accounted for in the verifier's guide (AESRD 2013c).
3. *[Landscape scale]* Offsets are created by landowners, and there is no evidence of spatial analysis of offset locations. The carbon dioxide reductions are not affected by offset location; however there may be other impacts to the offset location in terms of local amenities. As a result, the criteria does not directly apply to a carbon offset but may apply to other ES affected by the carbon offset program.
4. *[No net loss or explicit target]* The carbon offset has a well-defined goal of lowering emissions intensity for large emitters.
5. *[Additionality]* Additionality is considered and evaluated through the rigorous protocol system. The protocols identify the mechanisms used to establish additionality and the methods for dealing with other concerns like leakage (AESRD 2013a). There is also an established verification system and third party monitor to evaluate projects (AESRD 2013c).
6. *[Stakeholders aid in design]* Stakeholders, including the general public, were included in the design phase, and there is an ongoing effort to include stakeholder participation in developing new protocols (AESRD 2013a).
7. *[Equity considerations in design]* The program is not designed to have associated equity or distributional goals Equity in terms of access to programs and information is incorporated into the protocol design.

8. *[Long term focus]* Many of the offsetting activities provide long term reductions, for example recycling materials used in upgrading gravel and light surfaced roads, and afforestation (currently being revised) (AESRD 2013a).
9. *[Transparent]* Alberta's carbon offset program is very transparent, with relevant information found on the ESRD website, including offset calculations for different practices.
10. *[Employs best available science / traditional knowledge]* There is no evidence of traditional knowledge being used, however the protocols show a detailed approach to calculating emissions and reductions (AESRD 2013).
11. *[Economic efficiency / cost effectiveness]* There has not been an analysis of the cost effectiveness of the carbon offset program to the best of our knowledge. The calculations for offset values are given in an extensive library. Efficiency may be improved by standardizing the contract process under a third party (currently the third party acts as a verifier). The potential issue of leakage[24], or other risks, is addressed is a detailed risk management section for verifiers, including practices to minimize the different types of risk (AESRD 2013c).
12. *[Addresses multiple ecosystem services]* There have been concerns that offset programs that focus on carbon may create adverse impacts on other ES. However, in many cases carbon sequestration can be associated with improvements in valued ES. Afforestation, for example, can generate habitat benefits or other services. To the best of our knowledge, however, there are no assessments of the indirect impacts of the carbon offset program on other ES.
13. *[Effective monitoring and enforcement]* The requirements for data collection and reporting are laid out in a straightforward manner, including which party is responsible for certain pieces.
14. *[Incorporates program evaluation]* There is a mechanism for individual project auditing, but the system as a whole does not include a program evaluation.

Case 3: Alberta's wetland policy

1. *[Mitigation hierarchy employed]* The mitigation hierarchy is included in the policy framework (AESRD 2013b).
2. *[Incorporates risk of program failure]* Offset ratios based on the ecological function provided by a wetland reflect the importance of preserving high value wetlands (AESRD 2013b).
3. *[Landscape scale]* The need for regional planning and relative abundance is explicitly included in the offset program when determining wetland value (AESRD 2013b).

[25] Leakage and stacking are explained in the main body of the report. Leakage in this case would be a farmer selling offsets, then removing bush to increase the cultivated area. Stacking in this case could be a landholder restoring a wetland and receiving both carbon credits and wetland credits.

4. *[No net loss or explicit target]* NNL is not explicitly a goal, but the ratios are designed to, at minimum, "conserve, restore, protect, and manage" wetlands in Alberta (AESRD 2013b).
5. *[Additionality]* Restoring wetlands will be additional as long as there is not a subsequent loss of wetlands (leakage).
6. *[Stakeholders aid in design]* The development of the new policy included various stakeholders, including industry, environmental groups, and aboriginal groups (AESRD 2013b).
7. *[Equity considerations in design]* There is a stated goal of maintaining equitable roles and responsibilities in administering the program (2013b).
8. *[Long term focus]* The policy states a focus on managing wetlands for long term service provision (AESRD 2013b).
9. *[Transparent]* The ratios of areas of wetlands lost and area of restoration required for the offset, mitigation hierarchy, and other information are easily accessible. Additional detail on the ratios in particular will likely emerge as the policy is implemented.
10. *[Employs best available science]* The ratios for assessing equivalent offsets use an approach that includes various elements for determining the value of a wetland from multiple fields (AESRD 2013b).
11. *[Economic efficiency / cost effectiveness]* It is a stated goal that the program will be cost effective (2013b), but not specified as to how efficiency will be achieved. There is no explicit discussion of how to control for leakage, transaction costs, or discounting for the time lag between impact and offset.
12. *[Addresses multiple ecosystem services]* Multiple ES are included for justification in preserving wetlands, such as providing safe drinking water, healthy ecosystems, and water for industry (AESRD 2013b).
13. *[Effective monitoring and enforcement]* Monitoring, including adaptive management, is included in the program (AESRD 2013b).
14. *[Incorporates program evaluation]* There is mention of program evaluation, with the exact method to still be determined (AESRD 2013b).

Case 4: SEACOP

1. *[Mitigation hierarchy employed]* Because energy producers lease the land, there is an incentive to minimize the areal impact, indicating that the hierarchy is likely to be followed. SEACOP is a pilot to test an offset mechanism, therefore it will not likely include the mitigation hierarchy, but future programs that employ aspects of the SEACOP pilot will likely include the mitigation hierarchy.
2. *[Incorporates risk of program failure]* The program has incorporated offset ratios in part to reflect risks of failure, as well as habitat quality. Impacts such as the sounds associated with the long term operation of energy infrastructure and structure height (windmills,

transmission line, and posts) have been considered, but cannot be offset by an increase in area. Other issues, such as the time lag between impact and offset and the risk of offset failure have been addressed with the potential use of a conservation bank.

3. *[Landscape scale]* Landscape scale is being considered to the extent that the pilot is operating within the larger context of the regional habitat scarcity issues surrounding species at risk. There is also a preference for clustering offsets with contiguous grasslands which indicates alignment with concerns about scale.
4. *[No net loss or explicit target]* This is explicitly part of the offset, including varying offset ratios to reflect the different values of habitat based on location, soil type, etc.
5. *[Additionality]* Any offset created will be from seeding native grass on previously cultivated land, which meets additionality.
6. *[Stakeholders aid in design]* There is participation from government, industry, landowners, and NGOs. Planning meetings have engaged various stakeholders groups over a 1 year period.
7. *[Equity considerations in design]* Through stakeholder meetings, various concerns about the "fairness" of the program have been raised, which can be incorporated into the program design. Landowners have raised concerns that energy companies will simply buy cropland, convert it native grass, and use this as their offset. A potential outcome of the above practice is that land prices will rise, increasing taxes, and making it difficult for agricultural producers to remain profitable. The increase in the price of land is a pecuniary externality, which is a distributional issue and not an economic inefficiency.
8. *[Long term focus]* This is a pilot program, so there are not necessarily long-term perspectives for this pilot. But the lessons learned can be applied to a continuous program in the future. The offsets are designed to be temporary, as the industrial impact is also assumed to be temporary.
9. *[Transparent]* Because the pilot is still being developed it is difficult to assess the transparency of the program.
10. *[Employs best available science]* There is no known use of traditional knowledge; however the offset ratios are based on recommendations from an interdisciplinary group of experts.
11. *[Economic efficiency / cost effectiveness]* To achieve cost effectiveness, easy to use calculators, standardized contracts, and a third party administrator are being used. Using a streamlined approach should reduce transaction costs, therefore making the program more efficient. The current contract includes provisions to avoid leakage. Conservation groups have raised concerns about crowding out landowners currently providing ES for free.
12. *[Addresses multiple ecosystem services]* The focus of the program is the provision of habitat, which may include increasing numbers of endangered species. It does not appear that there are unintended negative consequences on other ES.

13. *[Effective monitoring and enforcement]* Monitoring will be done using an existing system by the third party.
14. *[Incorporates program evaluation]* Currently there is no formal consideration of a program evaluation, but this may be forthcoming as the pilot is still being developed.

Case 5: Australian Case Studies - BushBroker

1. *[Mitigation hierarchy employed]* The BushBroker program states that a mitigation hierarchy will be followed (BushBroker 2013).
2. *[Incorporates risk of program failure]* BushBroker includes standards for management to help minimize risk. Additionally, "habitat acres" (i.e. a ratio) are used as a unit to control for heterogeneity between disturbed area and offset area (BushBroker 2013).
3. *[Landscape scale]* There is no evidence of the scale of approach and whether a landscape perspective is adopted, but it is possible that the landscape scale is employed.
4. *[No net loss or explicit target]* No net loss is an explicitly stated goal (BushBroker 2013).
5. *[Additionality]* While the program is intended to provide additionality, a recent survey of non-landholders that have worked on Australian conservation offsets reinforces the need to ensure additionality, suggesting it may not always be met (Blackmore et al 2013).
6. *[Stakeholders aid in design]* It is unknown how and if stakeholders were included in design, but program reviews have included surveys of landowners (Blackmore and Doole 2013, Doole et al 2013).
7. *[Equity considerations in design]* The degree to which equity of stakeholders was included in the design is unknown but there is discussion of consultation with stakeholders as part of the program design and evaluation. .
8. *[Long term focus]* The intention of the program is to provide long term conservation benefits. However, reviews of conservation offsets in general find that non-landowners prefer a longer term contract while landowners favour short contracts for a more flexible management plan (Blackmore and Doole 2013, Doole et al 2013).
9. *[Transparent]* Programs such as BushBroker have easily accessible information online (BushBroker 2013); however it appears that landowners would like to have even more information (Blackmore et al 2013).
10. *[Employs best available science]* The standards for creating and managing offsets incorporate a variety of scientific and technical issues and appear to use best available science.
11. *[Economic efficiency / cost effectiveness]* BushBroker is designed to be cost effective, an attribute which is also identified as valuable by survey participants (Blackmore and Doole 2013, Doole et al 2013). BushBroker also includes methods to reward landowners already providing ES, which should limit the crowding out effect.
12. *[Addresses multiple ecosystem services]* BushBroker allows for fire management to limit the unintended consequence of increased vegetation (BushBroker 2013). The offset land can also be grazed to provide another use for the land (besides ecological function

provision). As such the benefits from Bushbroker are correlated with other important ES which should reduce unintended consequences.

13. *[Effective monitoring and enforcement]* The review of conservation tenders (Blackmore and Doole 2013; Doole 2013) revealed that landowners and non-landowners would like to see a more cost effective approach to monitoring (Blackmore and Doole 2013, Doole et al 2013), suggesting that monitoring has been costly in the current programs. However, the programs clearly include monitoring and enforcement within their frameworks.
14. *[Incorporates program evaluation]* There have been multiple evaluations of the BushBroker program, both internally and more broadly with the review of conservation offsets and conservation tenders in Australia (BushBroker 2013, Blackmore et al 2013). The extent to which the program has been formally evaluated with clear controls or through quasi-experimental methods is unclear.

Appendix B

Landowners face a private cost associated with wetland restoration, but providing a restored wetland will generate a public benefit. In order to bring about this action, positive incentives are necessary (Pannell 2008). Assuming TCs do not overpower the benefits or costs of these policies, and the willingness-to-pay (WTP) for wetland services by developers and willingness-to-accept (WTA) for provision of services by landowners are similar, the offsets should operate effectively, as the policy mechanism for each party is reciprocal to each other. In reality, when there is not an established market price, sellers tend to value the good much higher than buyers are willing to pay for the good (Knetsch 1990). The disparity exhibited in valuation may diminish the potential gains from trade, which can further reduce the effectiveness of conservation offsets as compared to extension or no action (Knetsch 1990).

The Ducks Unlimited (DU) revolving land purchase (RLP) program is a wetland restoration program intended to address issues around the costs of obtaining permanent conservation easements and the uncertainties and TCs associated with renewable fixed-term temporary easements[25]. We examine the financial implications of the RLP program relative to a series of fixed-term easements as well as a onetime payment for a permanent easement. Two case study RLP sites were examined[26]. The first site is a 160 ac (64.5 ha) piece of cultivated land in Red Deer County, AB. The second site is a 640 ac (259 ha) piece of rangeland in the County of Forty Mile, AB. Both sites were purchased in May 2007 and sold in February 2013. The costs of obtaining the permanent offsets in the RLP program includes the direct costs of restoration, as well as the opportunity costs of financing the project and the opportunity cost of the land. The opportunity cost of financing arises from the need to have funds tied up in assets during the restoration period. This opportunity cost is calculated using different discount rates (0%, 3%, and 8%), other discounted values are calculated using the Treasury Board recommended 8% (TBC 2007). In a separate simulation, the discount rate for the opportunity cost is assumed to be low, driving the opportunity cost down. The restoration cost includes all of the elements of wetland restoration (surveying, mapping, and the physical restoration). This restoration cost is based on an average $11 000/ha of wetland restored (Tracy Scott, personal communication). The opportunity cost of the land is the result of a permanent conservation easement, which will lower the value of the land (Lawley and Towe 2012). Cultivated land is restored to grassland. The costs of the temporary fixed term easements include the payments required to obtain the easement for

[26] For more detail on the analysis of the RLP program see Noga (2014).

[27] We would like to thank Barry Bishop of Ducks Unlimited Canada for providing background information on the RLP and data on the two case study areas.

each period, discounted to the present, as well as the initial restoration cost. Because these easements are temporary, there is no long-term effect on land value, and therefore the opportunity cost of land described above does not apply.

Values are adjusted for inflation using the consumer price index (CPI). Other costs incorporated into the analysis include property tax, including school taxes (Forty Mile, Red Deer), cash rental values (a potential profit generating activity while the land is held by DU), and trends in land values. When assessing the tax level for the Red Deer site, the provincial average dollar per acre was used to estimate the assessed value for each year (AARD 2013a). For the Forty Mile site, the assessed value was tied to the CPI because of a lack of data on land values.[27] The actual area of the wetlands for the Red Deer county site is approximated at 7 acres based on a map, which included the wetland area in neighbouring parcels of land (therefore, the actual area value for wetlands in the quarter section under study is not known).

The median value for cash rented cropland was used for each year to explore how the financial situation would change if the land was rented during the restoration process (AARD 2013b). For the Forty Mile site, instead of dollars per acre, the cash rent was based on dollars per animal unit month (AUM) from rented rangeland in the neighbouring Cypress County. The AUMs were estimated based on historic precipitation in the region and the land was assumed to be in "good" condition (0.5 AUM/ac) (AARD 2013c and AARD 1998). Because the Red Deer site is restored to grassland, a similar process is completed to determine the AUM of the site, and rent is calculated using median county rent data. Based on information provided by DU, a second renting simulation was completed where the standing hay is sold. The price for standing hay is heterogeneous based on plant composition. The price paid for standing hay is approximated from an advertisement on the Alberta Agriculture and Rural Development (AARD) website with the understanding that the price may change based on location and plant community.

For the calculation of a onetime payment for a permanent easement, other costs are considered. The first cost is the opportunity cost of decreased land value from the easement. The decreased land value is calculated using Lawley and Towe (2012), where a 1% increase in eased area decreases land value by 0.25% (Lawley and Towe 2012). The second opportunity cost considered is the nuisance cost of maneuvering farm equipment around wetlands. However, both sites are grassland (or converted to grassland), and therefore the nuisance cost is assumed to be zero (not driving large equipment repeatedly around wetlands). The opportunity cost is not included in the renewable case because after a contract is over, the landowner is free to not renew, and therefore not have the negative effect on land value.

[28] The land in the Forty Mile site is unirrigated rangeland, and the recorded values in the AARD database suggest that their price is heavily increased by the inclusion of irrigated cropland; therefore the prices given in the AARD database are too high to reflect the value of the rangeland site.

For the simulation of a series of renewable easements, the bid distribution discovered by Hill et al (2011) is used. First, the bids are separated by land type, either cropland or forage, which will then be applied to either the Red Deer or Forty Mile site respectively. Each distribution of bids is split into three approximately equal groups based on the bid submitted and averaged, to create an average low, medium, and high bid for each land type. These values are given in dollars/ac/year, so each is multiplied by the eased area for the site, and then discounted. The results are then aggregated into 12 year groups of payments (based on contract length) and can now be compared to the RLP program.

Results show there is a trade-off to be made between rising land prices and opportunity costs. If a low cost of financing loan is obtained, the land can be held longer to take advantage of rising land prices; this will reduce the cost of using the RLP program (assuming land prices are rising). If a higher discount rate is used, rising land prices do not offset the opportunity cost of money, and the RLP program is completed the most cost effectively if the land is sold quickly. The onetime payment for a permanent conservation easement (CE) or a series of renewable payments are more cost effective than the RLP program in a number of scenarios; it is important to choose the appropriate method of obtaining a CE given varying discount rates and timeframes.

Appendix C

In the creation of offset programs, there is often discussion around how many units of conservation/creation/reduction are required for one unit of development/pollution. Alberta's Provincial Wetland Restoration/Compensation Guide uses a minimum offset ratio of 3:1 (AESRD 2007). The reason for using a ratio greater than one is commonly cited as uncertainty surrounding the effectiveness of the offset (Horan 2001, as cited in Horowitz and Just 2013). However, Horowitz and Just (2013) show that it is optimal (assuming the correct baseline is used) to use an offset ratio greater than one, even with certainty. This arises because it gives regulators another option for dealing with additionality, aside from adjusting the baseline and assuming the price of offsets is set by the market (Horowitz and Just 2013).

The SEACOP program was designed to use adjustable offset ratios, dependent on the ecological features of the sending and receiving areas. Other programs such as those conducted by the ACA and the HADD do not require a ratio to be used. However, when a service-to-service system, such resource equivalency analysis is used, the usefulness of offset ratios for capturing heterogeneity in ecological services becomes more apparent. And as Just and Horowitz demonstrate, a ratio greater than 1:1 may be necessary even under perfect certainty (2013).

While pre-defined offset ratios can be effective, and notably decrease the costs associated with creating an offset, they may not be sufficient (McKenney and Kiesecker 2010). Offset ratios alone, such as 1:1 or 3:1, do not capture heterogeneity in offset methods, or services provided (McKenney and Kiesecker 2010). As a result, it will be useful to include more detailed criteria when determining offset ratios. Such a process can be aided by utilizing resource equivalency analysis – introduced below.

Resource or Habitat Equivalency Analysis has been used in Natural Resource Damage Assessment (NRDA) settings in the U.S. for many years. Application of these principles to offset programs may provide new insights. When offsetting injuries to a resource, according to the principles of Habitat Equivalency Analysis (HEA, also referred to as Resource Equivalency Analysis), it is useful to use a service-to-service mechanism (Roach and Wade 2006). In the case of the offset being a different habitat type than the injured area, it may be necessary to scale the amount of land required (Roach and Wade 2006). The idea of HEA is that accidental releases or damages to an ecosystem can be offset by creating new habitat which generates a comparable amount of services. The newly created habitat will require scaling based on time frames and the nature of the offset (Zafonte and Hampton 2007, Roach and Wade 2006). While HEA is typically used in the United States for natural resource damage assessments (NRDA) to develop habitats that compensate for damages (from oil spills, etc.), it is possible that this approach can be used *ex* *ante* to explore the sensitivity of various components. Specifically, HEA could be applied to the grassland offset pilot program in Southeastern Alberta. SEACOP uses ratios to reflect the heterogeneity in quality of land in terms ecological functions provided. HEA emphasizes offsetting a loss with equivalent service, which would make the offset area specific to the impacted area. Additionally, SEACOP will experience a time lag between impact and restoration; the energy firm will cause an immediate impact, but it may take multiple years for the offset to reach a comparable level of service. HEA uses a discounting method to account for this, which limits the need for a conservation bank as the timing of service flows can be accounted for in the HEA analysis (Roach and Wade 2006). HEA (and its more general version Resource Equivalency Analysis) is very similar to the concept of adjusting habitat areas for quality. The main difference is the role of discounting to account for the temporal dimension of quality adjusted habitat service flows.