Cost-effective Conservation Planning for Species at Risk in Saskatchewan’s Milk River Watershed: The Efficiency Gains of a Multi-species Approach

by

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Abstract

The federal Species at Risk Act requires economic analyses to be included in species at risk recovery plans. Recovery plans are often completed species by species and their economic analyses fail to employ modern analytical methods. A unique multi-species at risk recovery plan within Saskatchewan’s Milk River Watershed provided the opportunity to calculate costs associated with native grassland conservation, develop optimization models that create cost-effective grassland conservation designs, compare the costs of cost-effective conservation designs with the costs of current proposed critical habitat polygons, and assess the improvements in efficiency associated with multi-species plans relative to single species plans. The cost-effective conservation plans were designed using Marxan software and included both direct and opportunity costs. The results of the optimization models suggest there is a potential for large efficiency gains if economic considerations are included in habitat conservation plans and if conservation plans are created for multiple species simultaneously.
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1 Introduction

Interest in cost-effective and systematic conservation area design—inform ed by sound economic data and used to protect biodiversity and species at risk—has begun to increase (Klein et al. 2008; Meir et al. 2004; Cabeza and Moilanen 2003). Countries that have made legal commitments within their country and the global community to protect and recover species at risk appear to be particularly active in this area. Canada is one such country. The Species at Risk Act (SARA), born out of international agreements, is Canada’s legal framework for the identification, protection and recovery of species at risk (Environment Canada 2005). Historically, the plans for the protection and recovery of species at risk in Canada have failed to promote efficient, cost-effective protection and recovery because while economic considerations (cost-benefit analyses) are a required part of the process, they are often included too late in the process or in too limited a manner to provide meaningful input into the conservation process.

This thesis has been completed with the intent to assist the socio-economic analysis required for a multiple species at risk conservation planning initiative in Saskatchewan’s Milk River Watershed—the South of the Divide Action Plan.1,2 This document provides information on the costs of protecting and restoring native grasslands within the watershed.3 This cost information was used to calculate the cost of protecting and restoring the grasslands located within the region’s species’ critical habitat areas.4 These

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1 The names ‘Saskatchewan’s Milk River Watershed’ and ‘South of the Divide region’ are used interchangeably within this thesis. The South of the Divide region is delineated by the Milk River Watershed, and as such, both regions are geographically equivalent.

2 The conservation actions that will be used to protect and recover the species at risk populations in the region have not yet been determined. As such, the conservation actions and costs outlined in this thesis are simply informative and neither prescriptive nor indicative of the final actions that will be undertaken by either the federal or provincial governments.

3 Costs, within this document, include the foregone benefits of agricultural and oil and gas production as well as the direct costs of converting modified landscapes to native grasslands. Within this thesis, restoration refers to the conversion of annual cropland and tame pasture/hayland into native grasslands that will ultimately be able to provide habitat for grassland species at risk.

4 Critical habitat areas for several of the species included in this document have not yet been legally defined. As such, the critical habitat areas used in this document should not be considered
costs could be used in conjunction with other conservation costs – predator control, translocation of individuals, research and monitoring, etc. – to calculate the total cost of protecting (and, optimistically, recovering) the species of the region as well as their grassland habitats.

While it is both useful and legally required to calculate the costs associated with protecting and restoring the a priori selected critical habitat grassland areas\(^5\), it is interesting to consider how costs would change if an economic-ecological model or framework was used to select the grassland areas that would be protected and restored. This thesis used spatial economic and biological information for the Milk River Watershed to create several reserve site selection models. These models minimize the cost of grassland protection and restoration while meeting grassland habitat protection targets. While these models are not without limitation\(^6\), they can be used to demonstrate the potential efficiency gains that can be achieved by including economic considerations earlier in the species at risk protection and recovery process.

The reserve site selection models were used to answer several questions. These questions included (a) whether or not protected grassland areas could be more efficiently selected if cost information was included in the selection process; (b) whether or not efficiency gains are possible if conservation areas were selected for several species simultaneously, and if so, what is the magnitude of efficiency gains; (c) whether or not there are added costs of maximizing the size of habitat patches, and if so, what is the magnitude of the added costs; (d) which protection and restoration activities could meet conservation targets at the lowest cost; and (e) how costs increase as overall grassland protection targets increase. The answers to these questions provide information on the potential role of economics in conservation area planning and can

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\(^5\) Despite the multi-species nature of the South of the Divide project, to date, all critical habitat spatially selected within the region has been done on a species-by-species basis.

\(^6\) See Section 4.1.1.2 for a discussion on the limitations of reserve site selection models with an emphasis on the challenges faced within the South of the Divide analysis.
facilitate discussions of how economics can be better included within species at risk policy and legislation. The following sections provide a brief discussion on species at risk conservation area planning, the role of economics in conservation area planning, the South of the Divide action plan, and the research approach and framework.

1.1 Species at Risk and Conservation Area Planning
Canada’s Species at Risk Act (SARA), proclaimed in June 2003, is one component of Canada’s three part strategy to protect species at risk (Government of Canada 2011). The other two components are The National Accord for the Protection of Species at Risk and the Habitat Stewardship Program (Environment Canada 2005).

SARA has three purposes: to protect wildlife from becoming extinct in Canada; to secure the recovery of extirpated, endangered, or threatened species; and to manage species of special concern to prevent them from becoming threatened or endangered (Environment Canada, 2005). Under SARA, the federal government is required to list species at risk; develop and implement recovery plans for the survival and recovery of species at risk; and monitor species at risk (Government of Canada 2011). Once listed, SARA provides protection to individuals of a species at risk and their “residences” if the species are either aquatic species, migratory birds, or are located on federal lands (Government of Canada 2011). Once a recovery strategy – indicating critical habitat for a species’ survival and recovery – has been posted and accepted on the Species at Risk Act public registry, critical habitat on federal lands (or on any lands in the case of aquatic and migratory bird species) can be legally protected. Often SARA defers to provincial laws to protect species on private lands. However, the protection of habitat for species at risk on private lands appears to be based on cooperation and volunteerism rather than law. Section 2.9 of the Canada – Saskatchewan Agreement on Species at Risk (2007) states that both governments agree that “cooperative, voluntary measures are the first approach to securing the protection and recovery of species at risk” (Saskatchewan Conservation Data Centre 2010).

SARA’s lack of jurisdiction on private land and the province’s desire to use voluntary, cooperative stewardship for the protection of species at risk ultimately results in a requirement for cooperation amongst numerous stakeholders in order to protect species at risk (Kerr and Deguise 2004). However, cooperation and voluntary
stewardship becomes complicated when coordinating multiple landowners (Kerr and Dequise 2004). Species at risk located on private lands have exhibited poorer recovery trends than species on federal lands due in part to the limited implementation of recovery tasks on privately owned land (Hatch et al. 2002).

Conservation area planning within SARA and Saskatchewan’s Wildlife Act (1998) is strictly biology-based. Critical habitat is defined in subsection 2(1) of the Species at Risk Act as the “habitat that is necessary for the survival or recovery of a listed wildlife species” (SARA 2003). Critical habitat is largely a legal term with a definition that is so broad it results in considerable difficulty in the selection of critical areas for threatened and endangered species (Hall et al. 1997). Nonetheless, the identification of critical habitat – which may be commonly associated with a species’ high quality habitat (Hall et al. 1997) – is legally required (SARA 2003). Critical habitat locations are ultimately selected species-by-species using a combination of field data and modeling techniques that account for species occurrence as well as the amounts, locations and attributes of habitat required for a species’ persistence and recovery. Once a species’ critical habitat is identified it is included within the species’ recovery strategy report.

Species recovery planning is a two-stage process as outlined in section 11.1 of the Canada – Saskatchewan Agreement on Species at Risk (Saskatchewan Conservation Data Centre 2010). The first step – the creation of a species’ recovery strategy – determines whether or not the recovery of a species is technically and biologically feasible, and if recovery is deemed feasible, the plan will include recovery goals, objectives and strategies. The second step – the creation of an action plan – identifies and prioritizes recovery measures and includes a cost-benefit analysis of the implementation of the action plan. Thus, both recovery feasibility and critical habitat designation is decided in the absence of economic considerations. The only role provided by the economic analysis is an evaluation of the already decided upon recovery strategy.

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7 See the amendment to the recovery strategy of Lungle and Pruss 2008 for a brief discussion on the information used in the identification of critical habitat. The amendment is available on the Species at Risk Act’s public registry at http://www.sararegistry.gc.ca/virtual_sara/files/plans/rs_sage_grouse_sec_2-6_1009_e1.pdf
1.2 The Role of Economics within Conservation Area Planning

The consideration of economic costs and benefits has the potential to play an important role in efficient conservation area planning. By properly accounting for the costs and benefits associated with different courses of action for habitat protection, the limited resources available for species conservation could be strategically allocated to maximize net benefits (Naidoo and Ricketts 2006; Margules and Pressey 2000; Csuti et al. 1997). However, to date, most conservation area planning articles focus on the biological benefits of conservation areas and ignore the economic costs and benefits (Naidoo et al. 2006; Stewart and Possignham 2005).

In an ideal world each conservation plan would have the biological and economic information necessary to construct its own cost and benefit curves for biological protection. This could be achieved regardless of how biological protection is measured whether it is the number of individuals or breeding pairs of a species, the probability of species persistence, or, commonly in the case of SARA, the species’ habitat area (Figure 1.1). The benefits curve would include all market and non-market values of varying biological targets. The cost curves would include all implementation and opportunity costs associated with meeting the varying biological targets. Typically the benefit and cost curves take the shapes shown in Figure 1.1 (costs increase at an increasing rate and benefits increase at a decreasing rate). The curves illustrate how economic-ecological trade-offs (in standardized monetary units) vary as a function of biological targets. These curves provide the basis for a cost-benefit analysis which allows optimal biological targets to be selected within a conservation planning problem. Optimal biological targets are set where the positive difference between benefits and costs is maximized (i.e. net benefits are maximized) and it can be shown mathematically that this occurs where the slopes of the curves are equal (i.e. marginal benefits equals marginal costs).
Unfortunately the economic benefits of meeting biological targets (number of individuals or breeding pairs of a species, probability of species persistence, or, commonly in the case of SARA, species’ habitat area) are rarely calculated due to the difficulty of determining the non-market value of species at risk. The result is that the benefits curve in Figure 1.1 is seldom calculated and traditional cost-benefit analysis is not possible (Naidoo et al. 2006). Cost-effectiveness analyses, where costs are expressed in monetary terms but benefits remain measured in biological units, replace cost-benefit analysis in such cases. The most efficient plan, in the case where benefits are not calculated, is simply the plan that delivers a pre-determined conservation target for least-cost (Naidoo et al. 2006). Fortunately, consideration of the costs of conservation planning alone offers significant opportunities to achieve efficient conservation objectives in a world of limited resources (Naidoo et al. 2006; Stewart and Possingham 2005). The quantification of both biological targets and the costs of protecting those biological targets allow ecological-economic models and economic analysis to determine cost effective and highly efficient conservation plans (Carwardine et al. 2008). Improving the efficiency of conservation plans is likely to be important when
habitat protection is located on privately-owned or resource-rich land which requires difficult trade-offs to be considered.\textsuperscript{8}

The cost curve (Figure 1.1) created within a cost-effectiveness analysis provides information on the cost of an efficient conservation plan at every biological target. By illustrating the economic trade-offs required at each habitat protection level (i.e. the trade-off between higher biological targets and the higher costs necessary to meet the target) the cost curve can provide valuable information for decision makers such as whether or not the economic trade-offs required to meet certain biological targets are economically or politically feasible. For example, if the desired biological target is on the flat part of the curve, little to no additional cost is required to increase the target and decision makers may increase the habitat target. But, if the current habitat target is on the steep part of the curve, a very small decrease in the biological target can result in large reductions in total cost in which case decision makers may marginally decrease the biological target in order to meet budget requirements or political acceptance of conservation plans.

Figure 1.1 can also be used to demonstrate the potential biological and economic gains that can be achieved by conducting a cost-effectiveness analysis for critical habitat designation. A species’ recovery strategy, under SARA, legally requires the calculation of species recovery costs (Subsection 49(1e) of the Species at Risk Act). Within the species’ recovery strategy, the location and amount of critical habitat required for the survival and recovery of that species at risk is designated. It is the cost of protecting this designated habitat that needs to be calculated and reported within the species’ recovery documents. Figure 1.1 provides a stylized example that illustrates the information gains possible as a result of a cost-effectiveness analysis for conservation area planning. Within Figure 1.1, the cost of protecting the critical habitat target, CH, is CHC (cost of critical habitat). This point is located at point 1*. However, an equivalent area of land, CH, can be protected for a cost of B if habitat is selected using an optimization framework that minimizes costs while still meeting the habitat targets. This

\textsuperscript{8} Locating habitat protection on least-cost areas will be especially important in the case of private land which may require the implementation of financial incentives or conservation programs to meet conservation targets.
is point 2* in Figure 1.1. Substantial cost-savings are possible if efficient conservation plans are created. However, if the budget available for conservation is CHC, efficiently planning conservation areas using an optimization framework can increase a biological target with no additional cost. For example, a much larger area of land (A) can be protected for the same cost of protecting critical habitat (CHC). This is point 3* in Figure 1.1.

An additional argument for explicitly considering economic costs within conservation planning is that it is better to explicitly (and accurately) include costs within the processes of assessing recovery feasibility and setting biological objectives rather than implicitly (and perhaps inaccurately) include economic considerations. While there may be support for the idea that economic considerations should not be included in what may seem a purely biological task, there are potentially large consequences (biologically or economically) of failing to recognize that conservation targets are never truly free of economic considerations and political dialogue (Wilhere 2007). Excluding the explicit consideration of economic considerations does not rid conservation planning from the implicit consideration of economics and value judgments (Wilhere 2007), the inclusion of which can ultimately result in sub-optimal conservation plans.\(^9\)

Properly calculated protection and recovery costs should be used to assist in the difficult decision of where to place critical habitat on privately-owned and -managed land, or on land with high economic value. It is best to make informed economic-ecological trade-offs based on quantitatively measured values.

Currently, economic costs play an important role in conservation planning within Canada because SARA requires a cost-benefit analysis of each species at risk’s action plan (subsection 49(1e) of the Species at Risk Act). However, a more sophisticated

\(^9\) An example of implied economic consideration can be found within the Woodland Caribou Recovery Strategy. Within the strategy, the target habitat protection (65% undisturbed habitat) is set where a local caribou population has a 60% probability of being self-sustaining (Environment Canada 2011a). It seems that while economic considerations are not explicitly included or calculated within the process of setting the conservation objective, some sort of consideration of economics played a role and has impeded the setting of a much stricter conservation objective. For example, the same study used to set the conservation targets also found that a greater than 90% probability of survival could be achieved if habitat disturbance was reduced to 10% or less (Environment Canada 2011b).
inclusion of economic costs earlier within the conservation planning process could ensure that the habitat protection and recovery actions outlined within an action plan are feasible, cost-effective and allocate resources to the best use.

1.2.1 The Potential Benefits of Multi-species Conservation Area Planning

The Canada-Saskatchewan Agreement on Species at Risk states that “ecosystem, landscape and multi-species approaches will be used when appropriate for the protection and recovery of species at risk” (subsection 2.7), and Saskatchewan’s Wildlife Act states that a recovery plan may include provisions for respecting one or more designated species as well as ecosystem management (subsection 50(3)). Despite these legal provisions for multi-species planning, species are generally considered individually within SARA despite numerous cases where multiple species share overlapping habitat. In contrast to Canada’s slow adoption of multi-species plans, the United States’ Endangered Species Act (ESA) has employed many multi-species plans starting in the 1980s (Tear et al. 1995).

Multi-species conservation planning provides both practical and conceptual appeal. There is a belief that multi-species plans can speed up the recovery planning process for the large number of species requiring action plans by offering time and cost efficiencies during the planning and implementation stages (Tear et al. 1995; Scott et al. 1991; Shaffer 1992). However, multi-species plans add an additional layer of biological, management and political complexity which can limit the effectiveness of the plan (Tear et al. 1995), and a study of multi-species conservation on private lands suggested that multi-species plans are more time-consuming and expensive to prepare and do not necessarily improve recovery success (Langpap and Kerkvliet 2011).

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10 Habitat has been defined in the biological literature as the resources and conditions present in an area that produce occupancy – including survival and reproduction – by a given organism (Hall et al. 1997). Using this definition, habitat implies more than habitat type which refers only to the vegetation association (Hall et al. 1997). Appendix A contains detailed information on the habitat requirements for the species at risk included in this thesis; however, within the body of the thesis, habitat refers to habitat type. In the case of the species at risk in the South of the Divide, habitat type means native grassland. In turn, within this thesis, habitat protection refers to the protection and/or restoration of native grasslands within the region.