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An Opportunity Cost Model for Species at Risk Within Saskatchewan's Milk River Watershed

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Research Project Number: **Poster-02-2011**

Poster
February 2011

Canada

UNIVERSITY OF ALBERTA
DEPARTMENT OF RESOURCE ECONOMICS
AND ENVIRONMENTAL SOCIOLOGY

Growing Forward

AN OPPORTUNITY COST MODEL FOR SPECIES AT RISK WITHIN SASKATCHEWAN'S MILK RIVER WATERSHED

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Abstract

Species at risk recovery strategies and action plans, and their associated socio-economic analyses, have previously been completed on a species by species basis under the Species at Risk Act (SARA). The multiple species at risk (Multi-SAR) recovery strategy within Saskatchewan's Milk River Watershed provides a unique opportunity to study the opportunity costs of protecting multiple species' critical habitat within the dry mixed grass and mixed grass prairie of south-western Saskatchewan. MARXAN (Marine Spatially Explicit Annealing) and ArcGis 9.3 are used to determine a conservation strategy that will secure the future of the area's species at risk at the lowest possible cost given the current information on management/stewardship costs, program costs, land costs, land use, species threats, and critical habitat distribution. This model will provide insight into the opportunity or real costs incurred or potentially incurred by landowners and land managers as a result of stewardship initiatives. This model will inform decision makers of the costs of different levels of conservation effort as well as whether there are gains to be had from Multi-SAR recovery strategies under SARA. The ultimate outcome of this modelling exercise is to develop an integrated plan for species at risk management that incorporates multiple species in the region and the opportunity costs of species recovery strategies. It is hoped that this interdisciplinary model will help to better define the role of socio-economic analysis under SARA and related provincial legislation as well as provide a framework for socio-economic analyses that remain to be completed under SARA.

***Poster presented at**:*
Confor West 2011 Graduate Student Conference
Date: February 3rd - 6th
Location: Jasper, Alberta at the Marmot and Lobstick Lodges.
Topic: The meeting's theme was Ecosystems in perspective, integrating environment, society and economy.

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A New Direction for Species at Risk Policy?

•Recovery strategies and action plans for species at risk have been carried out by the federal and provincial governments one species at a time with limited economic analyses
•The development of cost curves and production possibility frontiers highlight trade-offs between conservation targets and economic activities which can better inform policy[1,2]
•There may also be improvements to efficiency by including multiple species and economic considerations[2,3] into a recovery strategy and its subsequent action plans

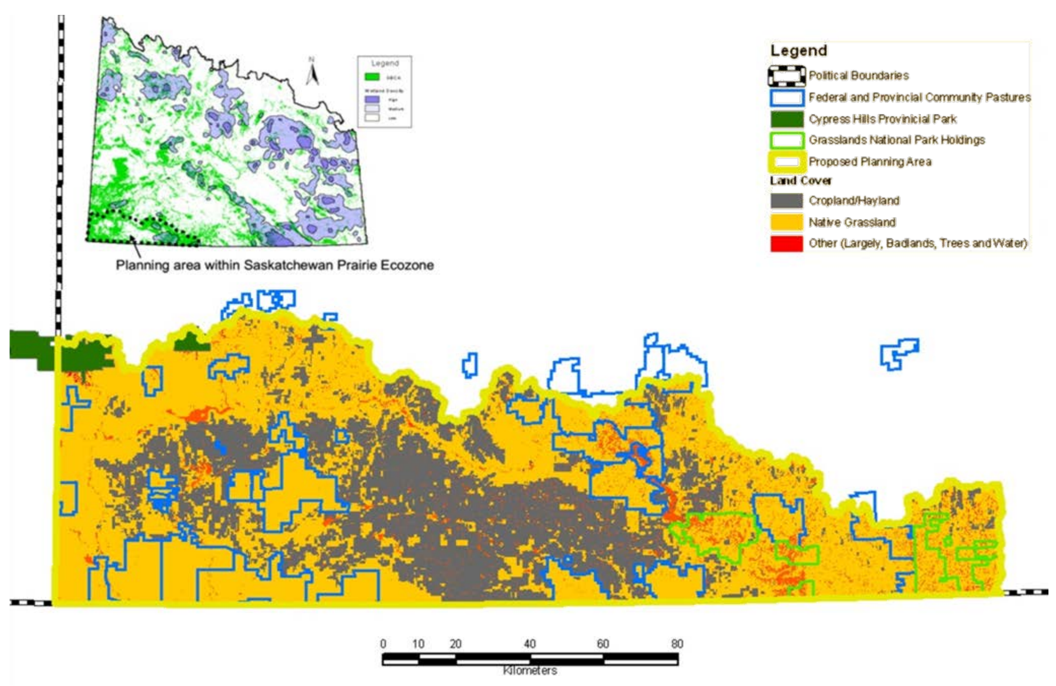

Figure 1. Proposed conservation management planning area based within the Milk River Watershed boundary.

Objectives:
(1) How do costs increase as the level of habitat protection increases?
(2) Are there returns to managing multiple species under one management plan?
(3) What quarter sections are optimal locations for critical habitat designation?

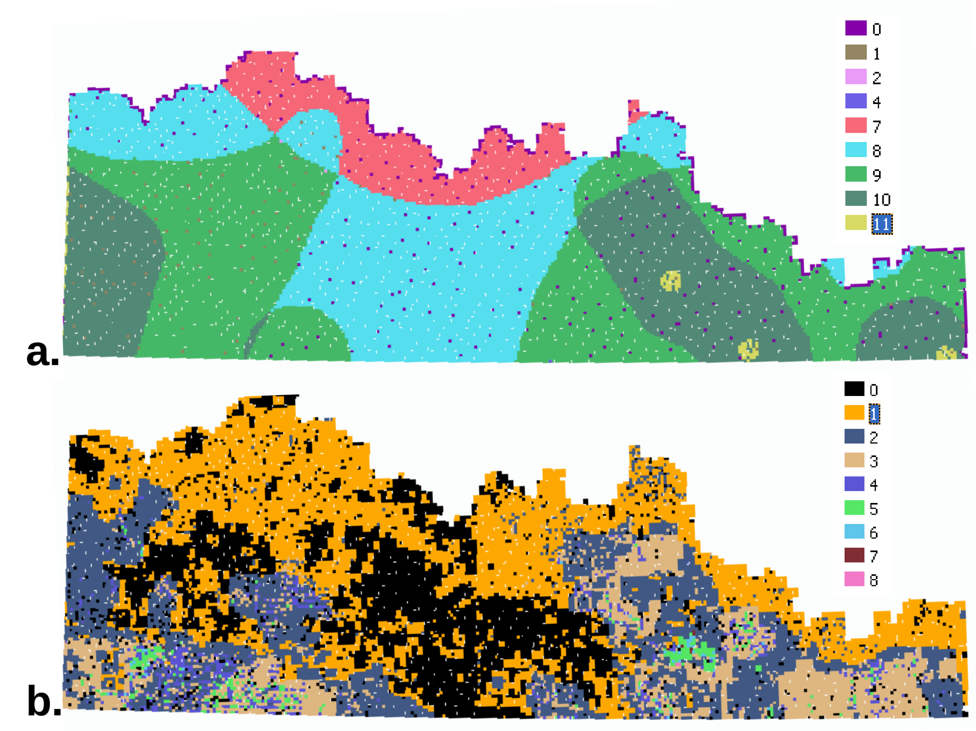

Figure 2. Maps of species richness within (a) historical ranges and (b) currently modeled and observed habitat for the 12 species within the Milk River Watershed.

Creating the Spatial Optimization Model

•The study area was delineated into 23 037 quarter section (64.75 ha) planning units
•Habitat models for 12 species were provided by the Canadian Wildlife Service
•Artificial land values were applied to all planning units in two different ways: random (uniform distribution from \$5 000 to \$55 000/quarter) or uniform (\$30 000/quarter)
•Land values represent the opportunity cost of designating an area as habitat
•Parks (national and provincial) were locked into the habitat model at zero land cost
Spatial clumping, land costs (uniform vs random), habitat protection levels and the number of species included within the model were all used to conduct sensitivity analyses
•MARXAN and ArcGIS 9.3 were used to run the optimization model

The Objective Function:

$$\sum_{PUs} Cost + BLM \sum_{PUs} Boundary + \sum_{ConValue} SPF \times Penalty$$

The MARXAN objective function minimizes the sum of:
1)The summed cost of all selected planning units.
2)The sum of all edge boundaries weighted by a boundary. length modifier (BLM). A BLM of zero removes this term from the objective function.
3)The sum of all habitat protection shortfalls (penalties) weighted by species-specific species penalty factors (SPF). A SPF of zero for all species removes this term from the objective function.

Results

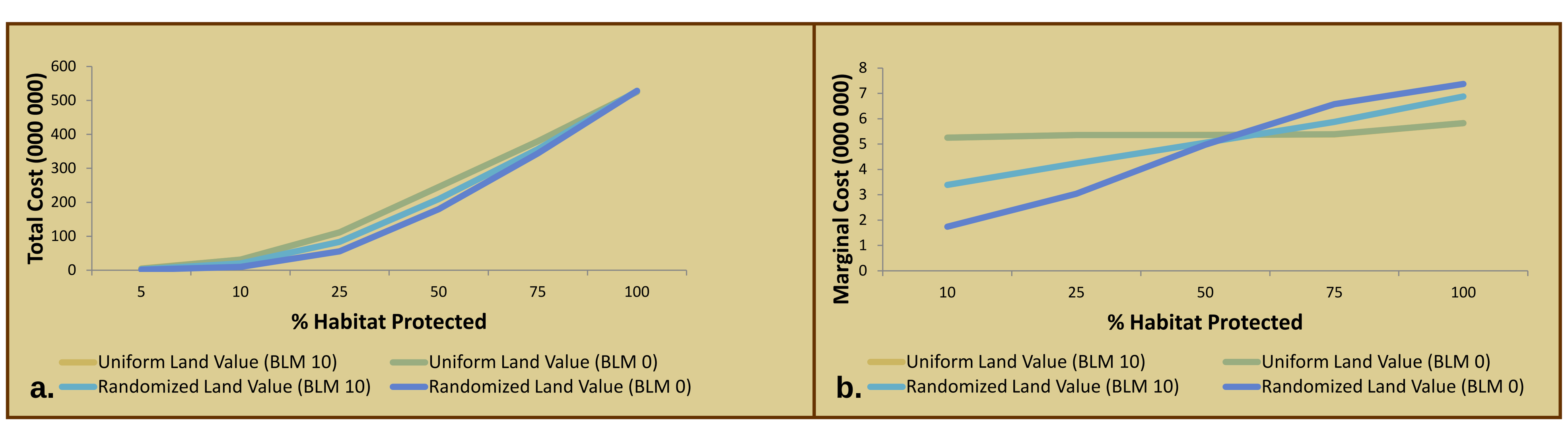

Figure 3. The (a) total and (b) marginal cost curves of habitat protection using random and uniform land values, and boundary length modifiers of 0 and 10

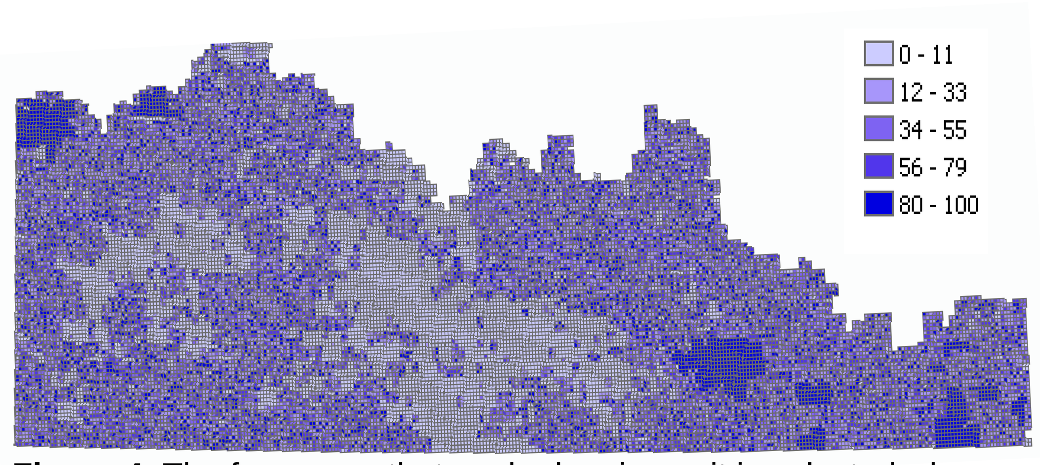

Figure 4. The frequency that each planning unit is selected when using all 12 species, a habitat protection requirement of 50%, a BLM of 0, and randomized land values

Table 1. The results of managing the 12 species within one optimization model versus summing over 12 separate optimization models (BLM = 0; randomized land values; habitat protection of 50%)

	All Species Independently	All Species Contemporaneously
No. of Planning Units	11 161	9 109
Total Cost (000 000)	242.07	179.95
Total Savings (000 000)	-	**62.12**

• The opportunity cost of protecting additional habitat increases at a constant rate with uniform land costs and increases at an increasing rate with random land costs (Figures 3a and 3b)
•There is a trade-off between selecting spatially contiguous planning units and selecting the lowest cost planning units (Figure 3b)
•When habitat protection is set at 50%, there is a large return to using a multiple species optimization model rather than optimizing over several species independently and accounting for overlap in habitat protection (Table 1)
•The model can highlight the optimal (low cost, high diversity, or favorable location) quarter sections to be set aside as habitat (Figure 4)

The Policy Implications of Multi-SAR Planning

•This model will provide insights into the opportunity costs resulting from critical habitat designation and stewardship initiatives
•This model will allow an integrated – ecological and economic – plan for species at risk management within Saskatchewan's Milk River Watershed
•It is hoped that this interdisciplinary model will provide a framework for future socio-economic analyses that will be completed under the Species at Risk Act

References and Acknowledgments

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Funding provided by:
LEARN (Linking Environment and Agricultural Research Network) – Agriculture and Agri-Food Canada