Predicting Land Use Transitions on Land Neighboring Riding Mountain National Park

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INTRODUCTION

- Human activities, particularly agricultural expansion and climate change have placed numerous grassland, wetland, and forestland ecosystems at significant risk (Lark et al., 2020)
- Research conducted by Dahl and Warmouth (2007) reveal that over half of the wetlands in the North American Prairie Pothole Region (PPR) have suffered degradation or damage since European settlement
- Challenges facing wetlands and waterfowl habitats are significant in Canada's western grain belt (Trottier 2002)

OBJECTIVES:

- Examine the influence of physical and economic factors on conversion of wetlands and grassland to cropland in the agricultural production region neighboring Riding Mountain National park
- Predict which parcels are at highest risk of conversion

DATA

- Annual parcel-level data from 2011 to 2021
- Dependent Variable: Cropland Share
  - Share of crop land within each parcel (Agriculture and Agrifood Canada Annual Crop Inventory)
- Independent Variables:
  - Soil characteristics: soil capability class (LCC), slope, elevation, stoniness, salinity, and erosion (Manitoba Land Initiative)
  - Census Agricultural Region (CAR) weighted average per acre crop revenue (Statistics Canada Table 32-10-0002-01)

NCC Targeted Region
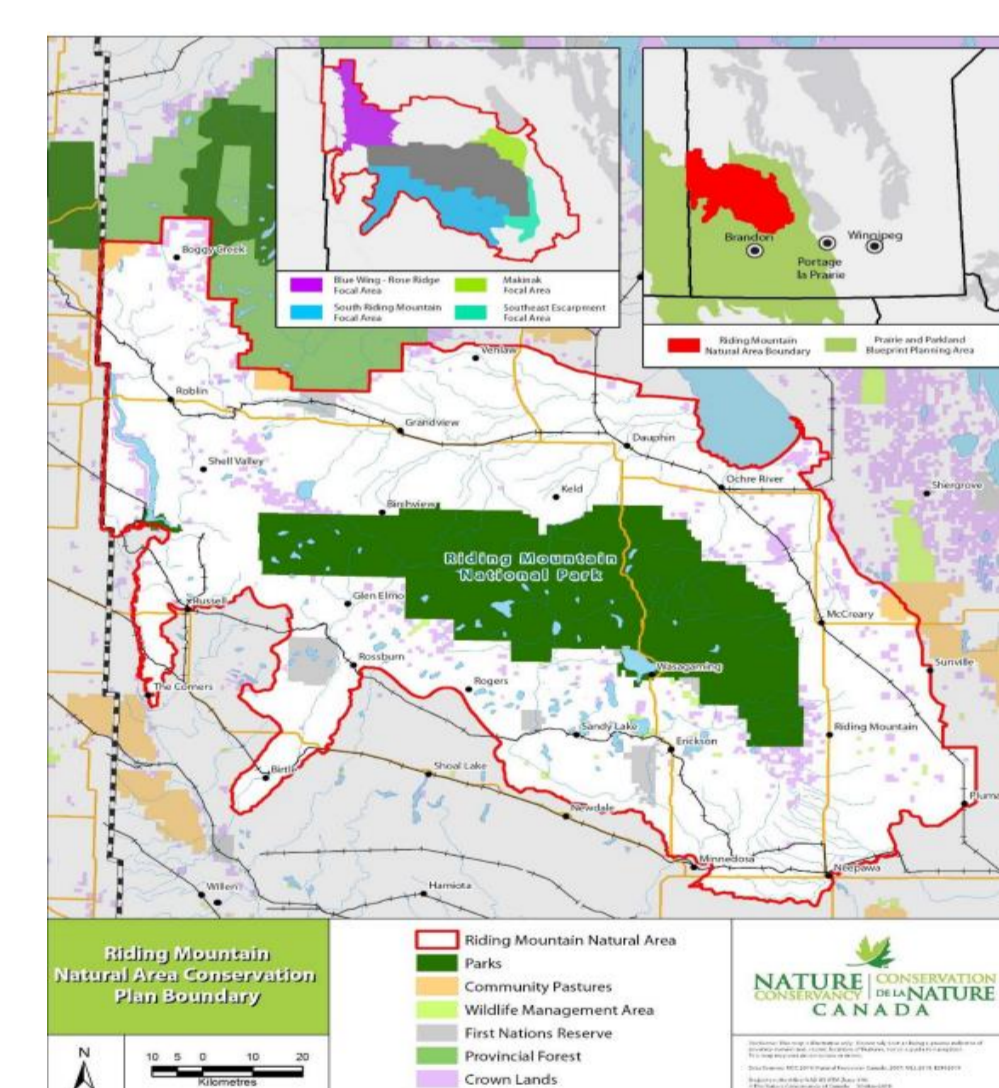
Study Region Municipalities

- Brandon
- Winnipeg
- Riding Mountain National park
- Selected Municipalities
- Other Municipalities
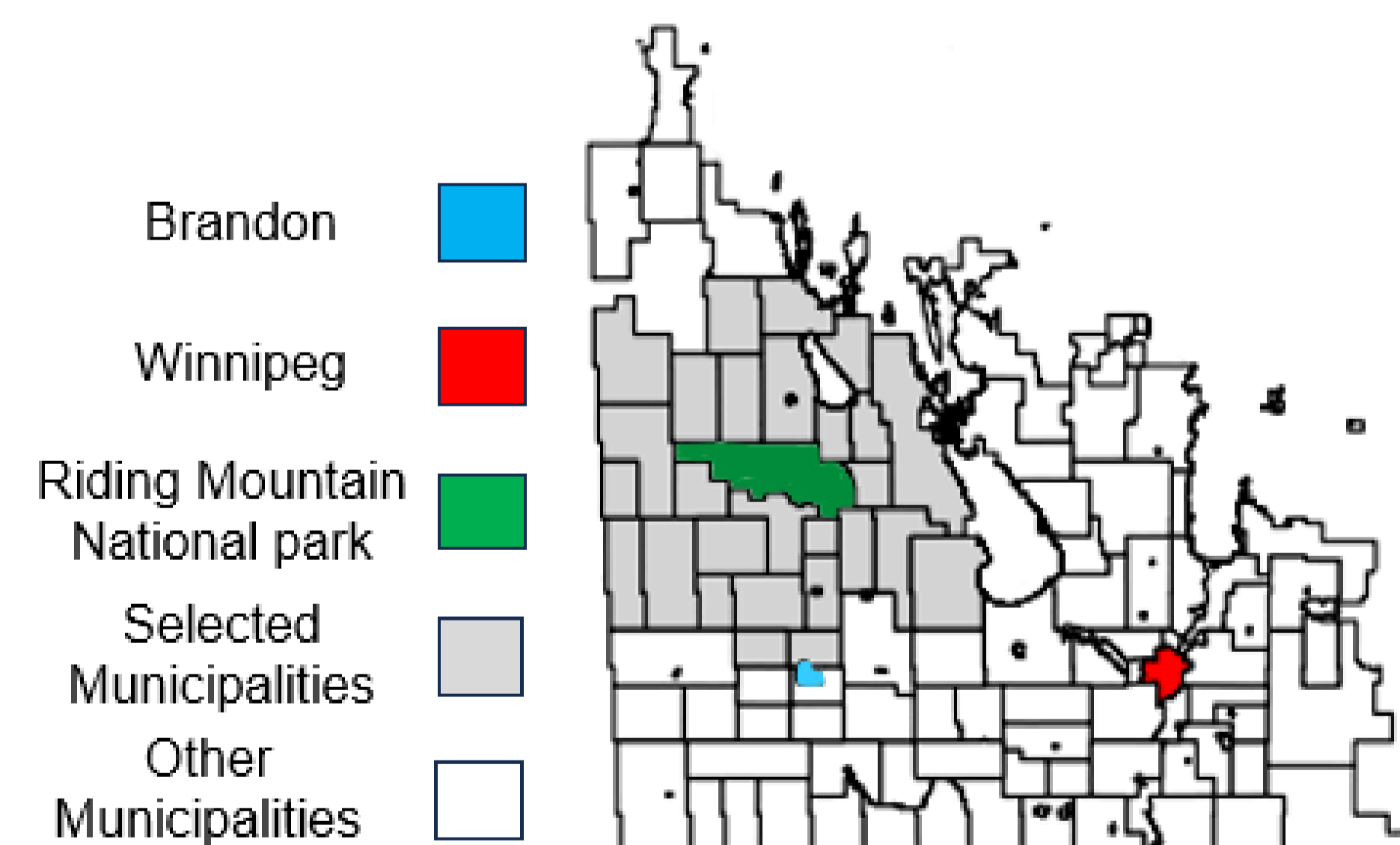
METHOD

Land-use share model:

Predict cropland share, C_{pt}, over time and across parcels:

$$(1) \quad C_{pt} = \alpha + \beta X_{pt} + \lambda Z_{rt} + \gamma_p + \delta_t + \varphi LCC * Z_{rt} + \xi_{pt}$$

- p indexes individual parcel, t indexes year, and r indexes municipality
- α, β, λ and φ are parameters; γ_p and δ_t are municipality and year fixed effects; and ξ is the error term
- X_{pt} is a vector of parcel-level physical characteristics and Z_{rt} captures weighted average CAR crop revenue

RESULTS

Table 1: Marginal effects from crop share model

Model	1		2	
	Marginal Effect	Standard Deviation	Marginal Effect	Standard Deviation
Income (at mean)	6.77E-04***	6.15E-05	7.68E-04***	7.20E-05
High capability soil	0.627***	2.00E-03	0.628***	2.00E-03
Medium capability soil	0.261***	2.00E-03	0.261***	2.00E-03
Income (on high capability soil)	8.87E-04***	6.53E-05	1.06E-03***	7.57E-05
Income (on medium capability soil)	8.86E-04***	6.35E-05	8.70E-04***	7.48E-05
Income (on low capability soil)	1.13E-04***	6.62E-05	2.68E-04***	7.74E-05
Crop Share Mean.		0.46		
Number of Observations		375,089		
R-Square	0.42		0.43	
Municipality Fixed Effect	Yes		Yes	
Time Fixed Effect	Yes		Yes	
Municipality x Time Trend	No		Yes	

Note: significant levels for this study defined as follows: * = 0.1, ** = 0.05, *** = 0.01

Define at-risk parcels:

1. Determine the minimum difference for each parcel by considering the smallest share difference over the entire 11-year period
2. Rank each parcel based on this minimum difference, arranging them from the largest to the lowest
3. Identify the top decile of parcels, considering those with the highest minimum share differences over the study period as the highest-risk parcels

Table 2: Parcels and Acres of High-Risk Municipalities

Municipality	Number of Parcels At-Risk of Conversion	Share of Municipality Acreage At-Risk of Conversion
323	74	1.48
181	110	0.96
159	42	0.89
353	8	0.81
200	112	0.73
443	33	0.72
359	57	0.70
118	114	0.63
183	40	0.63
403	89	0.63
107	50	0.62
124	22	0.61
132	27	0.52
445	28	0.50
142	79	0.48
331	12	0.40
147	22	0.38
170	22	0.35
609	11	0.27
101	28	0.26
182	31	0.22
143	33	0.18
126	16	0.16

CONCLUSION

- Land use share model reveals a positive correlation between crop revenue and cropland share
- Geophysical factors strongly influence land use changes, with income exhibiting a greater impact on cropland share on high-productivity soil parcels
- Model identifies parcels at the highest risk of conversion, providing a valuable tool for targeted conservation efforts and informed land management strategies

Policy Implications:

According to model predictions, almost all municipalities in our study area have some parcels at high risk of conversion. Although easement policies are employed to protect habitats surrounding Riding Mountain National Park, the majority of habitat in this area require more attention. Consequently, there is a need for further improvement by expanding easement coverage in these municipalities.

REFERENCES

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