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et de l'environnement

# Land Use Change Around Riding Mountain National Park

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# Land Use Change Around Riding Mountain National Park

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This paper is one in a series of internal discussion papers produced in Statistics Canada's National Accounts and Environment Division. These papers address topics related to environmental statistics and the National Accounts components which are currently under development.

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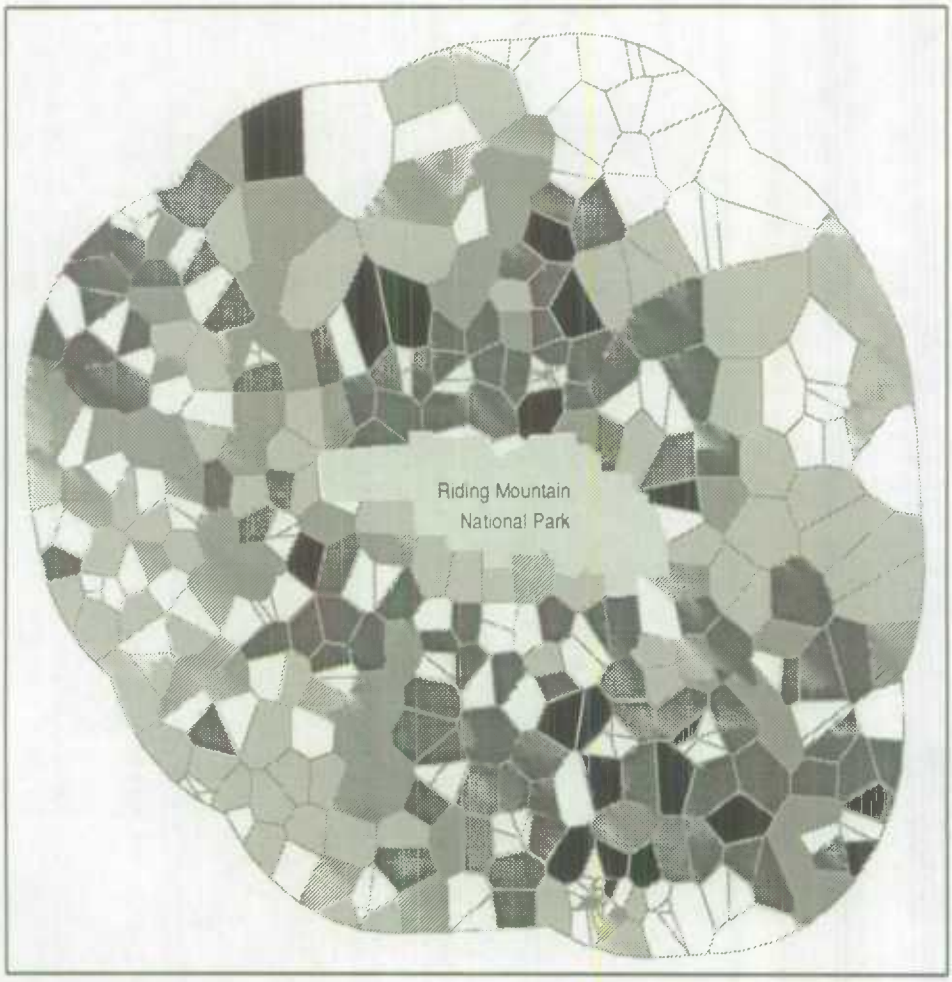
May 1992

Mai 1992

# Riding Mountain National Park

"An Island of Wilderness Within a Sea of Agricultural Development"




May 1, 1992

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Acknowledgements

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Riding Mountain National Park is a unique area of Canadian wilderness where habitats characteristic of eastern, western and northern Canada converge in a series of forests, grasslands, hills and valleys. Riding Mountain National Park's 3,000 square kilometre area is home to 5,000 elk, 4,000 moose, and over 1,000 black bears. Many other species such as wolf, beaver, cougar and osprey also inhabit this nature reserve. In summer months more than 30,000 people visit the park each weekend.

Riding Mountain National Park covers most of the Manitoba Escarpment, and can be described as an elevated boreal island surrounded by prairie. Because of it's unusual combination of attributes it was designated as an International Biosphere Reserve, as part of the United Nations Educational, Scientific and Cultural Organization's (UNESCO) Man-Biosphere Program. UNESCO established the Man-Biosphere Program in 1971 to foster the longevity of unique natural environments in each of the world's biogeographic regions. A Man-Biosphere reserve typically consists of a protected core of natural environment together with adjacent areas which collectively form a zone of co-operation. The Man-Biosphere Program recognizes that socio-economic activities and natural ecosystems must co-exist in an effort to guarantee the survival of both. Some 266 Man Biosphere Zones have been selected globally to date.

Riding Mountain National Park has been described as:

> "An island of natural environment surrounded by a sea of man-altered environment. The transition zone from farmlands is illustrated dramatically by the wheat fields and pastures abutting the natural environment" [1].

In recent years the transition zone from park to agriculture has become narrower, making the likelihood of conflict between activities more probable. Close co-existence of agriculture and wilderness can induce friction, as one interferes with the other. The survival of the nature reserve depends on careful organization, planning and management. The Man - Biosphere zone of co-operation around Riding Mountain facilitates increased communication. The role of information to support decision-making in this process is important. The findings of this analysis and the information that supports it will be added to a larger inventory of data supporting the Biosphere Reserve Program at Parks Canada.

This study will examine the changing mosaic of socio-economic activity that surrounds Riding Mountain National Park. The inter-relation between park, biosphere reserve and beyond will be explored from both spatial and temporal perspectives. Many Statistics Canada micro-databases have been tapped to generate a detailed profile of the area as it evolved over the last twenty years. Most of these information bases are accessed through the National Accounts and Environment Division's Environmental Information System (EIS) which uses geo-referenced data within a geographic information system (GIS) framework.[2]

This analysis is divided into three Sections. Section 1 provides background on the history of the park and focuses on issues that have emerged as human settlements and activities move closer to the park, placing more and more pressure on the nature reserve. Section 1 will also describe the physical setting of Riding Mountain, by briefly looking at physiography, hydrology and important biotic communities.

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1. Parks Canada, *Riding Mountain National Park Management Plan*, Environment Canada, Ottawa, 1987.
2. For more information contact Phil Fong or Doug Trant in Ottawa, at 613-951-5638 or 613-951-3829.

Section 2 will look at changing population and land use trends around the park over the last twenty years. A detailed statistical profile consisting of a series of concentric zones around the park, will be used to indicate composite activity changes in relation to proximity to the park.

Section 3 will examine changes in agricultural practices around the park. Trends in farm input levels and cropping practice changes will be examined longitudinally to suggest potential effects on the park.

**Section 1 - Physiography and Historical Background of Riding Mountain National Park**

**Riding Mountain History :** In the early 1800's Riding Mountain National Park was exploited largely as a timber resource for the construction of railways and farm buildings. In 1895, in response to continued pressure from growing settlements, the Dominion Government chose to set aside today's Park area as a forest reserve. The purpose of this reserve was to continue to provide lumber to developing communities at controlled rates in an effort to maintain a continual long term supply of wood. [3] As a new forest reserve, Riding Mountain came under the jurisdiction of the Forestry Branch of the former Department of the Interior. Husbandry of the reserve became the responsibility of foresters who controlled forest harvest rates. By the early 1900's increased demands for lumber and uncontrolled hunting access had diminished wildlife populations to dangerously low levels. In response to public concern the Manitoba Government enacted legislation to make Riding Mountain into a game reserve.[4]

Despite the economic depression of the 1920's and early 30's, agriculture continued to expand and ultimately advanced to the very edge of the Riding Mountain Reserve. In response to this pressure, and a new public demand for leisure and recreational space, Riding Mountain became a National Park in 1930. Since then two very different landscapes have evolved, and Riding mountain has become an "island of wilderness within a sea of agricultural development." [5]

**Physiography :** Riding Mountain National Park straddles an upland plateau formed by the geologic faulting of the Manitoba escarpment and the subsequent deposition of glacial moraine topography from the last glacial period some 12,000 years ago. The bedrock geology underneath the park and surrounding area is largely sedimentary, consisting of highly erodible shale types. The soils on Riding Mountain Plateau have developed from shale parent materials and are largely Grey Luvisols. These soils form in cool climates under woodland vegetation.(see map 1) The soils surrounding the Riding Mountain Plateau are largely Chernozems which form in cool climates under grassland vegetation. The Chernozems are quite fertile because of their high organic matter content and provide the soil base for a productive agricultural industry.

**Hydrology :** The Riding Mountain Plateau is the origin for many streams and rivers including the Wilson River, the Vermillion River, the Ochre River and the Turtle River. Flooding problems in these watersheds are not uncommon and are exacerbated by the build-up of shales in the stream network.[6]

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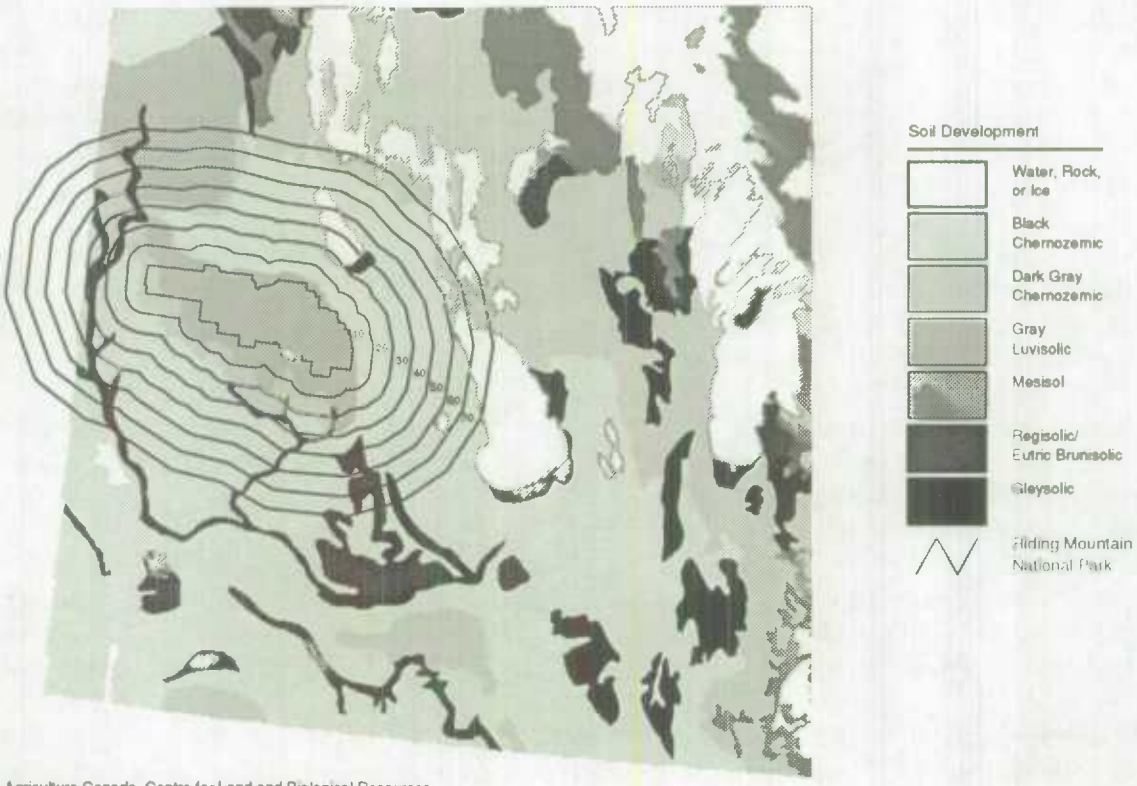
3. Tabulenas, D.T, *A Narrative Human History of Riding Mountain National Park and Area; Pre-history to 1980.* Parks Canada, micro-fiche report series 102, p.175, 1983.
4. Ibid, p.191, 1983.
5. Ibid, p.200, 1983.
6. Krawchuk, W.A. *The Riding Mountain Biosphere Reserve: A Synthesis of the Natural Resource Database,* (Masters Thesis) University of Manitoba, p.113, 1990.

The shale build-ups are primarily from re-erosion of alluvial fan material which has been disturbed by the recent clearing of land for agricultural use.

Natural Vegetation and Ecological Communities : There are three distinct ecological communities within the Riding Mountain Biosphere Reserve. These are: Mixedwood Forest, Aspen-Oak Woodland and Grassland. The rough fescue prairie grassland within the park is of international significance as there are few undisturbed examples left in the world. ( Most fescue grasslands are now producing grain crops ) The hardwood forest community on the southern slopes of the park is also unique. This forest is growing 700 hundred miles north of its traditional northern limit, and has survived because of the warm micro-climate created along the south facing escarpment.[7]

**Map 1** [8]

Soil Types in Southern Manitoba




Source: Agriculture Canada, Centre for Land and Biological Resources, Statistics Canada, National Accounts and Environment Division.

7. Ibid. p.124, 1990.
8. Map 1 is from Agriculture Canada's 1:1,000,000 Soil Landscape Series. Riding Mountain National Park is outlined in black and is surrounded by a series of radial buffers which will form the basis for a socio-economic data analysis in section 2.

## Section 2 - Population and Land Use Characteristics

The land use and population study area is oval in shape and extends 250 kilometres in an east-west direction and 160 kilometres in a north-south direction. The study area represents more than 3.3 million hectares of park and surrounding farmland. A series of 10 km wide radial buffer zones were developed to which micro-geographic data were linked and aggregated. This type of analysis has limitations that should be described at the outset. Micro-data for the Census Enumeration Areas used in this study, are stored on a single geographic co-ordinate, otherwise known as a point. This information has to be "rolled up" or aggregated to larger areas representing large land surfaces. The accuracy of this point-polygon match is determined by the density of points per polygon and the spatial distribution of the data represented by the points. In brief, where point densities are too low results have to be suppressed or ground truthed using paper maps.[9] The Riding Mountain study uses large surface areas with high point densities to ensure statistical reliability. The area is also more than 80% farmland, making the data distribution associated with the points quite homogeneous.

Other problems can arise when micro-data are aggregated to larger zones. Averaging of values can lead to under or over emphasis of certain characteristics for component smaller areas. The advantages of using composite concentric zones are that aggregate trends become discernible in contrast to the 'noise' that is generated by individual data points. Each radial zone around the central core represents an increasing area as the zones radiate away from the park. The 0-10 km zone is just under 320 thousand hectares while the 60-70 km zone is just under 656 thousand hectares. ( See zone areas in Table 2 and Map 1 )

Rural populations have been declining in Manitoba and Saskatchewan for some years now. Manitoba's rural population declined by 1.9 percent between 1971 and 1986, while Saskatchewan's declined by 10.6 percent. The Riding Mountain area has experienced even sharper declines in population. ( See Table 1 and Map 2 )

Table 1 indicates that rural population has declined by more than 21.6 percent, between 1971 and 1986. All zones showed a decline in rural population, zone 0-10 showed the smallest decline at 6.7 percent, and zone 20-30 showed the largest decline at 31.8 percent. These patterns indicate a declining farm population and an increasing trend towards living in urban centres.

Urban populations in the study area are quite small and exist primarily in zone 10-20 where the towns of Minnedosa and Dauphin are located. Zone 10-20 showed a moderate urban increase of slightly more than 10.3 percent. Urban population for the study period grew by 16.4 percent. ( See Table 1 )

Changing demographic patterns around Riding mountain reflect changing farm economics. Farm populations have been declining on the prairies for some time now. World grain prices have in part contributed to this decline. For example, in 1914, a tonne of wheat was worth $468 (1991 dollars) on the world market; in 1990, a tonne of wheat sold for an average of $113. [10] As the nature of farming changes in an intensely competitive international market, more and more rural dwellers move to urban areas. This trend is evident around Riding Mountain as it is elsewhere in Canada.

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9. Hamilton, K.E, Trant, D.F., *Statistical Aspects of the Application of Geographic Information Systems in Canadian Environment Statistics*, Journal of Official Statistics, Statistics Sweden, Vol 5, #4, p.340, 1989.
10. Statistics Canada, Canada Level Price Series, Agriculture Division, Farm Income and Prices Section, 1992.

## Table 1

### Population Trends Around Riding Mountain National Park, 1971 and 1986

| Radial Zone[1] | Rural population | | | Urban population | | | Total population | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1971 | 1986 | Change in population 1971-1986 | 1971 | 1986 | Change in population 1971-1986 | 1971 | 1986 | Change in population 1971-1986 |
| | number | | percent | number | | percent | number | | percent |
| 0-10 Kilometre Zone | 6 090 | 5 685 | - 6.7 | 0 | 0 | 0.0 | 6 090 | 5 685 | - 6.7 |
| 10-20 Kilometre Zone | 11 920 | 8 650 | - 27.4 | 10 415 | 11 485 | 10.3 | 22 335 | 20 135 | - 9.9 |
| 20-30 Kilometre Zone | 8 120 | 5 540 | - 31.8 | 0 | 1 030 | .. | 8 120 | 6 570 | - 19.1 |
| 30-40 Kilometre Zone | 9 000 | 7 465 | - 17.1 | 4 375 | 4 435 | 1.4 | 13 370 | 11 900 | - 11.0 |
| 40-50 Kilometre Zone | 8 620 | 6 930 | - 19.6 | 4 450 | 4 280 | - 3.8 | 13 073 | 11 215 | - 14.2 |
| 50-60 Kilometre Zone | 10 030 | 8 755 | - 12.7 | 0 | 0 | 0.0 | 10 030 | 8 755 | - 12.7 |
| 60-70 Kilometre Zone | 12 530 | 8 955 | - 28.5 | 0 | 1 160 | .. | 12 530 | 10 110 | - 19.3 |
| **Total** | **66 310** | **51 980** | **- 21.6** | **19 240** | **22 390** | **16.4** | **85 550** | **74 365** | **- 13.1** |

**Source:**
Statistics Canada, National Accounts and Environment Division and Census of Population.
**Notes:**
[1] 10 kilometre radial buffers were used to classify data concentrically around Riding Mountain National Park.
Figures may not add to totals due to rounding.

## Table 2

### Changes in Farmland Area Around Riding Mountain National Park, 1971 and 1986

| Radial Zone[1] | Zone area | Farmland area | | Proportion of Zone area in farmland | | | Average farm size | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1971 | 1986 | 1971 | 1986 | Change in farmland area 1971-1986 | 1971 | 1986 | Change 1971-1986 |
| | thousand hectares | | | percent | | | hectares | | percent |
| 0-10 Kilometre Zone | 320 | 246 | 297 | 76.8 | 92.7 | 20.7 | 191 | 263 | 38.0 |
| 10-20 Kilometre Zone | 354 | 316 | 273 | 89.4 | 77.1 | - 13.8 | 216 | 273 | 26.7 |
| 20-30 Kilometre Zone | 411 | 388 | 383 | 94.4 | 93.2 | - 1.3 | 257 | 324 | 26.1 |
| 30-40 Kilometre Zone | 471 | 343 | 340 | 72.7 | 72.1 | - 0.9 | 238 | 314 | 32.2 |
| 40-50 Kilometre Zone | 535 | 443 | 420 | 82.8 | 78.7 | - 5.0 | 292 | 360 | 23.5 |
| 50-60 Kilometre Zone | 595 | 411 | 455 | 69.0 | 76.5 | 10.8 | 264 | 354 | 34.4 |
| 60-70 Kilometre Zone | 656 | 487 | 467 | 74.3 | 71.2 | - 4.2 | 288 | 374 | 29.8 |
| **Total** | **3 341** | **2 634** | **2 634** | **79.9** | **80.2** | **0.3** | **249** | **323** | **29.8** |

**Source:**
Statistics Canada, National Accounts and Environment Division and Agriculture Division.
**Notes:**
[1] 10 kilometre radial buffers were used to classify data concentrically around Riding Mountain National Park.

Agriculture is the dominant land use activity around Riding Mountain National Park. Throughout the study period (1971-1986) agriculture has consistently occupied 80 percent of land around the park and directly provides almost a quarter of all employment in the study area. Table 2 describes farmland areas and changes in these areas as proportions of total area for the 7 radial zones between the 1971 and 1986 census years. (See Map 3)

In brief, farmland area for the entire study area has essentially remained constant over the 15 year study period, showing an increase of less than 1 percent. However, significant changes have occurred when individual radial zones are examined. The 0-10 kilometre zone nearest the park shows the highest change where agricultural areas continue to expand. Farmland has increased by 20 percent in this zone, going from 77 percent of zone area to over 92 percent, making it second only to zone 20-30 at 93 percent agriculture. This trend indicates that the boundaries separating land use activities are becoming narrower and the likelihood of conflict between uses is therefore increased.

# Riding Mountain National Park - Population Density, 1971 and 1986

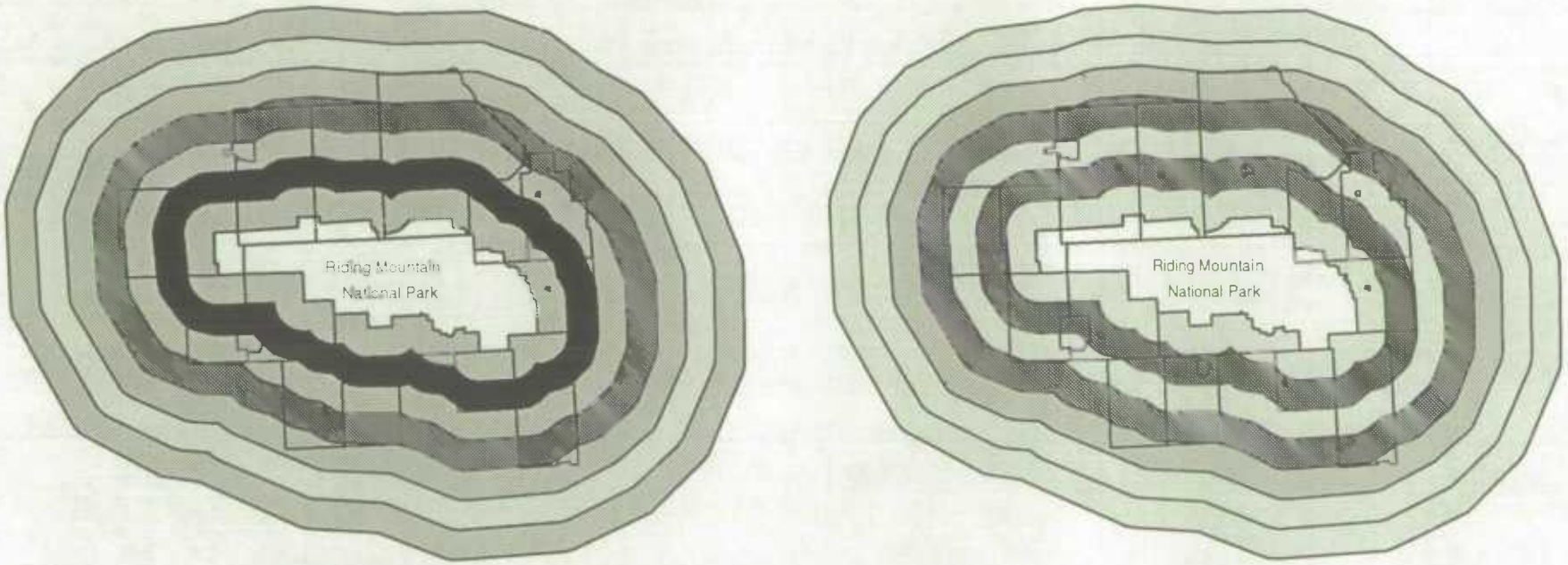


1971

Population = 85,550

1986

Population = 74,365

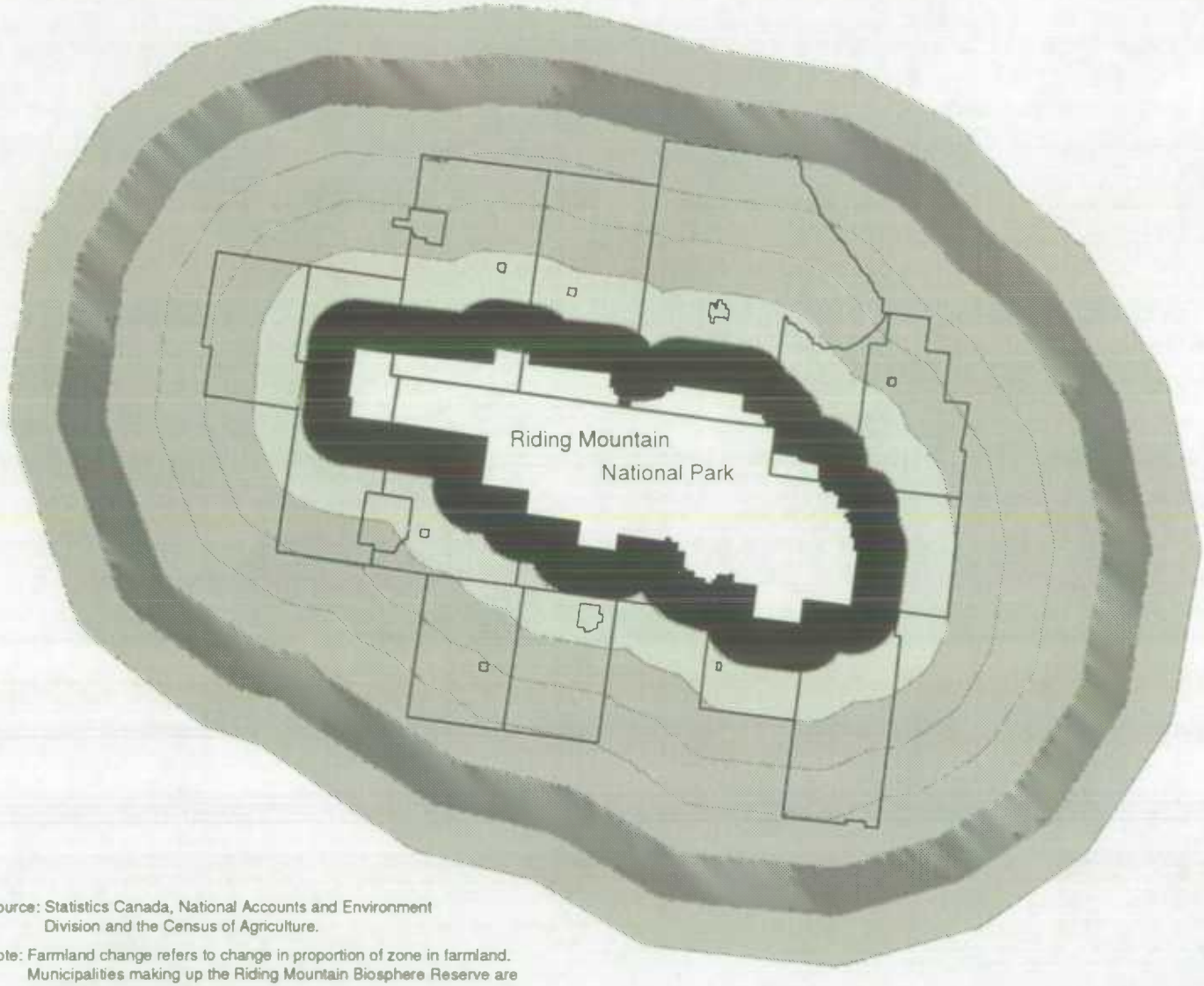



Source: Statistics Canada, National Accounts and Environment Division.

Note: Municipalities making up the Riding Mountain Biosphere Reserve are outlined around the park.

# Riding Mountain Biosphere Reserve Land Use Study

## Percent Change in Farmland Area, 1971-1986




Source: Statistics Canada, National Accounts and Environment Division and the Census of Agriculture.

Note: Farmland change refers to change in proportion of zone in farmland. Municipalities making up the Riding Mountain Biosphere Reserve are outlined around the park.

Idle land that used to form a cushion between activities is no longer there and the probability of having bears in farmers fields increases as does the potential for animal poisoning by farm pesticides.[11]

Table 3 looks at the 'Improved Farmland' [12] trends at varying distance from the park core area. Cropland trends are on the rise in all of the radial zones. The entire study area shows a 27.8 percent increase in cropland area. Since farmland areas in Table 2 have remained stable, and cropland areas in Table 3 are on the rise, it is apparent that a larger proportion of farmland is being placed in production and that land use intensity is increasing. Map 4 shows the radial distribution of cropland area changes around the park. The 0-10 zone shows the largest change with a 41.7 percent increase. Summerfallow areas are declining in all of the radial zones. The study area shows a decline of 43.8 percent. This is positive from a soil salinization perspective since the rate at which salinization occurs is dependent on soil moisture levels as they are affected by summerfallowing.[13] Summerfallowing contributes to salinization by raising soil moisture levels, and causing migration of stored salts.

Table 4 depicts trends in unimproved farmland. These areas, with the exception of unimproved pasture, are showing significant declines. Woodland which is important to wildlife as cover, and as a food source, shows sharp declines in all of the radial zones. The zone closest to the park contains the highest proportion of farm woodland, of its 320,000 hectares 8,887 remained in farm woodland in 1986. (Some woodland still exists outside farmland areas but this amount is less than 6 percent of the zone area because 92.7 percent of zone 0-10 is farmland.) Map 5 portrays the extent to which farm woodland areas have been declining around the park.

As human activities intensify and move closer to the park the likelihood of conflict increases. Agriculture-wildlife conflict can manifest itself in many different ways. For example, species such as the burrowing owl and prairie chicken can lose habitat to agriculture and be reduced in numbers or even disappear. Other birds such as the brown headed cowbird, thrive in a cleared cropland environment. These birds displace other species such as the yellow warbler by reproducing in a parasitic manner, reducing the breeding success of other species.[14]

Expanding agricultural land use further limits not only the diversity and numbers of wild animals, but that of plant life as well. Native plant communities are displaced and replaced by crop monocultures. (See section 3) Even when land is later withdrawn from agriculture, the original grasses and wild flowers tend to be supplanted by hardier opportunistic weed species.[15]

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11. Riding Mountain National Park warden Mac Estabrooks indicated, in a telephone conversation, that bear and elk were entering surrounding fields with increasing regularity.
12. Farmland that is considered 'Improved' can be cropland, improved pasture, summerfallow, or other improved land.
13. Dumanski, J. et al. *Soil Conservation in Canada*, Journal of Soil and Water Conservation, July/Aug, Soil Conservation Society of America, 1986, p.206.
14. Environment Canada, *The State of Canada's Environment*, Chapter 6, p.6-6, 1992.
15. Ibid, Chapter 6, p.6-6, 1992.

## Table 3

### Improved Farmland Changes Around Riding Mountain National Park, 1971-1986

| Radial Zone[1] | Improved Farmland | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Cropland | | | Improved pasture | | | Summerfallow | | | Other improved land | | |
| | 1971 | 1986 | Change 1971-1986 | 1971 | 1986 | Change 1971-1986 | 1971 | 1986 | Change 1971-1986 | | | Change 1971-1986 |
| | thousand hectares | | percent | thousand hectares | | percent | thousand hectares | | percent | thousand hectares | | percent |
| 0-10 Kilometre Zone | 107 | 151 | 41.5 | 9 | 15 | 58.3 | 46 | 34 | - 25.9 | 4 | 4 | 1.2 |
| 10-20 Kilometre Zone | 145 | 154 | 6.3 | 11 | 9 | - 15.9 | 58 | 30 | - 49.3 | 5 | 3 | - 36.8 |
| 20-30 Kilometre Zone | 150 | 192 | 27.5 | 15 | 18 | 17.0 | 67 | 34 | - 48.3 | 6 | 4 | - 32.0 |
| 30-40 Kilometre Zone | 141 | 184 | 30.2 | 8 | 9 | 8.2 | 70 | 35 | - 49.4 | 5 | 4 | - 17.6 |
| 40-50 Kilometre Zone | 159 | 203 | 27.7 | 22 | 27 | 22.0 | 70 | 41 | - 41.6 | 6 | 5 | - 16.3 |
| 50-60 Kilometre Zone | 157 | 211 | 34.6 | 17 | 14 | - 15.7 | 73 | 40 | - 44.8 | 6 | 5 | - 16.4 |
| 60-70 Kilometre Zone | 177 | 224 | 26.7 | 16 | 17 | 6.5 | 80 | 42 | - 47.6 | 6 | 5 | - 9.4 |
| **Total** | **1 035** | **1 318** | **27.3** | **97** | **107** | **10.4** | **463** | **256** | **- 44.7** | **37** | **30** | **- 18.9** |

**Source:**
Statistics Canada, National Accounts and Environment Division and Agriculture Division.
**Notes:**
[1] 10 kilometre radial zones were used to classify data concentrically around Riding Mountain National Park.

## Table 4

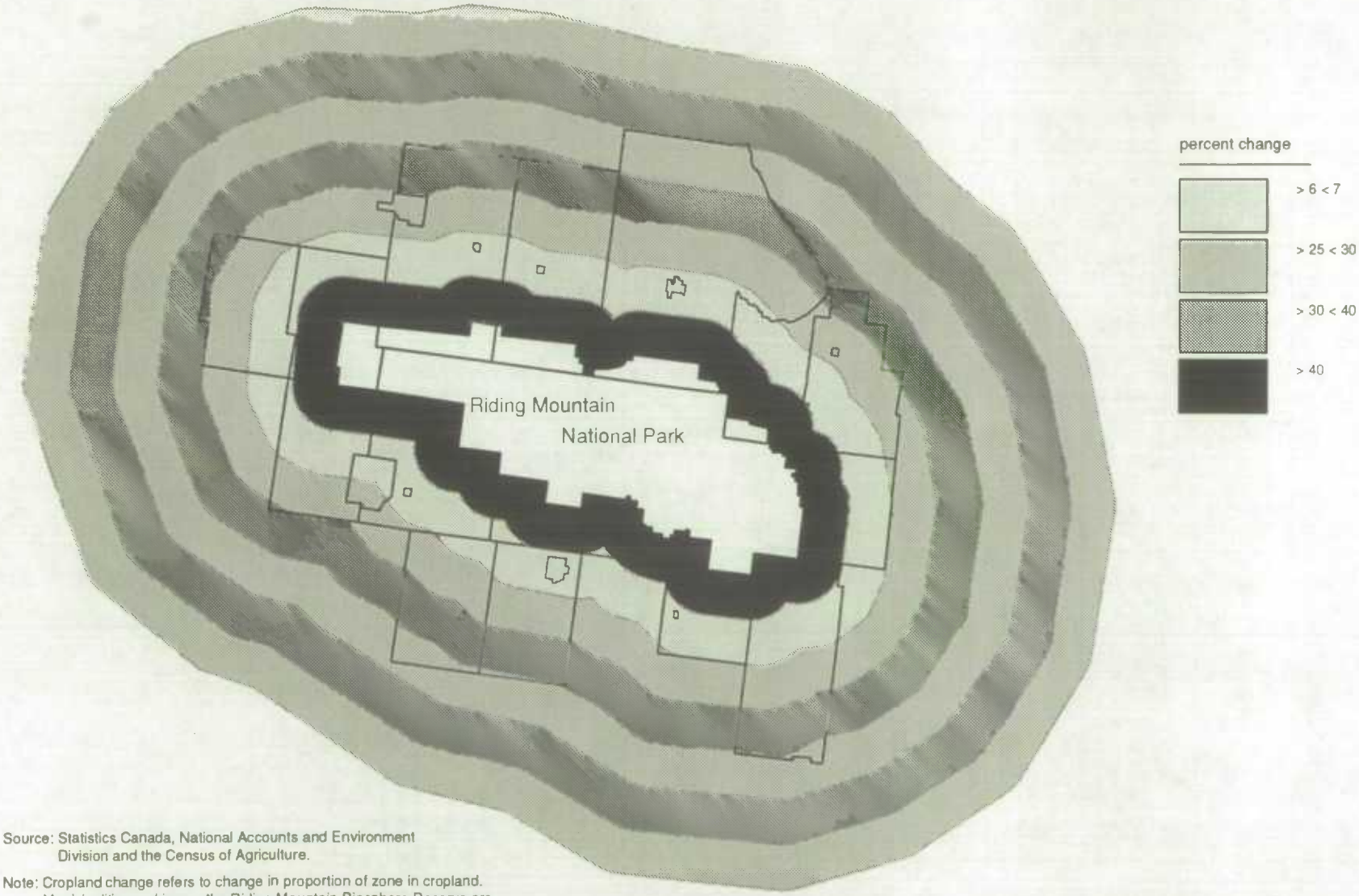
### Changes in Unimproved Farmland Around Riding Mountain National Park, 1971-1986

| Radial Zone[1] | Unimproved Farmland | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Unimproved pasture | | | Woodland | | | Other unimproved land | | |
| | 1971 | 1986 | Change 1971-1986 | 1971 | 1986 | Change 1971-1986 | 1971 | 1986 | Change 1971-1986 |
| | thousand hectares | | percent | thousand hectares | | percent | thousand hectares | | percent |
| 0-10 Kilometre Zone | 42 | 59 | 39.5 | 16 | 9 | - 45.2 | 63 | 25 | - 60.7 |
| 10-20 Kilometre Zone | 48 | 50 | 3.9 | 15 | 6 | - 60.6 | 83 | 21 | - 74.2 |
| 20-30 Kilometre Zone | 93 | 104 | 12.0 | 18 | 6 | - 64.8 | 132 | 25 | - 81.4 |
| 30-40 Kilometre Zone | 59 | 74 | 25.2 | 12 | 5 | - 59.0 | 108 | 29 | - 73.1 |
| 40-50 Kilometre Zone | 98 | 110 | 11.6 | 26 | 8 | - 70.2 | 160 | 28 | - 82.7 |
| 50-60 Kilometre Zone | 74 | 133 | 81.1 | 27 | 8 | - 72.3 | 132 | 44 | - 66.5 |
| 60-70 Kilometre Zone | 129 | 136 | 5.2 | 24 | 7 | - 69.7 | 185 | 36 | - 80.7 |
| **Total** | **544** | **667** | **25.5** | **138** | **48** | **- 63.1** | **863** | **207** | **- 74.2** |

**Source:**
Statistics Canada, National Accounts and Environment Division and Agriculture Division.
**Notes:**
[1] 10 kilometre radial zones were used to classify data concentrically around Riding Mountain National Park.

# Riding Mountain Biosphere Reserve Land Use Study

## Percent Change in Cropland Area, 1971-1986



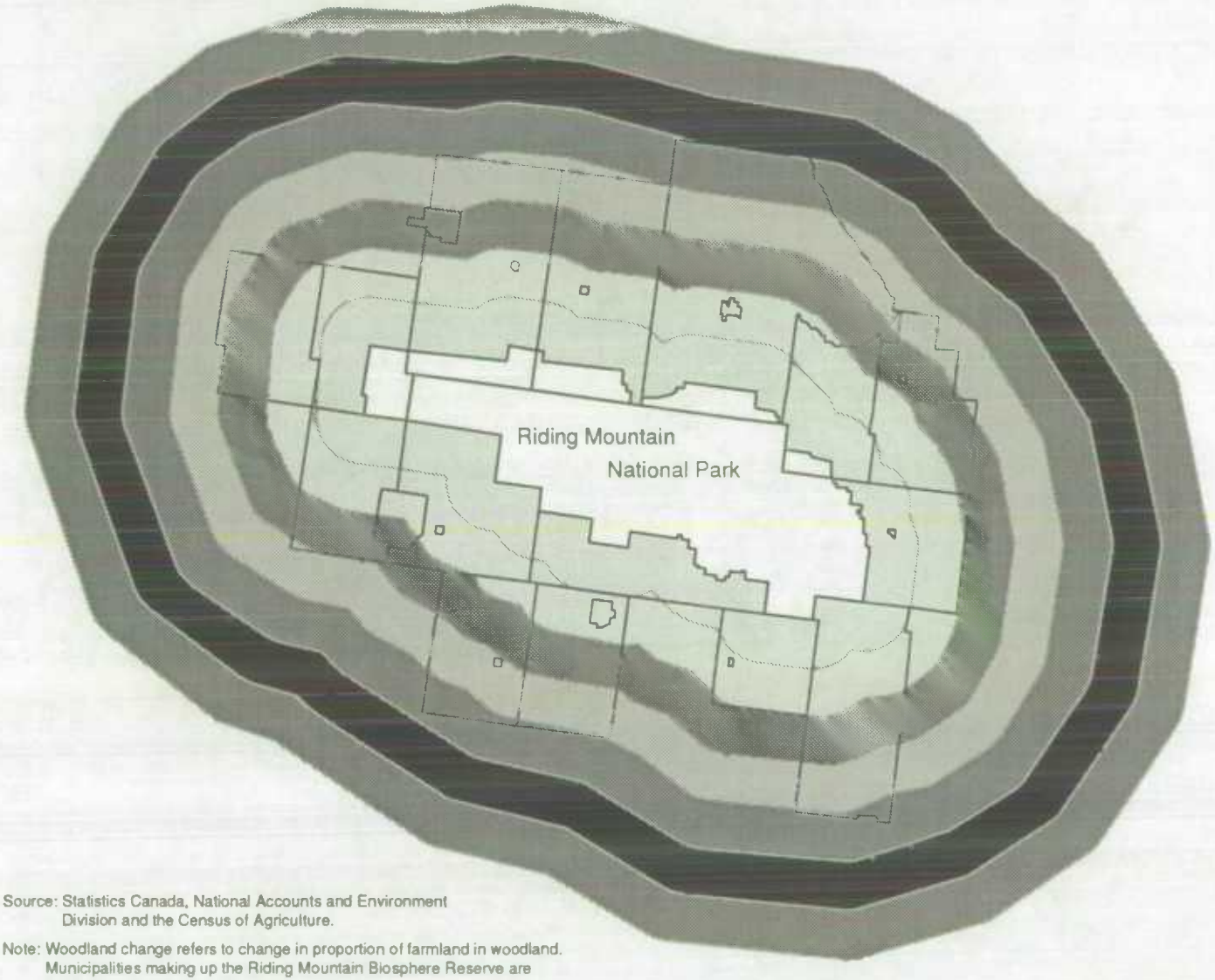

Source: Statistics Canada, National Accounts and Environment Division and the Census of Agriculture.

Note: Cropland change refers to change in proportion of zone in cropland. Municipalities making up the Riding Mountain Biosphere Reserve are outlined around the park.

Map 5

# Riding Mountain Biosphere Reserve Land Use Study

## Percent Change in Woodland Area, 1971-1986




Source: Statistics Canada, National Accounts and Environment Division and the Census of Agriculture.

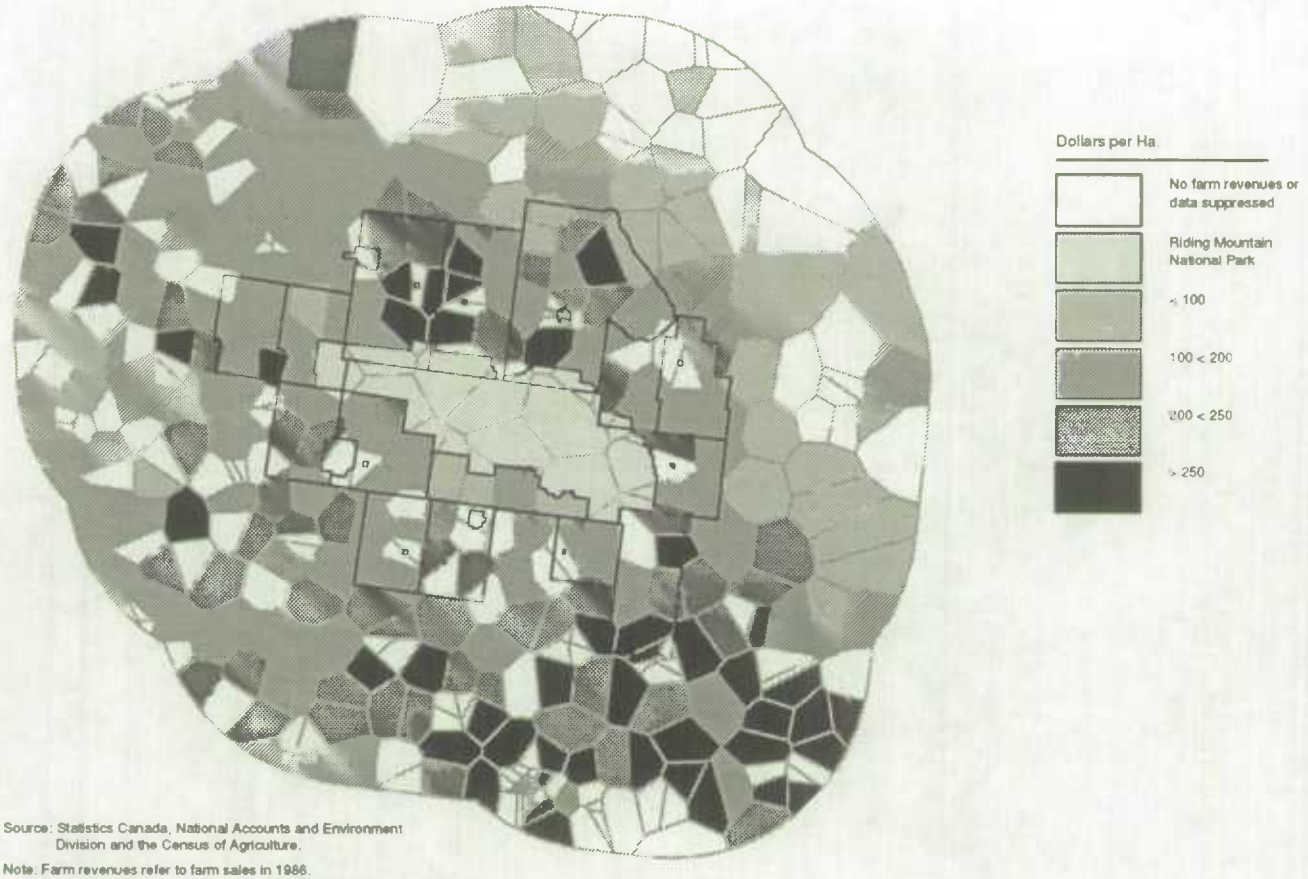
Note: Woodland change refers to change in proportion of farmland in woodland. Municipalities making up the Riding Mountain Biosphere Reserve are outlined around the park.

## Section 3 - Farm Income, Inputs and Agricultural Practices

The distribution of farm income per hectare of farmland around Riding Mountain appears to show a concentration of high income earners in the south on the black chernozemic soils, with lower incomes in the north on the luvisolic soils. (See Map 6 and Map 1) Farmers in areas close to the park have lower incomes, with the exception of some polygons[16] along the northern park boundary which are on dark grey chernozemic soils.

### Map 6

Riding Mountain Biosphere Reserve
Farm Revenue Per Hectare of Farmland, 1986




Source: Statistics Canada, National Accounts and Environment Division and the Census of Agriculture.

Note: Farm revenues refer to farm sales in 1986.
Municipalities making up the Riding Mountain Biosphere Reserve are outlined around the park.

16. The spatial units (polygons) in Map 5 are generated from enumeration area centroid points. Thiessen polygons are created around each centroid using a "nearest neighbor function". Lines between points are bisected at the mid-point to form continuous boundaries around each point.

Agricultural practices have changed significantly on the Prairies over the last twenty years. As previous tables indicated, fewer farmers are operating more farm area. In an effort to increase production and stay competitive, more farm inputs such as fertilizers, chemicals and fuels are being consumed than ever before. Bigger more costly equipment is being purchased to operate larger and larger farms. Farmers have expanded their operations and have begun to rely on labour saving, capital intensive technology to operate these bigger farms. The environmental cost of these new technologies is substantial.[17]

Agricultural production in Canada has quadrupled in the last 60 years.[18] Farming methods and cropping practices have changed. Farms have become highly productive and are specializing in a narrower range of activities than ever before. Farms are taking advantage of the economies of scale that evolve around having singular functions. Increased production often implies radically modifying the natural environment, so that growth can take place unimpeded by environmental factors which might otherwise slow it. An extreme example of this is the use of a green house where natural conditions are so controlled that almost any crop can be grown at any latitude. A less extreme example is the growth of a typical field crop. Environmental factors such as moisture level, flora diversity, fauna variety, soil tilth, wind strength and nutrient availability are all controlled by man. Implementing these types of controls on a large scale (millions of hectares) has inevitable consequences for the natural environment.

The agricultural activity surrounding Riding Mountain is not the intense, high yielding type found in the mid-western United States. The range of crops that can be grown economically at such northerly latitudes is small, and consists mainly of grains and cereals, or close-row type crops. Table 5 summarizes how the majority of cultivated land is being utilized.

## Table 5

### Close-Row Monoculture Cropping Changes, by Zone, 1971 and 1986

| | Cultivated land area[1] | | | Close-row monoculture area | | | Close-row monoculture proportion of total cultivated land | | |
|---|---|---|---|---|---|---|---|---|---|
| Radial Zone[2] | 1971 | 1986 | Change 1971-1986 | 1971 | 1986 | Change 1971-1986 | 1971 | 1986 | Change 1971-1986 |
| | thousand hectares | | percent | thousand hectares | | percent | | | |
| 0-10 Kilometre Zone | 153 | 185 | 21.3 | 131 | 143 | 9.1 | 86 | 77 | - 10.0 |
| 10-20 Kilometre Zone | 203 | 183 | - 9.7 | 180 | 152 | - 15.8 | 89 | 83 | - 6.8 |
| 20-30 Kilometre Zone | 217 | 226 | 4.2 | 192 | 185 | - 3.7 | 88 | 82 | - 7.6 |
| 30-40 Kilometre Zone | 211 | 219 | 3.8 | 195 | 198 | 1.7 | 93 | 91 | - 2.1 |
| 40-50 Kilometre Zone | 229 | 244 | 6.4 | 202 | 203 | 0.6 | 88 | 83 | - 5.5 |
| 50-60 Kilometre Zone | 229 | 251 | 9.5 | 210 | 217 | 3.5 | 91 | 86 | - 5.5 |
| 60-70 Kilometre Zone | 257 | 266 | 3.6 | 231 | 233 | 0.6 | 90 | 88 | - 2.9 |
| **Total** | **1 499** | **1 574** | **5.1** | **1 342** | **1 331** | **- 0.8** | **90** | **85** | **- 5.6** |

**Source:**
Statistics Canada, National Accounts and Environment Division and Agriculture Division.
**Notes:**
[1] Cultivated Land refers to land under crops and land in summerfallow.

17. Dumanski, J. et al. *Soil Conservation in Canada*, Journal of Soil and Water Conservation, July/Aug, Soil Conservation Society of America, 1986, p.205.
18. Statistics Canada, *Human Activity and the Environment*, National Accounts and Environment Division, cat 11-509, 1991, p. 186
18. Statistics Canada, *Environmental Information System*, National Accounts and Environment Division, 1992.

Close-row crops dominate the study area. In total they made up more than 85 percent of cultivated land in 1986, a decrease from more than 90 percent in 1971. The remainder of cropland in the study area is planted in forage type crops such as tame hay. Crop cover around the park is important because it influences food supply for wild animals, determines soil erosion rates, affects soil quality, affects water quality and influences ecological stability by limiting species diversity. The current downward trend away from completely close-row monoculture is positive because it indicates that crop rotation may be increasing and the cropping base is becoming more diverse from an ecological perspective. Two crop types of note are oilseeds and specialty crops, which have both increased significantly over the study period.

The volume of agricultural fertilizers applied around Riding Mountain National Park has more than quintupled during the study period, from roughly 20,000 tonnes in 1971, to almost 150,000 tonnes in 1986. The application rate also increased from 65 kilograms per hectare to 145 kilograms per hectare. (See Table 6 and Map 7)

## Table 6

### Commercial Agricultural Fertilizer Application, 1970 and 1985

| | Commercial fertilizer tonnage | | | Area fertilized | | | Application rate | | |
|---|---|---|---|---|---|---|---|---|---|
| Radial Zone[1] | 1971 | 1986 | Change 1971-1986 | 1971 | 1986 | Change 1971-1986 | 1971 | 1986 | Change 1971-1986 |
| | tonnes | | percent | thousand hectares | | percent | kg/hectare | | percent |
| 0-10 Kilometre Zone | 1 843 | 14 382 | 680.3 | 28 | 106 | 279.1 | 66.1 | 136.1 | 105.9 |
| 10-20 Kilometre Zone | 2 950 | 16 533 | 460.4 | 43 | 119 | 175.3 | 68.5 | 139.5 | 103.5 |
| 20-30 Kilometre Zone | 2 944 | 23 258 | 689.9 | 47 | 147 | 215.0 | 63.0 | 157.9 | 150.8 |
| 30-40 Kilometre Zone | 2 576 | 22 059 | 756.3 | 43 | 154 | 257.3 | 59.7 | 143.0 | 139.6 |
| 40-50 Kilometre Zone | 2 989 | 22 022 | 636.9 | 46 | 157 | 237.6 | 64.3 | 140.3 | 118.3 |
| 50-60 Kilometre Zone | 3 009 | 25 902 | 760.8 | 48 | 171 | 255.9 | 62.6 | 151.4 | 141.9 |
| 60-70 Kilometre Zone | 3 635 | 25 076 | 589.8 | 53 | 179 | 236.6 | 68.5 | 140.3 | 104.9 |
| **Total** | **19 947** | **149 233** | **648.2** | **309** | **1 032** | **234.7** | **64.7** | **144.5** | **123.6** |

**Source:**
Statistics Canada, National Accounts and Environment Division and Agriculture Division.
**Notes:**
[1] 10 kilometre radial zones were used to classify data concentrically around Riding Mountain National Park.

These rates have increased sharply, but are still well below those found in eastern Canada which can exceed 2,000 kilograms per hectare. Fertilized area around the park has gone up by 235 percent over the study period.

Fertilizer tonnages for 1971 were estimated from fertilizer expense data. Changing commercial fertilizer tonnages do not fully account for increases in commercial nutrients applied. Fertilizer nutrient contents have been increasing steadily over time. The average nutrient content of fertilizers in 1971 was 48 percent. By 1986 this value had increased to 58 percent.[19]

19. Agriculture Canada, *Statistics on Canadian Fertilizer Consumption 1985/1986*, doc. 0480n, 1987.

## Table 7

### Agricultural Pesticide Expenditures and Application Rates, 1970 and 1985

| Radial Zone[1] | Agricultural pesticide expenditures | | | Cultivated land area | | | Value of pesticide per hectare of cultivated land | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1970 | 1985 | Percent change 1970-1985 | 1970 | 1985 | Percent change 1970-1985 | 1970 | 1985 | Percent change 1970-1985 |
| | constant 1985 dollars | | percent | thousand hectares | | percent | $/hectare | | percent |
| 0-10 Kilometre Zone | 315 053 | 2 966 483 | 841.6 | 153 | 185 | 21.3 | 2 | 16 | 676.4 |
| 10-20 Kilometre Zone | 480 591 | 3 350 309 | 597.1 | 203 | 183 | - 9.7 | 2 | 18 | 671.7 |
| 20-30 Kilometre Zone | 422 734 | 4 009 348 | 848.4 | 217 | 226 | 4.2 | 2 | 18 | 810.0 |
| 30-40 Kilometre Zone | 489 741 | 4 209 813 | 759.6 | 211 | 219 | 3.8 | 2 | 19 | 727.8 |
| 40-50 Kilometre Zone | 522 824 | 3 668 696 | 601.7 | 229 | 244 | 6.4 | 2 | 15 | 559.5 |
| 50-60 Kilometre Zone | 457 376 | 4 407 643 | 863.7 | 229 | 251 | 9.5 | 2 | 18 | 780.4 |
| 60-70 Kilometre Zone | 516 911 | 4 444 918 | 759.9 | 257 | 266 | 3.6 | 2 | 17 | 730.2 |
| **Total** | **3 205 230** | **27 057 210** | **744.2** | **1 499** | **1 574** | **5.1** | **2** | **17** | **703.6** |

**Source:**
Statistics Canada, National Accounts and Environment Division and Agriculture Division.
**Notes:**
[1] 10 kilometre radial zones were used to classify data concentrically around Riding Mountain National Park.

Agricultural pesticide applications have also increased substantially in the study area. Pesticide expenditures indicate that there has been a 744 percent increase in pesticides applied. These increases are large but actual application rates are one third of those in eastern regions of Canada. The use of pesticide expense data does not directly indicate changing pesticide volumes or toxicity levels. (Tables 7 and 8, Map 8)

The increase in agricultural inputs around the park does not imply that the park itself is receiving similar increases of excess inputs. The transportation mechanisms bringing residual agricultural inputs into the park protect the park to some degree. Streamflow is downslope away from the park, keeping water soluble pesticides and fertilizer nutrients from entering the park in surface water. Ground water is a possible route of entry, and is very difficult to quantify without detailed subsurface hydrology data. More probable entry routes are via the wind, and in birds and animals as they forage in fields around the park.

## Table 8

### Areas Sprayed With Insecticides and Herbicides, 1970 and 1985

| Radial Zone[1] | Area sprayed for insects | | | Area sprayed for weeds | | |
|---|---|---|---|---|---|---|
| | 1970 | 1985 | Percent Change 1970-1985 | 1970 | 1985 | Percent Change 1970-1985 |
| | hectares | | percent | hectares | | percent |
| 0-10 Kilometre Zone | 3 316 | 6 124 | 84.7 | 41 538 | 111 147 | 167.6 |
| 10-20 Kilometre Zone | 5 234 | 5 043 | - 3.6 | 63 379 | 118 755 | 87.4 |
| 20-30 Kilometre Zone | 6 831 | 9 309 | 36.3 | 64 367 | 145 373 | 125.9 |
| 30-40 Kilometre Zone | 3 541 | 10 591 | 199.1 | 62 060 | 152 467 | 145.7 |
| 40-50 Kilometre Zone | 4 595 | 15 761 | 243.0 | 68 747 | 150 081 | 118.3 |
| 50-60 Kilometre Zone | 3 250 | 15 370 | 373.0 | 69 604 | 164 822 | 136.8 |
| 60-70 Kilometre Zone | 4 425 | 16 330 | 269.0 | 72 581 | 175 276 | 141.5 |
| **Total** | **31 191** | **78 528** | **151.8** | **442 276** | **1 017 921** | **130.2** |

**Source:**
Statistics Canada, National Accounts and Environment Division and Agriculture Division.
**Notes:**
[1] 10 kilometre radial zones were used to classify data concentrically around Riding Mountain National Park.

## Conclusions

Riding Mountain National Park has long been threatened by agricultural encroachment. The natural geographic barrier posed by the escarpment has always protected the park, and despite the multitude of changes that have occurred around the park, wildlife continues to thrive.

Nevertheless, agricultural activities around Riding Mountain National Park are still intensifying.

- Tilled land areas close to the park have increased by more than 20 percent.
- Woodland areas close to the park have declined by more than 45 percent.
- Pesticide use has increased markedly.
- Fertilizer application rates have more than doubled.
- Fertilized areas have more than tripled.

The land base used by agriculture is expanding to take up more and more land. At the same time, cultivation activities are also increasing with greater and greater proportions of farmland going into production. Farm pesticide and fertilizer application rates are also increasing, placing additional stress on natural systems. Reductions in biodiversity around the park brought on by large scale agricultural development and mono-cropping are potentially dangerous to established ecological balances within the park. Wildlife food supplies and subsequent population stabilities are at higher risk because of observed reductions in biodiversity.

These facts lead to important questions that will have to be answered if the relationship between the park and its surroundings is to remain stable in the long term. For example, how long can agriculture continue to intensify? Indeed, is the current relationship sustainable? What formula can be used to weigh environmental costs against the benefits of agricultural development? What measures can be taken to ensure a long term viable co-existence? These and other related questions will have to be carefully considered by society in the years ahead.

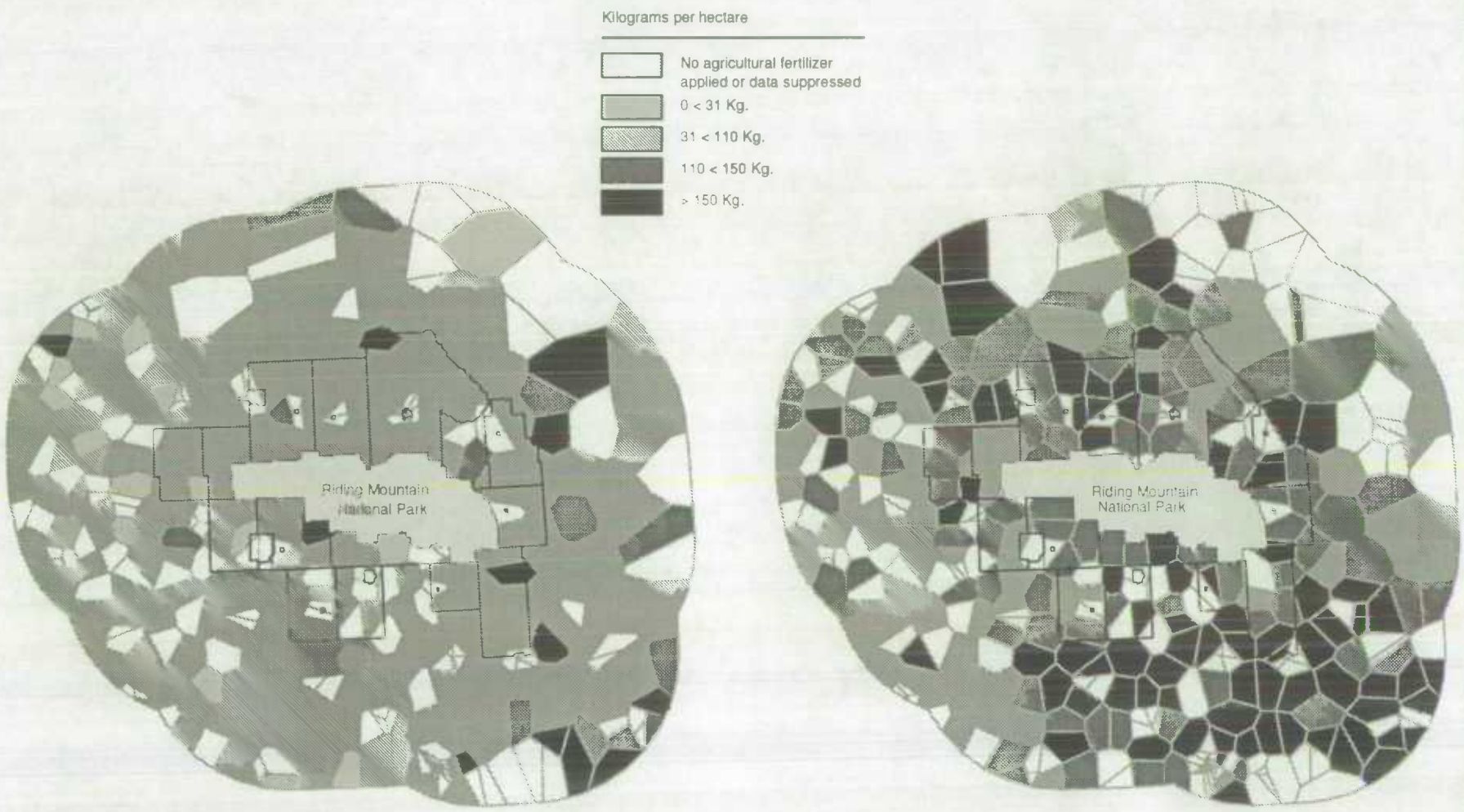
# Riding Mountain Biosphere Reserve - Agricultural Fertilizer Application Rates, 1970 and 1985

## 1970

Total tonnes = 31,080

## 1985

Total tonnes = 227,063




Source: Statistics Canada, National Accounts and Environment Division.

Note: Fertilizer data for 1970 were estimated from expense data.
This map represents areas within a 90 km radius of the park.
Municipalities making up the Riding Mountain Biosphere Reserve are outlined around the park.

# Riding Mountain Biosphere Reserve - Agricultural Pesticide Application Rates, 1970 and 1985

## 1970

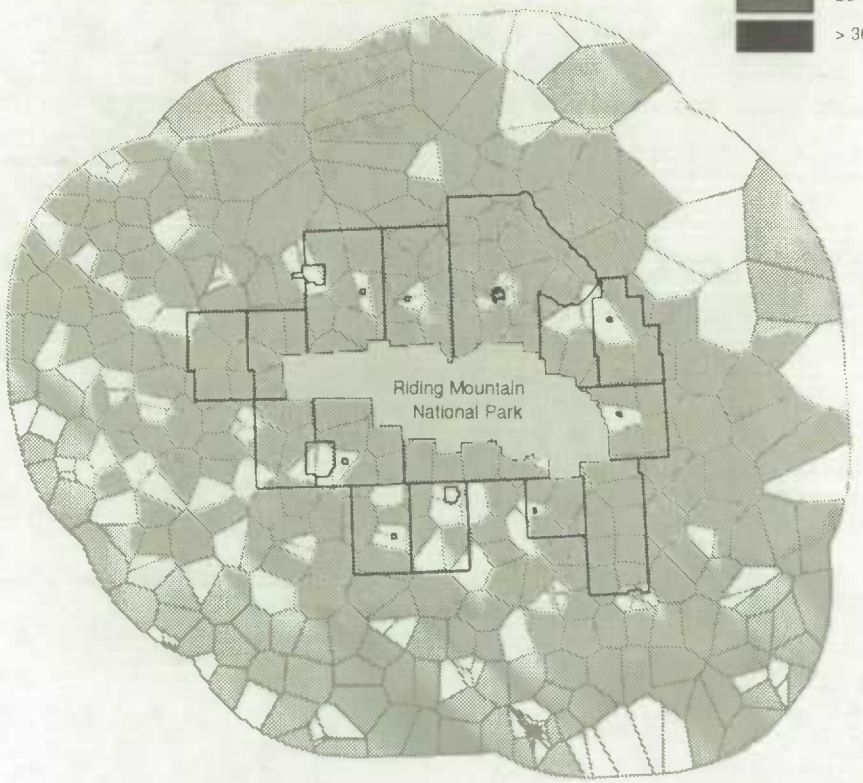
Total chemical value =
$4.88 million dollars

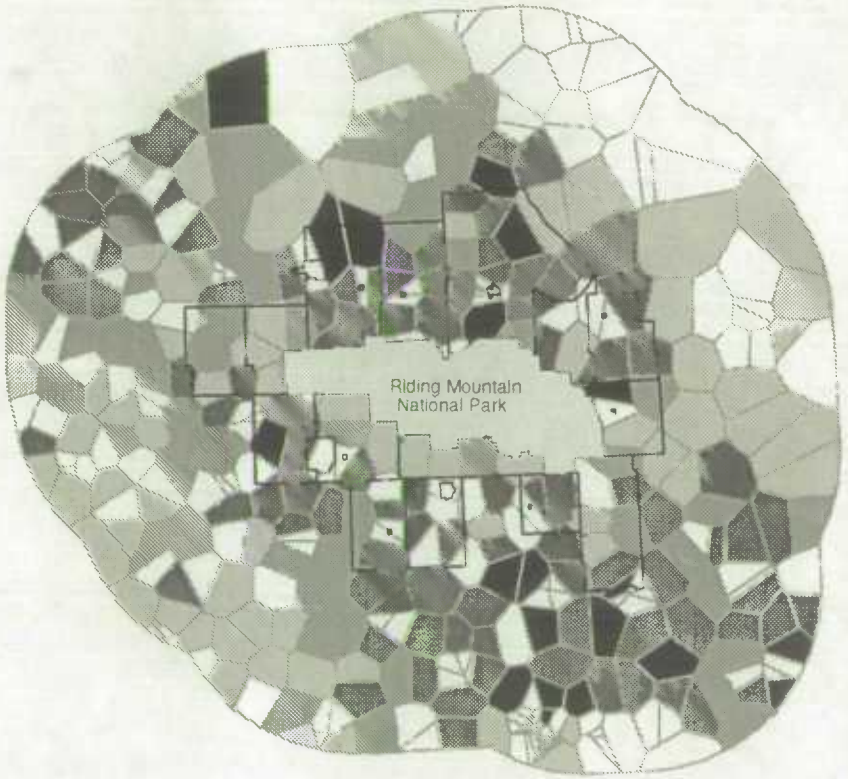
## 1985

Total chemical value =
$41.3 million dollars

1986 dollars per cropland hectare

- No agricultural chemicals applied or data suppressed
- 0 < 15
- 15 < 20
- 20 < 30
- > 30




Source: Statistics Canada, National Accounts and Environment Division.

Notes: Chemical expense data were converted to constant dollars using farm input price indicies.
This map represents areas within a 90 km radius of the park.
Municipalities making up the Riding Mountain Biosphere Reserve are outlined around the park.

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3. Smith, Robert (September 1990): ***An Annotated Bibliography of the Resource and Environmental Accounting and Valuation Literature.***

4. Gervais, Yvan (October 1990): ***Some Issues in the Development of Natural Resources Satellite Accounts: Valuation of Non-renewable Resources.***

5. Mitchell, Bruce and Kirk Hamilton (December 1990): ***Environmental Statistics at Statistics Canada,*** also available in French: ***La statistique environnementale à Statistique Canada.***

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