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The Changing Rural Environment: A Look at Eastern Ontario's Jock River Basin

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The Changing Rural Environment: A Look at Eastern Ontario's Jock River Basin

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The Changing Rural Environment: A Look At Eastern Ontario's Jock River Basin

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Forward

I was originally approached by Ray Bollman to present a paper to the Statistics Canada's Rural Reality Conference titled "The State of Canada's Rural Environment". I pointed out that if a team of 200 hundred scientists had difficulty determining the state of Canada's rural environment then perhaps the focus should be narrowed somewhat. The introduction to this paper describes some important historical trends and relationships which are contributing to the state of Canada's rural environment, but it does not tell us what the actual state of the environment is. As an alternative, I decided to present initial research results from a case study on the Jock River Basin. The Jock River comprises some 565 square kilometers, or 0.005% of Canada's land area, hardly representative of the rural environment in Canada. Nonetheless, it is our feeling that many of the problems encountered and trends observed will be indicative of the situation in many other rural river basins.

For the purposes of this paper, the rural environment is defined as everything within the boundaries of Canada that is not part of the urban environment. This definition includes such things as land, water, forests, minerals, soils, mountains, wildlife and even air.

I would like to thank all of Statistics Canada's Environment and Natural Resources Section staff for their critical review of this paper. In particular I would like to thank staff members Murray Cameron and Hélène Trépanier for their suggestions and contributions to the research which supports this study.

Introduction - Canada's Rural Environment

The rural environment in Canada has seen more changes in the 20th century, than it has since the last ice age. Most of these changes have been caused by a growing human population. One hundred years ago, Canada had a population of 4.8 million, today the population exceeds 26.2 million. At the same time, global population has grown exponentially, from under 1 billion in 1890 to over 5 billion today. Increasing population, has placed increased demands on the rural environment to not only feed people, but to support their economic livelihoods, by providing the essential raw materials for a modern, urban society. For the time being, the rural environment has been able to sustain increased demands for food and natural resources.

Natural resource consumption continues to grow in Canada. Canadians are consuming more water, minerals, forest products, and land resources than ever before. *(Statistics Canada, 1986)* For example, a century ago the energy demand of Canadian society was some 300 terajoules, (300 trillion joules) most of which came from renewable sources. Today, total energy demand is in excess of 8,000 terajoules, and most of this comes from non-renewable sources. On a per capita basis, Canadians consumed 60 megajoules (60 million joules) per person in 1890, by 1990 the average Canadian was consuming 300 megajoules.*(Statistics Canada, 1986)* The impacts of energy development on the rural environment range from the creation of reservoirs for hydro-electricity generation, to potential global climatic changes caused by energy based carbon dioxide emissions.

Another example of increasing natural resource consumption comes from agriculture where loss of fertile land and land degradation, pose a serious problem. Agriculture ranks only behind tundra and forests, in terms of Canadian land area occupied. In 1890, 5 million hectares of land were cultivated to provide food for 4.8 million people. Today, most of the suitable agricultural land resource base is being cultivated amounting to some 47 million hectares. Since 1890, the number of hectares cultivated per capita has doubled going from 1 hectare per capita to almost 2 in 1990. At the same time crop yields per hectare have more than doubled for most crops, due to improvements in cultivation techniques and developments in genetic research. For the most part, the impacts of agriculture on the rural environment have evolved since World War II, with the development of highly productive, capital-intensive, labor substituting technology.*(Dumanski et al., 1986)* Modern agricultural practices contribute to Canada's large food surplus. In 1987, Canada produced a crop surplus sufficient to feed 325 million people.*(UN. 1988)* Productivity does not come without a price. It is apparent that much of the productivity gain has been achieved at considerable cost to the environment and the natural fertility of many soils.*(Dumanski et al., 1986)* As resource demands from the rural environment increase, it is inevitable that the question of long term sustainability arises. Measuring resource flows and subsequent sustainability are challenges that will have to be met, if we are to maintain current living standards and provide for future generations.

The consumption habits of an increasing population are important determinants of rural environmental quality. Over the last century Canadians have been enjoying a steadily rising standard of living, which is reflected by an increased per capita consumption of goods and services. *(Statistics Canada, 1983, 1990.)* Rising living standards have not come without negative environmental costs. Take the solid waste problem as an example, where goods consumption and subsequent waste production have increased to the point where many waste storage sites are reaching capacity sooner than expected. (most urban waste sites are located in the rural environment. Unfortunately, the solid waste problem is often poorly catalogued, and it is not always known what is dumped where, or for that matter how wastes will interact with the environment at disposal sites. Unanswered questions such as these make it difficult to determine the actual state of the environment.

The main challenge faced by today's rural sector is to continue to provide food and resources for Canada's population at sustainable rates. This challenge is threatened by problems such as continued soil erosion, declining soil fertility, monoculturing, the build up of toxic materials, and loss of arable land to urban uses. Obtaining relevant information for analysis is essential to solving both large and small environmental problems. Finding applicable information is often most easily accomplished at a local level. The familiarity and concern that people have with their own immediate surroundings provides a wealth of knowledge that is often hidden to larger scale studies. The remainder of this paper will explore environmental issues in a small area only. The area that has been focused upon, is Eastern Ontario's Jock River Basin. The main objectives of this paper are to develop and analyze a river basin profile using detailed local information.

The Jock River Case Study

The purpose of the Jock River Case Study is to identify and assess the environmental impact of human activities in the river basin.

Background

The Jock River is a major tributary of the Rideau River which flows from the Rideau Lakes towards the city of Ottawa, where it meets the Ottawa River. The Jock River Basin has been mainly farmland since it was cleared of forests in the early 1800's. Today, while still predominantly agricultural, the Jock River Basin is being urbanized as Ottawa's rural-urban fringe expands away from city's central core. The Jock River basin is shared by 4 municipalities, Goulbourn, Nepean, Rideau and Beckwith. For some time now residents and users of the Jock River basin have been aware of water quality problems which make the Jock unusable for recreational activity. Weed growth makes the river un-navigable in summer months, swimming is a thing of the past, fishing is successful only in early spring and using the river as source of potable water would prove quite hazardous.

In 1989 a group of concerned citizens formed a committee known as *"The Friends of the Jock River"*. Preliminary results from an environmental monitoring program in the summer of 1990 showed the river to be polluted. Phosphorus levels as well as bacteria levels were well above provincial guidelines. Statistics Canada's Environment and Natural Resources Section, is providing data to this group to help it identify potential environmental impacts in the Jock River Watershed. The Environment and Natural Resources Section operates and maintains a large geographically referenced database known as the *Environmental Information System* **(EIS)** which can be used to analyze environmental problems on various scales ranging from large national studies to assessing local watershed concerns. The system is particularly useful for re-aggregating data to spatial units which will provide the necessary foundation for analysis. Watersheds are a good example of these spatial units, where impacts within a river system transcend traditional political boundaries, and it becomes essential to know about activities throughout the catchment area.

Methodology

Much of the Research in this study employed Geographic Information System (GIS) technology to develop a detailed statistical profile of the river Basin. A Rideau Valley Conservation Authority watershed map was used to capture a digital picture of the river and its catchment area. This was accomplished by digitizing the watershed boundaries and creating a computer map which could then be selectively combined with the information layers in the EIS. These information layers provided data on physiography, climate, soils, population, labour force characteristics, agricultural activity, and manufacturing establishments throughout the basin.

Jock River Hydrological Background

Annual hydrological discharge profiles provide information about the water flow characteristics of a river throughout the seasonal drainage cycle. In order to determine the factors behind the visible decline in Jock River water quality, an analysis of the discharge profile is necessary (see graph 1). To summarise, the Jock River is characterised by low summer flow and high spring discharge. Daily Jock River discharge readings have been kept by Environment Canada since 1969. From these records the average peak discharge (110.1 cubic metres per second - March 30) is 1,310 times greater than the average low discharge (0.084 cubic metres per second - July 15). The

INDEX MAP - JOCK RIVER BASIN

Source: Statistics Canada, Environment and Wealth Accounts Division.

hypothetical forested discharge curve on graph 1 represents the same volume of water but shows the effects of a greater proportion of forest cover. For comparison, the Bow River in Alberta has a maximum discharge only 38 times larger than the minimum discharge. The high spring run-off volumes on the Jock River, cause erosion problems along the river banks, while in contrast, the low summer flow contributes to stagnation and nutrient build-up. Reasons for high spring run-off and low summer flow in the basin can be attributed to human activity in the basin. The Jock River's discharge pattern has changed over time as vegetative cover and drainage conditions have changed. (see figure 1)

Unfortunately, historical discharge records do not go back to the pre-agricultural era, when the basin was under natural forested cover. Typically, the removal of forested land increases the run-off rate in a river basin, because forests intercept and store a great deal of moisture both in the trees themselves and in soils beneath the forest. In contrast, tilled land does not store water as readily as forested land, because tilled land is exposed to direct sunlight and is frequently cultivated which brings soil moisture to the surface to be evaporated. Spring snow is also not protected by tree cover so it melts and runs-off more quickly under tilled conditions. Agricultural land is often artificially drained to allow earlier spring planting and moisture level control. Artificial drainage lowers soil moisture which in turn reduces the flow of water to the river in dry months such as August, when ground water is the major source of water for the river. In 1986, some 6,890 hectares of agricultural land in the Jock river basin were artificially drained. This amounts to more than 12% of the river basin area, and represents a substantial alteration of natural drainage patterns.

Physiography, Climate and Soils

Access to Agriculture Canada's Land Potential Database (**LPDB**) is available through Statistics Canada's **EIS**. This database contains details on Canadian land potential at a scale of 1:5,000,000. The results from overlaying the Jock River digital map and the **LPDB** are briefly described as follows. The Jock River Basin consists of two soil types: an Orthic Melanic Brunisol, and a Humic Gleysol. These are young soils which have developed under a forested environment, with the brunsolic soil being the better drained soil of the two. Fertility of these soils is generally variable, but in the Jock River basin fertility of these soils is moderate to high. These soils developed from glacial parent materials, primarily from glacial till and lacustrine deposits.

The climate in the basin can be described as one of cold winters and warm summers with moderate precipitation throughout the year. The average minimum monthly temperature occurs in January with a temperature of -16 Celsius, and the average monthly maximum temperature occurs in July with a temperature of 26.3 Celsius. Average rainfall is 370.8 centimeters per year, the wind speed averages out at just over 3 meters per second, and the growing season length in the basin is 148 days. Given the physical properties alone, the area has only a slight chance of water erosion. However, cultivation practices and field slopes have significant local effect soil erosion.

Socio-economic Conditions

Historical data from the EIS were used to analyse trends that might be affecting Jock River environmental quality. The Jock River catchment area is 56,552 hectares, and in 1971, this area was divided into the following major land use categories: 65% agriculture, 10% urban / transportation, 10% wetlands, 15% forests. By 1986 the agricultural land area, had declined to 55%, the majority of this land use change was from agriculture to urban uses (see table 1).

Agricultural practices in the basin have significant impact on environmental quality. Agriculture affects vegetative cover, soil quality and basic stream hydrology. These factors determine the physical and chemical inputs to the river system via run-off and ground water flow. Chemical expense data, (constant 1971 dollars) shows more than a doubling of expenditures on pesticides in the watershed over the 1971-1986 study period. (see map 3) Other data indicate an intensification in land use. Actual cropped area increased from 12,845 Ha to 15,075 Ha by 1986. This means that crop output potential has gone up in the basin despite the decline in agricultural land area. Fertilizer application rates have doubled during the study period, going from 1600 tonnes in 1971 to 3300 tonnes in 1986 (data for 1971 were derived from fertilizer expense data).

Land management practices in the Jock River Valley were tested using the Agricultural Practices Impact Model **APIM**.*(Statistics Canada, 1990)* Results indicate that high stress monoculture cropping practices have been on the rise over the study period. Wide-row Monoculture, the practice of planting wide-row crops year after year, occupied 5.3 percent of total crop area in 1971 rising to 13.7 of total crop area by 1986. Wide-row Monoculture is associated with high run-off and subsequent soil erosion, as well as high levels of pesticide and fertilizer inputs. The spatial correlation between fertilizers, pesticides, and wide-row monoculture is evident by comparing maps 2,3 and 4, where these activities coincide.

Census of Population figures indicate that the urban population has grown by 380%, from 2,122 in 1971 to 10,187 by 1986. Rural Population has also increased from a low of 4,873 in 1971 to over 10,500 by 1986, bringing the total population in the catchment area to some 20,695 (see map 1). This population trend is expected to continue as urban development proposals for both Nepean and Goulbourn are implemented.

The Environment and Natural Resources Section has developed a set of environmental interaction classes which are used to classify manufacturing establishments. These classes indicate whether an industry has high, medium or low impact potential on the environment. The industrial data from the 1986 Census of Manufacturers indicates that there are 9 establishments in the Jock River Basin. Most of these industries are of the low impact variety with little effect on the environment. One could conclude that manufacturing had little overall environmental impact in the basin and that stresses in the area must be primarily from human settlements and agricultural activity.

Conclusions

The Jock River Basin has undergone many changes during the past two centuries. Stream Hydrology has been significantly altered making the river more sensitive to stagnation and bacterial build up. Statistical records show that over the last twenty years population has tripled, and that use of land, has intensified significantly. Fertilizer and pesticide inputs, each of which have high environmental impact, have increased as well.

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The Jock River Watershed, 1971-1986

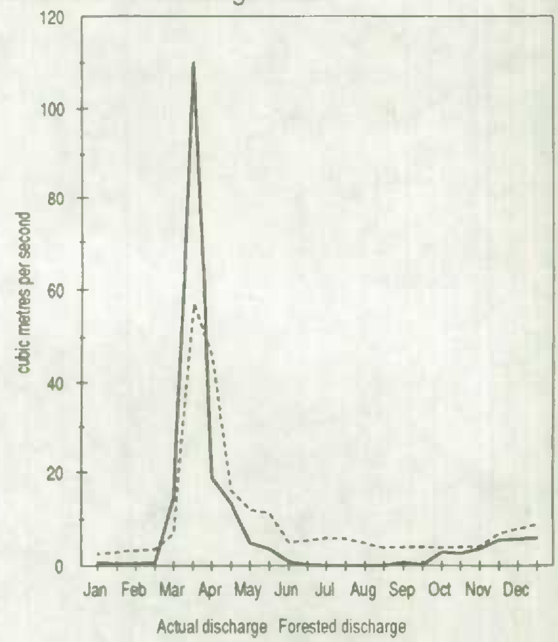
	1971	1986	percent change
Land use			
Watershed area (ha.)	56 552.2	56 552.2	
Farmland area (ha.)	35 461.0	30 850.4	- 13.0
Cropland area (ha.)	12 845.0	15 074.9	17.4
Wide-row monoculture area (ha.)	687.0	1 819.5	164.8
Chemicals			
Chemical expenses (1971 Dollars)	33 330.0	75 526.4	126.6
Chemical expenses per hectare cropland	2.6	5.0	
Population			
Urban	2 120.0	10 185.0	380.4
Rural	4 875.0	10 510.0	115.6
Total	6 995.0	20 695.0	195.9

Source:

Statistics Canada. Environment and Wealth Accounts Division.

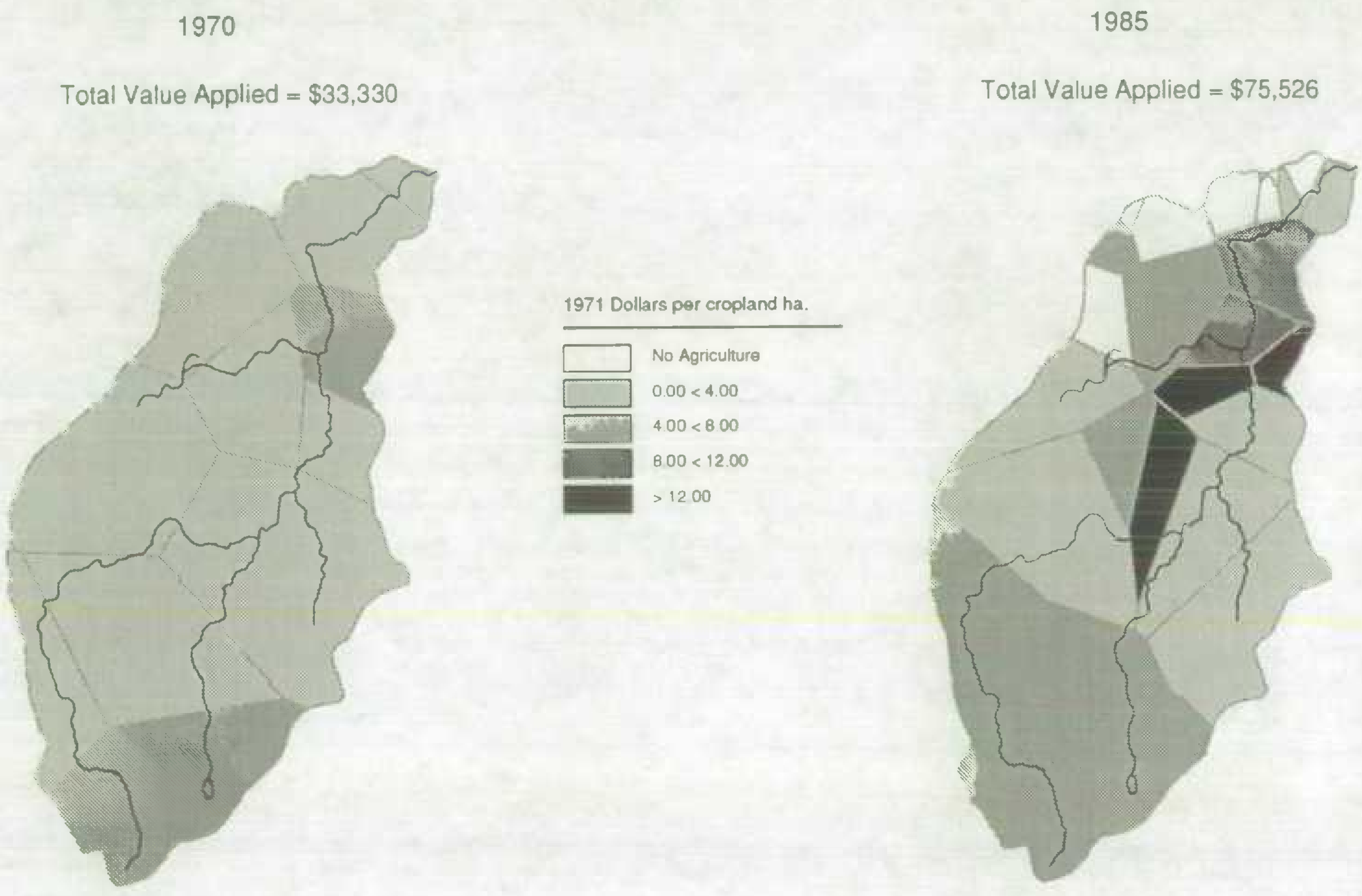
Census of Population. Census of Agriculture.

Jock River Discharge Rates



Source: Environment Canada, Inland Waters Directorate.

Agricultural Pesticide Application, 1970 and 1985
Jock River Basin



Source: Statistics Canada, Environment and Wealth Accounts Division.
Agriculture Division.

Note: All figures have been converted to constant 1971 dollars.

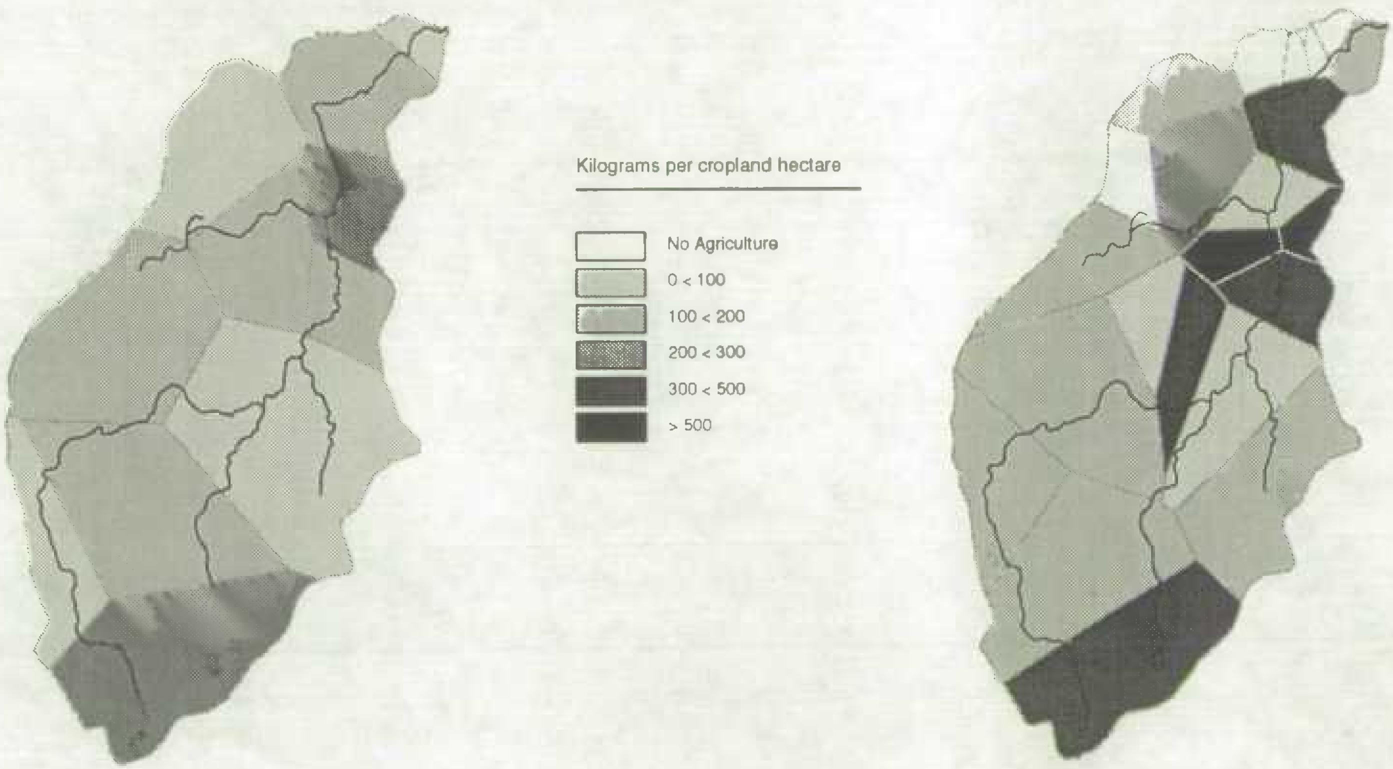
Fertilizer Application Rates, 1970 and 1985
Jock River Basin

1970

Total Tonnage = 1,615

1985

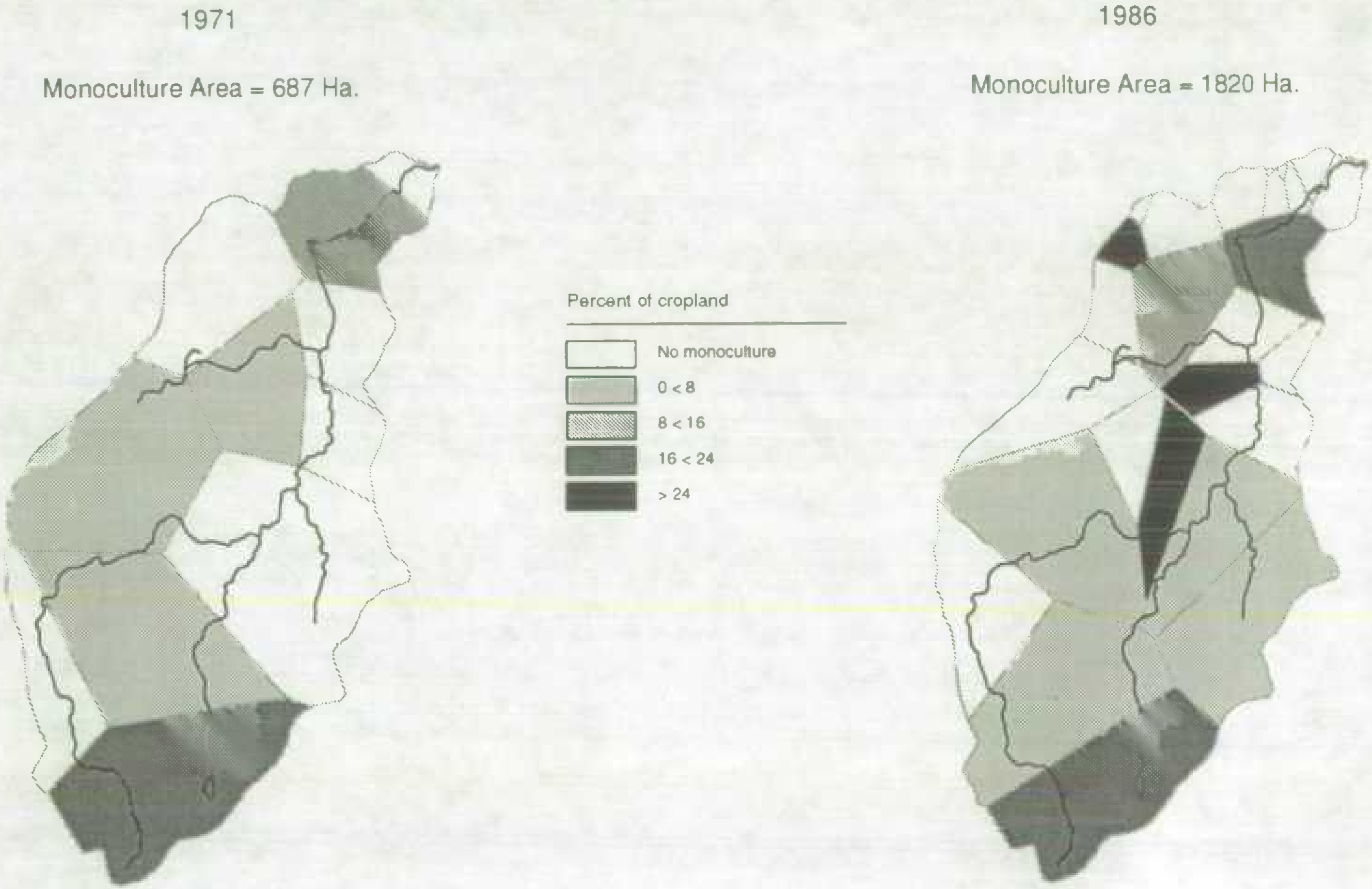
Total Tonnage = 3,295



Source: Statistics Canada, Environment and Wealth Accounts Division, Agriculture Division.

Note: Fertilizer tonnages for 1970 were estimated from fertilizer expense data.

Wide-row Monoculture, 1971 and 1986
Jock River Basin



Source: Statistics Canada, Environment and Wealth Accounts Division.
Agriculture Division.

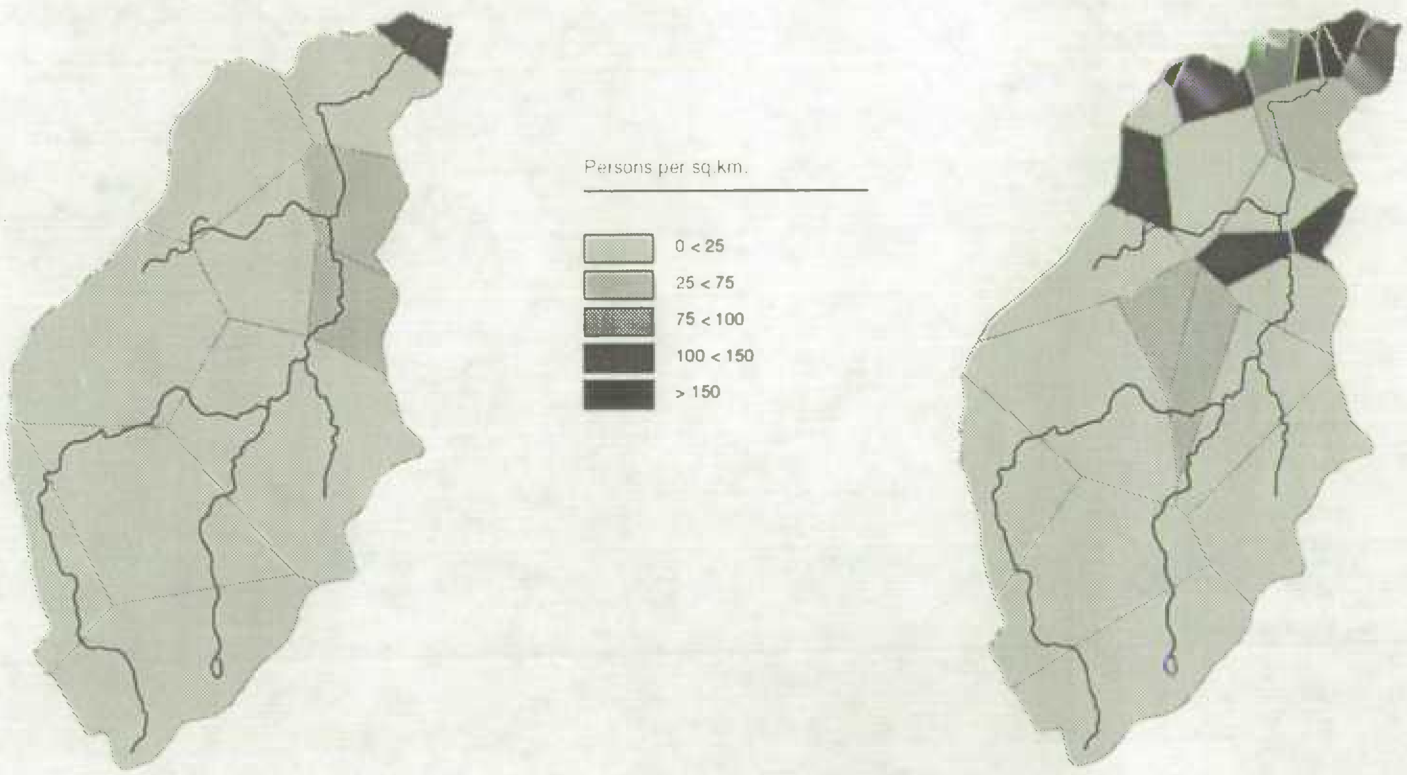
Population Density, 1971 and 1986
Jock River Basin

1971

Population = 6,995

1986

Population = 20,695



Source: Statistics Canada, Environment and Wealth Accounts Division,
Census of Population.

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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.***
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29. "National Income and Expenditure Accounts: Revised Estimates for the period from 1990 to 1993", reprinted from ***National Income and Expenditure Accounts***, first quarter 1994.

30. "The Canadian National Accounts Environmental Component: A Status Report", reprinted from ***National Income and Expenditure Accounts***, Annual Estimates, 1982-1993.

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16. "Estimations en volume du commerce international des services commerciaux", tiré à part de ***Comptes nationaux des revenus et dépenses***, troisième trimestre 1991.

17. "Le défi de la mesure dans les comptes nationaux", tiré à part de ***Comptes nationaux des revenus et dépenses***, quatrième trimestre 1991.

18. "Étude sur le flux des services de consommation générés par le stock de biens de consommation", tiré à part de ***Comptes nationaux des revenus et dépenses***, quatrième trimestre 1991.

19. "La valeur du travail ménager au Canada, 1986", tiré à part de ***Comptes nationaux des revenus et dépenses***, premier trimestre 1992.

20. "Révisions des données de la période 1988-1991 dans les comptes nationaux des revenus et dépenses", tiré à part de ***Comptes nationaux des revenus et dépenses***, estimations annuelles, 1980-1991.

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