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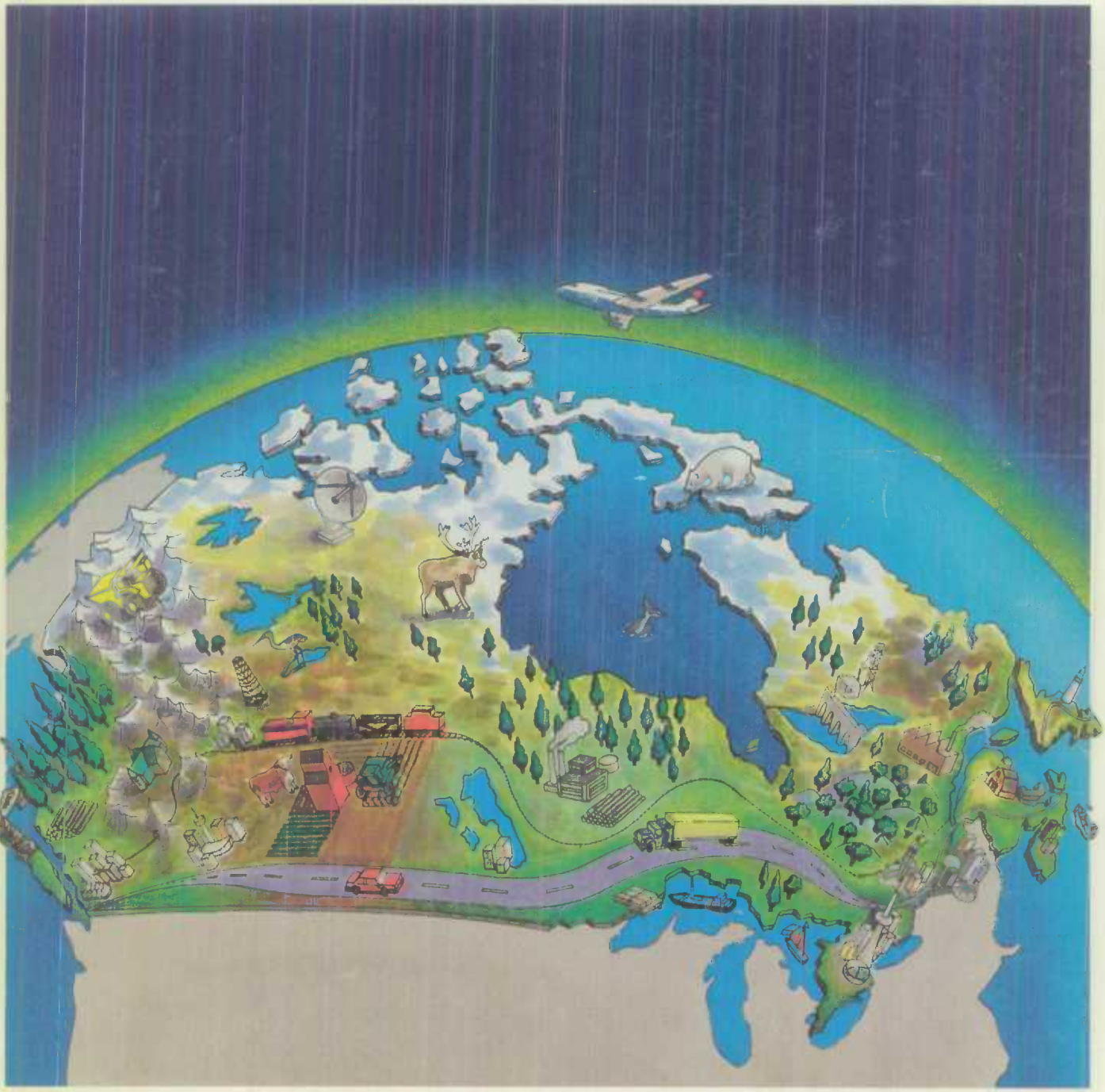
Human Activity and the Environment 1991



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Symbols and Abbreviations

The following standard symbols are used in Statistics Canada publications:

.. figures not available

... figures not appropriate or not applicable

\- nil or zero

-- amount too small to be expressed

[p] preliminary figures

[r] revised figures

x confidential to meet secrecy requirements of the Statistics Act

Prefixes of the International System of Units

prefix	Multiplication Factor	
peta	10^{15}	1 000 000 000 000 000
tera	10^{12}	1 000 000 000 000
giga	10^{9}	1 000 000 000
mega	10^{6}	1 000 000
kilo	10^{3}	1 000
hecto	10^{2}	100
deca	10^{1}	10
deci	10^{-1}	0.1
centi	10^{-2}	0.01
milli	10^{-3}	0.001
micro	10^{-6}	0.000001
nano	10^{-9}	0.000000001
pico	10^{-12}	0.000000000001

Energy Conversion Factors

1 barrel = .15891 cubic metres
1 ton = .9071847 metric tonnes

Fuel type	Natural unit	Conversion factor
		terajoules
Coal: Anthracite	kilotonnes	29.53
Imported bituminous	kilotonnes	29.99
Canadian bituminous	kilotonnes	23.81
Sub-bituminous	kilotonnes	19.76
Lignite	kilotonnes	15.35
Coke	kilotonnes	28.83
Coke oven gas	gigalitres	18.61
Propane	megalitres	25.53
Butane	megalitres	28.62
Ethane	megalitres	18.36
Crude oil	megalitres	38.51
Still gas	megalitres	41.73
Motor gasoline	megalitres	34.66
Kerosene	megalitres	37.68
Diesel	megalitres	38.68
Light fuel oil	megalitres	38.68
Heavy fuel oil	megalitres	41.73
Petroleum coke	megalitres	42.38
Aviation gasoline	megalitres	33.52
Aviation turbo fuel	megalitres	35.93
Natural gas	gigalitres	37.97
Electricity	gigawatt hours	3.6
Steam	kilotonnes	2.75
Solid wood wastes	kilotonnes	18.00
Spent pulping liquor	kilotonnes	14.00

Abbreviations

1986$	1986 constant dollars
°C	degrees Celsius
cm	centimetre
ha	hectare
hr	hour
kg	kilogram
km	kilometre
km^2	square kilometres
kPa	kilopascals
l	litre
m	metre
m^3	cubic metre
MCM	million cubic metres
mg	milligram
mm	millimetre
ng	nanogram
nec	not elsewhere classified
ppb	parts per billion
ppm	parts per million
SIC	Standard Industrial Classification
t	metric tonne
TAC	Total Allowable Catch
µg	microgram

Human Activity and the Environment

Table of Contents

1. Preface

Human Activity and the Environment provides a statistical overview of Canada's physical environment and the interactions between people and other elements of the natural system. This source book focuses on the activities of individuals and the socio-economic systems in consuming resources, in building and reshaping landscapes, and in generating wastes, as well as changes in the conditions of land, water, air and plants and animals.

Statistics Canada, Environment Canada, and other federal and provincial government agencies collect volumes of statistical information about human activities and the relationship between people and the natural environment. These data, however, are scattered among many separate databases and publications. The data are often not organized for integrated description or analysis of the environment. By bringing together a selection of these statistics and re-organizing them to enhance their value from an environmental perspective, this information will be accessible and useful to decision-makers, analysts, educators and members of the public who require environmental statistics.

Since the publication of the previous edition of *Human Activity and the Environment* in 1986, Statistics Canada has developed a statistical database of socio-economic and environmental data for state of the environment reporting. This database and associated geographic information system technology has been used by numerous agencies to provide information on many of the subject areas covered in this book. Information in this publication is available in more detail from the database which is often updated and augmented with new statistics.

Acknowledgements

This publication was prepared by the Environment and Natural Resources Section of the Environment and Wealth Accounts Division, System of National Accounts Branch under the general direction of Kishori Lal, Director General, System of National Accounts, and Kirk Hamilton, Manager of the Section. The book was edited by Michael Bordt and major contributions to the report were made by the following staff:

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Jason Siroonian
Douglas Trant
Hélène Trépanier

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1.1 Introduction and Highlights

Much has happened in the five years since Statistics Canada published the second edition of *Human Activity and the Environment*. Opinion polls show that damage to the environment has become one of the most important concerns of the public. There has been a proliferation of environmental interest groups, and many organizations in the private, public and non-profit sectors not previously involved in environmental issues have developed positions and programs on the environment.

Government has also been affected by this upsurge of interest. New environmental protection legislation has been enacted and there are embryonic attempts to integrate the environment in all government policies and plans. Advisory boards have been set up in many jurisdictions to broaden the basis on which environmental policies are made. Sustainable development has begun to compete with economic growth as the standard against which all our activities are to be evaluated.

Another important change relating to how we think about the environment is the increasing attention being given to environmental education from kindergarten to university. A better educated, more informed and more vigilant public is placing greater and greater demands on government and business to protect the environment.

The loss of species, the depletion of the ozone layer, the threat and reality of climate change, contamination of the environment with toxic wastes or the degradation of agricultural soils have generated much concern and strong emotional response. However, emotion is not enough for effective action. We need information and we need it in a form that is systematic and accessible. This is the contribution of *Human Activity and the Environment*, and the third edition is the most comprehensive and authoritative source of information for Canada on our population, our socio-economic activities, our environment and the links among them.

Using the information in *Human Activity and the Environment* to plan for the future is rather like driving a car when you can only look in the rear view mirror. Statistics, by their nature, only tell us about the past. Some of the information in *Human Activity and the Environment* is already several years old. Some is quite recent. Much of the information that we would like to have is not available at all or is not available at a national level. Nevertheless, a picture of how we interact with our environment does emerge from this book.

The Simple Equation of Human-Environment Interactions

The effect of human activity on the environment depends on how many we are, what we do, and the environmental effect of each of our activities. This relationship can be expressed as:

Effect on the environment = Population x
Socio-economic activity per person x
Environmental effect per unit of socio-economic activity

Trends in the items on the right hand side of this simple equation can tell us a lot about whether our effects on the environment are increasing or decreasing. At the same time, we should not lose sight of the effects on the population and on our activities of what happens to the environment . We should also be aware that our effects on the environment depends on the state of the environment, so that the same activity in two different places can have very different repercussions.

Human Activity and the Environment makes this kind of analysis possible by organizing the data into three components: population, socio-economic system and the natural environment within the Population-Environment Process Framework. Another feature of the report that makes it especially useful for understanding the links between the socio-economic system and the environment is the presentation of much of the data by drainage basin and ecozone[1]. Data presented in terms of these ecologically defined regions rather than jurisdictional regions can be particularly valuable for monitoring the effect of human activities on the environment.

Population

From 1971 to 1991 the Canadian population grew from 21.6 million to an estimated 26.7 million. This fact alone should alert us to the possibility that the effect of our activities on the environment has also increased. In the only section of *Human Activity and the Environment* that includes future projections, we learn that Statistics Canada expects the Canadian population to reach 30 to 35 million in the next two or three decades. Also, with the fertility rate at or below replacement rate, immigration is expected to be a more and more important determinant of population growth in Canada.

The size of the population is one consideration; its location is another. After a long period of increasing urbanization, the proportion of Canadians living in urban areas has settled down at about 75 percent with 60 percent of the population

1. A *drainage basin* is an area of land which drains into a common river or to the ocean. An *ecozone* is a natural region delineated by landform, water, soil, vegetation, climate, wildlife and human factors.

concentrated in 25 major metropolitan areas. Generally, the continuing growth in the population is expected to be most pronounced in western Canada although the demographic centre of gravity will remain in Ontario and Quebec.

Some of the effects of our activities on the environment are life threatening and yet between 1976 and 1981 life expectancy rose by 1.7 years for males and 1.5 years for females. Statistics Canada's population projections assume that these gains in life expectancy will continue, though at a diminishing rate.

Socio-Economic Activity per Person

In 1971 there was an average of 0.28 dwellings per person in Canada. Between 1971 and 1986 the number of dwellings grew much faster than the population, so that, in 1986, there were 0.35 dwellings per person. This is very significant from a social and environmental standpoint because vehicles, furnaces, air-conditioners, and appliances and the energy to operate them are purchased at the household level rather than that of the individual person, and all those purchases affect the environment. The construction of the dwellings themselves and the infrastructure required to service them also have environmental consequences. With the number of dwellings growing faster than the population it is conceivable that the environmental effects of socio-economic activity will continue to increase even as the population stabilizes or declines. Much depends on the efficiency of these activities, the third term in the equation.

The economic output per person has also risen dramatically. In 1986 each Canadian, on average, accounted for 44 percent more economic output than in 1971. The correspondence between economic output and environmental effect is not a simple one since much depends on which sectors have grown the most and what technologies and materials are employed. Of all the sectors of the economy, several stand out for their effects on the environment: energy, transportation, agriculture, smelting and refining, forestry and pulp and paper, and the chemical industry. A look at developments in just two of these is instructive.

Energy

Energy is the lifeblood of an economy. How energy is obtained and used and in what quantity is crucial for determining environmental effects. It is also a revealing indicator of the kind of economy we have and the quality of life it offers its members.

Between 1958 and 1989 the production and use of primary energy (from coal, crude oil, natural gas, hydroelectric, nuclear and steam) more than tripled. Although the annual rate of increase in primary energy has declined over the years, Canadians remain among the highest users of energy per person in the world.

About 75 percent of primary energy is used in final consumption. Industry is the largest single user followed closely by transportation. Residences, farms, public administration and commerce account for the rest. The remaining 25 percent of primary energy is used in the conversion of energy from one form to another (e.g. in the generation of electricity) or in refineries and pipelines and in non-energy use (i.e. petrochemicals).

During the past thirty years, our use of all forms of primary energy, with the exception of crude oil, has increased substantially. Oil consumption peaked in 1979 at the time of the second oil price "shock", but it has been rising again since 1986. The use of natural gas has risen more than eightfold since 1958. Our greater reliance on this comparatively clean form of fossil fuel has allowed energy use to rise with a lower effect on the environment than if we had maintained our traditional reliance on coal and oil.

The other significant change in energy production has come from the introduction of electricity obtained from nuclear power. In 1989 this source of energy provided over 12 percent of Canada's electrical generating capacity (and a higher percentage of electrical energy) but only 3 percent of total primary energy from all sources. By displacing coal fired generation and its attendant emissions of acid gases and greenhouse gases, nuclear energy reduces some adverse environmental effects. However, it brings other risks associated with the actual and potential release of radiation. Evaluating tradeoffs such as these is one of the most difficult tasks in managing future human activity and its effects on the environment.

Transportation

Transportation is important in all countries, but in one as large as Canada, with its highly mobile population, transportation takes on a particular significance. In 1981 there were 10.2 million passenger cars registered, which is 0.42 cars per person (or one car for every 2.4 Canadians). By 1986 an additional 600,000 cars were registered, and the number of cars per person increased to 0.46 (or one car for every 2.2 Canadians). In 1989 the number of cars surpassed 12.8 million.

Not only has the number of cars grown faster than the population, but the distance travelled per car has also risen. From 1981 to 1988 the total number of kilometres travelled by passenger cars grew by 22 percent.

The increasing use of the car has many environmental ramifications. Most obviously, the conversion of the chemical energy contained in oil to the kinetic energy required for travel produces enormous quantities of noxious gases. The production of cars requires very considerable quantities of steel, chemicals and energy, all having significant environmental effects. Also, the use of the car is both a cause and consequence of the suburbanization of the

population. This affects the environment through the conversion of agricultural to urban land and also by reducing the competitiveness of public transport.

Other significant developments in transportation in the past decade have been the increasing reliance on trucks rather than trains for moving freight, the decline in inter-city bus travel and the growth in air freight and air travel. Possibly, what will turn out to be more important for the environment than any of these changes is the rapidly rising use of electronic means of communication (such as fax, electronic mail, computer and video conferencing) as a substitute for travel.

Other Sectors

Developments in other sectors have also had environmental implications that are cause for concern. For example, in forestry, a mainstay of the Canadian economy, the area replanted has not kept pace with the area harvested, though the gap appears to have closed a little. In agriculture, expenditures on pesticides more than quadrupled between 1970 and 1985 and the area under monoculture continued to rise[2].

Probable and proven reserves of several important metals have declined steadily as measured by reserve life (i.e., known reserves divided by annual extraction). Crude oil reserves have declined in absolute terms, whereas those of natural gas have increased. However, even natural gas shows a decline in reserve life since increases in consumption have run ahead of discoveries. It is difficult to reconcile trends such as these with notions of sustainable development unless one believes that substitutes will always be available whenever they are needed.

Environmental Effect per Unit of Socio-economic Activity

Fortunately, there is a brighter side to the relationship between human activity and the environment. Most of the efforts to protect the environment have been directed at reducing the third component of the simple equation: the environmental effect per unit of socio-economic activity, and these efforts have met with some success.

One example of these successes is the increasing efficiency of motor vehicles. The average number of litres per 100 kilometres of car travel declined from 16.5 in 1980 to 12.0 in 1988. Electrical utilities have started to promote energy conservation to reduce the need for additional capacity. Recycling has been introduced in the residential, commercial and institutional, and industrial sectors, and although trend data are not available, there are indications that these programs are resulting in less waste being sent to landfills.

Other encouraging signs can be found in the reduction of some pesticides and other contaminants in birds' eggs as a result of deliberate efforts to eliminate their use. The control of several air pollutants has met with some success so that air quality in 11 major urban centres across the country is generally good. One indication that these gains have not been obtained easily or cheaply is that governments continue to extend the scope of environmental legislation, and government expenditures on environmental protection rose from $3.9 billion in 1984-85 to $6.4 billion in 1989-90. Even allowing for inflation, this represents a significant increase in the commitment of public funds to protect the environment.

Conclusion

Unfortunately, even a book as rich in information as this one has serious omissions. Inevitably, the statistical record lags our understanding of what we should be keeping statistics on. The new initiatives in resource accounting described in *Human Activity and the Environment* will give us a better understanding of the resource base of the economy, but it will be some time before we have a set of accounts that provide the historical record that we need for analyzing the changing dependence of the economy on natural resources.

Other issues, such as the greenhouse effect and the spread of the zebra mussel in the Great Lakes, which are addressed for the first time in this edition of *Human Activity and the Environment*, remind us that even as we struggle to cope with the old problems, new and more troubling ones may be around the corner. As human demands on the environment grow, these new problems can be expected to increase in frequency and severity. Furthermore, these newly recognized problems are not often local problems that can be solved within a single jurisdiction. Many cross national boundaries and require international cooperation if they are to be remedied.

Environmental problems at all levels are more likely to be solved if we work from a common and reliable source of information. Whether solutions to our environmental problems can always be found through increases in efficiency and substitution or whether the scale of our activities must also be reduced remains unclear, but the information in *Human Activity and the Environment* is a good place to start looking for the answer.

2. *Monoculture* is the practice of planting the same crop, year after year, a practice that can reduce the long term productivity of the soil.

2. Population

Ninety percent of Canada's 26.5 million people are concentrated in 8.5 percent of its land area. Although Canada may seem to be a land of limitless space and resources, many of its pressing social, economic and environmental issues have been influenced by the growth, composition and distribution of its population.

❑❑❑

The size and distribution of the population are major factors in determining the magnitude and location of the impacts of human activities on the environment. As people concentrate in one area, their effects are multiplied. Concentrations of population imply greater pressures on the surroundings to absorb wastes and to provide clean air, water and other amenities.

In highly populated areas, issues tend to concern the creation of wastes, major restructuring activities (roads, buildings, harbours), major changes in land-use, and exposure to pollutants. In less densely populated areas, concerns such as infrastructure (resource projects, roads, transmission lines and pipelines) and the impacts of agricultural practices and resource exploitation are more prominent.

It is crucial to take into account the distribution and density of the human population when analysing environmental issues. The quality of the environment has a direct effect on the quality of human life. Understanding the population distribution is necessary for quantifying the degree of human exposure to potentially unsafe levels of air and water pollutants and to other toxins.

As well as being exposed to adverse environmental conditions, people are the cause of many changes in the environment. The actions of individuals are responsible for much of the waste and air emissions generated.

Most concentrations of population are surrounded by agricultural lands, have facilities for power generation and water intake, and are linked by transportation networks — all have implications for environmental quality.

This section provides information on the conditions and trends of population and population change as they influence the environment. One important aspect of this is the presentation of statistics by drainage basin and ecozone[3]. The growth of population in a drainage basin will have implications for the water quality of downstream rivers. Similarly, changes in an ecozone imply changes in the interactions between human activities and terrestrial concerns. Many environmental quality issues are better analysed by these natural units.

2.1 Population Conditions

Since the first post-Confederation Census in 1871, the Canadian population has grown from 3.7 million persons to 26.5 million[4] in 1990. Over these years, the distribution of the Canadian population has also radically changed. This section presents statistics on population and population density by ecozone and drainage basin.

3. A *drainage basin* is an area of land which drains into a common river or to the ocean. A major drainage basin includes all the rivers which drain to the ocean. A sub-drainage basin is the catchment area around a river which drains to the ocean. A sub-sub drainage basin is the catchment area of a tributary of one of these rivers.

   An *ecozone* is a natural region delineated by landform, water, soil, vegetation, climate, wildlife and human factors.

   Drainage basins and ecozones are explained in more detail in the Appendix (**Geographic Units for Environmental Analysis**).

4. Statistics Canada postcensal estimate.

2.1.1 Population and Population Density

If Canada's 26.5 million people were evenly distributed over its 9.8 million square kilometres, the population density would be 2.6 persons per square kilometre. In reality, most of Canada's land area is sparsely populated. In some highly populated areas, the population density is over 1,000 persons per square kilometre.

The population of Canada continues to grow and this growth is most pronounced in the West. At the national level, the population increased by 17.6 percent from 1971 to 1986 (Table 2.1.1.1). But the growth rates are decreasing. Canada's population grew by 6.6 percent between 1971 and 1976 and only 4.2 percent between 1981 and 1986.

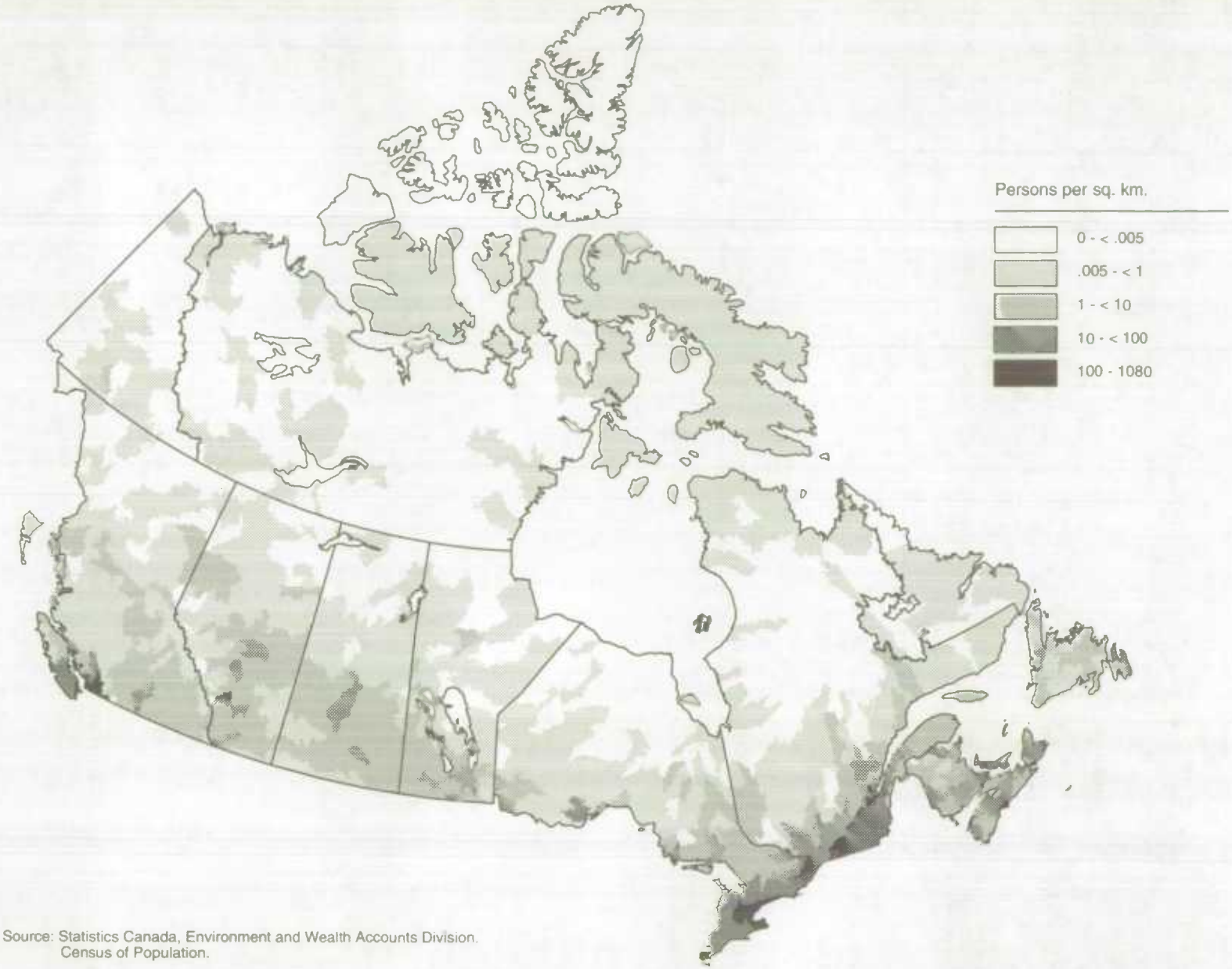
The Atlantic provinces, in general, experienced continued declines in population growth. The rate of growth of Quebec's population fell by half between 1976-1981 and 1981-1986. After a decline in 1976-1981, Ontario's growth in population increased during the 1981 to 1986 period. The Prairie provinces have been characterized by dramatic swings in population change since 1971. Alberta, British Columbia and Northwest Territories experienced population growth well above national average. After increases in the 1971-1981 period, the Yukon has seen a slow-down since 1981.

The 1986 population density shown on Map 2.1.1.1 highlights the 12 sub-sub drainage basins with a density greater than 100 persons per square kilometre. The highest densities are found in the basins containing the following cities: Toronto (1080 persons per square kilometre), Montréal (628), Hamilton (396), Québec (264), Halifax (231) and Vancouver (220).

Densities at the ecozone level (Table 2.1.1.2) are highest in the Mixed-Wood Plain of Ontario and Quebec. The highest percentage increases between 1971 and 1986 occurred in the less populated areas such as the Southern Arctic in Quebec, the Boreal Plain in Yukon and the Taiga Plain in Alberta. The 1986 population densities by ecozone are presented in Map 2.1.1.2.

Map: 2.1.1.1

Population Density by Sub-sub Basin, 1986



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

Table: 2.1.1.1

Total Population by Province and Territory, 1971, 1976, 1981 and 1986

Province/Territory	Total population				Change			
	1971	1976	1981	1986[1]	1971/76	1976/81	1981/86	1971/86
	persons				percent			
Newfoundland	522 104	557 725	567 681	568 349	6.8	1.8	0.1	8.9
Prince Edward Island	111 641	118 229	122 506	126 646	5.9	3.6	3.4	13.4
Nova Scotia	788 960	828 571	847 442	873 199	5.0	2.3	3.0	10.7
New Brunswick	634 557	677 250	696 403	710 422	6.7	2.8	2.0	12.0
Quebec	6 027 764	6 234 445	6 438 403	6 540 276	3.4	3.3	1.6	8.5
Ontario	7 703 106	8 264 465	8 625 107	9 113 515	7.3	4.4	5.7	18.3
Manitoba	988 247	1 021 506	1 026 241	1 071 232	3.4	0.5	4.4	8.4
Saskatchewan	926 242	921 323	968 313	1 010 198	- 0.5	5.1	4.3	9.1
Alberta	1 627 874	1 838 037	2 237 724	2 375 278	12.9	21.7	6.1	45.9
British Columbia	2 184 621	2 466 608	2 744 467	2 889 207	12.9	11.3	5.3	32.3
Yukon	18 388	21 836	23 153	23 504	18.8	6.0	1.5	27.8
Northwest Territories	34 807	42 609	45 741	52 238	22.4	7.4	14.2	50.1
Canada	**21 568 311**	**22 992 604**	**24 343 181**	**25 354 064**	**6.6**	**5.9**	**4.2**	**17.6**

Source:
Statistics Canada. Census of Population.
Note:
[1] Includes data for incompletely enumerated Indian reserves and Indian settlements.

Table: 2.1.1.2

Population by Ecozone, 1971 and 1986

Provincial/Territorial Ecozone	Area	Population		Change	Density		Percent change
		1971	1986	1971-1986	1971	1986	1971-1986
	km²	persons			persons / km²		percent
Newfoundland							
Taiga Shield	207 441	24 185	22 725	-1 460	0.117	0.110	- 6.0
Boreal Shield	130 317	496 230	542 860	46 640	3.808	4.166	9.4
Southern Arctic	51 311	1 690	2 760	1 070	0.033	0.054	63.4
Arctic Cordillera	10 124	-	-	-	-	-	-
Total	**399 193**	**522 105**	**568 350**	**46 245**	**1.308**	**1.424**	**8.9**
Prince Edward Island							
Atlantic Maritime	5 660	111 640	126 645	15 005	19.725	22.376	13.4
Total	**5 660**	**111 640**	**126 645**	**15 005**	**19.725**	**22.376**	**13.4**
Nova Scotia							
Atlantic Maritime	55 490	788 960	873 175	84 215	14.218	15.736	10.7
Total	**55 490**	**788 960**	**873 175**	**84 215**	**14.218**	**15.736**	**10.7**
New Brunswick							
Atlantic Maritime	73 440	634 560	709 440	74 885	8.640	9.660	11.8
Total	**73 440**	**634 555**	**709 440**	**74 885**	**8.640**	**9.660**	**11.8**
Quebec							
Taiga Shield	539 794	11 210	9 515	-1 690	0.021	0.018	- 15.1
Boreal Shield	643 159	991 165	1 127 365	136 200	1.541	1.753	13.7
Hudson Bay Plain	26 311	1 595	2 405	810	0.061	0.091	50.7
Mixed-Wood Plain	55 385	4 756 820	5 126 470	369 645	85.886	92.560	7.8
Atlantic Maritime	28 838	264 905	262 395	-2 510	9.186	9.099	- 0.9
Southern Arctic	138 223	185	2 460	2 275	0.001	0.018	1 222.0
Northern Arctic	67 105	1 645	1 850	205	0.025	0.028	12.6
Arctic Cordillera	7 535	235	-	- 230	0.031	-	- 100.0
Total	**1 506 350**	**6 027 765**	**6 532 460**	**504 695**	**4.002**	**4.337**	**8.4**
Ontario							
Boreal Shield	614 964	865 740	878 295	12 565	1.408	1.428	1.5
Hudson Bay Plain	268 924	5 825	2 390	-3 430	0.022	0.009	- 58.9
Mixed-Wood Plain	96 427	6 831 545	8 221 005	1 389 460	70.847	85.257	20.3
Total	**980 315**	**7 703 105**	**9 101 695**	**1 398 590**	**7.858**	**9.284**	**18.2**

Population by Ecozone, 1971 and 1986

Provincial/Territorial Ecozone	Area	Population		Change	Density		Percent change
		1971	1986	1971-1986	1971	1986	1971-1986
	km²	persons			persons / km²		percent
Manitoba							
Boreal Plain	96 559	56 590	54 255	-2 330	0.586	0.562	- 4.1
Prairie	74 005	843 945	919 435	75 495	11.404	12.424	8.9
Taiga Shield	103 672	900	1 220	315	0.009	0.012	35.2
Boreal Shield	244 367	83 385	85 680	2 290	0.341	0.351	2.7
Hudson Bay Plain	93 726	3 425	2 430	- 995	0.037	0.026	- 29.1
Southern Arctic	1 884	-	-	-	-	-	-
Total	**614 212**	**988 250**	**1 063 015**	**74 770**	**1.609**	**1.731**	**7.6**
Saskatchewan							
Boreal Plain	211 330	41 825	47 985	6 155	0.198	0.227	14.7
Prairie	285 333	875 925	950 780	74 855	3.070	3.332	8.5
Taiga Shield	55 605	2 875	2 240	- 630	0.052	0.040	- 22.1
Boreal Shield	85 478	5 610	8 605	2 995	0.066	0.101	53.3
Total	**637 746**	**926 240**	**1 009 610**	**83 375**	**1.452**	**1.452**	**9.0**
Alberta							
Montane Cordillera	43 504	24 990	35 930	10 935	0.574	0.826	43.6
Boreal Plain	363 280	253 685	369 815	116 125	0.698	1.018	45.8
Taiga Plain	83 683	385	830	450	0.005	0.010	116.1
Prairie	162 542	1 347 685	1 958 235	610 555	8.291	12.048	45.3
Taiga Shield	8 182	1 120	1 020	- 105	0.137	0.124	- 9.5
Total	**661 191**	**1 627 875**	**2 365 825**	**737 950**	**2.462**	**3.578**	**45.3**
British Columbia							
Boreal Cordillera	120 607	1 600	2 270	670	0.013	0.019	41.9
Pacific Maritime	282 594	1 657 815	2 165 300	507 490	5.866	7.662	30.6
Montane Cordillera	389 734	481 475	658 965	177 485	1.235	1.691	36.9
Boreal Plain	115 319	43 240	56 495	13 260	0.375	0.490	30.7
Taiga Plain	39 545	495	335	- 155	0.012	0.008	- 32.2
Total	**947 800**	**2 184 620**	**2 883 365**	**698 745**	**2.305**	**3.042**	**32.0**
Yukon							
Tundra Cordillera	174 893	215	295	75	0.001	0.002	36.1
Boreal Cordillera	259 506	17 620	21 920	4 300	0.068	0.084	24.4
Boreal Plain	32 518	555	1 295	740	0.017	0.040	133.6
Taiga Plain	16 534	-	-	-	-	-	-
Total	**483 450**	**18 390**	**23 505**	**5 115**	**0.038**	**0.049**	**27.8**
Northwest Territories							
Tundra Cordillera	107 453	130	240	105	0.001	0.002	83.1
Boreal Plain	1 826	-	-	-	-	-	-
Taiga Plain	444 446	14 380	18 035	3 660	0.032	0.041	25.5
Taiga Shield	470 308	7 905	14 430	6 525	0.017	0.031	82.6
Hudson Bay Plain	3 121	-	-	-	-	-	-
Southern Arctic	737 058	5 270	7 910	2 640	0.007	0.011	50.1
Northern Arctic	1 359 619	6 105	9 900	3 800	0.004	0.007	62.2
Arctic Cordillera	242 597	1 025	1 720	700	0.004	0.007	68.1
Total	**3 366 429**	**34 805**	**52 240**	**17 430**	**0.010**	**0.016**	**50.1**
Canada Total	**9 731 276**	**21 568 310**	**25 309 330**	**3 741 020**	**2.216**	**2.601**	**17.3**
Ecozone							
Atlantic Maritime	183 428	1 800 065	1 971 660	171 590	11.014	12.064	9.5
Mixed-Wood Plain	151 812	11 588 370	13 347 475	1 759 105	76.334	87.921	15.2
Boreal Shield	1 718 285	2 442 130	2 642 815	200 685	1.421	1.538	8.2
Prairie	521 880	3 067 555	3 828 455	760 900	5.878	7.336	24.8
Boreal Plain	820 833	395 895	529 840	133 945	0.482	0.645	33.8
Montane Cordillera	433 238	506 470	694 890	188 420	1.169	1.604	37.2
Pacific Maritime	282 594	1 657 810	2 165 295	507 485	5.866	7.662	30.6
Boreal Cordillera	380 113	19 220	24 190	4 970	0.051	0.064	25.9
Tundra Cordillera	282 346	345	535	190	0.001	0.002	53.8
Taiga Plain	584 208	15 255	19 205	3 950	0.026	0.033	25.9
Taiga Shield	1 385 003	48 205	51 150	2 950	0.035	0.037	6.1
Hudson Bay Plain	392 082	10 840	7 220	-3 615	0.028	0.018	- 33.4
Southern Arctic	928 475	7 145	13 130	5 985	0.008	0.014	83.7
Northern Arctic	1 426 724	7 750	11 750	4 005	0.005	0.008	51.7
Arctic Cordillera	260 256	1 255	1 720	465	0.005	0.007	37.1
Canada Total	**9 731 276**	**21 568 310**	**25 309 330**	**3 741 020**	**2.216**	**2.601**	**17.3**

Source:
Statistics Canada. Environment and Wealth Accounts Division. Original data provided by Statistics Canada, Census of Population.

Note:
The area figures for ecozones and the Canada total do not include the areas of a number of large freshwater bodies located on ecosystem boundaries. The total area of Canada including these is 9 970 610.

Population Density by Ecozone, 1986

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

2.2 Population Processes

If current trends continue, Canada will experience very low population growth rates over the next 20 years. Because of longer life expectancy and decreased fertility, the average age of the population will be substantially higher than it is today. It will be a major challenge to develop a socio-economic system that can adapt to this unprecedented situation.

❑❑❑

Although Canada's population has been increasing, the rate of growth has been slowing down. Over the past 90 years, annual growth rates have varied between 0.8 percent in the early 1980s to highs of 3 percent in the early 1900s and 2.8 percent in the early 1950s. The recent decline in growth may be attributed to lower immigration levels and a declining birth rate. A likely future scenario is that by the year 2011, population growth will slow even further, the average age of the population will increase substantially and immigration will become an increasingly larger component of population growth. Projections of total population for the year 2011 vary from 29.3 million to 32.1 million persons.

The movement of population is one of the ways by which societies adjust to an increasing population, changing economic conditions and to the discovery of new natural resources. In the last century almost the entire population was concentrated in one area of southern Ontario and southern Quebec. After the linking of east with west upon completion of the Trans-Canada Railway in 1887, the west and central provinces developed from isolated farm towns to diverse economic regions with large urban centres. This growth in population has resulted in massive changes to the existing natural environment. Millions of hectares of native grassland and forests were transformed into cultivated agricultural land. Wetlands were drained or filled and river systems were modified to meet immediate human needs. The greatest impacts took place in urbanizing centres as buildings, pavement and parks with exotic flora replaced existing ecosystems.

2.2.1 Fertility, Mortality and Migration

In 1960, the Canadian population stood at 17.7 million, the fertility rate was 3.9 children per woman and 7.6 percent of the population was over 65 years of age. In 1989, the population had grown by almost 9 million persons, the fertility rate had dropped to 1.7 children per woman and 11.2 percent of the population was over 65. Scenarios for the year 2021 range in population from 29.4 million to 34.7 million.

❑❑❑

Past Trends

The rate of growth of the Canadian population reached its lowest point of 0.7 percent per year in 1985 (Table 2.2.1.1, Figure 2.2.1.2). Since that year, the rate has been slowly increasing. In 1989 the rate of growth was 1.3 percent. This was the result of more births and higher immigration than in the previous year.

In 1936, the fertility rate was 2.7 children per woman. It slowly increased to reach almost 4 during the baby-boom period of 1946-1960. In 1962 the fertility rate started a decreasing trend that stabilized at around 1.67 in 1980. There was a minor turnaround in births in 1989. The number of births in 1989 (392 thousand) was the highest since 1965.

Although life expectancy has been following a slow and gradual increasing trend, a considerably greater increase occurred between 1976 and 1981. Male and female life expectancies increased by 1.7 and 1.5 years, respectively. This increase for males was almost double the gain of the previous fifteen-year period. As a result, the difference between male and female life expectancies narrowed slightly.

Immigration, in the past, has accounted for one-quarter to one-half of Canada's population growth. In the years between 1985 and 1989, increasing immigration and decreasing emigration resulted in a net immigration of over 100 thousand persons per year (Table 2.2.1.1, Figure 2.2.1.1).

Between 1871 and 1971, the proportion of the Canadian population living in urban areas increased from 19 percent to 76 percent. After 1971, the proportion of urban population stabilized at around 75 percent (Figure 2.2.1.4). In 1986, almost 60 percent of Canada's population lived in 25 major

metropolitan areas, which occupied approximately seven-tenths of one percent of the land area. The five most populous metropolitan areas in 1986 were Toronto, Montreal, Vancouver, Ottawa-Hull and Edmonton. Together they accounted for 37 percent of the total population (Table 2.2.1.2).

Of Canada's 1033 sub-sub drainage basins, 256 are unpopulated. Between 1971 and 1986, 195 basins decreased in population, 100 showed no change and 404 increased in population (Map 2.2.1.2, Table 2.2.1.3).

Population Projections and Assumptions

Statistics Canada's population projections for Canada, the provinces and the territories suggest that the demographic pattern emerging by the year 2000 could be marked by:

- a slowdown in population growth;
- a gradual aging of the population at first, followed by substantial acceleration by 2015 as the baby-boom cohorts reach retirement age;
- an increasing role played by immigration in the dynamics of Canada's population growth; and
- a preponderance of internal migration in the provincial distribution of the population.

Methodology

The general method used is the regional cohort component approach. After the analysis of previous trends in each component of population growth — fertility, mortality and migration (internal and international) — the parameters are applied to their corresponding base year (1989 estimates) to obtain an estimate of the future population. Four series of projections have been selected (Figure 2.2.1.5, Tables 2.2.1.4 and 2.2.1.5).

Assumptions

Fertility. Although the fertility rate in Canada has now reached its lowest level at 1.67 children per woman, births continue to be the most important demographic factor influencing population growth and age structure. The following three assumptions were selected and are summarized in Figure 2.2.1.3:

- Low assumption: The total fertility rate continues to decline from 1.67 births per woman in 1989 to 1.2 by 2011.
- Medium assumption: The total fertility rate remains constant at the level observed in 1989, at 1.67.
- High assumption: The total fertility rate remains constant at 1.67 births per woman up to 1991, then increases gradually to the replacement level of 2.1 by 2011.

Mortality. A single mortality rate has been selected in line with the assumption adopted by most industrialized countries, namely that current gains in life expectancy will continue, but at a gradually diminishing pace. The projected gains over the 22-year period from 1989 to 2011 are 3.5 years for males and 3.2 years for females.

Immigration and Emigration. Immigration is expected to play an increasing role as a major component of demographic growth in Canada during the coming decades. With fertility below the replacement level, and the prospect of negative natural increase at the turn of the century, the maintenance of a stable population size will depend largely on immigration. Recent annual levels of immigration ranged from 150,000 to 160,000, a substantial increase when compared to the level of 84,000 in 1985. Two immigration assumptions have been developed:

- A high assumption whereby annual levels would increase gradually to reach 200,000 by 1994.
- A low assumption of 140,000 immigrants per year reached by 1991.

Emigration is not as well documented as immigration, and therefore not as well understood. Estimates based on indirect data show that the emigration has fluctuated between 40,000 and 60,000 per year since the mid-seventies (Table 2.2.1.1). The emigration assumption has been set at 0.25 percent of the Canadian population.

In the recent past, the geographic distribution of immigrants and emigrants has not changed significantly from year to year. The average distribution for each province/territory for the period 1985 to 1987 has been assumed to remain the same for the projection period.

Internal Migration. Internal migration is the most unstable component of population growth in Canada. Being the most difficult to predict, internal migration is responsible for the greatest source of error in forecasting provincial population growth (Table 2.2.1.6). Three interprovincial migration assumptions were used:

- Migration focused on Ontario: This scenario reflects a population flow towards Ontario as the major province of attraction. This condition has prevailed since 1981, as it did before 1971.
- Long-term trends scenario: This scenario reflects the long-term trend in interprovincial migration observed since the 1960s. It falls somewhere between the other two scenarios. This is the high growth scenario for the Atlantic provinces. It is a medium assumption for all the Central and Western provinces, except Manitoba.
- Westward migration: This is based on the possibility that the migration associated with the economic boom in the West in the 1970s will recur, and that the migrant population will partially resume the flow to Alberta and British Columbia. The latter province is already experiencing large gains in population as a result of internal migration.

Projection Results

A total of 18 projections were developed using all possible combinations of the three fertility, the two international migration, and the three internal migration scenarios. From these, one projection was selected as the continuation of current trends (Projection 3). The other scenarios are intended to reflect possible deviations from current trends.

At the national level, Projection 1 is a low-growth scenario. Projections 2 and 3 are medium-growth scenarios, whereas Projection 4 yields much higher growth. All four projected population totals for Canada and their assumptions are found in Table 2.2.1.4.

Whichever projection is considered, Canada's population will likely grow at a slower pace than in the past, and the increase in the average age of the population will accelerate. Considering the internal migration assumptions, only minor changes in the distribution of population among the provinces and territories are expected by 2011.

The rationale of these assumptions and details on methodology can be obtained from Statistics Canada, *Population Projections for Canada, Provinces and Territories 1989-2011*. Catalogue 91-520.

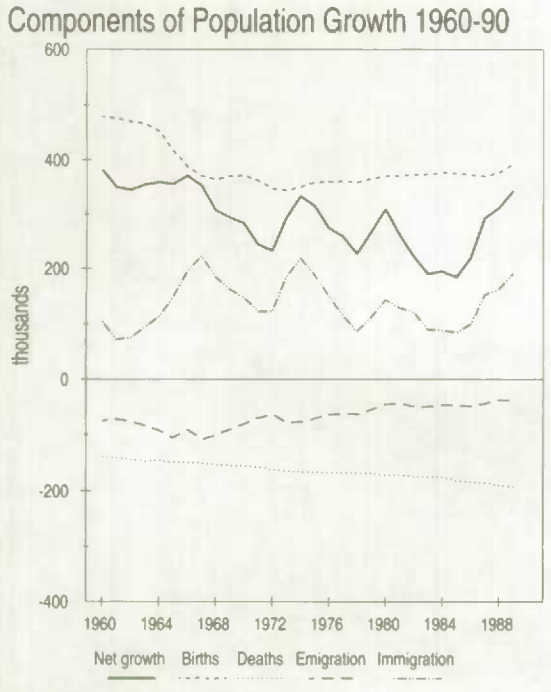
Table: 2.2.1.1

Components of Population Growth, 1960-1991

Year	Total Population	Annual total growth		Immigration	Emigration	Net migration	Births		Deaths	Life expectancy		Population aged 65 and over
		Number	Rate				Number	Rate		Male	Female	
	thousands	thousands	percent	thousands			thousands	births per woman	thousands	years		percent of population
1960	17 710.0	362.0	2.2	104.1	75.6	43.1	478.6	3.90	139.7	..	..	7.6
1961	18 092.0	350.0	1.9	71.7	72.3	15.3	475.7	3.85	141.0	68.3	74.2	7.6
1962	18 442.0	345.0	1.9	74.6	76.7	19.0	469.7	3.77	143.7	..	..	7.6
1963	18 787.0	355.0	1.9	93.2	83.6	36.6	465.8	3.68	147.4	..	..	7.6
1964	19 142.0	359.0	1.9	112.6	92.4	52.0	452.9	3.52	145.9	..	..	7.7
1965	19 501.0	356.0	1.8	146.8	105.3	86.3	418.6	3.16	148.9	..	..	7.7
1966	19 857.0	371.0	1.9	194.7	91.5	133.2	367.7	2.82	149.9	68.8	75.2	7.7
1967	20 228.0	353.0	1.7	222.9	108.5	132.4	370.9	2.60	150.3	..	..	7.7
1968	20 581.0	307.0	1.5	184.0	100.0	95.9	364.3	2.46	153.2	..	..	7.8
1969	20 888.0	294.0	1.4	161.5	90.1	78.9	369.7	2.41	154.5	..	..	7.9
1970	21 182.0	283.0	1.3	147.7	81.0	67.0	372.0	2.34	156.0	..	..	8.0
1971	21 465.0	244.6	1.1	121.9	70.1	39.7	362.2	2.19	157.3	69.3	76.4	8.1
1972	21 709.6	232.8	1.1	122.0	63.2	47.9	347.3	2.02	162.4	69.4	76.5	8.2
1973	21 942.4	292.9	1.3	184.2	78.5	112.5	344.3	1.94	164.0	69.5	76.7	8.3
1974	22 235.3	333.4	1.5	218.5	78.1	149.5	350.7	1.89	166.8	69.7	77.0	8.4
1975	22 568.7	315.2	1.4	187.9	70.7	122.3	359.3	1.87	166.4	69.9	77.3	8.5
1976	22 883.9	274.5	1.2	149.4	64.4	81.7	360.0	1.82	167.2	70.2	77.5	8.7
1977	23 158.4	259.0	1.1	114.9	61.4	65.1	361.4	1.80	167.5	70.5	78.0	8.9
1978	23 417.4	227.1	1.0	86.3	63.5	36.4	358.9	1.75	168.2	70.9	78.3	9.1
1979	23 644.5	267.4	1.1	112.1	54.7	69.5	366.1	1.76	168.2	71.1	78.6	9.3
1980	23 911.9	309.4	1.3	143.1	45.2	110.2	370.7	1.74	171.5	71.5	78.8	9.5
1981	24 221.3	262.1	1.1	128.6	43.7	61.7	371.4	1.70	171.0	71.9	79.0	9.7
1982	24 483.4	222.3	0.9	121.1	49.4	23.6	373.1	1.69	174.4	72.2	79.3	9.9
1983	24 705.7	190.1	0.8	89.2	50.1	- 8.6	373.7	1.68	175.0	72.6	79.5	10.0
1984	24 895.8	194.6	0.8	88.2	46.8	- 6.7	377.0	1.68	175.7	72.7	79.7	10.2
1985	25 090.4	183.6	0.7	84.3	46.9	- 10.8	375.7	1.67	181.3	73.0	79.8	10.4
1986	25 274.0	218.9	0.9	99.2	49.0	30.2	372.9	1.66	184.2	73.0	79.7	10.6
1987	25 492.9	292.9	1.1	152.1	43.9	109.5	369.7	1.65	185.0	..	..	10.9
1988	25 785.8	311.5	1.2	161.9	37.2	124.7	376.8	1.68	190.0	73.4	80.2	11.1
1989	26 097.3	355.0	1.4	192.0	36.3	153.7	391.9	..	191.0	..	..	11.2
1990[1]	26 452.3	380.4	1.4	212.2	37.6	174.6	399.3	..	193.5	..	..	..
1991[1]	26 832.7	..	..	..	..	..	..	..	..	..	..	..

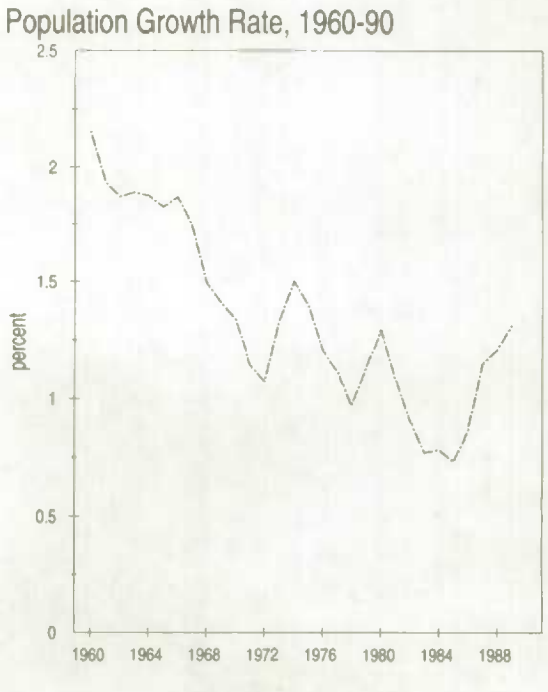
Source:
Statistics Canada. *Report on the Demographic Situation in Canada*, Catalogue 91-209. *Quarterly Estimates*, Catalogue 91-002.
Note:
[1] Preliminary data.

Figure: 2.2.1.1



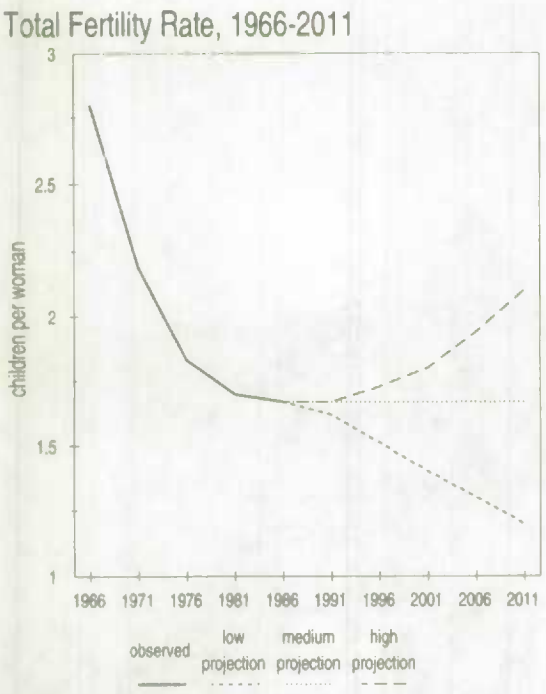
Source: Statistics Canada. Demography Division.

Figure: 2.2.1.2



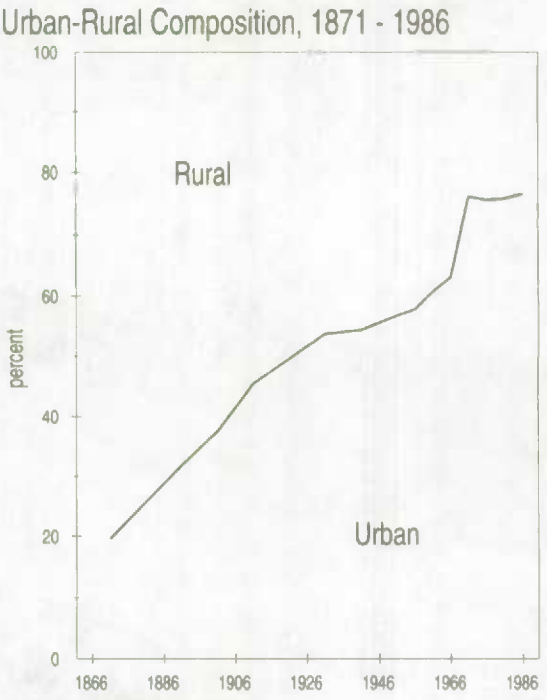
Source: Statistics Canada. Demography Division.

Figure: 2.2.1.3



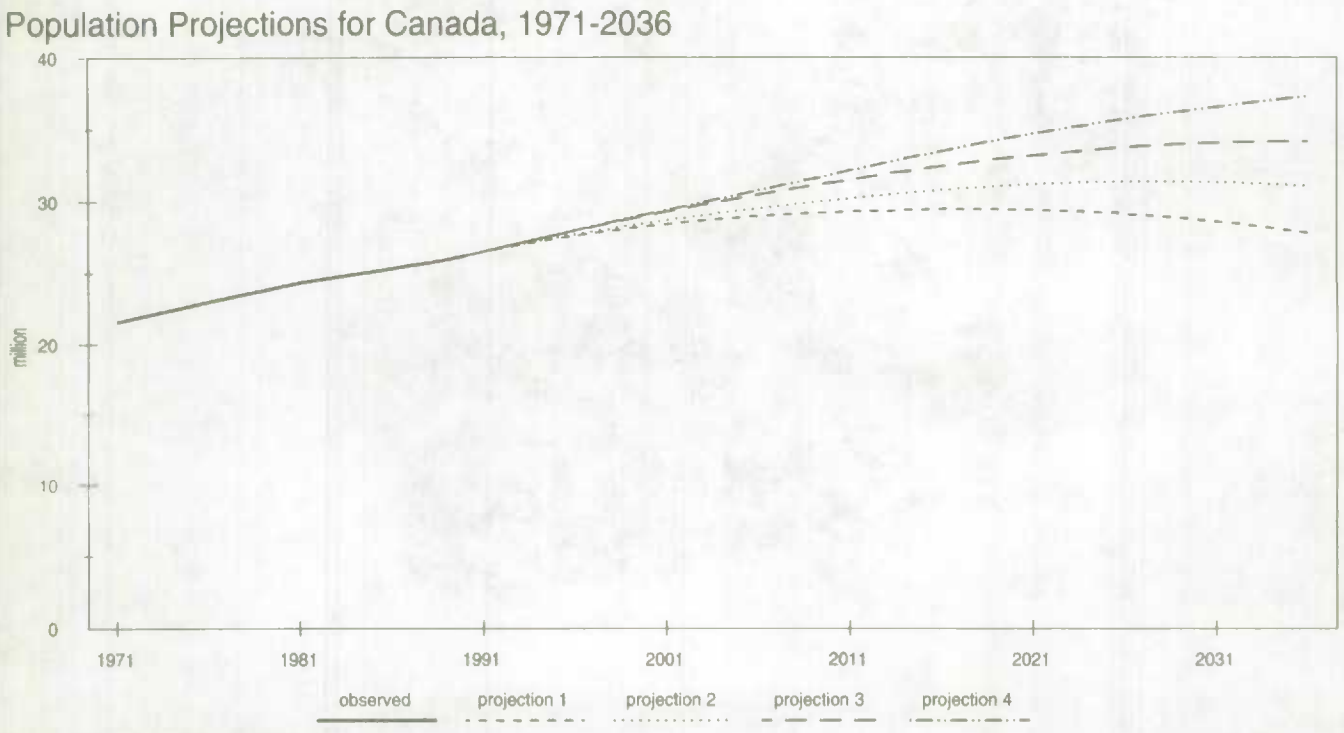
Source: Statistics Canada. Population Projections for Canada. Catalogue 91-520.

Figure: 2.2.1.4



Source: Statistics Canada. Census of Population.

Figure: 2.2.1.5



Source: Statistics Canada. Population Projections for Canada. Catalogue 91-520.

Population Growth by Sub-sub Basin, 1971-1986

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

Table: 2.2.1.2

Population of Major Census Metropolitan Areas, 1981 and 1986

Rank Census Metropolitan Area	Area 1986	Population 1981[1]	Population 1986	Density 1981	Density 1986	Population Change 1981-1986
	km²	persons		person/km²		percent
1 Toronto, Ontario	5 614	3 130 390	3 427 170	557.6	610.5	9.5
2 Montréal, Quebec	3 509	2 862 285	2 921 355	815.8	832.6	2.1
3 Vancouver, British Columbia	2 786	1 268 180	1 380 730	455.2	495.5	8.9
4 Ottawa-Hull, Ont.-Que.	5 138	743 820	819 265	144.8	159.4	10.1
5 Edmonton, Alberta	11 397	740 880	785 465	65.0	68.9	6.0
6 Calgary, Alberta	5 056	625 970	671 325	123.8	132.8	7.2
7 Winnipeg, Manitoba	3 295	592 060	625 305	179.7	189.8	5.6
8 Québec, Quebec	3 150	583 820	603 265	185.3	191.5	3.3
9 Hamilton, Ontario	1 358	542 095	557 030	399.0	410.0	2.8
10 St. Catharines-Niagara, Ontario	1 400	342 645	343 255	244.8	245.2	0.2
11 London, Ontario	2 105	326 815	342 305	155.3	162.6	4.7
12 Kitchener, Ontario	824	287 800	311 195	349.4	377.8	8.1
13 Halifax, Nova Scotia	2 508	277 730	295 990	110.7	118.0	6.6
14 Victoria, British Columbia	1 951	241 450	255 545	123.8	131.0	5.8
15 Windsor, Ontario	862	250 885	253 985	291.2	294.8	1.2
16 Oshawa, Ontario	894	186 445	203 540	208.5	227.6	9.2
17 Saskatoon, Saskatchewan	4 749	175 055	200 665	36.9	42.3	14.6
18 Regina, Saskatchewan	3 422	173 225	186 520	50.6	54.5	7.7
19 St. John's, Newfoundland	1 130	154 835	161 900	137.0	143.3	4.6
20 Chicoutimi-Jonquière, Quebec	1 723	158 230	158 465	91.8	92.0	0.2
21 Sudbury, Ontario	2 612	156 120	148 875	59.8	57.0	-4.6
22 Sherbrooke, Quebec	916	125 180	129 960	136.7	141.9	3.8
23 Trois-Rivières, Quebec	872	125 345	128 885	143.8	147.8	2.8
24 Thunder Bay, Ontario	2 203	121 945	122 215	55.4	55.5	0.2
25 Saint John, New Brunswick	2 905	121 010	121 265	41.7	41.7	0.2
Total Major CMAs	72 378	14 314 230	15 155 495	197.8	209.4	5.9
Canada	**9 848 015**	**24 343 180**	**25 309 330**	**2.5**	**2.6**	**4.0**
Major CMAs as a percentage of Canada	**0.7**	**58.8**	**59.9**	...	...	...

Source:
Statistics Canada. *Canada's Population From Ocean to Ocean*. Catalogue 98-120.
Note:
[1] Based on the 1986 area.

Table: 2.2.1.3

Rural-Urban Population by Drainage Sub-basin, 1971 and 1986

Provincial/Territorial Sub-basin	Total population		Rural population		Urban population		Urban population as a percentage of total	
	1971	1986	1971	1986	1971	1986	1971	1986
	persons						percent	
Canada	**21 568 310**	**25 309 335**	**5 157 530**	**5 957 245**	**16 410 780**	**19 352 090**	**76.1**	**76.5**
Newfoundland								
Romaine	-	-	-	-	-	-	-	-
Natashquan	-	-	-	-	-	-	-	-
Little Mecatina and Strait of Belle Isle	1 975	2 340	1 975	2 340	-	-	-	-
North Newfoundland	196 775	203 760	94 600	102 175	102 175	101 585	51.9	49.9
South Newfoundland	297 165	335 850	120 430	119 265	176 730	216 585	59.5	64.5
North Labrador	1 690	2 440	1 690	2 440	-	-	-	-
Churchill	20 735	19 500	840	2 940	19 890	16 560	95.9	84.9
Naskaupi and Central Labrador	1 110	1 470	1 110	1 470	-	-	-	-
Eagle and South Labrador	2 655	2 990	2 655	2 985	-	-	-	-
Total	**522 105**	**568 350**	**223 300**	**233 620**	**298 800**	**334 730**	**57.2**	**58.9**
Prince Edward Island								
Prince Edward Island	111 640	126 645	68 860	78 355	42 780	48 290	38.3	38.1
Total	**111 640**	**126 645**	**68 860**	**78 355**	**42 785**	**48 285**	**38.3**	**38.1**
Nova Scotia								
Bay of Fundy	254 015	303 095	148 465	185 795	105 545	117 300	41.6	38.7
Southeast Atlantic Ocean	364 940	403 970	130 595	147 240	234 345	256 730	64.2	63.6
Cape Breton Island	170 005	166 115	62 495	69 015	107 515	97 105	63.2	58.5
Total	**788 960**	**873 175**	**341 560**	**402 050**	**447 400**	**471 130**	**56.7**	**54.0**
New Brunswick								
Saint John and South Bay of Fundy	323 190	353 965	120 050	159 965	203 135	194 005	62.9	54.8
Gulf of St. Lawrence and North Bay of Fundy	311 370	355 475	153 360	199 175	158 010	158 300	50.7	44.0
North Gaspé Peninsula	-	-	-	-	-	-	-	-
Total	**634 555**	**709 440**	**273 410**	**359 140**	**361 145**	**350 300**	**56.9**	**49.4**
Quebec								
Saint John	42 140	39 350	27 870	31 860	14 270	7 490	33.9	19.0
Cascapedia and Gulf of St. Lawrence	97 195	92 835	57 690	62 025	39 500	30 810	40.6	33.2
Upper Ottawa	61 660	59 160	27 570	29 680	34 085	29 485	55.3	49.8
Coulonge and Central Ottawa	35 285	45 535	15 005	17 115	20 285	28 420	57.5	62.4
Gatineau and Lower Ottawa	326 250	377 485	98 320	141 890	227 930	235 595	69.9	62.4
Upper St. Lawrence	66 905	71 770	19 570	22 865	47 335	48 900	70.7	68.1
St-Maurice	177 990	176 890	13 775	30 805	164 220	146 085	92.3	82.6
Central St. Lawrence	3 640 245	3 943 865	405 735	524 425	3 234 510	3 419 445	88.9	86.7
Lower St Lawrence	942 630	1 055 110	272 390	321 790	670 245	733 320	71.1	69.5
North Gaspé Peninsula	142 940	141 880	63 415	69 025	79 520	72 855	55.6	51.3
Saguenay	269 210	287 300	75 285	87 930	193 925	199 370	72.0	69.4
Betsiamites	15 705	14 895	10 400	9 675	5 300	5 225	33.8	35.1
Manicouagan and Outardes	23 515	20 160	4 615	4 150	18 900	16 010	80.4	79.4
Moisie and St. Lawrence Estuary	45 870	53 825	5 710	8 920	40 160	44 900	87.5	83.4
Romaine and Gulf of St. Lawrence	4 980	5 370	1 980	2 255	3 000	3 115	60.2	58.0
Natashquan and Gulf of St. Lawrence	16 765	18 040	15 665	16 470	1 100	1 575	6.6	8.7
Petit Mecatina	4 110	4 195	4 110	4 200	-	-	-	-
Nottaway	29 490	29 410	5 940	6 185	23 550	23 225	79.9	79.0
Broadback and Rupert	2 400	3 525	2 400	3 520	-	-	-	-
Eastmain	305	360	305	360	-	-	-	-
Fort George and Sakami	1 780	3 545	1 775	3 540	-	-	-	-
Great Whale and Southeast Hudson Bay	985	1 045	985	1 045	-	-	-	-
Little Whale and East Hudson Bay	-	60	-	60	-	-	-	-
Northeast Hudson Bay	795	2 190	795	2 190	-	-	-	-
West Ungava Bay	960	1 490	955	1 490	-	-	-	-
Leaf	600	245	600	245	-	-	-	-
Koksoak	675	1 065	680	1 065	-	-	-	-
Caniapiskau	3 980	1 070	705	795	3 270	260	82.2	25.8
East Ungava Bay	230	385	235	385	-	-	-	-
Abitibi and North French	26 400	24 030	17 630	15 530	8 770	8 495	33.2	35.4
Harricanaw	45 780	56 375	14 410	21 970	31 370	34 405	68.5	61.0
Total	**6 027 760**	**6 532 460**	**1 166 520**	**1 443 465**	**4 861 245**	**5 088 995**	**80.6**	**77.9**
Ontario								
Nipigon and Northwest Lake Superior	126 640	134 425	14 690	22 345	111 955	112 080	88.4	83.4
Northeast Lake Superior	44 445	41 945	8 610	13 385	35 835	28 560	80.6	68.1
North Lake Huron	266 240	262 390	55 370	46 770	210 870	215 625	79.2	82.2
Wanipitai and French	93 510	86 960	33 680	30 870	59 830	56 085	64.0	64.5
East Georgian Bay	323 630	441 470	144 100	186 185	179 530	255 290	55.5	57.6
East Lake Huron	220 050	262 300	127 965	138 710	92 080	123 590	41.8	47.1

Rural-Urban Population by Drainage Sub-basin, 1971 and 1986

Provincial/Territorial Sub-basin	Total population		Rural population		Urban population		Urban population as a percentage of total	
	1971	1986	1971	1986	1971	1986	1971	1986
	persons						percent	
North Lake Erie	1 523 635	1 705 470	386 790	376 115	1 137 055	1 329 355	74.6	77.9
Lake Ontario	3 976 860	4 867 885	281 045	455 310	3 695 820	4 412 575	92.9	90.6
Montréal and Upper Ottawa	62 190	62 445	21 270	21 100	40 925	41 345	65.8	66.2
Madawaska, Petawawa and Central Ottawa	208 690	242 775	59 505	79 925	149 185	162 845	71.5	67.1
Rideau and Lower Ottawa	493 000	621 605	102 945	125 530	390 050	496 075	79.1	79.8
Upper St. Lawrence	173 130	187 305	57 270	66 260	115 650	121 045	66.9	64.6
Hayes	-	-	-	-	-	-	-	-
Nisksibi and Central Hudson Bay	150	265	150	265	-	-	-	-
Severn	2 510	305	2 510	310	-	-	-	-
Winisk	860	1 055	860	1 055	-	-	-	-
Ekwan	-	-	-	-	-	-	-	-
Attawapiskat	1 140	490	1 135	490	-	-	-	-
Upper Albany	1 630	1 050	1 630	1 050	-	-	-	-
Lower Albany	1 105	0	1 105	-	-	-	-	-
Kenogami	9 755	10 045	3 345	2 995	6 415	7 055	65.7	70.2
Kwataboahegaa	2 545	1 325	1 220	225	1 325	1 100	52.1	82.8
Moose	67 730	66 765	14 170	18 525	53 565	48 235	79.1	72.2
Abitibi	29 475	29 285	9 665	10 825	19 805	18 455	67.2	63.0
Harricanaw	865	595	865	600	-	-	-	-
Upper Winnipeg	46 155	43 575	15 965	18 010	30 190	25 560	65.4	58.7
English	26 160	28 745	12 810	14 195	13 350	14 545	51.0	50.6
East Lake Winnipeg	810	1 210	810	1 210	-	-	-	-
Total	**7 703 105**	**9 101 695**	**1 359 480**	**1 632 270**	**6 343 630**	**7 469 420**	**82.4**	**82.1**
Manitoba								
Hayes	4 580	7 645	4 580	7 650	-	-	-	-
Nisksibi and Central Hudson Bay	-	-	-	-	-	-	-	-
Severn	-	-	-	-	-	-	-	-
Qu'Appelle	-	-	-	-	-	-	-	-
Saskatchewan	21 980	21 785	7 045	8 025	14 935	13 760	67.9	63.2
Lake Winnipegosis and Lake Manitoba	82 480	73 765	65 545	54 510	16 930	19 250	20.5	26.1
Assiniboine	245 635	240 840	54 850	51 470	190 780	189 375	77.7	78.6
Souris	18 270	16 460	15 460	12 335	2 810	4 125	15.4	25.1
Red	534 605	628 355	105 490	114 665	429 310	513 695	80.3	81.8
Winnipeg	13 590	11 540	10 275	8 445	3 315	3 090	24.4	26.8
East Lake Winnipeg	3 095	4 065	3 095	4 060	-	-	-	-
West Lake Winnipeg	25 250	23 140	20 975	18 925	4 275	4 215	16.9	18.2
Rat and Grass	23 315	18 950	3 300	2 480	20 015	16 470	85.8	86.9
Nelson	6 935	8 765	6 935	7 540	-	1 225	-	14.0
Reindeer Lake	700	1 000	700	1 000	-	-	-	-
Central Churchill	4 690	5 275	1 795	3 635	2 895	1 645	61.7	31.1
Lower Churchill and West Hudson Bay	2 925	1 215	1 750	1 215	1 170	-	40.1	-
Seal and West Hudson Bay	-	220	-	220	-	-	-	-
Nuettin Lake	-	-	-	-	-	-	-	-
Kazan	-	-	-	-	-	-	-	-
Total	**988 245**	**1 063 015**	**301 600**	**296 165**	**686 445**	**766 850**	**69.5**	**72.1**
Saskatchewan								
Upper South Saskatchewan	835	620	830	620	-	-	-	-
Red Deer	-	-	-	-	-	-	-	-
Central North Saskatchewan	36 845	43 530	19 550	21 485	17 300	22 050	46.9	50.6
Battle	7 095	8 810	5 290	4 990	1 800	3 815	25.4	43.3
Lower North Saskatchewan	97 980	101 370	54 685	51 150	43 300	50 220	44.2	49.5
Lower South Saskatchewan	222 235	274 260	68 355	62 755	153 880	211 505	69.2	77.1
Qu'Appelle	297 570	326 130	101 955	87 325	195 610	238 805	65.7	73.2
Saskatchewan	49 595	50 190	34 870	30 630	14 725	19 555	29.7	39.0
Lake Winnipegosis and Lake Manitoba	21 375	19 995	18 350	16 790	3 025	3 210	14.1	16.0
Assiniboine	83 375	76 720	51 360	41 975	32 015	34 750	38.4	45.3
Souris	65 890	60 430	43 340	34 630	22 545	25 795	34.2	42.7
Beaver	18 120	19 925	14 685	15 950	3 435	3 975	19.0	20.0
Upper Churchill	5 025	6 495	3 895	3 840	1 130	2 650	22.5	40.8
Upper Central Churchill	4 205	7 375	4 205	4 680	-	2 695	-	36.6
Reindeer Lake	600	1 340	600	1 340	-	-	-	-
Central Churchill	495	875	500	875	-	-	-	-
Nueltin Lake	-	-	-	-	-	-	-	-
Kazan	-	-	-	-	-	-	-	-
Lower Central Athabasca	-	25	-	25	-	-	-	-
Lower Athabasca	-	-	-	-	-	-	-	-
Fond du Lac	770	1 660	765	1 660	-	-	-	-
Athabasca Lake	2 630	220	765	65	1 865	155	70.8	71.9
Tallson and Southeast Great Slave Lake	-	-	-	-	-	-	-	-
Missoun	11 605	9 645	11 605	8 640	-	1 005	-	10.4
Total	**926 240**	**1 009 615**	**435 610**	**389 420**	**490 630**	**620 195**	**53.0**	**61.4**

Rural-Urban Population by Drainage Sub-basin, 1971 and 1986

Provincial/Territorial Sub-basin	Total population		Rural population		Urban population		Urban population as a percentage of total	
	1971	1986	1971	1986	1971	1986	1971	1986
	persons						percent	
Alberta								
Upper South Saskatchewan	151 785	197 470	51 295	55 055	100 480	142 415	66.2	72.1
Bow	452 225	724 190	31 545	36 645	420 675	687 550	93.0	94.9
Red Deer	123 385	172 860	75 645	79 210	47 735	93 650	38.7	54.2
Upper North Saskatchewan	209 260	282 815	26 880	34 940	182 380	247 875	87.2	87.6
Central North Saskatchewan	404 110	593 080	78 810	96 985	325 300	496 100	80.5	83.6
Battle	82 600	99 665	49 425	49 335	33 175	50 335	40.2	50.5
Lower North Saskatchewan	8 765	8 460	7 270	6 735	1 490	1 725	17.0	20.4
Lower South Saskatchewan	260	215	260	215	-	-	-	-
Beaver	24 900	31 385	12 610	14 875	12 290	16 510	49.4	52.6
Upper Churchill	-	-	-	-	-	-	-	-
Upper Athabasca	22 950	35 685	6 715	7 850	16 230	27 830	70.7	78.0
Pembina and Central Athabasca	43 615	53 710	30 360	34 240	13 255	19 470	30.4	36.3
Lower Central Athabasca	16 210	43 630	7 575	7 990	8 640	35 640	53.3	81.7
Lower Athabasca	-	2 555	-	300	-	2 260	-	88.3
Upper Peace	17 425	19 330	12 510	12 665	4 915	6 660	28.2	34.5
Smoky	40 935	62 250	21 185	23 940	19 750	38 310	48.2	61.5
Central Peace	15 420	19 405	8 220	10 980	7 200	8 425	46.7	43.4
Lower Central Peace	7 400	11 840	5 785	8 840	1 615	3 000	21.8	25.4
Lower Peace and Lake Claire	565	1 095	565	1 095	-	-	-	-
Athabasca Lake	1 180	1 015	50	1 015	1 125	-	95.4	-
Slave	30	15	25	15	-	-	-	-
Upper Hay	1 370	2 045	1 370	2 045	-	-	-	-
Buffalo	0	0	0	0	-	-	-	-
Taltson and Southeast Great Slave Lake	-	-	-	-	-	-	-	-
West Great Slave Lake	-	-	-	-	-	-	-	-
Fort Nelson	-	-	-	-	-	-	-	-
Petitot	-	-	-	-	-	-	-	-
Missouri	3 495	3 095	3 500	3 095	-	-	-	-
Total	**1 627 875**	**2 365 825**	**431 620**	**488 065**	**1 196 255**	**1 877 755**	**73.5**	**79.4**
British Columbia								
Williston Lake	4 865	7 980	2 045	2 610	2 815	5 370	57.9	67.3
Upper Peace	38 765	50 305	17 040	24 330	21 730	25 970	56.0	51.6
Smoky	-	-	-	-	-	-	-	-
Upper Hay	495	325	495	325	-	-	-	-
West Great Slave Lake	-	-	-	-	-	-	-	-
Alsek	-	-	-	-	-	-	-	-
Taku and North Pacific Ocean	30	20	30	20	-	-	-	-
Stikine	555	685	555	685	-	-	-	-
Nass and North Central Pacific Ocean	3 315	2 665	3 315	2 665	-	-	-	-
Skeena	49 235	57 575	16 255	20 590	32 980	36 980	67.0	64.2
Gardner Canal and Central Pacific Ocean	17 870	15 845	4 705	5 095	13 170	10 750	73.7	67.8
Knight Inlet and South Pacific Ocean	164 315	194 520	29 295	26 255	135 015	168 265	82.2	86.5
Vancouver Island	381 795	517 380	112 385	130 405	269 410	386 980	70.6	74.8
Nechako	59 010	74 260	15 000	20 335	44 005	53 920	74.6	72.6
Upper Fraser	35 895	55 000	25 555	30 455	10 335	24 540	28.8	44.6
Thompson	99 840	136 225	44 675	59 380	55 170	76 845	55.3	56.4
Fraser	1 065 995	1 414 525	150 435	128 445	915 565	1 286 080	85.9	90.9
Columbia	252 975	343 600	102 130	138 030	150 840	205 570	59.6	59.8
Queen Charlotte Islands	4 350	5 480	4 350	5 480	-	-	-	-
Skagit	520	-	520	-	-	-	-	-
Upper Yukon	310	530	310	530	-	-	-	-
Upper Liard	1 245	1 585	160	1 580	1 080	-	87.0	-
Central Liard	155	55	155	55	-	-	-	-
Fort Nelson	3 090	4 815	800	1 085	2 290	3 730	74.1	77.5
Petitot	-	-	-	-	-	-	-	-
Total	**2 184 620**	**2 883 370**	**530 215**	**598 365**	**1 654 405**	**2 285 005**	**75.7**	**79.2**
Yukon								
Alsek	375	525	375	525	-	-	-	-
Upper Yukon	12 935	17 920	1 720	2 720	11 220	15 200	86.7	84.8
Pelly	1 090	995	1 095	995	-	-	-	-
Upper Central Yukon	375	115	375	110	-	-	-	-
Stewart	975	895	970	895	-	-	-	-
Central Yukon	1 300	1 375	1 300	1 370	-	-	-	-
Porcupine	215	230	215	230	-	-	-	-
Tanana	-	115	-	115	-	-	-	-
Upper Liard	1 120	1 340	1 120	1 340	-	-	-	-
Central Liard	-	-	-	-	-	-	-	-
Petitot	-	-	-	-	-	-	-	-
Peel and Northwest Arctic Ocean	-	-	-	-	-	-	-	-
Total	**18 385**	**23 505**	**7 175**	**8 305**	**11 220**	**15 195**	**61.0**	**64.7**

Rural-Urban Population by Drainage Sub-basin, 1971 and 1986

Provincial/Territorial Sub-basin	Total population		Rural population		Urban population		Urban population as a percentage of total	
	1971	1986	1971	1986	1971	1986	1971	1986
	persons						percent	
Northwest Territories								
Seal and West Hudson Bay	-	-	-	-	-	-	-	-
Nueltin Lake	-	-	-	-	-	-	-	-
Upper Thelon	-	-	-	-	-	-	-	-
Dubawnt Lake	-	-	-	-	-	-	-	-
Kazan	-	-	-	-	-	-	-	-
Lower Thelon	1 015	1 305	1 015	1 305	-	-	-	-
Northwest Central Hudson Bay	1 380	2 770	1 375	2 770	-	-	-	-
Northwest Hudson Bay	245	430	240	435	-	-	-	-
Southampton Island	595	900	590	900	-	-	-	-
Fond du Lac	-	-	-	-	-	-	-	-
Slave	3 000	2 925	630	485	2 365	2 440	78.9	83.4
Hay	1 120	2 660	-	100	1 120	2 560	100.0	96.3
Buffalo	2 160	1 740	285	180	1 880	1 555	86.9	89.6
Taltson and Southeast Great Slave Lake	220	275	220	275	-	-	-	-
Aylmer Lake and MacKay Lake	-	-	-	-	-	-	-	-
Yellowknife and Northeast Slave Lake	7 285	13 395	1 165	2 470	6 120	10 925	84.0	81.6
Marian	190	465	190	465	-	-	-	-
West Great Slave Lake	625	580	-	175	625	405	100.0	69.6
Petitot	-	-	-	-	-	-	-	-
Lower Liard	615	950	610	945	-	-	-	-
Upper Mackenzie	590	795	595	795	-	-	-	-
Upper Central Mackenzie	745	985	750	985	-	-	-	-
Central Mackenzie	150	175	155	175	-	-	-	-
Great Bear	675	1 055	675	1 050	-	-	-	-
Lower Central Mackenzie	300	625	300	625	-	-	-	-
Lower Mackenzie	3 095	4 060	430	670	2 670	3 390	86.2	83.5
Peel and Northwest Arctic Ocean	1 335	1 520	1 335	1 525	-	-	-	-
Anderson and West Arctic Ocean	660	980	660	980	-	-	-	-
Amundsen Gulf	95	190	95	190	-	-	-	-
Coppermine	640	925	635	925	-	-	-	-
Coronation Gulf and Dease Strait	-	80	-	80	-	-	-	-
Back and Queen Maud Gulf	155	-	155	-	-	-	-	-
Gulf of Boothia	1 250	2 090	1 250	2 090	-	-	-	-
Arctic Islands	6 670	10 365	4 625	7 425	2 050	2 940	30.7	28.4
Total	**34 805**	**52 240**	**17 980**	**28 025**	**16 830**	**24 210**	**48.3**	**46.3**
Canada	**21 568 315**	**25 309 330**	**5 157 530**	**5 957 240**	**16 410 785**	**19 352 090**	**76.1**	**76.5**

Source:
Statistics Canada. Environment and Wealth Accounts Division. Data were derived from the Census of Population.
Note:
[1]The figures have been subjected to a confidentiality procedure known as *random rounding* to prevent the possibility of associating small figures with any identifiable individual.
[2] See the appendix for hydrological classification codes and area figures for these sub-basins.

Table: 2.2.1.4

Components of Population Projections for Canada, Selected Years

Year	Total Population	5 year growth		Immigration	Emigration	Net migration	Fertility rate	Life expectancy		Population aged 65 and over
		Number	Rate					Male	Female	
	thousands	thousands	percent	thousands			births per woman	years		percent of population
Observed										
1986	25 274.0	...	...	99.2	49.0	30.2	1.66	73.0	79.7	10.6
Projection 1										
1991	26 499.1	1 124.4	4.2	150.0	66.4	83.6	3.90	..	..	11.9
1996	27 623.5	802.5	2.9	140.0	69.7	70.3	3.85	75.1	82.2	13.0
2001	28 426.0	541.3	1.9	140.0	72.1	67.9	3.77	..	..	14.0
2006	28 967.3	329.8	1.1	140.0	73.9	66.1	3.68	..	..	15.1
2011	29 297.1	145.1	0.5	140.0	75.0	65.0	3.52	77.2	84.0	16.8
2016	29 442.2	- 45.2	- 0.2	140.0	75.7	64.3	3.16	..	..	19.0
2021	29 397.0	- 281.8	- 1.0	140.0	75.8	64.2	2.82	..	..	21.7
2026	29 115.2	- 538.6	- 1.8	140.0	75.4	64.6	2.60	..	..	24.7
2031	28 576.6	- 780.1	- 2.7	140.0	74.2	65.8	2.46	..	..	27.3
2036	27 796.5	..	..	140.0	72.5	67.5	2.41	..	..	28.6
Projection 2										
1991	26 501.2	1 206.7	4.6	150.0	66.4	83.6	3.90	..	..	11.9
1996	27 707.9	984.5	3.6	140.0	69.8	70.2	3.85	75.1	82.2	13.0
2001	28 692.4	814.4	2.8	140.0	72.5	67.5	3.77	..	..	13.9
2006	29 506.8	691.9	2.3	140.0	74.8	65.2	3.68	..	..	14.8
2011	30 198.7	572.4	1.9	140.0	76.8	63.2	3.52	77.2	84.0	16.3
2016	30 771.1	399.2	1.3	140.0	78.5	61.5	3.16	..	..	18.7
2021	31 170.3	185.9	0.6	140.0	79.7	60.3	2.82	..	..	18.4
2026	31 356.2	- 41.2	- 0.1	140.0	80.4	59.6	2.60	..	..	..
2031	31 315.0	- 247.1	- 0.8	140.0	80.6	59.4	2.46	..	..	..
2036	31 067.9	..	..	140.0	80.1	59.9	2.41	..	..	..
Projection 3										
1991	26 511.2	1 456.4	5.5	180.0	66.4	113.6	3.90	..	..	11.9
1996	27 967.6	1 316.6	4.7	200.0	70.6	129.4	3.85	75.1	82.2	12.8
2001	29 284.2	1 162.3	4.0	200.0	74.3	125.7	3.77	..	..	13.4
2006	30 446.5	1 046.8	3.4	200.0	77.6	122.4	3.68	..	..	14.1
2011	31 493.3	929.3	3.0	200.0	80.6	119.4	3.52	77.2	84.0	15.2
2016	32 422.6	756.7	2.3	200.0	83.3	116.7	3.16	..	..	..
2021	33 179.3	545.8	1.6	200.0	85.6	114.4	2.82	..	..	..
2026	33 725.1	319.7	0.9	200.0	87.2	112.8	2.60	..	..	..
2031	34 044.8	109.0	0.3	200.0	88.3	111.7	2.46	..	..	..
2036	34 153.8	..	..	..	..	..	2.41	..	..	..
Projection 4										
1991	26 511.2	1 478.4	5.6	180.0	66.4	113.6	3.90	..	..	11.9
1996	27 989.6	1 407.7	5.0	200.0	70.4	129.6	3.85	75.1	82.2	12.8
2001	29 397.3	1 341.8	4.6	200.0	74.1	125.9	3.77	..	..	13.4
2006	30 739.1	1 369.0	4.5	200.0	77.5	122.5	3.68	..	..	13.9
2011	32 108.1	1 362.9	4.2	200.0	81.1	118.9	3.52	77.2	84.0	14.9
2016	33 471.0	1 205.3	3.6	200.0	84.6	115.4	3.16	..	..	..
2021	34 676.3	1 023.8	3.0	200.0	87.8	112.2	2.82	..	..	..
2026	35 700.1	859.3	2.4	200.0	90.5	109.5	2.60	..	..	..
2031	36 559.4	744.9	2.0	200.0	92.7	107.3	2.46	..	..	..
2036	37 304.3	..	..	..	..	..	2.41	..	..	..

Source:
Statistics Canada. *Population Projections for Canada, Provinces and Territories, 1989-2011.* Catalogue 91-520.

Table: 2.2.1.5

Total Population Projections for Canada, 1991-2036

Year	Projection 1	Projection 2	Projection 3	Projection 4
		thousands		
1991	26 499.1	26 501.2	26 511.2	26 511.2
1992	26 757.7	26 767.1	26 807.5	26 607.5
1993	26 993.9	27 015.3	27 101.7	27 103.0
1994	27 217.2	27 255.0	27 393.3	27 398.7
1995	27 427.0	27 485.9	27 681.9	27 694.2
1996	27 623.5	27 707.9	27 967.6	27 989.6
1997	27 807.4	27 921.2	28 245.6	28 280.3
1998	27 979.5	28 126.1	28 516.2	28 566.7
1999	28 139.8	28 322.6	28 779.1	28 847.8
2000	28 288.5	28 511.1	29 034.9	29 124.3
2001	28 426.0	28 692.4	29 284.2	29 397.3
2002	28 552.9	28 867.1	29 527.5	29 666.6
2003	28 670.6	29 035.8	29 765.4	29 934.8
2004	28 778.8	29 198.4	29 997.6	30 202.5
2005	28 877.5	29 355.2	30 224.4	30 470.4
2006	28 967.3	29 506.8	30 446.5	30 739.1
2007	29 049.0	29 653.7	30 664.0	31 008.9
2008	29 122.9	29 796.3	30 877.4	31 280.6
2009	29 188.6	29 934.5	31 086.8	31 554.0
2010	29 246.5	30 068.7	31 292.1	31 829.7
2011	29 297.1	30 198.7	31 493.3	32 108.1
2012	29 339.7	30 324.3	31 690.3	32 388.6
2013	29 297.1	30 445.6	31 882.9	32 668.4
2014	29 404.6	30 560.5	32 069.3	32 942.1
2015	29 427.0	30 669.1	32 249.2	33 209.7
2016	29 442.2	30 771.1	32 422.6	33 471.0
2017	29 449.9	30 866.2	32 589.1	33 725.8
2018	29 449.6	30 953.9	32 748.3	33 974.0
2019	29 441.0	31 034.1	32 900.0	34 215.2
2020	29 423.6	31 106.3	33 043.8	34 449.4
2021	29 397.0	31 170.3	33 179.3	34 676.3
2022	29 360.8	31 225.5	33 306.3	34 895.7
2023	29 314.7	31 271.8	33 424.5	35 107.7
2024	29 258.5	31 309.1	33 533.8	35 312.3
2025	29 192.0	31 337.2	33 633.9	35 509.7
2026	29 115.2	31 356.2	33 725.1	35 700.1
2027	29 028.1	31 365.9	33 807.0	35 883.8
2028	28 930.5	31 366.5	33 879.9	36 061.1
2029	28 822.7	31 358.2	33 943.7	36 232.5
2030	28 704.6	31 341.0	33 998.6	36 398.5
2031	28 576.6	31 315.0	34 044.8	36 559.4
2032	28 438.8	31 281.1	34 082.5	36 715.9
2033	28 291.5	31 239.0	34 112.0	36 868.2
2034	28 135.1	31 189.2	34 133.5	37 016.9
2035	27 969.9	31 132.0	34 147.3	37 162.1
2036	27 796.5	31 067.9	34 153.8	37 304.3

Source:
Statistics Canada. Demography Division. *Population Projections for Canada, Provinces and Territories 1989-2011*. Catalogue 91-520.

Table: 2.2.1.6

Population Projections for Canada, Provinces and Territories, 1991-2011

Year	Canada	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	Yukon	N.W.T.
						thousands							
Projection 1													
1991	**26 757.6**	574.7	132.9	894.6	726.1	6 777.9	9 814.6	1 086.2	998.4	2 493.4	3 177.7	25.7	55.4
1996	**27 807.5**	573.3	134.5	911.7	730.7	6 918.4	10 282.2	1 104.6	1 020.2	2 673.9	3 370.6	29.0	58.4
2001	**28 552.7**	566.4	134.4	920.6	727.5	6 988.6	10 633.9	1 115.7	1 038.2	2 819.1	3 515.8	31.7	60.8
2006	**29 048.8**	555.9	133.5	920.9	719.2	7 012.9	10 887.0	1 122.0	1 051.1	2 931.4	3 618.0	33.3	63.6
2011	**29 339.7**	543.0	132.2	914.9	707.1	6 996.1	11 062.3	1 125.2	1 060.6	3 014.7	3 683.0	34.1	66.5
Percent change	**9.6**	- 5.5	- 0.5	2.3	- 2.6	3.2	12.7	3.6	6.2	20.9	15.9	32.7	20.0
Projection 2													
1991	**26 767.1**	575.0	133.1	895.4	726.8	6 785.0	9 825.3	1 087.7	997.2	2 486.1	3 174.2	25.6	55.7
1996	**27 921.1**	576.6	137.3	922.6	740.1	7 022.7	10 430.1	1 123.5	998.6	2 558.0	3 320.7	26.8	61.9
2001	**28 867.1**	579.7	140.4	945.1	749.3	7 210.1	10 958.3	1 156.6	998.4	2 604.7	3 428.7	27.8	68.0
2006	**29 653.6**	578.8	142.8	961.8	754.2	7 357.2	11 407.7	1 186.6	998.3	2 647.4	3 516.2	28.4	74.2
2011	**30 324.5**	576.6	145.1	973.8	755.9	7 467.4	11 794.9	1 215.7	1 000.8	2 692.3	3 592.3	29.0	80.7
Percent change	**13.3**	0.3	9.0	8.8	4.0	10.1	20.0	11.8	0.4	8.3	13.2	13.3	44.9
Projection 3													
1991	**26 807.5**	575.0	133.0	895.6	726.6	6 792.0	9 831.8	1 088.7	1 000.0	2 499.2	3 184.3	25.8	55.5
1996	**28 245.7**	576.4	135.5	919.6	735.6	7 052.7	10 427.7	1 123.3	1 031.6	2 726.2	3 428.5	29.4	59.2
2001	**29 527.4**	574.7	136.9	939.3	740.0	7 286.1	10 953.0	1 156.7	1 063.8	2 936.1	3 645.4	32.7	62.7
2006	**30 664.0**	571.0	138.0	953.6	741.3	7 495.7	11 419.1	1 189.6	1 094.5	3 125.6	3 833.7	34.9	67.0
2011	**31 690.2**	566.1	139.0	963.8	740.6	7 684.3	11 843.2	1 223.7	1 124.6	3 298.7	3 997.8	36.6	71.8
Percent change	**18.2**	- 1.5	4.5	7.6	1.9	13.1	20.5	12.4	12.5	32.0	25.5	41.9	29.4
Projection 4													
1991	**26 807.6**	575.6	133.3	896.7	727.6	6 793.6	9 834.4	1 090.7	1 002.1	2 495.2	3 177.3	25.6	55.5
1996	**28 280.3**	587.7	140.0	938.3	756.0	7 097.4	10 480.0	1 152.7	1 060.7	2 636.4	3 346.5	26.6	58.0
2001	**29 934.6**	601.2	147.3	987.0	788.9	7 456.6	11 193.0	1 229.9	1 136.6	2 785.7	3 519.8	27.8	60.8
2006	**31 008.8**	609.9	151.7	1 016.8	808.8	7 701.6	11 649.1	1 279.6	1 185.6	2 882.2	3 631.4	28.8	63.3
2011	**32 388.4**	621.0	157.1	1 053.0	832.2	8 028.4	12 230.5	1 341.6	1 245.5	3 005.1	3 776.5	30.2	67.3
Percent change	**20.8**	7.9	17.9	17.4	14.4	18.2	24.4	23.0	24.3	20.4	18.9	18.0	21.3

Source:
Statistics Canada. Demography Division. *Population Projection for Canada, Provinces and Territories 1989-2011*. Catalogue 91-520.

2.3 Environmental Benefits and Impacts on Individuals

"If there were no fresh air or clean water; if the temperature were too hot or too cold — we could not live. Our environment is truly for life!"

Environment Canada. 1990. *What We Can Do for Our Environment.*

❑❑❑

A clean environment is essential to human well-being. People, animals and plants are dependent on the water, air, and land and on the other resources it provides.

This section provides available statistics on the interactions between individuals and the environment. These consist of both the benefits people receive from the environment and some of the negative impacts associated with the environment. New information in this area consists of the results of the Environment Canada survey of *The Importance of Wildlife to Canadians*, and Statistics Canada's survey on domestic travel.

How exposure to the natural environment sustains health and the quality of life is not well known. Some aspects of the negative impacts of environment, for example, losses from natural disasters, are well documented. Others, such as effect of pollution and other synthetic chemicals are currently the subject of extensive research:

> *"Systematic testing of chemicals used for pharmaceutical purposes, for example, began only after the thalidomide crisis of the 1950s. And scientists have only begun to understand the links between some chemicals and cancer. The same is true for respiratory, intestinal, cardiovascular, neurological and behavioural disorders or impacts on immune systems or the physiology of reproduction. In addition, statistics relating occupational or environmental agents to symptoms of illness or to disease are virtually non-existent."*[5]

This section presents statistics on causes of death and incidents of contaminants in food. The precise role of environmental factors in human health are not well understood and a detailed discussion is beyond the scope of this publication.

5. Environment Canada. 1986. *From cradle to grave: a management approach to chemicals.* Catalogue EN40-342/1986E.

2.3.1 Environmental Benefits

One direct economic benefit of wildlife is estimated to be $6.1 billion per year in personal expenditures. In 1987, non-commercial wildlife-related activities accounted for 159 thousand jobs, $3.7 billion of personal income and $2.5 billion in government revenues from taxes.

❑❑❑

One way of measuring the benefits of the environment to people is their willingness to pay for the services it provides. In 1987, Statistics Canada performed a household survey for the Canadian Wildlife Service of Environment Canada on the importance of wildlife to Canadians[6] The survey measured the economic impact of wildlife-related activities and the economic value people place on these activities. These are reported in terms of consumptive (recreational hunting) and non-consumptive (birdwatching, hiking, and camping) activities.

Environment Canada estimated that, in 1987, wildlife-related activities accounted for expenditures of $5.1 billion (Tables 2.3.1.2 and 2.3.1.4, Figures 2.3.1.1, 2.3.1.2). Participants were also asked to estimate the additional amount they would pay for the enjoyment they receive from wildlife through activities such as bird watching and hunting. This **net economic value** came to another $1 billion (Table 2.3.1.3). The **direct benefits of wildlife** were taken to be the sum of these values, of $6.1 billion. This was further estimated to account for $6.5 billion of the country's Gross Domestic Product, 159 thousand jobs, $3.7 billion of personal income, and $2.5 billion of government revenue from taxes.

Table 2.3.1.1 details the frequency of outdoor recreational activity. Of the 166 million domestic trips (of 80 kilometres or more) made in 1986, one-quarter were for outdoor recreation and enjoyment of nature.

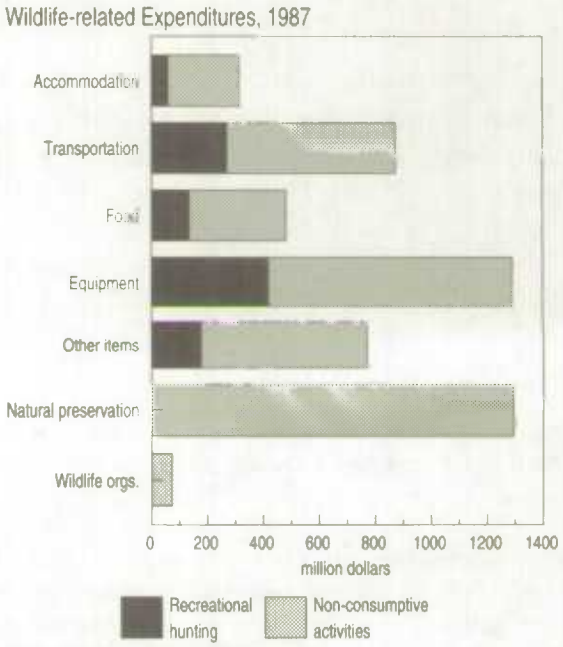
6. Environment Canada. 1990. *The Importance of Wildlife to Canadians: The Economic Significance of Wildlife-related Recreational Activities.* Catalogue CW 66-103/2-1990E.

Table: 2.3.1.1
Selected Activities of Canadian Travellers, 1986

Activity	Person-trips[1]	Percent of all trips
	thousands	percent
Visit zoo, museum or natural display	5 775	3.5
Visit national, provincial or regional park	7 948	4.8
Swimming	12 185	7.3
Other water sports	6 431	3.9
Hunting or fishing	7 506	4.5
Cross-country skiing	1 062	0.6
Downhill skiing	2 142	1.3
Other activities	123 131	74.1
Total	**166 180**	**100.0**

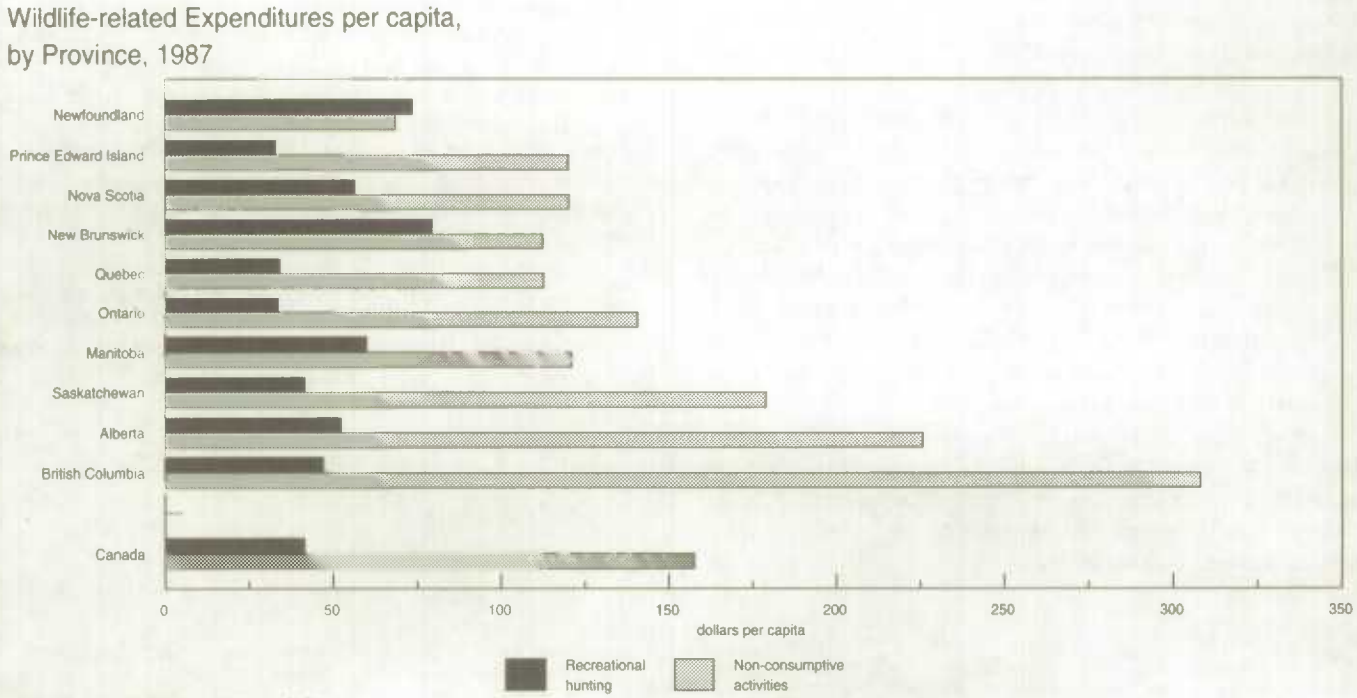
Source:
Statistics Canada. *Domestic Travel, Canadians Travelling in Canada. Catalogue 87-504.*
Note: [1] Trips of over 80 km. in length.

Figure: 2.3.1.1



Source: Environment Canada. Canadian Wildlife Service. The importance of wildlife to Canadians. Catalogue CW 66-103/2-1990E.

Figure: 2.3.1.2



Source: Environment Canada. Canadian Wildlife Service. The importance of wildlife to Canadians.

Table: 2.3.1.2

Distribution of Wildlife-related Expenditure, 1987

Category of expenditure	Recreational hunting	Non-consumptive and other activities	All wildlife-related recreational activities
	million dollars		
Accommodation	59	254	314
Transportation	269	606	875
Food	135	347	483
Equipment	419	872	1 292
Other items	177	594	771
Natural area preservation	...	1 292	1 292
Wildlife organizations	...	73	73
Total	**1 060**	**4 039**	**5 099**

Source:
Environment Canada. 1990. *The Importance of Wildlife to Canadians: The Economic Significance of Wildlife-related Recreational Activities*. Catalogue CW 66-103/2-1990E.

Table: 2.3.1.3

Net Economic Value by Wildlife-related Activity, 1987

Activity	Average value per participant		Annual value for all participants
	Daily	Yearly	
	dollars		million dollars
Hunting			
Large mammals	17.0	200.9	208.9
Small mammals	7.7	92.6	657.0
Waterfowl	15.6	167.2	83.1
Other birds	10.1	106.8	91.7
All hunting	**15.8**	**268.3**	**451.7**
Primary non-consumptive trips	7.2	121.7	535.6
Total	...	...	**987.4**

Source:
Environment Canada. 1990. *The Importance of Wildlife to Canadians: The Economic Significance of Wildlife-related Recreational Activities*. Catalogue CW 66-103/2-1990E.

Table: 2.3.1.4

Wildlife-related Expenditures by Province, 1987

Province	Total expenditures			Expenditures per capita[1]		
	Recreational hunting	Non-consumptive and other activities	All wildlife-related recreational activities	Recreational hunting	Non-consumptive and other activities	All wildlife-related recreational activities
	million dollars			dollars per capita		
Newfoundland	42	39	81	73.7	68.6	142.4
Prince Edward Island	4	15	19	33.0	120.2	153.2
Nova Scotia	50	106	155	56.5	120.3	176.8
New Brunswick	57	80	137	79.5	112.5	192.1
Quebec	225	744	969	34.2	112.8	147.0
Ontario	314	1 305	1 619	33.9	140.7	174.6
Manitoba	65	131	195	60.0	121.0	181.0
Saskatchewan	42	182	224	41.7	179.0	220.7
Alberta	125	537	661	52.4	225.6	277.8
British Columbia	137	901	1 039	47.0	308.1	355.0
Canada	**1 061**	**4 039**	**5 099**	**41.4**	**157.6**	**199.0**

Source:
Environment Canada. 1990. *The Importance of Wildlife to Canadians: The Economic Significance of Wildlife-related Recreational Activities*. Catalogue CW 66-103/2-1990E.
Note:
[1]Based on Statistics Canada estimates of 1987 population.

2.3.2 Impacts of Environment

Between 1951 and 1989, the crude death rate decreased from 1,802 to 1,458 deaths per 100,000 population. As well as declining, the mix of causes of death has undergone considerable change. Over this period, the average age of the population has increased, the population has nearly doubled and the environment has undergone many changes. The death rates from lung cancer and respiratory diseases has grown much faster than other causes. The influence of environmental factors on these death rates is currently being debated.

❑❑❑

In 1984 there were 9,857 cases of foodborne disease in Canada and 178 cases of waterborne disease. Of the foodborne cases, 5,682 were attributed to microbiological causes and 82 to chemicals. Many of these cases of illness can be associated with environmental factors.

❑❑❑

The negative impacts of the environment may either be independent of human effects (the climate, natural disasters, etc.) or the result of human activities (poor water or air quality, exposure to contaminants, etc.). Many of the associations between human health and environmental factors, such as the accumulation of toxins in human tissues, are not well understood. In the tables presented in this section, statistics are given for broad categories of causes of death and cases of foodborne diseases.

Causes of Death

Leading causes of death have changed gradually in rank over the years from 1951 through 1989, however, mortality rates for these causes have often changed substantially (Table 2.3.2.1 and Figure 2.3.2.1).

For both males and females, declines in mortality rates were very marked in diseases of the circulatory system, though these diseases remain as the first leading cause of death. Cancer mortality rates, while remaining in second rank, increased during this period for males and more recently for females. Mortality due to accidents and adverse effects remained in third rank for males, followed closely by respiratory diseases. For females, respiratory disease mortality returned to third rank during the 1980s, in part, due to decreasing rates for accidents and adverse effects. Rates for both sexes for perinatal mortality and for infective and parasitic diseases declined, as did their prominence as leading causes; they were supplanted by diseases of the nervous system and of the genito-urinary system.

Table 2.3.2.2 contains the standardized death rates, by selected causes and sex for Canada and the provinces for 1986. Rates above the national average occur in Quebec, Eastern Canada and the territories.

Contaminants in Food

Health and Welfare Canada[7] reported over 9,800 cases of foodborne disease in Canada in 1984 (Tables 2.3.2.3 and 2.3.2.4). These were cases reported to local health authorities and tend to be caused by short-term exposure to bacteria and chemicals.

7. Health and Welfare Canada, Health Protection Branch. 1988. *Foodborne and Waterborne Disease in Canada, Annual Summaries 1983, 1984.* Catalogue H40-11/1984E.

Table: 2.3.2.1

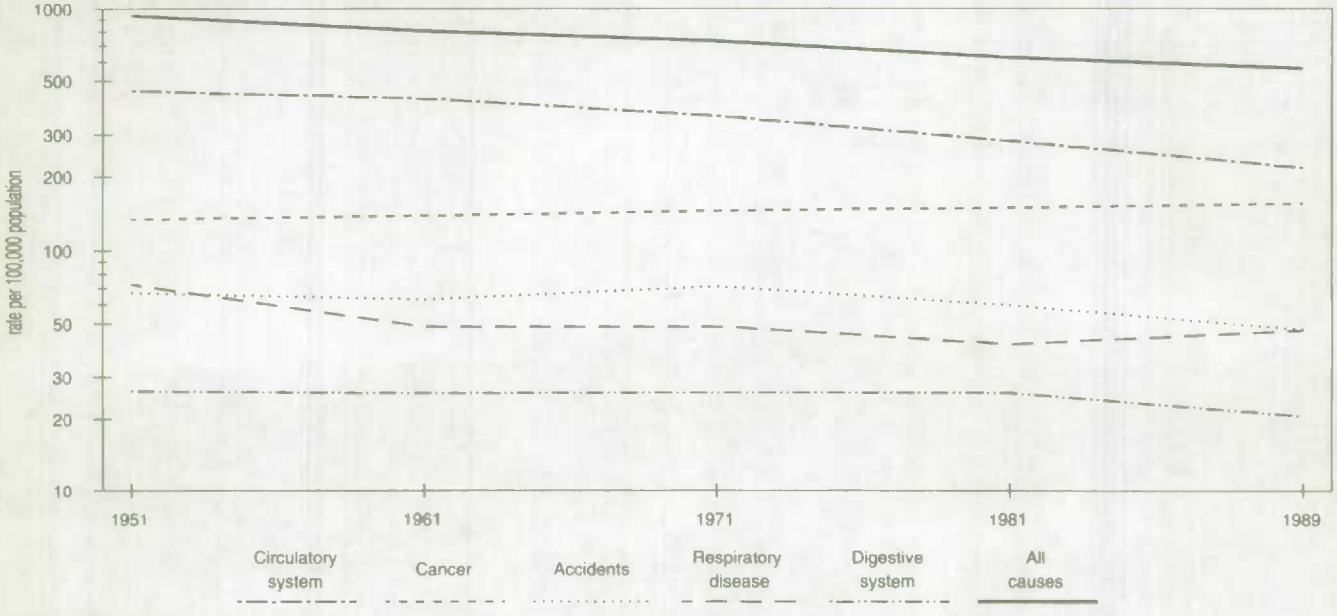
Age-adjusted Death Rates for Leading Causes of Death, Canada, Selected Years

Cause of death	1951		1961		1971		1981		1989	
	rate	rank	rate	rank	rate	rank	rate	rank	rate	rank
	per 100,000 population									
Male										
Diseases of the circulatory system	512.4	(1)	500.7	(1)	448.8	(1)	359.8	(1)	277.4	(1)
Cancer	138.7	(2)	157.6	(2)	173.1	(2)	181.4	(2)	191.2	(2)
Accidents and adverse effects	97.8	(3)	93.3	(3)	101.6	(3)	87.2	(3)	68.2	(3)
Respiratory diseases	81.6	(4)	60.4	(4)	67.2	(4)	59.0	(4)	63.9	(4)
Diseases of the digestive system	30.7	(8)	31.0	(5)	32.8	(5)	32.7	(5)	25.8	(5)
Endocrine diseases	13.4	*	13.2	*	17.3	(7)	14.3	(6)	16.0	(6)
Diseases of the nervous system	15.0	*	10.8	*	9.4	*	10.4	(7)	16.0	(7)
Diseases of the genito-urinary system	43.4	(6)	23.5	(7)	13.5	(8)	10.0	(8)	10.2	(8)
Infective and parasitic diseases	45.3	(5)	14.5	(8)	6.8	*	4.0	*	9.5	*
Causes of perinatal mortality	34.3	(7)	27.4	(6)	18.4	(6)	7.9	*	6.1	*
All other causes	79.3	...	58.1	...	44.3	...	38.1	...	37.6	...
All causes	**1 057.6**		**963.1**		**914.8**		**796.9**		**715.8**	
Female										
Diseases of the circulatory system	396.3	(1)	343.0	(1)	267.5	(1)	203.2	(1)	157.7	(1)
Cancer	129.2	(2)	120.0	(2)	117.2	(2)	116.6	(2)	120.1	(2)
Respiratory diseases	63.5	(3)	37.0	(3)	30.2	(4)	23.2	(4)	29.9	(3)
Accidents and advarse effects	36.3	(4)	32.7	(4)	40.5	(3)	32.0	(3)	26.3	(4)
Diseases of the digestive system	21.8	(8)	20.4	(5)	19.0	(5)	18.8	(5)	15.5	(5)
Endocrine diseases	19.2	*	17.1	(7)	16.8	(6)	13.0	(6)	12.6	(6)
Diseases of the nervous system	12.3	*	8.5	*	7.0	*	7.3	(7)	11.3	(7)
Diseases of the genito-urinary system	26.7	(6)	12.6	(8)	6.8	*	5.9	*	8.2	(8)
Congenital anomalies	11.7	*	11.0	*	8.7	(8)	6.4	(8)	5.5	*
Causes of perinatal mortality	24.8	(7)	20.4	(6)	13.0	(7)	5.9	*	4.5	*
Infective and parasitic diseases	33.3	(5)	8.7	*	4.6	*	2.6	*	3.3	*
All other causes	37.9	...	18.0	...	12.8	...	15.2	...	18.4	...
All causes	**813.0**		**649.4**		**544.1**		**450.1**		**411.3**	

Source:
Statistics Canada. Canadian Centre for Health Information.
Note:
* : Does not rank among top eight causes.

Figure: 2.3.2.1

Trends in Age-adjusted Death Rates for Selected Causes, 1950-1989



Source: Statistics Canada. Canadian Centre for Health Information.

Table: 2.3.2.2

Standardized[1] Death Rates, by Selected Causes and Sex, Canada and Provinces, 1986

Cause	Canada	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	Yukon	N.W.T.
	per 100,000 population												
Total all causes - Male	**690.1**	694.0	745.8	739.8	723.5	752.9	675.9	690.1	653.8	655.6	621.4	833.0	891.9
All malignant neoplasms	**176.2**	163.0	177.8	186.6	178.9	204.6	172.4	174.0	152.9	152.3	155.7	150.3	210.1
Intestine, except rectum	**17.3**	20.8	14.2	21.9	21.0	17.5	19.2	14.1	9.8	16.1	13.4	2.5	35.8
Lung(incl. trachea and bronchus)	**57.3**	52.1	62.0	63.7	63.4	73.7	54.0	57.9	47.1	39.3	47.2	47.0	60.3
Breast	**0.2**	0.3	0.0	0.5	0.5	0.2	0.1	0.1	0.1	0.2	0.1	2.8	1.2
All other malignant neoplasms	**101.4**	89.8	101.5	100.5	93.9	113.2	99.1	101.8	95.9	96.7	95.0	98.0	112.7
Diabetes mellitus	**11.3**	14.3	3.8	11.7	10.2	14.3	11.4	13.2	10.8	7.5	7.7	1.9	0.7
Diseases of the heart	**219.6**	248.9	269.1	251.6	259.4	236.3	222.1	208.9	198.6	197.0	182.9	300.3	196.4
Ischaemic heart disease	**182.4**	206.5	226.6	201.5	200.9	188.1	194.1	169.9	163.6	152.7	153.2	264.3	137.9
All other heart diseases	**37.2**	42.4	42.5	50.1	58.5	48.1	28.0	39.0	35.1	44.3	29.7	36.0	58.5
Cerebrovascular disease	**39.5**	50.8	53.5	39.2	30.0	40.4	39.5	43.7	35.8	39.6	36.9	16.6	64.6
Atherosclerosis	**7.5**	2.2	10.8	7.9	5.1	8.4	8.6	4.6	8.0	7.4	5.5	3.4	2.5
Respiratory diseases (excl. infectious and parasitic diseases)	**59.5**	53.2	56.2	67.2	63.8	66.7	56.8	61.3	58.8	58.6	51.6	45.6	99.2
Pneumonia and influenza	**21.7**	16.0	14.4	24.8	18.1	19.4	22.1	24.7	25.4	23.4	21.2	21.6	23.4
Bronchitis, emphysema and asthma (excl. acute bronchitis)	**9.9**	7.0	9.3	6.8	11.7	14.9	8.1	6.1	9.7	10.3	8.5	13.7	14.8
All other respiratory diseases	**27.9**	30.2	32.5	35.6	34.0	32.3	26.7	30.5	23.8	24.9	21.9	10.3	61.0
Chronic liver disease and cirrhosis	**10.3**	7.1	6.8	7.2	6.2	10.7	11.1	11.0	8.9	9.2	10.0	12.1	3.9
Congenital anomalies	**6.4**	4.7	11.0	5.6	7.1	6.2	6.2	7.1	6.8	8.0	6.0	15.2	4.8
Causes of perinatal mortality excl. stillbirths	**6.4**	8.0	3.5	7.9	6.5	7.2	6.0	6.1	8.5	4.9	6.0	22.7	13.8
All accidents and adverse effects	**69.9**	48.3	88.6	65.4	78.6	73.5	55.8	73.9	89.5	90.3	81.6	169.3	183.0
All other causes	**83.5**	93.5	86.7	89.5	77.8	84.8	85.8	86.5	75.4	80.8	77.4	95.5	113.2
Total all causes - Female	**486.9**	528.9	489.5	502.1	487.8	501.0	489.4	483.1	452.6	479.2	454.5	567.4	608.7
All malignant neoplasms	**131.3**	127.1	148.5	140.4	129.7	136.0	132.0	132.7	120.2	124.1	125.9	146.1	162.3
Intestine, except rectum	**16.3**	20.9	18.0	19.0	18.3	17.3	16.3	14.6	13.9	15.2	14.5	27.1	12.9
Lung(incl. trachea and bronchus)	**20.8**	14.3	26.8	24.0	18.7	20.0	21.3	20.2	17.5	16.8	25.0	3.3	76.4
Breast	**27.6**	21.8	30.8	27.2	28.9	27.3	28.9	30.6	24.5	26.4	25.4	36.2	1.9
All other malignant neoplasms	**66.7**	70.1	74.8	70.2	63.8	71.4	65.5	67.4	64.3	65.8	61.0	79.6	71.1
Diabetes mellitus	**11.4**	19.2	12.7	11.3	12.2	14.9	11.0	9.7	7.8	9.6	7.9	2.7	1.0
Diseases of the heart	**145.4**	179.4	149.3	158.9	152.0	153.1	148.3	141.8	124.1	134.8	125.5	184.0	99.8
Ischaemic heart disease	**112.9**	139.5	103.8	112.6	107.7	111.2	124.4	105.5	91.6	94.9	98.2	94.2	89.5
All other heart diseases	**32.6**	40.0	45.5	46.3	44.3	41.9	23.9	36.3	32.5	40.0	27.3	89.8	30.2
Cerebrovascular disease	**44.9**	57.3	46.0	37.9	47.8	45.1	45.3	42.8	41.9	48.2	43.0	28.7	42.5
Atherosclerosis	**8.2**	3.9	7.0	9.0	3.5	7.8	10.4	5.3	6.3	7.0	5.8	5.0	3.9
Respiratory diseases (excl. infectious and parasitic diseases)	**33.8**	33.1	33.0	40.5	32.1	31.4	32.9	35.5	41.5	34.9	35.1	60.5	50.0
Pneumonia and influenza	**17.3**	17.6	7.9	20.7	13.4	14.0	17.4	21.6	28.2	17.4	18.1	30.0	23.3
Bronchitis, emphysema and asthma (excl. acute bronchitis)	**4.6**	1.4	9.7	4.7	5.0	5.6	3.9	4.0	4.2	5.1	4.8	18.3	0.7
All other respiratory diseases	**11.9**	14.2	15.4	15.1	13.7	11.8	11.5	9.9	11.2	12.4	12.2	12.2	26.0
Chronic liver disease and cirrhosis	**4.6**	4.0	6.8	2.7	4.7	3.9	4.9	5.3	4.8	4.8	5.8	0.4	0.1
Congenital anomalies	**5.7**	8.0	4.4	6.6	5.0	5.5	5.6	6.3	6.3	5.8	5.5	12.9	2.2
Causes of perinatal mortality excl. stillbirths	**4.8**	4.4	1.7	4.8	4.1	5.2	4.2	4.2	4.2	4.3	5.2	6.4	10.9
All accidents and adverse effects	**28.4**	15.9	22.6	18.4	25.2	29.3	25.1	29.9	31.5	36.2	32.8	63.1	127.8
All other causes	**68.5**	76.5	57.4	71.6	71.4	68.8	69.8	69.7	64.1	69.5	62.1	57.5	108.2

Source:
Statistics Canada, *Mortality, Summary List of Causes.* Catalogue 84-206
Note:
Rates are age-standardized using the 1971 population for Canada.

Table: 2.3.2.3

Cases of Foodborne Disease, 1982, 1983 and 1984

Etiology	1982	1983	1984	1982	1983	1984
	number			percent		
Known causes						
Microbiological	3 554	2 297	5 592	48.13	38.57	56.73
Parasitic	59	-	-	0.80	-	-
Animal	33	3	6	0.45	0.05	0.06
Plant	11	67	2	0.15	1.13	0.02
Chemical	103	36	82	1.39	0.60	0.83
metal	9	2	2	0.12	0.03	0.02
solvents	5	-	5	0.07	-	0.05
cleaning solution	24	-	1	0.33	-	0.01
drug	1	1	-	0.01	0.02	-
penicillin	1	-	-	0.01	-	-
monosodium glutamate	-	-	7	-	-	0.07
rancid compounds	19	12	24	0.26	0.20	0.24
other chemicals	13	6	11	0.18	0.10	0.11
extraneous matter	31	15	32	0.42	0.25	0.32
Total: known causes	**3 760**	**2 403**	**5 682**	**50.92**	**40.35**	**57.64**
Unknown causes						
probably microbiological	1 068	1 293	1 220	14.46	21.71	12.38
probably animal	4	1	13	0.05	0.02	0.13
probably plant	4	3	1	0.05	0.05	0.01
probably chemical	55	67	50	0.74	1.13	0.51
probably chemical or microbiological	1	-	-	0.01	-	-
other	2 492	2 188	2 891	33.75	36.74	29.33
Total: unknown causes	**3 624**	**3 552**	**4 175**	**49.08**	**59.65**	**42.36**
Total	**7 384**	**5 955**	**9 857**	**100.00**	**100.00**	**100.00**

Source:
Health and Welfare Canada, Health Protection Branch. 1988. *Foodborne and Waterborne Disease in Canada.* Catalogue H40-11/1984E.

Table: 2.3.2.4

Regional Distribution of Cases of Foodborne Disease, 1983 and 1984

Province	Cases		Percentage of all cases		Frequency	
	1983	1984	1983	1984	1983	1984
	number		percent		cases/100,000 population	
Newfoundland	101	135	1.7	1.4	17.5	23.3
Prince Edward Island	-	-	-	-	-	-
Nova Scotia	23	112	0.4	1.1	2.7	12.9
New Brunswick	-	51	-	0.5	-	7.1
Quebec	726	900	12.2	9.1	11.1	13.7
Ontario	3 186	4 589	53.5	46.6	36.1	51.3
Manitoba	143	146	2.4	1.5	13.7	13.8
Saskatchewan	798	154	13.4	1.6	80.4	15.3
Alberta	495	228	8.3	2.3	21.0	9.7
British Columbia	482	813	8.1	8.2	17.1	28.3
Yukon	-	21	-	0.2	-	96.3
Northwest Territories	1	8	0.0	0.1	2.1	16.2
More than one province	-	2 700	-	27.4	...	...
Canada	**5 955**	**9 857**	**100.0**	**100.0**	**23.9**	**39.2**

Source:
Health and Welfare Canada, Health Protection Branch. 1988. *Foodborne and Waterborne Disease in Canada.* Catalogue H40-11/1984E.
Note:
[1] Based on 1986 Census Division data.

2.4 Regulations and Perceptions

Over the past 10 years, there has been an increasing concern about the quality of the environment by individuals, government and non-governmental organizations. Most polls show heightened awareness of environmental issues, increased optimism about the possibility of improving the environment and changes in the behaviour of individuals to modify their impact on the environment. There has been a proliferation of environmental interest groups and a great deal of new environmental legislation has been enacted.

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Changes in opinion on the environment have stimulated legislation, regulations and non-governmental activities to improve, conserve and protect the environment and the natural resource base. Furthermore, they have been instrumental in the adoption of more environmentally-conscious behaviour among many Canadians.

2.4.1 Regulating Processes

Canada's federal and provincial governments maintain hundreds of laws relating to the environment. These range from the comprehensive Canadian Environmental Protection Act to provisions in the municipal acts of most provinces.

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Legislation Relating to the Environment

The legislative process provides an important means through which members of society can collectively take action to improve, conserve and protect the quality of the environment and the natural resource base.

The **Canadian Environmental Protection Act**, proclaimed in 1988 consolidates the Environmental Contaminants Act, the Canada Water Act, the Clean Air Act, the Ocean Dumping Control Act, and some sections of the Department of Environment Act (1979). The new act upgrades the penalties for a breach of the toxic chemical provisions. The Minister is now endowed with powers to recall chemicals and products which he or she deems to be unsafe.

Table 2.4.1.1 provides a listing of laws related to the environment enacted by the federal, provincial or territorial governments of Canada. The titles of acts shown in the table are those shown in the latest *Table of Public Statutes* published by each government. This table complements the one shown in Appendix 8 to the 1986 edition of *Human Activity and the Environment*. To avoid repetition of outdated acts shown in that edition, acts have only been included in this edition where they have been subject to legislative action other than total repeal since 1983. Several laws related to land use planning had been excluded from the previous listing. Since these laws frequently have a significant role in environmental management, they were included in this table.

In this table, laws have been listed under up to three separate subjects. For example the Highway Traffic Act of Prince Edward Island includes provisions relating to noise levels, littering, solid waste, air pollution and smoke emissions. Where four or more subjects are covered by an Act it is classified as "General".

Enforcement of Legislation

No comprehensive statistics exist for the enforcement of the wide range of laws shown in Table 2.4.1.1. To illustrate the extent of activity being undertaken by Federal agencies Tables 2.4.1.2 through 2.4.1.6 present information obtained from Environment Canada, the Atomic Energy Control Board and Fisheries and Oceans Canada, the federal agencies most directly concerned with environmental protection.

A range of actions can be undertaken in respect to enforcing the Environmental Protection Act (Table 2.4.1.2). The reference period is the latest for which information has been compiled by Environment Canada. It should be noted that dates refer to when the specified actions were undertaken. Thus the convictions recorded in this period may refer to offences committed in previous periods.

International Environment Programs

Canada participates in the activities of several intergovernmental and non-governmental international organizations with environmental responsibilities[8]:

8. Statistics Canada. 1990. *Canada Year Book*. Catalogue 11-402E.

UNEP

Canada is a member of the United Nations Environmental Programme, established to deal with global and regional environmental issues. In 1987, one of UNEP's successes was in coordinating the signing of the Montreal Protocol on substances depleting the ozone layer.

WMO

The World Meteorological Organization deals with hydrology, climatology, and meteorology. Canada is involved in the WMO/UNEP intergovernmental panel on climate change, and the working group on the accidental release of hazardous materials.

ECE

Under the UN Economic Commission for Europe, Canada participates in the Executive body of the 1979 Convention on Long Range Transboundary Air Pollution and the committee on water problems. In 1985, Canada signed the protocol to the 1979 convention calling for the reduction of sulphur emissions by 30 percent by 1993. Another protocol on the control of nitrogen oxide emissions was signed in 1988.

UNESCO

Canada plays an important role in three UNESCO (United Nations Educational, Scientific and Cultural Organization) projects: the International Hydrological Program, Man and the Biosphere Program and the World Heritage Convention.

IMO

Canada is a contracting party to the International Maritime Organization's International Convention for the Prevention of Pollution from Ships and to the Convention on the Prevention of Wastes and Other Matter.

WHO

Through the National Water Research Institute, Canada participates in the World Health Organization's global monitoring of water pollution.

OECD

Canada participates in the Environment Committee of the Organization for Economic Cooperation and Development. In 1985 and 1991, the OECD published its **State of the Environment Report** which provides an overview of environmental conditions in OECD member countries.

IUCN

The International Union for Conservation of Nature and Natural Resources comprises 61 state governments, 128 government agencies and 383 non-governmental organizations in its membership. Its mandate is to promote international cooperation in the conservation and management of natural resources. It is also a technical advisor to the Convention on International Trade in Endangered Species (CITES) and the World Heritage and Wetlands Conventions.

Table: 2.4.1.1

Federal and Provincial Environmental Legislation

Subject	Jurisdiction	Legislation (Code[1])
General	**Federal**	Canadian Environment Protection Act (1988); Canadian Environment Week Act (E11); Environmental Contaminants Act (E12); Income Tax Act[2]; Northern Pipeline Act (N26)
	Newfoundland	Environmental Assessment Act (1980); Municipalities Act (1979)
	Prince Edward Island	Environmental Protection Act (E9); Public Health Act (P30)
	New Brunswick	Clean Environment Act (C6); Emergency Measures Act (1978); Health Act (H2); Mining Act (M14)
	Nova Scotia	Environmental Assessment Act (c149); Environmental Protection Act (c150); Health Act (c195); Municipal Act (c295); Trails Act (c476)
	Quebec	Cities and Towns Act (C19); Environment Quality Act (Q2); Railways Act (C14)
	Ontario	Environmental Assessment Act (c140); Environmental Protection Act (c141); Municipal Act (c302); Planning Act (1983)
	Manitoba	Environment Act (E125); Municipal Act (M225); Planning Act (P80); Public Health Act (P210)
	Saskatchewan	Environmental Assessment Act (E10.1); Environmental Management and Protection Act (E10.2); Northern Municipalities Act (N5.1); Pollution (By Livestock) Control Act (P16.1); Public Health Act (P37); Urban Municipalities Act (U10)
	Alberta	Hydro and Electric Energy Act (H13); Land Surface Conservation and Reclamation Act (L17); Public Health Act (P27.1); Public Lands Act (P30)
	British Columbia	Environment Management Act (1981); Waste Management Act (1982)
	Northwest Territories	Area Development Act (A5); Cities Towns and Villages Act (1987); Commissioner's Land Act (C6); Hamlets Act (1987); Municipal Act (M15); Public Health Act (P10)
Land	**Federal**	Indian Act (I5); National Capital Act (N4); National Housing Act (N11); National Parks Act (N14); Northwest Territories Act (N27); Prairie Farms Rehabilitation Act (P17); Railway Act (R3); Territorial Lands Act (T7); Yukon Act (Y2)
	Newfoundland	Crown Lands Act (c71); Development Areas (Land) Act (c95); Land Development Act (c197); Wilderness and Ecological Reserves Act (1970)
	Prince Edward Island	Municipalities Act (M13); National Park Act (N1); Planning Act (P8); Recreation Development Act (R8)
	New Brunswick	Agricultural Rehabilitation and Development Act (A6); Community Planning Act (C12); Ecological Reserves Act (1975); Marshland Reclamation Act (M5); Parks Act (1982); Weed Control Act (W7)
	Nova Scotia	Agriculture and Marketing Act (c6); Beaches Act (c32); Crown Lands Act (c114); Planning Act (c346); Provincial Parks Act (c371)
	Quebec	Agriculture Abuses Act (A2); Ecological Reserves Act (R26); Land Use Planning and Development Act (A19.1); Lands in the Public Domain Act (T8.1); Parks Act (P9); Preservation of Agricultural Land (P41.1)
	Ontario	Aggregate Resources Act (1989); Conservation Authorities Act (c85); Mining Act (c268); Niagara Escarpment Planning and Development Act (c316); Provincial Parks Act (c401); Public Lands Act (c413); Shoreline Property Assistance Act (c471); Weed Control Act (1988)
	Manitoba	Conservation Districts Act (C175); Crown Lands Act (C340); Mines Act (M160); Noxious Weeds Act (N110); Provincial Park Lands Act (P20); Surface Rights Act (S235)
	Saskatchewan	Construction and Development Act (C27); Critical Wildlife Habitat Act (C47.1); Noxious Weeds Act (N9.1); Parks Act (P1.1); Planning and Development Act (P13.1); Provincial Lands Act (P31); Regional Parks Act (R9.1); Rural Municipalities Act (R26.1)
	Alberta	Agricultural Service Board Act (A11); Drainage Districts Act (D39); Planning Act (P9); Provincial Parks Act (P22); Public Lands Act (P30); Soil Conservation Act (S19.1); Special Areas Act (S20); Surface Rights Act (S27.1); Wilderness Areas, Ecological Reserves etc Act (W8)
	British Columbia	Agricultural Land Commission Act (c9); Coal Act (c51); Islands Trust Act (c208); Land Act (c214); Minerals Act (c259); Mines Act (1980); Municipal Act (c290); Park (Regional) Act (c310); Park Act (c309); Range Act (c355); Soil Conservation Act (c391); Weed Control Act (c432)
	Yukon	Municipal Act (c119); Parks Act (c126)
	Northwest Territories	Territorial Parks Act (T5)
Water	**Federal**	Arctic Waters Pollution Prevention Act (A12); Canada Shipping Act (S9); Canada Water Act (C11); Fisheries Act (F14); Navigable Waters Protection Act (N22); Northern Inland Waters Act (N25); Railway Act (R3); Territorial Lands Act (T7)
	Newfoundland	Aquaculture Act (1987)
	Prince Edward Island	Municipalities Act (M13); Water and Sewerage Act (W2)
	New Brunswick	Aquaculture Act (1988); Clean Water Act (1989); Pesticides Control Act (P8)
	Nova Scotia	Aquaculture Act (c18); Towns Act (c472); Village Service Act (c493); Water Act (c500); Well Drilling Act (c502)
	Quebec	Mining Act (M13); Watercourses Act (R13)
	Ontario	Conservation Authorities Act (c85); Drainage Act (c126); Ontario Water Resources Act (c361); Public Utilities Act (c423); Water Transfer Control Act (1989)
	Manitoba	Fisherman's Assistance and Polluters Liability Act (F100); Rivers and Streams Act (R160); Water Resources Administration Act (W70); Water Rights Act (W80)
	Saskatchewan	Construction and Development Act (C27); Water Corporation Act (W4.1); Water Resources Management Act (W7)
	Alberta	Agricultural Chemicals Act (A6); Clean Water Act (C13); Drainage Districts Act (D39); Water Resources (W5.1)
	British Columbia	Fisheries Act (c137); Health Act (c161); Water Act (c429)
	Yukon	Municipal Act (c119)

(continued)

Federal and Provincial Environmental Legislation

Subject	Jurisdiction	Legislation
Air	**Federal**	Clean Air Act (C32); Non-smokers Health Act (1988)
	Prince Edward Island	Highway Traffic Act (H5)
	Nova Scotia	Motor Vehicle Act (c293)
	Quebec	Protection of Non-Smokers etc Act (P38.01)
	Ontario	Farm Practices Protection Act (1988); Highway Traffic Act (c198)
	Saskatchewan	Clean Air Act (C12.1)
	Alberta	Clean Air Act (C12)
	British Columbia	Motor Vehicle Act (c288); Weather Modification Act (c431)
Hazardous Waste	**Federal**	Feeds Act (F9); Fertilizers Act (F10); Food and Drugs Act (F27); Hazardous Products Act (H3); Pest Control Products Act (P9); Pesticides Residue Compensation Act (P10); Radiation Emitting Devices Act (R1); Transportation of Dangerous Goods Act (T19)
	Newfoundland	Aquaculture Act (1987); Dangerous Goods Transportation Act (1982); Fire Prevention Act (c131); Pesticides Control Act (1983); Radiation Health and Safety Act (1977)
	Prince Edward Island	Dangerous Goods Transportation Act (D3); Fire Prevention Act (F11); Pesticides Control Act (P4)
	New Brunswick	Apiary Inspection Act (A9); Aquaculture Act (1988); Fire Prevention Act (F13); Injurious Insect and Pest Act (I9); Pesticides Control Act (P8); Pipeline Act (1976); Radiological Health Protection Act (1987); Transportation of Dangerous Goods Act (1988)
	Nova Scotia	Dangerous Goods & Hazardous Wastes Management Act (c118); Dangerous Goods Transportation Act (c119); Pest Control Products (Nova Scotia) Act (c341); Pipeline Act (c345)
	Quebec	Bees Act (A1); Explosives Act (E22)
	Ontario	Bees Act (c42); Energy Act (c139); Gasoline Handling Act (c185); Health Protection and Promotion Act (1983); Highway Traffic Act (c198); Pesticides Act (c376)
	Manitoba	Dangerous Goods Handling and Transportation Act (D12); Industrial Minerals Drilling Act (I20); Pesticides and Fertilizer Control Act (P40)
	Saskatchewan	Dangerous Goods Transportation Act (D1.2); Fire Prevention Act (F15); Pest Control Products (Saskatchewan) Act (P8); Radiation Health and Safety act (R1.1); Rural Municipalities Act (R26.1)
	Alberta	Agricultural Chemicals Act (A6); Hazardous Chemicals Act (H3); Pipeline Act (P8); Radiation Protection Act (R2); Special Waste Management Corporation Act (S21.5); Transportation of Dangerous Goods (T6.5)
	British Columbia	Health Act (c161); Motor Vehicle Act (c288); Pesticide Control Act (c322); Petroleum and Natural Gas Act (c323); Pipelines Act (c328)
	Yukon	Dangerous Goods Transportation Act (c39)
	Northwest Territories	Fire Prevention Act (F5); Transport of Dangerous Goods Act (1982)
Noise	**Federal**	Aeronautics Act (A2)
	Newfoundland	Highway Traffic Act (c152)
	Prince Edward Island	Highway Traffic Act (H5)
	New Brunswick	Agricultural Operations Practices Act (1986); All Terrain Vehicle Act (1985); Motor Vehicle Act (M17)
	Nova Scotia	Motor Vehicle Act (c293)
	Quebec	Highway Safety Code (C24.2)
	Ontario	Farm Practices Protection Act (1988); Highway Traffic Act (c198); Motorised Snow Vehicles Act (c301)
	Manitoba	Highway Traffic Act (H60); Snowmobile Act (S150)
	Alberta	Highway Traffic Act (H7)
	British Columbia	Motor Vehicle Act (c288)
	Yukon	Motor Vehicles Act (c118); Noise Prevention Act (c121)
	Northwest Territories	Vehicles Act (V2)
Solid Waste	**Federal**	Indian Act (I5)
	Newfoundland	Highway Traffic Act (c152); Quarry Materials Act (1976); Waste Material Disposal Act (1973)
	Prince Edward Island	Automobile Junkyards Act (A25); Highway Traffic Act (H5); Municipalities Act (M13); Roads Act (R15); Unsightly Property Act (U5)
	New Brunswick	Agricultural Operations Practices Act (1986); Beverage Containers Act (1977); Highway Act (H5); Motor Vehicle Act (M17); Unsightly Premises Act (U2)
	Nova Scotia	Mineral Resources Act (c286); Motor Vehicle Act (c293); Public Highways Act (c371); Towns Act (c472); Village Service Act (c493)
	Quebec	Highway Safety Code (C24.2); Mining Act (M13)
	Ontario	Aggregate Resources Act (1989); Farm Practices Protection Act (1988); Mining Act (c268); Public Lands Act (c413)
	Manitoba	Highway Traffic Act (H60); Mines Act (M160); Rivers and Streams Act (R160)
	Saskatchewan	Highway Traffic Act (H3.1); Highways and Transportation Act (H3); Litter Control Act (L22); Rural Municipalities Act (R26.1)
	Alberta	Beverage Container Act (B4); Litter Act (L19)
	British Columbia	Municipal Act (c290); Park Act (c309); Soil Conservation Act (c391); Water Act (c429)
	Yukon	Motor Vehicles Act (c118); Municipal Act (c119)

(continued)

Federal and Provincial Environmental Legislation

Subject	Jurisdiction	Legislation
Energy	**Federal**	Canada Petroleum Resources Act (1986); Motor Vehicle Fuel Consumption Standards Act (M9); Motor Vehicle Safety Act (M10); National Energy Board Act (N7); Oil Substitution and Conservation Act (O8); Oil and Gas Production and Conservation Act (O7)
	Newfoundland	Petroleum and Natural Gas Act (c294)
	New Brunswick	Oil and Natural Gas Act (1976)
	Nova Scotia	Energy and Mineral Resources Conservation Act (c147); Petroleum Resources Act (c342)
	Quebec	Energy Conservation Act (E1.1); Mining Act (M13)
	Ontario	Energy Efficiency Act (1988); Public Utilities Act (c423)
	Manitoba	Mines Act (M160)
	Saskatchewan	Oil and Gas Conservation Act (O3)
	Alberta	Coal Conservation Act (C14); Energy Resources Conservation Act (E11); Gas Resources Preservation Act (G3.1); Hydro and Electric Energy Act (H13); Oil Sands Conservation Act (O5.5); Oil and Gas Conservation Act (O5)
	British Columbia	Coal Act (c51); Geothermal Resources Act (1982); Petroleum and Natural Gas Act (c323)
	Yukon	Energy Conservation Assistance Act (c55)
Wildlife	**Federal**	National Wildlife Week (W10); Northwest Territories Act (N27); Yukon Act (Y2)
	Newfoundland	Wild Life Act (400); Wilderness and Ecological Reserves Act (1970)
	Prince Edward Island	Fish and Game Protection Act (F12); Forests Management Act (F14); Natural Areas Protection Act (N2)
	New Brunswick	Endangered Species Act (1974); Fish and Wildlife Act (1980); Irish Moss Act (I15)
	Nova Scotia	Agriculture and Marketing Act (c6); Crown Lands Act (c114); Provincial Parks Act (c371); Wildlife Act (c504)
	Quebec	Conservation and Development of Wildlife Act (c61.1); Ecological Reserves Act (R26); Hunting and Fishing Rights Act (D13.1)
	Ontario	Endangered Species Act (c138); Game and Fish Act (c182)
	Manitoba	Ecological Reserves Act (E5); Heritage Resources Act (H39.1); Manitoba Habitat Heritage Act (H3); Provincial Park Lands Act (P20); Wild Rice Act (W140); Wildlife Act (W130)
	Saskatchewan	Critical Wildlife Habitat Act (C47.1); Wildlife Act (W13.1)
	Alberta	Agricultural Pests Act (A8.1); Provincial Parks Act (P22); Wilderness Areas, Ecological Reserves etc Act (W8); Wildlife Act (W9.1)
	British Columbia	Creston Valley Wildlife Act (c82); Ecological Reserves Act (c101); Park Act (c309); Wildlife Act (1981)
	Yukon	Wildlife Act (c126)
	Northwest Territories	Wildlife Act (1978)
Fish	**Federal**	Coastal Fisheries Protection Act (C33); Fisheries Act (F14)
	New Brunswick	Fish and Wildlife Act (1980)
	Nova Scotia	Fisheries Act (c173)
	Quebec	Commercial Fisheries and Aquaculture (P9.01); Conservation and Development of Wildlife Act (c61.1)
	Manitoba	Fisheries Act (F90); Fisherman's Assistance and Polluters Liability Act (F100)
	British Columbia	Fisheries Act (c137)
Forest	**Federal**	Forestry Research and Development Act (F30); Territorial Lands Act (T7)
	Newfoundland	Plant Protection Act (1978)
	Prince Edward Island	Fire Prevention Act (F11); Forests Management Act (F14)
	New Brunswick	Crown Lands and Forests Act (C38); Forest Fires Act (F20); Injurious Insect and Pest Act (I9); Plant Diseases Act (P9)
	Nova Scotia	Crown Lands Act (c114); Forest Enhancement Act (c178); Forests Act (c179)
	Quebec	Forests Act (F4.1); Plant Protection Act (P39); Preservation of Agricultural Land (P41.1); Tree Protection Act (P37)
	Ontario	Crown Timber Act (c109); Forest Fires Prevention Act (c173); Plant Diseases Act (c380)
	Manitoba	Dutch Elm Disease Act (D107); Fires Prevention Act (F8); Forests Act (F150)
	Saskatchewan	Forests Act (F19); Prairie and Forest Fires Act (P22)
	Alberta	Forest Reserves Act (F15); Forest and Prairie Protection Act (F14); Forests Act (F16)
	British Columbia	Forest Act (c140)
	Yukon	Forest Protection Act (c71)
	Northwest Territories	Forests Management Act (F8)

Source:
Federal and provincial tables of public statutes.

Notes:
[1] Codes in parentheses refer to the chapter number in the statutes. Some statutes arrange acts in order of enactment. These are represented by the letter "c" plus a number indicating the sequence. Other statutes arrange acts in alphabetic order. These are designated with the letter first letter of the title of the act followed by a sequence number.

[2] The Income Tax Act is not in sequence in the statutes.

Table: 2.4.1.2

Enforcement Action by Environment Canada, April to September 1990

Act/Type of action	Environment Canada Region					
	Atlantic	Quebec	Ontario	Western and Northern	Pacific and Yukon	Canada
	number of actions					
Environment Protection Act						
Inspection	271	188	263	209	379	1 310
Investigation	14	..	15	3	..	32
Warning	8	6	13	6	5	38
Direction	2	..	..	..	..	2
Prosecution	1	1	..	..	2	4
Conviction	1	1	..	..	2	4
Fisheries Act[1]						
Inspection	324	68	..	44	126	562
Investigation	5	..	1	6	9	21
Warning	5	..	..	6	..	11
Direction	2	..	..	..	..	2
Prosecution	1	1	..	..	..	2
Conviction	..	..	..	..	2	2
Total						
Inspection	595	256	263	253	505	1 872
Investigation	19	0	16	9	9	53
Warning	13	6	13	12	5	49
Direction	4	0	0	0	0	4
Prosecution	2	2	0	0	2	6
Conviction	1	1	0	0	4	6

Source:
Environment Canada. Conservation and Protection.
Notes:
[1] Sections of Fisheries Act administered by Environment Canada.
The enforcement actions were taken between April 1, 1990 and September 30, 1990.

Table: 2.4.1.3

Convictions Following Prosecution by Environment Canada, 1988-1990

Act/Date of offence	Environment Canada Region					
	Atlantic	Quebec	Ontario	Western and Northern	Pacific and Yukon	Canada
	number of offences					
Environment Protection Act						
April 1, 1988 to September 30, 1988	-	-	-	-	-	-
October 1, 1988 to March 31, 1989	-	-	-	-	4	4
April 1, 1989 to September 30, 1989	-	-	-	-	3	3
October 1, 1989 to March 31, 1990	-	-	-	-	-	-
April 1, 1990 to September 30, 1990	1	-	-	-	-	1
Fisheries Act[1]						
April 1, 1988 to September 30, 1988	5	-	-	-	2	7
October 1, 1988 to March 31, 1989	2	-	-	-	-	2
April 1, 1989 to September 30, 1989	2	-	-	1	4	7
October 1, 1989 to March 31, 1990	1	-	-	-	-	1
April 1, 1990 to September 30, 1990	-	-	-	-	1	1

Source:
Environment Canada. Conservation and Protection.
Notes:
[1] Sections of the Fisheries Act administered by Environment Canada.

Table: 2.4.1.4

Convictions for Environmental Offences, Atomic Energy Control Board, 1988

Date of Offence	Region					
	Atlantic	Quebec	Ontario	Western and Northern	Pacific and Yukon	Canada
	number of offences					
April 1, 1988 to September 30, 1988	-	-	-	1	-	1
October 1, 1988 to March 31, 1989	-	-	-	-	-	-
April 1, 1989 to September 30, 1989	2	-	-	1	-	3
October 1, 1989 to March 31, 1990	-	-	-	2	-	2
April 1, 1990 to September 30, 1990	-	-	1	-	-	1

Source:
Atomic Energy Control Board. Legal Services.
Notes:
Offences against sections of the Atomic Energy Control Act.

Table: 2.4.1.5

Penalties Imposed for Convictions Under Selected Legislation, April 1988 to September 1990

Result	Atomic Energy Control Act	Fisheries Act[1]	Environment Protection Act	Total
	number of offences			
Fine less than $1000	1	2	2	5
Fine $1000 - $4999	3	2	2	7
Fine $5000 - $9999	3	6	5	14
Fine $10000 or more	..	7	..	7
Total	**7**	**17**	**9**	**33**

Source:
Environment Canada. Conservation and Protection.
Atomic Energy Control Board. Legal Services.
Notes:
[1] Sections of Fisheries Act administered by Environment Canada.

Table: 2.4.1.6

Commercial Violations Detected by Fisheries and Oceans Canada, 1989

Region[1]	Most common		Second most common		Third most common	
	Offence	Number	Offence	Number	Offence	Number
Pacific	Illegal possession of fish	391	Licence offences	375	Fishing in close times	303
Scotia-Fundy	Groundfish licence offences	52	Undersize scallops	37	Untagged lobster traps	35
Gulf of St. Lawrence	Fishing in close times	114	Undersize lobsters	49	Licence offences	36
Newfoundland	Illegal fishing methods	45	Fishing in close times	37	Undersize crabs	25
Quebec	Undersize lobsters	29	Fishing contaminated area	28	Undersize crabs	19

Source:
Fisheries and Oceans Canada. Fish Habitat Management Branch.
Note:
[1] Regions as defined by Fisheries and Oceans Canada.

2.4.2 Attitudes and Perceptions

Canadians have been making personal sacrifices for a cleaner environment and a majority would be willing to pay for improved energy efficiency and waste reduction. A majority also approve of mandatory recycling. Many have already been making measurable changes in their lifestyles: eighteen percent of all households in Canada have programmable thermostats; 84 percent have thermal windows and 27 percent (with showers) have water-saver shower heads. Twenty two percent of those with gardens engage in composting; 52 percent with gardens never use pesticides.

In 1981-2, 70 percent of the respondents to a CROP[9] poll, believed that the level of pollution had increased in Canada; 38 percent responded that it had increased in their neighbourhood. In 1990, according to an Angus Reid poll[10] on the same subject, 33 percent of the respondents believed that the overall environment had deteriorated over the past year. The same poll indicated that 44 percent believed that the environment would improve over the next 10 years and 57 percent thought it would improve over the next 30 years (Tables 2.4.2.1 and 2.4.2.3). A majority believed that Canadians in general, the government and industry and business had shown an increased concern for the environment (Table 2.4.2.2).

Table: 2.4.2.1
Perceptions of Environmental Quality, 1990

Question	Time frame		
	Past year	Next 10 years	Next 30 years
	percent agreeing		
The environment has gotten/will get better:	29	44	57
The environment has gotten/will get worse:	33	31	26
The environment has stayed/will stay the same:	36	23	8

Source:
Angus Reid poll, reported in Montreal Gazette. October 15, 1990.

9. Centre de recherche sur l'opinion publique.
10. Montreal Gazette. Oct. 15, 1990. p. A1.

According to a Gallup poll[11], the proportion of shoppers purchasing environmentally friendly products increased from 46 percent in January, 1990 to 71 percent in January 1991.

Table: 2.4.2.2
Perception of Environmental Concern, 1990

Question		percent agreeing
Over the past year who has shown increased concern for the environment?	Government:	53
	Industry and business:	54
	Canadian consumers:	81
	You personally:	86

Source:
Angus Reid poll, reported in Montreal Gazette. October 15, 1990.

Table: 2.4.2.3
Changes in Environmental Behaviour, 1989-90

Question	Time of survey	
	July 1989	Sept 1990
	percent agreeing	
Over the past year, have you avoided taking your car to work for the sake of the environment?	37	43
Have you given money to clean up the environment?	32	37
Do you go out of your way to seek biodegradable products?	51	74

Source:
Angus Reid poll reported in Montreal Gazette. October 15, 1990.

The same poll indicated that 48 percent of Canadians lived in a community with a "blue box" recycling programme. Seventy eight percent of those living in Ontario had access to such a programme while only 20 percent in Atlantic Canada did.

Mandatory recycling of newspapers, cans and bottles was seen as beneficial by 80 percent of the respondents. Other actions meeting with high approval were:

Action	Percent approval
reduced product packaging	75
banning of plastic foam cups	75
banning of aerosol spray cans	73
banning of disposable diapers	70

A December 1990 poll by Decima Research[12] provided evidence that Canadians were making sacrifices for a cleaner environment and a majority would be willing to pay for

11. Toronto Star. January 15, 1991. p. A19.
12. Ottawa Citizen. April 14, 1991.

improved energy efficiency. Seventy-five percent of respondents said they would pay $25 to replace an inefficient shower head. Respondents also reported they would approve of penalty charges for plastic bags (65 percent) and garbage collection (57 percent).

According to the Canadian Wildlife Service survey, *The Importance of Wildlife to Canadians*,[13] Canadians spend over $5 billion annually on wildlife-related activities. Over $73 million of this is in contributions to wildlife organizations. According to the survey, Canadians would be willing to pay an additional $1 billion to protect their access to these activities.

Although the quality of the environment is seen as important to most people, how many people really make compromises in their lifestyles to have less of an impact? Often, the adoption of lower-impact lifestyles are motivated by economic concerns. If the price of gas rises, people drive smaller and more efficient cars. People buy more energy-efficient shower fittings and better insulation in response to the cost of energy. Other actions such as recycling, composting, the use of recycled products and limiting the use of pesticides demonstrate a conscious effort to lead a lower-impact lifestyle.

Households and the Environment Survey

More Efficient Equipment

Householders are generally aware of many steps they can take to reduce the household's impact on the environment. Some of these steps are simple, requiring only a change in the brand of product selected from the supermarket shelf. Others require a greater effort — avoiding the use of pesticides on a lawn may demand digging out the weeds by hand. In September 1990, Statistics Canada conducted a pilot survey that inquired about some of these actions.

Table: 2.4.2.4
Households with Energy Efficient Fittings, Canada, 1990

Type of fitting	Percentage of households which:[1] Have fitting	Do not have fitting
	Percent total households	
Programmable thermostat	17.8	81.0
Double glazed or other thermally efficient windows	84.0	14.0
	Percent households with at least one shower[2]	
Low flow showerheads	27.2	66.3

Source:
Statistics Canada, Environment and Wealth Accounts Division
Notes:
[1] Totals do not add to 100 percent because of non-response.
[2] Four percent of households reported no shower.

According to the survey, only 18 percent of households used programmable thermostats (Table 2.4.2.4); there was no significant difference between provinces.

According to the survey, 84 percent of Canadian households had storm windows or multi-pane windows. Only half the houses in British Columbia had such windows. This may be an effect of the milder climate in British Columbia. The amount of energy saved by installing this equipment may not justify the expense.

Of households with a shower, 27 percent reported having a water-saver shower head. These shower heads have been recently promoted as saving significant amounts of energy by reducing the amount of hot water required to shower.

Pesticides and Composting

Two-thirds of all households in Canada have a yard or garden. The survey collected information on the use of pesticides and whether the household had a compost bin or heap.

Legislation strictly controls the commercial use and disposal of pesticides. Households also contribute pesticides to the contaminant load in local wildlife and water. Forty three percent of Canadian households with yards or gardens apply pesticides. Provincial averages range from 50 percent in Ontario and the Prairie Provinces to 27 percent in the Atlantic Provinces. There is also a potential problem in the disposal of unused household pesticides and pesticide containers (Table 2.4.2.5).

Composting is an efficient method of returning organic matter to the soil as well as providing some plant nutrients without the resource use required for artificial fertilizers. Perhaps the greatest value of composting is that it reduces the load on public waste handling systems. As much as one third of household waste is organic matter which can be composted. Of all households with yards or gardens, 22 percent have facilities for composting. Provincial averages range from 52 percent in British Columbia to 10 percent in Quebec (Table 2.4.2.5).

Domestic Water Supplies

In Canada, 83 percent of households are supplied with water by their municipality. The extent to which households have water filters can be taken as a measure of lack of satisfaction with the quality of treatments applied to that water. This also applies to some extent to the purchase of bottled water for drinking. In Canada, 10.5 percent of households who obtain their water from the municipality have water filters; 23.4 percent buy bottled water (Table 2.4.2.6).

13. Environment Canada. *Op.cit.*

Table: 2.4.2.5

Households Which Use Pesticides and Composting, 1990

Province/Region	Percent all households		Percent of households with yard or garden[1]			
			Apply pesticides		Have compost bin/heap	
	no yard	with yard	yes	no	yes	no
	percent					
Atlantic Provinces	22.2	77.8	26.9	68.1	15.9	83.9
Quebec	44.3	55.7	36.9	60.2	9.8	89.8
Ontario	31.4	68.6	49.4	45.9	24.0	75.7
Prairie Provinces	23.7	76.3	50.4	45.9	20.1	79.0
British Columbia	32.8	67.2	38.0	55.2	52.0	47.8
Canada	**32.9**	**67.1**	**43.3**	**51.8**	**22.9**	**76.7**

Notes:
[1] Totals do not add to 100 percent because of non-response.
Source:
Statistics Canada. Environment and Wealth Accounts Division.

Table: 2.4.2.6

Households with Water Filters or Buying Bottled Water, 1990

Province/Region	Percent of total households[1] Water supplied by:		Percent of household on municipal supply[1]	
	Municipality	Other	Have filter	Buy water
	percent			
Atlantic Provinces	58.0	41.3	7.9	10.9
Quebec	88.1	11.4	8.1	44.1
Ontario	83.1	14.9	12.1	19.4
Prairie Provinces	82.8	16.4	9.8	12.8
British Columbia	87.2	10.7	12.5	8.2
Canada	**82.8**	**15.8**	**10.5**	**23.4**

Source:
Statistics Canada. Environment and Wealth Accounts Division.
Notes:
[1] Totals do not add to 100 percent because of non-response.

3. Socio-Economy

Canada's economy is characterized by a reliance on energy and natural resources. Exports are dominated by raw and semi-finished goods. Because of the availability of energy, water, land and mineral resources, Canada is competitive in industrial sectors using these resources intensively. Extraction, harvesting, energy generation, transportation and primary transformation are generally more stressful to the environment than services and secondary manufacturing industries.

❑❑❑

Agriculture, forestry, manufacturing, mining, fishing, transportation and construction are essential to the maintenance of a strong economy and high standard of living in Canada. Yet concentrating these activities in small geographic areas, and extending them into sensitive natural areas, has effects on the environment and risks their long-term sustainability.

This section provides statistics on socio-economic **conditions** and **processes**. Conditions represent the stock of man-made goods and the state of the economy. Processes cause changes in these conditions.

Understanding the **conditions** provides a perspective of the relative magnitude of the various economic activities and provides a background for assessing their relative impacts. The conditions are measured in terms of economic value, importance in terms of employment and the quantity of infrastructure.

Information on the **processes** (production, consumption, and mitigation efforts) provides insight into the potential for growth and change of these economic activities.

Wastes are discussed in a separate section rather than being grouped with environmental impacts. The generation of wastes does not necessarily have a direct effect on the environment. Wastes can be treated and recycled to minimize their impact. Therefore, wastes are considered an output of the socio-economic system.

3.1 Socio-economic Conditions

An understanding of the relationships between economic development and the environment is crucial to making environmental decisions. Economic decisions often have unintended effects on people and the environment. Environmental decisions often have economic side-effects.

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An overview of the activities and infrastructure associated with industry, transportation, utilities and dwellings is presented in this section. As well economic indicators and resource accounting provide linkages between socio-economic conditions and the environment.

3.1.1 Industry

Using the input-output tables of the System of National Accounts, it is possible to track the energy-intensity, resource-intensity and contaminant-intensity of the sectors of the Canadian economy.

❑❑❑

To help understand the interactions between economic activity and the environment it is helpful to group the activities according to the types of effect they have. Both the 1978 and 1986 editions of *Human Activity and the Environment* classified manufacturing industries into those with high, medium or low stress on air or water. This concept has been extended to take into account a wider variety of economic activities and impacts.

To simplify the long-term tracking of potential impacts, efficiencies, and mitigation efforts, Statistics Canada has developed an input-output based classification of economic activities. This classification is based on the categories used in the input-output tables of Statistics Canada **System of National Accounts**. These tables focus on the commodity transactions of all economic activities, showing the total input and output of commodities. In addition, the system provides

a measure of the value added by sector, the flow of commodities to final demand sectors[14] and the cost of primary inputs to industries. These tables are used to measure the Gross Domestic Product (GDP) of Canada.[15]

With this input-output information, one can assess the value of the inputs and outputs to each industry group. Currently, only value data are available but research is being undertaken to supplement this with physical quantity data in the future.

The input-output tables portray the structure of the Canadian economy in a categorization of commodities and industries. To determine impacts, these commodities were classified into raw natural resources, processed natural resources, energy commodities, potential contaminants and other commodities (Table 3.1.1.1):

Raw natural resources are commodities extracted from the ground or harvested from the land or water.

Energy commodities are generally consumed as fuel. The non-energy uses of these commodities (for example, the use of petroleum for chemicals and plastics) have been removed in the following tables.

Potential contaminants are commodities about which there is a concern about toxic or hazardous properties. Many contaminants of interest cannot be disaggregated in the input-output tables. However, the following items are available:

Potential contaminant	Reason for inclusion
Radioactive substances, asbestos, lead, sodium cyanide	hazardous substances
Coal tar	contains carcinogenic polynuclear aromatic hydrocarbons
Refrigeration equipment	contain CFCs, believed to contribute to the depletion of the ozone layer
Transformers	contain carcinogenic PCBs
Batteries	contain toxic heavy metals mercury and cadmium
Benzene, toluene, and xylene; carbon tetrachloride; trichloroethylene; perchloroethylene	hazardous substances
Vinylchloride monomer	carcinogenic
Sodium cyanide	toxic
Fluorinated halogen hydrocarbons	include CFCs and halogenated solvents

See the **Contaminants** section for more details on these and other substances.

Other Commodities include processed goods, services, and all other inputs.

The consumption of water is an extension of this method beyond the input-output tables. Industries take in, recirculate and discharge large amounts of water. In doing so, they risk altering the water by lowering the water table or contaminating water returned to the environment. The amount consumed is the difference between water intake and discharge; this is the actual amount incorporated into a product or released as steam[16]. By analyzing the relative value (or quantity, as in the case of water) of the commodities used by each industry, we can determine the degree of dependence on each of these commodity classes. For grouping the industries according to these values, the following categories are used:

- **Harvesting and Extracting Industries** extract raw materials from the environment (agriculture, fishing and trapping, logging and forestry, mining, crude petroleum and natural gas, and quarry and sand pit industries).
- **Resource-Intensive Industries** are primary transformers of raw natural resources, for example, metal smelting, food production, pulp and paper and wood industries. Raw natural resources for this analysis exclude energy resources. An industry is considered to have a **high** resource intensity if **raw resources** make up 6 percent or more of the total value of its inputs.
- **Energy-Intensive Industries** are major consumers of electricity or fuel. Among the most intensive energy consuming industries are: electrical power systems, non-ferrous smelting and refining, cement industry, utility industries and pulp and paper industries. An industry is considered to have a **high** energy intensity if **energy commodities** comprise 6 percent or more of the total value of its inputs.
- **Contaminant-Intensive Industries** have a high level of consumption of the potential contaminants (identified above). They include: commercial refrigeration equipment, battery industry, plastic and synthetic resin industry, industrial chemicals industry and non-ferrous smelting and refining. While not all the potential contaminants consumed will become wastes or environmental contaminants, it is useful to identify the consumers of these commodities. An industry is considered to be a **high** contaminant intensive industry if 0.25 percent or more of its input costs are **potential contaminants**[17].

14. Commodities purchased by the end-user.
15. See Statistics Canada. 1989. *A User Guide to the Canadian System of National Accounts.* Catalogue 13-589E.
16. The water consumption data were derived from information provided by the Inland Waters Directorate, Environment Canada.
17. This may appear to be a small proportion but the list of potential contaminants is so limited that most industries use none at all.

- **Water-Intensive Industries** include: non-metallic mineral industries, concrete products, crude petroleum and natural gas, plastic products, ready-mix concrete, motor vehicle parts and pulp and paper industries. An industry is considered to have a **high** water intensity if greater than 15 percent of its total water intake is consumed.

The division of the industries into high, medium and low impact classes is a way of simplifying the complex distribution of intensities. The high classification represents about the top twenty percent of the industries in each category.

For each industry, the value of total inputs, and proportion of input in each of the above interaction classes are detailed in Table 3.1.1.2. This table also summarizes the classification of industries into high, medium and low impact levels. Table 3.1.1.3 provides SIC (Standard Industrial Classification) codes for the high impact industries.

The economic importance of resource-intensive and energy-intensive industries declined between 1961 and 1987 (Tables 3.1.1.4 and 3.1.1.5, Figures 3.1.1.1 and 3.1.1.2).

In 1986, 22 percent of Canada's manufacturing employment was in the high resource-intensity class; 11 percent was in the high energy-intensity class; 22 percent was in the high contaminant-intensity class and 7 percent was in high water-intensity industries (Table 3.1.1.6). Similarly, 22 percent of manufacturing establishments[18] were classified as high resource-intensity and 2.4 percent were classified as high energy-intensity (Table 3.1.1.7). Since many industries are classified in more than one category, these numbers are not additive.

Distribution of Manufacturing

The 1986 Census of Manufactures is the most recent source of detailed data on the complete manufacturing sector. The Environment and Wealth Accounts Division's Manufacturing Database allows the aggregation of manufacturing data by geographic units appropriate for environmental analysis. This database has been used to create Tables 3.3.1.6 and 3.3.1.7 as well as the maps presented in the **Production** section.

18. An *establishment* is a reporting unit for the Census of Manufactures. It is the smallest unit capable of reporting certain specified input and output data; usually a plant or mill.

Table: 3.1.1.1

Commodities Used for Impact Classification

		Natural Resource Commodities			
1	Cattle and calves	22	Wool in grease	48	Crude mineral n.e.s.
2	Sheep and lambs	24	Logs and bolts	49	Sand and gravel
3	Hogs	25	Poles, pit props fence-posts etc.	50	Stone, crude
4	Poultry	26	Pulpwood	63	Animal materials for drugs and perfume
5	Other live animals	27	Other crude wood materials	245	Coal tar
7	Wheat, unmilled	28	Custom forestry	397	Lubricating oils and greases
8	Barley, oats, rye, corn, grain, n.e.s.	29	Fish landings	398	Benzene, toluene and xylene
9	Milk, whole, fluid, unprocessed	30	Hunting and trapping products	400	Naphtha
10	Eggs in the shell	32	Gold and alloys in primary form	401	Asphalt and coal oils, n.e.s.
11	Honey and beeswax	33	Radio-active ores and concentrates	402	Petrochemical feed stock
12	Nuts, edible, not shelled	34	Iron ores and concentrates	403	Fertilizers
13	Fruits, fresh, excluding tropical	35	Bauxite and alumina	516	Ice
14	Vegetables, fresh	36	Metal ores and concentrates n.e.s.	549	Water and other utilities
15	Hay, forage, and straw	41	Sulphur, crude and refined	588	Cotton raw and semi-processed
16	Seeds excluding oil and seed grades	42	Asbestos, unmanufactured, crude and fibrous	589	Natural rubber and allied gums
17	Nursery stock and related materials	43	Gypsum	590	Sugar, raw
18	Oil seeds, nuts and kernels	44	Salt	591	Cocoa beans, unroasted
19	Hops including lupulin	45	Peatmoss	592	Green coffee
20	Tobacco, raw	46	Clay and other crude refractory materials	593	Tropical fruit
21	Mink skins, ranch undressed	47	Natural abrasives and industrial diamonds		
		Energy Commodities			
37	Coal	394	Aviation gasoline	399	Butane, propane and other liquid petroleum gas
38	Crude mineral oils	395	Motor gasoline	546	Electric power
39	Natural gas	396	Fuel oil	548	Coke
		Potential Contaminant Commodities			
33	Radio-active ores and concentrates	355	Refrigerators, freezers and combination domestic	439	Carbon tetrachloride
42	Asbestos, unmanufactured, crude and fibrous	367	Transformers and converters excl. telephone	440	Vinylchloride monomer
245	Coal tar	369	Batteries	441	Trichloroethylene
255	Lead, primary forms	388	Asbestos products	442	Perchloroethylene
267	Lead and lead alloy products cast, rolled and extruded	398	Benzene, toluene and xylene	443	Fluorinated halogen hydrocarbons
326	Refrigeration and air conditioning equipment, excluding household	430	Sodium cyanide		

Source:
Statistics Canada. Environment and Wealth Accounts Division.
Note:
See the text for an explanation of the definitions used in this table.

Table: 3.1.1.2

Industry Impact Classification, 1984

	Title	Inputs[1]					Impact class			
		Total inputs	Raw resource	Energy	Potential contaminant	Other	Raw resource	Energy	Potential contaminant	Water
		thousand dollars	percent of total							
	Harvesting and Extraction									
1	Agricultural & Related Services Industries	23 782 214	24.1	6.0	0.0	69.9	High	High	Low	..
2	Fishing & Trapping Industries	949 959	3.0	13.3	0.0	83.7	Med	High	Low	..
3	Logging & Forestry Industries	6 049 599	18.1	3.8	0.0	78.2	High	Med	Low	..
4	Gold Mines	1 005 995	0.3	5.4	0.8	93.7	Low	Med	High	Low
5	Other Metal Mines	4 574 107	0.9	6.8	0.1	92.3	Low	High	Med	Low
6	Iron Mines	1 457 375	0.8	12.9	0.0	86.4	Low	High	Low	Low
7	Asbestos Mines	374 891	0.3	12.5	0.0	88.0	Low	High	Low	Low
8	Non-metal Mines excl. Coal & Asbestos	1 193 076	0.5	9.6	0.0	90.9	Low	High	Low	Low
9	Salt Mines	201 710	0.7	6.6	0.0	93.1	Low	High	Low	Med
10	Coal Mines	1 577 067	0.7	6.0	0.0	93.3	Low	High	Low	Low
11	Crude Petroleum & Natural Gas	28 661 447	0.1	1.5	0.0	98.4	Low	Low	Low	High
12	Quarry & Sand Pit Industries	792 882	2.8	7.6	0.0	89.6	Med	High	Low	..
	Manufacturing									
13	Service Related to Mineral Extraction	4 385 667	0.6	6.4	0.0	93.0	Low	High	Low	..
14	Meat & Meat Products (excl. Poultry)	8 350 428	50.3	0.8	0.0	48.9	High	Low	Low	Med
15	Poultry Products Industry	1 469 294	56.5	1.2	0.0	42.3	High	Low	Low	Low
16	Fish Products Industry	1 772 328	34.3	1.9	0.0	63.8	High	Low	Low	Low
17	Fruit and Vegetable Industries	2 377 051	12.1	1.7	0.0	86.2	High	Low	Low	High
18	Dairy Products Industries	6 123 106	48.0	1.3	0.0	50.7	High	Low	Low	Med
19	Feed Industry	2 711 413	23.4	1.6	0.0	75.0	High	Low	Low	Low
20	Vegetable Oil Mills (excl. Corn Oil)	958 958	70.8	1.3	0.0	27.9	High	Low	Low	Low
21	Biscuit Industry	567 350	0.3	1.4	0.0	98.3	Low	Low	Low	..
22	Bread & Other Bakery Products Industries	1 446 078	0.5	2.5	0.0	97.0	Low	Med	Low	High
23	Cane & Beet Sugar Industry	562 854	45.2	3.5	0.0	51.9	High	Med	Low	Low
24	Misc. Food Products Industries	6 279 177	19.7	1.4	0.0	78.9	High	Low	Low	Low
25	Soft Drink Industry	1 790 232	0.6	1.3	0.0	98.2	Low	Low	Low	High
26	Distillery Products Industry	833 733	3.7	2.7	0.0	93.7	Med	Med	Low	..
27	Brewery Products Industry	1 925 907	1.0	1.7	0.0	97.3	Med	Low	Low	High
28	Wine Industry	235 937	8.9	1.0	0.0	90.1	High	Low	Low	High
29	Tobacco Products Industries	1 641 344	20.9	0.5	0.0	78.5	High	Low	Low	..
30	Rubber Products Industries	2 720 714	5.0	2.2	0.0	92.7	Med	Med	Med	High
31	Plastic Products Industries	3 589 864	0.2	1.9	0.1	97.8	Low	Low	Med	High
32	Leather Tanneries	216 347	0.4	2.1	0.0	97.6	Low	Med	Low	..
33	Footwear Industry	898 995	0.3	0.8	0.0	98.9	Low	Low	Low	..
34	Misc. Leather & Allied Products Industries	221 992	0.2	0.9	0.0	98.9	Low	Low	Low	..
35	Man-made Fibre Yarn & Woven Cloth	2 067 846	5.2	3.4	0.0	91.5	Med	Med	Low	Med
36	Wool Yarn & Woven Cloth Industry	307 126	0.2	2.4	0.0	97.5	Low	Med	Low	Med
37	Broad Knitted Fabric Industry	378 717	0.3	1.4	0.0	98.3	Low	Low	Low	..
38	Misc. Textile Products Industries	1 714 853	1.5	1.4	0.0	97.1	Med	Low	Med	Med
39	Contract Textile Dyeing & Finishing	161 535	2.8	6.8	0.0	90.4	Med	High	Low	Med
40	Carpet, Mat & Rug Industry	701 449	0.1	2.4	0.0	97.6	Low	Med	Low	Med
41	Clothing Industries excl. Hosiery	5 080 341	2.7	0.6	0.0	96.6	Med	Low	Med	..
42	Hosiery Industry	275 792	0.1	1.7	0.0	98.2	Low	Low	Low	..
43	Sawmills, Planing & Shingle Mills	6 458 841	42.9	3.1	0.0	54.1	High	Med	Low	Low
44	Veneer and Plywood Industries	809 480	22.6	2.9	0.0	74.5	High	Med	Low	..
45	Sash, Door & Other Millwork Industries	1 777 078	0.4	1.3	0.0	98.3	Low	Low	Med	..
46	Wooden Box & Coffin Industries	232 052	1.4	1.8	0.0	96.8	Med	Low	Low	..
47	Other Wood Industries	819 129	13.3	3.9	0.0	82.8	High	Med	Low	..
48	Household Furniture Industries	1 391 456	0.1	1.2	0.0	98.7	Low	Low	Low	..
49	Office Furniture Industries	701 922	0.1	1.0	0.0	98.9	Low	Low	Low	..
50	Other Furniture & Fixture Industries	959 916	0.2	1.1	0.0	98.6	Low	Low	Med	..
51	Pulp & Paper Industries	13 318 456	12.0	14.6	0.1	77.1	High	High	Med	High
52	Asphalt Roofing Industry	360 803	26.6	2.6	0.4	70.3	High	Med	High	..
53	Paper Box & Bag Industries	2 256 883	0.6	1.1	0.0	98.3	Low	Low	Low	..
54	Other Converted Paper Products Industries	1 809 126	1.1	1.3	0.1	97.4	Med	Low	Med	High
55	Printing & Publishing Industries	8 058 984	0.2	0.7	0.0	99.1	Low	Low	Med	..
56	Platemaking, Typesetting & Bindery	823 181	0.6	0.9	0.1	98.4	Low	Low	Med	..
57	Primary Steel Industries	7 554 414	10.1	12.6	0.0	77.4	High	High	Low	Med
58	Steel Pipe & Tube Industry	1 153 140	0.1	1.8	0.0	98.0	Low	Low	Med	Med
59	Iron Foundries	763 387	4.7	4.5	0.0	90.8	Med	Med	Med	Low
60	Non-ferrous Smelting & Refining Industry	7 505 560	52.2	27.6	3.7	39.1	High	High	High	Med
61	Aluminum Rolling Casting, Extruding	1 427 290	0.2	2.2	0.0	97.6	Low	Med	Low	Med
62	Copper Rolling Casting & Extruding	490 486	0.3	2.4	0.0	97.3	Low	Med	Med	High
63	Other Metal Rolling, Casting etc.	798 018	0.4	2.4	1.7	95.4	Low	Med	High	..
64	Power Boiler & Struct. Metal Industry	2 050 380	0.1	1.1	0.0	98.7	Low	Low	Med	Low
65	Ornamental & Arch. Metal Products Industry	1 101 087	0.6	1.2	0.0	98.2	Low	Low	Low	..
66	Stamped, Pressed & Coated Metals	3 800 098	16.7	1.2	0.0	82.1	High	Low	Med	Med
67	Wire and Wire Products Industries	1 600 624	0.3	2.0	0.0	97.7	Low	Low	Med	Med

Industry Impact Classification, 1984

	Title	Inputs[1]					Impact class			
		Total inputs	Raw resource	Energy	Potential contaminant	Other	Raw resource	Energy	Potential contaminant	Water
		thousand dollars	percent of total							
68	Hardware, Tool & Cutlery Industries	1 188 187	0.3	1.3	0.0	98.4	Low	Low	Low	..
69	Heating Equipment Industry	361 404	0.1	0.9	1.1	97.8	Low	Low	High	..
70	Machine Shops Industry	843 007	0.3	1.4	0.0	98.3	Low	Low	Med	..
71	Other Metal Fabricating Industries	1 466 989	0.3	2.1	0.0	97.6	Low	Med	Med	..
72	Agriculture Implement Industry	1 043 761	0.4	1.4	0.2	98.0	Low	Low	Med	..
73	Commercial Refrigeration Equipment	409 913	0.2	0.8	17.5	81.5	Low	Low	High	..
74	Other Machinery & Equipment Industries	5 728 586	0.3	1.0	0.1	98.6	Low	Low	Med	..
75	Aircraft & Aircraft Parts Industry	2 444 498	0.1	1.1	0.0	98.9	Low	Low	Low	Low
76	Motor Vehicle Industry	21 441 816	0.1	0.4	2.2	97.3	Low	Low	High	Med
77	Truck, Bus Body & Trailer Industry	1 029 012	0.2	0.8	0.9	98.2	Low	Low	High	..
78	Motor Vehicle Parts & Accessories	11 650 235	0.4	1.1	0.3	98.3	Low	Low	High	High
79	Railroad Rolling Stock Industry	1 025 869	0.4	1.7	0.3	97.6	Low	Low	High	Med
80	Shipbuilding and Repair Industry	1 083 017	0.3	1.1	0.0	98.5	Low	Low	Med	Low
81	Misc. Transportation Equipment Industries	452 408	0.3	1.1	0.6	98.0	Low	Low	High	..
82	Small Electrical Appliance Industry	577 509	0.2	0.8	0.3	98.7	Low	Low	High	..
83	Major Appliances (Electric & Non-Electric)	957 034	0.3	0.9	5.9	92.9	Low	Low	High	..
84	Record Players, Radio & TV Receiver	483 299	0.0	0.2	0.0	99.7	Low	Low	Low	..
85	Electronic Equipment Industries	4 369 519	0.1	0.7	1.0	98.2	Low	Low	High	..
86	Office, Store & Business Machines	2 086 502	0.0	0.5	0.0	99.5	Low	Low	Low	..
87	Communications, Energy Wire & Cable	1 240 128	0.1	1.4	0.1	98.4	Low	Low	Med	..
88	Battery Industry	334 503	0.2	1.4	12.7	85.7	Low	Low	High	..
89	Other Electrical & Electronic Products	2 979 873	0.4	1.9	3.5	94.2	Low	Low	High	..
90	Clay Products Industry	200 539	3.4	12.0	0.0	84.6	Med	High	Low	..
91	Cement Industry	697 914	4.4	15.7	0.0	79.9	Med	High	Low	High
92	Concrete Products Industry	672 026	7.1	2.9	0.0	90.0	High	Med	Low	High
93	Ready-mix Concrete Industry	1 098 172	15.2	3.4	0.0	81.3	High	Med	Low	High
94	Glass & Glass Products Industries	1 251 542	2.7	5.0	0.0	92.3	Med	Med	Low	Med
95	Non-metallic Mineral Products n.e.c.	1 478 943	8.5	9.4	0.3	81.8	High	High	High	High
96	Refined Petroleum & Coal Products	23 793 326	6.2	4.2	0.0	15.7	High	Med	Med	Med
97	Industrial Chemicals Industries n.e.c.	6 738 446	32.9	9.0	3.7	56.8	High	High	High	Med
98	Plastic & Synthetic Resin Industry	1 916 633	1.4	4.2	5.2	89.2	Med	Med	High	Med
99	Pharmaceutical & Medicine Industry	1 985 875	1.4	0.7	0.0	97.9	Med	Low	Low	Med
100	Paint and Varnish Industry	1 113 636	4.7	0.9	1.9	92.5	Med	Low	High	Med
101	Soap & Cleaning Compounds Industry	1 359 532	0.2	1.0	0.0	98.8	Low	Low	Med	Med
102	Toilet Preparations Industry	916 580	0.3	0.6	0.1	99.0	Low	Low	Med	..
103	Chemical & Chemical Products n.e.c.	3 966 989	11.1	4.0	1.7	83.2	High	Med	High	High
104	Jewellery & Precious Metal Industry	636 115	34.5	0.6	0.0	64.9	High	Low	Med	..
105	Sporting Goods & Toy Industries	977 205	0.2	1.1	0.0	98.7	Low	Low	Med	..
106	Sign and Display Industry	467 583	0.2	1.4	2.6	95.8	Low	Low	High	..
107	Floor Tile, Linoleum, Coated Fabric	194 878	0.6	2.0	0.3	97.0	Low	Med	High	..
108	Other Manufacturing Industries n.e.c.	2 835 504	0.8	1.0	0.3	98.0	Low	Low	High	..
	Construction, Services and other Industries									
109	Repair Construction	9 617 600	2.4	1.1	0.1	96.4	Med	Low	Med	..
110	Residential Construction	18 772 299	1.3	0.8	0.6	97.3	Med	Low	High	..
111	Non-residential Building Construction	11 799 200	1.0	0.9	0.8	97.4	Low	Low	High	..
112	Road, Highway & Airstrip Construction	3 324 481	11.8	7.8	0.0	80.3	High	High	Med	..
113	Gas & Oil Facility Construction	7 955 025	0.4	1.5	0.0	98.1	Low	Low	Low	..
114	Dams & Irrigation Projects	3 522 337	0.3	0.9	0.0	98.8	Low	Low	Med	..
115	Railway & Telephone Telegraph Construction	1 753 101	1.8	0.5	0.2	97.4	Med	Low	Med	..
116	Other Engineering Construction	4 970 676	1.4	0.2	0.1	98.2	Med	Low	Med	..
117	Construction, Other Activities	330 138	0.5	8.3	0.1	91.0	Low	High	Med	..
118	Air Transport & Services Incidental	5 473 593	0.2	16.1	0.0	83.6	Low	High	Low	..
119	Railway Transport & Related Services	6 615 415	0.9	8.6	0.1	90.0	Low	High	Med	..
120	Water Transport & Related Services	3 060 857	0.8	9.8	0.0	89.4	Low	High	Med	..
121	Truck Transport Industries	9 720 694	0.7	10.4	0.3	88.6	Low	High	High	..
122	Urban Transit System Industry	987 930	2.4	12.8	0.8	84.0	Med	High	High	..
123	Interurban & Rural Transit Systems	323 692	0.9	9.8	0.6	88.6	Low	High	High	..
124	Taxicab Industry	928 704	0.5	12.8	0.2	86.6	Low	High	Med	..
125	Other Transport & Services to Transport	2 678 473	1.2	7.6	0.0	91.2	Med	High	Low	..
126	Highway & Bridge Maintenance Industry	136 824	5.5	9.6	0.0	84.8	Med	High	Low	..
127	Pipeline Transport Industries	2 940 849	0.2	10.6	0.0	89.2	Low	High	Low	..
128	Storage and Warehousing Industries	1 022 227	0.7	5.0	0.0	94.3	Low	Med	Low	..
129	Telecommunication Broadcasting Industry	2 424 904	0.1	1.2	0.0	98.7	Low	Low	Low	..
130	Telecommunication Carriers & Other	10 476 432	0.2	1.3	0.0	98.5	Low	Low	Low	..
131	Postal Service Industry	2 362 967	0.0	1.0	0.0	99.0	Low	Low	Low	..
132	Electric Power Systems Industry	14 283 387	1.3	43.2	1.3	86.3	Med	High	High	..
133	Gas Distribution Systems Industry	1 699 866	0.1	2.3	0.0	97.6	Low	Med	Low	..
134	Other Utility Industries n.e.c.	575 563	1.8	15.1	0.0	83.2	Med	High	Low	..
135	Wholesale Trade Industries	28 350 058	0.6	3.3	0.0	96.1	Low	Med	Med	..
136	Retail Trade Industries	35 792 904	1.4	3.7	0.0	94.8	Med	Med	Med	..
137	Banks, Credit Union & Other Deposit Institutions	9 031 153	0.1	0.9	0.0	99.0	Low	Low	Low	..

Industry Impact Classification, 1984

	Title	Inputs[1]					Impact class			
		Total inputs	Raw resource	Energy	Potential contam-inant	Other	Raw resource	Energy	Potential contam-inant	Water
		thousand dollars	percent of total							
138	Trust, Other Finance & Real Estate	35 003 951	1.3	3.9	0.0	94.9	Med	Med	Low	..
139	Insurance Industries	6 264 846	0.1	0.5	0.0	99.4	Low	Low	Low	..
140	Government Royalties on Natural Resources	6 445 699	0.0	0.0	0.0	100.0	Low	Low	Low	..
141	Owner Occupied Dwellings	32 231 900	0.0	0.0	0.0	100.0	Low	Low	Low	..
142	Other Business Service Industries	7 163 263	0.0	1.2	0.0	98.8	Low	Low	Low	..
143	Professional Business Services	9 548 481	0.1	0.5	0.0	99.5	Low	Low	Low	..
144	Advertising Services	1 141 573	0.4	2.2	0.0	97.4	Low	Med	Low	..
145	Educational Service Industries	1 223 290	1.5	3.4	0.0	95.1	Med	Med	Low	..
146	Hospitals	259 845	0.5	5.1	0.0	95.0	Low	Med	Low	..
147	Other Health Services	10 110 098	0.3	1.5	0.0	98.3	Low	Low	Low	..
148	Accommodation & Food Service Industry	16 592 958	2.1	3.5	0.0	94.4	Med	Med	Low	..
149	Motion Picture & Video Industries	1 057 817	0.2	1.3	0.0	98.5	Low	Low	Low	..
150	Other Amusement & Recreational Services	3 486 606	0.3	2.5	0.0	97.3	Low	Med	Low	..
151	Laundries & Cleaners	1 173 454	1.8	7.2	0.4	90.6	Med	High	High	..
152	Other Personal Services	2 996 903	0.4	2.0	0.0	97.6	Low	Low	Low	..
153	Photographers	342 962	1.1	5.4	0.0	93.6	Med	Med	Low	..
154	Misc. Service Industries	5 763 966	0.1	3.1	0.0	96.8	Low	Med	Low	..
155	Operating Supplies[2]	12 141 183	0.4	0.0	2.7	96.9	Low	Low	High	..
156	Office Supplies[2]	4 035 443	0.0	0.0	0.0	100.0	Low	Low	Low	..
157	Cafeteria Supplies[2]	1 661 452	7.5	0.0	0.0	92.5	High	Low	Low	..
158	Laboratory Supplies[2]	1 269 782	0.5	0.0	1.2	98.3	Low	Low	High	..
159	Travel & Entertainment[2]	7 904 958	0.1	7.8	0.1	92.0	Low	High	Med	..
160	Advertising & Promotion[2]	6 769 118	0.0	0.0	0.0	100.0	Low	Low	Low	..
161	Transportation Margins[2]	13 627 506	0.0	0.0	0.0	100.0	Low	Low	Low	..
	All industries	705 055 251	5.2	5.9	0.3	88.5				

Source:
Statistics Canada. Environment and Wealth Accounts Division. Original data provided by Input-Output Division.
Note:
See the text for an explanation of the categories used.
[1] The figures have been adjusted for self-generated energy and non-energy uses of energy commodities. Therefore the total for some industries may not total to 100.
[2] These are fictive categories used for classifying groups of commodities where the precise commodity content is unknown.

Table: 3.1.1.3

Industries by Impact Class[1]

Resource-Intensive Industries

Code[2]	Industry	SIC (1980)
20	Vegetable Oil Mills (excl. Corn Oil)	106
15	Poultry Products Industry	1012
60	Non-ferrous Smelting & Refining Industry	295
14	Meat & Meat Products (excl. Poultry)	1011
18	Dairy Products Industries	104
23	Cane & Beet Sugar Industry	1081
43	Sawmills, Planing & Shingle Mills	251
104	Jewellery & Precious Metal Industry	392
16	Fish Products Industry	102
97	Industrial Chemicals Industries n.e.c.[3]	371
52	Asphalt Roofing Industry	272
1	Agricultural & Related Services Industry	011-23
19	Feed Industry	1053
44	Veneer and Plywood Industries	252
29	Tobacco Products Industries	121,122
24	Misc. Food Products Industries	109,1051,1052,1082,1083
3	Logging & Forestry Industries	0411,0412,0511
66	Stamped, Pressed & Coated Metals	304
93	Ready-mix Concrete Industry	355
47	Other Wood Industries	259
17	Fruit and Vegetable Industries	103
51	Pulp & Paper Industries	271
112	Road, Highway & Airstrip Construction	401-449
103	Chemical & Chemical Products n.e.c.	372,379
57	Primary Steel Industries	291
28	Wine Industry	114
95	Non-metallic Mineral Products n.e.c.	357-359
92	Concrete Products Industry	354
96	Refined Petroleum & Coal Products	361,369

Energy-Intensive Industries

Code[2]	Industry	SIC (1980)
132	Electric Power Systems Industry	491
60	Non-ferrous Smelting & Refining Industry	295
118	Air Transport & Services Incidental	451,452
91	Cement Industry	352
134	Other Utility Industries n.e.c.	499
51	Pulp & Paper Industries	271
2	Fishing & Trapping Industries	031-033
6	Iron Mines	0617
122	Urban Transit System Industry	4571
124	Taxicab Industry	4581
57	Primary Steel Industries	291
7	Asbestos Mines	0621
90	Clay Products Industry	351
127	Pipeline Transport Industries	461
121	Truck Transport Industries	456
123	Interurban & Rural Transit Systems	4572
120	Water Transport & Related Services	454,455
126	Highway & Bridge Maintenance Industry	4591
8	Non-metal Mines excl. Coal & Asbestos	0622-0624,0629
95	Non-metallic Mineral Products n.e.c.	357-359
97	Industrial Chemicals Industries n.e.c.	371
119	Railway Transport & Related Services	453
117	Construction, Other Activities	401-449
112	Road, Highway & Airstrip Construction	401-449
12	Quarry & Sand Pit Industries	081,082
125	Other Transport & Services to Transport	4573-4575,4589,4592,4599,996
151	Laundries & Cleaners	972
39	Contract Textile Dyeing & Finishing	1992
5	Other Metal Mines	0612-0615,0619
9	Salt Mines	0625
13	Service Related to Mineral Extraction	091,092
1	Agricultural & Related Services Industry	011-23
10	Coal Mines	063

Contaminant-intensive Industries

Code[2]	Industry	SIC (1980)
73	Commercial Refrigeration Equipment	312
88	Battery Industry	3391
83	Major Appliances (Electric & Non-electric)	332
98	Plastic & Synthetic Resin Industry	373
97	Industrial Chemicals Industries n.e.c.	371
60	Non-ferrous Smelting & Refining Industry	295
89	Other Elect. & Electronic Products	333,337,3392-3399
155	Operating Supplies	Fictive
106	Sign and Display Industry	397
76	Motor Vehicle Industry	323
100	Paint and Varnish Industry	375
103	Chemical & Chemical Products n.e.c.	372,379
63	Other Metal Rolling, Casting etc.	299
132	Electric Power Systems Industry	491
158	Laboratory Supplies	Fictive
69	Heating Equipment Industry	307
85	Electronic Equipment Industries	335
77	Truck, Bus Body & Trailer Industry	324
122	Urban Transit System Industry	4571
4	Gold Mines	0611
111	Non-residential Building Construction	401-449
123	Interurban & Rural Transit Systems	4572
81	Misc. Transportation Equipment Industry	328,329
110	Residential Construction	401-449
151	Laundries & Cleaners	972
52	Asphalt Roofing Industry	272
107	Floor Tile, Linoleum, Coated Fabric	3993
79	Railroad Rolling Stock Industry	326
95	Non-metallic Mineral Products n.e.c.	357-359
82	Small Electrical Appliance Industry	331
78	Motor Vehicle Parts & Accessories	325
108	Other Manufacturing Industries n.e.c.	391,3991,3992,3994,3999
121	Truck Transport Industries	456

Water-intensive Industries

Code[2]	Industry	SIC (1980)
95	Non-metallic Mineral Products n.e.c.	357-359
92	Concrete Products Industry	354
11	Crude Petroleum & Natural Gas	071
31	Plastic Products Industries	161-169
93	Ready-mix Concrete Industry	355
78	Motor Vehicle Parts & Accessories	325
51	Pulp & Paper Industries	271
54	Other Converted Paper Products Industries	279
28	Wine Industry	114
22	Bread & Other Bakery Products Industry	1072
25	Soft Drink Industry	111
30	Rubber Products Industries	151-159
17	Fruit and Vegetable Industries	103
103	Chemical & Chemical Products n.e.c.	372,379
91	Cement Industry	352
62	Copper Rolling Casting & Extruding	297
27	Brewery Products Industry	113

Source: Statistics Canada. Environment and Wealth Accounts Division.

Notes:

[1] See the text for a description of derivation of these classes.

[2] Codes refer to the listing in Table 3.3.1.1.

[3] Not elsewhere classified.

Table: 3.1.1.4

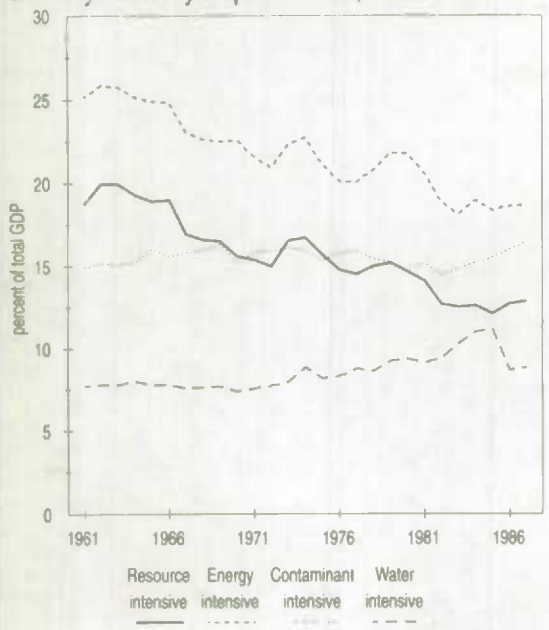
Gross Domestic Product by Impact Class, 1961-1987

Year	Contribution to GDP					Proportion of GDP[1]			
	Resource-intensive industries	Energy-intensive industries	Contaminant-intensive industries	Water-intensive industries	All business sector industries	Resource-intensive industries	Energy-intensive industries	Contaminant-intensive industries	Water-intensive industries
	million dollars					percent			
1961	5 788	7 775	4 607	2 384	30 919	18.72	25.15	14.90	7.71
1962	6 681	8 655	5 075	2 603	33 487	19.95	25.85	15.16	7.77
1963	7 185	9 272	5 428	2 807	36 008	19.95	25.75	15.08	7.79
1964	7 584	9 871	5 973	3 143	39 277	19.31	25.13	15.21	8.00
1965	8 203	10 797	6 954	3 371	43 361	18.92	24.90	16.04	7.78
1966	9 172	11 982	7 521	3 757	48 258	19.01	24.83	15.59	7.79
1967	8 625	11 722	8 068	3 859	50 913	16.94	23.02	15.85	7.58
1968	9 135	12 454	8 781	4 222	55 041	16.60	22.83	15.95	7.67
1969	9 940	13 543	9 811	4 624	60 160	18.52	22.51	16.31	7.89
1970	9 897	14 339	9 665	4 683	63 489	15.59	22.58	15.22	7.38
1971	10 684	14 969	11 012	5 263	69 429	15.39	21.56	15.86	7.58
1972	11 609	16 215	12 310	6 005	77 464	14.99	20.93	15.89	7.75
1973	15 329	20 683	14 940	7 385	92 588	16.56	22.34	16.14	7.98
1974	18 560	25 204	17 711	9 818	110 915	16.73	22.72	15.97	8.85
1975	19 828	26 653	19 390	10 319	126 231	15.71	21.11	15.36	8.17
1976	21 258	28 940	22 758	11 985	143 831	14.78	20.12	15.82	8.33
1977	22 992	31 746	25 203	13 919	158 361	14.52	20.05	15.91	8.79
1978	26 485	36 698	27 282	15 253	176 601	15.00	20.78	15.45	8.64
1979	31 205	44 792	31 318	19 003	205 359	15.20	21.81	15.25	9.25
1980	34 091	50 619	34 241	21 814	232 556	14.66	21.77	14.72	9.38
1981	36 965	53 897	39 738	23 924	261 666	14.13	20.60	15.19	9.14
1982	34 267	50 880	38 974	25 457	269 832	12.70	18.86	14.44	9.43
1983	38 906	53 444	43 811	30 426	294 767	12.52	18.13	14.86	10.32
1984	41 194	62 034	49 657	36 010	326 817	12.60	18.98	15.19	11.02
1985	42 618	64 550	54 655	39 248	351 836	12.11	18.35	15.53	11.18
1986	48 894	68 607	58 991	32 014	368 535	12.72	18.62	16.01	8.69
1987	52 057	75 512	66 637	35 831	404 569	12.87	18.66	16.47	8.86

Source:
Statistics Canada. Input-Output Division.
Note:
Since some industries occur in more than one impact class, these percentages are not additive.

Figure: 3.1.1.1

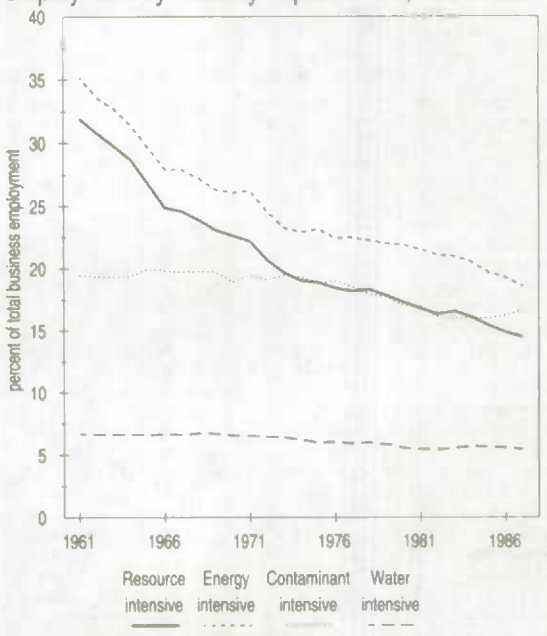
GDP by Industry Impact Class, 1961-1987



Source: Statistics Canada. Input-Output Division.
Note: The percentages are not additive.

Figure: 3.1.1.2

Employment by Industry Impact Class, 1961-1987



Source: Statistics Canada. Input-Output Division.
Note: The percentages are not additive.

Table: 3.1.1.5

Employment in the Business Sector by Impact Class, 1961-1987

Year	Employment					Proportion of total employment[1]			
	Resource-intensive industries	Energy-intensive industries	Contaminant-intensive industries	Water-intensive industries	All business sector industries	Resource-intensive industries	Energy-intensive industries	Contaminant-intensive industries	Water-intensive industries
	persons					percent			
1961	1 222 670	1 347 581	744 434	255 093	3 829 859.76	31.9	35.2	19.4	6.7
1962	1 217 926	1 330 099	764 015	261 669	3 955 207.78	30.8	33.6	19.3	6.6
1963	1 210 668	1 331 371	785 861	267 102	4 066 910.61	29.8	32.7	19.3	6.6
1964	1 219 166	1 332 801	821 753	282 041	4 244 640.78	28.7	31.4	19.4	6.6
1965	1 206 696	1 335 441	898 810	295 329	4 501 493.98	26.8	29.7	20.0	6.6
1966	1 172 698	1 318 353	934 623	313 454	4 715 892.08	24.9	28.0	19.8	6.6
1967	1 179 269	1 337 302	943 852	316 615	4 795 743.86	24.6	27.9	19.7	6.6
1968	1 150 225	1 308 937	952 668	322 183	4 818 131.66	23.9	27.2	19.8	6.7
1969	1 147 541	1 307 179	980 694	331 376	4 975 447.00	23.1	26.3	19.7	6.7
1970	1 127 919	1 298 983	942 011	324 313	4 986 229.98	22.6	26.1	18.9	6.5
1971	1 131 076	1 335 672	991 476	332 338	5 097 610.79	22.2	26.2	19.4	6.5
1972	1 101 304	1 305 649	1 013 766	342 707	5 321 646.95	20.7	24.5	19.0	6.4
1973	1 111 105	1 312 118	1 097 536	359 765	5 650 432.50	19.7	23.2	19.4	6.4
1974	1 128 722	1 360 775	1 146 332	367 179	5 943 484.72	19.0	22.9	19.3	6.2
1975	1 133 986	1 391 364	1 130 832	355 898	6 015 120.45	18.9	23.1	18.8	5.9
1976	1 124 826	1 367 507	1 158 917	367 510	6 108 419.75	18.4	22.4	19.0	6.0
1977	1 132 606	1 401 528	1 155 372	365 828	6 238 317.76	18.2	22.5	18.5	5.9
1978	1 167 325	1 419 110	1 143 263	380 526	6 383 773.14	18.3	22.2	17.9	6.0
1979	1 187 395	1 464 086	1 179 467	386 095	6 662 443.04	17.8	22.0	17.7	5.8
1980	1 180 789	1 495 813	1 159 635	378 322	6 838 845.89	17.3	21.9	17.0	5.5
1981	1 181 238	1 515 247	1 194 098	382 174	7 042 589.00	16.8	21.5	17.0	5.4
1982	1 108 708	1 431 392	1 093 782	366 248	6 798 940.00	16.3	21.1	16.1	5.4
1983	1 117 370	1 414 992	1 080 893	371 759	6 760 717.00	16.5	20.9	16.0	5.5
1984	1 115 797	1 422 653	1 110 766	393 845	6 941 797.00	16.1	20.5	16.0	5.7
1985	1 123 673	1 431 890	1 166 842	408 610	7 299 661.00	15.4	19.6	16.0	5.6
1986	1 108 080	1 436 243	1 213 261	414 086	7 475 122.00	14.8	19.2	16.2	5.5
1987	1 116 061	1 432 034	1 285 409	418 738	7 725 108.00	14.4	18.5	16.6	5.4

Source:
Statistics Canada. Input-Output Division.
Note:
Persons employed in the non-business sector and government sector are not included.
[1] Since some industries occur in more than one impact class, these percentages are not additive.

Table: 3.1.1.6

Manufacturing Employment by Ecozone and Impact Class, 1986

Province / Ecozone	Impact class								Total manufacturing employment
	High contaminant		High energy		High resource		High water		
	number[1]	percent[2]	number	percent	number	percent	number	percent	number
Newfoundland									
Taiga Shield	C	22	-	-	D	61	B	13	E
Boreal Shield	2 739	17	2 632	16	13 615	81	1 238	8	16 796
Total	**2 739**	**16**	**2 632**	**16**	**13 645**	**81**	**1 238**	**7**	**16 796**
Prince Edward Island									
Atlantic Maritime	F	3	A	0	2 393	70	F	4	3 402
Total	F	**3**	**A**	**0**	**2 393**	**70**	F	**4**	**3 402**
Nova Scotia									
Atlantic Maritime	9 642	28	4 328	13	16 527	48	3 203	9	**34 462**
Total	**9 642**	**28**	**4 328**	**13**	**16 527**	**48**	**3 203**	**9**	**34 462**
New Brunswick									
Atlantic Maritime	8 009	26	6 615	22	19 582	64	2 657	9	**30 516**
Total	**8 009**	**26**	**6 615**	**22**	**19 582**	**64**	**2 657**	**9**	**30 516**
Quebec									
Taiga Shield	D	62	-	-	E	96	C	34	E
Boreal Shield	25 224	51	22 455	48	37 030	75	2 622	5	**49 108**
Mixed-Wood Plain	88 769	21	37 887	9	89 467	21	29 882	7	**425 164**
Atlantic Maritime	1 263	14	H	8	6 636	73	H	6	**9 122**
Total	**115 256**	**24**	**60 342**	**12**	**133 133**	**28**	**32 504**	**7**	**483 394**
Ontario									
Boreal Shield	28 308	63	24 524	54	35 751	79	1 385	3	**45 043**

Manufacturing Employment by Ecozone and Impact Class, 1986

Province / Ecozone	Impact class: High contaminant number[1]	High contaminant percent[2]	High energy number	High energy percent	High resource number	High resource percent	High water number	High water percent	Total manufacturing employment number
Mixed-Wood Plain	159 831	19	55 651	7	163 183	19	59 723	7	842 141
Total	**188 139**	**21**	**80 175**	**9**	**198 934**	**22**	**61 108**	**7**	**887 184**
Manitoba									
Hudson Bay Plain	H	67	H	67	1 000	89	E	5	1 118
Prairie	6 232	10	2 995	3	10 591	22	4 182	8	47 582
Boreal Shield	H	35	H	35	1 537	62	G	8	2 488
Total	**6 232**	**12**	**2 995**	**6**	**13 128**	**26**	**4 182**	**8**	51 188
Saskatchewan									
Boreal Plain	A	0	-	-	G	91	-	-	G
Prairie	2 866	16	1 373	8	7 069	37	2 440	13	18 448
Total	**2 866**	**16**	**1 373**	**7**	**7 069**	**38**	**2 440**	**13**	18 448
Alberta									
Montane Cordillera	F	14	G	35	G	60	G	39	H
Boreal Plain	1 743	30	1 512	23	4 563	74	H	9	6 286
Prairie	11 466	18	5 576	9	22 162	35	7 256	10	63 397
Total	**13 209**	**19**	**7 088**	**10**	**26 725**	**38**	**7 256**	**10**	69 683
British Columbia									
Boreal Cordillera	D	100	-	-	D	100	-	-	D
Pacific Maritime	22 973	25	15 107	16	45 538	49	6 788	7	93 153
Montane Cordillera	9 673	30	6 293	19	26 094	80	1 839	5	32 641
Boreal Plain	-	-	-	-	1 223	86	E	5	1 421
Taiga Plain	-	-	-	-	A	100	-	-	A
Total	**32 646**	**26**	**21 400**	**17**	**72 870**	**57**	**8 627**	**7**	127 215
Yukon									
Boreal Cordillera	-	-	-	-	-	-	-	-	E
Total	-	-	-	-	-	-	-	-	E
Northwest Territories									
Taiga Plain	-	-	-	-	A	13	-	-	F
Taiga Shield	-	-	-	-	-	-	-	-	F
Southern Arctic	-	-	-	-	-	-	-	-	A
Northern Arctic	-	-	-	-	-	-	-	-	D
Total	-	-	-	-	**A**	**6**	-	-	F
Canada	**378 844**	**22**	**186 950**	**11**	**504 006**	**29**	**123 369**	**7**	**1 722 631**
Ecozone									
Atlantic Maritime	19 020	25	11 706	15	45 138	58	6 568	8	77 502
Mixed-Wood Plain	248 600	20	92 777	7	252 650	20	89 033	7	1 267 305
Boreal Shield	57 106	50	50 486	45	87 879	78	5 444	5	113 328
Prairie	18 933	15	8 319	6	39 539	31	12 830	10	129 115
Boreal Plain	1 639	23	1 252	17	5 621	77	H	6	7 271
Montane Cordillera	9 778	29	6 553	20	26 539	79	2 064	6	33 385
Pacific Maritime	22 944	25	15 107	16	45 509	49	6 786	7	93 124
Boreal Cordillera	D	26	0	0	D	26	0	0	F
Tundra Cordillera	-	-	-	-	-	-	-	-	-
Taiga Plain	0	0	0	0	C	16	0	0	F
Taiga Shield	D	20	0	0	E	38	D	11	G
Hudson Bay Plain	H	67	H	67	H	89	E	5	1 118
Southern Arctic	0	0	0	0	0	0	0	0	A
Northern Arctic	0	0	0	0	0	0	0	0	D
Arctic Cordillera	-	-	-	-	-	-	-	-	-

Source:
Statistics Canada. Environment and Wealth Accounts Division. Industry Division.
Note:
The following codes are used to maintain the confidentiality of cells with small values: A = 0 - 4; B = 5 - 9; C = 10 - 19; D = 20 - 49; E = 50 - 99; F = 100 - 199; G = 200 - 499; H = 500 - 999.
The values for cells with these values have been added to the nearest province or ecozone.
[1] Total employment in the high impact category. See the text for a definition of these categories.
[2] Percentage of total employment of the ecozone in this category.

Table: 3.1.1.7

Manufacturing Establishments by Ecozone and Impact Class, 1986

Province / Ecozone	Impact Class: High contaminant number[1]	High contaminant percent[2]	High energy number	High energy percent	High resource number	High resource percent	High water number	High water percent	Total establishments number
Newfoundland									
Taiga Shield	1	16.7	0	0.0	3	50.0	1	16.7	6
Boreal Shield	31	5.8	12	3.6	179	56.0	27	8.7	316
Total	**32**	**9.9**	**12**	**3.7**	**182**	**56.5**	**28**	**8.7**	**322**
Prince Edward Island									
Atlantic Maritime	14	9.9	1	0.7	75	53.2	9	6.4	141
Total	**14**	**9.9**	**1**	**0.7**	**75**	**53.2**	**9**	**6.4**	**141**
Nova Scotia									
Atlantic Maritime	80	9.8	24	2.9	319	39.1	81	9.9	815
Total	**80**	**9.8**	**24**	**2.9**	**319**	**39.1**	**81**	**9.9**	**815**
New Brunswick									
Atlantic Maritime	81	11.6	26	3.7	295	41.6	72	10.3	703
Total	**81**	**11.6**	**26**	**3.7**	**295**	**41.6**	**72**	**10.3**	703
Quebec									
Taiga Shield	1	33.3	0	0.0	2	66.7	1	33.3	3
Boreal Shield	108	10.4	40	3.9	348	33.6	112	10.8	1 035
Mixed-Wood Plain	1 208	12.4	251	2.6	1 664	17.0	584	6.0	9 751
Atlantic Maritime	19	6.9	5	1.8	133	48.5	23	8.4	274
Total	**1 336**	**12.1**	**296**	**2.7**	**2 147**	**19.4**	**720**	**6.5**	**11 063**
Ontario									
Boreal Shield	113	15.0	42	5.6	307	40.8	67	8.9	753
Mixed-Wood Plain	2 080	13.5	299	1.9	2 682	17.4	904	5.9	15 383
Total	**2 193**	**13.6**	**341**	**2.1**	**2 989**	**18.5**	**971**	**6.0**	**16 136**
Manitoba									
Hudson Bay Plain	3	11.1	3	11.1	12	44.4	4	14.8	27
Prairie	119	10.0	21	1.8	238	19.9	82	6.9	1 195
Boreal Shield	5	8.3	3	5.0	30	50.0	10	16.7	60
Total	**127**	**9.9**	**27**	**2.1**	**280**	**21.8**	**96**	**7.5**	1 282
Saskatchewan									
Boreal Plain	1	6.3	0	0.0	10	62.5	0	0.0	16
Prairie	73	8.8	22	2.6	216	26.0	104	12.5	831
Total	**74**	**8.7**	**22**	**2.6**	**226**	**26.7**	**104**	**12.3**	**847**
Alberta									
Montane Cordillera	6	15.4	4	10.3	17	43.6	8	20.5	39
Boreal Plain	23	9.7	5	2.1	105	44.3	29	12.2	237
Prairie	282	11.4	68	2.8	546	22.1	212	8.6	2 470
Total	**311**	**11.3**	**77**	**2.8**	**668**	**24.3**	**249**	**9.1**	2 746
British Columbia									
Boreal Cordillera	1	100.0	0	0.0	1	100.0	0	0.0	1
Pacific Maritime	427	12.8	74	2.2	854	25.5	216	6.5	3 339
Montane Cordillera	89	9.9	21	2.3	407	45.4	100	11.2	896
Boreal Plain	0	0.0	0	0.0	23	52.3	8	18.2	44
Taiga Plain	0	0.0	0	0.0	2	100.0	0	0.0	2
Total	**517**	**12.1**	**95**	**2.2**	**1 287**	**30.1**	**324**	**7.6**	4 282
Yukon									
Boreal Cordillera	0	0.0	0	0.0	0	0.0	0	0.0	15
Total	**0**	**0.0**	**0**	**0.0**	**0**	**0.0**	**0**	**0.0**	15
Northwest Territories									
Taiga Plain	0	0.0	0	0.0	1	11.1	0	0.0	9
Taiga Shield	0	0.0	0	0.0	0	0.0	0	0.0	10
Southern Arctic	0	0.0	0	0.0	0	0.0	0	0.0	1
Northern Arctic	0	0.0	0	0.0	0	0.0	0	0.0	3
Total	**0**	**0.0**	**0**	**0.0**	**1**	**4.3**	**0**	**0.0**	23
Canada	**4 765**	**12.4**	**921**	**2.4**	**8 469**	**22.1**	**2 654**	**6.9**	**38 375**
Ecozone									
Atlantic Maritime	194	10.0	56	2.9	822	42.5	185	9.6	1 933
Mixed-Wood Plain	3 288	13.1	550	2.2	4 346	17.3	1 488	5.9	25 134
Boreal Shield	257	11.9	97	4.5	864	39.9	216	10.0	2 164
Prairie	474	10.5	111	2.5	1 000	22.2	398	8.9	4 496
Boreal Plain	24	8.1	5	1.7	138	46.5	37	12.5	297
Montane Cordillera	95	10.2	25	2.7	424	45.3	108	11.6	935

Manufacturing Establishments by Ecozone and Impact Class, 1986

Province / Ecozone	Impact Class: High contaminant number[1]	High contaminant percent[2]	High energy number	High energy percent	High resource number	High resource percent	High water number	High water percent	Total establishments number
Pacific Maritime	427	12.8	74	2.2	854	25.6	216	6.5	3 339
Boreal Cordillera	1	6.3	0	0.0	1	6.3	0	0.0	16
Tundra Cordillera	-	-	-	-	-	-	-	-	-
Taiga Plain	0	0.0	0	0.0	3	27.3	0	0.0	11
Taiga Shield	2	10.5	0	0.0	5	26.3	2	10.5	19
Hudson Bay Plain	3	11.1	3	11.1	12	44.4	4	14.8	27
Southern Arctic	0	0.0	0	0.0	0	0.0	0	0.0	1
Northern Arctic	0	0.0	0	0.0	0	0.0	0	0.0	3
Arctic Cordillera	-	-	-	-	-	-	-	-	-

Source:
Statistics Canada. Environment and Wealth Accounts Division. Industry Division.
Notes:
[1] Total number of establishments in high impact category. See the text for a definition of these categories.
[2] Percentage of total establishments of ecozone in this category.

3.1.2 Transportation and Utilities

In 1989, there were over 12.7 million passenger cars in Canada. This amounts to one for every 2 persons or 1.3 cars per household. The transportation sector generates 66 percent of the carbon monoxide, 62 percent of the nitrogen oxides, and 42 percent of the hydrocarbons polluting the air. Power plants are responsible for 20 percent of sulphur dioxide emissions and 18 percent of nitrogen oxide emissions.

❑❑❑

Transportation, power generation and the movement of oil and gas affect the environment through construction (roads, airports and pipelines) and the generation of pollutants. These activities are also major consumers of natural resources such as oil and gas. Iron and other metals, asphalt, sand and gravel are consumed in the construction of equipment, roads and pipelines.

Transportation

In a country as large as Canada, the transportation of people and goods is an essential component of the development, welfare and integrity of the nation. Many of the most significant events in Canadian history have been connected with opening new territories and linking communities with roads, canals and railroads. Today, because of the vast distances between population centres, transportation is still an important element of daily life in all parts of the country.

The consumption of natural resources, disruption of land and the generation of wastes associated with road, rail, water and air transportation have focused attention on this sector as one with a high potential for improvement.

In 1990, the transportation sector constituted 4.4 percent of GDP. This figure represents more than 22 billion (constant 1986) dollars (Table 3.1.2.1). The transportation sector employs close to 5 percent of the labour force. This accounts for over 470 thousand jobs. Another 200 thousand jobs are in the manufacture and servicing of transportation equipment (Table 3.1.2.2).

In 1989, transportation consumed 21 percent of Canada's total energy. Most of this energy was derived from the combustion of fossil fuels. In the combustion of fossil fuels, a variety of wastes are emitted. The transportation sector alone produces 66 percent of all carbon monoxide emissions, 62 percent of nitrogen oxides, and 6 percent of all particulates. Another source of potential environmental problems emanating from transportation is the possibility of spills of contaminants from trains, trucks and ships.

Table: 3.1.2.1
Transportation Economic Indicators

Year	Total GDP	Value of transportation and storage sector	Transportation and storage sector as a proportion of total GDP
	million 1986 dollars		percent
1961	121 795	6 930	5.69
1971	209 077	12 619	6.04
1981	320 322	17 076	5.33
1986	368 535	20 254	5.50
1990	419 320	22 485	5.36

Source:
Statistics Canada. System of National Accounts.

Table: 3.1.2.2
Employment in Transportation, 1983-1990

Year	Total employment	Transportation	Employment in transportation equipment
	thousands		
1983	8 582	441	163
1984	8 654	448	171
1985	8 995	452	181
1986	9 178	451	187
1987	9 946	455	200
1988	10 107	461	213
1989	10 339	471	220
1990	10 188	473	209

Source:
Statistics Canada. *Employment, Earnings and Hours*. Catalogue 72-002.

The construction of roads, rail lines and airports has a direct impact by radically changing the land use. The indirect effects of this construction are much greater than the initial restructuring. Improved accessibility stimulates a wide variety of human activities such as mining, forestry, construction of settlements, recreation. In the last century, the economic development of western Canada was stimulated by the completion of the Trans-Canada Railway. In recent years, this development has been directed north in search of hydro-electric power, petroleum, natural gas, timber, and minerals.

The automobile has come to be regarded as necessary to maintaining one's lifestyle. In 1986, over 84 percent of households reported expenditures on the operation of private motor vehicles. The average expenditure for all households reporting was $4,982. In contrast, only 63.6 percent reported expenditures on local and commuter transportation (including

19. Table 3.2.2.5 in the **Consumption** section.

taxis), with an average of $557.[19] The passenger car now accounts for four-fifths of all intercity passenger travel.[20]

Transportation Activities

One significant trend in transportation is the increasing energy efficiency of road transportation. Most modes of transportation showed an increase in the number of vehicles and in the number of miles travelled. However, because of increases in fuel efficiency, the amount of fuel consumed was nearly constant between 1980 and 1988 for passenger cars and lower for rail and trucking.

Fuel Consumption. One positive outcome of the increases in fuel prices has been that this has provided an incentive to develop more fuel-efficient technology. In 1980, the average car required 16.5 litres of gasoline to travel 100 kilometres. By 1988, automobiles averaged 12 litres to travel the same distance. The fuel consumption ratios for most modes of transport have declined within the past ten years. These figures are derived from the Statistics Canada Fuel Consumption Survey, conducted annually between 1979 and 1989.

Passenger cars accounted for most of the fuel consumption in transportation. In 1988, over 27 billion litres of fuel were consumed by personal use passenger cars. This accounts for more than half of all energy consumed by transportation (Table 3.1.2.3). Statistics on the sale of gasoline for motive purposes are presented in Table 3.1.2.6.

Urban transport can be seen adopting cleaner fuels such as natural gas and propane (Table 3.1.2.11).

Table: 3.1.2.3
Fuel and Energy Use in Transportation, 1988

Mode of transport	Fuel consumed	Energy consumed
	billion litres	petajoules
Private use passenger cars	27.4	950.8
Trucking	4.9	189.6
Air	3.8	136.4
Rail	2.3	89.0
Marine	1.3	54.2
Bus and urban transit[1]	0.7	27.1
Others	6.3	392.3
Total	**46.7**	**1 839.4**

Source:
Statistics Canada. Environment and Wealth Accounts Division.
Note:
[1] This figure does not include small amounts of natural gas and electric power consumed. See the detailed tables for more information.

Personal Use Passenger Cars. Total distance driven by personal use passenger cars increased by 22 percent between 1980 and 1988. During the same period, the total amount of fuel consumed dropped by 11 percent. Although the total distance per vehicle increased by 6 percent, the average amount of fuel consumed per vehicle decreased by 22 percent (Table 3.1.2.5 and Figures 3.1.2.1 through 3.1.2.4).

Passenger Bus and Urban Transit. Fare passenger-trips[21] on urban transit increased from 1.3 billion in 1980 to over 1.5 billion in 1988. This growth lags both the growth of the economy and the growth of the population. During the same period, inter-city bus passenger-trips decreased from 33 million to 18 million (Table 3.1.2.11).

Inter-city Rail. Table 3.1.2.7 provides details on freight and passengers carried and fuel consumption in the rail industry. Note that this does not include urban transit companies. In 1987, freight carried amounted to 267 billion tonne-kilometres[22], total distance travelled amounted to 7.9 billion car-kilometres.[23] Also in 1987, 23.7 million passenger-trips were taken for a total distance of 2.7 million passenger-kilometres.

The total amount of fuel consumed in 1987 was 2.3 billion litres of fuel, primarily diesel fuel. Between 1986 and 1987 the fuel consumption ratio improved from 30.4 litres per 100 car-kilometres to 28.6.

Trucking. The movement of freight by the trucking industry has steadily increased over the past decade. In 1988, inter-city for-hire trucking establishments moved an estimated 57.9 billion tonne-kilometres of freight (Table 3.1.2.4). These figures cover only trucking companies (for-hire trucking) and do not include the activities of trucks operated by other establishments (private trucking) or owner-operators.

20. Statistics Canada. *Canada Year Book 1990.* Catalogue 11-402E.

21. A *passenger-trip* is one trip for one passenger.

22. A *tonne-kilometre* is one tonne of goods carried one kilometre.

23. A *car-kilometre* is one rail car travelling for one kilometre.

Table: 3.1.2.4
Intercity Freight Movement by For-hire Truckers

Year	Freight carried	annual percent change
	million tonne-kilometres	
1978	36 399	
1979	42 388	16.5
1980	41 734	- 1.5
1981	39 779	- 4.7
1982	37 910	- 4.7
1983	41 920	10.6
1984	43 624	4.1
1985	43 723	0.2
1986	48 930	11.9
1987	57 320	17.1
1988	57 888	1.0

Source:
Statistics Canada. *For-hire Trucking Survey.* Catalogue 53-224.
Statistics Canada. *Trucking in Canada.* Catalogue 53-222.

Gains in fuel efficiency and adoption of alternative fuels can also be seen in the trucking industry. For-hire trucking establishments showed a decrease from 58 litres per 100 kilometres in 1980 to 52 litres per 100 kilometres in 1988.

The figures shown in Table 3.1.2.9 represent adjustments to the standard values reported for the for-hire establishments. The under-reporting of fuel consumed by owner-operators has been estimated to be over 1.7 billion litres in 1988. The adjustments were made by estimating the value of fuel consumed by owner-operators. These independent truckers are not covered by the Statistics Canada For-Hire Trucking Survey[24].

The amount of propane and natural gas consumed in the trucking industry has increased from 72.8 million litres to 82.9. This still represents a small proportion of total fuel consumption.

Air Transport. In 1989, Canadian Level I air carriers flew a total of 723 thousand hours carrying passengers on 22.4 million trips and 443 million kilograms of goods. This activity consumed 3.8 billion litres of turbo fuel or 5.3 thousand litres of fuel per hour flown (Table 3.1.2.15, Figure 3.1.2.5). This represents a slight decrease from 1981.

Airplanes generate air pollutants in the populated areas near airports. The World Health Organization[25] estimates that each takeoff and landing of a wide-body jet generates 2 kg. of particulates, 3 kg. of SO_2, 30 kg of nitrogen oxides, 19 kg. of hydrocarbons and 74 kg. of carbon monoxide. During the period April to June 1989, a total of over 527 thousand aircraft movements (departures plus arrivals for major scheduled services) were recorded at Canadian airports. This represents an increase of 58 thousand movements (12 percent) over the corresponding period for the previous year. Half the aircraft movements were accounted for by the top 10 airports (Table 3.1.2.14).

Marine Transport. The amount of cargo handled at Canadian ports decreased by 7 percent between 1988 and 1989. This indicates the general decline in the marine shipping industry evident in both international and domestic shipping. Much of this decline has been attributed to the poor wheat harvest in 1988[26]. In 1989, almost 58 thousand vessels entered Canadian ports. About half of these vessels were engaged in domestic shipping. Five ports (Vancouver, Sept-Îles/Pointe-Noire, Port-Cartier, Montréal/Contrecoeur, and Halifax) accounted for 40 percent of all shipping activity.

Table 3.1.2.16 provides a summary of vessels, fuel consumption and passengers and vehicles carried by Canadian-domiciled carriers.

Transportation Infrastructure

Vehicles. In 1989, 16.7 million road vehicles were registered. Almost 74 percent of vehicles were passenger automobiles, another 23 percent were trucks and truck trailers. The remaining 3 percent were buses, motorcycles, mopeds and other road vehicles (Table 3.1.2.12, Figure 3.1.2.5). For some provinces, this category included ambulances, hearses and fire trucks.

Between 1980 and 1989, the number of passenger automobile registrations increased from 10.3 million to 12.7 million. This represents an annual average increase of 2.5 percent per year. The statistics on vehicle registrations were obtained from the 12 provincial and territorial governments, each of which has its own distinct registration system and definitions. For these reasons, inter-provincial comparisons are difficult and the categories used in the tables often contain variations.

The average distance travelled per vehicle has increased for most modes of transport. Personal use passenger cars, in 1988, travelled on average 17,224 kilometres, an increase of over 900 kilometres from 1980. Figures for the fuel consumption and distance travelled for personal-use passenger cars are derived from the Statistics Canada Fuel Consumption Survey. The number of cars estimated from this survey differs from the number derived from motor vehicle registrations (Table 3.1.2.5) because of differences in definitions and methods.

Roads and Highways. The total length of roads and highways is difficult to measure because of changes in jurisdiction. For example, if a road is transferred from provincial to municipal responsibility, this would appear as a decrease in the total length of federal, provincial and territorial

24. Davies, G. R. 1991. *Owner operators in inter-city for-hire trucking, 1976-1988.* [in] Canadian Transportation Research Forum. Québec City. May 28-31, 1991.

25. World Health Organization. 1982. *Rapid Assessment of Air, Water, and Land Pollution.* WHO Offset Publication NO. 62. Geneva.

26. Statistics Canada. *Shipping in Canada.* Catalogue 54-205.

roads. In 1988/89, Canada's roadways totalled over 879 thousand 2-lane equivalent kilometres (Table 3.1.2.8).

Airports. The number of total active airports decreased between 1980 and 1990 because of declines in smaller (less than 914 metres) airports (Table 3.1.2.13). Between 1980 and 1990, 226 small airports were either abandoned or upgraded to larger airports. The numbers in all other classes increased, including an addition of 8 large airports (more than 2134 metres).

Rail Track. Although the amount of freight carried by rail is increasing, length of track operated by rail companies has decreased by more than 4,500 kilometres since 1982. In 1987, the total length of track operated reached 94,184 kilometres (Table 3.1.2.10).

Many lines have been found to be unprofitable and are being abandoned. As rail lines are abandoned in rural areas, many of these rights of way revert to a more natural state and promote the re-establishment of habitats and corridors for the movement of wildlife. Note that in 1982, a change in coverage to include lines operated under trackage rights, makes data incomparable to the period before that year.

The number of rail vehicles (locomotives, freight cars and passenger cars) has decreased substantially since the early 1980s This reflects an increase in efficiency in terms of larger freight cars, more powerful locomotives and more effective routing.

Utilities

The utilities discussed in this section comprise the generation of electrical power and the movement of commodities by pipeline or transmission lines.

Power Generation

To satisfy Canada's demand for energy, hundreds of power generation plants, dams and hydroelectric stations have been constructed. Thermal generating plants burn fossil fuels and release contaminants into the atmosphere. The emission of substances such as sulphur dioxide from electric generation stations is a major source of environmental stress. Hydro plants dam up rivers and in the process, change settlements, wildlife habitats and hydrologic cycles.

In 1989, about 57 percent of Canada's electrical generation capacity was in hydro facilities. Another 30 percent was in thermal power generation equipment. The remaining 12 percent of Canada's power generating capacity was in nuclear power generation facilities (Table 3.1.2.17)

For thermal power generation, coal burning facilities dominated, comprising 61 percent of all facilities. Another 23 percent burned oil, 13 percent used natural gas and the remaining 3 percent was derived from other fuels (Table 3.1.2.18, Figure 3.1.2.7).

The total generation capacity of all power generating plants in 1989 was 102 gigawatts. This represented a small increase (less than 1 percent) over the previous year. These figures represent generation capacity and not production or consumption of energy. Plants do not always run at full capacity and a large portion of the power produced is sold in the United States.

Pipelines

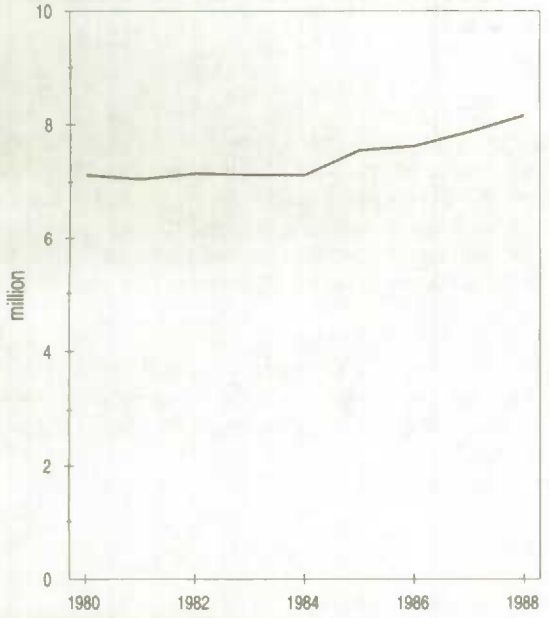
Canada's resources are rarely located near the consumers. Large networks of pipelines and transmission lines have been built to facilitate the movement of water, gas and electricity. Much of the pipeline network travels through rural and unpopulated areas. In addition to the disturbance caused during construction, pipelines impede the movement of wildlife.

In total, there are over 34 thousand kilometres of oil pipeline and 226 thousand kilometres of natural gas pipeline across Canada (Tables 3.1.2.19 through 3.1.2.21, Figure 3.1.2.8)

Figure: 3.1.2.1

Personal Use Passenger Cars Operated,

1980-1988

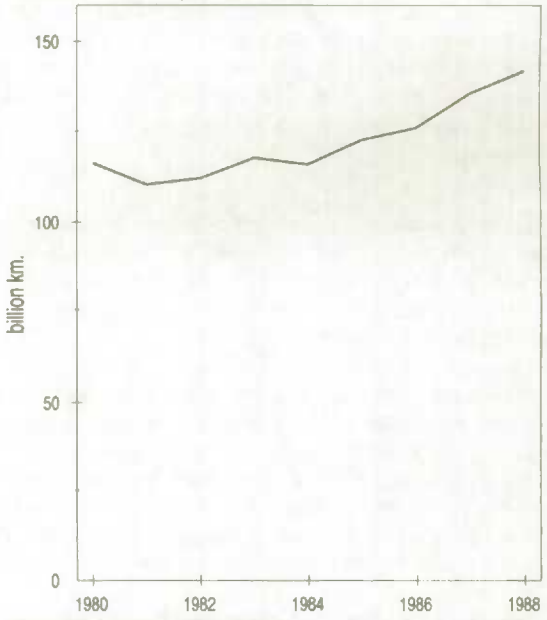


Source: Statistics Canada. 1990. Fuel Consumption Survey. Catalogue 53-226.

Figure: 3.1.2.2

Total Distance Driven,

Personal Use Passenger Cars, 1980-1988

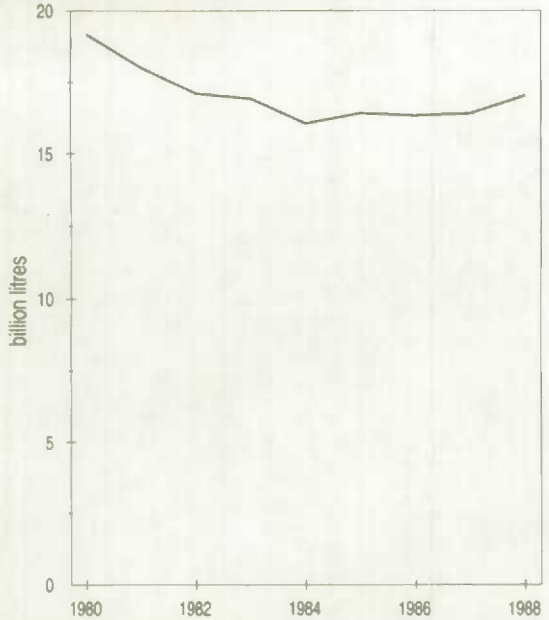


Source: Statistics Canada. 1990. Fuel Consumption Survey. Catalogue 53-226.

Figure: 3.1.2.3

Total Fuel Consumed,

Personal Use Passenger Cars, 1980-1988

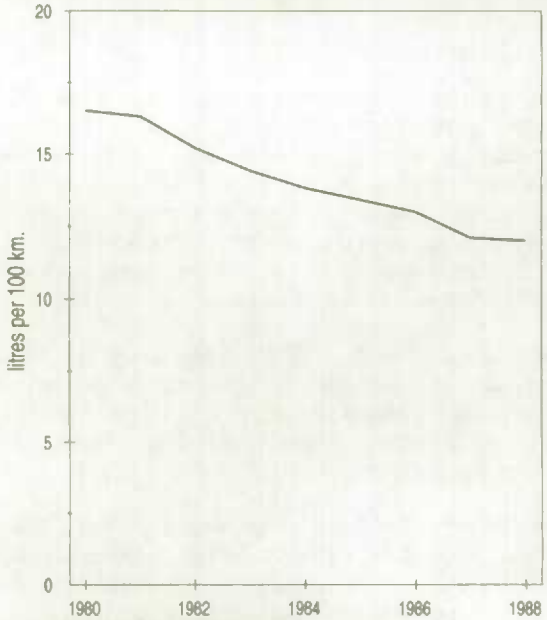


Source: Statistics Canada. 1990. Fuel Consumption Survey. Catalogue 53-226.

Figure: 3.1.2.4

Fuel Consumption Ratio,

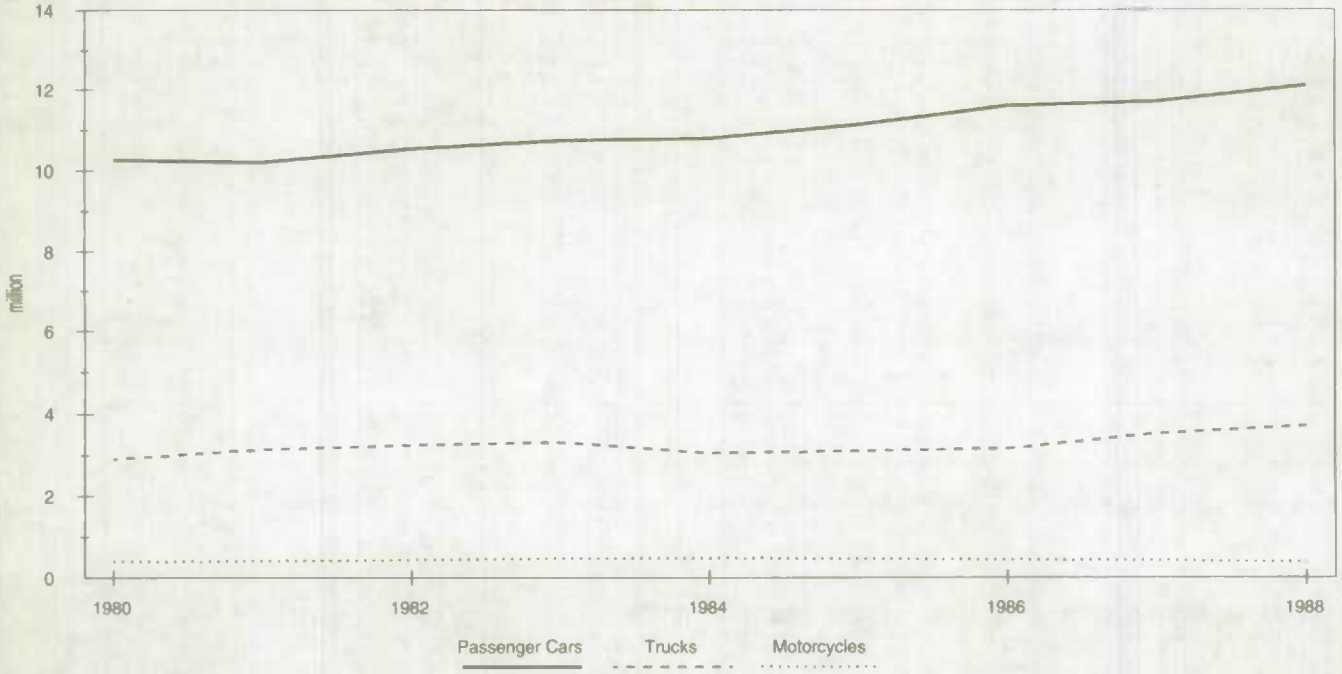
Personal Use Passenger Cars, 1980-1988



Source: Statistics Canada. 1990. Fuel Consumption Survey. Catalogue 53-226.

Figure: 3.1.2.5

Road Motor Vehicle Registrations, 1980-1988

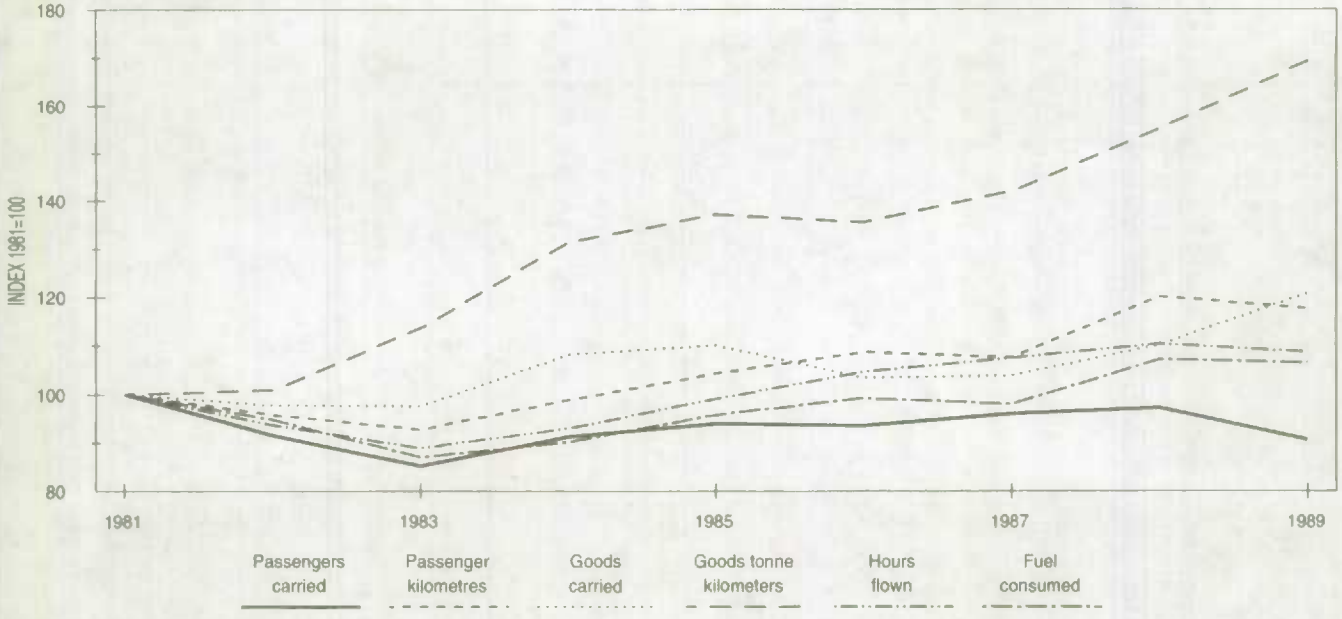


Source: Statistics Canada. 1990. Road Motor Vehicles: Registrations 1988. Cat. 53-219.

Figure: 3.1.2.6

Airline Annual Statistics, 1981-1989

Level I Air Carriers



Source: Statistics Canada. Aviation. Catalogue 51-004.

Note: See Table 3.1.2.15 for definitions.

Table: 3.1.2.5

Personal Use Passenger Cars and Fuel Consumption Estimates, 1980-88

Year	Estimated number of cars operated	Distance travelled	Total fuel consumed	Distance travelled per vehicle	Fuel consumption per vehicle	Fuel consumption ratio
	thousands	million kilometres	million litres	kilometres	litres	litres per 100 kilometres
1980	7 128	116 350	19 160	16 322	2 688	16.5
1981	7 055	110 515	17 998	15 664	2 551	16.3
1982	7 158	112 275	17 093	15 686	2 388	15.2
1983	7 134	117 812	16 910	16 515	2 371	14.4
1984	7 128	116 081	16 049	16 284	2 251	13.8
1985	7 553	122 676	16 408	16 242	2 172	13.4
1986	7 625	125 981	16 326	16 522	2 141	13.0
1987	7 867	135 657	16 399	17 244	2 085	12.1
1988	8 157	141 790	17 020	17 383	2 087	12.0
Average annual percent change 1980-1988	1.70	2.50	- 1.47	0.79	- 3.12	- 3.90

Source:
Statistics Canada. 1990. *Fuel Consumption Survey - Passenger Cars.* Catalogue 53-226.
Notes:
These data are based on a survey of between 1800 (in 1985) and 333 (in 1988) detailed monthly fuel-consumption diaries. See Table 3.1.2.12 for information on motor vehicle registrations.

Table: 3.1.2.6

Gross Sales of Gasoline for Motive Purposes, 1985-1989

Province	1985	1986	1987	1988	1989	Per capita 1989
			million litres			litres
Newfoundland	552	550	558	587	604	1 052
Prince Edward Island	169	171	171	180	181	1 386
Nova Scotia	1 066	1 069	1 085	1 119	1 128	1 263
New Brunswick	937	935	969	1 000	976	1 353
Quebec	6 688	6 666	6 755	6 997	7 181	1 071
Ontario	11 837	12 007	12 245	12 685	12 971	1 362
Manitoba	1 471	1 466	1 464	1 492	1 492	1 361
Saskatchewan	1 863	1 858	1 816	1 802	1 684	1 649
Alberta	4 312	4 312	4 362	4 306	4 285	1 767
British Columbia	3 653	3 705	3 678	3 750	3 755	1 246
Yukon	56	57	61	65	65	2 570
Northwest Territories	50	34	52	43	54	1 030
Canada	**32 654**	**32 830**	**33 215**	**34 025**	**34 375**	**1 317**

Source:
Statistics Canada. 1990. *Road Motor Vehicles Fuel Sales* Catalogue 53-218.

Table: 3.1.2.7

Rail in Canada, Traffic Statistics, 1961-1988

Year	Freight		Passenger			Total	Fuel[1]	Fuel consumption
	Tonne-km	Car-km	Passengers	Passenger-km	Car-km	Car-km	consumption	ratio
	millions		thousands	millions			million litres	litres/100 car km
1961	96 108	5 233	18 784	3 155	502	5 735	1 561	27.2
1962	99 186	5 264	19 258	3 249	478	5 742	1 578	27.5
1963	110 660	5 556	20 636	3 331	460	6 016	1 655	27.5
1964	124 146	6 099	22 915	4 315	497	6 596	1 805	27.4
1965	127 296	6 166	24 616	4 287	493	6 659	1 847	27.7
1966	138 840	6 518	23 195	4 164	445	6 963	1 878	27.0
1967	137 384	6 258	24 638	5 046	485	6 743	1 952	28.9
1968	138 844	6 180	19 953	4 110	390	6 570	1 904	29.0
1969	140 830	6 285	18 864	3 759	350	6 635	1 904	28.7
1970	160 750	6 852	23 849	3 657	309	7 161	2 002	28.0
1971	173 094	7 177	24 119	3 518	272	7 449	2 122	28.5
1972	180 536	7 442	23 012	3 288	246	7 688	2 242	29.2
1973	190 906	7 500	19 822	2 573	207	7 707	2 268	29.4
1974	202 433	7 858	24 134	3 023	237	8 095	2 433	30.1
1975	197 216	7 542	23 571	2 930	225	7 767	2 334	30.1
1976	202 223	7 505	23 636	2 942	216	7 721	2 336	30.3
1977	212 416	7 579	23 862	2 966	210	7 789	2 416	31.0
1978	215 352	7 620	23 933	3 974	197	7 817	2 433	31.1
1979	233 829	7 837	23 708	3 175	195	8 032	2 517	31.3
1980	234 972	8 056	22 964	3 280	189	8 245	2 484	30.1
1981	234 374	8 004	24 331	3 278	186	8 190	2 398	29.3
1982	219 418	6 879	21 346	2 639	252	7 131	2 108	29.6
1983	225 380	7 346	21 199	2 932	233	7 579	2 142	28.3
1984	253 971	7 912	21 864	2 915	234	8 146	2 268	27.8
1985	242 121	7 479	22 937	3 040	248	7 727	2 284	29.3
1986	244 784	7 413	22 991	2 831	241	7 654	2 326	30.4
1987	267 784	7 893	23 701	2 709	221	8 114	2 317	28.6
1988	271 045	7 757	26 708	2 989	235	7 992	2 243	28.1

Source:
Statistics Canada. *Rail in Canada*. Catalogue 52-216.
Note:
[1] Primarily (97 to 100 percent) diesel fuel.

Table: 3.1.2.8

Highway System Length, 1985-1989

Jurisdiction/ Year	Canada	Nfld	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta	B.C.	Yukon	N.W.T.
	kilometres (2-lane equivalent)[1]												
Federal[2]													
1985	**13 837**												
1987/88	**14 177**												
1988/89	**14 735**												
Provincial/Territorial													
1985	**267 979**	8 748	4 905	23 281	17 400	59 680	24 341	19 840	23 912	37 002	41 829	4 727	2 314
1987/88	**277 286**	8 401	4 916	23 405	17 450	59 895	24 292	20 318	25 973	38 337	47 182	4 803	2 314
1988/89	**277 268**	8 401	4 920	23 458	17 920	60 644	24 391	20 426	26 208	37 847	45 883	4 960	2 210
Municipal													
1985	**579 652**	3 483	184	2 243	2 700	48 000	141 295	64 500	165 600	132 349	18 697	261	340
1987/88	**583 091**	3 483	322	2 275	2 700	48 000	141 577	64 500	168 765	131 128	19 709	277	355
1988/89	**587 527**	3 483	322	2 282	2 700	48 000	144 170	64 500	168 117	133 355	19 965	278	355
Total													
1985	**861 468**	12 231	5 089	25 524	20 100	107 680	165 636	84 340	189 512	169 351	60 526	4 988	2 654
1987/88	**874 554**	11 884	5 238	25 680	20 150	107 895	165 869	84 818	194 738	169 465	66 891	5 080	2 669
1988/89	**879 530**	11 884	5 242	25 740	20 620	108 644	168 561	84 926	194 325	171 202	65 848	5 238	2 565

Source:
Roads and Transportation Association of Canada. 1990. *Canada's Roadway Infrastructure: Selected Facts and Figures*. Ottawa, Canada.
Notes:
[1] One kilometre of 4-lane highway would be counted as two kilometres of 2-lane equivalent.
[2] Includes roads under Canadian Parks Service, Department of Indian and Northern Development, the National Capital Commission and Public Works Canada.

Table: 3.1.2.9

For-hire and Private Trucking Fuel Consumption, 1980-1988

Establishment type	1980	1981	1982	1983	1984	1985	1986	1987	1988
For-hire trucking[1]									
Number of establishments	4 722	4 541	4 947	4 583	5 221	6 270	6 211	6 729	5 867
Vehicles (owned and leased) operated by the firms	61 471	57 852	54 280	52 187	53 670	57 987	56 377	57 337	55 034
Total distance travelled (million km.)	5 173.2	4 995.8	4 598.9	4 621.5	5 319.2	5 645.8	5 936.6	6 558.8	6 847.3
Distance travelled by firm vehicles (million km.)	3 509.7	3 416.1	3 056.8	3 025.6	3 371.7	3 740.0	3 718.8	3 785.1	3 921.3
Estimated distance travelled by owner-operators (million km.)	1 663.5	1 579.7	1 542.2	1 596.0	1 947.5	1 905.8	2 217.8	2 773.7	2 926.1
Average kilometres per vehicle	84 156.1	86 355.7	84 726.2	88 557.4	99 108.7	97 362.6	105 301.8	114 389.9	124 420.0
Fuel purchased by firms (million litres)	2 019.7	1 883.7	1 715.9	1 622.6	1 822.1	2 029.4	1 959.6	1 975.2	2 045.3
Gasoline purchased by firms (million litres)	447.8	330.6	218.3	177.5	172.7	162.2	129.0	104.5	85.1
Diesel purchased by firms (million litres)	1 572.0	1 553.2	1 469.2	1 431.5	1 632.0	1 845.4	1 812.5	1 854.0	1 943.8
Propane purchased by firms (million litres)	..	..	28.4	13.6	17.4	21.8	18.1	16.7	16.4
Natural gas purchased by firms (million litres)	..	..	..	..	..	..	..	..	..
Estimated fuel used by owner-operators (million litres)	957.3	871.1	865.7	855.9	1 052.4	1 034.2	1 168.6	1 447.4	1 526.2
Estimated total fuel used (million litres)	2 977.0	2 754.9	2 581.5	2 478.5	2 874.5	3 063.6	3 128.2	3 422.7	3 571.5
Fuel consumption ratio (l/100 km.)	57.55	55.14	56.13	53.63	54.04	54.26	52.69	52.18	52.16
Private Trucking[2]									
Number of establishments	..	..	5 524	4 672	2 954	3 183	2 676	2 320	2 487
Vehicles (owned and leased) operated by the firms	..	..	91 843	103 391	113 729	113 541	134 979	99 781	104 581
Total distance travelled (million km.)	..	..	4 476.9	4 928.4	3 692.1	3 891.0	4 155.9	3 366.4	3 415.8
Distance travelled by firm vehicles (million km.)	..	..	4 285.3	4 717.2	3 458.2	3 589.5	3 905.6	3 097.3	3 142.9
Distance travelled by owner-operators (million km.)	..	..	191.6	211.2	233.9	301.5	250.3	269.1	272.9
Average kilometres per vehicle	..	..	48 745.0	47 667.6	32 464.3	34 270.0	30 789.0	33 737.4	32 662.0
Fuel purchased by firms (million litres)	..	..	1 666.5	1 726.0	1 410.2	1 438.4	1 486.4	1 261.9	1 244.7
Gasoline purchased by firms (million litres)	..	..	765.4	753.5	487.5	430.6	495.0	328.1	326.1
Diesel purchased by firms (million litres)	..	..	856.6	915.7	860.4	936.8	903.5	855.7	852.1
Propane purchased by firms (million litres)	..	..	44.5	56.9	62.3	66.4	78.3	70.3	61.4
Natural gas purchased by firms (million litres)	..	..	-	-	-	4.6	9.5	7.8	5.1
Estimated fuel purchased by owner-operators (million litres)	..	..	103.5	118.3	131.0	159.8	121.0	125.7	128.1
Estimated total fuel purchased (million litres)	..	..	1 770.0	1 844.3	1 541.2	1 598.2	1 607.4	1 387.6	1 372.7
Fuel consumption ratio (l/100 km.)	..	..	39.54	37.42	41.74	41.07	38.88	41.22	40.19
Combined operations									
Number of establishments	..	..	10 471.0	9 255.0	8 175.0	9 453.0	8 887.0	9 049.0	8 354.0
Vehicles (owned and leased) operated by the firms	..	..	146 123.0	155 578.0	167 399.0	171 528.0	191 356.0	157 118.0	159 615.0
Total distance travelled (million km.)	..	..	9 075.8	9 549.9	9 011.3	9 536.8	10 092.5	9 925.1	10 263.2
Distance travelled by firm vehicles (million km.)	..	..	7 342.0	7 742.8	6 829.9	7 329.5	7 624.4	6 882.4	7 064.2
Estimated distance travelled by owner-operators (million km.)	..	..	1 733.8	1 807.2	2 181.4	2 207.3	2 488.1	3 042.7	3 199.0
Average kilometres per vehicle	..	..	62 110.8	61 383.6	53 831.3	55 599.1	52 741.9	63 169.9	84 299.5
Fuel purchased by firms (million litres)	..	..	3 382.3	3 348.6	3 232.3	3 467.8	3 446.0	3 237.1	3 290.0
Gasoline purchased by firms (million litres)	..	..	983.7	931.0	660.2	592.9	624.0	432.6	411.1
Diesel purchased by firms (million litres)	..	..	2 325.8	2 347.1	2 492.4	2 782.2	2 716.0	2 709.7	2 795.9
Propane purchased by firms (million litres)	..	..	72.8	70.5	79.7	88.2	96.4	87.0	77.8
Natural gas purchased by firms (million litres)	..	..	0.0	0.0	0.0	4.6	9.5	7.8	5.1
Estimated fuel purchased by owner-operators (million litres)	..	..	969.1	974.2	1 183.4	1 194.0	1 289.6	1 573.1	1 654.2
Estimated total fuel purchased (million litres)	..	..	4 351.5	4 322.8	4 415.8	4 661.8	4 735.6	4 810.2	4 944.2
Fuel consumption ratio (l/100 km.)	..	..	47.95	45.26	49.00	48.88	46.92	48.46	48.17

Sources:

Statistics Canada. *Motor Carriers—Freight and Household Goods Movers*. Catalogue 53-222.

Statistics Canada. *Trucking in Canada*. Catalogue 53-222.

Statistics Canada. *Road Transport Service Bulletin*. Catalogue 53-006.

Davies, G. R., 1991. *Owner operators in inter-city for-hire trucking, 1978-1988*. [in] Canadian Transportation Research Forum. Québec City. May 28-31, 1991.

Notes:

[1] "For-hire" trucking refers to trucking companies.

[2] "Private" trucking refers to non-trucking companies which operate trucks.

Table: 3.1.2.10

Rail In Canada, Infrastructure, Vehicles and Track Length, 1957-1988

Year	Equipment			Length of track operated
	Locomotives	Fraight cars	Passenger cars	
	units			kilometres
1957	4 821	197 907	5 942	95 087
1958	4 823	196 893	5 733	95 444
1959	4 720	194 512	5 456	95 565
1960	3 752	191 553	5 119	95 242
1961	3 547	186 387	4 737	94 580
1962	3 497	185 169	4 378	94 543
1963	3 385	181 719	4 172	94 144
1964	3 304	179 854	3 985	93 713
1965	3 323	182 090	3 638	93 647
1966	3 329	185 964	3 660	93 134
1967	3 311	188 770	3 444	93 824
1968	3 294	188 254	2 999	94 381
1969	3 316	188 269	2 942	95 114
1970	3 417	188 737	2 801	95 943
1971	3 463	187 306	2 516	96 073
1972	3 812	186 541	2 383	96 600
1973	3 762	186 653	2 175	96 936
1974	3 884	190 892	2 056	96 939
1975	3 977	193 197	1 936	96 612
1976	4 008	193 401	1 855	96 299
1977	4 035	187 183	1 753	94 987
1978	4 071	182 138	1 544	94 085
1979	4 082	180 089	1 596	94 051
1980	4 167	179 139	1 580	93 361
1981	4 154	179 105	1 405	92 413
1982[1]	3 900	155 897	1 304	98 927
1983	3 783	149 432	1 337	99 444
1984	3 699	142 407	1 326	97 387
1985	3 509	130 185	1 286	95 670
1986	3 897	129 509	1 295	93 544
1987	3 855	121 679	926	94 184
1988	3 836	134 156	1 233	91 365

Source:
Statistics Canada, *Railway Transport. Part 1 (Comparative Summary Statistics)*. Catalogue 52-207.
Statistics Canada, *Railway Transport. Part 3 (Equipment, Track and Fuel Statistics)*. Catalogue 52-207.
Statistics Canada, 1988. *Rail in Canada*. Catalogue 52-218.
Notes:
[1]The figuras for total length of rail operated for 1982-1987 include lines operated under lease, contract, trackage rights or jointly owned. The figures for 1981 and before do not include lines operated under trackage rights.

Table: 3.1.2.11

Passenger Bus and Urban Transit, 1980-1988

	1980	1981	1982	1983	1984	1985	1986	1987	1988[4]
Inter-city bus:									
Establishments	34	31	32	33	38	48	34	35	22
Vehicles	1 805	1 704	1 683	1 526	1 558	1 538	1 417	1 429	1 308
Distance run ('000 km.)	203 119	185 014	197 838	194 388	182 773	173 613	174 717	170 953	157 052
Fare passengers carried ('000)	33 282	29 585	31 187	32 032	27 834	26 943	22 871	22 686	18 262
Fuel consumed:									
Gasoline ('000 litres)	1 848	1 313	1 341	1 253	1 272	1 457	1 398	956	670
Diesel ('000 litres)	87 615	81 445	85 665	82 279	78 929	79 895	76 775	75 283	73 190
Others ('000 litres)	-	-	9	28	-	-	-	1 780	-
Fuel cost ($'000)	15 729	19 478	22 576	22 940	29 787	31 965	29 582	27 753	26 868
Kilometres per vehicle	112 531	108 576	117 551	127 384	117 312	112 882	123 300	119 631	120 070
Litres[3] per 100 km	44.0	44.7	44.0	43.0	43.9	46.9	44.7	45.6	47
Urban Transit:									
Establishments	69	69	73	77	73	84	70	77	73
Vehicles	12 670	12 856	13 318	13 233	13 212	13 496	13 032	13 481	13 379
Distance run ('000 km.)	656 245	698 858	712 436	565 588	691 373	725 991	757 748	695 785	749 934
Fare passengers carried ('000)	1 307 199	1 368 870	1 333 121	1 382 908	1 413 676	1 448 275	1 522 160	1 469 245	1 514 979
Fuel consumed:									
Gasoline ('000 litres)	6 873	5 846	5 408	3 689	3 607	5 933	4 069	2 973	2 897
Diesel ('000 litres)	236 058	301 871	252 917	201 241	301 628	315 303	312 086	307 887	360 764
Propane ('000 litres)	..	49	253	327	580	632	976	978	395
Natural gas ('000 m^3)	..	..	..	..	..	1 697	1 854	1 312	1 475
Electric power ('000 kWh)	636 957	644 349	677 724	660 495	653 588	569 848	825 710	574 040	577 175
Fuel cost ($'000)	71 336	99 287	107 401	113 508	139 294	136 457	113 487	113 933	12 130
Kilometres per vehicle	51 795	54 360	53 494	42 741	52 329	53 793	58 145	51 612	56 053
Litres[3] per 100 km	...	...	...	...	...	...	...	...	...
Other passenger bus:									
Establishments	717	765	844	904	779	986	856	1 032	556
Vehicles	21 761	21 646	22 773	22 598	21 679	23 562	24 210	25 892	24 345
Distance run ('000 km.)	421 033	471 986	478 011	470 888	483 437	522 767	504 128	553 945	541 509
Fare passengers carried ('000)[1]	...	...	...	...	...	...	...	...	
Fuel consumed:									
Gasoline ('000 litres)	183 900	191 186	187 705	174 293	173 583	175 488	154 299	144 930	121 204
Diesel ('000 litres)	21 173	37 122	39 842	36 600	40 361	56 228	84 034	85 312	95 412
Propane ('000 litres)	..	..	..	6 556	9 460	19 853	26 759	33 152	35 199
Fuel cost ($'000)	50 617	68 523	90 899	95 863	96 621	110 094	109 393	107 940	102 239
Kilometres per vehicle	19 348	21 805	20 990	20 838	22 300	22 187	20 823	21 394	22 243
Litres[3] per 100 km	48.7	48.4	47.6	46.2	46.2	48.1	52.6	47.5	47
Total motor carrier industry:									
Establishments	820	865	949	1 014	890	1 118	960	1 144	651
Vehicles	36 236	36 206	37 774	37 357	36 449	38 596	38 659	40 802	39 032
Distance run ('000 km.)	1 280 397	1 355 858	1 388 285	1 230 865	1 357 583	1 422 371	1 436 593	1 420 683	1 448 494
Fare passengers carried ('000)[2]	1 340 482	1 398 455	1 364 308	1 414 940	1 441 510	1 475 218	1 545 030	1 491 931	1 533 241
Fuel consumed:									
Gasoline ('000 litres)	192 620	198 346	194 454	179 235	178 462	182 878	159 766	148 858	124 771
Diesel ('000 litres)	344 845	420 438	378 425	320 120	420 918	451 425	472 895	468 482	529 365
Propane ('000 litres)	0	49	262	6 911	10 041	20 485	27 735	35 910	35 594
Natural gas ('000 m^3)	..	..	..	..	..	1 697	1 854	1 312	1 475
Electric power ('000 kWh)	636 957	644 349	677 724	660 495	653 588	569 848	625 710	574 040	577 175
Fuel cost ($'000)	137 683	187 288	220 876	232 311	265 702	278 515	252 462	249 626	141 238
Kilometres per vehicle	35 335	37 448	38 752	32 949	37 246	36 853	37 161	34 819	37 110
Litres[3] per 100 km	...	...	...	...	...	...	...	...	...

Source:
Statistics Canada. 1989. *Passenger Bus and Urban Transit Statistics 1987.* Catalogue 53-215.

Notes:
[1]Passenger statistics are not collected for school bus and other passenger bus establishments.
[2]Excludes passengers carried by school bus establishments.
[3]Litres per 100 km has not been calculated since a large portion of the energy consumed in urban transit is electricity.
[4] In 1988, the coverage of the passenger bus and urban transit surveys was reduced to all carriers earning $250,000 or more, compared to carriers earning $100,000 or more for the previous reference period.

Table: 3.1.2.12

Road Motor Vehicle Registrations, Canada, 1980-1989

Vehicle type	1980	1981	1982	1983	1984[1]	1985	1986	1987	1988	1989	Average annual change 1980-89
	thousands										percent
Road motor vehicle registrations											
Passenger automobiles	10 256	10 199	10 530	10 732	10 781	11 118	11 586	11 686	12 086	12 811	2.5
Trucks and truck tractors[1]	2 903	3 138	3 239	3 308	3 047	3 095	3 156	3 517	3 706	3 396	1.8
School buses	24	26	26	28	25	26	28	30	29	30	2.4
Other buses	28	28	28	29	27	28	29	29	31	33	1.7
Motorcycles	389	407	431	466	470	453	430	414	370	348	- 1.2
Registered mopeds	68	39	42	43	37	35	35	34	31	30	- 8.6
Other road motor vehicles	50	14	14	14	20	64	72	83	84	72	4.1
Total, road motor vehicle registrations	**13 717**	**13 851**	**14 311**	**14 621**	**14 406**	**14 819**	**15 336**	**15 794**	**16 336**	**16 720**	**2.2**
Percent Annual Change		0.98	3.32	2.17	- 1.46	2.86	3.49	2.98	3.43	2.35	
Off-road vehicles:											
Snowmobiles	476	509	451	400	425	455	488	532	546	600	2.6
Others (tractors, construction equipment etc.)	197	162	191	222	208	295	365	375	407	392	7.9
Total off-road vehicles	**673**	**671**	**641**	**622**	**633**	**751**	**853**	**907**	**952**	**992**	**4.4**
All vehicles	**14 390**	**14 523**	**14 952**	**15 243**	**15 039**	**15 569**	**16 189**	**16 701**	**17 289**	**17 712**	**2.3**
Vehicles per capita	**2.36**	**2.37**	**2.33**	**2.30**	**2.31**	**2.26**	**2.18**	**2.18**	**2.13**	**2.04**	

Source:
Statistics Canada. *Road Motor Vehicles: Registrations 1989*. Catalogue 53-219.
Note:
[1] The total number of trucks and truck tractors registered decreased in 1984 due to a change in reporting requirements for Ontario.

Table: 3.1.2.13

Airports and Heliports, 1980 and 1990

Province	Estimated[1] area	Active airports: Length of longest runway 1990: Less than 914 metres	914 to 1524 metres	1525 to 2134 metres	More than 2134 metres	Total active airports 1990	Total active airports 1980	Abandoned airports and heliports	Active heliports
	km²								
Newfoundland	66	17	8	3	4	32	25	5	3
Prince Edward Island	13	2	2	0	2	6	4	0	0
Nova Scotia	42	8	5	3	4	20	17	0	2
New Brunswick	60	12	21	3	3	39	29	7	1
Quebec	255	40	56	29	7	132	141	42	54
Ontario	270	85	88	22	8	203	186	21	93
Manitoba	123	54	42	9	3	108	103	12	4
Saskatchewan	157	88	52	13	3	156	163	15	1
Alberta	304	84	104	27	4	219	223	26	26
British Columbia	246	44	69	34	6	153	164	34	119
Yukon	54	8	12	12	1	33	45	51	8
Northwest Territories	152	15	45	26	2	88	101	16	1
Canada: 1990	**1 743**	**457**	**504**	**181**	**47**	**1 189**		**229**	**312**
Canada: 1980		683	351	128	39		1 201	78	109

Source:
Energy, Mines and Resources. Canada Centre for Mapping. 1990. *Canada Flight Supplement*.
Note:
[1] Based on square of runway length.

Table: 3.1.2.14

Airports Ranked by Number of Movements, April-June 1988-1989

Rank April-June 1989	Airport	Province	Total movements April-June 1988	Total movements April-June 1989	Percent change April-June 1988-89	Percent of Canada total movements April-June 1989
1	Lester B. Pearson International	Ont.	66 222	75 267	13.7	14.0
2	Vancouver International	B.C.	49 056	50 383	2.7	9.4
3	Montréal/Dorval International	Que.	29 306	30 192	3.0	5.6
4	Calgary International	Alta.	21 158	25 572	20.9	4.8
5	Ottawa International	Ont.	16 843	16 952	0.6	3.2
6	Halifax International	N.S.	14 210	16 501	16.1	3.1
7	Winnipeg International	Man.	13 636	15 450	13.3	2.9
8	Edmonton Municipal	Alta.	6 244	9 989	60.0	1.9
9	Victoria International	B.C.	11 087	9 510	- 14.2	1.8
10	Edmonton International	Alta.	8 779	8 649	- 1.5	1.6
11	Québec	Que.	5 481	7 976	45.6	1.5
12	Vancouver-Sea Plane Base	B.C.	4 798	7 168	49.4	1.3
13	Montréal/Mirabel International	Que.	6 201	6 690	7.9	1.2
14	Thunder Bay	Ont.	5 453	6 564	20.4	1.2
15	Nanaimo	B.C.	6 024	6 078	0.9	1.1
16	Victoria-Inner Harbour	B.C.	5 292	5 594	5.7	1.0
17	Saskatoon	Sask.	4 515	4 986	10.4	0.9
18	St. John's	Nfld.	4 166	4 965	19.2	0.9
19	Prince Rupert	B.C.	4 912	4 764	- 3.0	0.9
20	London	Ont.	4 492	4 681	4.2	0.9
21	Regina	Sask.	3 886	4 629	19.1	0.9
22	Sudbury	Ont.	4 305	4 524	5.1	0.8
23	Sioux Lookout	Ont.	2 336	4 060	73.8	0.8
24	Inuvik	N.W.T.	3 021	4 018	33.0	0.7
25	Windsor	Ont.	3 672	3 891	6.0	0.7
26	Moncton	N.B.	2 905	3 875	33.4	0.7
27	Timmins	Ont.	2 384	3 845	61.3	0.7
28	Saint John	N.B.	3 185	3 806	19.5	0.7
29	Kelowna	B.C.	4 229	3 518	- 16.8	0.7
30	North Bay	Ont.	3 396	3 508	3.3	0.7
31	Sault Ste. Marie	Ont.	2 914	3 492	19.8	0.6
32	Fredericton	N.B.	1 401	3 259	132.6	0.6
33	Campbell River	B.C.	3 630	3 232	- 11.0	0.6
34	Yellowknife	N.W.T.	2 336	3 211	37.5	0.6
35	Red Lake	Ont.	1 928	3 176	64.7	0.6
36	Lethbridge	Alta.	1 806	3 048	68.8	0.6
37	Thompson	Man.	3 470	3 038	- 12.4	0.6
38	Toronto Island	Ont.	4 070	2 987	- 26.6	0.6
39	Deer Lake	Nfld.	2 282	2 782	21.9	0.5
40	Nanaimo-Harbour	B.C.	2 168	2 632	21.4	0.5
41	Prince George	B.C.	2 316	2 507	8.2	0.5
42	Hamilton	Ont.	1 671	2 495	49.3	0.5
43	Sydney	N.S.	2 047	2 389	16.7	0.4
44	Kamloops	B.C.	2 318	2 376	2.5	0.4
45	Gander International	Nfld.	1 809	2 371	31.1	0.4
46	Penticton	B.C.	1 942	2 296	18.3	0.4
47	Val D'or	Que.	1 949	2 239	14.9	0.4
48	Charlottetown	P.E.I.	1 931	2 137	10.7	0.4
49	Sept-Îles	Que.	1 568	2 134	36.1	0.4
50	Grande-Prairie	Alta.	1 726	1 968	14.0	0.4
	Others		113 519	126 084	11.1	23.7
	Total		**479 995**	**537 462**	**12.0**	**100.0**

Source:
Statistics Canada. *Air Carrier Traffic at Canadian Airports.* Catalogue 51-005.
Notes:
Figures refer to total arriving plus departing flights for scheduled services and major charter services.

Table: 3.1.2.15

Airlines, Annual Statistics, Level I Air Carriers[1] 1981-1989

Year	Passengers carried	Passenger-kilometres	Kilograms of goods carried	Goods tonne-kilometres	Hours flown	Turbo fuel consumed	Fuel consumption ratio
	thousands	millions	millions	millions	thousands	million litres	litres per hour
1981	24 785	45 204	367	853	665	3 607	5 424.5
1982	22 694	43 296	358	661	623	3 420	5 490.0
1983	21 115	41 933	358	969	592	3 139	5 302.3
1984	22 628	44 666	397	1 120	618	3 252	5 261.8
1985	23 281	47 170	403	1 169	859	3 455	5 242.7
1986	23 188	49 124	379	1 155	696	3 579	5 142.5
1987	23 799	48 628	381	1 210	715	3 536	4 944.9
1988	24 097	54 279	404	1 323	734	3 867	5 268.7
1989	22 482	53 178	443	1 445	723	3 842	5 314.6
				Index 1981=100			
1981	100	100	100	100	100	100	100
1982	92	96	98	101	94	95	101
1983	85	93	98	114	89	87	98
1984	91	99	108	131	93	90	97
1985	94	104	110	137	99	96	97
1986	94	109	103	136	105	99	95
1987	96	108	104	142	108	98	91
1988	97	120	110	155	110	107	97
1989	91	118	121	169	109	107	98

Source:
Statistics Canada. *Aviation.* Catalogue 51-004.
Notes:
[1] From 1981 to 1986, Level I included Air Canada, CP Air, Eastern Provincial Nordair, Quebecair, Pacific Western and Wardair. In 1987 Level I included Air BC, Air Canada, Canadian Pacific Airlines, Quebecair, Pacific Western and Wardair. In 1988, Air Canada, Canadian Airlines International and Wardair are included in Level I. Commencing January 1990, Level I Air Carriers include Air Canada and Canadian Airlines International Ltd.

Table: 3.1.2.16

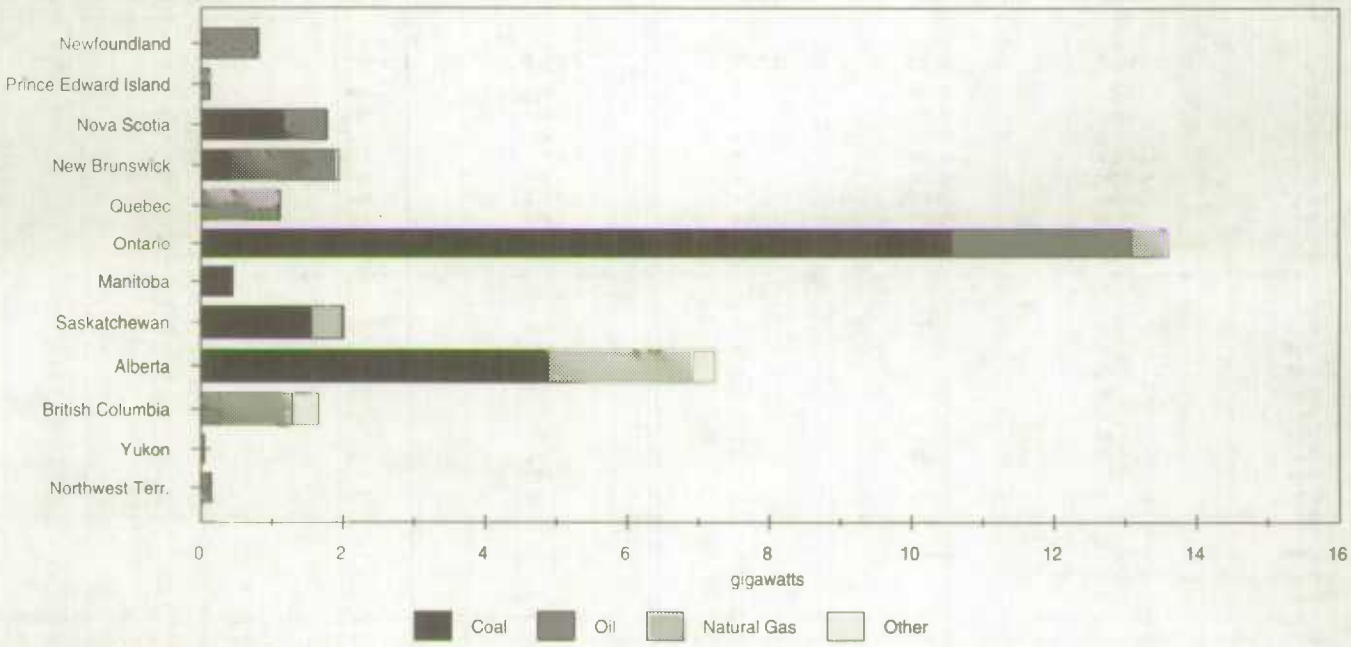
Marine Transport, Canadian Domiciled Carriers, 1986-1988

Year	Number of carriers	Number of vessels operated	Fuel and lubricating oil consumed[1]	Passengers carried	Number of vehicles carried
			million litres	thousands	
1985	312	1 451	1 277	27 405	9 312
1986	296	1 843	1 220	30 715	10 406
1987	303	2 001	1 258	31 689	10 907
1988	241	2 538	1 294	30 811	11 942

Source:
Statistics Canada, 1989. *Surface and Marine Transport.* Catalogue 50-002.
Statistics Canada. *Shipping in Canada 1989.* Catalogue 54-205.
Notes:
[1] Primarily fuel oil, includes small amounts of gasoline, lubricating oil and other fuel.

Figure: 3.1.2.7

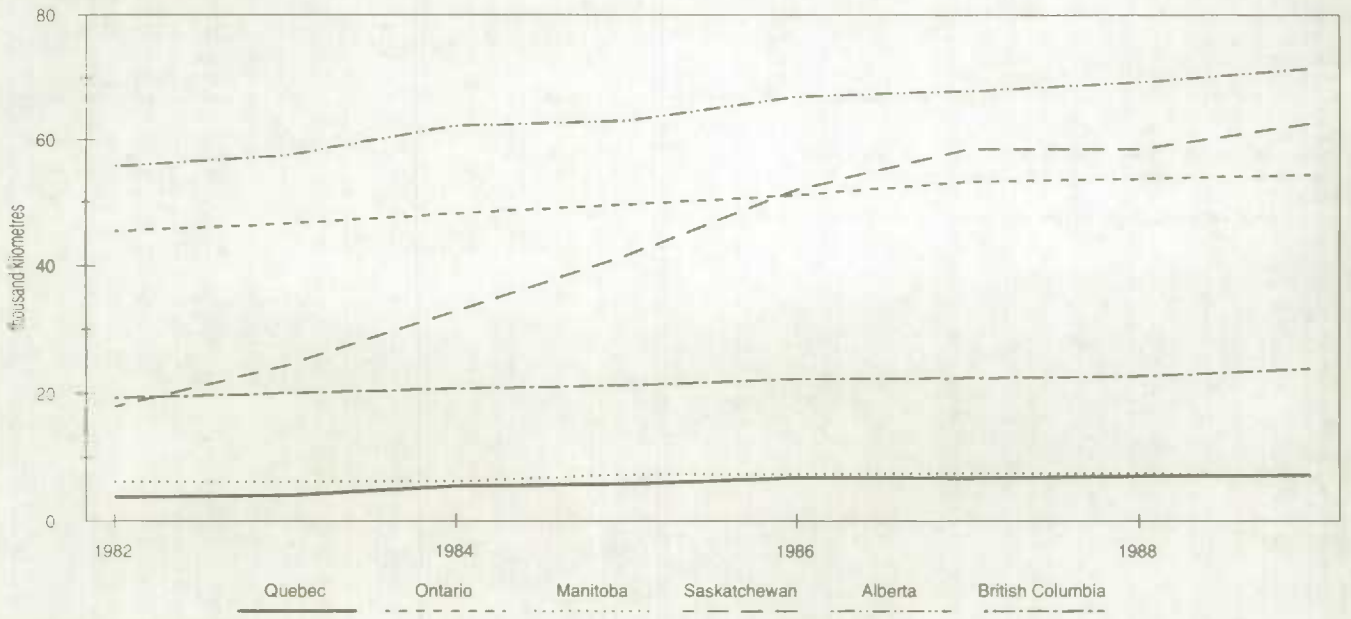
Conventional Thermal Electricity Generating Capacity by Fuel, 1989



Source: Statistics Canada. Electric Power Statistics. Catalogue 57-206

Figure: 3.1.2.8

Natural Gas Pipeline Lengths, All Types, 1982-1989



Source: Statistics Canada. Gas Utilities Transportation and Distribution Systems. Catalogue 57-205.

Table: 3.1.2.17

Electrical Power Generation Capacity by Province and Type, 1989

Province	Method of generation					
	Steam	Nuclear	Internal combustion	Hydro	Combustion turbine	All Types
	megawatts					
Newfoundland	560	-	79	6 656	170	7 465
Prince Edward Island	70	-	11	-	40	122
Nova Scotia	1 569	680	2	386	205	2 842
New Brunswick	1 871	-	16	903	48	2 838
Quebec	628	685	118	26 529	363	28 323
Ontario	13 081	11 238	12	7 796	504	32 630
Manitoba	431	-	17	3 641	-	4 089
Saskatchewan	1 852	-	4	836	155	2 846
Alberta	6 744	-	36	734	464	7 978
British Columbia	1 399	-	104	10 849	151	12 503
Yukon	-	-	45	82	-	126
Northwest Territories	-	-	124	53	19	197
Canada: 1989	**28 203**	**12 603**	**568**	**58 465**	**2 121**	**101 960**
Canada: 1988	**27 839**	**12 593**	**534**	**57 936**	**2 152**	**101 055**
Percent of total: 1989	27.66	12.36	0.56	57.34	2.08	100.00
Percent of total: 1988	27.55	12.46	0.53	57.33	2.13	100.00
	number of plants					
Newfoundland	6	-	48	37	6	97
Prince Edward Island	1	-	1	-	1	3
Nova Scotia	9	1	1	36	3	50
New Brunswick	14	-	3	13	2	32
Quebec	4	1	26	96	2	129
Ontario	23	4	3	119	12	161
Manitoba	5	-	14	13	-	32
Saskatchewan	8	-	5	7	3	23
Alberta	27	-	34	15	9	85
British Columbia	23	-	20	47	3	93
Yukon	-	-	15	5	-	20
Northwest Territories	-	-	57	5	1	63
Canada: 1989	**120**	**6**	**227**	**393**	**42**	**788**
Canada: 1988	**118**	**6**	**227**	**390**	**41**	**782**
Percent of total: 1989	15.23	0.76	28.81	49.87	5.33	100.00
Percent of total: 1988	15.09	0.77	29.03	49.87	5.24	100.00

Source:
Statistics Canada. *Electric Power Statistics*. Catalogue 57-206.

Table: 3.1.2.18

Conventional Thermal Electricity Generating Capacity by Principal Fuel, 1989

Province	Principal fuel				
	Coal	Oil	Natural gas	Other	Total
	megawatts				
Newfoundland	1.3	802.3	-	5.0	808.6
Prince Edward Island	-	122.1	-	-	122.1
Nova Scotia	1 182.3	594.2	-	18.8	1 775.3
New Brunswick	417.5	1 455.4	-	62.4	1 935.3
Quebec	3.2	1 092.5	7.5	5.4	1 108.6
Ontario	10 553.0	2 526.9	445.1	71.7	13 596.7
Manitoba	404.0	17.4	4.0	22.8	448.2
Saskatchewan	1 531.3	24.4	432.6	22.3	2 010.6
Alberta	4 861.4	15.2	2 031.4	336.0	7 244.0
British Columbia	6.6	244.2	1 032.7	370.2	1 653.7
Yukon	1.0	43.7	-	-	44.7
Northwest Territories	-	124.3	19.5	-	143.8
Canada	**18 941.6**	**7 062.6**	**3 972.8**	**914.6**	**30 891.6**
Percent of total	61.32	22.86	12.86	2.96	100.00

Source:
Statistics Canada. *Electric Power Statistics*. Catalogue 57-206.

Table: 3.1.2.19

Crude Oil Pipeline Lengths by Type and Province, 1989

Province	Type of line				Pumping stations
	Gathering[1]	Trunk	Product	Total	
	kilometres				number
Quebec	-	347.8	253.6	601.4	5
Ontario	72.1	1 489.4	1 957.8	3 519.3	35
Manitoba	230.9	1 775.2	311.9	2 318.0	16
Saskatchewan	2 920.4	3 917.1	1 363.0	8 200.5	40
Alberta	6 572.0	9 494.5	1 117.6	17 184.1	142
British Columbia	492.9	1 649.5	55.9	2 198.3	15
Yukon	-	-	88.9	88.9	1
Northwest Territories	-	752.1	-	752.1	3
Canada 1989	**10 288.3**	**19 425.6**	**5 148.7**	**34 862.6**	**257**
Canada 1988	**9 137.5**	**19 482.7**	**5 107.6**	**33 727.8**	**247**
Canada 1987	**9 060.9**	**19 895.8**	**4 820.4**	**33 777.1**	**249**
Canada 1986	**8 873.0**	**19 024.3**	**4 964.2**	**32 881.5**	**247**
Canada 1985	**8 629.7**	**18 488.4**	**4 948.3**	**32 066.4**	**236**
Canada 1984	**8 104.7**	**18 777.3**	**5 012.2**	**31 894.2**	**223**

Source:
Statistics Canada. *Oil Pipe Line Transport.* Catalogue 55-201.
Notes:
[1]Excludes producers' gathering lines.

Table: 3.1.2.20

Natural Gas Pipeline[1] Lengths by Type and Province, 1989

Province	Type of line				Compressor stations	Prime movers
	Gathering	Transmission	Product	Total		
	kilometres				number	
Quebec	-	1 122.8	6 073.6	7 196.4	2	4
Ontario	944.7	11 440.5	41 972.3	54 357.5	56	136
Manitoba	-	3 075.1	3 847.2	6 922.3	7	21
Saskatchewan	398.0	14 364.3	47 867.0	62 629.3	38	96
Alberta	2 928.9	25 238.5	43 288.4	71 455.8	89	178
British Columbia	2 181.2	6 313.3	15 406.3	23 900.8	41	105
Yukon	-	-	-	-	-	-
Northwest Territories	50.6	-	-	50.6	-	-
Canada	**6 503.4**	**61 554.5**	**158 454.8**	**226 512.7**	**233**	**540**

Source:
Statistics Canada. *Gas Utilities.* Catalogue 57-205.
Notes:
[1]Total natural gas industries excluding Alberta cooperatives.

Table: 3.1.2.21

Natural Gas Pipeline[1] Lengths by Province, 1982-1989

Province	1982	1983	1984	1985	1986	1987	1988	1989
	kilometres							
New Brunswick	189	189	189	189	189	189	-	-
Quebec	3 791	3 999	5 464	5 814	6 817	6 761	7 052	7 196
Ontario	45 418	46 542	48 232	49 631	51 097	53 268	53 772	54 358
Manitoba	6 130	6 152	6 227	7 329	7 423	7 487	7 555	6 922
Saskatchewan	17 965	24 390	32 859	41 594	52 009	58 453	58 453	62 629
Alberta	55 704	57 448	62 253	63 051	66 946	67 858	69 313	71 456
British Columbia	19 335	20 045	20 779	21 353	22 329	22 461	22 769	23 901
Yukon and Northwest Territories	55	55	55	55	51	51	51	51
Canada	**148 587**	**158 819**	**176 058**	**189 016**	**206 860**	**216 526**	**218 964**	**226 513**

Source:
Statistics Canada. *Gas Utilities Transportation and Distribution Systems.* Catalogue 57-205.
Notes:
[1] Excludes gathering pipelines of the upstream producing industry.

3.1.3 Dwellings

Between 1971 and 1986 Canada's population increased by 17 percent. The number of dwellings increased by 49 percent. The purchase of major appliances, vehicles and household equipment occur at the household level, as does energy consumption and waste generation.

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The number and density of private dwellings are better indicators than numbers of people of resource consumption and some environmental impacts. The construction of dwellings and purchases of vehicles, appliances and energy in the residential sector are all driven by the number of households rather than simply the number of people. For example, a household will usually have a set of major appliances such as a stove, washing machine and refrigerator and an automobile regardless of the number of people in it.

Between 1971 and 1986, the count of private occupied dwellings increased by almost 3 million. These increases were mainly in the Mixed-Wood Plain of Ontario and Quebec. Large proportional increases occurred in some sparsely-populated regions — the Boreal Shield of Quebec, the Boreal Cordillera of the Yukon and the Taiga Shield in the Northwest Territories showed increases of 65 percent and higher. Table 3.1.3.2 presents the number of dwellings by ecozone during census years from 1971 to 1986. Comparing this to Table 2.1.1.2 in the **Population Conditions** section highlights the changing demography of Canada. The population increased by only 17 percent over the same period. The number of persons per dwelling decreased from 3.6 in 1971 to 2.8 in 1986 (Table 3.1.3.1).

Table: 3.1.3.1
Persons per Dwelling, 1971-1986

Year	Population	Dwellings	Persons per dwelling
	thousands		
1971	21 568	6 044	3.6
1976	22 993	7 166	3.2
1981	24 343	8 281	2.9
1986	25 354	8 992	2.8

Source:
Statistics Canada. Census of Population.

The distribution of dwelling density in Canada is shown in Map 3.1.3.1. The categories used in this map define classes of human disturbance:

- **No Dwellings**: no dwellings within the area
- **Greater than 0 but fewer than 1 dwelling per 10 square kilometres**: This is a low density with minimal infrastructure and potential for impact
- **Greater than .1 but less than one dwelling per square kilometre**: Low density representing sparsely populated rural areas.
- **One or more dwelling per square kilometre**: This category ranges from moderately populated rural areas to urban centres. A substantial amount of infrastructure: roads, sewers, commercial centres, community facilities, is required to support this level of density.

Dwelling Density by Sub-sub Basin, 1986

Source: Statistics Canada, Environment and Wealth Accounts Division

Table: 3.1.3.2

Dwellings by Ecozone, 1971-1986

Province / Ecozone	Area	Total occupied private dwellings 1971	1976	1981[1]	1986	Dwelling density 1986	Change 1971-86
	km²					dwellings/km²	percent
Newfoundland							
Taiga Shield	207 441	4 790	6 475	6 735	6 065	0.03	26.57
Boreal Shield	130 317	105 345	124 765	141 180	152 445	1.17	44.71
Southern Arctic	51 311	315	430	505	575	0.01	80.76
Arctic Cordillera	10 124	..	..	..	..	..	..
Total	**399 193**	**110 455**	**131 665**	**148 420**	**159 080**	**0.40**	**44.02**
Prince Edward Island							
Atlantic Maritime	5 660	27 885	32 930	37 660	40 695	7.19	45.94
Total	**5 660**	**27 880**	**32 930**	**37 660**	**40 695**	**7.19**	**45.94**
Nova Scotia							
Atlantic Maritime	55 490	207 540	243 095	273 195	295 780	5.33	42.52
Total	**55 490**	**207 535**	**243 095**	**273 190**	**295 780**	**5.33**	**42.52**
New Brunswick							
Atlantic Maritime	73 440	157 650	190 435	214 895	231 680	3.15	46.96
Total	**73 440**	**157 655**	**190 435**	**214 900**	**231 680**	**3.15**	**46.96**
Quebec							
Taiga Shield	539 794	2 360	4 200	4 560	2 430	0.00	3.01
Boreal Shield	643 159	223 740	282 770	340 955	368 150	0.57	64.54
Hudson Bay Plain	26 311	355	270	275	400	0.02	12.71
Mixed-Wood Plain	55 385	1 321 375	1 542 110	1 750 365	1 900 755	34.32	43.85
Atlantic Maritime	28 838	56 675	64 325	76 070	84 580	2.93	49.24
Southern Arctic	138 223	30	40	340	460	0.00	1 334.37
Northern Arctic	67 105	270	335	235	335	0.00	23.33
Arctic Cordillera	7 535	35	50	0	0	0.00	- 100.00
Total	**1 506 350**	**1 604 840**	**1 894 110**	**2 172 810**	**2 357 105**	**1.56**	**46.87**
Ontario							
Boreal Shield	614 964	230 920	263 225	291 745	305 490	0.50	32.29
Hudson Bay Plain	268 924	1 070	955	1 135	595	0.00	- 44.53
Mixed-Wood Plain	96 427	1 993 580	2 370 440	2 676 880	2 915 650	30.24	46.25
Total	**980 315**	**2 225 565**	**2 634 620**	**2 969 755**	**3 221 725**	**3.29**	**44.76**
Manitoba							
Boreal Plain	96 559	14 780	15 980	17 135	17 445	0.18	18.06
Prairie	74 005	252 355	288 275	316 900	338 430	4.57	34.11
Taiga Shield	103 672	130	95	200	235	0.00	84.50
Boreal Shield	244 367	20 355	22 975	23 235	25 555	0.10	25.52
Hudson Bay Plain	93 726	750	685	510	675	0.01	- 10.37
Southern Arctic	1 884	..	..	..	..	..	..
Total	**614 212**	**288 380**	**328 000**	**357 980**	**382 345**	**0.62**	**32.59**
Saskatchewan							
Boreal Plain	211 330	10 315	11 340	13 165	14 060	0.07	36.34
Prairie	285 333	255 390	277 745	316 960	341 745	1.20	33.81
Taiga Shield	55 605	675	715	970	430	0.01	- 35.65
Boreal Shield	85 478	1 195	1 350	1 620	2 030	0.02	69.54
Total	**637 746**	**267 575**	**291 155**	**332 715**	**358 265**	**0.56**	**33.89**
Alberta							
Montane Cordillera	43 504	7 220	9 340	11 455	12 235	0.28	69.44
Boreal Plain	363 280	65 620	76 505	108 050	118 225	0.33	80.17
Taiga Plain	83 683	105	105	200	200	0.00	94.06
Prairie	162 542	391 500	487 090	638 285	705 200	4.34	80.13
Taiga Shield	8 182	195	240	215	270	0.03	39.90
Total	**661 191**	**464 635**	**575 280**	**758 210**	**836 130**	**1.26**	**79.95**
British Columbia							
Boreal Cordillera	120 607	360	515	650	760	0.01	110.80
Pacific Maritime	282 594	519 915	629 980	750 660	828 990	2.93	59.45
Montane Cordillera	389 734	138 285	185 340	228 210	238 425	0.61	74.95
Boreal Plain	115 319	10 885	12 325	17 020	18 835	0.16	73.05
Taiga Plain	39 545	120	125	150	105	0.00	- 10.26
Total	**947 800**	**667 565**	**828 290**	**996 690**	**1 087 115**	**1.15**	**62.85**

Dwellings by Ecozone, 1971-1986

Province / Ecozone	Area	Total occupied private dwellings				Dwelling density	Change
		1971	1976	1981[1]	1986	1986	1971-86
	km²					dwellings/km²	percent
Yukon							
Tundra Cordillera	174 893	45	50	75	95	0.00	125.58
Boreal Cordillera	259 506	4 880	6 035	7 120	7 445	0.03	52.66
Boreal Plain	32 518	175	405	390	435	0.01	144.89
Taiga Plain	16 534	..	..	..	..	..	..
Total	**483 450**	**5 095**	**6 495**	**7 590**	**7 975**	**0.02**	**56.46**
Northwest Territories							
Tundra Cordillera	107 453	25	50	70	75	0.00	181.48
Boreal Plain	1 826	..	..	..	..	..	..
Taiga Plain	444 446	3 290	4 320	4 440	5 160	0.01	56.67
Taiga Shield	470 308	1 845	2 825	3 645	4 355	0.01	136.15
Hudson Bay Plain	3 121	..	5	..	..	..	..
Southern Arctic	737 058	965	1 165	1 435	1 605	0.00	66.05
Northern Arctic	1 359 619	1 250	1 435	1 665	2 255	0.00	80.70
Arctic Cordillera	242 597	195	230	280	320	0.00	63.78
Total	**3 366 429**	**7 575**	**10 015**	**11 530**	**13 775**	**0.00**	**81.81**
Ecozone							
Atlantic Maritime	163 428	449 745	530 765	601 820	652 740	3.99	45.13
Mixed-Wood Plain	151 812	3 314 950	3 912 555	4 427 245	4 816 400	31.73	45.29
Boreal Shield	1 718 285	581 560	695 090	798 735	853 665	0.50	46.79
Prairie	521 880	899 250	1 053 110	1 272 145	1 385 380	2.65	54.06
Boreal Plain	820 833	101 775	118 555	155 760	169 005	0.21	66.06
Montane Cordillera	433 238	143 505	194 680	239 670	250 660	0.58	74.67
Pacific Maritime	282 594	519 915	629 980	750 660	828 990	2.93	59.45
Boreal Cordillera	380 113	5 235	6 550	7 775	8 205	0.02	56.66
Tundra Cordillera	282 346	70	100	140	175	0.00	147.14
Taiga Plain	584 208	3 510	4 545	4 795	5 460	0.01	55.51
Taiga Shield	1 385 002	9 995	14 545	16 325	13 795	0.01	38.03
Hudson Bay Plain	392 082	2 175	1 915	1 920	1 665	0.00	- 23.40
Southern Arctic	928 475	1 315	1 635	2 285	2 635	0.00	100.46
Northern Arctic	1 426 724	1 520	1 765	1 900	2 590	0.00	70.51
Arctic Cordillera	260 256	235	280	285	325	0.00	38.36
Canada Total	**9 731 276**	**6 034 765**	**7 166 090**	**8 281 450**	**8 991 670**	**0.92**	**49.00**

Source:
Statistics Canada, Environment and Wealth Accounts Division. Original data provided by Statistics Canada, Census of Population.
Notes:
[1] The 1981 figures have been revised from the previous edition. Values may also be different since ecozone boundaries have been revised.

3.1.4 Economic Indicators

In 1989, crude and fabricated materials accounted for approximately 65 percent of merchandise exports, whereas end products comprised 60 percent of merchandise imports.

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Economic indicators such as employment, Gross Domestic Product, international trade and prices are used to measure past economic activity and to predict future economic performance. These indicators, when focused upon the primary industries (agriculture, fishing and trapping, forestry, mining) provide a perspective of the magnitude and performance of these environmentally significant industries. This section discusses these traditional economic indicators from a natural resource point of view.

The level of employment in primary sector industries (Table 3.1.4.3) is an indirect indicator of the rate of resource exploitation as well as the geographic concentration of primary industries. A high proportion of a regional population employed in one industry creates a vulnerable economy. Changes in world prices, weather, quality of the stock and condition of the environment can have severe consequences for these regional economies (Table 3.1.4.1, Figures 3.1.4.1 and 3.1.4.2).

Maps 3.1.4.1 to 3.1.4.4, show the proportion of total employment in primary sector industries by sub-sub drainage basin. The maps indicate the concentration of employment in primary industries (agriculture, fishing, mining and forestry) by sub-sub basin and not the number of persons employed. These maps indicate the reliance on agriculture in the Prairie Provinces; fishing in the Atlantic Provinces; logging and forestry in northern Ontario, northern Quebec and British Columbia; and mining and quarrying in central Ontario and central Alberta.

The Balance of Payments current account summarizes Canadian international trade. Canadian commodity exports consist of a higher proportion of crude and fabricated materials than end products (Table 3.1.4.4, Figure 3.1.4.3). End products comprise the majority of imports (Table 3.1.4.5, Figure 3.1.4.4). The merchandise balance, exports less imports, has historically been a surplus. However, this surplus has not been large enough in recent years to offset the deficit of the non-merchandise balance, resulting in a net deficit position (Figure 3.1.4.6).

GDP (Gross Domestic Product) is a widely-quoted indicator of the nation's economic performance. The level of production in the primary sector has increased over the period. However, the rate of growth in the primary sector has been outpaced by other industries, notably service sector industries. Primary sector industries accounted for 12.2 percent of GDP in 1961 compared to 6.8 percent in 1990 (Table 3.1.4.2, Figure 3.1.4.5).

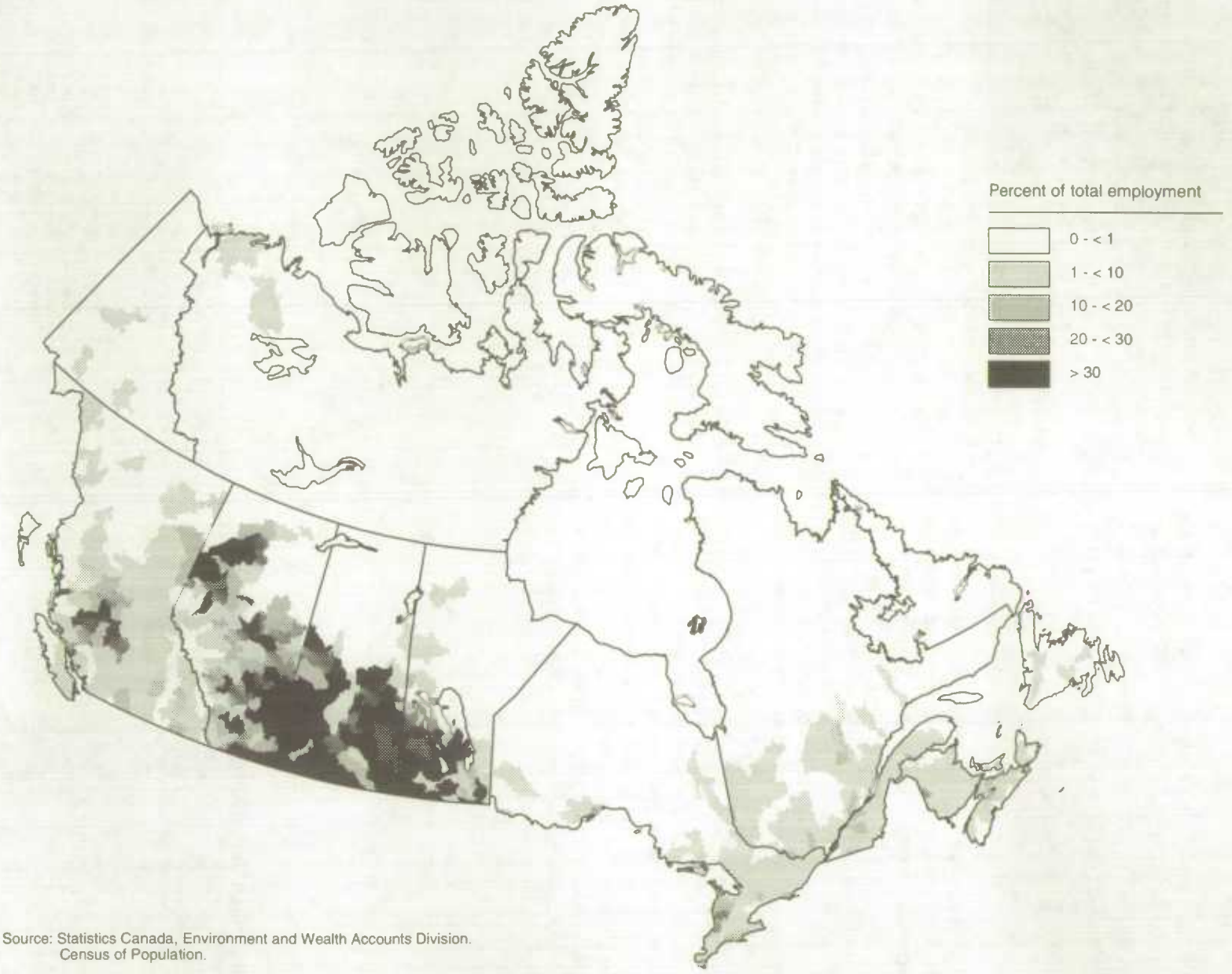
Table: 3.1.4.1

Raw Resource Commodity Price Index, 1981-1990

	Commodity								
Year	Raw materials price index total	Vegetable products	Animal and animal products	Wood	Ferrous materials	Non-ferrous metals	Non-metal minerals	Mineral fuels	Raw materials excluding mineral fuels
1981	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1982	107.5	87.5	105.4	96.2	96.9	88.5	111.6	120.3	97.0
1983	112.2	91.5	103.0	100.1	98.4	92.3	114.8	128.8	98.5
1984	115.5	98.8	109.0	103.6	107.7	91.6	118.5	130.7	103.1
1985	116.6	91.3	107.4	104.2	109.5	86.4	124.4	136.8	100.4
1986	96.2	89.9	113.2	109.3	110.3	89.6	127.8	86.8	103.9
1987	102.3	84.7	119.0	121.1	108.8	102.3	127.8	93.7	109.3
1988	97.0	93.4	113.6	131.1	110.8	121.9	131.4	75.6	114.7
1989	100.7	93.3	115.0	133.0	106.3	118.7	133.5	83.7	114.7
1990	100.8	90.2	119.2	133.5	100.0	104.0	133.6	86.6	112.5

Source:
Statistics Canada. *Industry Price Indexes*. Catalogue 62-011.

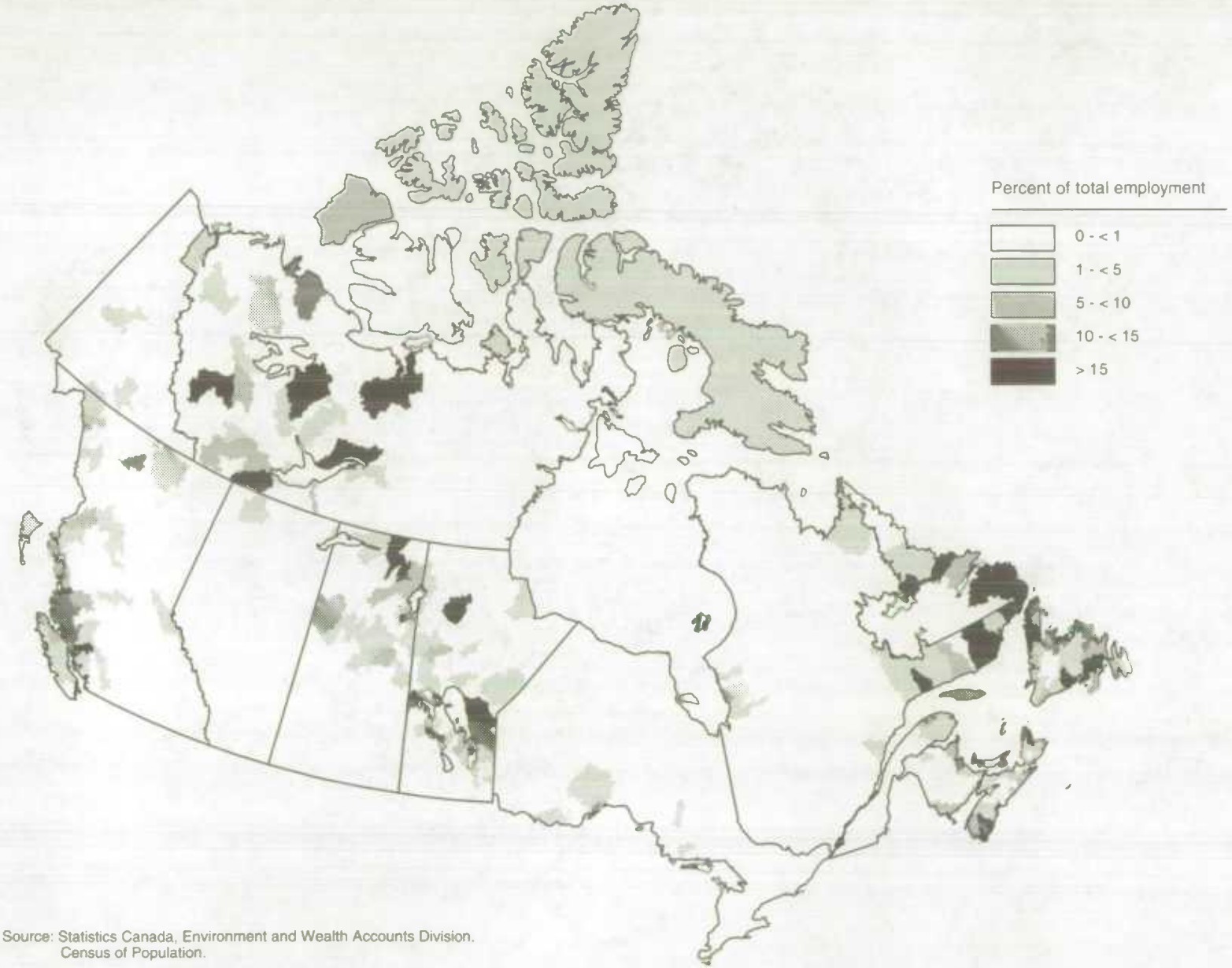
Employment in Agriculture by Sub-sub Basin, 1986



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

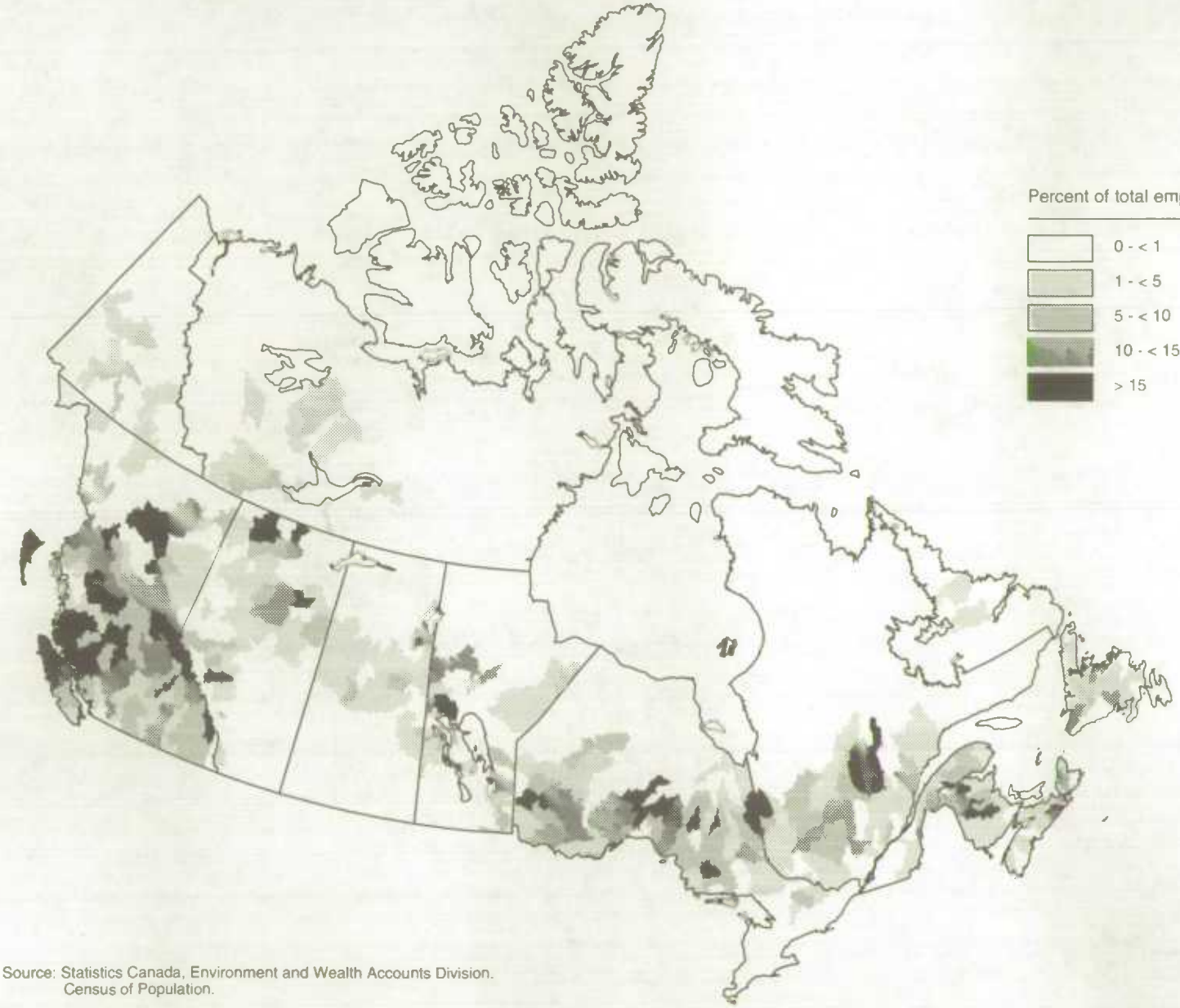
Map: 3.1.4.2

Employment in Fishing and Trapping by Sub-sub Basin, 1986



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

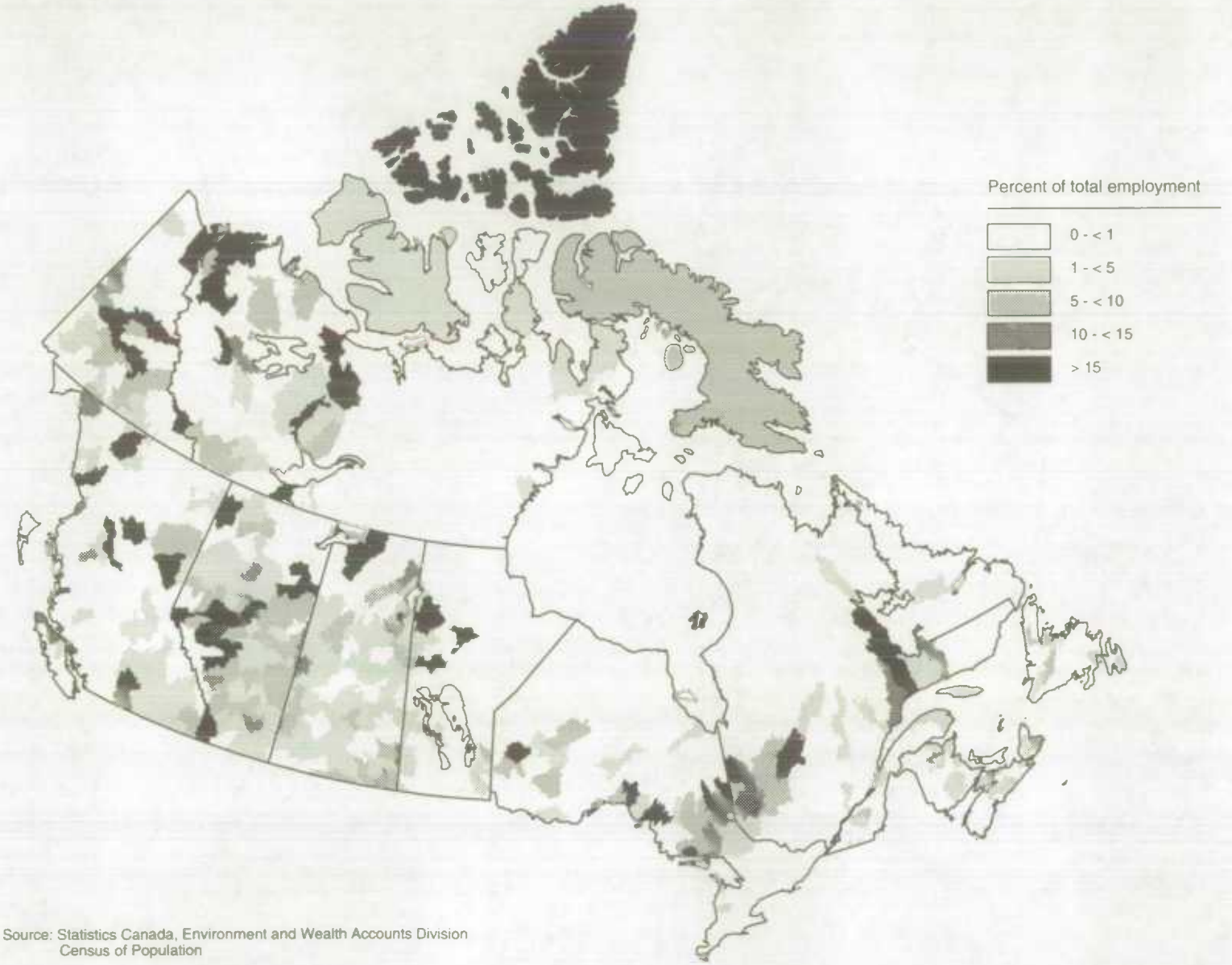
Employment in Logging and Forestry by Sub-sub Basin, 1986



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

Map: 3.1.4.4

Employment in Mining, Quarrying and Oil Well Industries by Sub-sub Basin, 1986

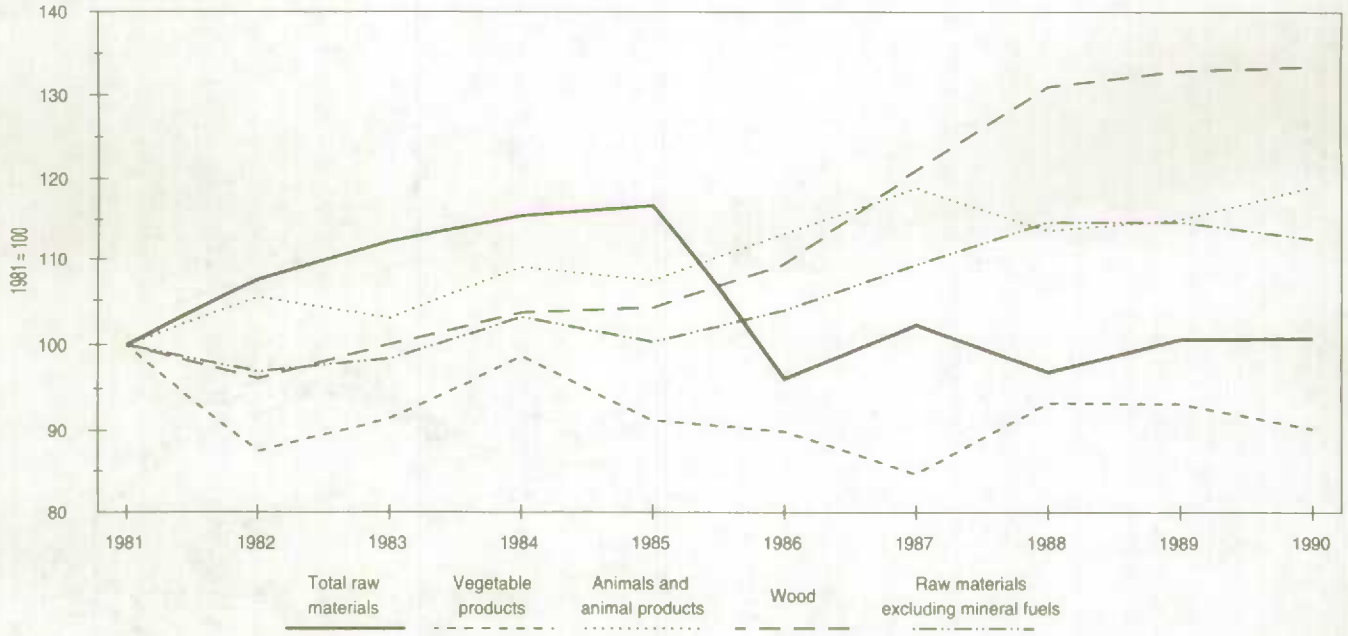


Source: Statistics Canada, Environment and Wealth Accounts Division
Census of Population

Figure: 3.1.4.1

Natural Resource Commodity

Price Index 1981-1990



Source: Statistics Canada. Industry Price Indexes. Catalogue 62-011.

Figure: 3.1.4.2

Natural Resource Commodity

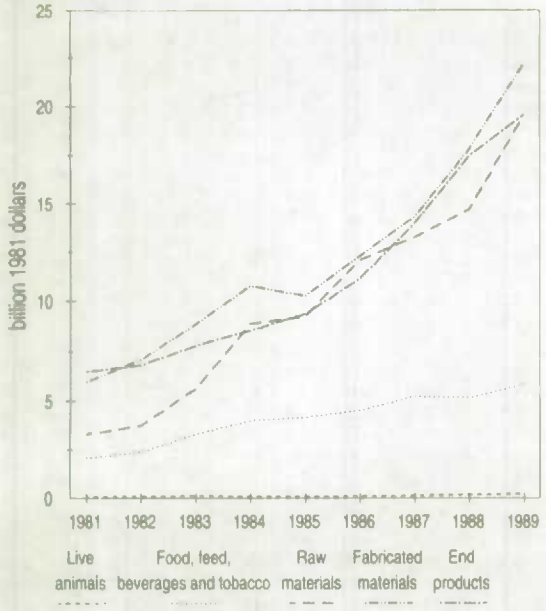
Price Index 1981-1990

Source: Statistics Canada. Industry Price Indexes. Catalogue 62-011.

Figure: 3.1.4.3

Merchandise Exports, 1981-1989

(Balance of Payments Basis)

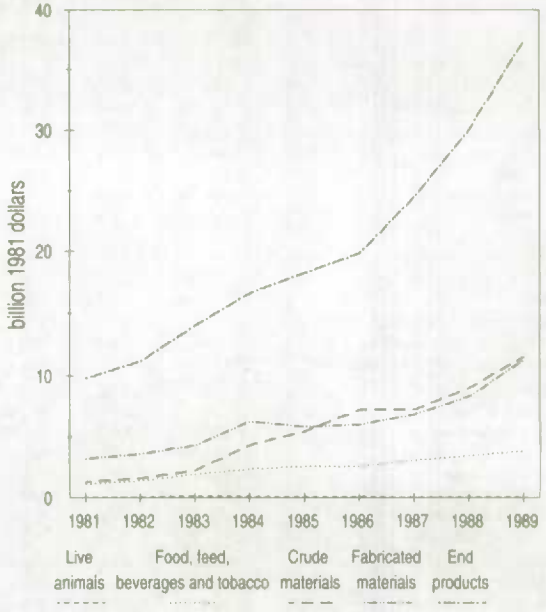


Source: Statistics Canada. Summary of Canadian International Trade. Catalogue 65-001.

Figure: 3.1.4.4

Merchandise Imports, 1981-1989

(Balance of Payments Basis)

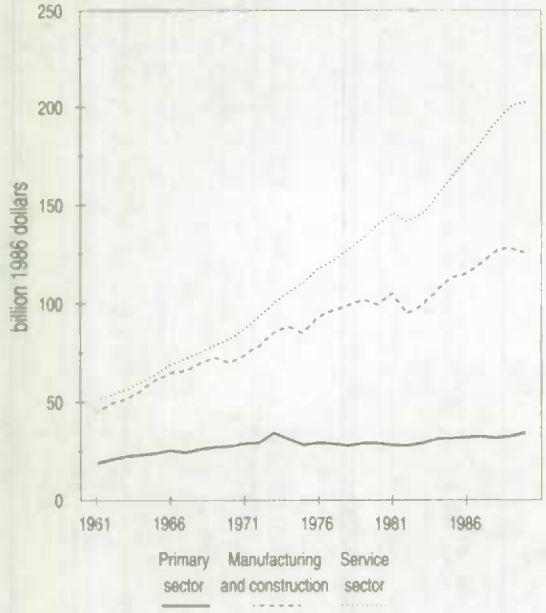


Source: Statistics Canada. Summary of Canadian International Trade. Catalogue 65-001.

Figure: 3.1.4.5

Gross Domestic Product by Sector,

at Factor Cost, 1961-1990

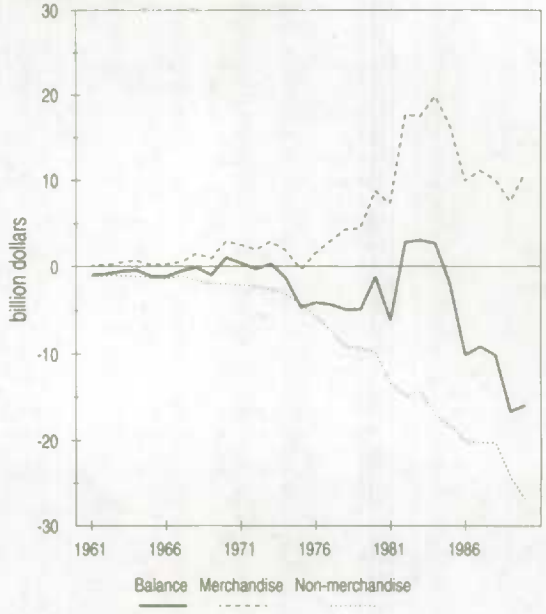


Source: Statistics Canada. Gross Domestic Product by Industry. Catalogue 15-001.

Figure: 3.1.4.6

Balance of International Payments

Current Account Balance, 1961-1990



Source: Statistics Canada. Summary of Canadian International Trade. Catalogue 65-001.

Table: 3.1.4.2

Gross Domestic Product at Factor Cost by Industry, Selected Years

Industry	1961	1966	1971	1976	1981	1986	1990	1961	1966	1971	1976	1981	1986	1990
	million 1986 dollars							percent						
Business Sector	**121 794.8**	**171 161.0**	**209 077.5**	**269 291.4**	**320 322.4**	**368 535.2**	**419 320.0**	**77.9**	**79.0**	**78.3**	**79.4**	**80.7**	**81.6**	**82.2**
Agriculture and related services industries	6 389.9	9 557.6	9 381.0	9 780.1	9 627.3	11 056.7	11 201.5	4.1	4.4	3.5	2.9	2.5	2.4	2.2
Fishing and trapping industries	772.3	820.8	725.3	610.2	834.1	980.2	1 109.3	0.5	0.4	0.3	0.2	0.2	0.2	0.2
Logging and foresty industries	1 547.3	1 828.6	1 764.4	1 871.8	2 195.1	2 691.0	2 525.8	1.0	0.8	0.7	0.6	0.6	0.6	0.5
Mining, quarrying and oil well industries	10 283.3	13 297.4	17 026.5	17 176.9	15 306.8	17 502.2	19 655.3	6.6	6.1	6.4	5.1	3.9	3.9	3.9
Mining industries	3 611.2	4 118.4	4 758.2	4 890.5	4 100.1	5 158.0	6 227.3	2.3	1.9	1.8	1.4	1.0	1.1	1.2
Gold mines	1 973.2	1 438.2	793.4	457.3	391.0	880.6	1 519.5	1.3	0.7	0.3	0.1	0.1	0.2	0.3
Other metal mines	2 528.4	2 396.7	2 492.2	2 621.8	1 752.4	2 346.5	2 522.0	1.6	1.1	0.9	0.8	0.4	0.5	0.5
Iron mines	248.9	551.4	820.6	819.1	761.3	452.7	465.4	0.2	0.3	0.3	0.2	0.2	0.1	0.1
Asbestos mines	245.6	297.0	322.6	285.0	199.3	102.0	101.3	0.2	0.1	0.1	0.1	0.1	0.0	0.0
Non-metal mines exc. coal and asbestos	40.5	163.3	259.2	321.7	468.6	485.4	532.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1
Salt mines	22.0	36.1	53.7	69.5	90.3	135.6	138.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal mines	160.7	167.1	234.2	213.9	409.3	755.3	948.7	0.1	0.1	0.1	0.1	0.1	0.2	0.2
Crude petroleum & natural gas industries	7 014.1	11 261.8	18 028.4	16 058.9	8 622.9	9 762.6	11 426.8	4.5	5.2	6.8	4.7	2.2	2.2	2.2
Quarry and sand pit industries	226.0	424.5	460.9	441.0	460.7	643.7	602.6	0.1	0.2	0.2	0.1	0.1	0.1	0.1
Service related to mineral extraction	526.1	651.0	661.1	1 024.0	2 344.4	1 937.9	1 398.6	0.3	0.3	0.2	0.3	0.6	0.4	0.3
Manufacturing industries	31 126.5	47 685.6	56 668.3	69 978.5	77 895.0	86 789.3	91 268.4	19.9	22.0	21.2	20.6	19.6	19.2	17.9
Construction industries	13 808.7	16 985.0	17 317.5	22 998.3	27 158.5	28 081.9	33 695.3	8.8	7.8	6.5	6.8	6.8	6.2	6.6
Transportation and storage industries	6 930.0	9 609.3	12 619.5	14 608.6	17 076.4	20 253.9	22 484.7	4.4	4.4	4.7	4.3	4.3	4.5	4.4
Communication industries	1 911.1	2 870.8	4 347.4	7 377.4	11 128.1	13 247.9	18 860.4	1.2	1.3	1.6	2.2	2.8	2.9	3.7
Other utility industries	2 968.5	4 415.6	6 707.5	9 975.0	12 651.9	15 198.0	15 777.7	1.9	2.0	2.5	2.9	3.2	3.4	3.1
Electric power systems industry	2 559.2	3 741.6	5 624.5	8 475.7	10 875.9	13 165.8	13 246.8	1.6	1.7	2.1	2.5	2.7	2.9	2.6
Gas distribution systems industry	423.7	686.3	1 074.5	1 349.4	1 519.9	1 653.0	1 758.7	0.3	0.3	0.4	0.4	0.4	0.4	0.3
Other utility industries n.e.c.	13.6	30.9	72.3	192.9	280.5	379.2	772.2	0.0	0.0	0.0	0.1	0.1	0.1	0.2
Wholesale trade industries	5 965.6	8 912.5	11 526.5	14 876.5	17 952.7	23 312.0	27 272.0	3.8	4.1	4.3	4.4	4.5	5.2	5.3
Retail trade industries	10 906.9	14 759.3	18 195.2	23 497.4	24 156.7	28 269.4	31 213.6	7.0	6.8	6.8	6.9	6.1	6.3	6.1
Finance, insurance & real estate industries	21 446.0	27 095.8	34 443.2	45 422.1	58 075.2	69 033.7	80 213.4	13.7	12.5	12.9	13.4	14.6	15.3	15.7
Community, business, personal service ind.	12 777.9	18 033.0	22 868.6	33 647.1	45 640.8	52 119.0	64 042.6	8.2	8.3	8.6	9.9	11.5	11.5	12.6
Non-business sector	36 226.5	45 986.7	59 823.4	71 350.3	77 080.4	83 304.1	90 604.3	23.2	21.2	22.4	21.0	19.4	18.4	17.8
Total economy	**156 427.6**	**216 770.4**	**267 059.6**	**339 251.3**	**397 089.7**	**451 839.3**	**509 924.3**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source:
Statistics Canada. *Gross Domestic Product by Industry.* Catalogue 15-001.

Table: 3.1.4.3

Employment in Primary Sector Industries, 1986

Province/Territory	All industries	Employment: Total primary sector	Agriculture	Fishing, trapping	Forestry, logging	Mining, quarrying, oil wells	Proportion of all industries: Total primary sector	Agriculture	Fishing, trapping	Forestry, logging	Mining, quarrying, oil wells
	persons						percent				
Newfoundland	237 960	20 830	1 490	10 990	4 020	4 330	8.8	0.6	4.6	1.7	1.8
Prince Edward Island	62 560	9 810	5 745	3 550	420	100	15.7	9.2	5.7	0.7	0.2
Nova Scotia	408 695	30 450	9 265	9 050	5 675	6 460	7.5	2.3	2.2	1.4	1.6
New Brunswick	319 200	25 155	8 110	4 315	8 750	3 980	7.9	2.5	1.4	2.7	1.2
Quebec	3 089 530	131 740	78 470	3 870	26 530	22 875	4.3	2.5	0.1	0.9	0.7
Ontario	4 877 015	189 100	137 660	2 540	17 105	31 795	3.9	2.8	0.1	0.4	0.7
Manitoba	535 275	51 760	44 380	995	1 590	4 795	9.7	8.3	0.2	0.3	0.9
Saskatchewan	495 090	105 945	91 655	250	1 575	12 460	21.4	18.5	0.1	0.3	2.5
Alberta	1 280 035	172 045	86 195	260	3 835	79 755	13.4	6.9	0.0	0.3	6.2
British Columbia	1 440 875	105 555	39 140	7 990	39 640	18 790	7.3	2.7	0.6	2.8	1.3
Yukon	13 730	1 125	95	35	135	860	8.2	0.7	0.2	1.0	6.3
Northwest Territories	23 545	2 530	55	230	125	2 115	10.7	0.2	1.0	0.5	9.0
Canada	**12 783 510**	**846 045**	**504 255**	**44 075**	**109 410**	**188 300**	**6.6**	**3.9**	**0.3**	**0.9**	**1.5**

Source:
Statistics Canada. Census of Population.

Table: 3.1.4.4

Merchandise Exports, 1981 - 1989

Year	Total	Live animals	Food, feed beverages and tobacco	Crude materials	Fabricated materials	End products	Live animals	Food, feed beverages and tobacco	Crude materials	Fabricated materials	End products
	billion 1981 dollars						percent				
1981	17.78	0.07	2.06	3.29	5.96	6.49	0.38	11.58	18.51	33.53	36.52
1982	20.12	0.09	2.37	3.74	7.10	6.80	0.42	11.80	18.59	35.29	33.82
1983	25.55	0.14	3.30	5.63	6.85	7.79	0.56	12.90	22.05	34.66	30.49
1984	31.45	0.09	3.98	8.87	10.74	8.55	0.27	12.67	28.21	34.15	27.19
1985	32.14	0.09	4.15	9.22	10.23	9.35	0.27	12.92	28.70	31.83	29.09
1986	37.75	0.11	4.51	12.04	12.26	11.09	0.29	11.94	31.90	32.47	29.38
1987	44.94	0.12	5.23	13.24	14.29	13.92	0.26	11.63	29.45	31.80	30.98
1988	53.90	0.17	5.15	14.67	17.84	17.46	0.32	9.55	27.22	33.10	32.40
1989	64.87	0.22	5.83	19.54	22.18	19.55	0.34	8.99	30.12	34.19	30.14

Source:
Statistics Canada. *Summary of Canadian International Trade*. Catalogue 65-001.
Note:
Exports are calculated on a Balance of Payments basis.
Amounts do not sum to total due to the exclusion of Balance of Payments Adjustments and the exclusion of Special Trade Transactions.
Current dollar export figures were deflated using the current weighted Paasche price index for exports (1961 = 100)

Table: 3.1.4.5

Merchandise Imports, 1981 - 1989

Year	Total	Live animals	Food, feed beverages and tobacco	Crude materials	Fabricated materials	End products	Live animals	Food, feed beverages and tobacco	Crude materials	Fabricated materials	End products
	billion 1981 dollars						percent				
1981	15.31	0.04	1.12	1.32	3.21	9.78	0.26	7.30	8.63	20.93	63.87
1982	17.64	0.04	1.38	1.61	3.59	11.13	0.25	7.84	9.12	20.38	63.13
1983	22.24	0.13	1.94	2.25	4.28	14.01	0.60	8.70	10.12	19.24	63.00
1984	28.91	0.09	2.37	4.31	6.25	16.55	0.32	8.19	14.92	21.63	57.26
1985	31.24	0.07	2.60	5.44	5.82	18.18	0.23	8.32	17.41	18.84	58.20
1986	33.86	0.10	2.58	7.22	6.00	19.79	0.29	7.62	21.32	17.72	58.45
1987	40.20	0.05	3.07	7.26	6.83	24.48	0.11	7.65	18.05	16.99	60.90
1988	48.37	0.07	3.45	8.98	8.32	30.00	0.14	7.14	18.56	17.21	62.03
1989	61.28	0.06	3.84	11.49	11.25	37.23	0.10	6.27	18.75	18.35	60.76

Source:
Statistics Canada. *Summary of Canadian International Trade*. Catalogue 65-001.
Note:
Imports are calculated on a Balance of Payments basis.
Amounts do not sum to total due to the exclusion of Balance of Payments Adjustments and the exclusion of Special Trade Transactions.
Current dollar import figures were deflated using the current weighted Paasche price index for imports (1981 = 100).

3.1.5 Natural Resource Accounting

...figuring profits from logging rarely takes full account of the losses in future revenue incurred through the degradation of the forest. Similar incomplete accounting occurs in the exploitation of other resources, especially the resources that are not capitalised in enterprise or national accounts: air, water and soil. In all countries, rich or poor, economic development must take full account in its measurement of growth of the improvement or deterioration in the stock of natural resources.

World Commission on Environment and Development, 1987.

There is a growing recognition of the need to bring the environment into economics, that this is required to improve both environmental policy and economic policy. This is the motivation for a new project on natural resource and environmental accounting at Statistics Canada.

The Gross Domestic Product, or GDP, is probably the most important economic indicator used by ministries of finance, politicians, bankers and journalists worldwide. It measures the total of all incomes (wages, salaries and profits) generated in the production of goods and services in a given year. GDP is used primarily to measure economic growth - changes in growth rates have important implications for other economic phenomena such as inflation and unemployment.

While GDP is widely interpreted as a measure of welfare, this is incorrect; GDP is simply the measure of total economic activity in the accounting period. Because of this narrow focus, GDP has been subject to criticism from environmental analysts and theorists, notably that it measures the "goods" but not the "bads" associated with production, and that there is no way to determine from the GDP accounts whether an economy is evolving sustainably.

An obvious example of this sort of problem is the industrial plant whose wages, salaries and profits are measured in GDP, but for which the damages caused by its pollution emissions (to buildings, fisheries or tourism for instance) are not measured in GDP. Another example is the depletion of non-renewable resources, where the drawing down of resource stocks is not treated as capital consumption in the standard GDP accounts.

The concept of *sustainable development*, implicitly integrating environmental and economic concerns as presented in the report of the World Commission on Environment and Development, has given new impetus to attempts to supplement the System of National Accounts (of which GDP forms a part) with information on the state and quality of the environment and the natural resource base. Recent suggestions in the literature attempt to bring the environment into the national accounts through deductions from GDP for various aspects of environmental degradation. The different deductions proposed have included the value of pollution abatement and control expenditures, the value of environmental damage in the accounting period, and the depletion of natural resources. Other proposals include a new definition of "sustainable" income from resource exploitation, which would change the existing measure of GDP.

Natural resource accounting complements these approaches by constructing a time series of resource stock and flow accounts, for both living and non-living resources, in physical quantities and values. Valuation of resources is most straightforward where a market price for the resource exists. Imputation of values for non-market resources is more problematic and often intractable; for instance some assets, such as the ozone layer, have no substitutes. Limiting the value accounts to marketable resources would still measure some of the effects of environmental degradation, since the extent and quality of living resources will vary with environmental quality.

Natural resource accounts can have a simple structure. For a non-renewable resource the closing stock of resource should equal the opening stock, less extraction, plus discoveries, plus or minus revisions (which represent changes in stock estimates). For a renewable resource extraction would be replaced by harvest and discoveries by net growth in this accounting structure. Resource accounts for living resources may also include negative entries for damage from environmental deterioration.

The natural resource accounting project at Statistics Canada will have at least three benefits: (i) it will provide a coherent and comprehensive accounting of Canada's resource status within a national accounting framework; (ii) it will expand the data base on which environmental and economic policy-making depends, making tradeoffs in dollar values explicit; and (iii) it will provide a limited measurement of sustainability by tracking the value of both human-made and natural assets over time. The last point implies expanding the concept of *wealth* in the national accounts - this is important because wealth, in economics, represents the potential for future income.

There is no international consensus on how to deal with these issues. Both the United Nations and the World Bank are carrying out research programmes on environment and national accounting. It is likely that different approaches will be pursued experimentally by different countries, through "satellite accounts" to the National Accounts that, while not fully integrated with the accounts, provide explicit links to them. Statistics Canada is a major participant in this international effort.

3.2 Socio-economic Processes

Many environmental impacts are the unintended results of socio-economic processes. The consumption of goods drives a process of production. Production, in turn, consumes resources, generates wastes and restructures the environment. When we buy a car, we have little idea of the amount of steel and energy consumed in the process. We are never told how much waste has been generated in producing one car.

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The nature and extent of the economic processes change over time, and consumer preferences and priorities also change. The proliferation of *green* products over the past few years is evidence of of an increased awareness of environmental concerns by producers and consumers.

This section provides an overview of the **production** and **consumption** by industries, the consumption by households and the efforts of governments and industry to mitigate the detrimental impacts of these processes.

3.2.1 Production

The greatest economic dependence on energy-intensive, resource-intensive, contaminant-intensive and water-intensive industries occurs outside of urban-industrialized centres.

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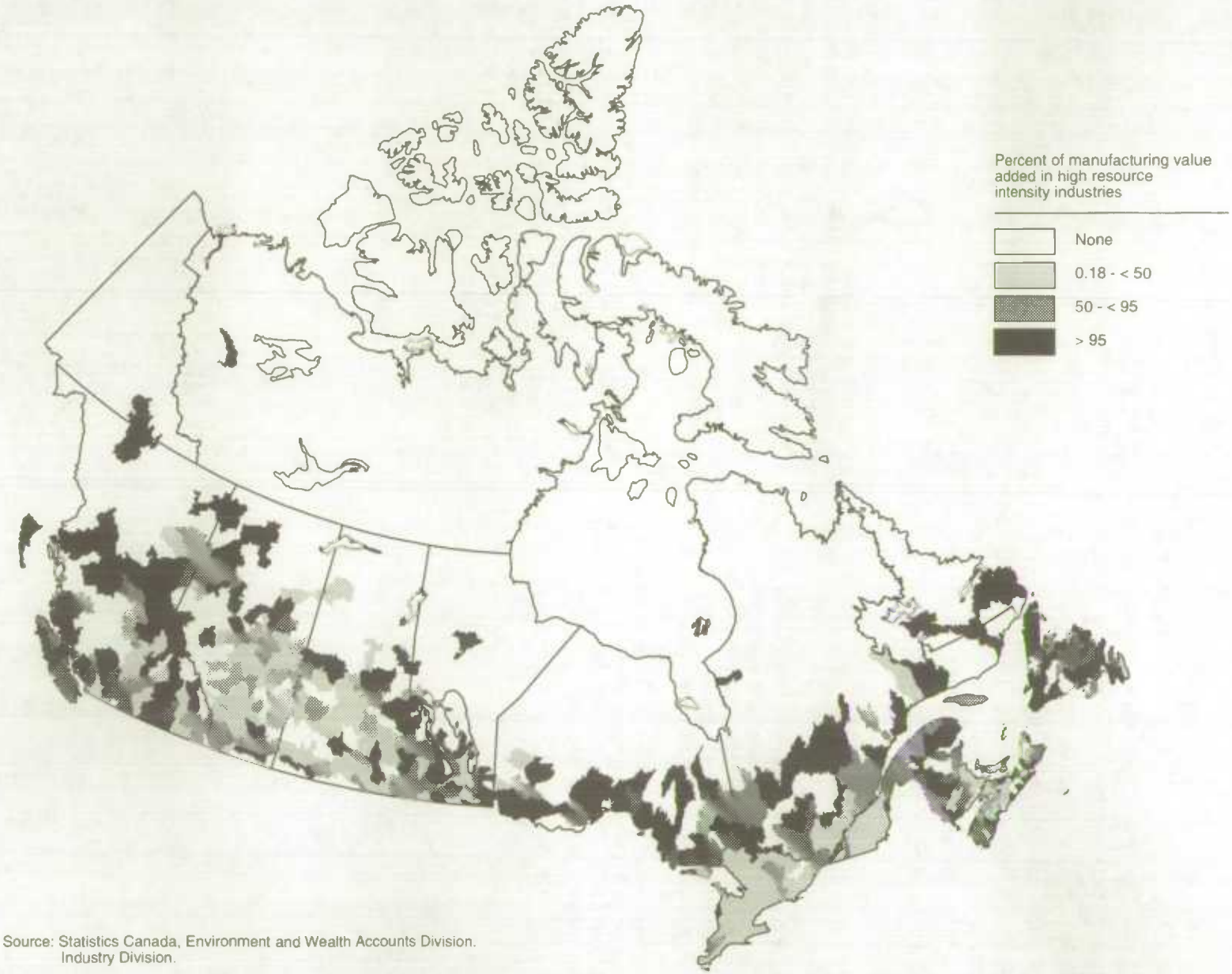
One indicator of the level of production of a given industry is its total value added. This is measured by gross output less purchased commodity inputs (raw materials, fuel, etc.) and contract work by others. The industrial impact classification presented in the **Industry** section is used here to provide an overview of where in Canada the high impact industries predominate. In the following maps, the total value added of manufacturing in a sub-sub basin is compared to the value added of high impact industries in that basin.

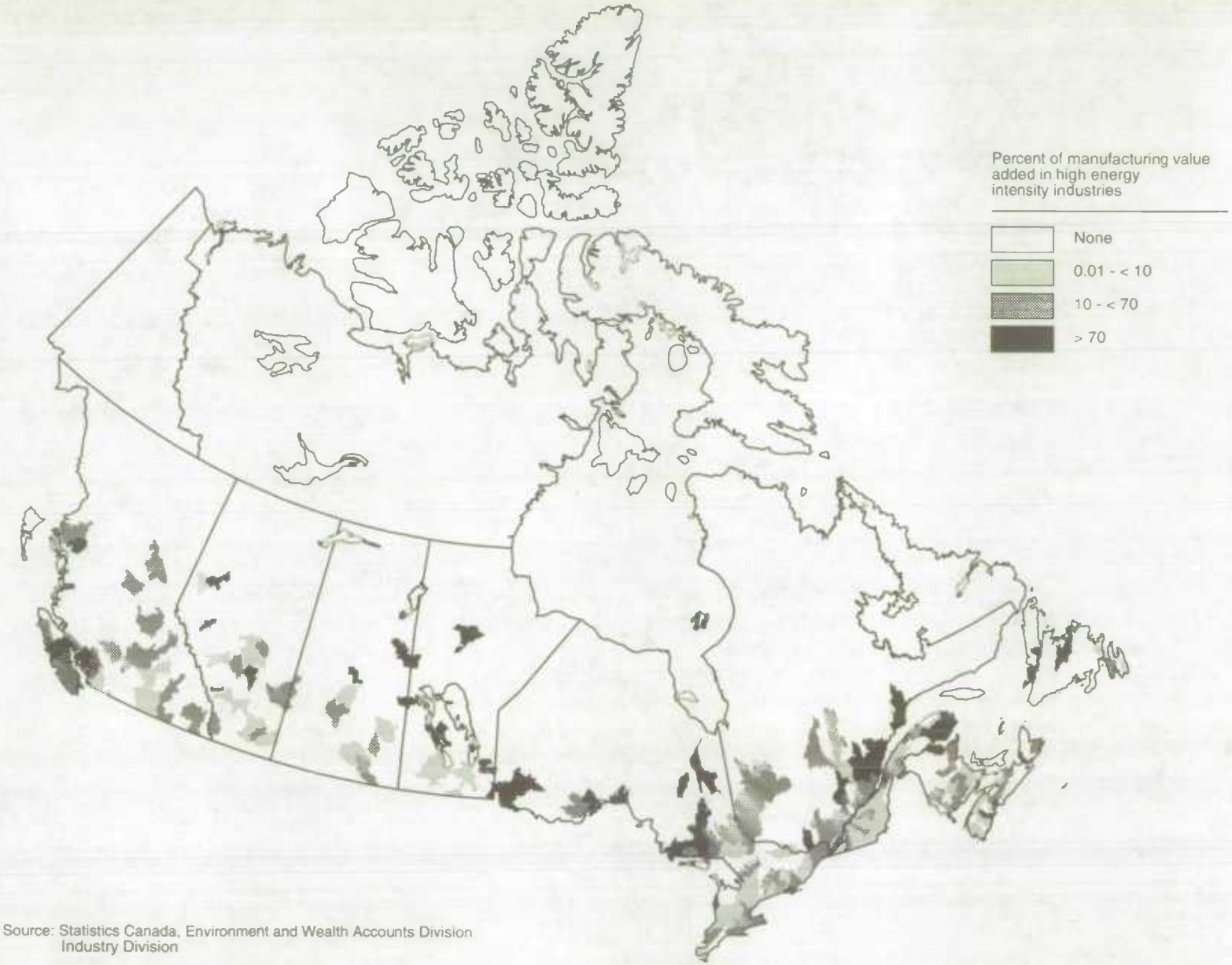
Maps 3.2.1.1 through 3.2.1.4 illustrate the economic importance of resource-intensive, energy-intensive, contaminant-intensive and water-intensive industries by sub-sub drainage basin. Note that this is not an indication of the *magnitude* of the impacts; for example, there are areas of north-western Ontario with a higher dependence on contaminant-intensive industries than southern Ontario. Tables 3.1.1.6 and 3.1.1.7, in the **Industry** section show that southern Ontario had a much larger number of these industries.

Resource Intensity in Manufacturing, 1986



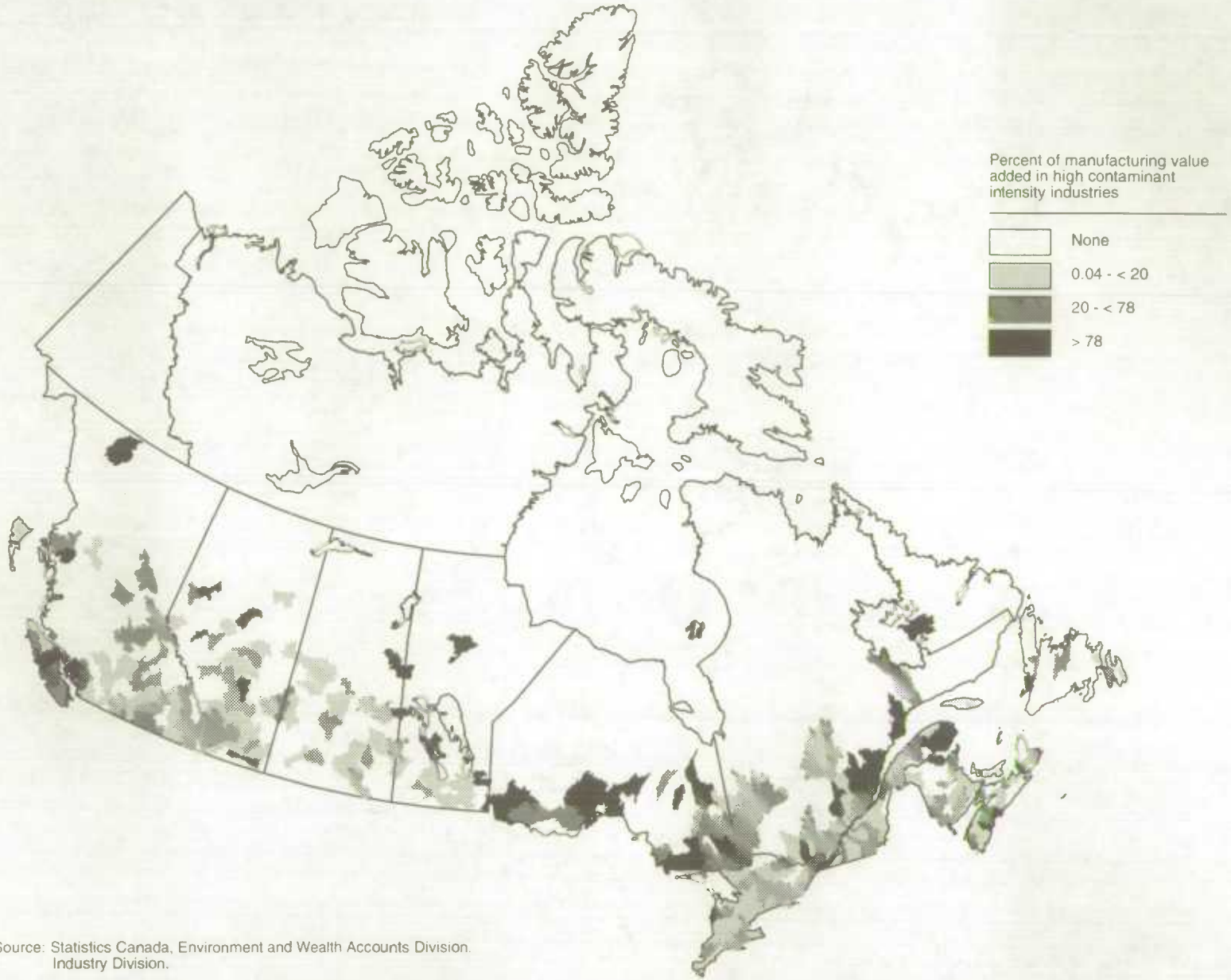
Source: Statistics Canada, Environment and Wealth Accounts Division. Industry Division.

Energy Intensity in Manufacturing, 1986



Source: Statistics Canada, Environment and Wealth Accounts Division
Industry Division

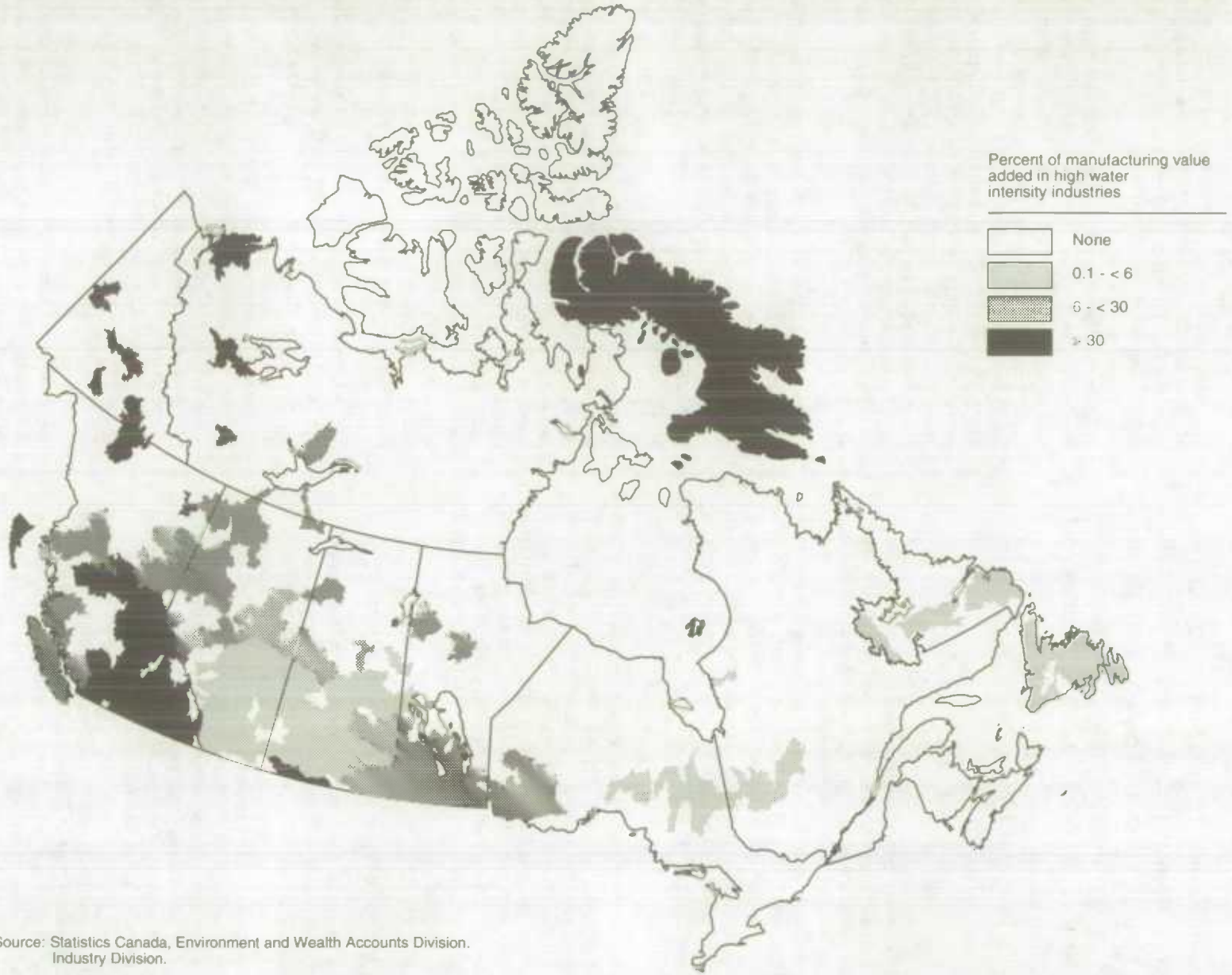
Contaminant Intensity in Manufacturing, 1986



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

Map: 3.2.1.4

Water Intensity in Manufacturing, 1986



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

3.2.2 Consumption

Although Canadians are still the highest users of energy in the world, demand per capita has been slowing down. The economy is also becoming less dependent on energy-intensive industries. Total primary energy demand per unit Real GDP decreased by 13 percent between 1958 and 1989.

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Energy is a key factor in economic development and is directly related to important environmental concerns such as the greenhouse effect and the risks associated with nuclear power. In the past, sources of energy such as coal, hydro-power, electricity, petroleum and nuclear power provided the energy necessary to power human inventions and promote economic growth. As a result, human activities changed drastically as did the relationship between the human species and its environment. This section explores some of the facts and issues related to energy, human activities and the environment.

Household consumption of durable and non-durable goods drives a major proportion of industrial production. What people buy, such as gasoline or pesticides, may have a direct effect on the environment. The impacts of some other commodities are less direct. The demand for cars, creates a demand for steel and energy. This in turn, creates a demand for iron ore, fossil fuels and hydro power. This section provides a summary of the levels of consumption of some selected commodities.

Energy Production and Consumption

The energy sector plays an important role in the Canadian economy. Between 1983 and 1987, this sector represented an average of 8 percent of Canada's Gross Domestic Product (GDP), 19 percent of gross investment, 12 percent of gross export income, and 4 percent of employment. Canada produces more energy than it consumes (production exceeded consumption by more than 25 percent from 1985 to 1989). The Canadian energy production itself requires large amounts of energy. This contributes to the high level of energy consumption in Canada.

Until 1974, energy demand in Canada increased by more than 6 percent per year (Table 3.2.2.2, Figures 3.2.2.1 and 3.2.2.5). The growth in demand slowed drastically for the following ten years (0.3 percent per year). Then it resumed a higher growth rate from 1984 to 1989 (about 3.7 percent per year). Several factors contributed to these movements.

The increase in population explains part of the primary energy demand growth. Per capita primary energy demand (Table 3.2.2.4, Figure 3.2.2.2) has been expanding at lower rates (4.3 percent per year for 1958 to 1974, -0.8 percent for 1974-84 and 2.7 percent for 1984-89) than total demand. The gradual slowing down of population growth in the future may reduce energy demand in the future.

In addition to the growth in energy demand because of an increasing population, energy demand also changes according to the efficiency and mix of energy-intensive industries. Constant Price Gross Domestic Product (Real GDP) increased more rapidly (2.7 times) than total primary energy demand (2.2 times) between 1958 and 1989. Thus, total primary energy demand per Real GDP was 13 percent lower in 1989 than in 1958 (Table 3.2.2.4, Figure 3.2.2.3). There was a large increase in this ratio up to 1974 followed by a steep decline up to 1986 before it stabilized. This change in trend coincided with the dramatic increase in energy prices.

The drop in primary energy demand per dollar of Real GDP suggests that Canadians used energy more efficiently. It also reflects the gradual decline of the relative contribution of the energy-intensive industries as described in the **Industry** section. Thus, Canadians consumed less energy per unit of Real GDP because industries produced a lower proportion of energy-intensive goods.

Conversion to secondary energy (mostly electricity), consumption by energy producer and non-energy use (e.g., natural gas used for plastics) has been increasing to represent more than 25 percent of total primary energy demand since 1985 (Table 3.2.2.2). Final energy consumption by industry and transportation increased at a rapid rate after the important drop during the 1981-82 recession (Figure 3.2.2.5). Residential and farm consumption was stable from 1978 to 1989, while the number of dwellings increased considerably. This suggests that better home insulation may have reduced energy demand.

The sources of energy determine to some extent the impact of energy consumption. Fossil fuels, for example, produce carbon dioxide (CO_2) when burned to produce energy. CO_2 emissions from fossil fuel consumption have been closely tied to primary energy demand (Figure 3.2.2.7). The relative decline of crude oil and coal as sources of energy (Table 3.2.2.3, Figure 3.2.2.6) has helped to lower CO_2 emissions from fossil fuels per unit of energy consumed (Table 3.2.2.4). Although natural gas consumption increased, it generates relatively less CO_2 than oil and coal. As a result, CO_2 emissions from fossil fuels per capita was stable from mid-1970s to 1989.

The interplay of population, economic growth, energy prices, and changes in energy intensity will determine future demand for primary energy. The effect of this demand on the environment will depend on these factors as well as the growth of alternative sources of power such as nuclear and solar energy.

Household Consumption

Data shown in Table 3.2.2.5 are derived from the Statistics Canada Family Expenditures Survey, conducted in 1986. The expenditures selected for the table include the major components (food, household operation, clothing, etc.) and selected items, relevant because of:

- energy consumption (gasoline, electricity, appliances, vehicles)
- resource consumption (automobiles, paper products, water)
- contaminant generation (paints, chemicals, pesticides, batteries)
- waste generation (fuel, paper products, disposable products)
- disturbance of wildlife (recreational vehicles, motorboats, snowmobiles)
- appreciation of wildlife and outdoor activities (campgrounds, recreation services, sporting and athletic equipment).

The 1990 Statistics Canada *Survey of Households and the Environment* provides detail on some specific consumer items, such as the use of disposable diapers. An estimated 10.6 percent of household using diapers for children never use disposable diapers. Table 3.2.2.1 below provides more detail on this question.

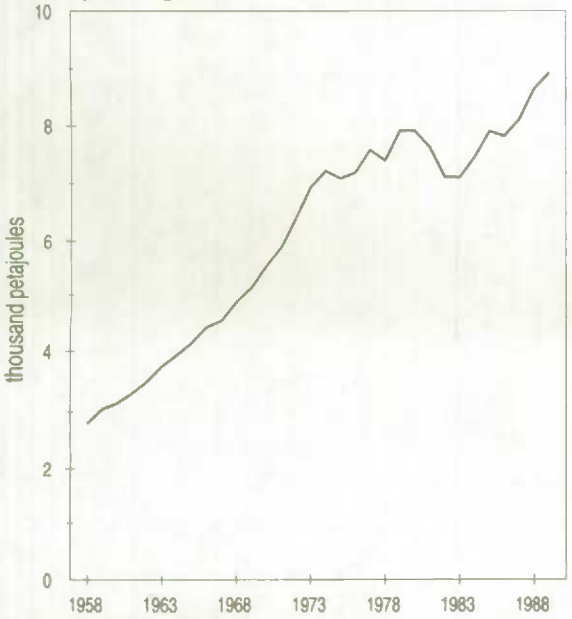
Table: 3.2.2.1
Consumption of Disposable Diapers for Children, 1990

	Number of households	Percent of diaper users
	thousands	percent
Total Households using diapers	**862.1**	**100.0**
Always use disposables	523.1	60.7
Mostly use disposables	74.9	8.7
Sometimes use disposables	173.1	20.1
Never use disposables	91.0	10.6
Total households not using diapers	**8 763.9**	
Households with children less than 4 years old not in diapers	249.6	
Households without children < 4 years old	8 428.5	
Not stated	85.8	

Source:
Statistics Canada. Environment and Wealth Accounts Division.

Figure: 3.2.2.1

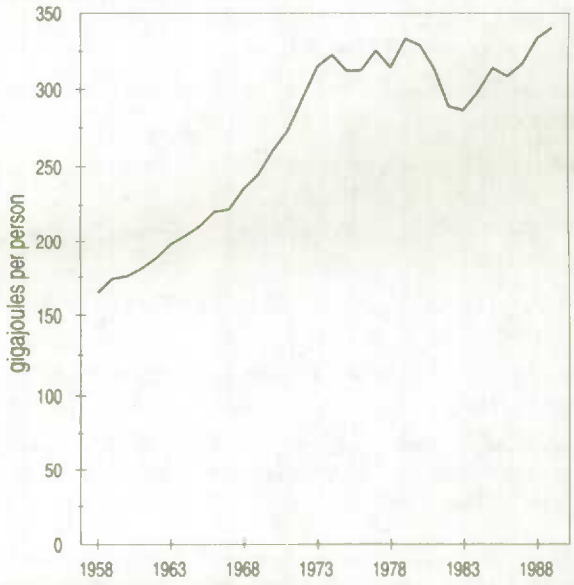
Primary Energy Consumption, 1958-1989



Source: Statistics Canada. Detailed Energy Supply and Demand in Canada. Catalogue 57-505 and 57-207.

Figure: 3.2.2.2

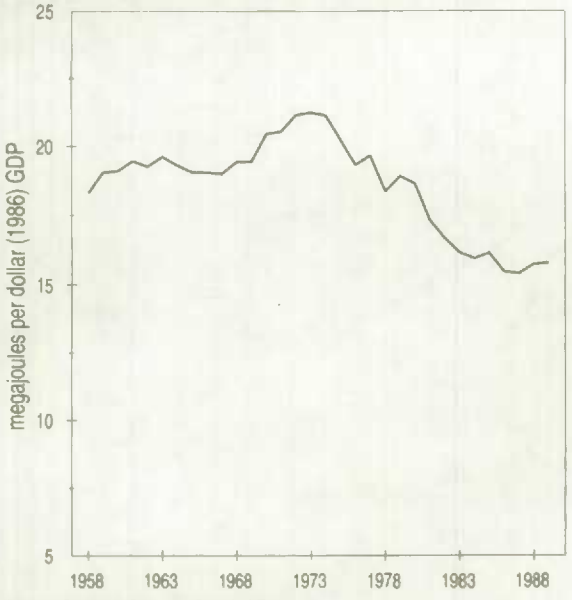
Primary Energy Consumption per Capita, 1958-1989



Source: Statistics Canada. Detailed Energy Supply and Demand in Canada. Catalogue 57-505 and 57-207.

Figure: 3.2.2.3

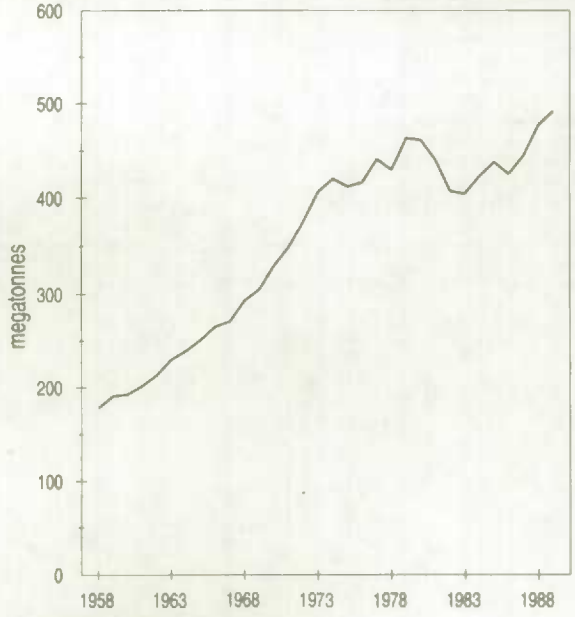
Primary Energy Consumption per Dollar Real GDP, 1958-1989



Source: Statistics Canada. Detailed Energy Supply and Demand in Canada. Catalogue 57-505 and 57-207.

Figure: 3.2.2.4

Carbon Dioxide Emissions from Fossil Fuels, 1958-1989



Source: Statistics Canada. Environment and Wealth Accounts Division.

Table: 3.2.2.2

Consumption of Primary Energy, 1958-1989

	Conversion to secondary energy	Producer consumption	Non-energy use	Final energy consumption				
				Industrial	Transportation	Residential and agriculture	Public administration, commerce and others	Total
	petajoules							
1958	23	196	18	808	776	674	197	2 455
1959	50	216	18	892	783	739	236	2 651
1960	59	231	22	917	786	753	261	2 717
1961	130	232	19	934	764	764	288	2 751
1962	135	273	19	978	838	805	311	2 932
1963	196	289	20	997	882	846	359	3 084
1964	139	318	21	1 085	932	889	396	3 301
1965	89	356	25	1 166	990	913	449	3 518
1966	154	381	29	1 223	1 054	915	507	3 700
1967	73	407	28	1 277	1 108	955	559	3 899
1968	141	441	29	1 335	1 165	996	634	4 130
1969	141	479	34	1 406	1 208	1 044	694	4 353
1970	217	539	34	1 474	1 275	1 093	739	4 581
1971	408	570	23	1 499	1 319	1 113	775	4 706
1972	607	621	20	1 575	1 413	1 193	874	5 055
1973	843	675	32	1 757	1 541	1 154	785	5 237
1974	927	657	39	1 846	1 601	1 240	810	5 498
1975	873	679	33	1 753	1 624	1 226	764	5 367
1976	743	671	49	1 856	1 691	1 240	842	5 630
1977[1]	977	702	57	1 970	1 737	1 202	860	5 769
1978[1]	615	470	476	1 912	1 667	1 359	892	5 830
1979	839	401	516	2 024	1 880	1 369	892	6 166
1980	824	398	530	2 004	1 928	1 371	853	6 157
1981	764	364	532	1 903	1 794	1 288	964	5 949
1982	626	345	458	1 733	1 574	1 318	1 050	5 675
1983	722	328	502	1 709	1 507	1 284	1 014	5 515
1984	817	343	558	1 871	1 584	1 245	1 036	5 736
1985	719	726	615	1 904	1 625	1 297	1 020	5 847
1986	607	760	609	1 940	1 622	1 285	1 021	5 887
1987	723	816	664	2 012	1 709	1 240	957	5 918
1988	809	850	677	2 122	1 839	1 326	1 021	8 309
1989	833	911	677	2 128	1 871	1 425	1 076	6 499

Source:
Statistics Canada. *Detailed Energy Supply and Demand in Canada*. Catalogue 57-505 and 57-207.
Statistics Canada. *Quarterly Report on Energy Supply-Demand in Canada*. Catalogue 57-003.
Note:
There is a break in the time series between 1977 and 1978. This break affected mostly estimates for conversion to secondary energy, producer consumption and non-energy use.

Figure: 3.2.2.5

Final Energy Consumption by Sector, 1958-1989

Source: Statistics Canada. Detailed Energy Supply and Demand in Canada. Catalogue 57-505 and 57-003.

Table: 3.2.2.3

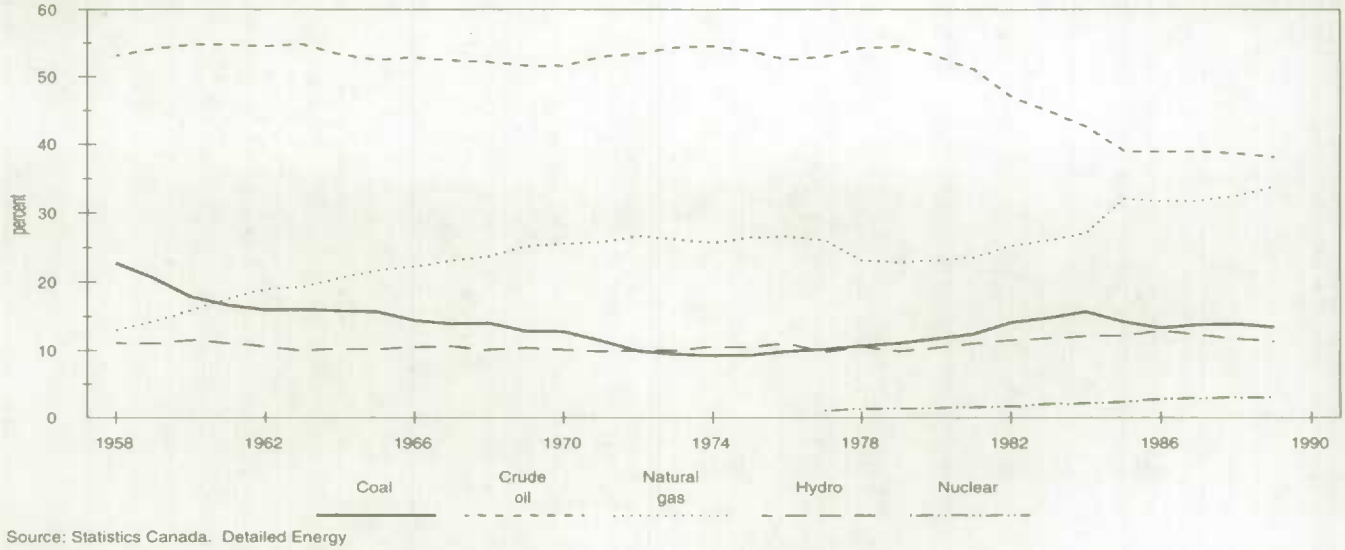
Sources of Primary Energy, 1958-1989

	Coal	Crude oil	Natural gas[1]	Hydro	Nuclear	Steam	Total
				petajoules			
1958	637	1 490	366	312	..	..	2 806
1959	625	1 644	433	334	..	..	3 037
1960	559	1 715	497	362	..	..	3 134
1961	548	1 803	579	364	..	..	3 294
1962	557	1 903	662	370	..	..	3 491
1963	598	2 050	721	371	..	..	3 740
1964	621	2 092	809	405	..	..	3 926
1965	648	2 168	895	421	..	..	4 131
1966	635	2 328	982	464	..	..	4 408
1967	629	2 372	1 045	479	..	..	4 524
1968	683	2 544	1 160	490	..	..	4 878
1969	660	2 654	1 294	533	..	..	5 141
1970	708	2 860	1 418	559	..	..	5 545
1971	673	3 119	1 518	579	..	..	5 890
1972	635	3 425	1 711	641	..	..	6 411
1973	654	3 771	1 818	695	..	..	6 937
1974	665	3 931	1 851	762	..	..	7 209
1975	658	3 806	1 873	744	..	..	7 081
1976	709	3 770	1 912	792	..	..	7 183
1977	770	4 011	1 974	737	83	..	7 574
1978	789	4 011	1 710	780	98	..	7 388
1979	876	4 310	1 811	781	107	24	7 910
1980	928	4 196	1 831	817	118	20	7 910
1981	948	3 887	1 798	841	121	30	7 625
1982	1 002	3 332	1 791	820	116	44	7 106
1983	1 048	3 183	1 847	838	146	37	7 098
1984	1 167	3 170	2 016	901	157	36	7 448
1985	1 122	3 077	2 532	962	183	24	7 900
1986	1 040	3 038	2 481	1 009	222	28	7 817
1987	1 118	3 155	2 574	1 001	234	23	8 105
1988	1 200	3 339	2 810	1 015	263	13	8 640
1989	1 198	3 402	3 026	1 011	266	21	8 923

Source:
Statistics Canada. *Detailed Energy Supply and Demand in Canada.* Catalogue 57-505 and 57-207.
Statistics Canada. *Quarterly Report on Energy Supply-Demand in Canada.* Catalogue 57-003.
Statistics Canada. *Electric Power Statistics, Volume II.* Catalogue 57-202.
Note:
[1] Natural Gas includes propane, butane and ethane.

Figure: 3.2.2.6

Composition of Primary Energy Supply, 1958-1989



Source: Statistics Canada. Detailed Energy Supply and Demand in Canada. Catalogue 57-505 and 57-003.

Table: 3.2.2.4

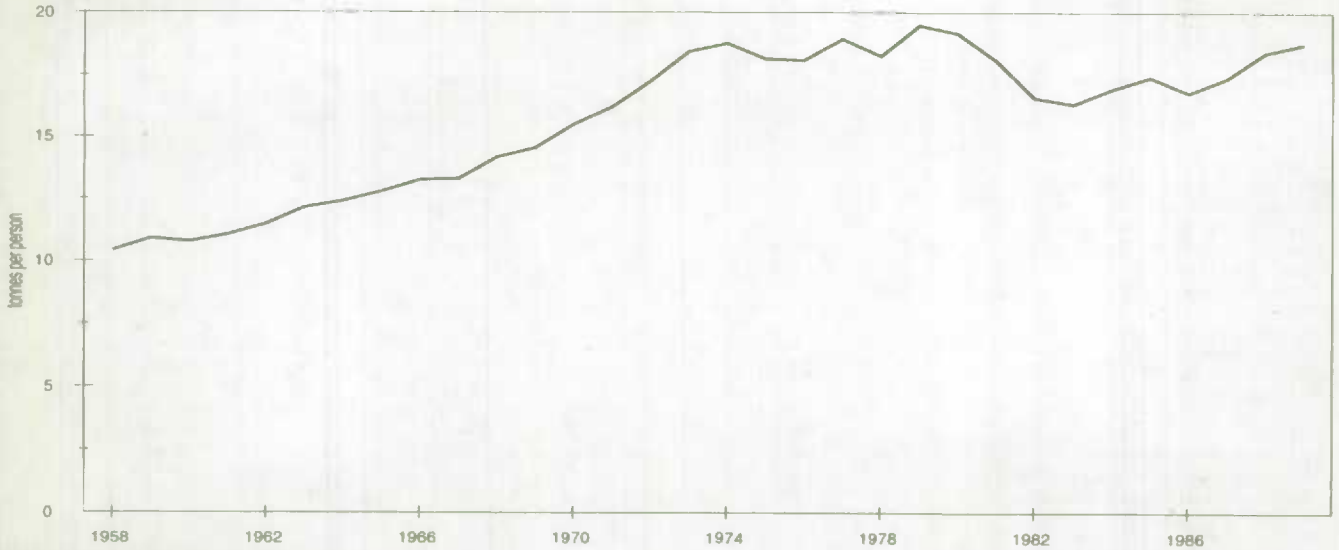
Energy Indicators, 1958-1989

	Primary energy demand	Population	Real GDP in 1986$	CO_2 emissions by fossil fuels	Primary energy demand per capita	Primary energy demand per $ of real GDP	CO_2 emissions per capita	CO_2 emissions per $ of real GDP	CO_2 emissions per unit of primary energy
	petajoules	thousands	billions	megatonnes	gigajoules per capita	megajoules per 1986$	tonnes per capita	kilograms per 1986$	kilotonnes per petajoule
1958	2 806	17 080	153.4	177.8	164.3	18.3	10.4	1.16	63.4
1959	3 037	17 483	159.5	190.5	173.7	19.0	10.9	1.19	62.7
1960	3 134	17 870	164.1	192.4	175.4	19.1	10.8	1.17	61.4
1961	3 294	18 238	169.3	201.4	180.6	19.5	11.0	1.19	61.1
1962	3 491	18 583	181.3	213.1	187.9	19.3	11.5	1.18	61.0
1963	3 740	18 931	190.7	229.8	197.6	19.6	12.1	1.21	61.4
1964	3 926	19 291	203.4	239.1	203.5	19.3	12.4	1.18	60.9
1965	4 131	19 644	216.8	251.0	210.3	19.1	12.8	1.16	60.8
1966	4 408	20 015	231.5	265.1	220.2	19.0	13.2	1.14	60.1
1967	4 524	20 378	238.3	270.6	222.0	19.0	13.3	1.14	59.8
1968	4 878	20 701	251.1	293.1	235.6	19.4	14.2	1.17	60.1
1969	5 141	21 001	264.5	305.1	244.8	19.4	14.5	1.15	59.3
1970	5 545	21 297	271.4	329.7	260.4	20.4	15.5	1.21	59.4
1971	5 890	21 568	287.0	349.0	273.1	20.5	16.2	1.22	59.3
1972	6 411	21 801	303.4	375.8	294.1	21.1	17.2	1.24	58.6
1973	6 937	22 043	326.8	406.4	314.7	21.2	18.4	1.24	58.6
1974	7 209	22 364	341.2	419.9	322.3	21.1	18.8	1.23	58.2
1975	7 081	22 697	350.1	411.8	312.0	20.2	18.1	1.18	58.2
1976	7 183	22 993	371.7	416.1	312.4	19.3	18.1	1.12	57.9
1977	7 574	23 273	385.1	441.0	325.4	19.7	19.0	1.15	58.2
1978	7 388	23 517	402.7	429.6	314.1	18.3	18.3	1.07	58.2
1979	7 910	23 747	418.3	463.0	333.1	18.9	19.5	1.11	58.5
1980	7 910	24 042	424.5	461.1	329.0	18.6	19.2	1.09	58.3
1981	7 625	24 342	440.1	440.2	313.3	17.3	18.1	1.00	57.7
1982	7 106	24 583	426.0	407.2	289.0	16.7	16.6	0.96	57.3
1983	7 098	24 787	439.4	404.1	286.4	16.2	16.3	0.92	56.9
1984	7 448	24 978	467.2	422.6	298.2	15.9	16.9	0.90	56.7
1985	7 900	25 165	489.4	437.8	313.9	16.1	17.4	0.89	55.4
1986	7 817	25 353	505.7	425.1	308.3	15.5	16.8	0.84	54.4
1987	8 105	25 617	526.1	444.9	316.4	15.4	17.4	0.85	54.9
1988	8 640	25 909	549.2	476.6	333.5	15.7	18.4	0.87	55.2
1989	8 923	26 223	565.7	491.4	340.3	15.8	18.7	0.87	55.1

Source:
Statistics Canada, Environment and Wealth Accounts Division.
Note:
CO_2 emissions are calculated with the following factors applied to energy demand in petajoules: 25*44/12000 for coal, 18.5*44/12000 for crude oil and 13.6*44/12000 for natural gas

Figure: 3.2.2.7

Carbon Dioxide Emissions from Fossil Fuels
per Capita, 1958-1989



Source: Statistics Canada. Environment and Wealth Accounts Division.

Table: 3.2.2.5

Selected Household Expenditures, 1986

Expenditure item	Average per family[1]	Percentage reporting	Estimated number of families[2]	Average[3] per family reporting	Total[4] expenditure	Percent of total current consumption[5]
	dollars	percent	thousands	dollars	million dollars	percent
Food	**5 013**	**100.0**	**8 849**	**5 013**	**44 362**	**19.3**
Shelter	**5 680**	**99.7**	**8 823**	**5 697**	**50 264**	**21.9**
Maintenance	369	44.9	3 973	822	3 265	1.4
Replacement of heating and air conditioning equipment	22	1.8	159	1 222	195	0.1
Replacement of built-in appliances	2	0.3	27	667	18	0.0
Caulking and weather stripping	2	0.9	80	222	18	0.0
Materials	130	34.9	3 088	372	1 150	0.5
Painting (interior and exterior)	34	25.4	2 248	134	301	0.1
Replacement of heating and air conditioning equipment	3	0.7	62	429	27	0.0
Replacement of built-in appliances (materials)	3	0.6	53	500	27	0.0
Caulking and weather stripping	4	7.0	619	57	35	0.0
Water	91	48.3	4 274	188	805	0.4
Fuel oil and other liquid fuel	156	19.1	1 690	817	1 381	0.6
Piped gas	227	33.4	2 956	680	2 009	0.9
Bottled gas	9	16.3	1 442	55	80	0.0
Fuel wood	31	13.8	1 221	225	274	0.1
Other fuel and heating costs	2	4.9	434	41	18	0.0
Electricity	575	86.1	7 619	668	5 088	2.2
Owned Vacation Home	101	7.4	655	1 365	894	0.4
Water and Fuel	5	2.0	177	250	44	0.0
Electricity	16	5.1	451	314	142	0.1
Campgrounds	14	11.2	991	125	124	0.1
Rented vacation homes	22	4.0	354	550	195	0.1
Household Operation	**1 525**	**99.9**	**8 841**	**1 527**	**13 495**	**5.9**
Cleaning supplies	230	98.4	8 708	234	2 035	0.9
Detergent and soap	110	98.0	8 672	112	973	0.4
Cleaning and polishing preparations	59	95.8	8 478	62	522	0.2
Chemical specialities	61	95.2	8 425	64	540	0.2
Bleach	14	81.6	7 221	17	124	0.1
Fabric softeners	24	74.6	6 602	32	212	0.1
Disinfectants and deodorizers	11	64.8	5 734	17	97	0.0
Paper, plastic and foil household supplies	231	99.4	8 796	232	2 044	0.9
Paper towels	28	85.8	7 593	33	248	0.1
Facial and bathroom tissue	80	97.5	8 628	82	708	0.3
Plastic garbage bags	25	80.2	7 097	31	221	0.1
Other plastic supplies	11	50.0	4 425	22	97	0.0
Foil supplies	16	81.7	7 230	20	142	0.1
Horticultural goods and services	115	73.2	6 478	157	1 018	0.4
Seeds	7	33.4	2 956	21	62	0.0
Nursery and greenhouse stock	30	39.7	3 513	76	265	0.1
Potted plants, cut flowers, etc	30	45.4	4 018	66	265	0.1
Herbicides, insecticides and rodenticides	8	33.2	2 938	24	71	0.0
Fertilizers, soil and soil conditioners	14	41.4	3 664	34	124	0.1
Horticultural services and snow removal	27	14.8	1 310	182	239	0.1
Other household supplies	53	95.4	8 442	56	469	0.2
Dry-cell batteries	15	65.3	5 779	23	133	0.1
Household furnishings and equipment	**1 278**	**93.9**	**8 310**	**1 361**	**11 309**	**4.9**
Air conditioning and refrigeration	61	12.5	1 106	488	540	0.2
Appliances for cooking and warming food	100	36.6	3 239	273	885	0.4
Electric appliances for food preparation	8	11.2	991	71	71	0.0
Appliances for laundry	60	18.0	1 593	333	531	0.2
Other electric equipment and appliances	53	24.9	2 203	213	469	0.2
Portable electric lamps	17	15.7	1 389	108	150	0.1
Home and workshop tools and equipment	59	32.9	2 911	179	522	0.2
Lawn, garden and snow removal tools	70	32.2	2 849	217	619	0.3
Lawn and garden tractors and tillers	22	1.8	159	1 222	195	0.1
Power lawn-mowers	19	6.4	566	297	168	0.1
Snow blowers	14	1.9	168	737	124	0.1
Other lawn and garden tools	15	27.8	2 460	54	133	0.1
Clothing	**2 215**	**99.5**	**8 805**	**2 226**	**19 601**	**8.5**
Dry-cleaning service	71	73.1	6 469	97	628	0.3
Transportation	**4 656**	**98.2**	**8 690**	**4 741**	**41 203**	**17.9**
Private transportation	4 235	85.0	7 522	4 982	37 477	16.3
Purchase of private automobiles and trucks	1 953	28.2	2 496	6 926	17 283	7.5
Rented and leased automobiles and trucks	99	12.3	1 088	805	876	0.4

Selected Household Expenditures, 1986

Expenditure item	Average per family[1]	Percentage reporting	Estimated number of families[2]	Average[3] per family reporting	Total[4] expenditure	Percent of total current consumption[5]
	dollars	percent	thousands	dollars	million dollars	percent
Operation of automobiles and trucks	2 162	84.1	7 442	2 571	19 132	8.3
Automotive fuels	991	80.4	7 115	1 233	8 770	3.8
Tires	84	33.3	2 947	252	743	0.3
Batteries	14	17.8	1 575	79	124	0.1
Maintenance and repair	333	74.0	6 549	450	2 947	1.3
Oil changes and lubrication	55	59.3	5 248	93	487	0.2
Tune-ups	53	39.3	3 478	135	469	0.2
Public transportation	421	75.6	6 690	557	3 726	1.6
Local and commuter transportation	162	63.6	5 628	255	1 434	0.6
Street car, city bus and subway	95	44.9	3 973	212	841	0.4
Commuter bus and train	10	6.7	593	149	88	0.0
Local taxi service	33	34.7	3 071	95	292	0.1
Other local transportation	13	8.3	734	157	115	0.1
Inter-city transportation	259	42.3	3 743	612	2 292	1.0
Air	211	21.8	1 929	968	1 867	0.8
Rail	13	7.4	655	176	115	0.1
Highway bus	14	12.6	1 115	111	124	0.1
Other passenger transportation	9	10.3	911	87	80	0.0
Other inter-city transportation	4	11.2	991	36	35	0.0
Health Care	**648**	**95.9**	**8 487**	**676**	**5 734**	**2.5**
Personal Care	**679**	**99.8**	**8 832**	**680**	**6 009**	**2.6**
Toilet preparations and cosmetics	264	98.9	8 752	267	2 336	1.0
Toilet and other personal soap	31	93.0	8 230	33	274	0.1
Disposable razors and razor blades	15	66.6	5 894	23	133	0.1
Disposable diapers	33	9.8	867	337	292	0.1
Personal care electric equipment	12	27.3	2 416	44	106	0.0
Recreation	**1 771**	**95.9**	**8 487**	**1 847**	**15 672**	**6.8**
Sporting and athletic equipment	103	44.5	3 938	231	911	0.4
Downhill skiing	16	5.0	442	320	142	0.1
Cross-country skiing	5	3.9	345	128	44	0.0
Fishing	13	17.0	1 504	76	115	0.1
Sleighs, toboggans and childrens vehicles	5	9.9	876	51	44	0.0
Tents, back packs, sleeping bags	8	8.8	779	91	71	0.0
Other camping equipment	5	8.4	743	60	44	0.0
Supplies and parts for recreational equipment	12	17.8	1 575	67	106	0.0
Rental, maintenance and repairs	3	4.5	398	67	27	0.0
Recreation vehicles and outboard motors	305	36.1	3 195	845	2 699	1.2
Bicycles	25	14.1	1 248	177	221	0.1
Travel trailers	24	0.8	71	3 000	212	0.1
Tent trailers	4	0.6	53	667	35	0.0
Motorcycles	26	2.9	257	897	230	0.1
Snowmobiles	18	1.6	142	1 125	159	0.1
Motor homes	21	0.3	27	7 000	186	0.1
Truck campers	10	0.3	27	3 333	88	0.0
Boats (including canoes)	27	1.8	159	1 500	239	0.1
Other recreational vehicles	29	2.3	204	1 261	257	0.1
Outboard motors	13	1.2	106	1 083	115	0.1
Fuels	25	15.5	1 372	161	221	0.1
Home entertainment equipment and services	388	76.2	6 743	509	3 434	1.5
Recreation services	630	88.9	7 867	709	5 575	2.4
Skiing memberships	5	1.9	168	263	44	0.0
Skiing fees	13	9.4	832	138	115	0.1
Reading materials and other printed matter	**205**	**92.6**	**8 195**	**221**	**1 814**	**0.8**
Newspapers	82	80.9	7 159	101	726	0.3
Magazines and periodicals	51	68.1	6 026	75	451	0.2
Education	**296**	**44.1**	**3 903**	**671**	**2 619**	**1.1**
Tobacco products and alcoholic beverages	**1 128**	**89.2**	**7 894**	**1 265**	**9 982**	**4.3**
Miscellaneous	**899**	**94.5**	**8 363**	**951**	**7 956**	**3.5**
Total current consumption[5]	**25 994**	**100.0**	**8 849**	**25 994**	**230 031**	**100.0**

Source:
Statistics Canada. *Family Expenditures in Canada, 1986.* Catalogue 62-255.

Notes:
[1] This is the average of all families including those who reported no expenditures in this category.
[2] The 1986 Family Expenditures survey samples 10 356 families. The figures above are based on an estimated 8,849,370 families for Canada.
[3] This is the average of those families reporting expenditures for this category.
[4] Total expenditures for Canada.
[5] **Current consumption** includes all expenditures except: personal taxes, security, gifts and contributions.

3.2.3 Mitigation

In 1989-90, all levels of government spent 6.5 billion dollars on water purification, pollution control, sewage collection and water purification. Another 12.6 billion dollars was spent on resource conservation and the development of resource industries. Total government revenues from natural resources and taxes on resources amounted to 14.5 billion dollars.

There are efforts at many levels of society to limit the negative impacts of human activities on the environment and to control the depletion of natural resources. Governments, non-governmental organizations, industries and individuals have all changed their behaviour in response to the growing concern over the environment and natural resources. One way of measuring the level of activity by governments is through expenditures on environment and natural resource programmes.

Expenditures on Construction

In 1990, a total of 3 billion dollars was spent on waterworks and sewage systems. Another 560 million dollars was spent on dams and irrigation (Table 3.2.3.1). These data are derived from a survey of organizations and individuals paying for work done. Contractors performing the work are also surveyed.

Government Finance Relevant to the Environment

Expenditures

In 1990, total government expenditures on functions related to the environment (water purification, sewage disposal, pollution control and waste collection) amounted to almost 6.5 billion dollars. Another 12.6 billion dollars were spent on resource conservation and industrial development related to the environment (Table 3.2.3.2).

Revenue

In 1990, government revenues derived from the exploitation of natural resources and from taxes levied on the use of resources amounted to 14.5 billion dollars (Table 3.2.3.3).

Table: 3.2.3.1

Value of Selected Construction Work Purchased, 1985-1990

Type of Structure	1985	1986	1987	1988	1989	1990
	million current dollars					
Waterworks and sewage systems						
Tile drains, drainage ditches, storm sewers	490.9	601.4	834.9	936.6	990.0	1 062.7
Water mains, hydrants and services	774.5	589.8	654.6	752.8	816.6	900.6
Sewage systems, disposal plants and connections	799.9	739.4	584.6	512.1	648.0	778.4
Water pumping stations and filtration plants	395.0	395.9	209.0	251.3	260.6	297.7
Water storage tanks	20.9	50.8	20.9	24.5	26.8	29.8
Total	**2 481.2**	**2 377.3**	**2 304.0**	**2 477.3**	**2 742.0**	**3 069.2**
Dams and irrigation						
Dams and reservoirs	74.4	122.9	100.3	150.9	191.9	230.3
Irrigation and land reclamation projects	208.1	119.8	207.1	247.1	300.4	329.3
Total	**282.5**	**242.7**	**307.4**	**398.0**	**492.3**	**559.6**
Total construction work	**67 983.2**	**71 700.6**	**81 971.5**	**90 715.1**	**95 196.8**	**105 987.4**

Source:
Statistics Canada. *Construction in Canada.* Catalogue 64-201.
Note:
The figures in this table are the result of information received from organizations and individuals paying for work done and on information received from contractors performing the work. Of the total value of construction shown, about 89.4 percent was reported. The remainder is estimated.

Table: 3.2.3.2

Government Expenditure on Environment and Resources, 1984-1990

	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90[1]	1990-91[1]	1991-92[1]
	million current dollars							
All Government								
Environment								
Water purification / supply	1 436.4	1 487.4	1 624.5	1 820.8	..	..	..	..
Sewage collection and disposal	962.8	949.4	1 096.2	1 164.2	..	..	..	..
Pollution control	190.4	209.5	244.4	261.8	..	..	..	..
Garbage and waste collection	514.4	564.4	628.7	714.5	..	..	..	..
Other	830.6	983.8	693.4	626.9	..	..	..	..
Total environment	**3 934.6**	**4 194.4**	**4 287.2**	**4 588.3**	**5 508.7**	**6 482.9**	**7 023.3**	..
Resource conservation and industrial development								
Agriculture	3 762.1	4 916.1	5 142.1	6 365.9	..	..	..	..
Fish and game	823.8	746.4	635.1	579.2	..	..	..	..
Forests	1 010.3	1 181.8	1 283.4	1 848.1	..	..	..	..
Mines	193.1	236.8	203.0	200.5	..	..	..	..
Oil and gas	5 143.4	3 763.8	2 633.9	1 722.4	..	..	..	..
Tourism	242.7	311.3	302.8	348.1	..	..	..	..
Trade and industry	2 303.9	2 432.1	2 706.2	2 483.9	..	..	..	..
Water	46.8	52.7	12.7	11.3	..	..	..	..
Other	1 653.0	1 625.4	1 671.7	1 590.2	..	..	..	..
Total resource conservation	**15 179.0**	**15 266.3**	**14 590.9**	**15 149.7**	**13 990.4**	**12 598.5**	**11 606.4**	..
Total expenditures	**209 243.2**	**223 960.2**	**233 709.0**	**251 129.8**	**265 107.7**	**287 944.0**	..	..
Federal								
Environment								
Water purification / supply	-	-	-	-	-	-	-	-
Sewage collection etc.	13.0	2.3	-	-	-	-	-	-
Pollution control	58.6	55.9	62.0	62.3	81.1	-	119.4	110.1
Garbage and waste collection	-	-	-	-	-	-	-	-
Other	419.7	363.9	383.7	435.7	442.9	590.0	587.7	536.7
Total environment	**491.3**	**422.1**	**445.7**	**498.0**	**530.0**	**590.0**	**707.1**	**646.8**
Resource conservation and industrial development								
Agriculture	2 226.4	2 427.3	3 238.4	4 720.9	3 614.2	3 354.0	2 851.2	239.2
Fish and game	594.7	510.0	388.3	328.4	393.5	336.0	415.1	374.0
Forests	163.6	199.9	224.7	660.2	311.8	298.0	223.4	201.3
Mines	37.3	50.1	54.5	60.2	76.5	183.0	155.9	129.3
Oil and gas	5 909.8	2 893.5	1 040.5	648.8	690.8	351.0	299.8	342.4
Tourism	64.0	62.0	43.0	50.0	43.0	39.0	32.5	32.0
Trade and industry	1 314.0	1 306.0	1 374.0	1 584.0	1 700.0	1 791.0	1 585.7	1 598.0
Water	6.2	5.8	5.8	5.3	5.3	8.0	6.3	9.2
Other	612.6	622.7	703.0	650.5	707.8	650.0	560.1	665.9
Total resource conservation	**10 929.0**	**8 077.0**	**7 072.0**	**8 708.0**	**7 542.0**	**7 010.0**	**6 130.0**	**5 691.4**
Total expenditures	**115 039.0**	**116 911.0**	**120 826.0**	**130 720.0**	**136 334.0**	**149 320.0**	**159 285.0**	**168 062.0**
Provincial								
Environment								
Water purification / supply	660.1	694.2	765.1	757.2	..	..	..	..
Sewage collection etc.	-	-	-	-	..	..	..	..
Pollution control	148.8	170.6	209.4	228.2	..	..	..	..
Garbage and waste collection	-	-	-	-	..	..	..	..
Other	388.0	567.4	242.2	314.7	..	..	..	..
Total environment	**1 195.0**	**1 432.2**	**1 216.8**	**1 300.1**	**1 702.0**	**1 643.6**	**1 848.0**	..
Resource conservation and industrial development								
Agriculture	1 825.7	2 672.7	2 081.8	1 864.6	..	..	..	..
Fish and game	230.2	237.6	249.8	256.8	..	..	..	..
Forests	903.5	1 050.0	1 111.7	1 245.7	..	..	..	..
Mines	156.2	197.1	162.0	155.5	..	..	..	..
Oil and gas	1 256.2	1 242.5	1 633.2	1 102.3	..	..	..	..
Tourism	180.4	234.5	252.8	291.0	..	..	..	..
Trade and industry	989.0	1 068.0	1 207.3	777.8	..	..	..	..
Water	46.7	52.7	12.6	12.3	..	..	..	..
Other	849.7	912.2	878.7	804.7	..	..	..	..
Total resource conservation	**6 437.6**	**7 667.3**	**7 589.9**	**6 510.7**	**7 581.0**	**6 843.7**	**6 867.8**	..
Total expenditures	**97 752.5**	**107 639.0**	**112 856.5**	**119 355.2**	**128 014.2**	**134 851.2**	**144 150.6**	..

Government Expenditure on Environment and Resources, 1984-1990

	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90[1]	1990-91[1]	1991-92[1]
	million current dollars							
Local								
Environment								
Water purification / supply	1 248.0	1 353.1	1 519.0	1 678.2	1 732.4	2 198.7	2 271.5	..
Sewage collection etc.	965.0	992.9	1 138.9	1 208.6	1 305.3	1 701.8	1 937.5	..
Pollution control	-	-	-	-	-	-	..	..
Garbage and waste collection	514.4	564.4	628.7	714.5	796.0	921.4	1 065.3	..
Other	43.4	70.1	76.9	87.9	113.6	104.4	97.7	..
Total environment	**2 770.9**	**2 980.4**	**3 363.5**	**3 689.2**	**3 952.3**	**4 948.4**	**5 731.9**	**..**
Resource conservation and industrial development								
Agriculture	-	145.0	184.9	170.1	140.9	158.4	176.9	..
Fish and game	-	-	-	-	-	-	..	..
Forests	-	-	-	-	-	-	..	..
Mines	-	-	-	-	-	-	..	..
Oil and gas	-	-	-	-	-	-	..	..
Tourism	-	16.5	10.4	9.4	15.8	19.1	19.1	..
Trade and industry	126.0	142.5	189.8	193.9	172.1	182.5	184.9	..
Water	-	-	-	-	-	-	..	..
Other	269.1	136.0	147.3	196.2	175.5	231.1	236.5	..
Total resource conservation	**395.1**	**440.0**	**532.5**	**569.5**	**504.2**	**591.1**	**617.4**	**..**
Total expenditures	**39 289.7**	**41 883.5**	**44 417.8**	**47 704.0**	**50 776.1**	**55 317.4**	**59 593.5**	**..**

Notes:
[1] Estimates.
Source:
Statistics Canada. Public Institutions Division.

Table: 3.2.3.3

Government Gross Revenue from Natural Resources and Selected Taxes

	1984-85	1985-86	1986-87	1987-88	1988-89[4]	1989-90[4]	1990-91[4]	1991-92[4]
	million current dollars							
All Government								
Selected taxes								
Petroleum and natural gas taxes[1]	6 140.0	3 489.0	467.0	- 14.0	111.0	-	-	-
Consumption of motive fuel	3 584.5	4 033.9	4 776.4	6 500.6	6 730.8	7 274.5	8 165.3	..
Total selected taxes	**9 724.5**	**7 522.9**	**5 243.4**	**6 486.6**	**6 841.8**	**7 274.5**	**8 165.3**	..
Natural resource revenue								
Fish and game	76.7	87.4	97.1	120.3	..	..	..	..
Forests	356.9	381.3	429.9	806.9	..	..	..	..
Mines	307.5	273.7	373.3	237.0	..	..	..	..
Oil and gas[2]	7 156.4	6 774.5	3 094.7	4 133.5	..	..	..	..
Water power	280.7	333.7	365.1	370.6	..	..	..	..
Other	91.6	73.7	77.0	59.3	..	..	..	..
Total natural resource revenue	**8 269.9**	**7 924.2**	**4 437.2**	**5 727.7**	**5 329.5**	**5 587.9**	**6 041.1**	..
Water sales[3]	**1 088.7**	**1 162.1**	**1 255.6**	**1 354.9**	**1 409.4**	**1 536.2**	..	..
Total selected revenue	**19 083.1**	**16 609.2**	**10 469.1**	**13 583.2**	**13 580.7**	**14 400.6**	..	..
Total revenue all sources	**167 241.0**	**179 378.9**	**191 102.1**	**216 199.4**	**233 732.8**	**253 076.3**	..	..
Federal government								
Selected taxes								
Petroleum and natural gas taxes[1]	6 140.0	3 489.0	467.0	- 14.0	111.0	-	-	-
Consumption of motive fuel	404.6	770.0	1 491.4	2 671.0	2 542.2	3 110.0	2 975.0	3 395.0
Total selected taxes	**6 544.6**	**4 259.0**	**1 958.4**	**2 657.0**	**2 653.2**	**3 110.0**	**2 975.0**	**3 395.0**
Natural resource revenue								
Fish and game	9.3	15.3	20.4	27.0	26.7	..	..	..
Forests	--	--	0.1	--	0.1	..	..	..
Mines	3.0	1.7	1.0	5.3	14.8	..	..	..
Oil and gas[2]	148.1	195.8	21.7	6.6	1.3	..	..	..
Other	20.7	11.4	11.7	11.7	11.6	45.0	70.0	75.0
Total natural resource revenue	**181.0**	**224.1**	**54.9**	**52.7**	**54.5**	**45.0**	**70.0**	**75.0**
Total selected revenue	**6 725.5**	**4 483.1**	**2 013.3**	**2 709.7**	**2 707.7**	**3 155.0**	**3 045.0**	**3 470.0**
Total revenue all sources	**78 055.0**	**83 060.0**	**90 145.0**	**103 089.0**	**109 505.0**	**116 896.0**	**126 894.0**	**137 654.0**
Provincial government								
Selected taxes								
Consumption motive fuel	3 180.0	3 264.0	3 285.0	3 830.0	4 188.8	4 164.5	4 610.3	..
Total selected taxes	**3 180.0**	**3 264.0**	**3 285.0**	**3 830.0**	**4 188.8**	**4 164.5**	**4 610.3**	..
Natural resource revenue								
Fish and game	67.4	72.1	76.7	93.3	..	..	..	..
Forests	356.9	381.3	429.9	806.9	..	..	..	..
Mines	304.5	272.0	372.2	231.7	..	..	..	..
Oil and gas[2]	7 008.3	6 578.7	3 072.6	4 125.6	..	..	..	..
Water Power	280.7	333.7	365.1	370.5	..	..	..	..
Other	71.0	62.2	65.3	47.7	..	..	..	..
Total natural resource revenue	**8 088.6**	**7 700.1**	**4 381.6**	**5 675.7**	**5 273.5**	**5 524.9**	**5 991.1**	..
Total selected revenue	**11 268.7**	**10 964.1**	**7 666.8**	**9 505.6**	**9 462.3**	**9 689.4**	**10 601.4**	..
Total revenue all sources	**91 086.7**	**97 574.9**	**100 744.7**	**112 592.2**	**123 092.0**	**132 837.4**	**142 489.7**	..
Local government								
Selected taxes	-	-	-	-	-	-	-	..
Natural resource revenue	-	-	-	-	-	-	-	..
Water sales	1 088.7	1 162.1	1 255.6	1 360.4	1 446.5	1 552.8	1 642.9	..
Total selected revenue	**1 088.7**	**1 162.1**	**1 255.6**	**1 360.4**	**1 446.5**	**1 552.8**	**1 642.9**	..
Total revenue all sources	**38 906.0**	**41 052.4**	..	..	**51 333.6**	**530 539.7**	**57 737.4**	..

Source: Statistics Canada. Public Institutions Division.

Notes:

[1] Federal government only.

[2] Excludes petroleum and natural gas taxes.

[3] Sales by local government only.

[4] Estimate.

3.3 Environmental Impacts

Most human activities have some effect on the environment. Whether these impacts are considered major or minor is largely a question of our understanding of the relationships between the stresses and the responses. Twenty five years ago, PCBs, DDT, fertilizers, smoking tobacco and cholesterol were considered harmless, if not outright beneficial.

Households, vehicles, industries and offices generate wastes and pollutants which, if untreated, enter the air, rivers, land and living organisms. In the pursuit of increased agricultural production, the natural nutrients in the soil are being depleted and being replaced by chemical fertilizers. Agriculture, forestry and other changes in land-use often replace the natural land cover and promote erosion and permanent changes in the hydrological cycle. Demands for electrical power, water for irrigation and municipal use have led to the development of dams and other water diversions. In the process, human settlements and wildlife habitats are displaced. Fishing, trapping and the introduction of exotic species exert pressures on native fish and wildlife.

3.3.1 Contaminants

"Toxic materials abound — oil spilling into the oceans at 10 times the rate of natural seeps, lead being deposited on soils and in waterways at 100 times the prehistoric levels, cadmium being released into the environment at 40 times the natural rates, radioactive materials contaminating soils at many sites, and the acidity of precipitation over millions of square kilometres is increasing 10-fold."

World Resources Institute and the United Nations Environment Program. 1990. *World Resources 1990-91*. Oxford University Press. New York.

Although many pollutants, such as lead and sulphur dioxide, exist in nature, they are now generated in great volumes and at high concentrations. Often, these pollutants reach levels that are hazardous to the health of humans and other living organisms.

Other contaminants are newly-created substances that have never existed in nature. The long-term effects of these substances are often not well understood before they are released into to the environment. Table 3.3.1.11 provides a summary of some toxins and their known health effects.

Together with monitoring the levels of these contaminants in the environment, it is also important to investigate their sources. Understanding the relative contributions of various human activities to the quantities of pollutants is an essential step in reducing the impacts of these activities.

Spills and Emergencies

NATES (National Trends in Emergencies System) is a data system to enable Environment Canada and other participating government agencies to store and analyse information on oil spills and other environmental emergencies. Spill information for NATES is provided by several federal and provincial regulatory agencies. Fluctuations in reporting give the annual figures a high degree of variability. The summaries provided account for most, but not all, of the recorded spill events (Tables 3.3.1.1, 3.3.1.4 and 3.3.1.5).

Table: 3.3.1.1
Spills Reported in Canada, 1980-1987

Year	Total spills	Number where amount is known	Total amount spilled
	number		thousand metric tonnes
1980	3 302	2 982	134
1981	2 712	2 315	159
1982	2 266	2 047	144
1983	2 236	2 037	108
1984	2 790	2 498	359
1985	3 596	3 106	262
1986	4 213	3 857	771
1987	4 214	3 888	1 427

Source:
Environment Canada. National Environmental Emergency Centre. Conservation and Protection.

Acid Deposition

Acid precipitation is a major environmental problem in Eastern Canada, and in other industrialized nations. It is created when rain combines with the oxides of nitrogen and sulphur, produced primarily by metal smelting, transportation and thermal power generation. The Canadian Air and Precipitation Monitoring Network, at Environment Canada, measures acid rain deposition at sites across Canada. Map 3.3.1.1 was developed from long term annual averages.

The effect of acid rain is not fully explained by science. Acid rain has significant impacts on ecological stability. Natural plant, fish and animal communities undergo increasing stress when the inherent acid buffering capacity of the environment is no longer able to neutralize increasing acidity.

Humans are able to protect themselves from some of the direct effects of acid rain. For example, agricultural land that is acidified can be neutralized with the addition of limes or other buffering agents. However, other effects such as human health effects, the erosion of buildings, and the loss of mature trees are more difficult to overcome. Acid precipitation has been identified as a factor in human health. It dissolves aluminum and other toxins. This may result in contaminated water supplies. Acid precipitation has also been associated with breathing and respiratory problems in humans.[27]

Human exposure to acid rain varies considerably geographically. The high deposition rates occur around urban areas in southern Ontario and Quebec (Map 3.3.1.1). Population trends by deposition class demonstrate that an increasing number of people in Eastern Canada are being exposed to the highest levels of acid deposition. Table 3.3.1.6 shows a 15.4 percent increase from 1971 to 1986. Almost 80 percent of Eastern Canadians lived in the most stressed areas.

Air Emissions

Most air emissions are generated in Ontario, British Columbia, Quebec and Alberta (Table 3.3.1.9). This measure highlights the importance of these provinces in adding to the total pollutant load. In terms of pollutant emitted per unit surface area, the Maritimes and Ontario are highest. On a per capita basis, Alberta, British Columbia, the Northwest Territories and Saskatchewan ranked highest.

Sulphur dioxide

In 1985, about 70 percent of sulphur dioxide emissions were from industrial and manufacturing process mostly from Ontario, Alberta, Manitoba, Quebec, and British Columbia. In provinces where industrial activity is less dominant, fuel combustion was the dominant source of sulphur dioxide emissions.

Total sulphur dioxide emissions (Table 3.3.1.8, Figure 3.3.1.2) decreased from 1955 to 1985. This reduction was a result of increased use of control devices for industries in compliance with government legislation.

Nitrogen Oxide

Transportation activity was the major contributor to nitrogen oxide emissions in all provinces except Alberta where natural gas power generation was the primary source. In the Atlantic provinces, thermal power generation was the top contributor.

Total nitrogen oxide emissions tripled between 1955 and 1985 (Table 3.3.1.7, Figure 3.3.1.1). The transportation sector accounts for 60 percent of total emissions largely because of automobile use.

27. Nebel, Bernard, J. 1987. *Environmental Science*. Prentice-Hall Inc. Engelwood Cliffs, New Jersey.

Carbon Monoxide

Transportation sources contributed a large portion of carbon monoxide emissions. The highest levels occurred in the more urbanized provinces of Ontario, British Columbia and Quebec.

Total Hydrocarbons

Ontario and British Columbia accounted for close to half the total hydrocarbon emissions in 1985. The transportation sector contributed almost half of the Canadian total.

Greenhouse Gases

According to the World Resources Institute, Canada ranks 12th in total contributions of greenhouse gases — carbon dioxide, methane and CFCs, and first in contributions per capita (Table 3.3.1.10). These gases are known to absorb the sun's heat and the levels of these gases have been increasing rapidly over the past 40 years.

Table 3.3.1.2 provides WRI estimates of the sources of gross additions of carbon dioxide, methane and CFCs. Table 3.3.1.3 is an estimate of the net greenhouse heating effect of these emissions.

Table: 3.3.1.2
Greenhouse Gas Emissions, Canada, 1987

Source	Amount
Anthropogenic additions to the carbon dioxide flux	thousand tonnes of carbon
Cement	1 700
Solid	26 000
Liquid	52 000
Gas	29 000
Flaring	1 400
Anthropogenic additions to the methane flux	thousand tonnes of methane
Solid waste	1 700
Livestock	760
Hard coals	150
Pipeline leakage	7 800
CFC use per capita	0.8

Source:
World Resources Institute. *Op.cit.*
Note:
Data were estimated for Canada, 1987.

Table: 3.3.1.3
Net Additions to Greenhouse Heating, Canada, 1987

Source	Net annual atmospheric increase	Equivalent Carbon Dioxide heating effect
	thousand tonnes	
Carbon dioxide emissions		
Fossil fuels and cement	48 000	48 000
Annual land use change	..	..
Methane Emissions	1 700	33 000
CFC Use	20.7	36 000
Net total atmospheric increase		117 000

Source:
World Resources Institute. *Op.cit.*

The Great Lakes

A recent report by Environment Canada[28] concludes that the concentrations of toxins in the open waters of the Great Lakes are within the objectives of the Great Lakes Water Quality Agreement between Canada and the United States. Areas near harbours, bays and connecting channels may exceed levels specified in the objectives. Map 3.3.1.2 identifies these 42 Areas of Concern. The report further concludes that the amounts of toxins deposited in the bottom sediments of the lakes are still entering the food web although the rates of additional deposits have decreased.

Since the increased regulation of organochlorine pesticides and PCBs, the levels of contaminants in Great Lakes fish decreased from the extremely high levels of the 1970s and stabilized at a lower level. Toxin levels in wildlife have remained constant since the early 1980s. This indicates a continuing input of toxins into the lakes from air pollution, seepage from hazardous waste sites and the transfer of contaminants from tributaries (Table 3.3.1.12). These sources are not yet regulated.

The report further concludes:

- Some fisheries, closed because of toxic contaminants in the early 1970s, such as the walleye fishery in Lakes Erie and St. Clair, have been reopened.
- Fish consumption advisories have been issued in 36 of 42 highly contaminated Areas of Concern.
- Municipal drinking water, drawn from the Great Lakes, may contain minute quantities of organochlorines but these amounts rarely exceed guidelines for Canadian drinking water quality.
- Species of bottom-dwelling fish, such as the brown bullhead and white sucker exhibit liver tumours that can be associated with toxic chemicals.

28. Environment Canada, Fisheries and Oceans Canada, and Health and Welfare Canada. 1991. *Toxic Chemicals in the Great Lakes and Associated Effects.* Catalogue EN-94/1990E.

- Two mammal and eight bird species, all fish-eating species, have been identified as experiencing reproductive and other problems attributable to chemical contaminants[29]
- Two bird populations, the cormorant and ring-billed gull, are growing at a rate believed to be outside the range of variation normally recorded for vertebrate species (20 to 40-fold greater than any population recorded historically). This indicates a serious alteration of the Great Lakes ecosystem.
- The population of bald eagles has increased but the lack of suitable habitat makes a recovery to historical levels doubtful.
- Birth defects, at levels up to 87 times the normal, have been recorded in 10 species of birds in the Great Lakes basin. Snapping turtles from the shores of Lakes Ontario and Erie have higher numbers of unhatched eggs and deformed embryos than those from inland populations.
- The rates of human cancer and adverse reproductive outcomes are no higher in the Great Lakes basin than in other highly industrialized areas of Canada. Individuals consuming large quantities of contaminated fish and wildlife have greater exposure to several persistent pollutants.

Critical Pollutants in the Great Lakes

Out of the 200 chemicals identified as existing in the Great Lakes basin, eleven have been identified as critical pollutants. The following review of these pollutants is excerpted from *Toxic Chemicals in the Great Lakes and Associated Effects*:

Chlorinated Organic Chemicals

PCBs are a group of chemicals used in electrical and hydraulic equipment, lubricants and in many other fluids because they are chemically stable and heat resistant. They are carcinogenic, persistent and ubiquitous in the environment. PCBs will continue to cycle through the environment although they are no longer manufactured and new uses are restricted. It has been estimated that there are more PCBs still in use than have been released into the environment to date. PCBs are found in higher concentrations in top predator fish from the Great Lakes. They are suspected to delay neurobehavioural development in infants.

Mirex is an extremely persistent insecticide. In sunlight, it breaks down slowly to photomirex. Both mirex and photomirex are toxic. Although mirex was never used in the Great Lakes basin for agriculture, it is present in the Lake Ontario food web because of industrial releases into the Niagara and Oswego rivers during its manufacture. All uses in Canada were banned in 1978, as was its use as an insecticide in the United States. Since the 1970s, the levels of mirex have decreased in lake trout and coho salmon; levels in herring gull eggs during the same period have not decreased appreciably. Mirex has also been identified in the tissues of people living in the Great Lakes basin. Exposure to mirex at levels currently found in Great Lakes fish is not a threat to human health if fish advisories are followed.

HCB (Hexachlorobenzene) is a persistent chemical that was originally manufactured as a fungicide for cereal crops. Its use was restricted in Canada in 1971. It is also generated as a by-product in the manufacture of pesticides, and it can be formed during the combustion of substances containing chlorine. This compound is ubiquitous and is found in the tissues of fish, wildlife and humans from the Great Lakes basin. Current levels of hexachlorobenzene are not a threat to health.

Dieldrin is a persistent toxic chemical that was used mainly as a soil insecticide. It is no longer manufactured in Canada or the United States, and its use is now restricted to applications for termite control. Levels of dieldrin in the environment have not decreased as much as levels of other pesticides. Dieldrin continues to enter the aquatic environment as leachate. Current levels of dieldrin in fish from the Great Lakes are not a hazard to human health.

DDT was introduced into North America in 1946 as an insecticide. Its use was restricted in Canada in 1974 and suspended in 1985. In 1989, the last permitted use was banned. The levels of this chemical and its principal metabolite,[30] DDE, have decreased significantly although concentrations in wildlife and fish have now equilibrated. DDT is still used elsewhere in the hemisphere and may be entering the Great Lakes through atmospheric transportation and deposition. DDE is stored in the fatty tissues of fish, birds and mammals, including humans. DDE was identified as the cause of eggshell thinning in many birds and has since been found to disrupt endocrine hormone metabolism and to change the activity of liver enzymes. Current levels of DDT/DDE in Great Lakes fish are not a hazard to human health.

Dioxin (2,3,7,8-TCDD) (2,3,7,8-tetrachlorodibenzo-p-dioxin) is the most toxic member of a group of chemicals known as polychlorinated-dibenzo-p-dioxins (PCDDs). It is highly persistent and bioaccumulates[31]. Dioxins enter the environment as the by-products of industrial processes. The most significant sources are pulp and paper mills using chlorine in the bleaching process and chlorophenoxyl herbicide production. Dioxins are released as the result of combustion processes in incinerators and motor vehicles using leaded fuel. As a result, dioxins are ubiquitous in the environment and are found in human tissues.

2,3,7,8-TCDF (2,3,7,8-tetrachlorodibenzofuran) is a

29. See Table 4.1.3.1 in the **Fish and Wildlife** section.

30. A metabolite is a product of the chemical breakdown of another chemical.

31. Bioaccumulation is the accumulation higher and higher concentrations of a contaminant in the tissues of an organism over time.

polychlorinated dibenzofuran (PCDF). PCDFs are structurally and chemically similar to PCDDs. They are not produced intentionally and result from some of the same industrial processes listed for PCDDs. In general, 2,3,7,8-TCDF is ten times less toxic than 2,3,7,8-TCDD, but has similar toxicological properties. It also tends to bioaccumulate.

Toxaphene is a contact insecticide that consists of a complex mixture of chlorinated camphenes. It was widely used in the United States on cotton crops until the late 1970s. Between the late 1970s and the early 1980s, the use of toxaphene ceased almost completely and its manufacture was banned in the United States in 1982. Toxaphene exposure from average fish consumption is not a hazard to health.

Polynuclear Aromatic Hydrocarbons

Benzo(a)pyrene (B[a]P) is one of several polynuclear aromatic hydrocarbons (PAHs) that are formed by the incomplete combustion of fossil fuels, wood and tobacco, the incineration of garbage, as well as in steel and coke production and coal liquification and gasification. B[a]P is present at high levels in sediments of specific industrialized areas within the Great Lakes basin. The presence of B[a]P is associated with a high incidence of liver tumours in fish.

Toxic Metals

Mercury is a non-essential natural element and is a ubiquitous contaminant in air, water and food. Food is the major source of human exposure to mercury. Fish and seafood are major contributors to human intake because of the propensity for organic mercury to bioaccumulate. In the past, mercury was widely used as a slimicide in the pulp and paper industry and formerly in the manufacture of chlorine and caustic soda (chlor-alkali process) and was subsequently discharged to the water. Because of several documented episodes of serious mercury toxicity, government actions led to the substitution of mercury in these processes. Reductions in industrial releases of mercury have resulted in a decrease in mercury levels in fish and the restoration of some commercial fisheries in the Great Lakes. Methyl mercury has been cited as the possible cause of neurological disease in some native communities which consume large amounts of fish. It is also a neurotoxin and a developmental toxin in animals.

Alkylated lead compounds (e.g., tetraethyl lead) are produced mainly as lead additives for gasoline. Single acute doses of tetrethyl lead are at least 20 times more toxic than equivalent doses of inorganic forms of lead. Levels of alkylated lead in the environment have decreased since 1981 and will continue to decrease as it is phased out of gasoline. The presence of alkylated lead in the terrestrial environment, especially in urban areas, has been associated with adverse effects in children. Alkylated lead in the waters of the Great Lakes should not pose any risk to human health, provided fish guidelines are followed.

Table: 3.3.1.4

Spills Reported[1] in Pacific and Yukon Region, 1984-1988

Ecozone	Class of spill		
	Major	Medium	Minor
Boreal Cordillera	1	1	14
Boreal Plain	2	13	113
Montane Cordillera	6	37	395
Pacific Maritime	17	117	1 787
Taiga Plain	0	1	3
Not specified or marine spills	4	32	710
Total	**26**	**169**	**2 312**

Source:
Environment Canada. Environmental Protection Service. Pacific Region.
Note:
[1] Spills reported to the regional office are not necessarily reported to the NATES (National Trends in Emergencies) system.

Table: 3.3.1.5

Spills Reported in the Atlantic Region, 1974-1985

Province / Ecozone	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Not specified or marine spills	19	16	16	21	10	22	13	21	8	10	14	9
Newfoundland												
Taiga Shield	7	5	4	10	10	11	2	6	10	3	6	8
Boreal Shield	41	73	69	59	72	40	13	21	29	27	16	37
Southern Arctic	1	-	-	2	-	2	1	-	-	1	-	-
Prince Edward Island												
Atlantic Maritime	3	2	5	4	5	1	3	2	12	1	8	4
Nova Scotia												
Atlantic Maritime	47	60	56	14	29	17	28	30	19	22	25	39
New Brunswick												
Atlantic Maritime	10	37	35	31	31	23	17	24	19	29	18	33
Total	**128**	**193**	**185**	**141**	**157**	**116**	**77**	**104**	**97**	**93**	**87**	**130**

Source:
Environment Canada. National Environmental Emergency Centre. Conservation and Protection.

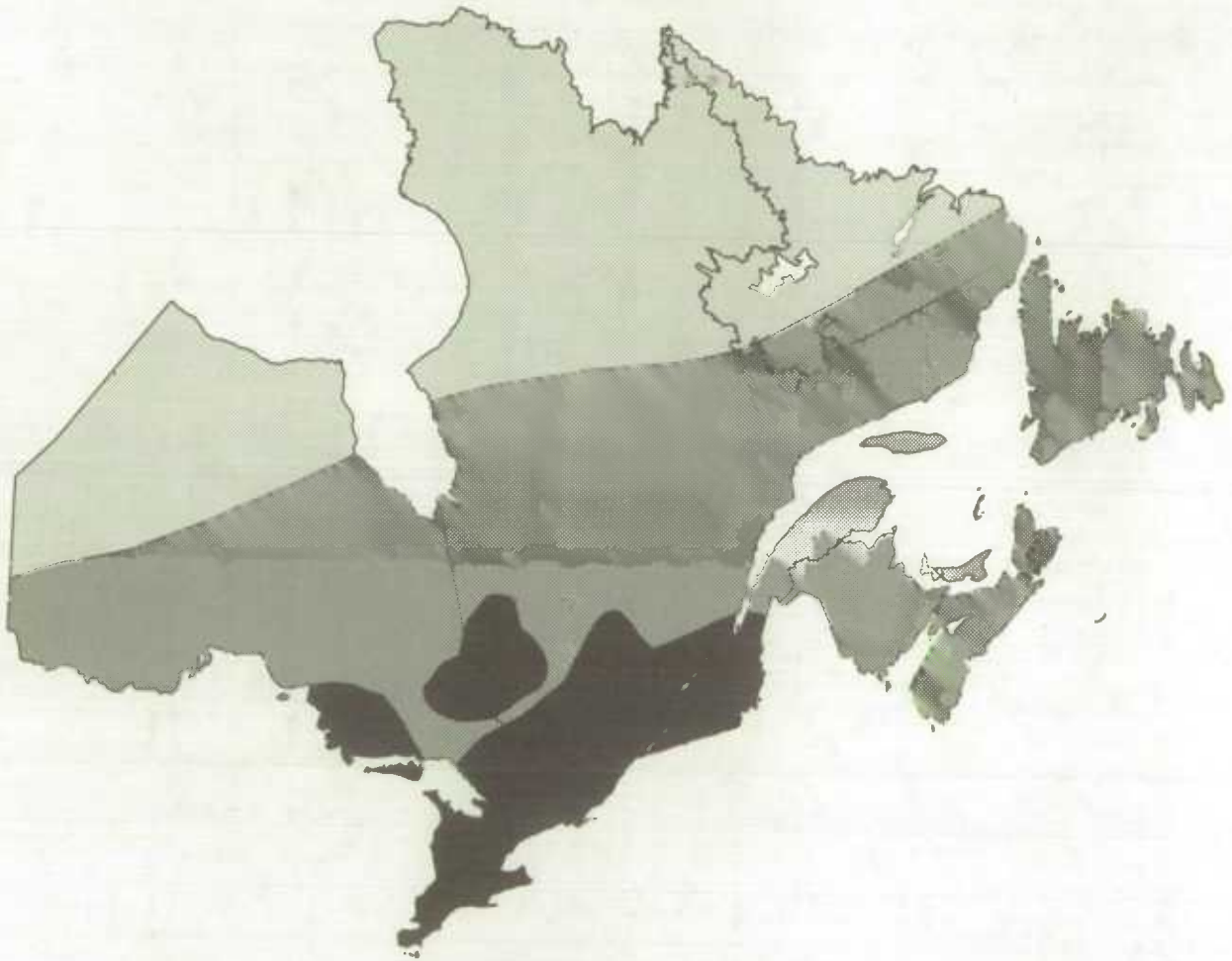
Table: 3.3.1.6

Population Exposure to Sulphate Deposition from Acid Rain, Eastern Canada, 1971 and 1986

Province	Population						Change		
	1971			1986			1981-1986		
	low exposure	medium exposure	high exposure	low exposure	medium exposure	high exposure	low exposure	medium exposure	high exposure
	persons			persons			percent		
Newfoundland	21 125	500 980	-	22 175	546 175	-	5.0	9.0	-
Prince Edward Island	-	111 640	-	-	126 650	-	-	13.4	-
Nova Scotia	-	788 960	-	-	873 175	-	-	10.7	-
New Brunswick	-	634 555	-	-	709 445	-	-	11.8	-
Quebec	8 225	773 760	5 245 035	7 575	797 305	5 727 575	- 7.9	3.0	9.2
Ontario	10 390	590 860	7 102 575	8 420	575 965	8 517 310	- 19.0	- 2.5	19.9
Eastern Canada Total	**39 740**	**3 400 780**	**12 347 615**	**38 170**	**3 828 715**	**14 244 885**	**- 4.0**	**6.7**	**15.4**
As a percentage of Eastern Canada	**0.3**	**21.5**	**78.2**	**0.2**	**20.3**	**79.5**	-	-	-

Source:
Statistics Canada. Environment and Wealth Accounts Division. Census of Population.
Environment Canada. Canadian Air and Precipitation Monitoring Network.
Note:
Low exposure : < 3 kg dry sulphate deposition / hectare
Medium exposure : 3-8 kg dry sulphate deposition / hectare
High exposure : > 8 kg dry sulphate deposition / hectare

Sulphate Deposition from Acid Rain, Eastern Canada, 1984



Source: Statistics Canada, Environment and Wealth Accounts Division.
Environment Canada, Canadian Air and Precipitation Monitoring Network, 1984.

Table: 3.3.1.7

Trends in Emissions[1] of Nitrogen Oxides (NO_x)

Sector	1955		1965		1976		1980		1985	
	kilotonnes	percent	kilotonnes	percent	kilotonnes	percent	kilotonnes	percent	kilotonnes	percent
Transportation	330	51.56	510	60.00	980	61.25	1 075	61.43	1 175	62.33
Non-utility fuel combustion[2]	230	35.94	250	29.41	350	21.87	335	19.14	250	13.26
Power plants	10	1.56	55	6.47	215	13.44	260	14.86	345	18.30
Other[3]	70	10.94	35	4.12	55	3.44	80	4.57	115	6.10
Total	**640**	**100.00**	**850**	**100.00**	**1 600**	**100.00**	**1 750**	**100.00**	**1 885**	**100.00**

Source:
Environment Canada, Regulatory Affairs and Program Integration Branch, Environmental Protection.
Notes:
[1]Emission coefficients were applied to basic data except for major stationary sources such as non-ferrous smelters and some power plants, for which actual emission data were used.
[2]Includes fuel combustion from residential, industrial, and commercial sources.
[3]Includes sources such as tar sands operations, kraft pulping, and incineration but does not include forest fires.

Table: 3.3.1.8

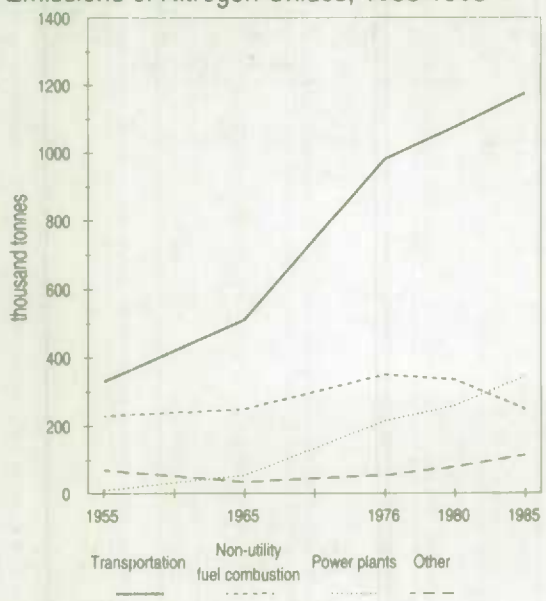
Trends in Emissions[1] of Sulphur Dioxide (SO_2)

Sector	1955		1965		1976		1980		1985	
	kilotonnes	percent	kilotonnes	percent	kilotonnes	percent	kilotonnes	percent	kilotonnes	percent
Non-ferrous smelting[2]	2 865	63.18	3 835	58.19	2 595	48.82	2 085	44.98	1 800	48.78
Power plants	55	1.21	260	3.95	610	9.26	770	11.68	740	20.05
Non-utility fuel combustion[3]	1 000	22.05	1 130	17.15	880	13.35	610	9.26	280	7.59
Transportation	80	1.76	50	0.76	115	1.75	135	2.05	95	2.57
Iron ore processing	110	2.43	155	2.35	165	2.50	160	2.43	130	3.52
Other[4]	425	9.37	1 160	17.60	950	14.42	870	13.20	650	17.62
Total	**4 535**	**100.00**	**6 590**	**100.00**	**5 315**	**100.00**	**4 635**	**100.00**	**3 690**	**100.00**

Source:
Environment Canada, Regulatory Affairs and Program Integration Branch, Environmental Protection.
Notes:
[1]Emission coefficients were applied to basic data except for major stationary sources such as non-ferrous smelters and some power plants, for which actual emission data were used.
[2]Includes copper, nickel, aluminum, lead and zinc production.
[3]Includes fuel combustion from residential, industrial, and commercial sources.
[4]Includes sources such as natural gas processing, tar sands operations, chemical pulping, and incineration.

Figure: 3.3.1.1

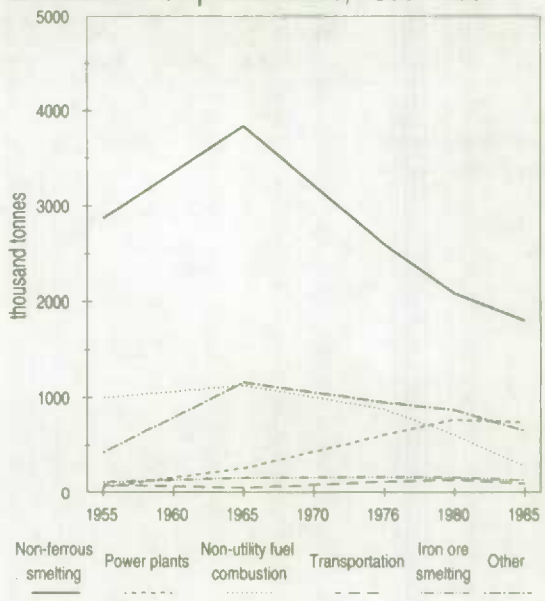
Emissions of Nitrogen Oxides, 1955-1985



Source: Environment Canada. Regulatory Affairs and Integration Branch. Conservation and Protection.

Figure: 3.3.1.2

Emissions of Sulphur Dioxide, 1955-1985



Source: Environment Canada. Regulatory Affairs and Integration Branch. Conservation and Protection.

Table: 3.3.1.9

Air Emissions by Province, 1985

Sector	Canada	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	Yukon	N.W.T.
							tonnes						
Total Particulate Matter													
Industrial	**909 706**	101 318	195	46 657	51 270	154 320	97 540	33 006	69 378	138 707	210 573	6 742	454
Stationary fuel combustion	**374 725**	15 536	6 583	15 206	24 234	77 564	84 235	9 268	39 421	44 410	58 268	0	2 273
Transportation	**110 533**	2 127	441	3 682	2 282	16 177	40 812	5 704	7 923	15 186	15 338	171	749
Incineration	**38 096**	100	36	379	785	6 590	5 407	181	449	1 827	22 342	0	6
Miscellaneous	**273 350**	4 110	913	6 222	11 781	55 250	54 714	5 814	8 806	18 593	107 054	93	341
Total	**1 706 410**	123 191	8 168	72 146	90 352	309 841	282 708	53 973	125 977	218 723	413 575	7 006	3 823
Sulphur Dioxide													
Industrial	**2 572 912**	2 778	0	11 889	20 341	569 318	977 978	459 720	8 378	446 621	75 548	341	0
Stationary fuel combustion	**1 015 665**	38 349	1 345	155 161	115 560	90 349	429 986	6 375	73 781	87 411	17 348	0	1 427
Transportation	**94 546**	2 234	340	3 361	1 771	32 314	31 631	3 026	3 361	4 548	11 930	30	311
Miscellaneous	**1 745**	20	5	36	39	734	402	43	46	115	305	0	3
Total	**3 684 868**	43 381	1 690	170 447	137 711	692 715	1 439 998	469 164	85 566	538 695	105 131	371	1 741
Nitrogen Oxides													
Industrial	**88 931**	1 320	0	1 585	2 647	6 860	38 154	572	857	26 243	10 693	0	0
Stationary fuel combustion	**589 659**	8 953	618	27 618	13 489	34 246	168 155	7 622	61 316	222 404	45 238	0	3 732
Transportation	**1 242 617**	24 502	5 312	47 914	29 053	192 759	376 344	76 147	95 617	197 060	195 783	2 126	10 284
Incineration	**7 440**	68	19	136	170	1 851	2 160	146	156	471	2 263	0	10
Miscellaneous	**16 797**	295	48	404	928	4 160	317	202	355	1 055	9 033	0	22
Total	**1 945 444**	35 138	5 997	77 657	46 287	239 876	585 130	84 689	158 301	447 233	263 010	2 126	14 048
Carbon Monoxide													
Industrial	**774 849**	0	0	443	5 556	198 797	455 793	1 238	8 844	28 986	75 292	0	0
Stationary fuel combustion	**1 255 552**	51 592	26 303	35 493	32 676	237 391	212 054	14 375	65 972	86 751	492 945	0	8 782
Transportation	**7 140 724**	128 456	34 686	235 427	187 454	1 159 360	2 341 057	401 498	544 175	1 079 518	1 015 811	13 282	22 893
Incineration	**429 433**	757	313	3 739	8 945	77 800	39 060	1 199	4 258	19 357	274 005	0	8
Miscellaneous	**1 147 214**	17 091	2 932	23 654	53 160	241 155	194 756	12 790	20 872	61 988	518 774	42	1 292
Total	**10 747 772**	197 896	64 234	298 756	287 791	1 914 503	3 242 720	431 000	644 121	1 276 600	2 376 827	13 324	32 975
Total Hydrocarbons													
Industrial	**577 580**	70	5	20 304	5 731	59 906	131 455	1 712	41 723	177 212	139 462	0	351
Stationary fuel combustion	**219 765**	9 075	4 578	5 447	5 524	41 584	39 234	3 034	3 424	44 480	63 385	0	1 658
Transportation	**959 105**	19 653	4 587	33 117	25 209	160 044	330 870	51 941	62 642	127 428	141 989	1 625	2 903
Incineration	**43 257**	74	29	334	741	14 628	4 428	124	378	1 692	20 829	0	2
Miscellaneous	**510 436**	9 095	2 423	14 675	16 138	121 849	169 755	16 578	16 289	41 413	101 818	403	697
Total	**2 310 143**	37 967	11 622	73 877	53 343	398 011	675 742	73 389	124 456	392 225	467 483	2 028	5 611
Volatile Organic Compounds													
Industrial	**258 090**	49	5	4 426	2 842	50 727	114 172	1 599	4 196	63 256	16 818	0	193
Stationary fuel combustion	**164 068**	8 954	4 522	5 057	5 402	40 692	36 578	2 644	3 010	8 506	47 132	0	1 570
Transportation	**870 215**	17 815	4 148	29 988	22 782	144 624	298 939	47 029	56 806	115 420	128 542	1 471	2 650
Incineration	**19 369**	32	12	139	301	7 587	2 044	56	157	692	8 349	0	1
Miscellaneous	**486 032**	8 649	2 349	14 064	14 735	115 560	169 600	16 273	15 753	39 818	88 163	403	664
Total	**1 797 969**	35 499	11 036	53 674	46 062	359 190	621 333	67 601	79 922	227 692	289 004	1 874	5 078

Source:
Environment Canada, Regulatory Affairs and Program Integration Branch, *Canadian Emissions Inventory of Common Air Contaminants (1985)*, Report EPS 5/AP/3, March 1990.

Table: 3.3.1.10

The Greenhouse Index, 1987

Country	Greenhouse index rank	Greenhouse gases				Percent of total	Metric tons per capita
		Carbon dioxide	Methane	CFCs[1]	Total		
		carbon dioxide heating equivalent (million tonnes)					
United States	1	540	130	350	1 020	17.3	4.2
U.S.S.R.	2	450	60	180	690	11.7	2.5
Brazil	3	560	28	16	604	10.2	4.3
China	4	260	90	32	382	6.5	0.3
India	5	130	98	1	229	3.9	0.3
Germany	6	118	10	95	223	3.8	3.4
Japan	7	110	12	100	222	3.8	1.8
United Kingdom	8	69	14	71	154	2.6	2.7
Indonesia	9	110	19	9	139	2.3	0.8
France	10	41	13	69	123	2.1	2.2
Italy	11	45	6	71	122	2.1	2.1
Canada	12	48	33	36	117	2.0	4.5
Mexico	13	49	20	9	78	1.3	0.9
Myanmar	14	68	9	0	77	1.3	2.0
Poland	15	56	7	13	76	1.3	2.0
Spain	16	21	4	48	73	1.2	1.9
World		**3 700**	**800**	**1 400**	**5 900**		

Source:
World Resources Institute. 1990. *World Resources 1990-91*. Oxford University Press. New York.
Notes:
[1] Chlorofluorocarbons.

Table: 3.3.1.11

Examples of Toxic, Synthetic Organic Compounds

Chemical	Known health effects							
	Causes mutations	Carcino-genic	Birth defects	Causes still-births	Causes nervous disorders	Liver disease	Kidney disease	Lung disease
Benzene	✔	✔	✔	✔	—	—	—	—
dichlorobenzene	✔	—	—	✔	✔	✔	—	—
HCB (hexachlorobenzene)	✔	✔	✔	✔	✔	—	—	—
Chloroform	—	✔	✔	✔	—	✔	—	—
Carbon tetrachloride	—	✔	✔	✔	✔	✔	✔	—
Ethylene								
chloroethylene (vinyl chloride)	✔	✔	—	—	✔	✔	—	✔
dichloroethylene	✔	✔	—	✔	✔	✔	✔	—
tetrachloroethylene	—	✔	—	—	✔	✔	✔	—
trichloroethylene	✔	✔	—	—	✔	✔	—	—
Heptachlor	✔	✔	—	✔	✔	✔	—	—
PCBs (polychlorinated biphenyls)	✔	✔	✔	✔	✔	✔	—	—
Dioxin (Tetrachlorodibenzo dioxin)	✔	✔	✔	✔	✔	✔	—	—
Toluene	✔	—	—	✔	✔	—	—	—
chlorotoluenes	✔	✔	—	—	—	—	—	—
Xylene	—	—	✔	✔	✔	—	—	—

Source:
Nebel, Bernard. J. 1987. *Environmental Science*. Prentice-Hall Inc. Engelwood Cliffs, New Jersey.

Table: 3.3.1.12

Estimated Chemical Loads to the Great Lakes, 1988

Lake basin	Chemical							
	PCBs		DDT		Benzo(a)pyrene		Lead	
	Total	Attributable to atmospheric deposition	Total	Attributable to atmospheric deposition	Total	Attributable to atmospheric deposition	Total	Attributable to atmospheric deposition
	kg/year	percent	kg/year	percent	kg/year	percent	tonnes/year	percent
Superior	606	90	92	97	72	96	241	97
Michigan	685	58	65	98	208	86	543	99
Huron	636	63	92	97	290	80	430	94
Erie	2 520	7	319	22	122	79	567	39
Ontario	2 540	6	111	32	155	72	426	50
Total	**6 987**	**24**	**679**	**51**	**847**	**81**	**2 207**	**73**

Source:

Environment Canada, Department of Fisheries and Oceans, Health and Welfare Canada. 1991. *Toxic Chemicals in the Great Lakes and Associated Effects: Synopsis*. Catalogue En. 37-94/1990E. [originally published in] International Joint Commission. 1988. *Mass Balancing of Toxic Chemicals in the Great Lakes; the Role of Atmospheric Deposition*. by W. Strachan and S. Eisenreich;

Notes:

Data to carry out mass balance were sufficient only for these four chemicals and mirex; even for these there is a great deal of uncertainty.

The upper lakes: Superior, Michigan and Huron receive a significant fraction of their PCBs, DDT and lead directly from the atmosphere. Compared to the lower lakes, they have a larger surface area and fewer local contaminant sources. In absolute terms, total PCB inputs to the lower lakes are four times higher than the upper lakes due to local sources.

Map: 3.3.1.2

Great Lakes Areas of Concern

Lake Superior
1. Peninsula Harbour
2. Jackfish Bay
3. Nipigon Bay
4. Thunder Bay
5. St. Louis River (Minn)
6. Torch Lake (Mich)
7. Deer Lake (Mich)

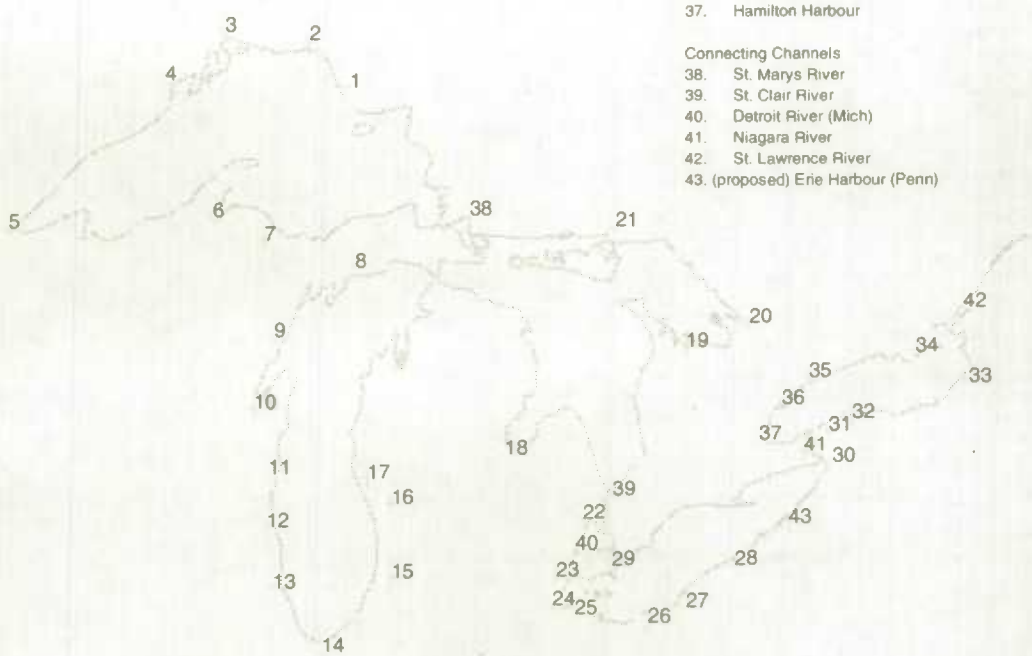
Lake Michigan
8. Manistique River (Mich)
9. Menominee River (Mich)
10. Fox River/Green Bay (Wis)
11. Sheboygan Harbour (Wis)
12. Milwaukee Harbour (Wis)
13. Waukegan Harbour (Ill.)
14. Grand Calumet River (Ill.)
15. Kalamazoo River (Mich)
16. Muskegon Lake (Mich)
17. White Lake (Mich)

Lake Huron
18. Saginaw River (Mich)
19. Collingwood Harbour
20. Severn Sound
21. Spanish River

Lake Erie
22. Clinton River (Mich)
23. Rouge River (Mich)
24. River Raisin (Mich)
25. Maumee River (Ohio)
26. Black River (Ohio)
27. Cuyahoga River (Ohio)
28. Ashtbula River (Ohio)
29. Wheatley Harbour
30. Buffalo River (NY)

Lake Ontario
31. Eighteen Mile Creek (NY)
32. Rochester Embayment (NY)
33. Oswego River (NY)
34. Bay of Quinte
35. Port Hope
36. Toronto Harbour
37. Hamilton Harbour

Connecting Channels
38. St. Marys River
39. St. Clair River
40. Detroit River (Mich)
41. Niagara River
42. St. Lawrence River
43. (proposed) Erie Harbour (Penn)



Source: The Great Lakes Reporter, Jan/Feb 1991.

3.3.2 Agricultural Contaminants

Between 1971 and 1986, pesticide application increased almost five-fold. Fertilizer application grew by 15 percent between 1980 and 1985.

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Historically, the application of fertilizers and pesticides has been considered an essential means of increasing agricultural production. Only within the past decade has it been realized that these practices may be doing much harm. Continual fertilizer application upsets natural nutrient balances, making it increasingly difficult to re-establish the equilibrium found in natural systems.

The same holds true for pesticides. Pesticides are applied to kill specific pests. During pesticide applications many other organisms are killed incidentally. Many of these organisms are beneficial to soil stability and structure, or to plant communities. Some help to control other insects that may become pests without their natural predators. Over time many pests become resistant to some pesticide types so more complex and more powerful pesticides are required. Recently, some farmers have been adopting low-input technologies that promote crop rotation, mixed agriculture and natural pest controls instead of manufactured chemicals.

The value of pesticide applied on farmland increased more than five-fold between 1970 and 1985 (Table 3.3.2.1). The most significant increases in pesticide application rates occurred in the Prairie Provinces where pesticide inputs have increased ten-fold (Map 3.3.2.1). However, application rates per hectare of cultivated land were still much lower in the Prairie Provinces than in Ontario and Quebec where application rates ranged as high as 19 dollars per hectare.

Pesticide expense data are not the best indicators of toxicity changes in soil. Many factors other than pesticide cost influence the environmental impacts of pesticides. These include the time of year they are applied, rainfall at the time, toxic life of the pesticide, method of application, and many others. At best, pesticide expense data serve only as general indicators of potential environmental impact.

The Census of Agriculture measured farm fertilizer use in both the 1981 and 1986 censuses. On a national scale, agricultural fertilizer application increased from 3.5 million tonnes in 1980 to over 4.0 million by 1985 (Table 3.3.2.2). Regionally, Eastern Canada showed declines in absolute tonnages applied, with Newfoundland showing the largest drop of more than 24 percent. Western Canada experienced the largest increase. Saskatchewan led all other provinces with a rise of 62 percent in quantity of fertilizer.

Interpreting fertilizer tonnage changes has to be done with some caution. Nutrient content of commercial fertilizer materials is highly variable and ranges from a low of 30 percent to well over 95 percent depending on the compound applied. Local knowledge of fertilizer types is essential in assessing potential environmental stresses.

Table: 3.3.2.1

Agricultural Pesticide Expenditures and Densities by Sub-basin, 1970 and 1985

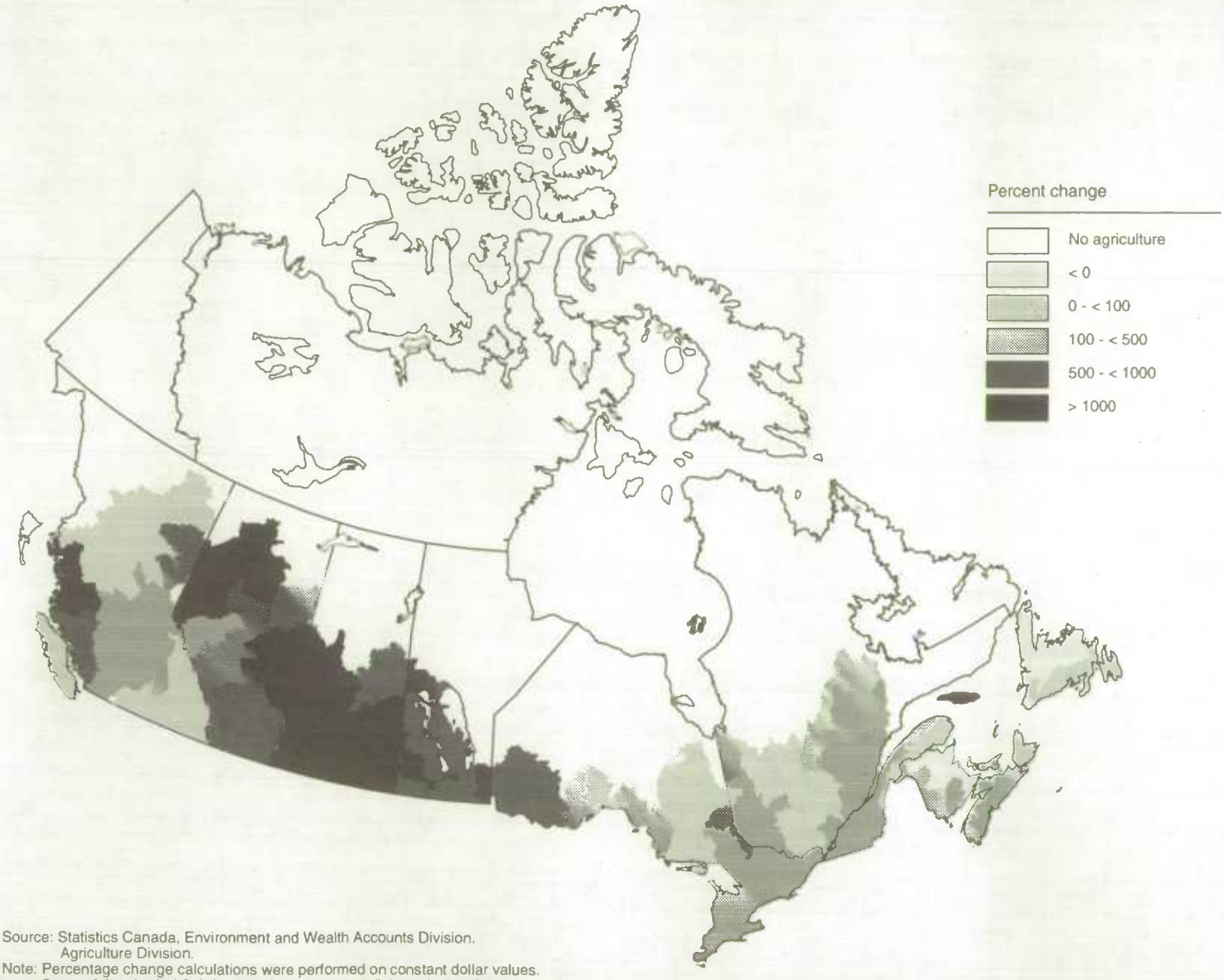
Provincial Sub-basin	Agricultural pesticide expenditures			Agricultural pesticide per hectare cultivated land		
	1970	1985	Change 1970-1985	1970	1985	Change 1970-1985
	thousand constant 1971 dollars		percent	dollars/hectare		percent
Newfoundland						
North Newfoundland	22.1	16.6	- 24.7	11.69	5.71	- 51.1
South Newfoundland	23.2	27.0	16.3	4.61	4.40	- 4.7
Total	**45.3**	**43.6**	**- 3.7**	**6.54**	**4.82**	**- 26.3**
Prince Edward Island						
Prince Edward Island	909.7	2 801.3	207.9	4.73	15.41	225.5
Total	**909.7**	**2 801.3**	**207.9**	**4.73**	**15.41**	**225.5**
Nova Scotia						
Bay of Fundy	622.9	1 248.4	100.4	5.21	9.92	90.3
Southeast Atlantic Ocean	23.5	50.3	113.7	1.58	3.62	128.4
Cape Breton Island	12.1	16.9	39.8	1.22	1.71	40.0
Total	**658.6**	**1 315.6**	**99.8**	**4.56**	**8.79**	**92.6**
New Brunswick						
Saint John and South Bay of Fundy	824.6	1 940.8	135.4	6.72	17.44	159.6
Gulf of St. Lawrence and North Bay of Fundy	270.9	227.3	- 16.1	4.70	4.57	- 2.7
Total	**1 095.5**	**2 168.1**	**97.9**	**6.07**	**13.47**	**121.8**
Quebec						
Saint John	33.0	37.0	12.0	0.74	1.18	58.1
Cascapedia and Gulf of St. Lawrence	34.4	58.5	70.3	0.63	1.36	116.5
Upper Ottawa	19.8	54.9	177.1	0.30	1.16	288.4
Coulonge and Central Ottawa	41.0	112.6	174.7	0.92	2.91	215.0
Gatineau and Lower Ottawa	190.9	336.7	76.4	1.37	3.09	125.3
Upper St. Lawrence	104.4	491.1	370.2	1.96	9.60	389.6
St-Maurice	26.8	31.6	17.9	2.80	5.80	107.3
Central St. Lawrence	3 619.1	9 444.9	161.0	3.27	9.70	196.7
Lower St Lawrence	695.4	1 629.2	134.3	1.14	3.35	193.2
North Gaspé Peninsula	88.2	184.3	109.1	0.60	1.60	166.9
Saguenay	96.0	265.2	176.4	0.65	2.16	229.3
Betsiamites	0.9	3.5	288.2	0.48	2.41	397.7
Manicouagan and Outardes	3.7	11.3	203.3	5.68	16.88	197.0
Natashquan and Gulf of St. Lawrence	0.0	0.3	3 270.0	0.02	0.83	4 596.2
Nottaway	0.8	0.8	5.3	0.19	0.18	- 2.5
Abitibi and North French	7.0	10.2	44.9	0.20	0.37	86.0
Harricanaw	3.9	9.4	144.6	0.21	0.50	136.5
Total	**4 965.2**	**12 681.7**	**155.4**	**2.00**	**6.11**	**205.1**
Ontario						
Nipigon and Northwest Lake Superior	11.8	32.6	176.1	0.65	2.09	222.5
Northeast Lake Superior	1.0	2.3	133.9	0.74	2.06	177.2
North Lake Huron	34.9	58.8	68.7	0.71	1.32	85.1
Wanipitai and French	13.8	29.2	111.4	0.41	1.09	167.8
East Georgian Bay	1 427.2	3 153.8	121.0	4.74	11.27	137.7
East Lake Huron	2 113.8	8 132.0	284.7	2.51	10.32	311.2
North Lake Erie	9 513.0	28 164.8	196.1	6.43	19.04	196.0
Lake Ontario	3 500.3	7 381.9	110.9	4.75	10.96	130.8
Montréal and Upper Ottawa	11.8	112.4	851.8	0.23	2.05	807.7
Madawaska, Petawawa and Central Ottawa	161.7	348.1	115.3	1.02	2.59	153.3
Rideau and Lower Ottawa	775.3	1 933.1	149.3	2.13	6.29	195.2
Upper St. Lawrence	191.4	540.8	182.5	1.43	4.94	248.2
Moose	6.7	10.2	54.0	1.09	1.95	78.9
Abitibi	4.0	6.6	64.1	0.38	0.52	39.0
Upper Winnipeg	6.9	44.2	538.4	0.25	1.42	458.9
English	0.7	4.6	601.8	0.09	0.72	693.9
Total	**17 774.3**	**49 955.5**	**181.1**	**4.21**	**12.58**	**198.9**
Manitoba						
Saskatchewan	3.4	133.1	3 768.1	0.16	4.85	2 841.3
Lake Winnipegosis and Lake Manitoba	908.0	8 747.5	863.4	0.73	6.64	810.6
Assiniboine	795.6	9 224.1	1 059.3	0.61	6.67	995.2
Souris	328.6	3 388.8	931.3	0.55	5.46	885.5
Red	1 520.8	16 185.8	964.3	0.95	9.80	931.1
Winnipeg	18.3	260.7	1 326.8	0.42	5.55	1 223.6
West Lake Winnipeg	141.5	1 453.5	926.9	0.56	5.66	914.7
Total	**3 716.3**	**39 393.4**	**960.0**	**0.73**	**7.43**	**911.9**

Agricultural Pesticide Expenditures and Densities by Sub-basin, 1970 and 1985

Provincial Sub-basin	Agricultural pesticide expenditures			Agricultural pesticide per hectare cultivated land		
	1970	1985	Change 1970-1985	1970	1985	Change 1970-1985
	thousand constant 1971 dollars		percent	dollars/hectare		percent
Saskatchewan						
Upper South Saskatchewan	10.5	45.6	334.7	0.35	2.37	584.5
Central North Saskatchewan	207.5	3 577.8	1 624.6	0.33	4.77	1 342.1
Battle	84.2	1 414.1	1 579.7	0.37	5.68	1 445.5
Lower North Saskatchewan	748.8	11 179.6	1 393.0	0.29	4.07	1 300.5
Lower South Saskatchewan	1 115.0	13 837.8	1 141.1	0.31	3.62	1 059.0
Qu'Appelle	1 240.5	17 317.2	1 295.9	0.24	3.23	1 232.3
Saskatchewan	879.5	8 030.1	813.0	0.82	7.39	798.9
Lake Winnipegosis and Lake Manitoba	220.7	3 675.5	1 565.2	0.41	5.77	1 308.2
Assiniboine	645.3	9 768.2	1 413.7	0.37	5.21	1 325.0
Souris	453.6	6 216.3	1 270.5	0.22	2.92	1 203.5
Beaver	65.9	1 142.3	1 633.6	0.24	3.50	1 377.1
Missouri	163.6	1 922.3	1 075.4	0.22	2.23	904.7
Total	**5 835.1**	**78 126.8**	**1 238.9**	**0.31**	**3.93**	**1 151.2**
Alberta						
Upper South Saskatchewan	1 090.1	8 586.3	687.7	0.57	3.92	582.5
Bow	517.0	3 551.7	586.9	0.70	4.80	590.7
Red Deer	1 151.0	11 459.7	895.6	0.53	4.85	816.0
Upper North Saskatchewan	138.9	936.1	573.8	0.41	2.51	513.0
Central North Saskatchewan	696.2	8 562.3	1 129.8	0.43	5.05	1 077.9
Battle	600.5	9 697.0	1 514.8	0.39	5.98	1 424.2
Lower North Saskatchewan	114.5	1 621.5	1 315.6	0.26	2.75	976.1
Lower South Saskatchewan	7.7	42.9	457.0	0.32	1.76	445.2
Beaver	30.8	446.0	1 350.1	0.16	1.89	1 054.8
Upper Athabasca	11.8	45.6	287.3	0.28	0.77	173.0
Pembina and Central Athabasca	194.3	1 780.4	816.2	0.33	2.55	680.8
Lower Central Athabasca	27.5	263.9	859.1	0.24	2.01	721.0
Upper Peace	134.7	1 888.2	1 302.0	0.28	3.18	1 054.1
Smoky	189.1	2 358.1	1 147.1	0.32	3.46	972.6
Central Peace	48.3	1 001.1	1 974.3	0.19	2.64	1 264.4
Lower Central Peace	6.1	210.1	3 362.0	0.17	2.31	1 221.8
Missouri	48.5	371.1	665.4	0.26	1.93	651.1
Total	**5 007.1**	**52 821.9**	**954.9**	**0.44**	**4.17**	**838.9**
British Columbia						
Williston Lake	0.0	2.6	...	0.00	0.49	...
Upper Peace	98.8	917.7	828.8	0.33	2.35	605.4
Skeena	8.7	9.4	8.4	0.49	0.42	- 13.8
Gardner Canal and Central Pacific Ocean	0.0	0.5	1 025.0	0.02	0.15	574.2
Knight Inlet and South Pacific Ocean	0.3	3.4	891.2	0.19	1.01	427.5
Vancouver Island	111.2	203.9	83.3	5.88	8.20	39.4
Nechako	7.9	13.3	69.4	0.26	0.21	- 16.4
Upper Fraser	11.5	24.1	110.2	0.31	0.41	35.7
Thompson	46.5	137.0	194.4	0.71	1.51	112.1
Fraser	744.6	2 003.7	169.1	7.33	18.92	158.2
Columbia	1 289.0	1 821.8	41.3	12.90	20.30	57.4
Fort Nelson	0.0	4.6	45 930.0	0.48	2.61	449.1
Total	**2 318.6**	**5 141.9**	**121.8**	**3.45**	**6.00**	**74.1**
Canada	**42 325.7**	**244 449.9**	**477.5**	**0.99**	**5.40**	**446.4**

Sources:
Statistics Canada. Environment and Wealth Accounts Division. Agriculture Division.
Note:
Farm input price indices were used to obtain 1971 constant dollar expenditures.

Change in Agricultural Pesticide Expenditure By Sub-basin, 1970 to 1985



Source: Statistics Canada, Environment and Wealth Accounts Division.
Agriculture Division.
Note: Percentage change calculations were performed on constant dollar values.
Some of the shaded Sub-basins above have very little agricultural activity.

Table: 3.3.2.2

Commercial Agricultural Fertilizer Application by Sub-basin, 1980 and 1985

Provincial Sub-basin	Commercial fertilizer applied			Area fertilized			Fertilizer per hectare fertilized		
	1980	1985	Change 1980-1985	1980	1985	Change 1980-1985	1980	1985	Change 1980-1985
	tonnes		percent	hectares		percent	tonnes/hectare		percent
Newfoundland									
North Newfoundland	819	739	- 9.7	851	1 382	62.4	0.96	0.54	- 44.4
South Newfoundland	2 164	1 522	- 29.6	3 562	3 375	- 5.2	0.61	0.45	- 25.7
Total	**2 983**	**2 262**	**- 24.2**	**4 413**	**4 757**	**7.8**	**0.68**	**0.48**	**- 29.7**
Prince Edward Island									
Prince Edward Island	55 477	57 606	3.8	107 442	113 297	5.5	0.52	0.51	- 1.5
Total	**55 477**	**57 606**	**3.8**	**107 442**	**113 297**	**5.5**	**0.52**	**0.51**	**- 1.5**
Nova Scotia									
Bay of Fundy	28 259	24 993	- 11.6	74 577	71 900	- 3.6	0.38	0.35	- 8.3
Southeast Atlantic Ocean	2 990	2 260	- 24.4	8 476	7 415	- 12.5	0.35	0.30	- 13.6
Cape Breton Island	2 238	1 946	- 13.0	5 484	5 728	4.4	0.41	0.34	- 16.7
Total	**33 487**	**29 199**	**- 12.8**	**68 537**	**85 043**	**- 3.9**	**0.38**	**0.34**	**- 9.2**
New Brunswick									
Saint John and South Bay of Fundy	43 588	38 490	- 11.7	55 243	61 766	11.8	0.79	0.62	- 21.0
Gulf of St. Lawrence and North Bay of Fundy	8 955	9 454	5.6	20 753	22 282	7.4	0.43	0.42	- 1.7
Total	**52 543**	**47 944**	**- 8.8**	**75 997**	**84 048**	**10.6**	**0.69**	**0.57**	**- 17.5**
Quebec									
Saint John	4 310	2 610	- 39.4	13 623	13 471	- 1.1	0.32	0.19	- 38.7
Cascapedia and Gulf of St. Lawrence	7 663	4 783	- 37.8	22 845	19 394	- 15.1	0.34	0.25	- 26.8
Upper Ottawa	4 522	2 848	- 37.0	12 369	11 819	- 4.4	0.37	0.24	- 34.1
Coulonge and Central Ottawa	3 414	3 186	- 6.7	8 687	9 862	13.5	0.39	0.32	- 17.8
Gatineau and Lower Ottawa	15 408	13 282	- 13.8	34 145	40 724	19.3	0.45	0.33	- 27.7
Upper St. Lawrence	18 648	22 100	18.5	35 273	42 008	19.1	0.53	0.53	- 0.5
St-Maurice	1 632	941	- 42.3	2 104	2 264	7.6	0.78	0.42	- 46.4
Central St. Lawrence	286 854	309 089	7.8	602 932	684 182	13.5	0.48	0.45	- 5.0
Lower St Lawrence	85 593	69 043	- 19.3	247 604	248 623	0.4	0.35	0.28	- 19.7
North Gaspé Peninsula	16 309	12 560	- 23.0	67 746	60 460	- 10.8	0.24	0.21	- 13.7
Saguenay	13 388	11 997	- 10.4	48 833	42 403	- 9.5	0.29	0.28	- 1.0
Betsiamites	65	54	- 17.5	157	407	159.7	0.42	0.13	- 68.2
Manicouagan and Outardes	314	282	- 10.1	512	501	- 2.1	0.61	0.56	- 8.2
Natashquan and Gulf of St. Lawrence	126	94	- 25.8	151	70	- 53.7	0.83	1.34	60.4
Nottaway	314	162	- 42.1	1 335	837	- 37.3	0.24	0.22	- 7.7
Abitibi and North French	1 922	2 061	7.3	5 119	8 691	69.8	0.38	0.24	- 36.8
Harricanaw	1 162	814	- 29.9	3 965	3 517	- 11.3	0.29	0.23	- 21.0
Total	**461 644**	**455 908**	**- 1.2**	**1 105 400**	**1 189 233**	**7.6**	**0.42**	**0.38**	**- 8.2**
Ontario									
Nipigon and Northwest Lake Superior	2 699	2 146	- 20.5	11 196	10 105	- 9.7	0.24	0.21	- 11.9
Northeast Lake Superior	69	94	36.8	287	398	38.5	0.24	0.24	- 1.2
North Lake Huron	3 598	3 083	- 14.3	14 823	14 738	- 0.6	0.24	0.21	- 13.8
Wanipitai and French	2 909	2 150	- 26.1	12 251	11 531	- 5.9	0.24	0.19	- 21.5
East Georgian Bay	64 609	55 272	- 14.5	159 841	156 869	- 1.9	0.40	0.35	- 12.8
East Lake Huron	177 332	182 462	2.9	535 885	549 657	2.6	0.33	0.33	0.3
North Lake Erie	507 604	482 691	- 4.9	1 137 743	1 154 771	1.5	0.45	0.42	- 6.3
Lake Ontario	129 656	117 850	- 9.1	362 765	377 066	3.9	0.36	0.31	- 12.5
Montréal and Upper Ottawa	5 208	4 492	- 13.8	27 384	25 789	- 5.8	0.19	0.17	- 8.4
Madawaska, Petawawa and Central Ottawa	12 253	10 276	- 16.1	39 612	40 859	3.1	0.31	0.25	- 18.7
Rideau and Lower Ottawa	55 161	58 408	5.9	164 509	181 301	10.2	0.34	0.32	- 3.9
Upper St. Lawrence	14 613	16 906	15.7	43 648	47 436	8.7	0.33	0.36	6.5
Moose	711	852	- 8.4	2 698	2 586	- 10.8	0.25	0.25	2.7
Abitibi	846	709	- 16.2	4 398	3 758	- 14.6	0.19	0.19	- 1.9
Upper Winnipeg	1 831	1 570	- 14.2	13 419	11 783	- 12.2	0.14	0.13	- 2.3
English	413	477	15.6	3 143	2 479	- 21.1	0.13	0.19	46.6
Total	**979 512**	**939 239**	**- 4.1**	**2 533 823**	**2 591 126**	**2.3**	**0.39**	**0.36**	**- 6.2**
Manitoba									
Saskatchewan	1 662	2 465	48.3	13 288	16 170	21.7	0.13	0.15	21.9
Lake Winnipegosis and Lake Manitoba	109 241	133 162	21.9	718 932	859 036	19.5	0.15	0.16	2.0
Assiniboine	121 093	148 593	22.7	750 260	917 614	22.3	0.16	0.16	0.3
Souris	43 184	54 225	25.6	334 152	400 060	19.7	0.13	0.14	4.9
Red	248 459	270 191	8.7	1 248 127	1 359 810	8.9	0.20	0.20	- 0.2
Winnipeg	2 169	4 176	92.5	14 817	21 583	45.7	0.15	0.19	32.2
West Lake Winnipeg	17 102	24 898	45.6	116 878	152 100	30.1	0.15	0.16	11.9
Total	**542 890**	**637 710**	**17.5**	**3 196 455**	**3 726 374**	**16.6**	**0.17**	**0.17**	**0.8**

Commercial Agricultural Fertilizer Application by Sub-basin, 1980 and 1985

Provincial Sub-basin	Commercial fertilizer applied			Area fertilized			Fertilizer per hectare fertilized		
	1980	1985	Change 1980-1985	1980	1985	Change 1980-1985	1980	1985	Change 1980-1985
	tonnes		percent	hectares		percent	tonnes/hectare		percent
Saskatchewan									
Upper South Saskatchewan	91	267	193.2	2 110	4 490	112.8	0.04	0.06	37.8
Central North Saskatchewan	37 436	60 649	62.0	354 264	487 737	37.7	0.11	0.12	17.7
Battle	15 670	21 051	34.3	149 057	183 508	23.1	0.11	0.11	9.1
Lower North Saskatchewan	82 471	131 449	59.4	954 190	1 335 429	40.0	0.09	0.10	13.9
Lower South Saskatchewan	83 415	127 076	52.3	934 552	1 398 075	49.6	0.09	0.09	1.8
Qu'Appelle	87 713	151 236	72.4	979 333	1 612 603	64.7	0.09	0.09	4.7
Saskatchewan	88 677	114 970	29.6	634 468	786 899	24.0	0.14	0.15	4.5
Lake Winnipegosis and Lake Manitoba	26 636	48 498	82.1	259 097	383 481	48.0	0.10	0.13	23.0
Assiniboine	56 740	135 744	139.2	660 760	1 138 872	72.4	0.09	0.12	38.8
Souris	42 675	50 700	18.8	427 717	542 927	26.9	0.10	0.09	- 6.4
Beaver	16 139	29 264	81.3	115 560	178 402	54.4	0.14	0.16	17.5
Missouri	3 458	4 858	40.5	54 744	72 608	32.6	0.06	0.07	5.9
Total	**541 121**	**875 761**	**61.8**	**5 525 853**	**8 125 031**	**47.0**	**0.10**	**0.11**	**10.1**
Alberta									
Upper South Saskatchewan	123 862	143 969	16.4	810 942	1 032 881	27.4	0.15	0.14	- 8.6
Bow	52 951	64 202	21.2	348 754	402 575	15.4	0.15	0.16	5.0
Red Deer	150 524	188 758	25.4	1 104 488	1 333 660	20.7	0.14	0.14	3.9
Upper North Saskatchewan	20 547	23 005	12.0	136 738	156 642	14.6	0.15	0.15	- 2.3
Central North Saskatchewan	117 025	146 196	24.9	902 479	1 081 975	19.9	0.13	0.14	4.2
Battle	110 510	142 905	29.3	954 410	1 123 910	17.8	0.12	0.13	9.8
Lower North Saskatchewan	11 272	22 907	103.2	131 892	227 259	72.3	0.09	0.10	17.9
Lower South Saskatchewan	69	231	234.5	1 221	1 822	49.2	0.06	0.13	124.2
Beaver	10 204	11 817	15.8	71 459	82 067	14.8	0.14	0.14	0.8
Upper Athabasca	2 577	3 607	40.0	17 784	23 484	32.1	0.14	0.15	6.0
Pembina and Central Athabasca	35 696	43 358	21.5	231 687	281 137	21.3	0.15	0.15	0.1
Lower Central Athabasca	5 066	7 184	41.8	37 654	52 245	38.7	0.13	0.14	2.2
Upper Peace	28 142	39 198	39.3	241 978	346 688	43.3	0.12	0.11	- 2.8
Smoky	40 994	51 407	25.4	309 501	398 624	28.8	0.13	0.13	- 2.6
Central Peace	18 150	24 192	33.3	142 436	204 688	43.7	0.13	0.12	- 7.2
Lower Central Peace	2 455	4 299	75.1	21 548	47 487	120.4	0.11	0.09	- 20.5
Missouri	4 365	6 156	41.0	40 201	57 731	43.6	0.11	0.11	- 1.8
Total	**734 209**	**923 392**	**25.8**	**5 505 173**	**6 854 875**	**24.5**	**0.13**	**0.13**	**1.0**
British Columbia									
Williston Lake	238	218	- 8.3	1 197	1 445	20.6	0.20	0.15	- 24.0
Upper Peace	22 785	20 870	- 8.4	148 698	159 662	7.4	0.15	0.13	- 14.7
Skeena	1 555	1 178	- 24.2	12 156	8 711	- 28.3	0.13	0.14	5.7
Gardner Canal and Central Pacific Ocean	42	51	22.1	226	278	23.3	0.19	0.18	- 0.9
Knight Inlet and South Pacific Ocean	322	228	- 29.2	1 066	1 115	4.6	0.30	0.20	- 32.3
Vancouver Island	7 685	6 647	- 13.5	14 764	13 805	- 6.5	0.52	0.48	- 7.5
Nechako	4 206	3 983	- 5.3	27 027	30 694	13.6	0.16	0.13	- 16.6
Upper Fraser	4 343	3 649	- 16.0	27 844	24 413	- 12.3	0.16	0.15	- 4.2
Thompson	7 605	6 283	- 17.4	27 405	28 861	5.3	0.28	0.22	- 21.5
Fraser	33 321	28 047	- 15.8	56 528	58 301	3.1	0.59	0.48	- 18.4
Columbia	14 713	12 230	- 16.9	45 147	46 272	2.5	0.33	0.26	- 18.9
Queen Charlotte Islands	6	8	38.3	5	26	441.7	1.24	0.32	- 74.5
Fort Nelson	2	76	3 695.0	40	601	1 402.1	0.05	0.13	152.6
Total	**96 823**	**83 470**	**- 13.8**	**362 104**	**374 185**	**3.3**	**0.27**	**0.22**	**- 16.6**
Canada	**3 500 689**	**4 052 491**	**15.8**	**18 505 196**	**23 147 970**	**25.1**	**0.19**	**0.18**	**- 7.5**

Source:
Statistics Canada. Environment and Wealth Accounts Division. Agriculture Division.
Note:
Declines in fertilizer tonnages may not reflect actual declines in the nutrients going onto the land.

3.3.3 Restructuring of Land and Water Systems

In 1986, 75 percent of Canada's crops were grown using methods that promote soil erosion.

The restructuring of land and water systems describes the environmental impacts associated with physical restructuring. This section focuses on erosion, an agent of restructuring of the land and on the downstream areas of the drainage basin receiving the silt.

In natural forest and grassland ecosystems, most rain falls on vegetation then infiltrates the soil. Continuous natural vegetative cover prevents water from running off by intercepting and holding precipitation around plants' root and stem systems. If the land's natural vegetation cover is removed, water runs off much faster and soil moisture levels decline. Increased rates of overland flow take away, much of the valuable top-soil. Not only is the soil washed away, but so are essential plant nutrients. Ultimately these eroded materials enter river systems and are carried away often destroying fish habitat, filling reservoirs, plugging water intakes and silting harbours further downstream.

Both soil particles and excess nutrients contribute to problems such as siltation and eutrophication[32] further downstream. Soil degradation also increases production costs for the farmer. Nutrients lost by erosion must be replenished with additional fertilizer. Degraded soils also require additional tillage and irrigation, increasing farmer input costs. Product quality and quantities also decline on degraded soils. Agriculture Canada estimates that land degradation costs Canadian farmers over one billion dollars annually.

As a result of the lowered moisture retention of the soil, streams and rivers which are fed from the eroding land area have higher flow rates in the spring and lower rates in the summer. This raises the risk of added erosion of riverbanks during times of high flow and increased concentration of contaminants during times of low flow.

Monoculture cropping systems are inherently unstable, being susceptible to widespread outbreaks of insects, disease, weeds, and micro-nutrient imbalances.

In 1986, 75 percent of crops were grown in monoculture cropping systems. This amounts to 32.5 million hectares of tilled land either in a close-row or wide-row type monoculture (Table 3.3.3.1). Close-row monocultures are mostly rotations between wheat, oats, barley, rye and oilseeds. These crops have similar effects in terms of erosion, nutrient loss and pest species.

Wide-row monocultures consist of rotations among the following crops: corn, beans, potatoes, soybeans, sugar beets and tobacco. For the most part, these crops are grown with wide spacing between the rows making erosion by water a greater risk than for either close-row or forage crops. Monoculture crops are grown without a soil conditioning forage crop in the rotation.

Provincial programs to encourage crop rotation have been introduced recently and their impacts will be assessed when the 1991 Agricultural Census results are released.

On a national scale wide-row monoculturing practices have increased by more than 68 percent going from 680,000 hectares in 1971 to over 1,147,000 hectares by 1986 (Table 3.3.3.1). Close-row monoculture grew more slowly but the total land area it occupied was almost thirty times that devoted to wide-row monoculture.

Map 3.3.3.1 highlights areas of the prairie provinces where significant changes have occurred in monoculture land area. Map 3.3.3.2 shows concentrations of close-row monoculture as a proportion of tilled land. Map 3.3.3.3 looks at the spread of wide-row monoculture in eastern Canada. Northern basins, where the area under monoculture is small, show the greatest changes. Map 3.3.3.4 indicates which tilled land is under the most intense wide-row monoculture activity.

Map 3.3.3.5 indicates areas at risk of water erosion and Map 3.3.3.6 shows areas at risk of wind erosion. More detailed information on erosion risk is now becoming available at Agriculture Canada's Land Resource Research Institute.

32. *Eutrophication* is the nutrient enrichment of a body of water. This leads to excessive growth of algae which, in turn, depletes the oxygen in the water as the dead algae are consumed by decomposers.

Table: 3.3.3.1

Cropping Practice Changes, by Sub-Basin, 1971 and 1986

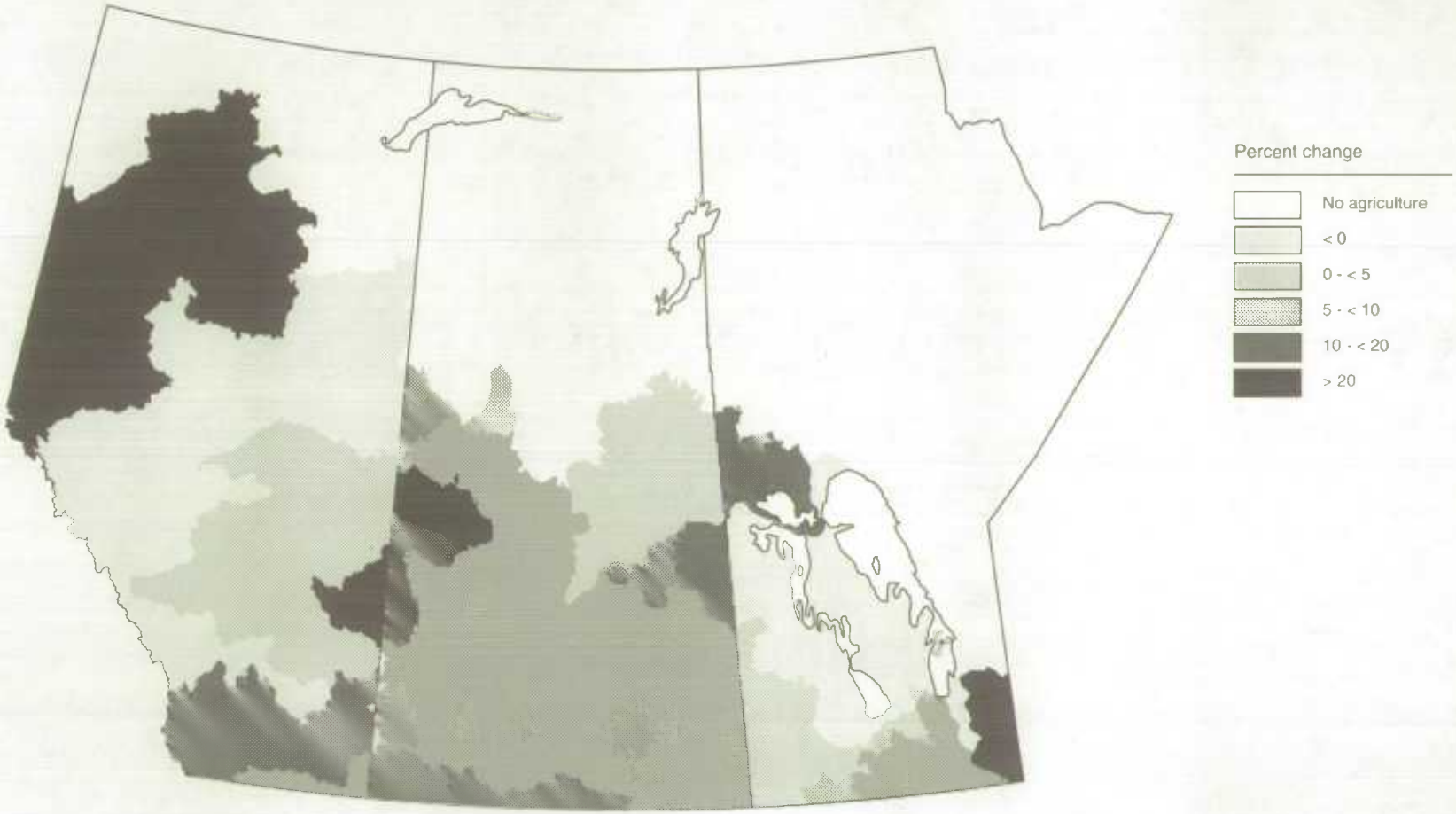
Provincial Sub-basin	Close-row monoculture area			Wide-row monoculture area		
	1971	1986	Change 1971-1986	1971	1986	Change 1971-1986
	hectares		percent	hectares		percent
Newfoundland						
North Newfoundland	29	67	133.8	106	29	- 72.4
South Newfoundland	72	97	34.8	121	3	- 97.5
Total	**101**	**164**	**63.1**	**227**	**32**	**- 85.8**
Prince Edward Island						
Prince Edward Island	24 781	28 492	15.0	4 437	7 032	58.5
Total	**24 781**	**28 492**	**15.0**	**4 437**	**7 032**	**58.5**
Nova Scotia						
Bay of Fundy	4 695	4 104	- 12.6	1 060	1 247	17.7
Southeast Atlantic Ocean	238	154	- 35.3	9	12	27.9
Cape Breton Island	94	105	11.2	8	12	42.9
Total	**5 027**	**4 362**	**- 13.2**	**1 077**	**1 271**	**18.0**
New Brunswick						
Saint John and South Bay of Fundy	6 222	4 875	- 21.7	15 442	10 499	- 32.0
Gulf of St. Lawrence and North Bay of Fundy	4 180	3 785	- 9.5	301	352	16.6
Total	**10 402**	**8 659**	**- 16.8**	**15 743**	**10 851**	**- 31.1**
Quebec						
Saint John	1 261	1 071	- 15.1	50	127	152.6
Cascapedia and Gulf of St. Lawrence	1 467	1 481	1.0	62	286	361.3
Upper Ottawa	1 103	1 210	9.7	208	40	- 80.5
Coulonge and Central Ottawa	1 185	662	- 44.1	961	1 061	10.4
Gatineau and Lower Ottawa	3 360	2 326	- 30.8	1 388	2 473	78.2
Upper St. Lawrence	1 190	1 539	29.3	1 436	17 133	1 093.4
St-Maurice	367	265	- 27.8	174	38	- 78.2
Central St. Lawrence	32 487	49 577	52.6	38 087	155 180	307.4
Lower St Lawrence	12 216	18 478	51.3	2 240	5 330	137.9
North Gaspé Peninsula	4 076	4 084	0.2	170	247	45.6
Saguenay	4 733	4 668	- 1.4	659	1 618	145.6
Betsiamites	112	61	- 45.7	0	0	...
Manicouagan and Outardes	204	96	- 52.9	68	0	- 100.0
Natashquan and Gulf of St. Lawrence	74	2	- 96.7	8	7	- 19.0
Abitibi and North French	650	631	- 3.0	0	130	...
Harricanaw	569	362	- 36.5	23	95	312.3
Total	**65 054**	**86 514**	**33.0**	**45 534**	**183 766**	**303.6**
Ontario						
Nipigon and Northwest Lake Superior	531	515	- 3.0	31	0	- 100.0
Northeast Lake Superior	32	52	62.0	0	0	...
North Lake Huron	1 463	890	- 39.2	202	174	- 13.9
Wanipitai and French	1 957	755	- 61.4	3	212	6 440.0
East Georgian Bay	34 145	26 003	- 23.8	17 520	20 703	18.2
East Lake Huron	59 300	61 959	4.5	68 754	155 921	126.8
North Lake Erie	116 097	82 139	- 29.3	463 584	655 989	41.5
Lake Ontario	69 204	42 248	- 39.0	28 680	54 768	91.0
Montréal and Upper Ottawa	2 613	8 209	214.1	2	63	3 129.2
Madawaska, Petawawa and Central Ottawa	3 925	5 168	31.6	3 699	3 320	- 10.2
Rideau and Lower Ottawa	6 566	10 885	65.8	14 938	24 199	62.0
Upper St. Lawrence	2 724	2 763	1.4	3 345	8 599	157.1
Moose	141	440	212.4	2	10	459.5
Abitibi	313	437	39.7	16	85	427.5
Upper Winnipeg	564	3 314	487.4	0	2	...
English	501	513	2.3	0	75	...
Total	**300 077**	**246 288**	**- 17.9**	**600 776**	**924 139**	**53.8**
Manitoba						
Saskatchewan	14 964	17 417	16.4	11	0	- 100.0
Lake Winnipegosis and Lake Manitoba	939 100	902 717	- 3.9	1 198	1 988	65.9
Assiniboine	1 134 710	1 163 810	2.6	1 040	1 431	37.5
Souris	511 235	519 781	1.7	189	330	74.3
Red	1 266 111	1 349 701	6.6	1 797	5 250	192.1
Winnipeg	17 643	25 195	42.8	2	129	6 300.1
West Lake Winnipeg	162 013	153 510	- 5.2	0	12	...
Total	**4 045 775**	**4 132 132**	**2.1**	**4 238**	**9 140**	**115.6**

Cropping Practice Changes, by Sub-Basin, 1971 and 1986

Provincial Sub-basin	Close-row monoculture area			Wide-row monoculture area		
	1971	1986	Change 1971-1986	1971	1986	Change 1971-1986
	hectares		percent	hectares		percent
Saskatchewan						
Upper South Saskatchewan	27 933	18 952	- 32.2	0	0	...
Central North Saskatchewan	515 096	621 338	20.6	1	0	- 100.0
Battle	202 599	228 235	12.7	0	0	...
Lower North Saskatchewan	2 317 800	2 484 745	7.2	19	0	- 100.0
Lower South Saskatchewan	3 241 487	3 451 393	6.5	92	231	151.5
Qu'Appelle	4 743 165	5 007 020	5.6	105	181	71.8
Saskatchewan	939 214	940 613	0.1	32	1	- 97.4
Lake Winnipegosis and Lake Manitoba	467 991	538 017	15.0	8	0	- 100.0
Assiniboine	1 589 844	1 707 872	7.4	9	115	1 195.5
Souris	1 848 106	1 968 606	6.5	4	123	3 345.5
Beaver	184 473	206 163	11.8	2	0	- 100.0
Missouri	629 522	749 981	19.1	0	0	...
Total	**16 707 232**	**17 922 935**	**7.3**	**271**	**651**	**140.4**
Alberta						
Upper South Saskatchewan	1 549 147	1 797 829	16.1	3 084	3 004	- 2.6
Bow	527 028	513 058	- 2.7	1 718	2 929	70.5
Red Deer	1 570 316	1 646 968	4.9	401	503	25.8
Upper North Saskatchewan	135 708	97 718	- 28.0	98	204	109.1
Central North Saskatchewan	1 182 874	1 185 164	0.2	698	361	- 48.3
Battle	1 170 511	1 205 376	3.0	22	176	689.1
Lower North Saskatchewan	338 492	457 475	35.2	0	0	...
Beaver	87 903	87 376	- 0.6	0	0	...
Upper Athabasca	12 096	8 755	- 27.6	0	0	...
Pembina and Central Athabasca	308 744	219 864	- 28.8	0	26	...
Lower Central Athabasca	59 187	55 091	- 6.9	0	0	...
Upper Peace	361 951	445 116	23.0	0	0	...
Smoky	385 662	475 847	23.4	39	0	- 100.0
Central Peace	176 552	293 194	66.1	2	0	- 100.0
Lower Central Peace	25 885	80 681	211.7	0	18	...
Missouri	148 154	160 231	8.2	0	0	...
Total	**8 040 210**	**8 729 743**	**8.6**	**6 063**	**7 220**	**19.1**
British Columbia						
Williston Lake	448	1 078	140.3	0	0	...
Upper Peace	193 576	184 723	- 4.6	6	0	- 100.0
Skeena	315	326	3.4	40	12	- 68.8
Vancouver Island	223	167	- 25.0	247	374	51.0
Nechako	761	3 269	329.7	2	8	275.0
Upper Fraser	679	2 114	211.5	24	1	- 96.6
Thompson	1 725	2 873	66.6	100	561	459.7
Fraser	2 479	1 307	- 47.3	1 257	2 051	63.2
Columbia	9 448	5 940	- 37.1	379	643	69.9
Fort Nelson	0	668	...	0	0	...
Total	**209 653**	**202 464**	**- 3.4**	**2 055**	**3 648**	**77.5**
Canada	**29 408 312**	**31 361 754**	**6.6**	**680 421**	**1 147 750**	**68.7**

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

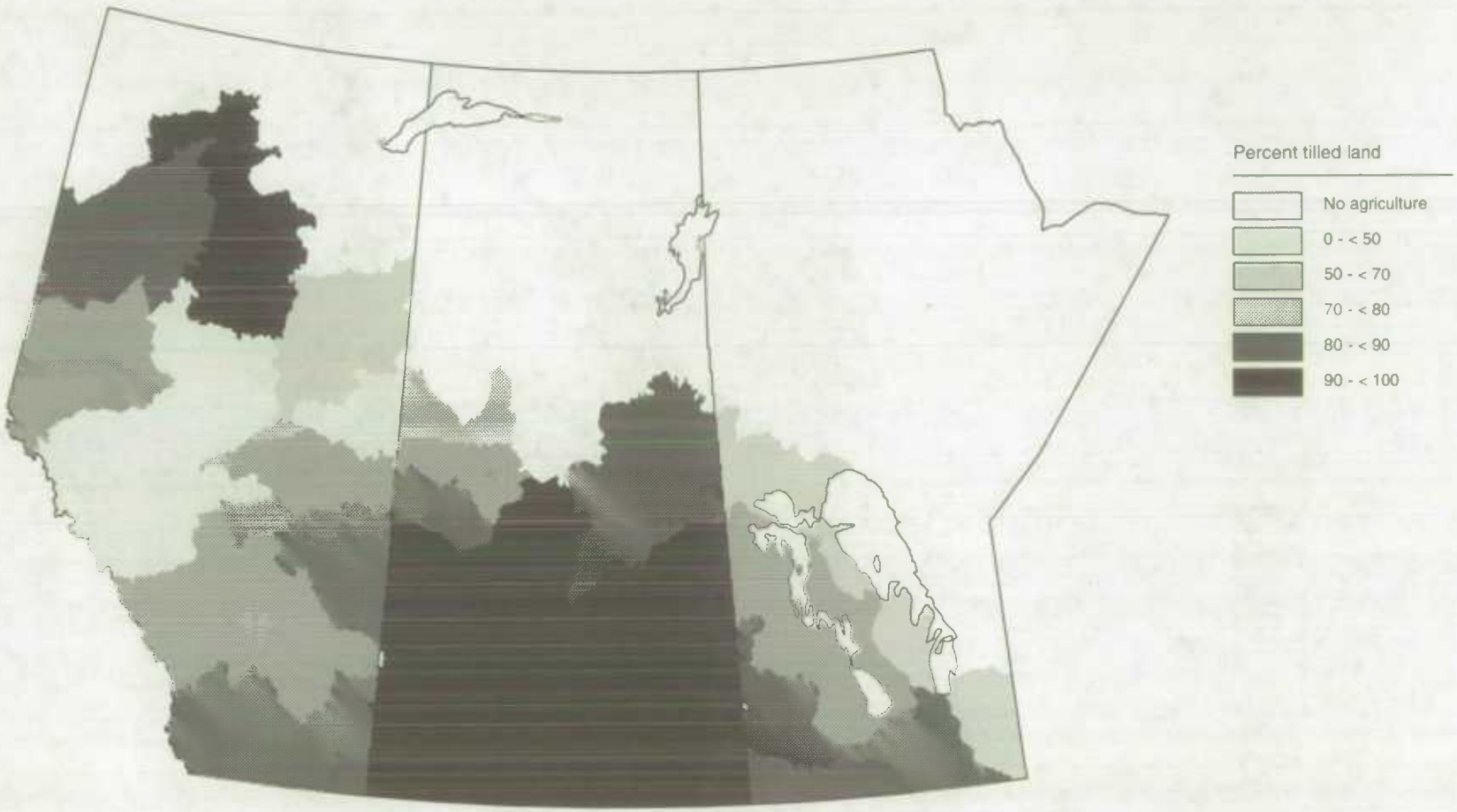
Change in Land Area Under Close-row Monoculture by Sub-basin, 1971 to 1986



Source: Statistics Canada, Environment and Wealth Accounts Division. Agriculture Division.
Note: Close-row monoculture is most prevalent in the prairie provinces.

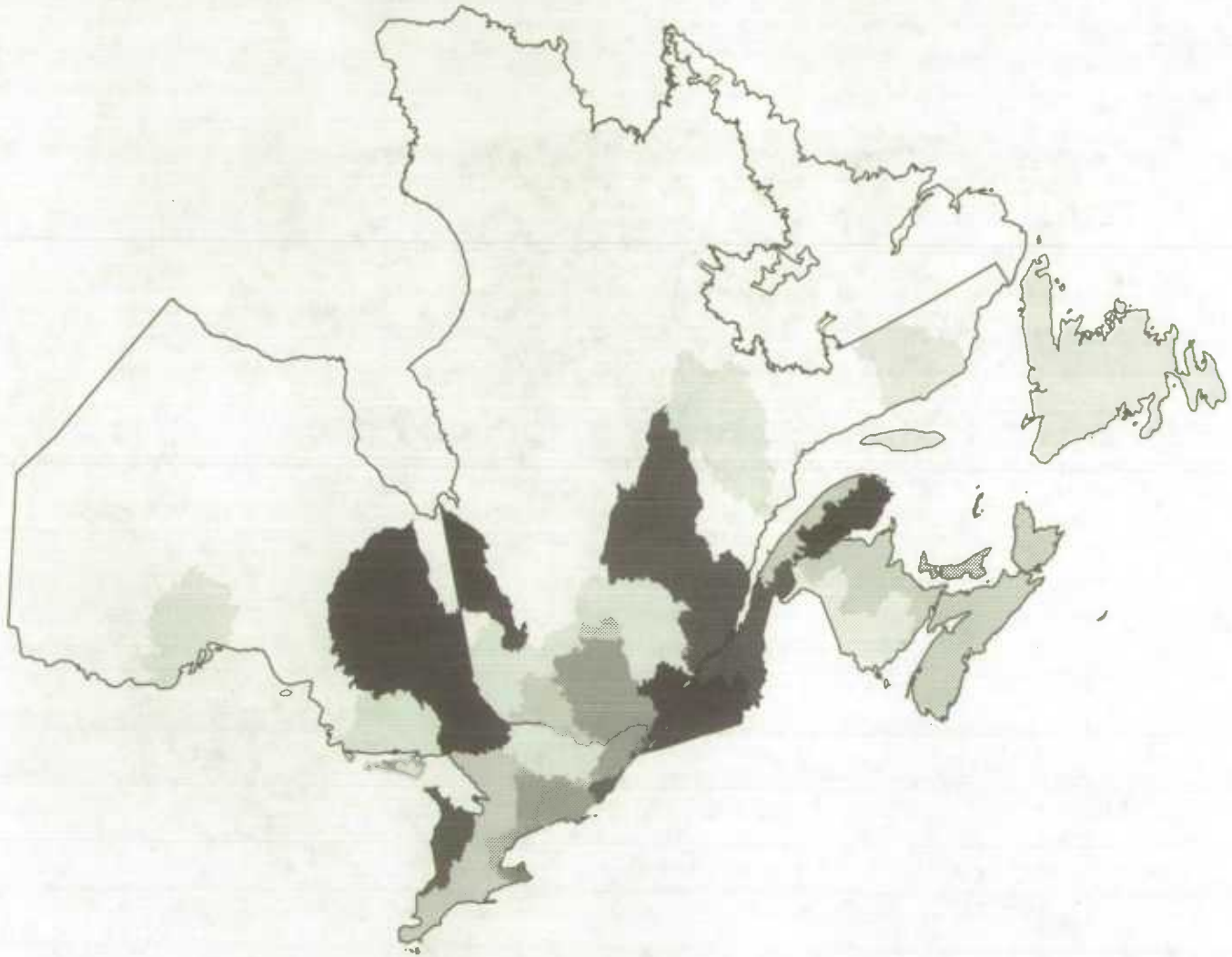
Map: 3.3.3.2

Tilled Land Under Close-row Monoculture, 1986



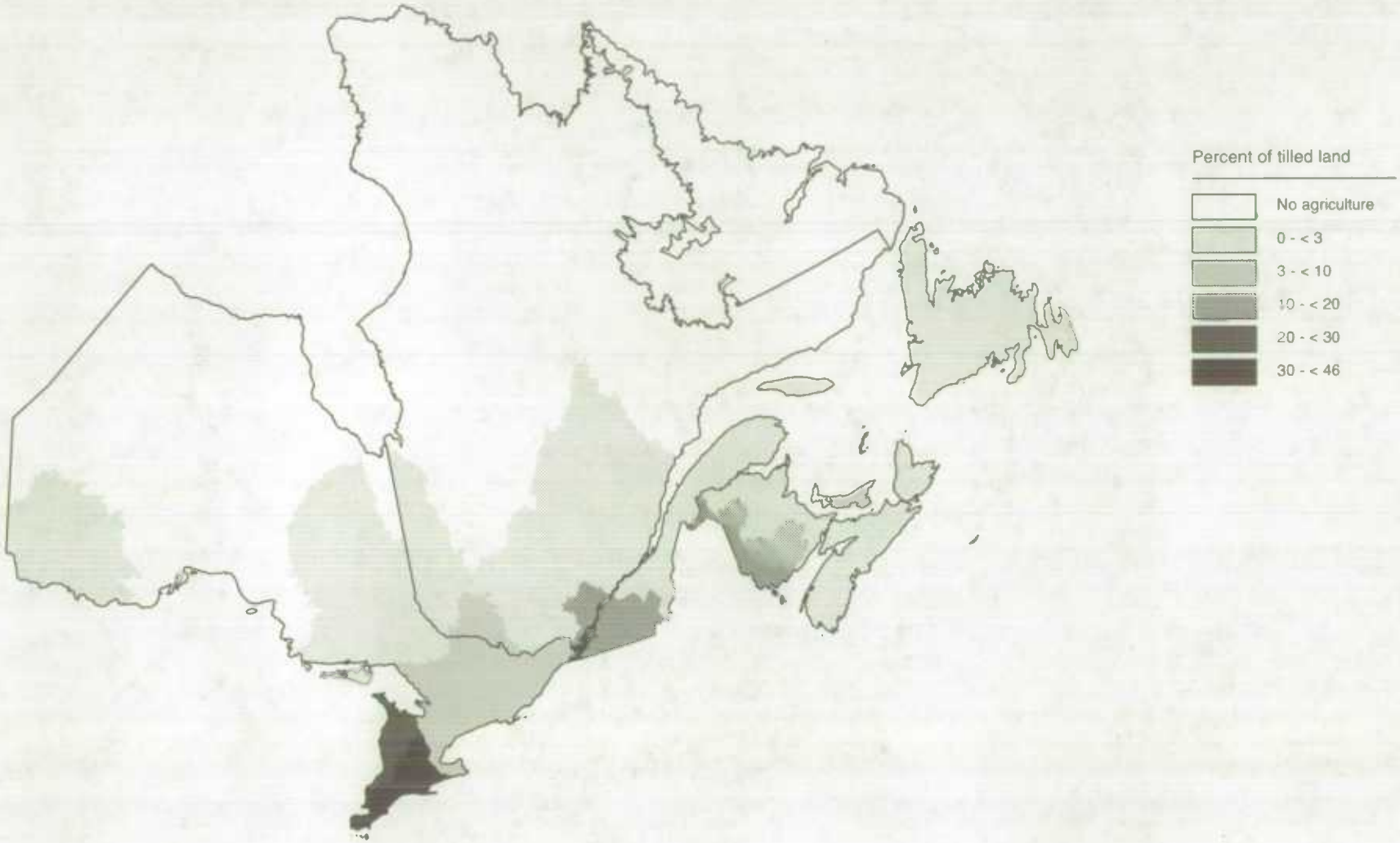
Source: Statistics Canada, Environment and Wealth Accounts Division.
Agriculture Division.
Note: Close-row monoculture is most prevalent in the prairie provinces.

Change In Land Area Under Wide-row Monoculture by Sub-basin, 1971 to 1986



Source: Statistics Canada, Environment and Wealth Accounts Division.
Agriculture Division.
Note: Wide-row monoculture is most prevalent in eastern Canada.

Tilled Land Under Wide-row Monoculture, 1986



Source: Statistics Canada. Environment and Wealth Accounts Division. Agriculture Division.
Note: Wide-row monoculture is most prevalent in Eastern Canada.

Map: 3.3.3.5

Risk of Soil Erosion By Water on Agricultural Land, 1989

Source: Agriculture Canada, Land Resource Research Center, 1989.
Note: Data are presented for Great Group soil polygons.

Risk of Soil Erosion By Wind on Agricultural Land, 1989

Source: Agriculture Canada, Land Resource Research Center, 1989.
Note: Data are presented for Great Group soil polygons.

3.3.4 Composition and Range of Wildlife

The zebra mussel and purple loosestrife are only two of the many non-native species that are causing difficulties for native ecosystems. Expensive efforts are underway to control these rapidly growing populations.

Changes in Species Composition

Either on purpose or incidentally, people have introduced species into natural ecosystems. Introduction of non-native species into an ecosytem can have great detrimental effects on the environment by displacing native flora and fauna. The introduced species has no natural predators and therefore is limited only by the resources available. Two such species are the zebra mussel (*Dreissena polymorpha*), a mollusc, and the purple loosestrife (*Lythrum salicaria*), a plant. Both are causing extensive damage to local ecosystems.

The Zebra Mussel

The first Canadian zebra mussel was discovered in Lake St. Clair in 1988. Free-floating mussel larvae were likely released from the ballast of a European transoceanic ship. The zebra mussel has dispersed rapidly to all five Great Lakes (Map 3.3.4.1). They attach to boat hulls, engines, fish cages, waterfowl and wildlife. Thus, the potential to spread throughout inland waters is immense.

Zebra mussels rapidly induce changes in the local aquatic ecosystem. They filter phytoplankton and other suspended material out of the water. Thus, large quantities of phytoplankton are not available for zooplankton, and subsequently, to larval fish. This could lead to declining populations of commercially valuable species such as walleye, bass, lake trout and perch. Bottom feeding species, carp, whitefish, and crayfish, could increase because of the concentration of nutrients from mussel biomass on the lake bottom. The zebra mussel reproduces rapidly and has no natural predators in its new habitat.

Many water-treatment plants and utilities have reported up to 50 percent reductions in pumping capability and occasional shutdowns due to zebra mussel encrustment. Millions of dollars have been spent trying to remove and control zebra mussels.

The Purple Loosestrife

The purple loosestrife is an exotic plant species from Europe that is rapidly invading wetlands across North America. It displaces native plant communities and promotes the drying of wetlands, resulting in the loss of food and shelter for waterfowl, furbearers and other aquatic wildlife. In lowland pastures, the purple loosestrife, which is not palatable to livestock, displaces existing feed crops.

This plant arrived accidentally in a ship's ballast and in livestock bedding and forage. It was also intentionally imported as seeds or rootstalks for cultivation. Since the early 1800s, the purple loosestrife has spread to all provinces in Canada (Map 3.3.4.2). Its cultivation has also been promoted by apiculturists as a honey plant and by nurseries as an ornamental plant.[33]

Purple loosestrife reproduces prolifically by producing millions of small seeds that are readily dispersed and by sprouting from stem and root fragments. Control efforts directed towards preventing the establishment of new populations and preventing the spread of existing ones are urgently needed.

33. Keddy, C. J. 1988. *A review of* **Lythrum salicaria** *(purple loosestrife), ecology and management: The urgency for management in Ontario.* Report prepared for the Ontario Heritage Foundation, Toronto, Ontario.

Thompson, D. Q., R. L. Stuckey and E. B. Thompson. 1987. *Spread, impact and control of purple loosestrife (***Lythrum salicaria***) in North American wetlands.* U.S. Fish and Wildlife Service, Washington. Fish and Wildlife Research.

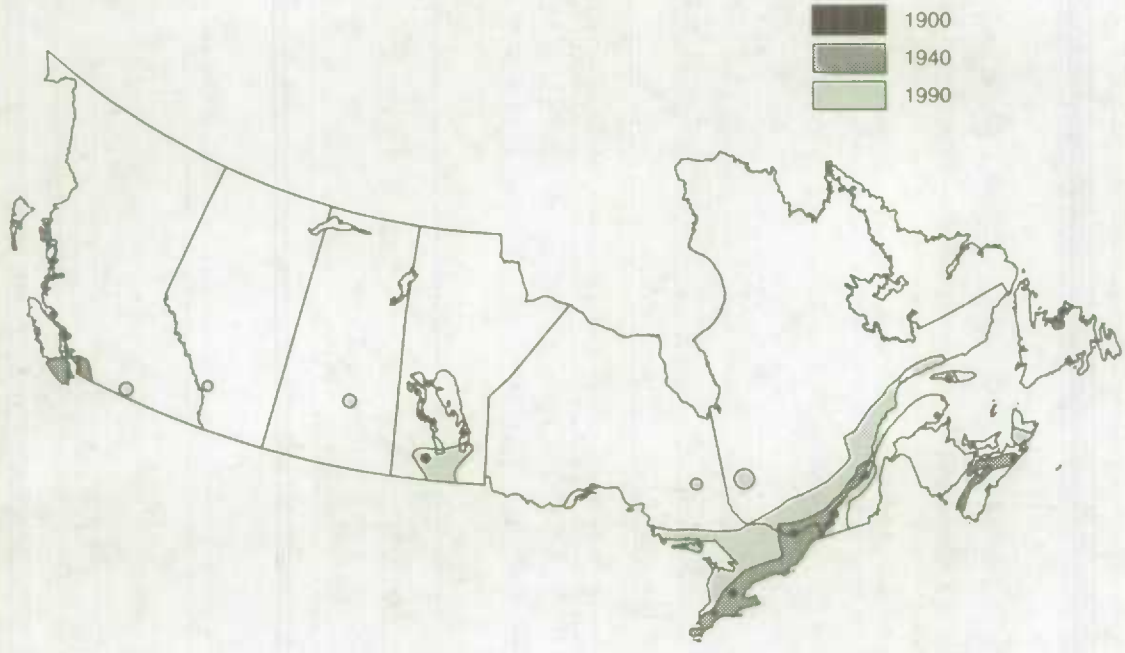
Map: 3.3.4.1

Zebra Mussels in the Great Lakes, 1990

Source: Ontario Ministry of Natural Resources, Fisheries Branch.

Map: 3.3.4.2

Range of Purple Loosestrife, 1900, 1940 and 1990



Source: Keddy, C.J. 1988. Op cit.
Thompson, D.Q. Op. cit.

3.3.5 Soil Nutrients

In some areas of Canada, the amount of nutrients applied to agricultural land has increased thirty-fold. There is a diminishing rate of return to fertilizer application. The net effect is to damage the natural self-sustaining nutrient equilibrium of the soil for a small gain in crop yield.

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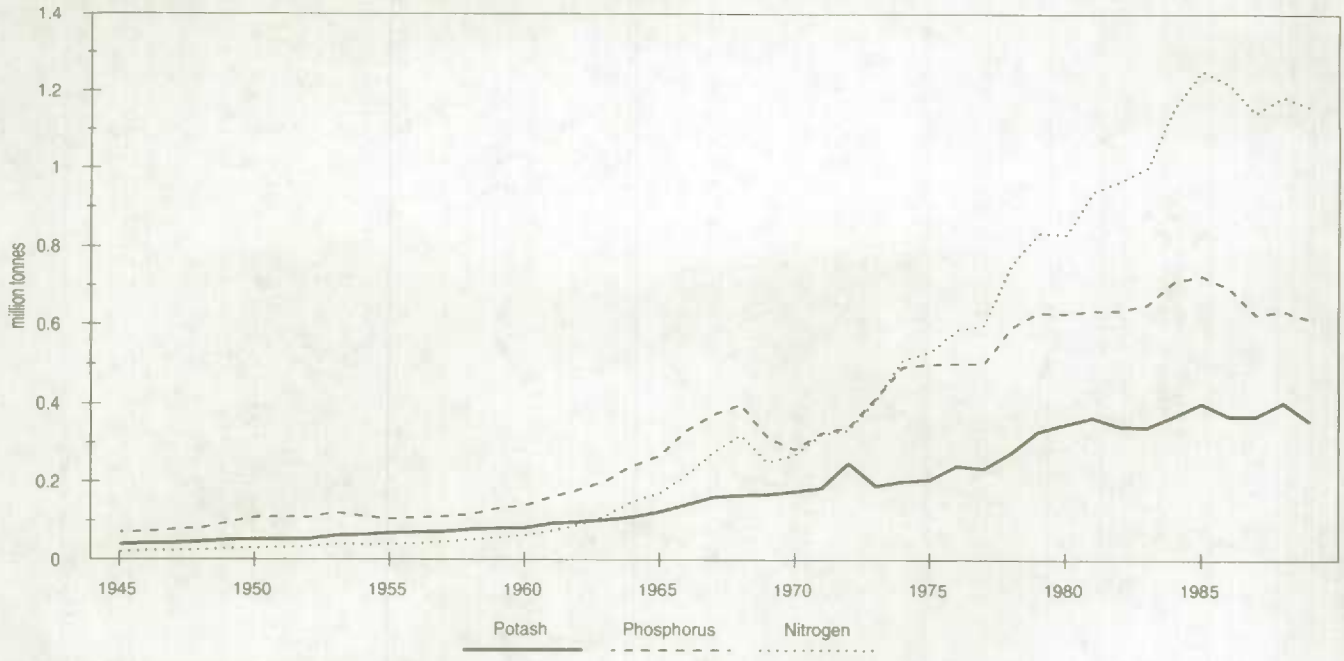
In some agricultural areas, the application of fertilizer nutrients has increased by 3000 percent between 1970 and 1985. This trend indicates an increasing reliance on artificial nutrients to support agricultural activity.

The nutrient content of fertilizer has been increasing steadily as technology develops more concentrated, more easily applied fertilizer products. Fertilizer nutrient content has gone from just over 20 percent in the 1920s to over 50 percent by the 1980s (Figure 3.3.5.1, Table 3.3.5.2). The largest percentage increases in nutrient application between 1970 and 1985 were in the Prairie Provinces, where fertilizers were being applied to land which previously had not been fertilized (Map 3.3.5.1).

In 1986, approximately 514 thousand tonnes of nitrogen and 264 thousand tonnes of phosphorus were generated in the form of farm animal manures (Table 3.3.5.1). A large proportion of these nutrients are also applied to the soil.

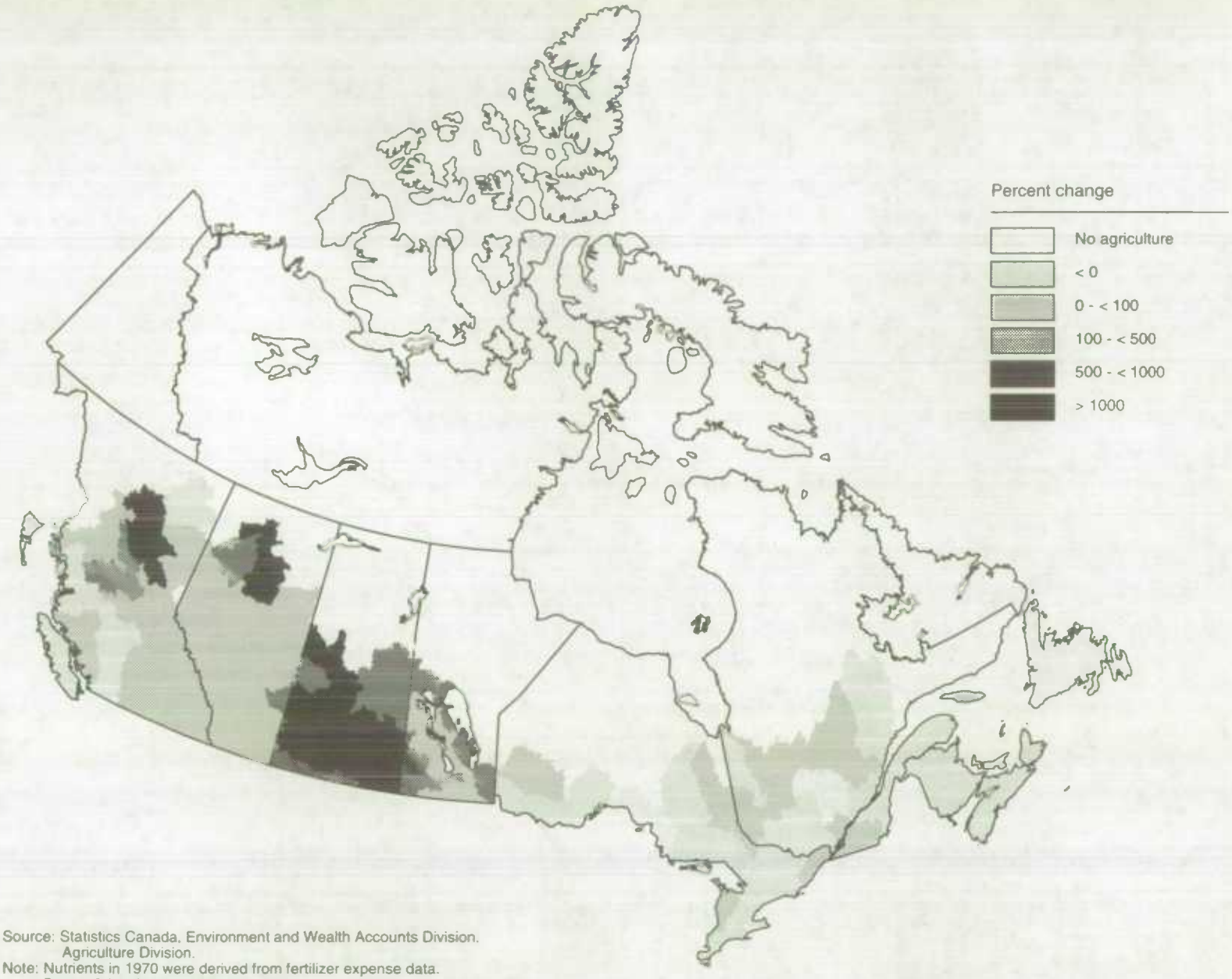
Figure: 3.3.5.1

Nutrient Content of Fertilizers Sold, 1949-1989



Sources: Statistics Canada. Fertilizer Trade. Catalogue 47-207. Agriculture Canada, Farm Policy Development Branch.

Change in Agricultural Fertilizer Nutrients By Sub-basin, 1970 to 1985



Source: Statistics Canada, Environment and Wealth Accounts Division.
Agriculture Division.
Note: Nutrients in 1970 were derived from fertilizer expense data.
Some of the shaded sub-basins above have very little agricultural activity.

Table: 3.3.5.1

Nitrogen and Phosphorus Content of Animal Manures Produced on Farms, 1971 - 1986

Provincial Sub-basin	Nitrogen from agricultural animal manures			Phosphorus from agricultural animal manures		
	1971	1986	Change 1971-1986	1971	1986	Change 1971-1986
	tonnes		percent	tonnes		percent
Newfoundland						
North Newfoundland	191.3	351.5	83.8	85.7	186.9	118.1
South Newfoundland	816.3	744.3	- 8.8	365.2	392.8	7.5
Total	**1 007.6**	**1 095.8**	**8.8**	**450.9**	**579.7**	**28.6**
Prince Edward Island						
Prince Edward Island	5 007.4	4 714.7	- 5.8	2 575.0	2 504.3	- 2.7
Total	**5 007.4**	**4 714.7**	**- 5.8**	**2 575.0**	**2 504.3**	**- 2.7**
Nova Scotia						
Bay of Fundy	6 145.4	6 322.1	2.9	2 897.6	3 301.9	14.0
Southeast Atlantic Ocean	1 156.7	899.3	- 22.2	543.6	471.0	- 13.4
Cape Breton Island	609.5	443.4	- 27.2	283.2	223.5	- 21.1
Total	**7 911.6**	**7 664.8**	**- 3.1**	**3 724.4**	**3 996.5**	**7.3**
New Brunswick						
Saint John and South Bay of Fundy	3 770.1	4 051.6	7.5	1 770.6	2 096.6	18.4
Gulf of St. Lawrence and North Bay of Fundy	2 344.3	1 981.7	- 15.5	1 102.5	1 018.0	- 7.7
Total	**6 114.4**	**6 033.2**	**- 1.3**	**2 873.1**	**3 114.6**	**8.4**
Quebec						
Saint John	1 595.8	980.4	- 38.6	761.0	479.7	- 37.0
Cascapedia and Gulf of St. Lawrence	1 945.8	1 243.5	- 36.1	924.5	602.7	- 34.8
Upper Ottawa	1 663.7	1 204.8	- 27.6	790.2	581.6	- 26.4
Coulonge and Central Ottawa	1 735.4	1 452.5	- 16.3	823.1	700.4	- 14.9
Gatineau and Lower Ottawa	5 208.4	3 722.0	- 28.5	2 455.1	1 807.6	- 26.4
Upper St. Lawrence	1 944.8	1 493.6	- 23.2	910.6	755.8	- 17.0
St-Maurice	282.9	151.8	- 46.3	132.6	74.5	- 43.8
Central St. Lawrence	53 060.9	51 865.4	- 2.3	24 894.5	27 771.8	11.6
Lower St Lawrence	31 665.1	30 562.2	- 3.5	15 392.9	16 289.0	5.8
North Gaspé Peninsula	4 731.5	3 039.1	- 35.8	2 294.4	1 479.5	- 35.5
Saguenay	5 506.2	3 552.0	- 35.5	2 617.5	1 740.0	- 33.5
Betsiamites	51.5	40.2	- 21.9	24.5	19.8	- 19.2
Manicouagan and Outardes	14.7	14.8	1.0	6.5	7.0	8.3
Natashquan and Gulf of St. Lawrence	1.1	0.0	- 100.0	0.5	0.0	- 100.0
Nottaway	45.0	45.6	1.3	20.6	22.1	7.0
Abitibi and North French	106.8	117.9	10.4	51.0	57.1	11.8
Harricanaw	994.5	798.7	- 19.7	475.7	385.6	- 18.9
Total	**110 554.0**	**100 284.5**	**- 9.3**	**52 575.2**	**52 774.2**	**0.4**
Ontario						
Nipigon and Northwest Lake Superior	532.1	426.4	- 19.9	230.5	215.7	- 6.4
Northeast Lake Superior	31.3	26.2	- 16.3	12.8	13.0	1.5
North Lake Huron	1 609.9	1 367.3	- 15.1	713.4	692.5	- 2.9
Wanipitai and French	847.0	683.1	- 19.3	371.2	348.5	- 6.1
East Georgian Bay	12 487.1	8 819.2	- 29.4	5 623.5	4 596.2	- 18.3
East Lake Huron	36 977.1	32 411.6	- 12.3	16 857.1	17 487.1	3.7
North Lake Erie	49 721.3	44 626.6	- 10.2	23 172.5	24 556.6	6.0
Lake Ontario	29 024.6	22 296.2	- 23.2	12 745.6	11 652.6	- 8.6
Montréal and Upper Ottawe	1 151.7	1 022.6	- 11.2	509.6	522.9	2.6
Madawaska, Petawawa and Central Ottawa	5 529.2	4 331.4	- 21.7	2 427.1	2 202.7	- 9.2
Rideau and Lower Ottawa	11 565.5	8 862.5	- 23.4	5 062.1	4 563.8	- 9.8
Upper St. Lawrence	4 802.7	3 478.8	- 27.6	2 075.0	1 787.5	- 13.9
Moose	157.6	128.7	- 18.4	68.4	65.9	- 3.7
Abitibi	256.3	228.0	- 11.0	112.4	116.0	3.2
Upper Winnipeg	789.8	700.2	- 11.3	345.5	354.8	2.6
English	113.7	121.9	7.2	50.6	65.7	29.9
Total	**155 596.8**	**129 530.7**	**- 16.8**	**70 377.4**	**69 241.3**	**- 1.6**
Manitoba						
Saskatchewan	13 996.5	13 333.0	- 4.7	8 941.7	6 581.2	- 5.2
Lake Winnipegosis and Lake Manitoba	11 288.6	9 792.1	- 13.3	5 627.2	4 955.6	- 11.9
Assiniboine	4 685.2	3 798.3	- 18.9	2 309.0	1 879.3	- 18.6
Souris	16 715.7	15 717.9	- 6.0	8 351.4	8 468.3	1.4
Red	627.0	610.8	- 2.6	300.1	331.0	10.3
Winnipeg	2 781.1	2 547.0	- 8.4	1 369.2	1 305.0	- 4.7
Total	**50 094.1**	**45 799.3**	**- 8.6**	**24 898.5**	**23 520.5**	**- 5.5**

Nitrogen and Phosphorus Content of Animal Manures Produced on Farms, 1971 - 1986

Provincial Sub-basin	Nitrogen from agricultural animal manures			Phosphorus from agricultural animal manures		
	1971	1986	Change 1971-1986	1971	1986	Change 1971-1986
	tonnes		percent	tonnes		percent
Saskatchewan						
Upper South Saskatchewan	133.5	28.5	- 78.7	64.3	13.5	- 78.9
Central North Saskatchewan	5 165.1	3 939.7	- 23.7	2 504.7	1 907.6	- 23.8
Battle	1 542.1	893.3	- 42.1	748.3	432.6	- 42.2
Lower North Saskatchewan	11 931.1	8 399.0	- 29.6	5 859.6	4 136.7	- 29.4
Lower South Saskatchewan	15 703.1	12 682.6	- 19.2	7 700.1	6 270.5	- 18.6
Qu'Appelle	19 689.3	13 503.5	- 31.4	9 559.3	6 557.2	- 31.4
Saskatchewan	4 425.2	2 371.9	- 46.4	2 315.4	1 221.0	- 47.3
Lake Winnipegosis and Lake Manitoba	2 468.1	2 149.3	- 12.9	1 217.0	1 049.6	- 13.8
Assiniboine	9 488.8	6 448.0	- 32.0	4 584.7	3 170.8	- 30.8
Souris	10 238.6	6 692.5	- 34.6	4 967.4	3 203.5	- 35.5
Beaver	3 014.7	3 018.1	0.1	1 455.4	1 449.4	- 0.4
Upper Churchill	3.6	3.2	- 11.3	1.7	1.6	- 3.5
Missouri	5 575.9	3 911.9	- 29.8	2 670.0	1 870.1	- 30.0
Total	**89 379.0**	**64 041.6**	**- 28.3**	**43 647.9**	**31 284.1**	**- 28.3**
Alberta						
Upper South Saskatchewan	22 500.6	22 080.1	- 1.9	11 125.5	11 108.4	- 0.2
Bow	11 866.9	9 090.0	- 23.4	5 786.1	4 438.9	- 23.3
Red Deer	30 360.3	30 054.8	- 1.0	15 117.5	15 113.4	0.0
Upper North Saskatchewan	5 246.2	5 920.4	12.8	2 614.4	2 896.5	10.8
Central North Saskatchewan	18 703.6	15 869.5	- 15.2	9 401.6	7 985.6	- 15.1
Battle	17 363.6	16 283.2	- 6.2	8 706.3	8 148.1	- 6.4
Lower North Saskatchewan	4 251.8	4 471.0	5.2	2 075.0	2 199.1	6.0
Lower South Saskatchewan	98.2	67.6	- 31.2	47.6	32.6	- 31.5
Beaver	2 592.6	3 058.0	18.0	1 306.4	1 521.4	16.5
Upper Athabasca	722.2	997.1	38.1	361.4	481.2	33.1
Pembina and Central Athabasca	7 471.1	10 100.6	35.2	3 812.7	5 050.1	32.5
Lower Central Athabasca	1 034.4	1 255.9	21.4	516.8	615.1	19.0
Upper Peace	1 442.9	1 555.2	7.8	735.1	757.5	3.1
Smoky	2 484.5	2 663.6	7.2	1 262.5	1 306.1	3.5
Central Peace	822.6	759.6	- 7.7	427.6	373.0	- 12.6
Lower Central Peace	190.6	165.5	- 13.2	99.8	80.3	- 19.6
Missouri	1 998.6	1 564.0	- 21.7	975.0	777.5	- 20.3
Total	**129 150.7**	**125 956.0**	**- 2.5**	**64 371.3**	**62 884.6**	**- 2.3**
British Columbia						
Williston Lake	19.5	48.3	148.4	8.9	22.3	149.8
Upper Peace	1 279.3	2 722.6	112.8	611.1	1 284.7	110.2
Skeena	571.7	523.2	- 8.5	270.7	248.0	- 8.4
Gardner Canal and Central Pacific Ocean	134.1	120.2	- 10.4	62.7	56.1	- 10.5
Knight Inlet and South Pacific Ocean	135.6	146.7	8.2	63.0	68.6	8.8
Vancouver Island	1 420.0	1 749.6	23.2	643.2	884.5	37.5
Nechako	728.1	1 232.7	69.3	345.5	584.1	69.0
Upper Fraser	1 186.9	1 431.2	20.6	561.0	677.6	20.6
Thompson	4 716.3	5 021.9	6.5	2 252.5	2 412.3	7.1
Fraser	11 199.7	11 531.0	3.0	4 924.4	5 870.7	19.2
Columbia	3 827.5	3 830.3	0.1	1 819.4	1 830.8	0.6
Total	**25 218.6**	**28 357.6**	**12.4**	**11 562.2**	**13 939.6**	**20.6**
Canada	**580 034.0**	**513 478.4**	**- 11.5**	**277 056.0**	**263 839.3**	**- 4.8**

Source:
Statistics Canada. Environment and Wealth Accounts Division. Agriculture Division.
Note:
Nutrient tonnages were derived from livestock population data.

Table: 3.3.5.2

Nitrogen and Phosphorus Content of Commercial Fertilizer Applied on Farmland, 1970 and 1985

Provincial Sub-basin	Nitrogen from commercial agricultural fertilizer			Phosphorus from commercial agricultural fertilizer		
	1971	1986	Change 1971-1986	1971	1986	Change 1971-1986
	tonnes		percent	tonnes		percent
Newfoundland						
North Newfoundland	75	83	10.96	107	89	- 16.76
South Newfoundland	140	170	21.96	200	181	- 9.58
Total	**214**	**253**	**18.13**	**308**	**270**	**- 12.08**
Prince Edward Island						
Prince Edward Island	3 342	7 763	132.30	6 320	9 565	51.34
Total	**3 342**	**7 763**	**132.30**	**6 320**	**9 565**	**51.34**
Nova Scotia						
Bay of Fundy	2 115	3 886	83.77	2 858	3 292	15.21
Southeast Atlantic Ocean	207	351	70.10	279	298	6.64
Cape Breton Island	134	303	125.84	181	256	41.58
Total	**2 455**	**4 540**	**84.91**	**3 318**	**3 846**	**15.93**
New Brunswick						
Saint John and South Bay of Fundy	2 332	5 003	114.54	3 605	5 045	39.96
Gulf of St. Lawrence and North Bay of Fundy	450	1 229	173.10	696	1 239	78.17
Total	**2 782**	**6 232**	**124.01**	**4 300**	**6 284**	**46.14**
Quebec						
Saint John	140	436	212.46	246	386	55.91
Cascapedia and Gulf of St. Lawrence	219	796	264.03	388	705	81.65
Upper Ottawa	91	476	422.58	162	421	160.76
Coulonge and Central Ottawa	130	532	308.00	232	471	103.59
Gatineau and Lower Ottawa	543	2 219	308.71	964	1 965	103.94
Upper St. Lawrence	439	3 691	741.36	779	3 270	319.83
St-Maurice	80	157	95.34	143	139	- 2.53
Central St. Lawrence	10 305	51 629	401.03	18 293	45 733	150.01
Lower St Lawrence	3 656	11 533	215.47	6 490	10 216	57.42
North Gaspé Peninsula	674	2 098	211.20	1 197	1 658	55.29
Saguenay	402	2 004	398.97	713	1 775	148.98
Betsiamites	3	9	232.68	5	8	66.00
Manicouagan and Outardes	14	50	261.43	25	42	69.60
Natashquan and Gulf of St. Lawrence	3	16	381.25	6	14	140.14
Nottaway	5	30	499.12	9	27	198.95
Abitibi and North French	44	344	683.81	78	305	291.11
Harricanaw	33	136	313.18	58	121	106.17
Total	**16 779**	**76 156**	**353.86**	**29 787**	**67 457**	**126.46**
Ontario						
Nipigon and Northwest Lake Superior	309	438	41.86	178	281	57.57
Northeast Lake Superior	44	19	- 56.42	26	12	- 51.60
North Lake Huron	487	630	29.33	281	403	43.65
Wanipitai and French	332	439	32.36	191	281	47.01
East Georgian Bay	8 260	11 291	36.69	4 762	7 230	51.82
East Lake Huron	21 930	37 273	69.96	12 643	23 867	88.77
North Lake Erie	74 142	98 604	32.99	42 744	63 139	47.71
Lake Ontario	16 066	24 074	49.85	9 262	15 416	88.43
Montréal and Upper Ottawa	402	918	128.24	232	588	153.50
Madawaska, Petawawa and Central Ottawa	1 453	2 099	44.50	838	1 344	60.50
Rideau and Lower Ottawa	7 291	11 931	63.64	4 204	7 640	81.75
Upper St. Lawrence	1 706	3 453	102.38	984	2 211	124.78
Moose	126	133	5.88	72	85	17.60
Abitibi	89	145	63.67	51	93	81.79
Upper Winnipeg	234	321	36.90	135	205	52.05
English	45	98	119.18	26	62	143.45
Total	**132 917**	**191 867**	**44.35**	**76 629**	**122 859**	**60.33**
Manitoba						
Saskatchewan	92	869	841.93	87	390	346.35
Lake Winnipegosis and Lake Manitoba	6 316	46 959	643.47	5 980	21 067	252.31
Assiniboine	4 752	52 400	1 002.75	4 499	23 508	422.56
Souris	1 827	19 122	946.85	1 729	8 579	396.07
Red	12 523	95 281	660.85	11 856	42 745	280.54
Winnipeg	127	1 472	1 057.02	120	681	448.03
West Lake Winnipeg	1 032	8 781	750.97	977	3 939	302.06
Total	**26 669**	**224 884**	**743.25**	**25 246**	**100 888**	**299.59**

Nitrogen and Phosphorus Content of Commercial Fertilizer Applied on Farmland, 1970 and 1985

Provincial Sub-basin	Nitrogen from commercial agricultural fertilizer			Phosphorus from commercial agricultural fertilizer		
	1971	1986	Change 1971-1986	1971	1986	Change 1971-1986
	tonnes		percent	tonnes		percent
Saskatchewan						
Upper South Saskatchewan	14	89	559.56	28	56	102.58
Central North Saskatchewan	1 026	20 311	1 879.44	2 085	12 674	507.97
Battle	523	7 050	1 246.80	1 064	4 399	313.66
Lower North Saskatchewan	1 796	44 021	2 350.84	3 649	27 470	652.76
Lower South Saskatchewan	1 453	42 556	2 828.92	2 952	26 557	799.60
Qu'Appelle	1 371	50 647	3 595.13	2 785	31 606	1 034.94
Saskatchewan	2 664	38 502	1 345.36	5 412	24 027	343.93
Lake Winnipegosis and Lake Manitoba	824	16 241	1 870.83	1 674	10 135	505.33
Assiniboine	1 531	45 459	2 869.00	3 111	28 368	811.91
Souris	592	16 979	2 766.90	1 203	10 595	780.55
Beaver	411	9 800	2 285.97	835	6 116	632.84
Missouri	93	1 627	1 644.40	189	1 015	435.78
Total	**12 298**	**293 282**	**2 284.77**	**24 987**	**183 018**	**632.47**
Alberta						
Upper South Saskatchewan	8 935	51 136	472.33	7 066	25 197	256.60
Bow	5 722	22 804	298.51	4 525	11 236	148.30
Red Deer	13 397	67 045	400.44	10 595	33 035	211.81
Upper North Saskatchewan	1 936	8 171	321.97	1 531	4 026	162.92
Central North Saskatchewan	7 988	51 927	550.09	6 317	25 586	305.05
Battle	6 375	50 758	696.19	5 042	25 010	396.08
Lower North Saskatchewan	534	8 136	1 422.46	423	4 009	848.60
Lower South Saskatchewan	1	62	6 621.85	1	40	4 088.19
Beaver	505	4 197	730.92	399	2 068	417.72
Upper Athabasca	190	1 281	575.06	150	631	320.61
Pembina and Central Athabasca	2 644	15 400	482.56	2 091	7 588	262.98
Lower Central Athabasca	2 126	2 552	20.05	1 681	1 257	- 25.21
Upper Peace	2 559	13 923	444.04	2 024	6 860	238.97
Smoky	664	18 259	2 649.15	525	8 997	1 612.92
Central Peace	0	8 593	...	0	4 234	...
Lower Central Peace	48	1 526	3 075.79	38	752	1 878.74
Missouri	258	2 187	748.10	204	1 077	428.43
Total	**53 882**	**327 978**	**508.69**	**42 611**	**161 606**	**279.26**
British Columbia						
Williston Lake	0	58	...	0	30	...
Upper Peace	933	5 557	495.64	816	2 836	247.70
Skeena	92	314	242.15	80	160	99.73
Gardner Canal and Central Pacific Ocean	6	14	127.76	5	7	32.95
Knight Inlet and South Pacific Ocean	10	61	530.31	8	31	267.93
Vancouver Island	793	1 770	123.17	693	903	30.27
Nechako	96	1 061	1 003.40	84	541	544.09
Upper Fraser	191	972	408.33	167	496	196.73
Thompson	409	1 673	309.30	357	854	138.92
Fraser	3 399	7 468	119.74	2 972	3 812	28.27
Columbia	1 292	3 279	153.67	1 130	1 662	47.08
Total	**7 221**	**22 225**	**207.80**	**8 314**	**11 333**	**79.49**
Canada	**258 560**	**1 155 178**	**346.77**	**219 821**	**667 126**	**203.49**

Source:
Statistics Canada. Environment and Wealth Accounts Division. Agriculture Division.
Notes:
Nutrient tonnages for 1971 were derived from fertilizer expense data.
Figures may not add to totals due to rounding.

3.4 Wastes and Recycling

In the past, the population and its associated industrial activities were sparse so that municipal garbage, industrial wastes, and mine tailings did not constitute major problems. Over the years, the amount, concentration and composition of wastes have changed so that in most populated areas, the disposal of waste is a major problem. Now, cities such as Toronto are seeking innovative means of disposing of growing mountains of garbage.

In natural ecosystems, most materials are recycled. The complex web of producers, consumers and detritus feeders assure that organic materials are converted back to their original form. Modern human societies produce materials which cannot be easily converted — what is not consumed becomes trash.

Until the 1960s, most municipal waste was discarded in open dumps and burned. Many municipalities, in reaction to complaints of air pollution and vermin associated with these dumps, began burying trash underground and covering it with earth. This was known as "sanitary landfill". When a site was filled with trash and covered over, it would then be used for parks or buildings.

Along with the relatively innocuous household wastes of paper, glass and food scraps, municipal wastes also contain pesticides, solvents, paints, petroleum and other toxic compounds. These compounds can easily leach into the groundwater and render it unfit for drinking. Another consequence of sanitary landfill is the generation of methane gas from the decomposition of organic wastes. The gas is dangerous to breathe and flammable.

To deal with mounting volumes of waste, reducing waste, reusing materials and recycling have been proposed as principles for households and businesses. Paper can be repulped and made into new paper, cardboard and other products such as paper towels and cellulose insulation. Glass can be crushed, remelted and made into new containers and construction materials. Metals can also be remelted and reused. Textiles can be shredded and processed into new textile products.

Despite the apparent virtues of recycling, the cost of recycling is usually higher than disposing the materials. Separating materials is expensive and the market for recycled products is limited. Recycled paper is of lower quality but more expensive than virgin paper.

Thirty years ago many containers were returnable and few items were packaged in plastic. Since that time, it has been considered more sanitary and simpler to distribute beverages and milk in non-returnable glass, plastic or paper containers. These containers, together with other packaging, now constitute a large portion of municipal wastes. Returning to reusable containers would reduce the amount of municipal waste and litter.

Composting also reduces the amount of waste treated at the municipal level. Furthermore, by composting food wastes, leaves and lawn clippings, the nutrients are returned to the soil. This has also been proposed[34] as a means for reusing the sludge generated by sewage treatment plants.

There are no recent national-level data on the generation and disposal of wastes. Statistics Canada is conducting surveys of municipalities and waste management firms to better determine the quantity, composition and disposal methods of wastes. As well, these surveys will provide much-needed information on recycling activities of municipalities and industries.

The federal government is committed to reducing its own 1988 level of solid wastes output by 50 percent by the year 2000. Many ways of doing this are being explored. Large-scale recycling programmes for fine paper are now in place in many departments. Other recycling programmes may be considered. Purchasing practices will be reviewed to ensure that goods using excessive packaging are no longer purchased.

34. Nebel, Bernard, J. 1987. *Environmental Science*, Second Edition. Prentice-Hall. Englewood Cliffs, New Jersey.

3.4.1 Recycling

Thirty one percent of Canadian households seek out recycled paper products when shopping. Ten percent use special disposal depots for household chemicals and wastes. Twenty one percent reported regularly taking their own shopping bag to the grocery store.

Household Activities

The 1990 Statistics Canada Survey of Households and the Environment posed questions on the use of recycled paper products, the use of facilities for recycling used household chemicals, and the use of recycled and plastic shopping bags.

Thirty one percent of households responded that they sought out recycled paper products at the grocery store. The provincial rates varied from 18.7 percent in Quebec to 40.2 percent in Ontario.

Across Canada, 10 percent of households reported they used special disposal depots for households chemicals or paints. If disposed in general purpose landfills, such chemicals could contaminate land or groundwater.

Reusing shopping bags and other containers reduces resource consumption and reduces one source of household waste. According to the survey, 21 percent of households regularly bring their own bags to the store.

Table: 3.4.1.1

Household Recycling Activities by Province, 1990

Province / Region	Estimated number of households	Percentage of households which[1]: Buy recycled paper towels etc		Use disposal depot for household chemicals		Take own bag to store	
		yes	no	yes	no	yes	no
	thousands	percent					
Atlantic Provinces							
Newfoundland	173.4	23.0	62.0	..	..	..	..
Prince Edward Island	45.0	33.6	55.3	..	..	11.6	88.4
Nova Scotia	318.0	38.5	47.5	..	..	14.7	84.9
New Brunswick	246.8	35.0	53.6	..	..	16.4	82.9
Total	**782.9**	**33.7**	**53.2**	**2.4**	**96.1**	**12.5**	**87.1**
Quebec	2 534.1	18.7	71.7	7.5	90.5	20.6	79.0
Ontario	3 479.5	40.2	46.0	9.7	86.1	22.6	74.6
Prairie Provinces							
Manitoba	387.9	28.3	60.1	7.8	89.4	15.0	84.8
Saskatchewan	358.4	30.3	58.5	9.5	87.7	10.1	89.4
Alberta	868.8	28.8	60.4	25.5	72.5	15.6	83.9
Total	**1 614.7**	**28.9**	**60.0**	**17.8**	**79.9**	**14.4**	**85.2**
British Columbia	1 213.6	32.0	58.0	10.9	86.8	29.7	67.9
Canada	**9 625.5**	**31.1**	**57.2**	**10.0**	**87.1**	**20.8**	**77.7**

Source:
Statistics Canada. Environment and Wealth Accounts Division.
Note:
[1] Totals do not add to 100 percent because of non-response.

4. Environment

It is necessary for us to understand the ecological principles and the environmental implications of various actions if we are to make rational value decisions.

Bernard J. Nebel. *Op. cit.*.

Within the past two centuries, the impacts of human activities have grown from occasional localized problems to the point where human-made pollutants are found at the depths of the oceans and in the ice of the Antarctic. The result of economic development and population growth has been to change the quality of the land, air, water and the health of plants, animals and people.

Agricultural activities can remove the natural land cover, alter the nutrient content and hydrology of the soil, promote erosion and introduce substances such as fertilizers and pesticides. In high concentrations, these substances are toxic to wildlife and people.

Industries, power plants and motor vehicles generate air and water pollutants and solid wastes. These pollutants sometimes reach concentrations toxic to humans and wildlife.

Natural areas on land are physically altered by agriculture, urbanization, forestry, transportation networks, pipelines and mining activities. Together with increased contaminants, harvesting, and the introduction of exotic species, these factors have contributed to the extinction and loss of habitat for uncountable animal and plant species.

A major part of Canada's economy is sustained by its wealth of natural resources. Mining and petroleum production extract non-renewable resources. Agriculture, forestry, fisheries, hunting and trapping activities harvest renewable resources. The sustainability of these extraction and harvesting rates are currently the subject of analysis.

Over the past three decades there has been considerable progress in understanding and measuring these impacts. Protecting the environment through changing attitudes, legislation and improved technology has become accepted as essential to maintaining a sustainable economy. This section provides statistics on environmental conditions, natural processes, and extraction of resources and services.

4.1 Environmental Conditions

Monitoring the state of the air, water, land and living organisms contributes to our understanding of the ways in which human activities are altering natural ecosystems.

Monitoring the quality of the environment is an integral part of understanding the impacts of human activities. Changes in human activities are often initiated by perceived changes in quality of the air, water, land or living resources. In the late 1950s and early 1960s investigations into the reproductive failure and eggshell thinning of birds led to the discovery of the dangers of DDT and a consequent ban of the pesticide in Canada in 1970 and in the United States in 1972. The peregrine falcon populations, once near extinction as a result of exposure to DDT, are recovering in some regions.

Since the early 1960s incidents such as this have led to the creation of large-scale programs for monitoring contaminants in the air, water, wildlife and food. Research into changing lake and forest ecosystems in the late 1970s led to the understanding of the sources and effects of acid rain. Legislation was enacted to reduce emissions and subsequently emissions and ambient levels decreased.

Contaminants are not the only priority for monitoring. Statistics on land use, the quality of soils, resource exploitation, habitats and fish and wildlife quality contribute to understanding the ways in which human activities are altering natural systems.

4.1.1 Air Quality

Emissions and levels of sulphur dioxide have decreased within the past 10 years. The levels of nitrogen dioxide, carbon monoxide and particulates exceed maximum acceptable levels in some cities.

❑❑❑

Not all contaminants emitted into the air alter the quality of the ambient air. Climatic, chemical and physical factors confound the relationship between emissions and air quality. Emissions, for example, may be transported to regions distant from the original source. This section focuses on the ambient air quality.

Air quality standards set objectives for the protection of human health and the environment. The three levels of quality used by Environment Canada are:

1. **maximum desirable** level defines the long-term goal for air quality and provides a basis for an anti-degradation policy for the unpolluted parts of the country;
2. **maximum acceptable** level is intended to provide adequate protection against adverse effects on soil, water, vegetation, materials, animals, visibility, personal comfort and human health;
3. **maximum tolerable** level denotes concentrations of air contaminants where action is required to protect the health of the general population.

Table 4.1.1.1 illustrates the air quality standards for pollutants and their effects.

Table: 4.1.1.1

Pollutants and their Effects

Air Quality Standards	Carbon Monoxide (1 hr, 8 hr)	Nitrogen Dioxide (1 hr)	Ozone (1 hr)	Sulphur Dioxide (1 hr, 24 hr)	Suspended Particulates (24 hr)
(very poor range)	increasing cardiovascular symptoms in non-smokers with heart disease, some visual impairment	increasing sensitivity of people with asthma and bronchitis	light exercise produces effect in some people with chronic pulmonary disease	increasing sensitivity of people with asthma and bronchitis	increasing sensitivity of people with asthma and bronchitis
Maximum Tolerable					
(poor range)	increasing cardiovascular symptoms in smokers with heart disease	odour and atmospheric discoloration, increasing bronchial reactivity in asthmatics	decreasing performance by some people exercising heavily	odorous, increasing vegetation damage and sensitivity	visibility decrease, soiling evident
Maximum Acceptable					
(fair range)	no detectable impairment but blood chemistry changing	odorous	increasing injury to some species of vegetation	increasing injury to some species of vegetation	decreasing visibility
Maximum Desirable (good range)	no effect	no effect	no effect	no effect	no effect

Source:
Environment Canada, Regulatory Affairs and Program Integration Branch, Environmental Protection. 1990. *National Urban Air Quality Trends, 1978 to 1987.* May 1990.

Air quality in the 11 selected urban centres is usually good. For sulphur dioxide, nitrogen dioxide, and carbon monoxide, average concentrations are below the maximum desirable level. Maximum readings for these pollutants peak in the fair range (Figures 4.1.1.1 through 4.1.1.6 and Table 4.1.1.2).

One pollutant that is being more carefully monitored in recent years is ozone. Ozone (O_3) is formed as a result of a series of photochemical reactions in the air that are energized by temperature and sunlight in a stagnant air mass. Ozone levels in the fair range cause injury to some species of vegetation. Ozone levels in the poor range decrease the performance of people exercising heavily. All eleven cities for which readings are available have five-year composite average 1 hour readings in the fair range. Maximum readings extended into the poor range (Figure 4.1.1.6). Montreal and Toronto have measurements that peaked over the maximum tolerable level. This level affects some people with chronic pulmonary disease.

Total suspended particulates (**TSP**) is the most easily perceived form of air pollution. This pollutant reduces visibility, soils materials , and irritates the respiratory tract. All but one city, Hamilton, have averages in the good range. Hamilton's average reading is above the maximum tolerable level. This causes increased sensitivity in people with asthma and bronchitis.

Table: 4.1.1.2

Urban Air Quality for Selected Pollutants, 1985-1989

City	Sulphur Dioxide (annual)			Carbon Monoxide (8 hour)			Nitrogen Dioxide (annual)			Ozone (1 hour)			Suspended Particulates (annual)		
	average	minimum	maximum	average	minimum	maximum	average	minimum	maximum	average	minimum	maximum	average	minimum	maximum
	parts per billion			parts per million			parts per billion			parts per billion			micrograms per cubic meter		
Halifax	10.0	5.0	14.0	3.6	2.0	7.0	6.0	5.0	7.0	62.0	50.0	80.0	24.0	13.0	35.0
Québec	3.6	1.0	6.0	3.7	2.0	5.0	24.1	12.0	38.0	63.0	40.0	110.0	42.8	32.0	55.0
Montréal	6.6	1.0	18.0	3.6	2.0	8.0	27.0	15.0	39.0	84.6	40.0	170.0	42.2	25.0	60.0
Ottawa	5.0	3.0	7.0	3.2	2.0	4.0	21.2	16.0	31.0	75.0	50.0	120.0	31.0	27.0	36.0
Toronto	4.9	1.0	10.0	4.3	2.0	13.0	26.4	18.0	33.0	93.0	40.0	130.0	56.4	47.0	74.0
Hamilton	10.1	7.0	14.0	2.5	2.0	4.0	23.2	22.0	25.0	57.5	30.0	90.0	76.2	61.0	95.0
Winnipeg	1.4	1.0	2.0	2.4	2.0	3.0	16.7	13.0	20.0	69.0	60.0	80.0	41.2	27.0	56.0
Regina	1.0	1.0	1.0	3.8	3.0	4.0	21.5	19.0	23.0	50.0	30.0	60.0	35.6	24.0	53.0
Edmonton	2.5	2.0	3.0	4.7	2.0	7.0	24.6	20.0	31.0	67.0	60.0	80.0	51.0	39.0	84.0
Calgary	3.8	2.0	5.0	5.2	3.0	9.0	27.0	17.0	36.0	64.0	50.0	70.0	61.5	34.0	85.0
Vancouver	5.9	4.0	8.0	5.3	3.0	9.0	25.5	22.0	32.0	62.5	30.0	120.0	39.8	26.0	75.0
Maximum desirable			11.0			5.0			32.0			50.0			60.0
Maximum acceptable			23.0			13.0			53.0			82.0			70.0
Maximum tolerable						17.0						153.0			

Source:
Environment Canada, Regulatory Affairs and Program Integration Branch, Environmental Protection.

Figure: 4.1.1.1

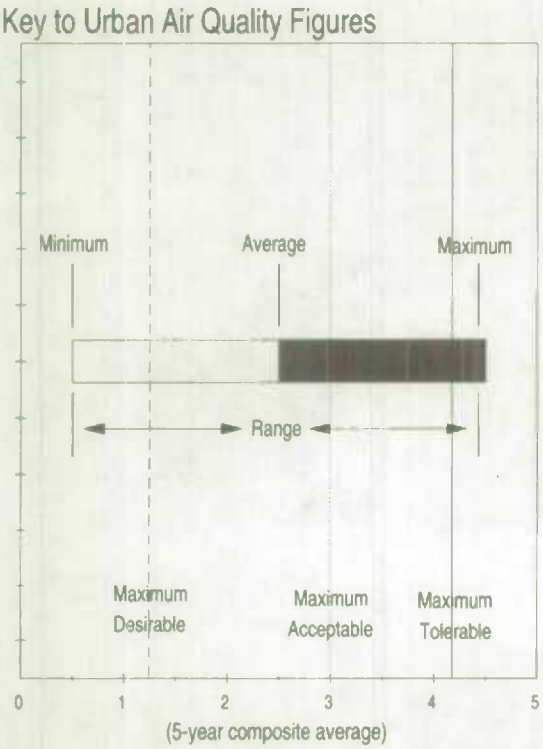
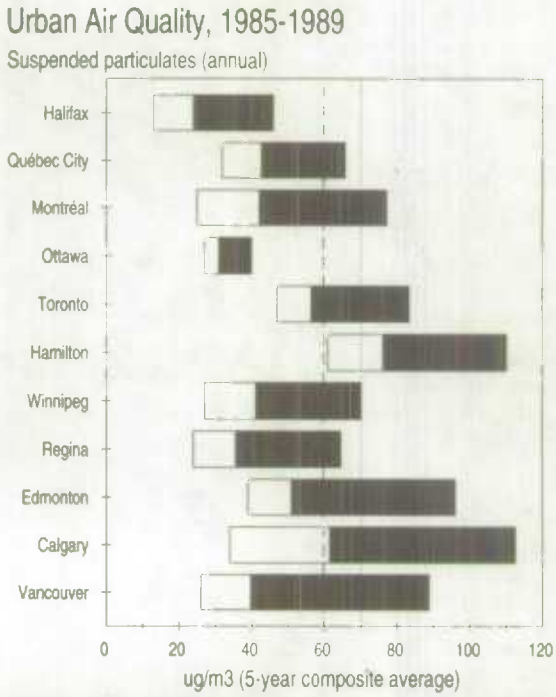
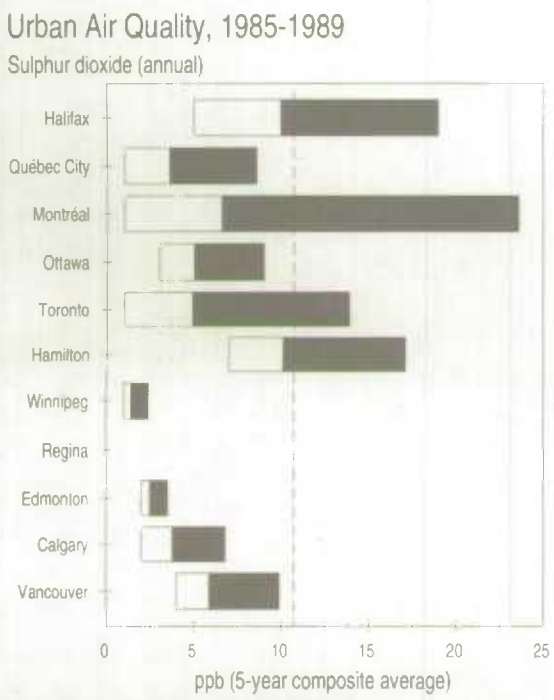


Figure: 4.1.1.2



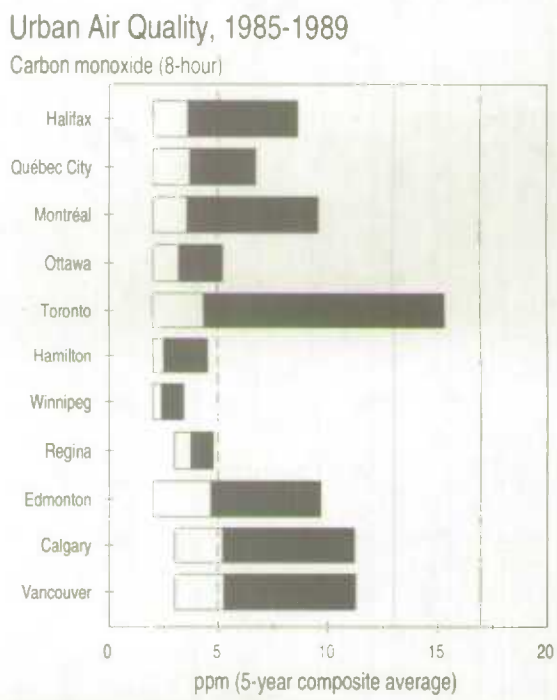
Source: Environment Canada. Regulatory Affairs and Program Integration Branch.

Figure: 4.1.1.3



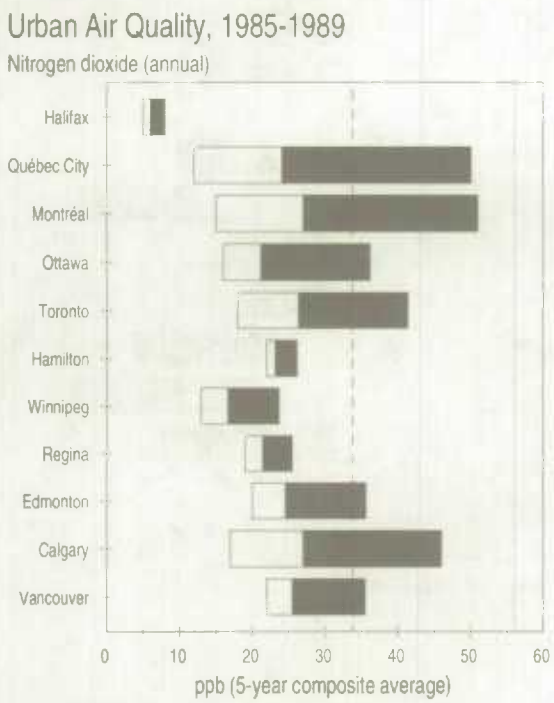
Source: Environment Canada. Regulatory Affairs and Program Integration Branch.

Figure: 4.1.1.4



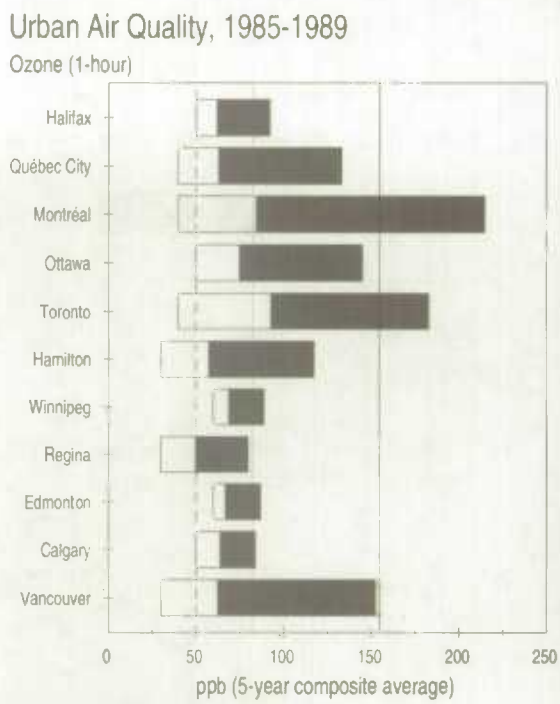
Source: Environment Canada. Regulatory Affairs and Program Integration Branch.

Figure: 4.1.1.5



Source: Environment Canada. Regulatory Affairs and Program Integration Branch.

Figure: 4.1.1.6



Source: Environment Canada. Regulatory Affairs and Program Integration Branch.

4.1.2 Water Quality

Much of the current concern with regard to environmental quality is focused on water because water is essential to the maintenance of human health and the health of the ecosystem.

❑❑❑

Fresh Water Quality

All water contains many naturally occurring substances, however the disposal of wastes generated by human activities has introduced many physical, chemical, biological and synthetic compounds into our water supplies[35]. For example, over 360 chemical compounds have been identified in the Great Lakes alone[36]. Many of these substances are dangerous to human health and are contributing to the destruction of the aquatic ecosystems of the Great Lakes.

Water bodies have provided mankind with a convenient means of disposal for urban and industrial wastes. Establishments such as municipal sewage treatment facilities introduce BOD and TSS loadings[37] into the water system which contribute to the excess growth of algae in rivers and lakes. This process, known as eutrophication[38], results in the depletion of dissolved oxygen required for the survival of aquatic life.

Phosphorus discharges increased between 1983 (the base year) and 1989 while TSS discharges declined (Figure 4.1.2.1). Over this same period the proportion of sewage treatment facilities discharging to fresh water bodies increased from 66 percent in 1983 to 73 percent in 1989[39].

Pulp and paper mills also introduce chlorinated organic compounds into aquatic systems, but these discharges are not monitored on a regular basis[40]. TSS and BOD discharges from pulp and paper mills decreased by 67 percent and 50 percent, respectively, between 1970 and 1987, while over the same period, production increased by 47 percent (Figure 4.1.2.2).

The qualities of groundwater differ from those of surface water in two ways. Groundwater is almost free of suspended sediments (due to filtering through rocks and soil) and it has minimal bacterial activity (a result of the absence of organic matter and dissolved oxygen). Also, because of its inaccessibility, groundwater is protected more than surface water from pollutants. However, once polluted, groundwater contamination may go undetected until surface water is affected.

Marine Water Quality

Although the oceans have a tremendous capacity to dilute and neutralize wastes discharged into them, pollution in coastal zones can reach harmful levels. Along both the Pacific and Atlantic coasts effluents from pulp and paper mills and municipalities are contributing to the increasing pollution of our coastal zones.

BOD and TSS loadings increased on the Pacific coast (Figure 4.1.2.3) between 1983 and 1989 owing to increasing population and industrial activity. The BOD loadings for the Atlantic along with the TSS loadings for both coasts remained constant during this period. For pulp and paper mills, the BOD and TSS loadings declined from 1970 to 1987, a time when production rose (Figure 4.1.2.4). This decline can be linked to the installation and use of primary treatment systems.

35. Environment Canada. 1985. *Currents of Change - Final Report Inquiry on Federal Water Policy.* P.H. Pearse, F. Bertrand and J.W. MacLaren.

36. Environment Canada. 1990. *Clean Water - Life Depends on It!* Fact Sheet No. 3.

37. Biochemical oxygen demand (BOD) is caused by organic decomposition resulting in oxygen depletion in water while total suspended solids (TSS) includes suspended particles of non-biodegradable materials, sand, grit and fecal matter. The latter substance can result in fecal bacteria contamination.

38. Eutrophication is caused by increased levels of phosphorus and nitrogen in the water body which, along with light availability and water flow rate factors, can produce excessive algal growth.

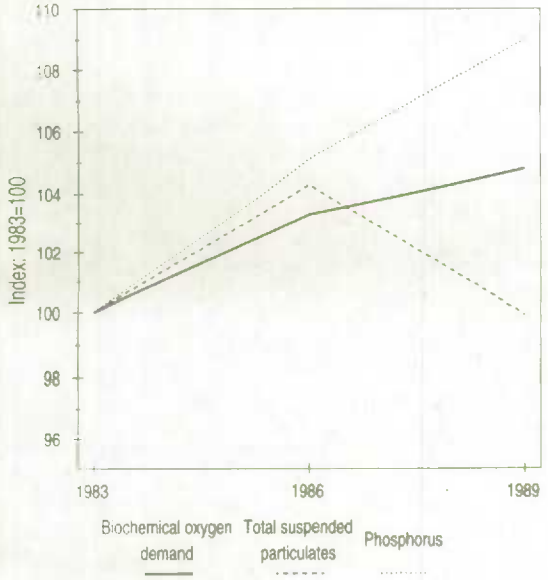
39. Environment Canada. 1991. *A Report on Canada's Progress Towards a National Set of Environmental Indicators.* The Indicators Task Force. SOE Report No. 91-1.

40. *Ibid.*

Figure: 4.1.2.1

Municipal Discharges to Fresh Water,

BOS, TSS and Phosphorus, 1983-1989

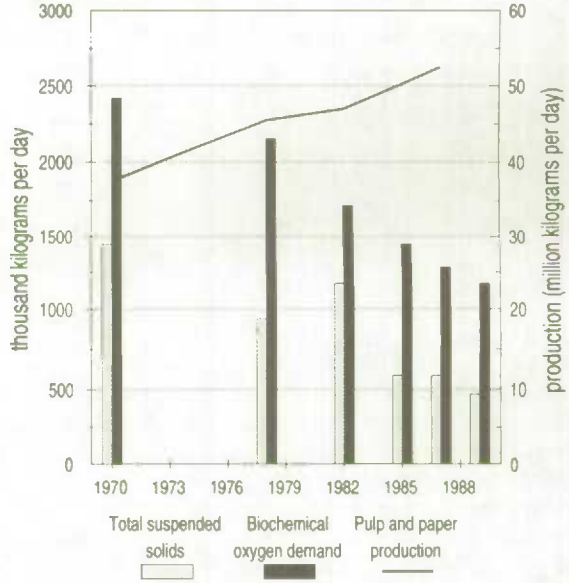


Source: Environment Canada. A Report on Canada's Progress Towards a National Set of Environmental Indicators, SOE Report No. 91-1.

Figure: 4.1.2.2

Pulp and Paper Mill Discharges to Fresh Water

TSS and BOD, 1970-1989

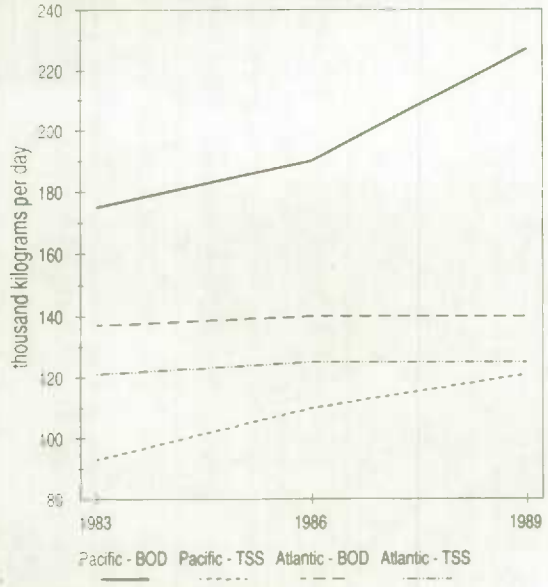


Source: Environment Canada. A Report on Canada's Progress Towards a National Set of Environmental Indicators, SOE Report No. 91-1.

Figure: 4.1.2.3

Municipal Discharges to Coastal Waters,

TSS and BOD, 1983-1989

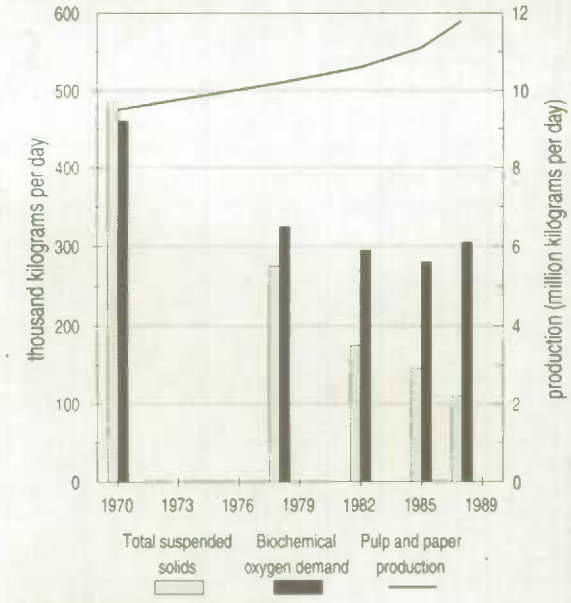


Source: Environment Canada. A Report on Canada's Progress Towards a National Set of Environmental Indicators, SOE Report No. 91-1.

Figure: 4.1.2.4

Pulp and Paper Mill Discharges to Coastal Waters

TSS and BOD, 1970-1987



Source: Environment Canada. A Report on Canada's Progress Towards a National Set of Environmental Indicators, SOE Report No. 91-1.

4.1.3 Fish and Wildlife

A good indication of the impacts of human activities on the environment is the condition of living organisms. Hundreds of species are near extinction because of pressures such as the elimination of habitat, toxins in the environment and harvesting.

This section examines some wildlife quality indicators such as population change and contaminant levels. Also presented are statistics on the activity of the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in assessing the protection status of wildlife.

Wildlife Status

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) is responsible for determining the status of wildlife species. The status designations are:

extinct	species that no longer exist
extirpated	species no longer existing in a certain area
endangered	native species whose existence is threatened by human actions; extirpation or extinction a possibility
threatened	slightly at risk
vulnerable	species with declining populations, restricted range

COSEWIC completed status reports on 30 percent of the species recommended for classification (Table 4.1.3.3). The number of status reports are directly linked to the amount of funding available.

Tables 4.1.3.5 and 4.1.3.6 shows recovery efforts for some of the endangered and threatened species. In 1988, an organization for the REcovery of Nationally Endangered Wildlife (RENEW) was established. The goal of this committee, like that of COSEWIC, is to preserve endangered and threatened species from extinction and to prevent vulnerable species from becoming threatened or endangered by developing recovery plans for each designated species.

Of the 3,269 known plant species in Canada, 1,009 (31 percent) are considered rare. The highest counts of rare species occurs in British Columbia (426), followed by Ontario (355) (Table 4.1.3.4). Both provinces have many habitats unique to Canada. Both provinces are also located at the northern edges of floristic zones which extend into the United States.

In British Columbia, many rare species belonging to the Californian floristic elements in the Western Coastal Cordilleran forest reach their northern limits. Some Pacific Rim floristic elements also reach their southern limits in the province.

In Ontario, many rare species are associated with the floristically rich Carolinian Eastern Deciduous Forest that has a limited distribution in Canada and has been largely eliminated by urbanization and agriculture.

Both the Yukon and the Northwest Territories are rich in endemic species with restricted distributions. The Yukon endemics are mainly restricted to the unglaciated part of the territory. Those in the Northwest Territories are high arctic species.

Contaminant Levels in Wildlife

Since the early 1970s, there has been an ongoing program to monitor contaminants found in waterbirds around the Great Lakes region. The waterbirds were among the most contaminated in the world. Toxic chemicals dumped into the lakes enter the food web and are passed up to the top level predators, waterbirds. Within each step of the food web, increased contaminant concentrations occur in organisms.

An overview of the Great Lakes wildlife species known to be affected by contaminants is provided in Table 4.1.3.13.

Herring gulls are a good indicator species for contaminants. They are a top level predator in the food web and they reside in the region year round. The six contaminants measured were DDE, dieldrin, mirex, dioxins, HCB, and PCB. The locations of the monitored nesting sites are provided in Map 4.1.3.1.

Almost all contaminant levels in herring gull eggs have greatly decreased from the early 1970s to 1990 (Tables 4.1.3.7 through 4.1.3.12, Figures 4.1.3.1 through 4.1.3.6). The one exception is dieldrin. Contaminant levels declined most sharply between 1975 and 1980 as a result of regulations implemented in the late 1960s and early 1970s restricting the use and production of many of these contaminants. Also note that the higher levels of contamination generally occurred in the industrialized Lake Ontario and Lake Michigan.

The Whooping Crane

The whooping crane population in 1870 was estimated at 1,400. By 1941, the numbers had dwindled to 15 in Canada. Loss of marshland habitat, hunting, and egg collecting contributed to the near extinction of this species. Increased management efforts by Canadian and American wildlife agencies, the Migratory Birds Treaty in 1917, the establishment of Wood Buffalo National Park (1922) and Aransas National Wildlife Refuge (1937), and increased

public awareness on the plight of the whooping crane, resulted in a modest increased population to 43 by 1966 (Figure 4.1.3.7).

From 1966 to 1990, the population steadily increased to a total estimated at 143 in Wood Buffalo National Park. The continuing efforts, such as the egg transfer program starting in 1966, and the development of recovery programs, have brought the whooping crane back from near extinction.

The Peregrine Falcon

In 1970, only 23 breeding pairs of peregrine falcons remained in Canada. In eastern Canada, it appeared they had been virtually extirpated. The rapid decline was traced to the buildup of DDT and other pesticides in the prey of the peregrines. This resulted in the thinning of eggshells, breakage of eggs and reduced breeding success. Reintroduction programs were started in 1975 to increase peregine falcon populations. This recovery program has shown success with a breeding pair population increasing to about 300 (Table 4.1.3.15). However, two regions, southern Ontario and the Prairies, have not been as successful. This could be caused by the high levels of contaminants found in the prey in those particular regions. Table 4.1.3.14 shows prey species in the southern prairies and the Great Lakes region have the highest contaminant levels.

Breeding Bird Populations

Each Spring the Canadian Wildlife Service co-ordinates interested and knowledgeable volunteers in collecting data on breeding birds. This Breeding Bird Survey (BBS) was first conducted in Canada in 1966 with the objective of measuring trends in bird populations (especially small land birds) across North America.

The following tables report information for species showing a long-term trend, significant at the 95 percent level, in two or more regions. Although Table 4.3.1.16 shows these trends as average percent change, the small numbers of observations for some species and regions mean that these should be regarded as indicators rather than precise measures.

A summary of the changes in population by habitat type are provided in Table 4.1.3.1. Regional trends are presented in Table 4.1.3.2.

Table: 4.1.3.1
Breeding Bird Population Trends by Habitat, 1966-1989

Type of habitat[1]	Population trend	
	Increasing	Decreasing
	species × region[2]	
Margins	9	..
Open	5	11
Thickets	4	3
Wetland	6	2
Woodland	11	2
Total	**35**	**18**

Source:
Environment Canada. Canadian Wildlife Service. Breeding Bird Survey.
Notes:
[1] Typical habitat: in some regions and seasons may also be found in other habitats.
[2] Species are counted separately in each region.

Table: 4.1.3.2
Breeding Bird Population Trends by Region, 1966-1989

Region	Population trend	
	Increasing	Decreasing
	species × region[1]	
Atlantic	6	4
Central Ontario and Quebec	5	5
Southern Ontario and Quebec	12	3
Central Prairies	6	3
Southern Prairies	3	2
Southern British Columbia	3	1
Total	**35**	**18**

Source:
Environment Canada. Canadian Wildlife Service. Breeding Bird Survey.
Notes:
[1] Species are counted separately in each region.

The most widespread change is that of the American Robin, showing a significant long term growth in each of the four regions covering southern and central Quebec, Ontario, Manitoba, Saskatchewan and Alberta (Table 4.3.1.16). Many species in the families *Fringillidae* (which includes sparrows and finches) and *Icteridae* (including grackles and cowbirds) show declines in two or three regions.

Fish Size

Figure 4.1.3.8 presents average weights of northern cod by age class. The weights of the sampled fish increased by 14 to 109 percent between the period 1962-1971 and 1982-1989.

Table: 4.1.3.3

Wildlife Status in Canada, 1990

Group[1]	Candidate species	Status reports	Status assessment						Percent of candidate species assessed
			no status[2]	vulnerable	threatened	endangered	extirpated	extinct	
Birds[3]	60	48	12	16	8	8	1	3	80
Mammals									
marine[3]	43	27	6	11	4	3	2	1	63
othera[3]	39	27	15	3	2	4	2	1	70
Fish	117	67	16	32	10	3	2	4	57
Amphibians	11	3	0	2	0	1	0	0	27
Plants	500	62	2	20	22	17	1	0	12
Reptiles	27	2	0	1	0	1	0	0	7
Total	**797**	**236**	**51**	**85**	**46**	**37**	**8**	**9**	**30**

Sources:
Dr. Merlin Shoesmith, Chairman, Mammal Subcommittee, COSEWIC.
Dr. E. Haber, Chairman, Plant Subcommittee, COSEWIC.
Dr. Bob Campbell, Chairman, Fish and Marine Mammals Subcommittee, COSEWIC.
Dr. Francis Cook, Chairman, Reptiles and Amphibians Subcommittee, COSEWIC.
Dr. Ross James, Chairman, Bird Subcommittee,COSEWIC.
Notes:
[1]Insects and molluscs are not yet considered under COSEWIC.
[2]Species not considered vulnerable upon review of status report.
[3]Where status reports have been prepared for one or more species populations, the species is included under the category at greatest risk.

Table: 4.1.3.4

Status of Plant Species, 1990

Province/Territory	Total number of species	Percent of national total	Number of rare species	Percent of national rare total	Number of priority rare species[1]	Percent of national priority rare total
Newfoundland	1 548	47.35	40	3.96	9	4.23
Prince Edward Island	1 040	31.81	6	0.59	2	0.94
Nova Scotia	1 500	45.89	45	4.46	18	8.45
New Brunswick	1 987	60.78	25	2.48	11	5.16
Quebec	2 543	77.79	106	10.51	36	16.90
Ontario	2 888	88.35	355	35.18	108	50.70
Manitoba	1 417	43.35	52	5.15	17	7.98
Saskatchewan	1 536	46.99	77	7.63	22	10.33
Alberta	1 692	51.76	125	12.39	18	8.45
British Columbia	2 000	61.18	426	42.22	42	19.72
Yukon	1 150	35.18	91	9.02	34	15.96
Northwest Territories	1 113	34.05	62	6.14	27	12.68
Canada	**3 269**	**100.00**	**1 009**	**100.00**	**213**	**100.00**

Source:
Canadian Museum of Nature. 1990. *Rare Vascular Plants in Canada*. Argus, George W. and Kathleen M. Pryer.
Dr. J. Morton, University of Waterloo, Dr. P.M. Calling, Agriculture Canada, Cheryl McJanet, Canadian Museum of Nature (personal communication).
Notes:
[1]Priority ranks 1 and 2 based on Argus ranking system.

Table: 4.1.3.5

Level of Protection and Recovery Effort for Endangered Vertebrate Species[1], 1989

Species or population	Killing or disturbance regulated by law	Key habitat protected	Species bred in captivity	Re-introduced successfully	Recovery plan	
					begun	complete
Beluga (St. Lawrence)	✔	✔	✔	-	✔	-
Beluga (Ungava Bay)	✔	-	-	-	-	-
Bowhead whale	✔	-	-	-	-	-
Eastern cougar	✔	-	✔	-	-	-
Eastern wolverine	✔	-	✔	-	-	-
Right whale	✔	-	-	-	-	✔
Sea otter	✔	✔	✔	✔	✔	✔
Vancouver Island marmot	✔	✔	✔	-	✔	-
Eskimo curlew	✔	-	-	-	-	-
Greater prairie-chicken	✔	-	✔	-	-	-
Kirtland's warbler	✔	-	-	-	-	✔
Mountain plover	✔	-	-	-	-	-
Peregrine falcon, *Anatum*	✔	-	✔	✔	-	✔
Piping plover	✔	✔	-	-	✔	-
Spotted owl	✔	-	-	-	-	✔
Whooping crane	✔	✔	✔	✔	-	✔
Atlantic whitefish	✔	-	-	-	-	-
Aurora trout	✔	✔	✔	-	-	✔
Salish sucker	-	-	-	-	-	-
Leatherback turtle	-	-	-	-	-	-

Source:
Environment Canada. 1989. *On the Brink, Endangered Species in Canada*. J.A. Burnett, C.T. Dauphine Jr., S.H. McCrindle, and T. Mosquin.
Notes:
[1] Designated by COSEWIC.

Table: 4.1.3.6

Level of Protection and Recovery Effort for Threatened Vertebrate Species[1], 1989

Species or population	Killing or disturbance regulated by law	Key habitat protected	Species bred in captivity	Re-introduced successfully	Recovery plan	
					begun	complete
Beluga (Eastmain)	-	-	-	-	-	-
Humpback Whale (Pacific)	✔	-	-	-	-	-
Maritime woodland caribou	✔	✔	-	-	-	-
Peary caribou	-	-	-	-	-	-
Pine marten (Newfoundland)	✔	-	✔	✔	✔	-
Prairie long-tailed weasel	-	-	-	-	-	-
Wood bison	✔	✔	✔	✔	-	✔
Baird's sparrow	✔	-	-	-	-	-
Burrowing owl	✔	✔	✔	✔	✔	-
Ferruginous hawk	✔	-	-	-	✔	-
Henslow's sparrow	✔	-	-	-	-	-
Loggerhead shrike	✔	-	-	-	✔	-
Peregrine falcon, *tundrius*	✔	✔	✔	-	-	-
Roseate tern	✔	-	-	-	-	-
Blackfin cisco	✔	-	-	-	-	-
Black redhorse	✔	✔	-	-	-	-
Copper redhorse	-	-	-	-	-	-
Enos Lake sticklebacks	-	-	-	-	-	-
Great Lakes deepwater sculpin	✔	-	-	-	-	-
Lake Simcoe whitefish	✔	✔	-	✔	-	-
Margined madtom	-	-	-	-	-	-
Shorthead scuplin	✔	-	-	-	-	-
Shortjaw cisco	✔	-	-	-	-	-
Shortnose cisco	✔	-	-	-	-	-

Source:
Environment Canada. 1989. *On the Brink, Endangered Species in Canada*. J.A. Burnett, C.T. Dauphine Jr., S.H. McCrindle, and T. Mosquin.
Notes:
[1] Designated by COSEWIC.

Map: 4.1.3.1

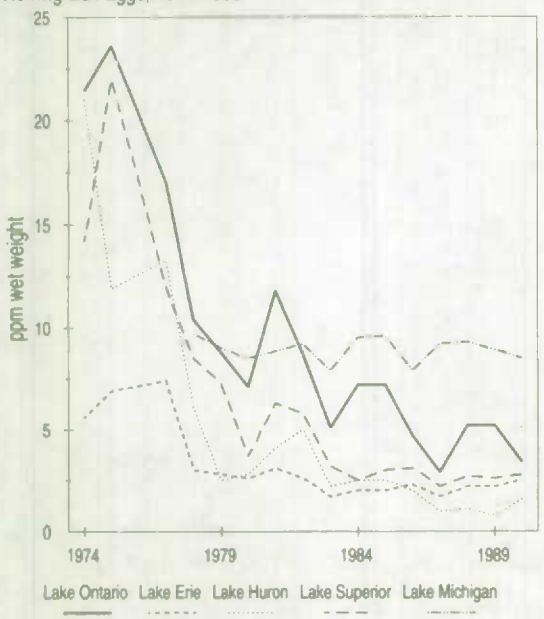
Herring Gull Nesting Sites Monitored

Source: Environment Canada, Canadian Wildlife Service.

Figure: 4.1.3.1

DDE Concentrations in Great Lakes

Herring Gull Eggs, 1974-1990

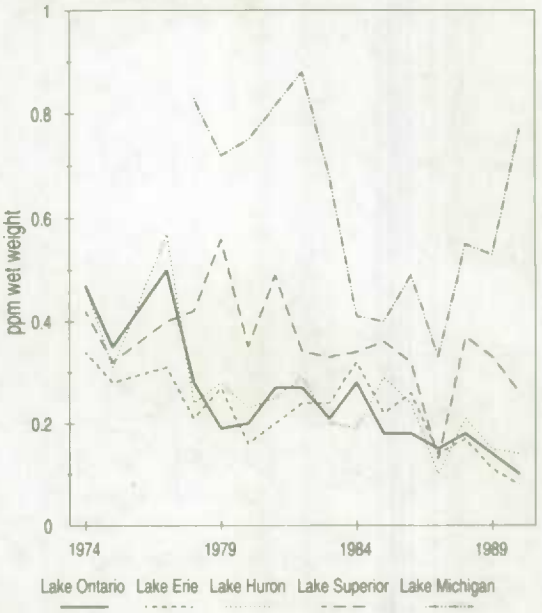


Source: Environment Canada, National Water Research Institute

Figure: 4.1.3.2

Dieldrin Concentrations in Great Lakes

Herring Gull Eggs, 1974-1990

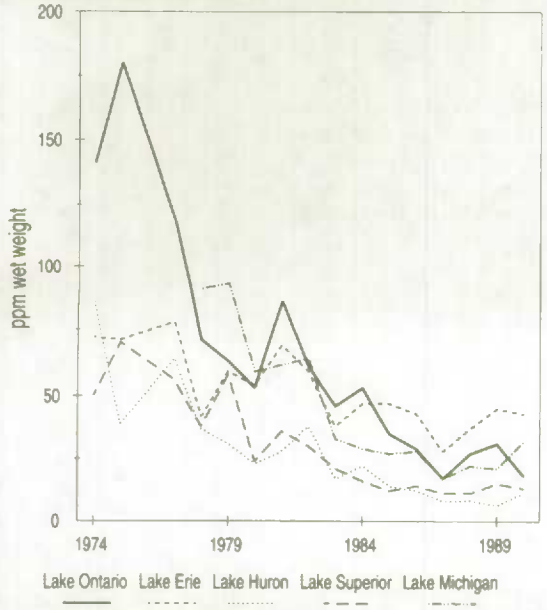


Source: Environment Canada, National Water Research Institute.

Figure: 4.1.3.3

PCB Concentrations in Great Lakes

Herring Gull Eggs, 1974-1990

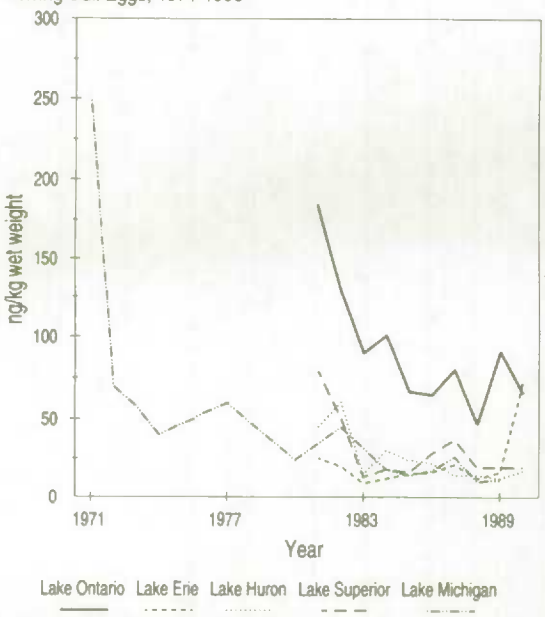


Source: Environment Canada, National Water Research Institute.

Figure: 4.1.3.4

Dioxin Concentrations in Great Lakes

Herring Gull Eggs, 1971-1990

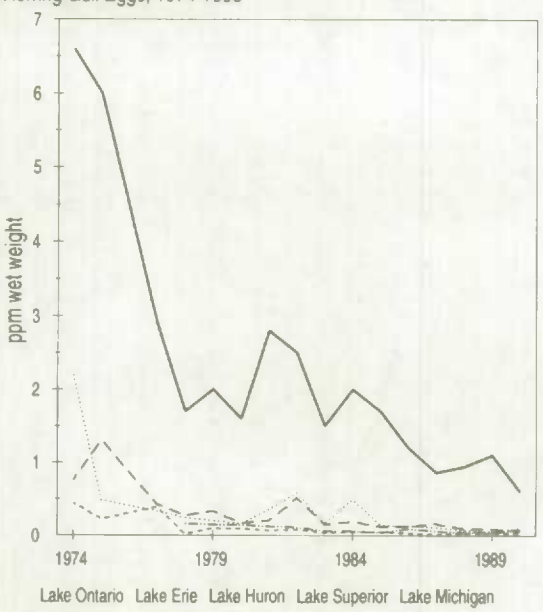


Source: Environment Canada, National Water Research Institute.

Figure: 4.1.3.5

Mirex Concentrations in Great Lakes

Herring Gull Eggs, 1974-1990

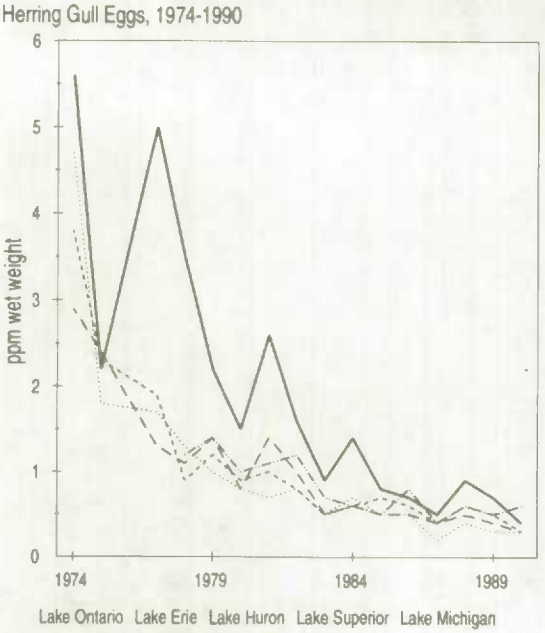


Source: Environment Canada, National Water Research Institute.

Figure: 4.1.3.6

HCB Concentrations in Great Lakes

Herring Gull Eggs, 1974-1990



Source: Environment Canada, National Water Research Institute.

Table: 4.1.3.7

Average Annual Concentrations of DDE in Herring Gull Eggs, 1974-90

Year	Lake Ontario Snake Island	Lake Erie Middle Island	Lake Huron Chantry Island	Lake Superior Agawa Rocks	Lake Michigan Gull Island
	ppm wet weight				
1974	21.4	5.6	21.0	14.2	..
1975	23.6	6.9	11.9	22.0	..
1976	..	..	..	..	..
1977	17.0	7.4	13.3	12.0	..
1978	10.4	3.0	6.1	8.5	9.7
1979	8.8	2.8	2.5	7.3	9.0
1980	7.1	2.6	2.8	3.7	8.5
1981	11.8	3.1	4.1	6.3	..
1982	8.7	2.6	5.0	5.8	9.2
1983	5.1	1.7	2.2	3.2	7.9
1984	7.2	2.0	2.5	2.5	9.5
1985	7.2	2.0	2.5	3.0	9.6
1986	4.7	2.3	2.0	3.1	7.9
1987	2.9	1.7	1.0	2.2	9.2
1988	5.2	2.2	1.1	2.7	9.3
1989	5.2	2.2	0.8	2.6	8.9
1990	3.4	2.5	1.6	2.8	8.5

Source:
Environment Canada, Canadian Wildlife Service, National Water Research Institute. D.V. Weseloh and R. Norstrom.

Table: 4.1.3.8

Average Annual Concentration of Dieldrin in Herring Gull Eggs, 1974-90

Year	Lake Ontario Snake Island	Lake Erie Middle Island	Lake Huron Chantry Island	Lake Superior Agawa Rocks	Lake Michigan Gull Island
	ppm wet weight				
1974	0.5	0.3	0.5	0.4	..
1975	0.3	0.3	0.3	0.3	..
1976	..	..	..	..	..
1977	0.5	0.3	0.6	0.4	..
1978	0.3	0.2	0.2	0.4	0.8
1979	0.2	0.3	0.3	0.6	0.7
1980	0.2	0.2	0.2	0.3	0.8
1981	0.3	0.2	0.3	0.5	..
1982	0.3	0.2	0.3	0.3	0.9
1983	0.2	0.2	0.2	0.3	0.7
1984	0.3	0.3	0.2	0.3	0.4
1985	0.2	0.2	0.3	0.4	0.4
1986	0.2	0.3	0.2	0.3	0.5
1987	0.1	0.1	0.1	0.1	0.3
1988	0.2	0.2	0.2	0.4	0.6
1989	0.1	0.1	0.1	0.3	0.5
1990	0.1	0.1	0.1	0.3	0.8

Source:
Environment Canada, Canadian Wildlife Service, National Water Research Institute. D.V. Weseloh and R. Norstrom.

Table: 4.1.3.9

Average Annual Concentration of Dioxin in Herring Gull Eggs, 1974-90

Year	Lake Ontario Snake Island	Lake Erie Middle Island	Lake Huron Chantry Island	Lake Superior Agawa Rocks	Lake Michigan Gull Island
	ng/kg wet weight				
1971	..	..	..	..	249
1972	..	..	..	..	70
1973	..	..	..	..	58
1974	..	..	..	..	40
1975	..	..	..	..	..
1976	..	..	..	..	54
1977	..	..	..	..	60
1978	..	..	..	..	..
1979	..	..	..	..	..
1980	..	..	..	..	24
1981	185	25	45	79	..
1982	129	20	61	51	45
1983	90	9	15	13	..
1984	101	12	30	18	18
1985	67	15	24	16	14
1986	65	16	22	28	17
1987	80	21	14	37	26
1988	47	12	14	19	10
1989	91	16	12	19	11
1990	66	73	17	19	..

Source:
Environment Canada, Canadian Wildlife Service, National Water Research Institute. D.V. Weseloh and R. Norstrom.

Table: 4.1.3.10

Average Annual Concentration of HCB in Herring Gull Eggs, 1974-90

Year	Lake Ontario Snake Island	Lake Erie Middle Island	Lake Huron Chantry Island	Lake Superior Agawa Rocks	Lake Michigan Gull Island
	ppm wet weight				
1974	0.6	0.4	0.5	0.3	..
1975	0.2	0.2	0.2	0.2	..
1976	..	..	..	..	..
1977	0.5	0.2	0.2	0.1	..
1978	0.3	0.1	0.1	0.1	0.1
1979	0.2	0.1	0.1	0.1	0.1
1980	0.1	0.1	0.1	0.1	0.1
1981	0.3	0.1	0.1	0.1	..
1982	0.2	0.1	0.1	0.1	0.1
1983	0.1	0.1	0.1	0.1	0.1
1984	0.1	0.1	0.1	0.1	0.1
1985	0.1	0.1	0.1	0.1	0.1
1986	0.1	0.1	0.1	0.1	0.1
1987	0.1	0.0	0.0	0.0	0.0
1988	0.1	0.1	0.0	0.1	0.1
1989	0.1	0.1	0.0	0.0	0.1
1990	0.0	0.0	0.0	0.0	0.1

Source:
Environment Canada, Canadian Wildlife Service, National Water Research Institute. D.V. Weseloh and R. Norstrom.

Table: 4.1.3.11

Average Annual Concentrations of Mirex in Herring Gull Eggs, 1974-90

Year	Lake Ontario Snake Island	Lake Erie Middle Island	Lake Huron Chantry Island	Lake Superior Agawa Rocks	Lake Michigan Gull Island
	ppm wet weight				
1974	6.60	0.44	2.20	0.76	..
1975	6.00	0.22	0.48	1.30	..
1976	..	..	..	..	..
1977	2.90	0.39	0.33	0.42	..
1978	1.70	0.02	0.24	0.27	0.16
1979	2.00	0.10	0.20	0.33	0.15
1980	1.60	0.09	0.16	0.17	0.14
1981	2.80	0.07	0.35	0.20	..
1982	2.50	0.08	0.58	0.51	0.11
1983	1.50	0.04	0.16	0.15	0.06
1984	2.00	0.05	0.49	0.19	0.06
1985	1.70	0.05	0.14	0.12	0.04
1986	1.20	0.03	0.13	0.12	0.09
1987	0.86	0.01	0.11	0.16	0.06
1988	0.94	0.03	0.07	0.09	0.04
1989	1.10	0.03	0.05	0.09	0.04
1990	0.60	0.03	0.10	0.06	0.08

Source:
Environment Canada, Canadian Wildlife Service, National Water Research Institute. D.V. Weseloh and R. Norstrom.

Table: 4.1.3.12

Average Annual Concentration of PCB in Herring Gull Eggs, 1974-90

Year	Lake Ontario Snake Island	Lake Erie Middle Island	Lake Huron Chantry Island	Lake Superior Agawa Rocks	Lake Michigan Gull Island
	ppm wet weight				
1974	141	72	86	50	..
1975	180	71	39	70	..
1976	..	..	..	..	..
1977	118	78	64	56	..
1978	71	42	37	38	91
1979	63	59	31	58	93
1980	53	54	23	24	59
1981	86	69	28	36	..
1982	61	59	38	30	64
1983	46	38	17	21	33
1984	53	47	22	16	29
1985	35	47	14	12	27
1986	29	43	12	14	28
1987	17	28	8	11	17
1988	27	37	8	11	22
1989	31	45	6	15	21
1990	18	43	11	13	32

Source:
Environment Canada, Canadian Wildlife Service, National Water Research Institute. D.V. Weseloh and R. Norstrom.

Table: 4.1.3.13

Species of Fish and Wildlife Known to be Affected by Contaminants in the Great Lakes

Species	Effect							
	Population decrease	Effects on reproduction	Eggshell thinning	Congenital malformations	Behavioural changes	Biochemical changes	Mortality	Alterations in recruitment
Mink	✔	✔	...	NE	NE	NE	✔	?
Otter	✔		...	NE	NE	NE	?	?
Double-crested cormorant	✔	✔	✔	✔		✔	?	?
Black-crowned night-heron	✔	✔	✔	✔		✔	?	?
Bald eagle		✔	✔	NE		NE	NE	?
Herring gull		✔	✔	✔	✔	✔	✔	
Ring-billed gull			✔	✔		NE	✔	
Caspian tern		✔		✔	NE	NE		✔
Common tern		✔	✔	✔		✔		
Forster's tern		✔		✔	✔	✔		
Snapping turtle	NE	✔	...	✔	NE	NE	NE	NE
Lake trout		✔	...			✔		
Brown bullhead		✔	...			✔		
White sucker			...	✔		✔		

Source:
Environment Canada, Department of Fisheries and Oceans, Health and Welfare Canada. 1991. *Toxic Chemicals in the Great Lakes and Associated Effects: Synopsis.* Catalogue En. 37-94/1990E.
Notes:
✔ = effects documented
.. = not applicable
NE = not examined
? = suspected since population declined

Table: 4.1.3.14

Contaminants in Peregrine Falcon Prey[1] by Region, 1989

Southern Prairies			Central Arctic			Great Lakes		
number[2]	Prey species	Tissue	number[2]	Prey species	Tissue	number[2]	Prey species	Tissue
8	Red-necked grebe	eggs	6	Semipalmated plover	whole body	6/7	Black-crowned night heron	eggs
3	Killdeer	whole body	4	Dunlin	whole body	5	Killdeer	whole body
3	Eared grebe	whole body	3	Lapland longspur	whole body	5/7	Bufflehead	muscle
2	Blue-winged teal	whole body	2	Horned lark	whole body	3	Semipalmated sandpiper	whole body
2/7	Red-winged blackbird	whole body						

Boreal			Atlantic			Rocky Mountains		
number[2]	Prey species	Tissue	number[2]	Prey species	Tissue	number[2]	Prey species	Tissue
7	Bank swallow	whole body	4	Leach's storm petrel	eggs	4	Wester grebe	eggs
3	Northern flicker	whole body	4	Semipalmated sandpiper	whole body	2/8	American kestrel	eggs
2	American robin	whole body	4	American robin	whole body	1	American robin	whole body
2	Common grackle	whole body	1	Red-winged blackbird	whole body	1/4	Western meadowlark	whole body

Source:
Environment Canada, Canadian Wildlife Service. *Contaminants in the Prey of the Peregrine Falcon in Canada.* A. Banl, J.E. Elliot, J.D. Somers, G. and Erickson. CWS Technical Report Series No. 62.
Notes:
[1]Prey species in which contaminant levels are greater than threshold values.
[2]Number of contaminants from 9 samples tested over threshold unless indicated.

Table: 4.1.3.15

Peregrine Falcon Population[1], 1970-1990

Region	1970	1975	1980	1985	1990
Maritimes and Southern Quebec	0	0	1	2	19
Southern Ontario	0	0	1	0	2
Prairies	1	0	0	3	4
Mackenzie River Valley	6	5	20	45	87
Yukon	5	4	46	48	125-140
British Columbia	?	?	?	?	?
Great Slave Lake	?	?	?	?	?
Northern Ontario	?	?	?	?	?
Labrador and Ungava Coasts	11	9	10	25	55
Total	**23**	**18**	**78**	**123**	**292-307**

Sources:
Environment Canada, Canadian Wildlife Service. 1988. *Anatum peregrine falcon recovery plan.* Erickson et. al.
Geoff Halroyd, Canadian Wildlife Service, Edmonton.
Notes:
[1]Population of territorial breeding pairs.

Table: 4.1.3.16

Trends in Breeding Bird Populations, 1966-1989

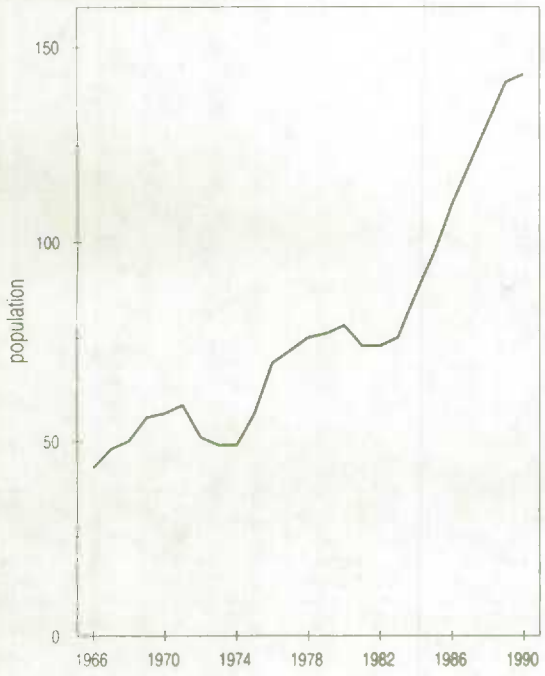
Species	Habitat[1]	Region					
		Atlantic	Central Ontario and Quebec	Southern Ontario and Quebec	Central Prairies	Southern Prairies	Southern British Columbia
		Average annual percent change, 1966-1989[2]					
Great blue heron	Wetlands	...	5.8	6.5	...	...	...
American bittern	Wetlands	...	...	5.0	- 8.7	...	...
Red-tailed hawk	Open	...	...	...	3.1	...	5.8
Killdeer	Open	...	...	...	- 4.3	- 2.6	...
Tree swallow	Wetlands	...	...	3.6	4.2	...	...
Black-capped chickadee	Woodland	5.4	...	11.9	...	...	...
American robin	Margins	...	1.1	1.3	2.1	4.3	...
Hermit thrush	Woodland	5.2	5.2	...	...	...	...
Cedar waxwing	Margins	8.8	3.8	5.9	...	...	...
Red-eyed vireo	Woodland	5.3	1.5	...	2.7	...	...
Warbling vireo	Woodland	...	...	5.8	...	...	4.1
Yellow warbler	Thickets	4.1	...	2.8	...	...	...
Common yellowthroat	Wetland	...	- 2.0	1.7	...	...	...
Ovenbird	Woodland	1.9	...	5.4	...	...	...
Brown-headed cowbird	Open	...	- 5.2	- 3.3	...	2.5	...
Common grackle	Open	- 2.3	- 4.4	- 2.5	...	...	...
Meadowlark (Eastern and Western)	Open	...	...	- 3.9	...	- 2.0	...
American goldfinch	Open	...	...	...	2.9	...	- 3.6
White-throated sparrow	Woodland	- 3.0	- 1.9	...	...	...	...
Chipping sparrow	Margins	...	...	1.6	...	5.0	...
Song sparrow	Thickets	- 1.5	- 3.1	...	- 4.1	...	...
Lincoln's sparrow	Thickets	...	...	...	18.6	...	29.4
Savannah sparrow	Open	- 2.8	...	- 1.8	...	...	...

Source:
Environment Canada. Canadian Wildlife Service. Breeding Bird Survey.
Notes:
[1] Typical habitat: in some regions and seasons may also be found in other habitats.
[2] See text for commentary on reliability of estimates.

Figure: 4.1.3.7

Whooping Crane Population, 1966-1990

Wood Buffalo National Park



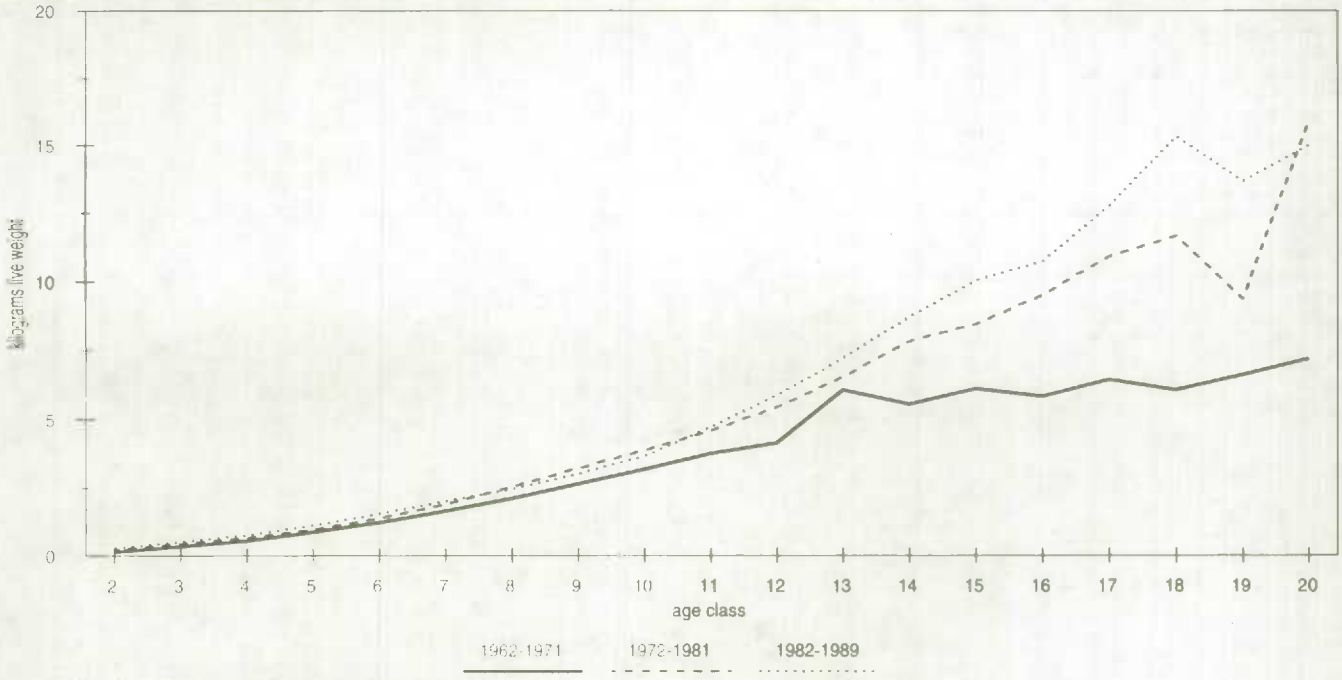
Whooping Crane Population
Wood Buffalo National Park
Significant Events

- 1917 - Migratory Birds Treaty, Migratory Birds Convention Act - Canada/US Protection Agreements
- 1922 - Wood Buffalo National Park created (summer breeding grounds)
- 1937 - Aransas National Wildlife Refuge created (wintering grounds)
- 1966 - active management activities - egg transfers
- 1973 - Endangered status in US
- 1978 - Endangered status in Canada
- 1985 - Memorandum of Understanding on the Conservation of Whooping Cranes between Canada/US
- 1986 - US Recovery Plan
- 1987 - Canadian Recovery Plan

Source: Cooch, F.G. (ed.), Canadian Whooping Crane Recovery Plan, Canadian Wildlife Service, Environment Canada, 1987. Gollop, M.A., Status Report on the Whooping Crane, Grus americana. Committee on the Status of Endangered Wildlife in Canada, Canadian Wildlife Service, Environment Canada, 1978. Cooch, F.G., personal communication. C. Dauphine, personal communication.

Figure: 4.1.3.8

Northern Cod Weight by Age Class



Source: Fisheries and Oceans Canada, Biological Sciences Directorate.

4.1.4 Habitats

Forests, plains, estuaries, rivers, oceans and wetland habitats are being altered by human activities. Canada holds one-quarter of the world's wetlands — 127 million hectares or one-seventh of Canada's land area is covered by bog, fen, marsh, swamp and shallow. It is estimated that one-seventh of Canada's pre-settlement wetlands have been converted to other uses.

❑❑❑

A *habitat* is a place where a plant or animal usually lives. It is often characterized by a dominant plant form or physical characteristic (i.e., the forest habitat, the river habitat). An *ecosystem* is a much more complex concept. It incorporates all the interactions between the physical and biophysical environment.

This section focuses on wetlands and peatlands as a particular habitat under stress from human activities. Other habitat types such as forests, rivers, oceans, agricultural land, protected lands are discussed elsewhere in this publication. Whereas forests and agricultural lands have obvious economic benefits, wetlands — marshes, swamps and bogs — have long been considered wasteland, available for conversion to "productive" uses. It is now understood that wetlands support a rich wildlife and that they provide beneficial hydrological and water-purification functions.

Wetlands and Peatlands

A *wetland* is land that is saturated with water long enough to promote wetland or aquatic processes: poorly drained soils, hydrophytic vegetation[41], and other biological activities adapted to a wet environment[42]. Wetlands occupy a transitional position between water and land since they are neither solid land nor open water. Wetlands also include waterlogged soil, such as peat, where the production of plant materials has exceeded decomposition. However, not all wetlands are peatlands, therefore a thickness of 40 cm of peat has been chosen as a minimum requirement for wetlands to be classified as peatlands[43].

Wetlands are linked to many environmental issues including: climate change, freshwater and groundwater quality and supply, wildlife habitat, soil and water conservation, and water and air pollution. Wetlands not only provide waterfowl habitat but are also essential in supporting coastal and estuarine fishery resources, protecting shorelines from erosion, protecting watersheds from flooding and removing nutrients from wastewater and runoff.

Most wetlands at risk in Canada are either privately or provincially owned. In 1990, the federal government managed only 29 percent of Canada's wetlands[44].

Canada contains almost one-quarter of all the wetlands on earth; 14 percent of Canada, or 1,271,990 km^2, (127.2 million hectares), is covered by wetlands (Tables 4.1.4.1 and 4.1.4.2). Wetlands are concentrated in the central provinces and are sparsest in the north and mountainous areas. Peatlands cover 12 percent or 1,113,270 km^2 of Canada.

Map 4.1.4.1 was produced by the National Wetlands Working Group (NWWG) and illustrates the distribution of wetlands in Canada based upon 5 classes. The 0-5 percent range indicates that within this category up to 5 percent of the land cover can be classified as wetland. This map was based on a limited amount of provincial data, resource maps, and data provided by resource managers familiar with wetland areas. According to this group, the conversion of wetlands have been severe in areas such as the Central Prairies sloughs (70 percent converted), Atlantic salt marshes (65 percent), urban wetlands (80 to 98 percent), Pacific estuarine marshes (70 percent) and southern Ontario and St. Lawrence Valley hardwood and shoreline swamps (70 to 80 percent).

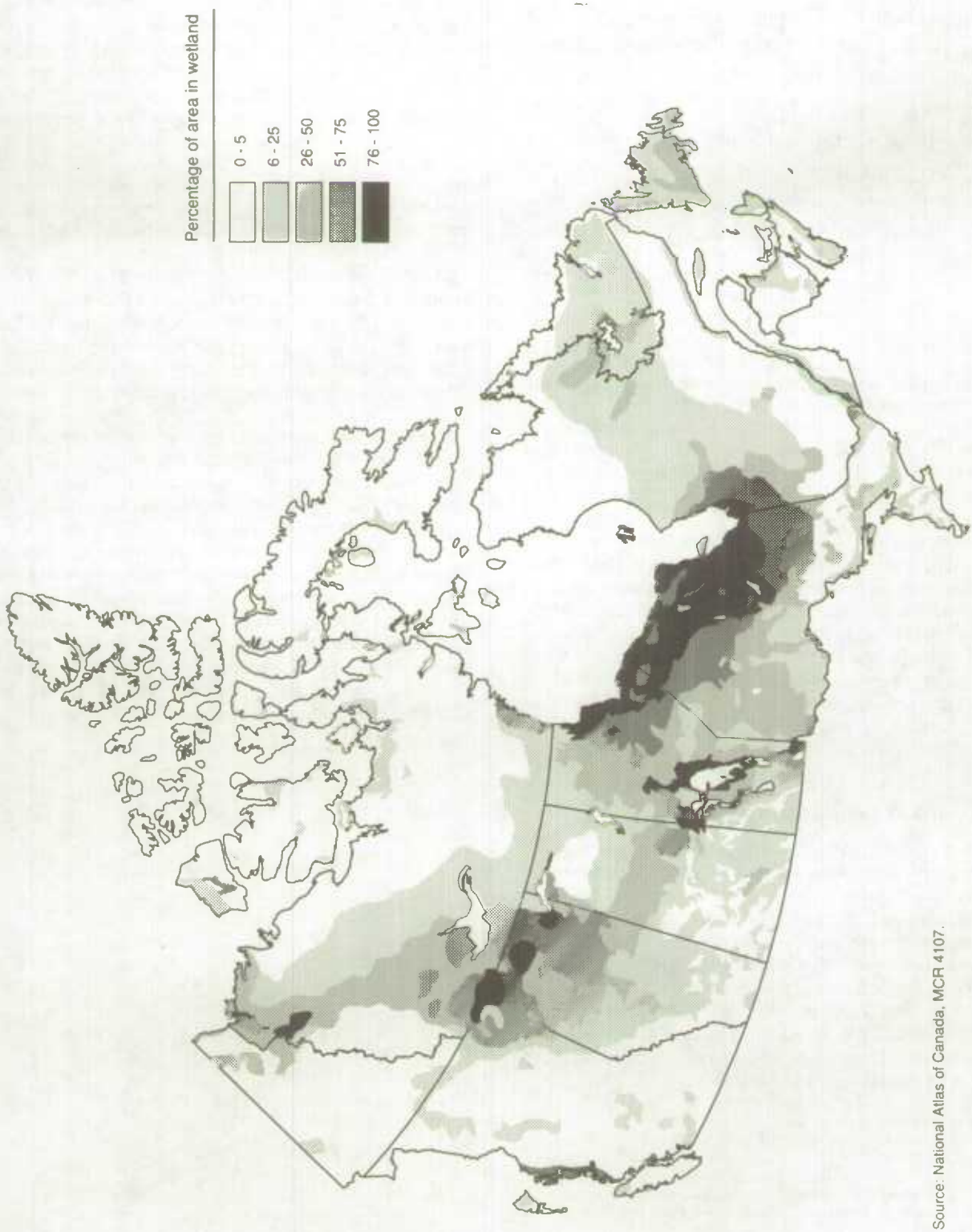
41. *Hydrophytic vegetation* are plants which grow only in water or very wet soil. Algae are hydrophytic.

42. Tarnocai, C. 1980. *Canadian Wetland Registry.* [in] Proceedings, Workshop on Canadian Wetlands. C.D.A. Rubec and F.C. Pollett [editors]. Lands Directorate, Environment Canada, Ecological Land Classification Series No. 12.

43. National Wetlands Working Group. 1988. *Wetlands of Canada.* Environment Canada, Ecological Land Classification Series No. 24.

44. Sustaining Wetlands Forum. 1990. *Sustaining Wetlands - International Challenge for the 90s.* Sustaining Wetlands Forum. Ottawa, Canada.

Map: 4.1.4.1



Distribution of Wetland, 1986

Source: National Atlas of Canada, MCR 4107.

Table: 4.1.4.1

Occurrence of Wetlands[1] and Peatlands[2], 1986

Province	Peatland		Wetland	
	Area	Land area in peatland	Area	Land area in wetland
	km²	percent	km²	percent
Newfoundland	64 290	17	67 920	18
Prince Edward Island	80	1	90	1
Nova Scotia	1 580	3	1 770	3
New Brunswick	1 200	2	5 440	8
Quebec	117 130	9	121 510	9
Ontario	225 550	25	292 410	33
Manitoba	206 640	38	224 700	41
Saskatchewan	93 090	16	96 870	17
Alberta	126 730	20	137 040	21
British Columbia	12 890	1	31 200	3
Yukon	251 110	8	277 940	9
Northwest Territories	12 980	3	15 100	3
Canada	**1 113 270**	**12**	**1 271 990**	**14**

Source:
Environment Canada, Sustainable Development Branch, Canadian Wildlife Service, Conservation and Protection, National Wetlands Working Group, Canada Committee on Ecological Land Classification. *Wetlands of Canada, 1988.* Ecological Land Classification Series, No. 24.

Notes:
[1] The extent and distribution of wetlands in Canada can only be estimated. Presently some provinces have completed surveys of peatlands while others are currently undertaking or planning such projects.
[2] Based on both ecological and land use considerations, a thickness of 40 cm of peat is the minimum requirement for wetlands to be classified as peatlands.

Table: 4.1.4.2

Estimated Wetland Area by Province, 1986

Province	Wetland class					Total area	Percent of provincial land area	Percent of national wetlands
	0-5%	6-25%	26-50%	51-75%	76-100%			
	square kilometres						percent	
Newfoundland	580	35 960	31 380	-	-	**67 920**	18	5
Prince Edward Island	40	-	-	-	-	**40**	1	1
Nova Scotia	220	1 550	-	-	-	**1 770**	3	1
New Brunswick	1 280	2 940	1 220	-	-	**5 440**	8	1
Quebec	6 280	45 790	35 060	28 490	5 890	**121 510**	9	10
Ontario	1 050	6 840	47 950	86 340	150 230	**292 410**	33	23
Manitoba	380	22 250	70 890	51 840	79 340	**224 700**	41	18
Saskatchewan	3 980	41 700	36 950	12 710	1 530	**96 870**	17	8
Alberta	1 070	10 800	32 490	68 730	23 950	**137 040**	21	11
British Columbia	3 520	6 620	1 460	16 560	3 040	**31 200**	3	2
Yukon	22 410	75 200	95 480	65 210	19 640	**277 940**	9	22
Northwest Territories	1 980	1 850	7 640	3 630	-	**15 100**	3	1
Canada	**42 790**	**251 500**	**360 520**	**333 510**	**283 620**	**1 271 940**	14	100

Source:
Energy, Mines and Resources Canada. *The National Atlas of Canada. Fifth Edition.*
Environment Canada, Sustainable Development Branch, Canadian Wildlife Service, Conservation and Protection, National Wetlands Working Group, Canada Committee on Ecological Land Classification. *Wetlands of Canada, 1988.* Ecological Land Classification Series, No. 24.

4.1.5 Protected Land

For Canada to comply with the World Conservation Union target of protecting 10 percent of our land area from development, the land area dedicated to parks and reserves would have to double from 58 million hectares to more than 120 million.

The World Commission on Environment and Development[45] reported in 1988 that 8 percent of the world's land area was protected. The World Conservation Union suggested a global target of 10 percent for total protected area.

Canada's government protected area is currently 5.9 percent (Table 4.1.5.3). This reflects land that has been protected by legislation by some level of government. Approximately 96 percent of protected land is found under IUCN categories II and IV (national, provincial, and territorial parks, and nature reserves).

The ecozones with the greatest protected areas are the Boreal Shield, Southern Arctic, Montane Cordillera, Arctic Cordillera, and Northern Arctic which have the least conflict with human activities. The ecozones with the smallest total protected areas are the Mixed-Wood Plain and Prairies, which have the greatest conflict with human activities.

Governments are not the only institutions protecting land. Non-government groups, such as Ducks Unlimited and the Nature Conservancy of Canada owned over 7 million hectares of land in 1983 (Table 4.1.5.2).

The rate of declaring protected land in Canada has been growing at a steady rate since the first national park, Banff, was established in 1885 (Table 4.1.5.1, Figure 4.1.5.1).

45. *Op.cit.*

Table: 4.1.5.2
Selected Non-Government Conservation Lands in Canada, 1983

Organization	Sites	Total area
		hectares
Ducks Unlimited Canada	5 049	6 862 674
Nature Conservancy of Canada	400	32 400
British Columbia Second Century Fund	77	3 643
Island Nature Trust (P.E.I.)	10	300
Niagara Escarpment Commission, Ontario[1]	38	190 000
Federation of Ontario Naturalists	13	530
Wildlife Habitat Canada Foundation	> 130	≠15 000
Total	**> 5 700**	**> 7 106 547**

Source:
Environment Canada, Sustainable Development and State of Environment Branch. *Conserving Canadian Ecosystems: A Systems Approach*. Rubec, C.D.A., A. Turner, N. Chartrand, E.B. Wiken [authors].
Notes:
[1] Overlaps with many other parks.

Table: 4.1.5.1
Total Protected Land by Ecozone, Selected Years

Ecozone	1885-1900			1901-1930			1931-1960			1961-1990		
	sites	hectares	percent[1]	sites	hectares	percent[1]	sites	hectares	percent[1]	sites	hectares	percent[1]
Atlantic Maritime	0	0	0.00	8	207 785	1.20	59	545 531	3.15	306	934 852	5.39
Mixed-Wood Plain	1	3 254	0.02	5	5 836	0.04	38	18 667	0.12	221	264 522	1.76
Boreal Shield	76	1 592 597	0.90	86	1 676 367	0.95	194	6 987 773	3.97	549	15 080 058	8.56
Prairie	2	20 342	0.04	10	90 054	0.17	45	189 698	0.36	197	744 794	1.40
Boreal Plain	0	0	0.00	4	2 029 327	2.41	32	2 312 058	2.75	204	2 937 124	3.49
Montane Cordillera	4	982 960	2.08	13	1 435 141	3.03	88	2 185 499	4.61	281	4 708 501	9.94
Pacific Maritime	0	0	0.00	5	197 393	0.80	50	203 455	0.82	255	2 658 703	10.71
Boreal Cordillera	0	0	0.00	0	0	0.00	2	591 800	1.56	13	3 282 890	8.68
Tundra Cordillera	0	0	0.00	0	0	0.00	0	0	0.00	2	1 086 664	4.10
Taiga Plain	0	0	0.00	3	3 136 490	5.33	3	3 136 490	5.33	25	3 139 960	5.34
Taiga Shield	0	0	0.00	1	718 800	0.52	1	718 800	0.52	14	761 207	0.55
Hudson Bay Plain	0	0	0.00	0	0	0.00	6	561 050	1.35	26	3 422 009	8.25
Southern Arctic	0	0	0.00	2	1 677 200	1.81	6	2 866 500	3.09	16	9 731 574	10.48
Northern Arctic	0	0	0.00	0	0	0.00	2	26 700	0.02	10	4 652 950	3.29
Arctic Cordillera	0	0	0.00	0	0	0.00	0	0	0.00	4	4 706 130	16.77
Canada	**83**	**2 599 153**	**0.26**	**137**	**11 174 393**	**1.13**	**526**	**20 344 021**	**2.07**	**2 123**	**58 111 938**	**5.90**

Source:
Environment Canada. Sustainable Development and State of Environment Branch. *Protected Areas Database*, 1990.
Notes:
[1]Percentage of total protected land by ecozone area.

Table: 4.1.5.3

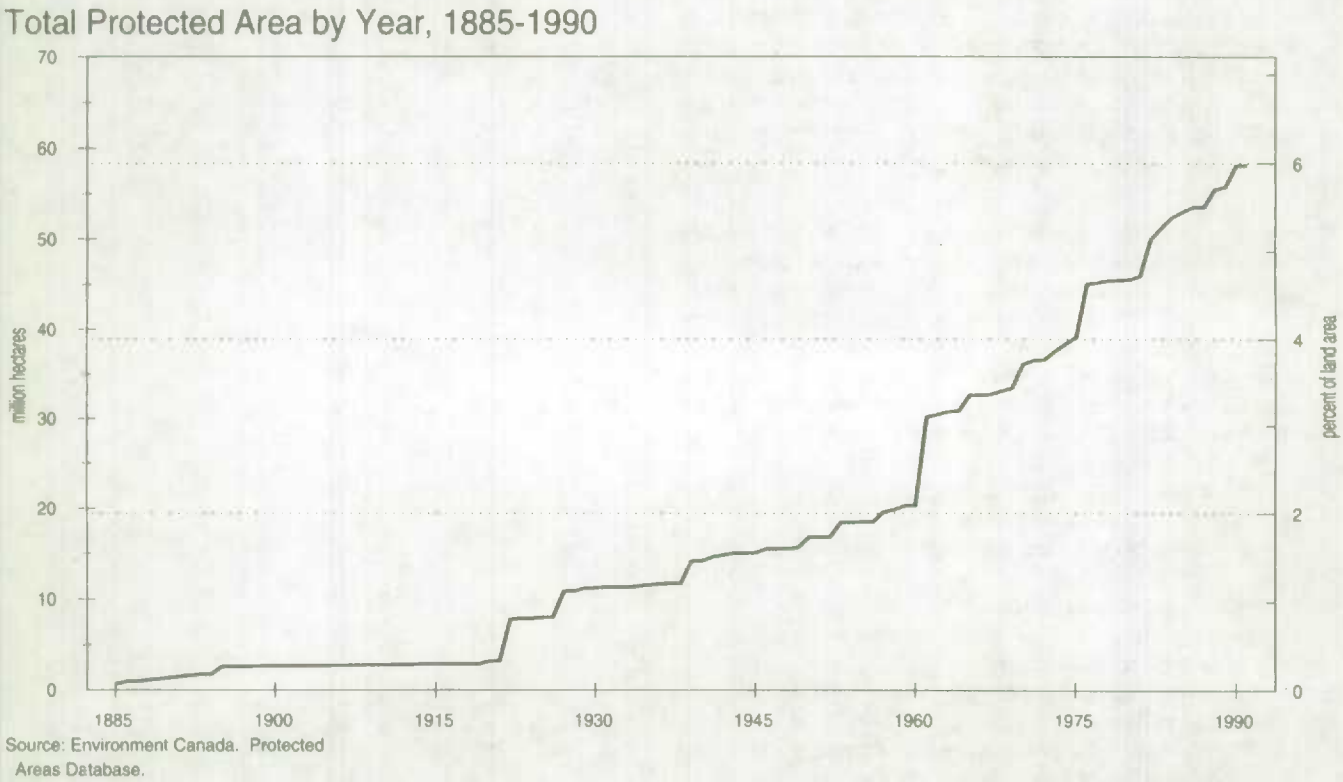
Protected Land by Ecozone, 1990

Ecozone	IUCN category[1] I[2] sites	I[2] hectares	II[3] sites	II[3] hectares	III[4] sites	III[4] hectares	IV[5] sites	IV[5] hectares	All categories sites	All categories hectares	Area of ecozone percent
Atlantic Maritime	21	2 145	203	278 764	0	0	82	653 943	306	934 852	5.39
Mixed-Wood Plain	83	18 052	65	99 643	1	5	72	146 822	221	264 522	1.76
Boreal Shield	282	155 154	204	4 177 030	4	3 225	59	10 744 649	549	15 080 058	8.56
Prairie	6	7 085	131	528 032	0	0	60	209 677	197	744 794	1.40
Boreal Plain	16	68 210	133	2 327 389	0	0	55	541 525	204	2 937 124	3.49
Montane Cordillera	60	482 498	216	4 221 313	0	0	5	4 690	281	4 708 501	9.94
Pacific Maritime	65	99 972	182	2 555 591	0	0	8	3 140	255	2 658 703	10.71
Boreal Cordillera	4	1 258	7	2 689 832	0	0	2	591 800	13	3 282 890	8.68
Tundra Cordillera	0	0	2	1 086 664	0	0	0	0	2	1 086 664	4.10
Taiga Plain	1	121	24	3 139 839	0	0	0	0	25	3 139 960	5.34
Taiga Shield	1	39 000	12	3 407	0	0	1	718 800	14	761 207	0.55
Hudson Bay Plain	15	277 749	5	2 583 210	0	0	6	561 050	26	3 422 009	8.25
Southern Arctic	0	0	4	406 774	0	0	12	9 324 800	16	9 731 574	10.48
Northern Arctic	1	81 000	3	2 370 170	0	0	6	2 201 780	10	4 652 950	3.29
Arctic Cordillera	0	0	3	3 727 110	0	0	1	979 020	4	4 706 130	16.77
Canada	**555**	**1 232 244**	**1 194**	**30 194 768**	**5**	**3 230**	**369**	**26 681 696**	**2 123**	**58 111 938**	**5.90**

Source:
Environment Canada, Sustainable Development and State of Environment Branch. *Protected Areas Database*, 1990.

Notes:
[1]Categories I-IV of the International Union for Conservation of Nature and Natural Resources (IUCN) correlate to "reasonably well protected" land/water which excludes land uses such as logging, mining, and hunting.
[2]Category I includes ecological reserves which are legally protected natural areas with minimal human influence. Ecological reserves are established primarily for scientific research and species preservations.
[3]Category II includes national, provincial and territorial parks.
[4]Category III includes national monuments and landmarks.
[5]Category IV incluces nature conservation reserves, managed nature reserves, and wildlife sanctuaries.

Figure: 4.1.5.1



Source: Environment Canada. Protected Areas Database.

4.1.6 Soil Quality

Canada's prime agricultural land occupies an area smaller than Prince Edward Island.

Canada has a limited amount of dependable soil (Map 4.1.6.1). Canada Land Inventory (CLI) classes 1-3 represent Canada's dependable land supply. Soils in these classes have fair to high capability for agriculture. These soils, considered capable of long term crop production, occupy less than 5 percent of Canada's total land area (Table 4.1.6.1).

Class 1 - Soils in this class have no significant limitations for crops. These deep soils are level or have very gentle slopes, are well to imperfectly drained and have a good water holding capacity. They are easily maintained in good tilth and productivity, and damage from erosion is slight. They are moderately high to high in productivity for a wide range of field crops adapted to the region.

Class 2 - Soils in this class have moderate limitations that restrict the range of crops or require moderate conservation practices. These deep soils have a good water holding capacity, can be managed with little difficulty and are moderately high to high in productivity for fairly wide range of field crops. The moderate limitations of these soils may be from any one of a number factors including mildly adverse regional climate, moderate effects of erosion, poor soil structure or low permeability, low fertility correctable with lime, gentle to moderate slopes, or occasional overflow or wetness.

Class 3 - Soils in this class have moderately severe limitations that restrict the range of crops or require special conservation practices. Under good management these soils are fair to moderately fair in productivity for a wide range of field crops adapted to the region. Conservation practices are more difficult to apply and maintain. Limitations arise from a combination of two of the factors described under class 2, or from one of the following:

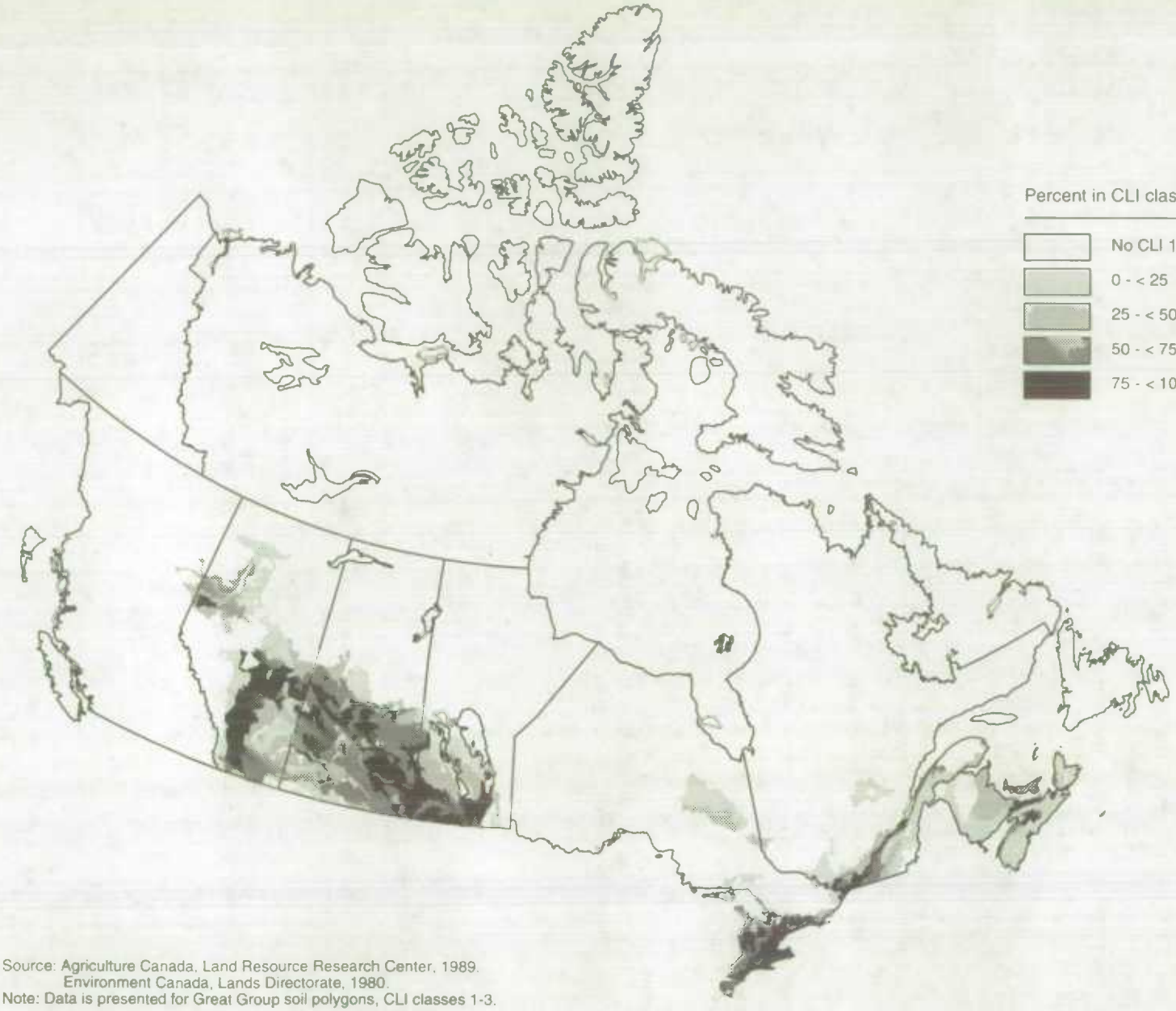
- moderate climatic limitations;
- moderately severe effects of erosion;
- an intractable soil mass of very low permeability;
- low fertility;
- moderate to strong slopes;
- frequent overflow or poor drainage resulting in occasional crop damage;
- low water holding capacity or a soil which is slow to release water;
- stoniness sufficiently severe to seriously handicap cultivation and necessitating some clearing;
- a restricted rooting zone;
- moderate salinity.

Table: 4.1.6.1
Dependable Land, Canada Land Inventory Classes 1-3

	Soil capability class		
	1	2	3
	hectares		
Newfoundland	0	0	1 851
Prince Edward Island	0	251 561	141 519
Nova Scotia	0	166 317	982 877
New Brunswick	0	160 528	1 151 144
Quebec	19 556	907 106	1 277 202
Ontario	2 156 752	2 217 667	2 908 818
Manitoba	162 501	2 530 607	2 440 659
Saskatchewan	999 691	5 874 448	9 424 700
Alberta	786 527	3 837 093	6 105 329
British Columbia	21 057	235 474	692 026
Canada	**4 146 084**	**16 180 801**	**25 126 125**

Source:
Environment Canada, Lands Directorate. 1982. *Agricultural Land Use Change in Canada*. Catalogue 73-1/21E.

Dependable Agricultural Land, 1989



Source: Agriculture Canada, Land Resource Research Center, 1989.
Environment Canada, Lands Directorate, 1980.
Note: Data is presented for Great Group soil polygons, CLI classes 1-3.

4.1.7 Agricultural Land

Almost 68 million hectares of Canada's land area was classified as farmland in 1986. Between 1971 and 1986, the number of farms decreased from 366 thousand to 293 thousand. The average farm size increased from 188 hectares to 231 hectares.

The area of farmland remained stable between 1971 and 1986, while the number of farms decreased from 366 thousand to 293 thousand (Table 4.1.7.2). Average farm size grew from 188 hectares to 231 hectares over the same period.

Summerfallowing is known to promote salinization. Between 1971 and 1986, the amount of farmland used for summerfallow decreased by almost 22 percent, from 10.8 to 8.5 million hectares.

Cropland area has increased steadily since 1901 despite the apparent stabilization of total farmland by 1931 (Table 4.1.7.1). This indicates an intensification of land use where a greater proportion of farmland is being regularly cultivated.

The decline in woodland areas on farms may also indicate a similar trend in intensifying land use on farms.

The Census of Agriculture definitions of the land classes used are:

farmland	the total area of land operated
cropland	total area seeded for harvest
woodland	includes woodlots, windbreaks and Christmas trees
summerfallow	land without a cultivated crop

Table: 4.1.7.1

Farms and Farmland, 1901-1986

Year	Improved farmland			Unimproved farmland	Other land	Total farmland	Number of farms	Average farm size
	Cropland	Improved pasture	Summer-fallow					
	million hectares						thousand	hectares
1901	8.1	0.0	0.0	13.5	4.1	25.7	511.1	50.3
1911	14.4	0.0	1.0	24.4	4.3	44.1	682.8	64.6
1921	20.2	3.1	4.8	28.4	0.5	57.0	711.1	80.2
1931	23.6	3.2	6.8	31.3	1.1	66.0	728.6	90.6
1941	22.8	3.4	9.5	33.1	1.4	70.2	732.9	95.8
1951	25.2	4.0	8.9	31.2	1.1	70.4	623.1	113.0
1961	25.3	4.1	11.4	28.0	1.0	69.8	480.9	145.1
1971	27.8	4.1	10.8	25.0	1.0	68.7	366.1	187.7
1976	28.3	4.1	10.9	24.2	0.9	68.4	338.6	202.0
1981	30.9	4.1	9.7	19.8	1.4	65.9	318.4	207.0
1986	33.2	3.6	8.5	21.8	0.7	67.8	293.1	231.3

Source:
Statistics Canada. *Handbook of Agricultural Statistics.* Catalogue 21-503.
Statistics Canada. Agriculture Division.

Table: 4.1.7.2

Agricultural Land Use by Sub-basin, 1971 and 1986

Provincial Sub-basin[1]	Sub-basin area	Farmland area				Average farm size		
		1971	1986	Change 1971-1986	Proportion of sub-basin in in farmland 1986	1971	1986	Change 1971-1986
	kilometre^2	hectares		percent		hectares		percent
Newfoundland								
North Newfoundland	66 367	5 804	10 554	81.8	0.2	21	51	143.6
South Newfoundland	46 058	19 571	26 007	32.9	0.6	26	58	128.7
Total	**112 425**	**25 375**	**36 561**	**44.1**	**0.3**	**24**	**56**	**130.6**
Prince Edward Island								
Prince Edward Island	5 660	313 482	272 433	- 13.1	48.1	69	96	39.4
Total	**5 660**	**313 482**	**272 433**	**- 13.1**	**48.1**	**69**	**96**	**39.4**
Nova Scotia								
Bay of Fundy	20 860	379 747	319 855	- 15.8	15.3	94	103	9.6
Southeast Atlantic Ocean	23 062	103 833	63 260	- 39.1	2.7	79	79	- 0.2
Cape Breton Island	11 568	54 196	33 392	- 38.4	2.9	85	91	7.7
Total	**55 490**	**537 777**	**416 507**	**- 22.6**	**7.5**	**90**	**97**	**8.6**
New Brunswick								
Saint John and South Bay of Fundy	34 627	370 697	284 499	- 23.3	8.2	105	124	17.3
Gulf of St. Lawrence and North Bay of Fundy	38 736	171 231	124 393	- 27.4	3.2	87	99	14.1
Total	**73 363**	**541 928**	**408 893**	**- 24.5**	**5.6**	**99**	**115**	**16.4**
Quebec								
Saint John	7 011	121 642	95 975	- 21.1	13.7	97	138	42.5
Cascapedia and Gulf of St. Lawrence	21 809	128 790	93 599	- 27.3	4.3	79	138	74.1
Upper Ottawa	33 256	125 666	104 136	- 17.1	3.1	107	200	86.4
Coulonge and Central Ottawa	17 320	84 622	71 671	- 15.3	4.1	94	114	21.1
Gabneau and Lower Ottawa	45 401	319 815	255 568	- 20.1	5.6	94	107	14.1
Upper St. Lawrence	955	66 283	61 643	- 7.0	64.5	62	81	31.3
St-Maurice	44 296	22 420	11 791	- 47.4	0.3	70	71	2.0
Central St. Lawrence	34 539	1 719 133	1 472 273	- 14.4	42.6	64	74	16.5
Lower St Lawrence	37 577	1 123 790	921 333	- 18.0	24.5	65	78	20.9
North Gaspé Peninsula	13 795	289 280	209 356	- 27.6	15.2	89	131	47.0
Saguenay	87 489	248 322	216 748	- 12.7	2.5	92	130	41.0
Betsiamites	27 280	5 198	4 766	- 8.3	0.2	104	140	34.8
Manicouagan and Outardes	67 763	2 158	1 667	- 22.7	0.0	108	72	- 32.8
Natashquan and Gulf of St. Lawrence	47 282	956	873	- 8.8	0.0	9	21	134.6
Nottaway	65 559	8 195	13 306	62.4	0.2	114	242	112.6
Abitibi and North French	4 297	68 757	80 912	- 11.4	14.2	108	180	66.2
Harricanaw	28 598	36 027	43 182	19.9	1.5	108	177	84.6
Total	**584 227**	**4 371 056**	**3 638 800**	**- 16.8**	**6.2**	**71**	**88**	**23.0**
Ontario								
Nipigon and Northwest Lake Superior	43 038	42 917	30 621	- 28.7	0.7	103	113	8.9
Northeast Lake Superior	40 068	2 486	2 440	- 1.8	0.1	44	41	- 8.4
North Lake Huron	34 378	163 176	132 660	- 18.7	3.9	148	140	- 5.2
Wanipitai and French	19 109	94 466	67 558	- 28.5	3.5	128	122	- 4.1
East Georgian Bay	22 254	508 690	433 169	- 14.8	19.5	68	75	9.5
East Lake Huron	14 810	1 148 400	1 025 053	- 10.7	69.2	73	82	13.1
North Lake Erie	22 944	1 813 257	1 721 611	- 5.1	75.0	56	68	22.5
Lake Ontario	28 709	1 232 742	1 048 344	- 15.0	36.5	60	67	12.3
Montréal and Upper Ottawa	17 624	100 386	93 326	- 7.0	5.3	120	141	18.2
Madawaska, Petawawa and Central Ottawa	22 903	402 596	313 219	- 22.2	13.7	110	105	- 4.4
Rideau and Lower Ottawa	9 009	562 166	451 468	- 19.7	50.1	77	86	12.6
Upper St. Lawrence	4 454	252 518	192 224	- 23.9	43.2	82	95	16.9
Moose	63 296	13 336	11 148	- 16.4	0.2	122	115	- 6.1
Abitibi	32 707	27 336	30 257	10.7	0.9	118	145	23.4
Upper Winnipeg	43 435	75 798	76 833	1.4	1.8	147	187	27.0
English	51 416	19 746	16 651	- 15.7	0.3	169	160	- 5.1
Total	**470 153**	**6 460 019**	**5 646 582**	**- 12.6**	**12.0**	**68**	**78**	**13.9**
Manitoba								
Saskatchewan	18 815	43 819	41 522	- 5.2	2.2	337	322	- 4.5
Lake Winnipegosis and Lake Manitoba	54 912	2 393 275	2 470 472	3.2	45.0	261	348	33.1
Assiniboine	24 874	1 905 621	1 931 633	1.4	77.7	249	313	25.7
Souris	9 040	806 679	803 351	- 0.4	88.9	297	377	26.9
Red	25 547	2 037 883	2 003 009	- 1.7	78.4	167	210	26.1
Winnipeg	12 973	71 650	68 848	- 3.9	5.3	129	162	25.5
West Lake Winnipeg	23 910	433 440	421 391	- 2.8	17.6	171	228	33.4
Total	**170 071**	**7 692 369**	**7 740 226**	**0.6**	**45.5**	**220**	**283**	**28.8**

Agricultural Land Use by Sub-basin, 1971 and 1986

Provincial Sub-basin[1]	Sub-basin area	Farmland area				Average farm size		
		1971	1986	Change 1971-1986	Proportion of sub-basin in in farmland 1986	1971	1986	Change 1971-1986
	kilometre²	hectares		percent		hectares		percent
Saskatchewan								
Upper South Saskatchewan	920	49 230	25 090	- 49.0	27.3	535	512	- 4.3
Central North Saskatchewan	13 562	1 081 053	1 143 180	5.7	84.3	356	455	27.8
Battle	4 431	350 300	350 465	0.0	79.1	413	501	21.2
Lower North Saskatchewan	41 103	3 550 855	3 572 914	0.6	86.9	362	440	21.5
Lower South Saskatchewan	55 013	5 112 095	5 213 686	2.0	94.8	392	451	15.3
Qu'Appelle	70 192	6 625 190	6 694 158	1.0	95.4	344	412	19.7
Saskatchewan	58 186	1 290 316	1 271 774	- 1.4	21.9	233	310	32.9
Lake Winnipegosis and Lake Manitoba	18 789	777 880	842 472	8.3	44.8	231	306	32.8
Assiniboine	26 964	2 376 787	2 361 402	- 0.6	87.6	227	305	34.5
Souris	29 449	2 697 056	2 691 262	- 0.2	91.4	353	418	18.3
Beaver	32 379	637 530	645 708	1.3	19.9	371	481	29.6
Missouri	20 506	1 779 290	1 787 240	0.4	87.2	839	961	14.6
Total	**371 494**	**26 327 581**	**26 599 354**	**1.0**	**71.6**	**342**	**419**	**22.6**
Alberta								
Upper South Saskatchewan	45 921	3 559 909	3 819 260	7.3	83.2	500	538	7.6
Bow	25 442	1 382 546	1 315 670	- 4.8	51.7	394	400	1.5
Red Deer	49 135	4 102 515	4 061 542	- 1.0	82.7	367	389	6.2
Upper North Saskatchewan	27 964	553 432	622 894	12.6	22.3	156	180	15.9
Central North Saskatchewan	28 759	2 409 187	2 344 818	- 2.7	81.5	201	234	16.6
Battle	25 703	2 346 445	2 284 856	- 2.6	88.9	300	336	12.0
Lower North Saskatchewan	10 764	1 054 318	1 074 472	1.9	99.8	853	911	6.7
Beaver	16 973	414 533	498 781	20.3	29.4	260	339	30.4
Upper Athabasca	34 896	123 533	147 318	19.3	4.2	225	232	3.1
Pembina and Central Athabasca	41 135	976 406	1 091 892	11.8	26.5	205	239	16.8
Lower Central Athabasca	42 244	204 027	230 095	12.8	5.4	219	262	19.3
Upper Peace	17 550	788 812	871 118	10.4	49.6	299	377	26.0
Smoky	46 148	944 333	1 043 764	10.5	22.6	270	334	23.9
Central Peace	35 731	410 854	558 662	36.0	15.6	282	337	19.5
Lower Central Peace	58 730	75 282	152 717	102.9	2.6	264	395	49.4
Missouri	6 982	688 348	537 481	- 21.9	77.0	1 326	1 197	- 9.7
Total	**514 076**	**20 034 481**	**20 655 340**	**3.1**	**40.2**	**320**	**358**	**11.9**
British Columbia								
Williston Lake	72 865	5 389	16 385	204.0	0.2	449	431	- 4.0
Upper Peace	49 133	671 655	859 647	28.0	17.5	387	484	25.0
Skeena	56 521	83 607	70 608	- 15.5	1.2	296	183	- 38.1
Gardner Canal and Central Pacific Ocean	52 379	8 168	8 293	1.5	0.2	227	163	- 28.3
Knight Inlet and South Pacific Ocean	43 196	9 782	24 835	153.9	0.6	104	177	70.5
Vancouver Island	34 786	50 169	53 109	5.9	1.5	28	24	- 15.3
Nechako	46 939	134 216	189 118	40.9	4.0	256	290	13.2
Upper Fraser	65 949	143 794	151 070	5.1	2.3	187	168	- 10.2
Thompson	55 991	545 790	425 721	- 22.0	7.6	364	227	- 37.5
Fraser	63 094	320 789	300 447	- 6.3	4.8	48	49	3.5
Columbia	102 684	382 155	301 595	- 21.1	2.9	77	61	- 20.6
Queen Charlotte Islands	9 844	1 070	617	- 42.4	0.1	67	51	- 23.1
Fort Nelson	53 979	1 796	9 616	435.4	0.2	163	370	126.5
Total	**707 161**	**2 358 382**	**2 411 061**	**2.2**	**3.4**	**128**	**126**	**- 1.2**
Canada	..	**68 662 448**	**67 825 757**	**- 1.2**	**22.1**	**166**	**231**	**23.4**

Source:
Statistics Canada. Environment and Wealth Accounts Division. Agriculture Division.
Notes:
[1] Includes only sub-basins where agriculture is present.

Table: 4.1.7.3

Agricultural Land Use Changes, by Sub-basin, 1971 and 1986

Provincial Sub-basin	Cropland area			Summerfallow area			Woodland area		
	1971	1986	Change 1971-1986	1971	1986	Change 1971-1986	1971	1986	Change 1971-1986
	hectares		percent	hectares		percent	hectares		percent
Newfoundland									
North Newfoundland	1 034	1 942	87.9	62	173	177.9	1 556	2 795	79.7
South Newfoundland	2 502	2 934	17.3	140	212	51.6	3 033	2 435	- 19.7
Total	**3 535**	**4 876**	**37.9**	**202**	**385**	**90.6**	**4 588**	**5 231**	**14.0**
Prince Edward Island									
Prince Edward Island	142 200	156 498	10.1	3 717	2 647	- 28.8	85 353	61 199	- 28.3
Total	**142 200**	**156 498**	**10.1**	**3 717**	**2 647**	**- 28.8**	**85 353**	**61 199**	**- 28.3**
Nova Scotia									
Bay of Fundy	82 623	93 756	13.5	2 261	3 413	50.9	199 296	146 475	- 26.5
Southeast Atlantic Ocean	9 169	9 447	3.0	181	255	41.2	69 018	37 783	- 45.3
Cape Breton Island	6 530	6 309	- 3.4	96	242	152.7	31 291	16 541	- 47.1
Total	**98 322**	**109 512**	**11.4**	**2 538**	**3 910**	**54.1**	**299 604**	**200 799**	**- 33.0**
New Brunswick									
Saint John and South Bay of Fundy	93 055	90 573	- 2.7	2 333	2 960	26.9	190 049	130 107	- 31.5
Gulf of St. Lawrence and North Bay of Fundy	37 379	38 902	4.1	1 145	1 329	16.0	86 042	54 320	- 36.9
Total	**130 434**	**129 475**	**- 0.7**	**3 478**	**4 289**	**23.3**	**276 091**	**184 427**	**- 33.2**
Quebec									
Saint John	30 596	25 498	- 16.7	429	653	52.3	62 521	52 067	- 16.7
Cascapedia and Gulf of St. Lawrence	37 479	33 874	- 9.6	632	593	- 6.1	61 052	41 957	- 31.3
Upper Ottawa	44 780	37 661	- 15.9	941	837	- 11.1	28 891	32 811	12.9
Coulonge and Central Ottawa	26 872	27 937	4.0	353	811	73.1	25 266	16 313	- 35.4
Gatineau and Lower Ottawa	92 862	86 841	- 6.5	2 514	1 877	- 33.3	125 991	93 127	- 26.1
Upper St. Lawrence	41 242	48 097	16.6	779	346	- 55.6	5 109	3 840	- 24.8
St-Maurice	5 853	4 341	- 25.8	355	166	- 53.1	8 256	4 530	- 45.1
Central St. Lawrence	827 676	857 034	3.5	15 635	13 442	- 14.0	367 953	304 026	- 17.4
Lower St Lawrence	414 921	394 165	- 5.0	5 862	7 360	25.6	374 342	317 955	- 15.1
North Gaspé Peninsula	102 446	93 427	- 8.8	2 133	1 534	- 28.1	108 852	72 229	- 33.5
Saguenay	91 980	94 170	2.4	2 152	2 539	18.0	60 856	56 978	- 6.4
Betsiamites	960	1 242	29.4	45	49	10.9	1 813	2 560	41.2
Manicouagan and Outardes	507	684	34.8	36	177	386.7	377	325	- 13.6
Natashquan and Gulf of St. Lawrence	344	338	- 1.5	29	25	- 11.3	131	74	- 43.5
Nottaway	2 470	3 248	31.5	226	103	- 54.5	1 547	4 655	201.0
Abitibi and North French	22 851	21 660	- 5.2	552	1 110	101.3	14 481	14 295	- 1.3
Harricanaw	11 379	14 178	24.6	379	579	52.6	6 848	12 044	75.9
Total	**1 755 217**	**1 744 396**	**- 0.6**	**33 051**	**31 803**	**- 3.8**	**1 254 088**	**1 029 587**	**- 17.9**
Ontario									
Nipigon and Northwest Lake Superior	13 287	12 512	- 5.8	507	393	- 22.4	14 253	6 574	- 53.9
Northeast Lake Superior	845	847	0.2	46	110	139.8	563	409	- 27.3
North Lake Huron	32 879	32 352	- 1.6	1 138	1 104	- 3.0	49 461	31 111	- 37.1
Wanipitai and French	23 824	21 559	- 9.5	1 138	544	- 52.2	32 975	15 979	- 51.5
East Georgian Bay	220 091	236 224	7.3	10 256	6 964	- 32.1	79 859	47 866	- 40.1
East Lake Huron	571 081	669 735	17.3	10 176	8 236	- 19.0	133 186	95 544	- 28.3
North Lake Erie	1 253 067	1 387 405	10.7	38 750	26 217	- 32.3	135 159	101 572	- 24.9
Lake Ontario	549 304	563 368	2.6	24 558	24 707	0.6	165 246	104 002	- 37.1
Montreal and Upper Ottawa	38 804	45 184	16.4	477	936	96.4	23 369	11 959	- 48.8
Madawaska, Petawawa and Central Ottawa	102 066	102 945	0.9	1 282	1 908	48.8	137 669	77 894	- 43.4
Rideau and Lower Ottawa	247 123	257 124	4.0	5 489	5 122	- 6.7	76 817	45 831	- 40.3
Upper St. Lawrence	92 703	89 880	- 3.0	1 462	1 747	19.5	41 239	26 344	- 36.1
Moose	4 294	4 038	- 5.9	23	121	426.3	3 530	1 924	- 45.5
Abitibi	7 069	8 686	22.9	225	178	- 20.9	7 955	5 325	- 33.1
Upper Winnipeg	17 765	21 204	19.4	553	1 801	225.6	22 920	11 148	- 51.4
English	4 963	4 903	- 1.2	202	246	21.4	6 826	4 065	- 40.4
Total	**3 179 166**	**3 457 966**	**8.8**	**96 281**	**80 337**	**- 16.6**	**931 026**	**587 548**	**- 36.9**
Manitoba									
Saskatchewan	14 073	21 695	54.2	4 706	3 537	- 24.8	4 503	456	- 89.9
Lake Winnipegosis and Lake Manitoba	862 186	1 076 038	24.8	276 585	134 707	- 51.3	172 424	49 300	- 71.4
Assiniboine	874 698	1 134 421	29.7	371 173	182 784	- 50.8	68 919	27 834	- 59.9
Souris	417 574	542 929	30.0	146 480	49 096	- 66.5	11 633	4 724	- 59.4
Red	1 309 099	1 521 275	16.2	226 494	79 064	- 65.1	77 865	25 356	- 67.4
Winnipeg	31 757	37 808	19.1	5 191	6 568	26.5	6 161	2 507	- 59.3
West Lake Winnipeg	182 147	185 168	1.7	43 891	53 457	21.8	47 066	14 240	- 69.7
Total	**3 691 734**	**4 519 335**	**22.4**	**1 074 520**	**509 213**	**- 52.6**	**388 572**	**124 217**	**- 68.0**

Agricultural Land Use Changes, by Sub-basin, 1971 and 1986

Provincial Sub-basin	Cropland area			Summerfallow area			Woodland area		
	1971	1986	Change 1971-1986	1971	1986	Change 1971-1986	1971	1986	Change 1971-1986
	hectares		percent	hectares		percent	hectares		percent
Saskatchewan									
Upper South Saskatchewan	16 393	10 000	- 39.0	12 901	9 100	- 29.5	0	0	..
Central North Saskatchewan	374 976	566 502	51.1	211 240	126 378	- 40.2	32 020	13 867	- 56.7
Battle	132 023	195 040	47.7	83 373	43 931	- 47.3	3 219	1 023	- 68.2
Lower North Saskatchewan	1 520 659	1 780 274	17.1	942 034	826 983	- 12.2	55 858	21 332	- 61.8
Lower South Saskatchewan	2 063 359	2 373 594	15.0	1 364 109	1 283 139	- 5.9	31 830	10 014	- 68.5
Qu'Appelle	2 988 427	3 403 531	13.9	1 954 180	1 779 229	- 9.0	33 690	12 455	- 63.0
Saskatchewan	680 792	910 513	33.7	348 011	138 888	- 60.1	56 970	25 071	- 56.0
Lake Winnipegosis and Lake Manitoba	322 903	476 109	47.4	182 784	119 975	- 34.4	50 591	24 152	- 52.3
Assiniboine	1 115 347	1 430 716	28.3	571 116	374 991	- 34.3	75 381	28 311	- 62.4
Souris	1 262 827	1 441 558	14.2	686 716	615 788	- 10.3	15 438	4 006	- 74.0
Beaver	184 503	242 990	31.7	66 356	44 915	- 32.3	48 542	11 287	- 76.7
Missouri	401 550	494 984	23.3	278 703	298 287	7.0	814	1 176	44.4
Total	**11 063 759**	**13 325 811**	**20.4**	**6 701 523**	**5 661 605**	**- 15.5**	**404 354**	**152 694**	**- 62.2**
Alberta									
Upper South Saskatchewan	1 124 743	1 547 340	37.6	638 500	507 495	- 20.5	10 293	5 884	- 42.8
Bow	468 400	526 315	12.4	190 981	133 779	- 30.0	13 988	5 828	- 58.3
Red Deer	1 404 836	1 705 664	21.4	546 440	400 990	- 26.6	72 847	26 863	- 63.1
Upper North Saskatchewan	245 851	269 652	9.7	34 569	18 365	- 46.9	59 152	19 011	- 67.9
Central North Saskatchewan	1 099 863	1 279 326	16.3	357 583	228 054	- 36.2	105 869	41 150	- 61.1
Battle	974 623	1 277 688	31.1	406 189	186 957	- 54.0	58 826	24 444	- 58.4
Lower North Saskatchewan	256 569	358 136	39.6	149 197	171 147	14.7	2 353	1 120	- 52.4
Beaver	130 697	163 626	25.2	33 180	26 080	- 21.4	29 329	11 901	- 59.4
Upper Athabasca	27 230	36 702	34.8	4 817	3 448	- 28.4	20 107	7 876	- 80.8
Pembina and Central Athabasca	412 483	487 012	18.1	93 042	52 699	- 43.4	92 912	35 527	- 61.8
Lower Central Athabasca	77 918	96 097	23.3	21 755	13 515	- 37.9	21 232	8 389	- 60.5
Upper Peace	357 130	430 870	20.6	111 715	120 260	7.6	67 891	34 537	- 49.1
Smoky	431 617	513 151	18.9	119 564	115 295	- 3.6	77 089	28 780	- 62.7
Central Peace	163 494	280 072	52.6	53 655	72 248	34.7	31 485	30 695	- 2.5
Lower Central Peace	23 050	68 043	195.2	8 435	20 507	143.1	10 469	6 759	- 35.4
Missouri	103 289	122 827	18.9	66 702	52 821	- 20.8	450	59	- 86.9
Total	**7 321 792**	**9 162 523**	**25.1**	**2 836 325**	**2 123 659**	**- 25.1**	**674 291**	**288 824**	**- 57.2**
British Columbia									
Williston Lake	845	3 692	336.8	157	745	373.3	1 972	713	- 63.8
Upper Peace	209 510	261 717	24.9	62 552	66 907	7.0	83 661	40 958	- 51.0
Skeena	10 795	14 994	38.9	295	354	19.9	21 158	4 111	- 80.6
Gardner Canal and Central Pacific Ocean	354	1 692	378.3	89	5	- 94.1	365	592	62.3
Knight Inlet and South Pacific Ocean	1 161	2 343	101.8	23	68	193.0	1 003	513	- 48.8
Vancouver Island	11 175	15 177	35.8	353	340	- 3.8	15 110	9 504	- 37.1
Nechako	20 022	38 361	91.6	1 169	3 450	195.1	35 677	13 032	- 63.5
Upper Fraser	23 690	34 917	47.4	609	2 099	244.9	37 988	12 249	- 67.8
Thompson	41 569	56 531	36.0	985	2 592	163.1	63 715	31 665	- 50.3
Fraser	56 398	74 205	31.6	1 412	1 441	2.1	30 908	17 017	- 44.9
Columbia	66 744	65 564	- 1.8	2 291	2 795	22.0	49 695	23 123	- 53.5
Queen Charlotte Islands	59	31	- 47.0	0	0	..	407	136	- 66.7
Fort Nelson	160	1 620	913.2	15	370	2 441.4	41	904	2 111.9
Total	**442 481**	**570 843**	**29.0**	**69 951**	**81 167**	**16.0**	**341 701**	**154 516**	**- 54.8**
Canada	**27 828 641**	**33 181 234**	**19.2**	**10 821 587**	**8 499 015**	**- 21.5**	**4 659 671**	**2 789 041**	**- 40.1**

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

4.1.8 Forest Land

Canada contains 10 percent of the world's productive forest. This forest is being harvested at a rate of over one million hectares per year. Although attempts are being made to regenerate harvested area, the resulting forests are different from the original forests. These forests contain trees of only one age and species, which create an environment where only a few other flora and fauna species can thrive.

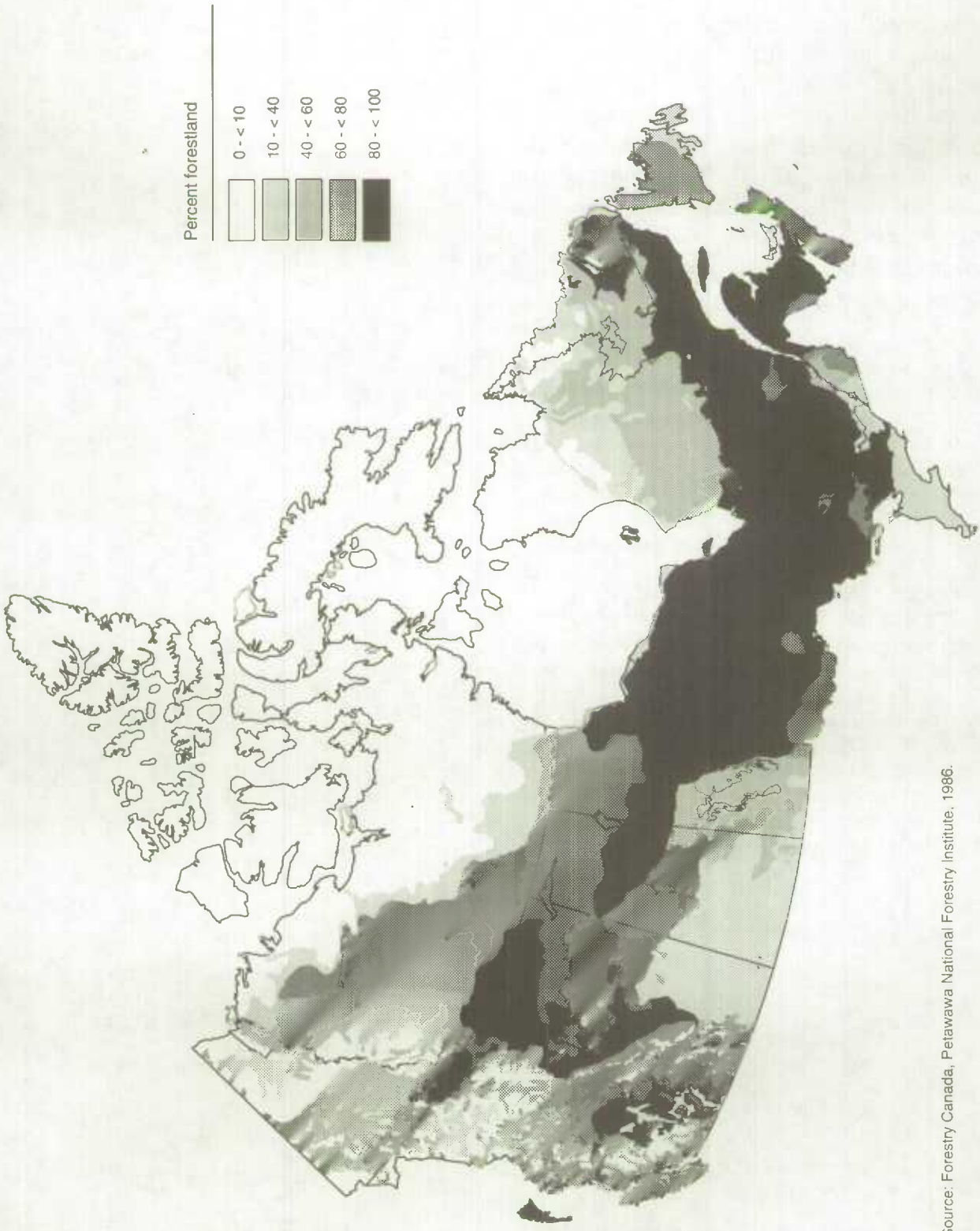
More than half of Canada's land area is covered by forests. Forest resources provide employment for almost 900,000 Canadians. The sustainability of the forest resource is important not only to the Canadian economy but to the entire world as it represents almost one-third of the world's Boreal Forest.

Forestry Canada uses Rowe's Forest Regions[46] to define areas with homogeneous characteristics. Map 4.1.8.1 shows the extent of forestland in Canada according to these regions.

Canada's Forest Inventory defines **productive forest land** as capable of producing a merchantable stand within a reasonable length of time. **Stocked productive land** is not only productive but is stocked with growing trees. More than half of Canada's forest area is considered to be economically productive (Map 4.1.8.2).

46. Rowe, J.S. 1972. *Forest Regions of Canada.* Canadian Forestry Service.

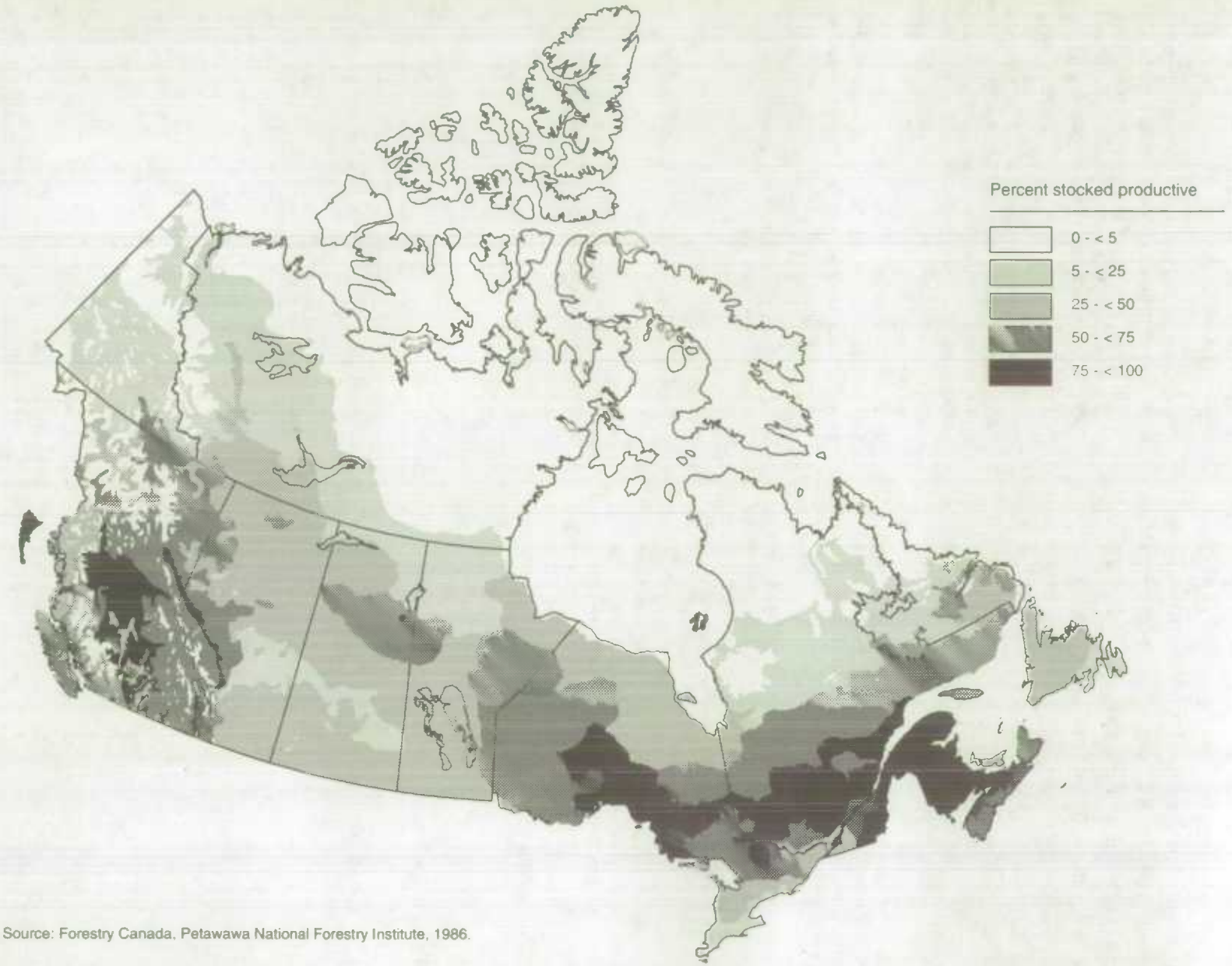
Map: 4.1.8.1



Forestland Distribution, 1986

Source: Forestry Canada, Petawawa National Forestry Institute, 1986.

Stocked Productive Forestland Distribution, 1986



Source: Forestry Canada, Petawawa National Forestry Institute, 1986.

4.1.9 Minerals

At current production levels, estimated reserves of conventional petroleum will be depleted within 14 years. The estimated reserve life of natural gas is 27 years. Canada's coal reserves could last another 70 years. The reserve lives for other minerals range from 20 to 30 years.

❑❑❑

Measuring the reserves of minerals provides an estimate of how long the stock may last at current production levels. Furthermore, regions that contain established reserves are at risk of environmental stress from production.

The measurement of reserves is not straightforward. Prices and available technology determine the feasibility of exploring for minerals and extracting them. The figures in these tables represent **established reserves**, reserves recoverable under current economic conditions with present technology.

Canada has substantial reserves of minerals, petroleum and gas. Although the reserves of conventional oil are diminishing (Figure 4.1.9.1 and Table 4.1.9.2), there are many regions not yet explored. At current production levels, the existing established reserves would be depleted within 14 years. Coal and natural gas are plentiful and the reserves have been stable or growing. The estimated reserve life of is 27 years for natural gas (Table 4.1.9.3, Figure 4.1.9.2) and 70 years for coal (Table 4.1.9.1).

The reserves of copper, nickel, lead, zinc, molybdenum and silver have all diminished over the past decade. The reserve lives of these minerals are all between 20 and 30 years. Gold reserves have steadily increased since the early 1980s. In 1989, the estimated reserve life for gold was 11 years (Table 4.1.9.4).

The potash reserves of Canada amount to almost seventy five percent of world reserves. It is estimated[46] that 14,000 million tonnes of potash are accessible by conventional mining methods. Another 30,000 million tonnes, mainly in southern Saskatchewan, are believed to be available by solution mining.

The most recent appraisal of iron ore reserves indicates that there are approximately 6 billion tonnes of proven iron ore reserves remaining in Canada. At current production levels of about 40 million tonnes of iron ore per year, this reserve level is not significantly affected by production[47].

46. Energy, Mines and Resources Canada. Canadian Potash 1980-2000. Working paper.

47. Energy, Mines and Resources Canada. Mineral Policy Sector.

Table: 4.1.9.1

Recoverable Reserves and Production of Coal in Canada, 1974-88

	Remaining recoverable reserves					Gross mine production			
	Class of coal					Class of coal			
			Bituminous						
Year	Lignitic	Sub-bituminous	Thermal	Metallurgical	Total	Lignitic	Sub-bituminous	Bituminous	Total
	megatonnes (million tonnes)								
1974	..	..	..	..	..	3.5	5.1	16.1	**24.7**
1975	..	..	..	..	..	3.5	6.0	21.3	**30.8**
1976	..	..	..	..	**5 381**	4.7	6.4	14.4	**25.5**
1977	1 921	1 979	..	..	**5 358**	5.5	7.9	20.4	**33.8**
1978	2 117	2 182	344	1 263	**5 906**	5.1	8.3	22.3	**35.7**
1979	2 117	2 182	344	1 263	**5 906**	5.0	9.6	25.2	**39.8**
1980	2 117	2 182	344	1 263	**5 906**	6.0	10.5	27.3	**43.8**
1981	2 117	2 182	344	1 263	**5 906**	6.8	11.6	28.7	**47.1**
1982	2 263	918	1 057	2 030	**6 268**	9.5	13.0	31.4	**53.9**
1983	2 263	918	1 057	2 030	**6 268**	7.8	14.6	31.9	**54.3**
1984	2 263	918	1 057	2 030	**6 268**	9.9	15.4	45.8	**71.1**
1985	2 236	871	1 553	1 918	**6 578**	9.7	16.9	50.1	**76.7**
1986	2 236	871	1 553	1 918	**6 578**	8.3	18.2	46.3	**72.8**
1987	2 236	871	1 553	1 918	**6 578**	10.0	18.5	48.9	**77.4**
1988	2 236	871	1 553	1 918	**6 578**	12.2	20.0	57.1	**89.3**

Source:
Canmet Report 87-3E. *Coal Mining in Canada.*
Statistics Canada. *Coal Mines.* Catalogue 26-206.
Energy Mines and Resources. 1979. *Assessment of Canada's Coal Resources and Reserves. Catalogue EP 77-5.*

Table: 4.1.9.2

Remaining Established Reserves of Crude Oil in Canada, 1961-89[1]

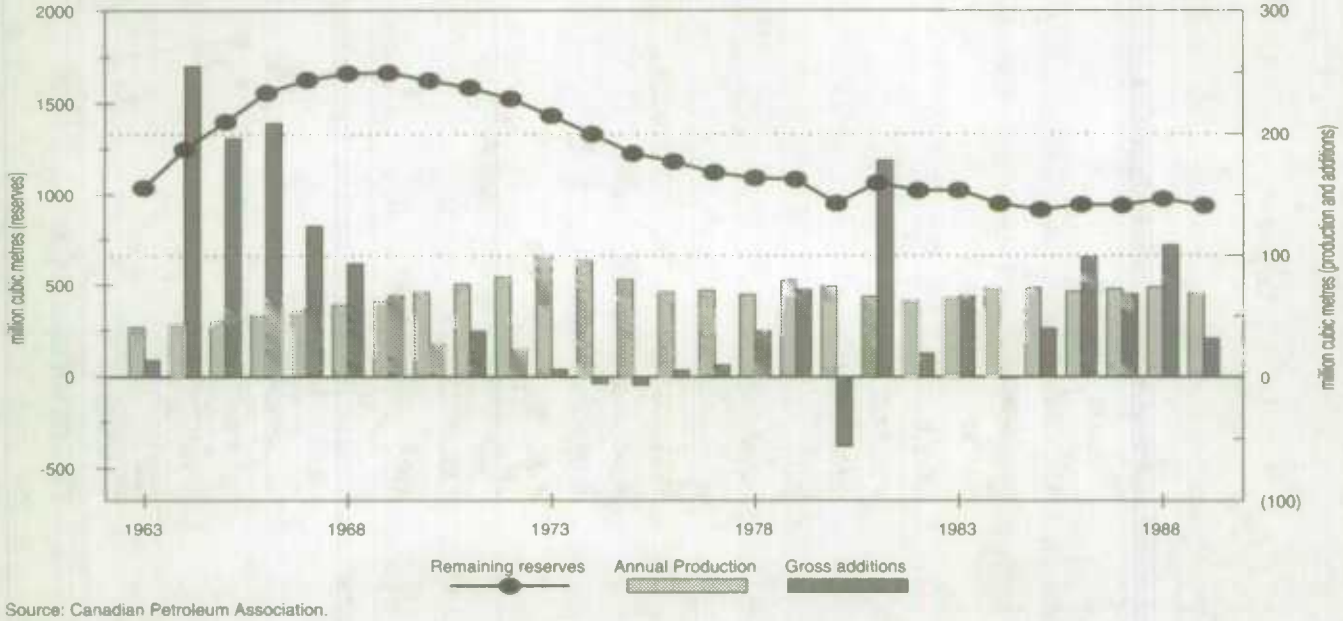
Year	Remaining at beginning of year	Gross additions	Net production[2]	Remaining at end of year	Net change in reserves
	thousand cubic metres				
1961[3]	584 557	113 788	35 123	663 222	78 665
1962[3]	663 222	87 720	38 914	1 062 733	48 806
1963	1 062 733	13 944	40 758	1 035 919	-26 814
1964	1 035 919	255 384	43 033	1 248 270	212 351
1965	1 248 270	196 556	46 337	1 398 489	150 219
1966	1 398 489	208 887	50 224	1 557 152	158 663
1967	1 557 152	124 587	54 690	1 627 049	69 897
1968	1 627 049	93 668	59 030	1 661 687	34 638
1969	1 661 687	66 636	62 516	1 665 807	4 120
1970	1 665 807	26 894	69 606	1 623 095	-42 712
1971	1 623 095	37 636	76 297	1 584 434	-38 661
1972	1 584 434	22 229	82 319	1 524 344	-60 090
1973	1 524 344	6 537	99 423	1 431 458	-92 886
1974	1 431 458	-5 065	95 530	1 330 863	- 100 595
1975	1 330 863	-6 280	79 897	1 224 686	-86 177
1976	1 224 686	5 921	69 683	1 180 924	-63 762
1977	1 180 924	10 227	70 872	1 120 279	-60 645
1978	1 120 279	37 426	67 647	1 090 058	-30 221
1979	1 090 058	71 415	79 469	1 082 004	-8 054
1980	1 082 004	-56 247	74 529	951 228	- 130 776
1981	951 228	178 220	65 873	1 063 575	112 347
1982	1 063 575	19 341	61 756	1 021 133	-42 415
1983	1 021 133	66 074	64 488	1 022 719	1 586
1984	1 022 719	- 588	73 108	949 023	-73 696
1985	949 023	39 837	73 030	915 830	-33 193
1986	915 830	98 719	70 138	944 411	28 581
1987	944 411	67 943	72 192	940 162	-4 249
1988	940 162	108 488	73 482	975 148	-37 155
1989	975 148	31 677	68 832	937 993	61 904

Source:
Canadian Petroleum Association. *Statistical Yearbook.*
Notes:
[1] Includes conventional and frontier areas.
[2] Preliminary estimate; corrections to previous year production included with gross additions.
[3] 1961 and 1962 reported as proved reserves.

Figure: 4.1.9.1

Reserves of Crude Oil in Canada

Remaining Established Reserves, 1962-89



Source: Canadian Petroleum Association.
Statistical Yearbook.

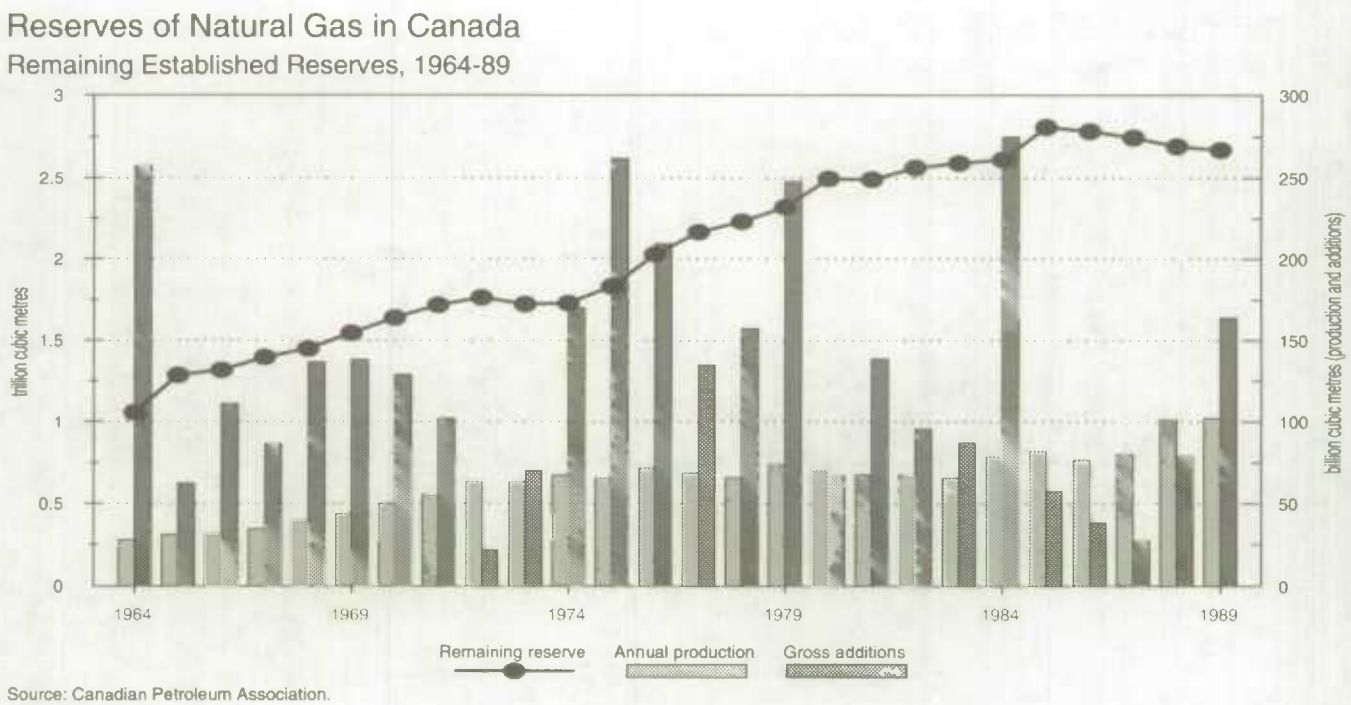
Table: 4.1.9.3

Remaining Established Reserves of Marketable Natural Gas in Canada, 1961-89[1]

Year	Remaining at beginning of year	Gross additions	Net production[2]	Remaining at end of year	Net change in reserves
	million cubic metres				
1961[3]	760 530	91 169	19 552	832 147	71 617
1962[3]	832 147	70 930	23 565	879 512	47 365
1963[3]	879 512	74 749	24 738	1 054 466	174 954
1964	1 054 466	257 146	27 654	1 283 958	229 492
1965	1 283 958	62 203	30 860	1 315 301	31 343
1966	1 315 301	110 766	31 199	1 394 868	79 567
1967	1 394 868	86 355	34 146	1 447 077	52 209
1968	1 447 077	136 443	39 335	1 544 185	97 108
1969	1 544 185	137 938	43 792	1 638 331	94 146
1970	1 638 331	128 611	50 121	1 716 821	78 490
1971	1 716 821	101 860	55 025	1 763 656	46 835
1972	1 763 656	21 822	83 486	1 721 992	-41 664
1973	1 721 992	70 228	63 539	1 728 681	6 689
1974	1 728 681	169 925	67 140	1 831 466	102 785
1975	1 831 466	261 729	65 680	2 027 515	196 049
1976	2 027 515	209 181	71 906	2 164 790	137 275
1977	2 164 790	134 970	68 918	2 230 842	66 052
1978	2 230 842	157 213	65 842	2 322 213	91 371
1979	2 322 213	247 681	73 837	2 496 057	173 844
1980	2 496 057	66 784	70 977	2 491 864	-4 193
1981	2 491 864	138 614	67 505	2 562 973	71 109
1982	2 562 973	95 498	67 421	2 591 050	28 077
1983	2 591 050	87 478	65 933	2 612 595	21 545
1984	2 612 595	275 000	79 014	2 808 581	195 986
1985	2 808 581	57 764	82 422	2 783 923	-24 658
1986	2 783 923	38 554	76 967	2 745 510	-38 413
1987	2 745 510	27 141	79 868	2 692 783	-52 727
1988	2 692 783	78 870	101 108	2 670 545	-22 238
1989	2 670 545	163 947	102 043	2 732 449	61 904

Source:
Canadian Petroleum Association. *Statistical Yearbook.*
Notes:
[1] Includes conventional and frontier areas.
[2] Preliminary estimate; corrections to previous year production included with gross additions; includes adjustments for underground storage.
[3] 1961-1963 reported as proved reserves.

Figure: 4.1.9.2



Source: Canadian Petroleum Association.
Statistical Yearbook.

Table: 4.1.9.4

Proven and Probable Reserves of Major Metals in Canada, 1974-1990

Metal Contained in Proven and Probable Minable Ore in Operating Mines and Deposits Committed to Production

Copper (thousand tonnes)

Year	Remaining reserves	Gross additions	Production	Remaining reserves	Reserve life (years)
1974	17 033	836	821	17 048	21
1975	17 048	489	734	16 803	23
1976	16 803	562	731	16 634	23
1977	16 634	596	759	16 471	22
1978	16 471	28	659	15 840	24
1979	15 840	1 201	636	16 405	26
1980	16 405	1 142	716	16 831	24
1981	16 831	- 294	722	15 815	22
1982	15 815	1 946	739	17 022	23
1983	17 022	- 160	699	16 163	23
1984	16 163	419	794	15 788	20
1985	15 788	- 665	739	14 384	19
1986	14 384	- 354	699	13 331	19
1987	13 331	449	794	12 986	16
1988	12 986	322	759	12 549	17
1989	12 549	413	704	12 258	17
1990	12 258	..	780	..	..

Nickel (thousand tonnes)

Year	Remaining reserves	Gross additions	Production	Remaining reserves	Reserve life (years)
1974	7 119	418	269	7 268	27
1975	7 268	240	242	7 266	30
1976	7 266	301	241	7 326	30
1977	7 326	296	233	7 389	32
1978	7 389	- 191	128	7 070	55
1979	7 070	302	127	7 245	57
1980	7 245	1 244	185	8 304	45
1981	8 304	- 131	160	8 013	50
1982	8 013	- 343	89	7 581	85
1983	7 581	- 117	125	7 339	59
1984	7 339	57	174	7 222	42
1985	7 222	- 5	170	7 047	41
1986	7 047	- 179	164	6 704	41
1987	6 704	90	189	6 605	35
1988	6 605	- 127	199	6 279	32
1989	6 279	49	196	6 132	31
1990	6 132	..	197	..	..

Lead (thousand tonnes)

Year	Remaining reserves	Gross additions	Production	Remaining reserves	Reserve life (years)
1974	9 328	276	294	9 310	32
1975	9 310	257	349	9 218	26
1976	9 218	66	256	9 028	35
1977	9 028	187	281	8 934	32
1978	8 934	297	320	8 911	28
1979	8 911	957	311	9 557	31
1980	9 557	814	252	10 119	40
1981	10 119	394	269	10 244	38
1982	10 244	- 943	272	9 029	33
1983	9 029	291	272	9 048	33
1984	9 048	103	264	8 887	34
1985	8 887	- 807	268	8 012	30
1986	8 012	- 511	334	7 167	21
1987	7 167	- 113	373	6 681	18
1988	6 681	659	351	6 989	20
1989	6 989	221	269	6 941	26
1990	6 941	..	224	..	..

Zinc (thousand tonnes)

Year	Remaining reserves	Gross additions	Production	Remaining reserves	Reserve life (years)
1974	28 725	676	1 127	28 274	25
1975	28 274	864	1 055	28 083	27
1976	28 083	306	982	27 407	28
1977	27 407	572	1 071	26 908	25
1978	26 908	611	1 067	26 452	25
1979	26 452	3 283	1 100	28 635	26
1980	28 635	1 685	884	29 436	33
1981	29 436	980	911	29 505	32
1982	29 505	-2 462	966	26 077	27
1983	26 077	1 282	988	26 371	27
1984	26 371	910	1 063	26 218	25
1985	26 218	-1 422	1 049	23 747	23
1986	23 747	- 336	988	22 423	23
1987	22 423	- 524	1 158	20 741	18
1988	20 741	1 703	1 370	21 074	15
1989	21 074	1 887	1 273	21 688	17
1990	21 688	..	1 285	..	..

Molybdenum (thousand tonnes)

Year	Remaining reserves	Gross additions	Production	Remaining reserves	Reserve life (years)
1974	294	64	14	344	25
1975	344	11	13	342	26
1976	342	50	15	377	25
1977	377	24	17	384	23
1978	384	92	14	462	33
1979	462	103	11	554	50
1980	554	8	12	550	46
1981	550	- 23	13	514	40
1982	514	- 6	14	494	35
1983	494	- 38	10	446	45
1984	446	- 42	12	392	33
1985	392	- 21	8	363	45
1986	363	- 6	11	346	31
1987	346	- 89	15	242	16
1988	242	2	14	230	16
1989	230	18	14	234	17
1990	234	..	14	..	..

Silver (tonnes)

Year	Remaining reserves	Gross additions	Production	Remaining reserves	Reserve life (years)
1974	27 377	2 542	1 332	28 587	21
1975	28 587	514	1 235	27 866	23
1976	27 866	3 905	1 281	30 490	24
1977	30 490	- 91	1 314	29 085	22
1978	29 085	1 580	1 267	29 398	23
1979	29 398	3 313	1 147	31 564	28
1980	31 564	3 120	1 070	33 614	31
1981	33 614	- 331	1 129	32 154	28
1982	32 154	541	1 314	31 381	24
1983	31 361	1 175	1 197	31 359	26
1984	31 359	1 266	1 327	31 298	24
1985	31 298	-1 303	1 197	28 798	24
1986	28 798	-1 016	1 088	26 694	25
1987	26 694	341	1 375	25 660	19
1988	25 660	3 194	1 443	27 411	19
1989	27 411	691	1 312	26 790	20
1990	26 790	..	1 400	..	..

Proven and Probable Reserves of Major Metals in Canada, 1974-1990

Metal Contained in Proven and Probable Minable Ore in Operating Mines and Deposits Committed to Production

	Gold (tonnes)[1]				
Year	Remaining reserves	Gross additions	Production	Remaining reserves	Reserve life (years)
1974	371	54	53	372	7
1975	372	33	51	354	7
1976	354	94	52	396	8
1977	396	23	53	366	7
1978	366	97	53	410	8
1979	410	181	51	540	11
1980	540	278	49	770	16
1981	770	122	50	842	17
1982	842	58	62	838	13
1983	838	399	70	1 167	17
1984	1 167	118	80	1 205	15
1985	1 205	237	84	1 358	16
1986	1 358	238	100	1 496	15
1987	1 496	364	112	1 748	16
1988	1 748	201	130	1 819	14
1989	1 819	88	159	1 748	11
1990	1 748	..	164	..	..

Source:
Energy, Mines and Resources Canada. *Canadian Mineral Yearbook.*
Statistics Canada. *General Review of the Mineral Industries, Mines, Quarries and Oil Wells.* Catalogue 26-201.
Note:
[1] Reserve data exclude metal in placer deposits; production data are adjusted to exclude production from placer operations.

Table: 4.1.9.5

Estimates of Uranium Reserves Recoverable from Mineable Ore in Canada (1973-1989)[2]

	Reserve type							
	Proven (measured)		Probable (indicated)		Total remaining recoverable reserves[3,4]			
Year	A[1,5]	B[1,5]	A[1,5]	B[1,5]	A[1,6]	A[1,5]	Annual production	Net change
	thousand tonnes							
1973	65	4	91	14		156		
1974	59	3	82	13	156	141	5	- 15
1975	63	11	82	17	141	145	6	4
1976	79	4	88	11	145	167	8	22
1977	78	4	94	13	167	172	8	5
1978	76	4	139	16	172	215	8	43
1979	73	4	157	25	215	230	7	15
1980	67	6	163	22	230	230	7	0
1981	45	2	153	12	230	198	8	- 32
1982	32	1	144	8	198	176	8	- 22
1983	30	0	162	41	176	192	7	16
1984	31	0	124	59	192	155	11	- 37
1985	41	0	119	72	155	160	11	5
1986	46	1	107	95	160	153	12	- 7
1987	44	1	104	94	153	148	12	- 5
1988	41	2	98	94	148	139	11	- 9
1989	45	2	87	93	139	132	9	- 7

Source:
Energy Mines and Resources Canada. Uranium Resource Appraisal Group (URAG).
Notes:
[1] Price ranges within which mineable ore is assessed. Over the period since 1974, the dollar value placed on the price categories has increased. For year to year comparative purposes, the two price categories are A is less than B. Over the years 1984-1987 the price has ranged from $C100-115/kg for Category A.
[2] Prior to 1983, estimates were reported in terms of uranium "Contained in Mineable Ore". Average ore processing recoveries in Canada range from 90 to 98 per cent.
[3] The price of $100/kg U (Category A) is used by URAG for its assessment of those resources that are of economic interest in Canada.
[4] Includes proven and probable reserves classified in the lowest price category (<$C100-115/kg range over the period).
[5] As of December 31.
[6] As of January 1.

4.2 Natural Processes

Not all changes in the environment are the result of human activities. The natural cycles inherent in climatic systems and the natural fluctuations of wildlife populations provide a background from which to assess the magnitude of human-induced impacts.

This section provides information on natural disasters and climate.

4.2.1 Natural Disasters

Between 1983 and 1989, Canada experienced 7 major earthquakes, 12 major storms (including 3 tornados) and 17 major floods. Total damages from these natural disasters amounted to 40 deaths, 214 injuries and an estimated 469 million dollars in damages.

Major Storms, Floods and Earthquakes

Disasters of significance in Canada from 1983 to 1989 are presented in Table 4.2.1.1. Information on previous natural disasters is contained in the previous edition of *Human Activity and the Environment* (1986). Disasters meeting the following criteria were included in the table:

- earthquakes of 5.0 on the Richter scale and over
- disasters requiring more than $250,000 in Disaster Relief Assistance (DRA), and
- disasters where extensive physical and human damage occurred.

Table: 4.2.1.1

Major Storms, Floods and Earthquakes, 1983-1989

Date	Location	Type	Cause/ Characteristics	Major Impacts
1983, Winter	Newfoundland	Flood	Heavy Rain	$2.4 million in DRA[1]
1983, Winter	Gaspé, Quebec	Flood	High tides, severe storm	Road, bridges and property damages $12.0 million, $17.0 million in DRA
1983, Spring	Regina, Saskatchewan	Flood	Spring run-off	Extensive damage, $1.1 million in DRA
1983, Spring	Montreal, Quebec	Flood	Ice jams, heavy rain	Property damages of $4.0 million
1984, February	Western and Eastern Nfld.	Flood	Ice jams, haavy rain	Fishing boats sunk; damages of $100,000, $1.8 million DRA
1984, Winter	Lower Fraser River, B.C.	Flood	Heavy rain, snowmelt	Roads, bridges and fish hatchery damaged ($4.0 million), $1.2 million DRA
1984	Manitoba	Storm	Sleet storm	$816,000 in DRA
1984	Manitoba	Flood	-	$300,000 in DRA
1985, Spring	Southern Ontario	Flood	Heavy rain, melting snow	5,600 ha land flooded, erosion; $2.0 million in damages
1985, Spring	Hay River, N.W.T.	Flood	Ice jams, spring run-off	One injury, $618,000 in damages; $400,000 in DRA
1985, June 19	St. Sylvere, Quebec	Storm	Tornado	Three injuries; $1.0 million in damages
1985, July 7	Mississauga, Ontario	Storm	Tornado	Ten injuries; $400,000 in damages
1985, July 21	New Liskeard, Ontario	Storm	Hailstorm	$2.0 million in damages to crops
1985, July 30	Southwestern Quebec	Storm	Wind, rain and hail storms	$3.0 million in damages to crops, farms, utility poles downed, buildings impacted; $70.0 million in damages
1985, November 19	Southern Manitoba	Storm	Heavy snowfall and winds	$1.5 million for clean-up
1985, October 5 and December 23	N.W.T., Alberta, British Columbia	Earthquake	6.6 and 6.9 on the Richter Scale	Two separate quakes felt in Edmonton and Yellowknife, minor damage; 590,000 people affected
1986, June 16	Southern and Eastern Ontario	Storm	Severe hail and thunderstorm	Damages of $4.0 million to trees, property, hydro lines
1986, Summer	Saskatchewan and Alberta	Flood	Heavy rainfall and soil moisture	One recorded death, $28.3 million in damages to roads and crops; $7.5 million in DRA
1986, Summer	Manitoba	Flood	-	$908,000 in DRA
1986, August 2	Southern Ontario	Storm	Hailstorm	$20.0 million in damages to crops
1986, November 8	Southwestern Manitoba	Storm	Blizzard	Snowfall of 50 cm, two deaths; $2.0 million in clean-up
1986, March 21	Central British Columbia	Earthquake	5.4 on Richter Scale	Strongly felt in Prince George, minor damage; 70,000 people affected
1987, March 17	Eastern Canada	Storm	High winds and snow storm	Eight reported deaths, traffic disrupted, schools and businesses closed
1987, Spring	Beauce Region, Québec City	Flood	Heavy rain, snowmelt	Damages $10.0 million (flood), $2.0 million (landslide)
1987, July 14	Montreal, Quebec	Flood	Severe thunderstorm, flash flood	Two recorded deaths, widespread property damage. Hydro lines and subways system impacted. $20.0 million in DRA and $94.0 million in damages
1987, July 31	Edmonton, Alberta	Storm	Tornados	200 injured and 27 reported deaths. Extensive property damage, toppled hydro lines; $250.0 million in damages and $22.0 million in DRA
1987, Summer	Upper Peace River District, B.C. and Alberta	Flood	Heavy rainfall	$5.0 million in damages to roads and crops
1987	Perth-Andover, N.B.	Flood	-	$5.6 million in DRA
1987	British Columbia, Yukon	Earthquake	7.6 on Richter Scale	Strongly felt in Whitehorse; 20,000 people affected
1988, March 25	Northwest Territories	Earthquake	6.0 on Richter Scale	Mackenzie Region, widely felt
1988, June 5	Camrae, Alberta	Storm	Storm and tornado	$3.0 million in damages to farms and utility poles
1988	Slave Lake, Alberta	Flood	-	$400,000 in DRA
1988	British Columbia, Yukon	Earthquake	7.6 on Richter Scale	Strongly felt in Whitehorse; 20,000 people affected
1988, November 25	Southern Quebec	Earthquake	6.5 on Richter Scale	Quake strongly felt in Montreal; $20.0 million in damages; 1.75 million people affected
1989	Northwest Territories	Flood	-	$450,000 in DRA
1989, December 25	Northern Quebec	Earthquake	6.2 on Richter Scale	Quake strongly felt in Quebec by 470,000 people

Sources:
Environment Canada. Inland Waters Directorate. Water Planning and Management Branch.
Emergency Preparedness Canada.
Environment Canada. Atmospheric Environment Service.
Energy Mines and Resources Canada, Geophysics and Marine Geoscience Branch, Seismology Section.

Notes:
This table updates Tables 1.3.2 (Major Earthquakes), 1.3.3 (Major Floods) and 1.3.4 (Major Storms) in *Human Activity and the Environment* (1986) which lists events from the 17th century.
The criterion for inclusion of storms and floods here is major impact on man. In a number of cases significant storms and floods have not been listed because they caused minor damage or occurred in isolated regions.
The Richter Scale is a logarithmic scale used to measure the intensity of an earthquake.
[1] Disaster relief payments are made by the Federal and Provincial Governments under the "Disaster Relief Assistance Programme" (DRA) of Emergency Preparedness Canada.

4.2.2 Climate

Canada's climate ranges from Vancouver, British Columbia with an annual average temperature of 9.8°C to Resolute, Northwest Territories with an annual average of -16.6°C. Vancouver experiences, on average, 55 days per year of freezing temperature; Resolute has 324.

❑❑❑

Climate Profile

Canada is a land of climatic contrasts and extremes. This is evident in the variety of Canadian climatic landscapes. The climate profile presented in Tables 4.2.2.2 through 4.2.2.5 lists climate data from a selection of twenty nine weather stations across Canada[49]. Data from the most populated cities and each of the climatic regions in Canada are represented. For the most part, weather stations are located at airport sites.

The tables contain monthly and annual data for: temperature (Table 4.2.2.2); "number of days with" and sunshine (Table 4.2.2.3); degree-days, humidity, wind and precipitation (Table 4.2.2.4); average frost data, climatic extremes and climate severity (Table 4.2.2.5).

The Climate Severity Index

As the term *Climate Severity Index* suggests, the CSI provides an index of the uncomfortable, depressing, confining and hazardous aspects of the Canadian climate[50]. The CSI comprises the four severity factors: the Discomfort Factor; the Psychological Factor; the Hazardousness Factor; and the Mobility Factor. Each severity factor is comprised of its own sub-set of climate factors (Table 4.2.2.1) and the extreme values of these eighteen variables are combined into the CSI, which can range from 0 to 100. The CSI is a product of the four severity factors weighted as follows:

$$CSI = (5A + 2B + 2C + D) / 7.5$$

where:

A = Discomfort

B = Psychological state

C = Hazardousness

D = Outdoor mobility

Table 4.2.2.1 presents the weighting scheme assigned to the severity factors and their corresponding subfactors. For the weather stations listed, the CSI ranges from 16 for Penticton, B.C. to 95 for Resolute, N.W.T.

Precipitation

Whereas five percent of the earth's precipitation occurs as snow, in Canada 36 percent falls as snow. Canada's nation-wide average precipitation is 535 mm, ranging from 64 mm at Eureka, N.W.T. to 6655 mm at Henderson Lake, B.C.

49. See Map 5.2.0.3 in the appendix for locations

50. Environment Canada. 1984. *Climate Severity Index for Canadians.* D.W. Phillips and R.B. Crowe. CLI-1-84. Atmospheric Environment Service, Downsview, Canada.

Table: 4.2.2.1

Climate Severity Index Factors

Severity factor	Climate factor	Description	Points
DISCOMFORT			100
Winter (70 Points)	Wind chill	Mean percentage of time in January that wind chill exceeds 1400 W/m²	30
	Length of winter	Number of months with mean daily temperature less than 0°C	20
	Severity of winter	Mean daily temperature of coldest month	20
Summer (30 Points)	Humidex	Mean percentage of days with humidax greater than 30°C for 1 hour or more - highest 10-day total for summer	10
	Length of summer	Number of months with mean daily temperature of 10°C or greater	5
	Warmth of summer	Mean daily maximum temperature of warmest month	5
	Dampness	Mean July wet-bulb depression	10
PSYCHOLOGICAL			100
	Darkness	Increasing darkness factor with increasing latitude	35
	Sunshine	Mean annual number of hours of bright sunshine	25
	Wet days	Annual number of days with measurable precipitation	25
	Fog	Absolute frequency (in 10 years) of number of hours with fog	15
HAZARDOUSNESS			100
	Strong winds	Mean percentage frequency of wind speed equal to or greater than 30.6 km/h - average of January and July	30
	Thunderstorms	Absolute frequency (in 10 years) of number of hours with thundar	10
	Blowing snow	Absolute frequency (in 10 years) of number of hours with blowing snow	40
	Snowfall	Mean winter snowfall (cm)	20
MOBILITY			100
	Visibility	Absolute frequency (in 10 years) of number of hours with fog, snow and rain	40
	Freezing precipitation	Absolute frequency (in 10 years) of number of hours with freezing precipitation	40
	Snowfall	Mean winter snowfall (cm)	20

Source:
Environment Canada. *Climate Severity Index for Canadians.* D.W. Phillips and R.B. Crowe. CLI-1-84. Atmospheric Environment Service. Downsview, 1984.

Table: 4.2.2.2

Average Daily Temperatures by Month for Selected Weather Stations

	Average[1] daily temperature (°C)												
Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**Annual**
Goose Bay	- 16.4	- 14.5	- 8.6	- 1.7	5.0	11.3	15.8	14.3	9.1	2.7	- 3.8	- 13.0	**0.0**
St. John's	- 3.9	- 4.5	- 2.3	1.2	5.4	10.9	15.5	15.3	11.6	6.9	3.4	- 1.5	**4.8**
Charlottetown	- 7.1	- 7.5	- 3.1	2.3	8.5	14.5	18.3	17.8	13.5	8.1	2.9	- 3.9	**5.4**
Halifax	- 6.0	- 6.1	- 1.6	3.3	9.2	14.8	18.2	18.1	13.8	8.6	3.4	- 2.9	**6.1**
Saint John	- 7.8	- 7.5	- 2.5	3.2	9.0	13.8	16.9	16.6	12.7	7.6	2.3	- 4.8	**5.0**
Kuujjuaq	- 23.3	- 22.4	- 17.7	- 9.2	0.2	6.9	11.4	10.4	5.4	- 0.9	- 8.3	- 18.4	**- 5.5**
Kuujjuarapik	- 22.5	- 22.6	- 17.1	- 6.8	1.2	6.5	10.5	10.4	7.1	2.0	- 4.9	- 15.9	**- 4.3**
Québec	- 12.1	- 10.8	- 4.5	3.3	10.8	16.4	19.1	17.5	12.6	6.6	- 0.2	- 9.0	**4.1**
Sept-Îles	- 14.0	- 12.5	- 6.6	0.0	5.9	11.7	15.2	14.1	9.3	3.6	- 2.5	- 11.0	**1.1**
Montréal	- 10.2	- 9.0	- 2.5	5.7	13.0	18.3	20.9	19.6	14.8	8.7	2.0	- 6.9	**6.2**
Ottawa	- 10.9	- 9.5	- 3.0	5.6	12.8	18.0	20.6	19.2	14.3	8.1	1.2	- 7.7	**5.7**
Thunder Bay	- 15.4	- 13.0	- 6.3	2.5	8.8	14.0	17.6	16.4	11.1	5.7	- 2.6	- 11.1	**2.3**
Toronto	- 6.7	- 6.1	- 1.0	6.2	12.3	17.7	20.6	19.7	15.5	9.3	3.3	- 3.5	**7.3**
Windsor	- 4.9	- 3.8	1.2	8.1	14.2	19.7	22.2	21.3	17.4	11.1	4.4	- 1.9	**9.1**
The Pas	- 22.7	- 18.0	- 11.2	0.0	8.4	14.4	17.7	16.1	9.8	3.6	- 7.5	- 17.6	**- 0.6**
Winnipeg	- 19.3	- 15.6	- 8.2	3.4	11.3	16.8	19.6	18.3	12.4	6.1	- 4.5	- 14.0	**2.2**
Churchill	- 27.5	- 25.9	- 20.4	- 10.1	- 1.5	6.2	11.8	11.3	5.4	- 1.5	- 12.1	- 22.2	**- 7.2**
Regina	- 17.9	- 13.6	- 7.8	3.3	11.1	15.9	18.9	17.8	11.7	5.2	- 5.1	- 12.8	**2.2**
Saskatoon	- 19.3	- 14.6	- 8.6	3.3	11.1	15.7	18.5	17.2	11.2	4.9	- 5.7	- 14.1	**1.6**
Calgary	- 11.8	- 7.3	- 4.0	3.3	9.4	13.5	16.4	15.2	10.6	5.5	- 2.7	- 7.8	**3.4**
Edmonton	- 15.0	- 9.6	- 5.0	4.2	11.3	15.1	17.4	16.2	11.0	5.8	- 3.7	- 10.4	**3.1**
Penticton	- 2.7	0.6	3.9	8.6	13.4	17.2	20.3	19.5	14.7	8.7	3.0	- 0.4	**8.9**
Vancouver	2.5	4.6	5.8	8.8	12.2	15.1	17.3	17.1	14.2	10.0	5.9	3.9	**9.8**
Prince Rupert	- 0.2	2.3	3.0	5.4	8.3	10.8	12.8	13.1	11.4	7.9	3.8	1.6	**6.7**
Alert	- 32.1	- 33.6	- 33.2	- 24.9	- 11.7	- 1.0	3.6	0.9	- 10.2	- 19.7	- 26.6	- 30.0	**- 16.2**
Inuvik	- 29.6	- 28.9	- 25.0	- 14.3	- 0.8	10.1	13.6	10.7	3.1	- 8.1	- 20.7	- 27.2	**- 9.8**
Yellowknife	- 28.8	- 25.1	- 18.9	- 6.9	5.0	12.9	16.3	14.1	6.7	- 1.6	- 14.1	- 24.0	**- 5.4**
Whitehorse	- 20.7	- 13.2	- 8.2	0.3	6.7	12.0	14.1	12.5	7.5	0.6	- 8.8	- 16.6	**- 1.2**
Resolute	- 32.1	- 33.2	- 31.4	- 23.1	- 10.9	- 0.6	4.1	2.4	- 5.1	- 15.1	- 24.5	- 29.3	**- 16.6**

Source:
Environment Canada. *The Climates of Canada* by David Phillips, Supply and Services Canada, Ottawa, 1990.
Environment Canada, Atmospheric Environment Service, *Canadian Climate Normals*, various issues.
Environment Canada, Atmospheric Environment Service, *Principal Station Data*, various issues.
Notes:
[1] Average, mean or normal refer to the value of the particular element averaged over the period from 1951-1980.

Table: 4.2.2.3

Annual Average "Number of Days With" and Bright Sunshine Hours for Selected Weather Stations

Station	Average[1] number of days with[2]: Winds (>63 km/h)	Hail[4]	Thunder[5]	Fog[6]	Freezing temperatures[7]	Freezing precipitation[8]	Rain[9]	Snow[10]	Bright sunshine[3] (hours)
Goose Bay	1	*	9	14	215	13	102	97	1 564.9
St. John's	23	*	3	124	176	38	156	88	1 497.4
Charlottetown	6	*	9	47	169	17	124	68	1 818.4
Halifax	3	*	9	122	163	19	125	64	1 885.0
Saint John	6	*	11	106	173	12	124	59	1 865.3
Kuujjuaq	4	3	3	17	256	8	70	99	1 467.2
Kuujjuarapik	3	*	6	45	243	10	63	100	1 497.8
Québec	*	*	24	35	180	15	115	73	1 651.7
Sept-Îles	9	*	7	51	206	8	93	72	1 990.6
Montréal	1	*	25	20	155	13	114	62	2 054.0
Ottawa	*	*	24	35	165	16	107	62	2 008.5
Thunder Bay	*	*	26	38	204	8	88	61	2 202.8
Toronto	*	*	27	35	155	10	99	47	2 045.4
Windsor	2	*	33	37	136	9	105	45	n/a
The Pas	*	*	23	15	209	12	65	73	2 167.5
Winnipeg	1	3	27	20	195	12	72	57	2 321.4
Churchill	11	*	7	48	258	19	58	100	1 627.9
Regina	9	1	23	29	204	14	59	58	2 331.1
Saskatoon	*	*	19	25	202	9	57	59	2 449.7
Calgary	6	3	25	22	201	5	58	62	2 314.4
Edmonton	*	3	22	17	185	8	70	59	2 283.7
Penticton	*	*	12	1	129	1	78	29	2 032.2
Vancouver	*	*	6	45	55	1	156	15	1 919.6
Prince Rupert	4	8	2	37	107	0	218	35	1 224.1
Alert	10	0	0	46	338	5	10	93	1 767.4
Inuvik	*	*	1	24	267	6	36	99	1 898.8
Yellowknife	*	*	5	21	226	13	46	82	2 276.6
Whitehorse	*	*	6	16	224	1	52	120	1 843.8
Resolute	25	0	*	62	324	13	20	62	1 505.1

Source:
Environment Canada. *The Climates of Canada*. David Phillips. Supply and Services Canada. Ottawa, 1990.
Environment Canada, Atmospheric Environment Service. *Canadian Climate Normals*.
Environment Canada, Atmospheric Environment Service. *Principal Station Data*.

Notes:
* denotes a value less than 0.5 (but not zero).
[1] Average, mean or normal refer to the value of the particular element averaged over the period from 1951-1980.
[2] A "day with" is counted once per day regardless of the number of individual occurrences of that phenomenon that day.
[3] Bright sunshine is reported in hours and tenths.
[4] Hail is a piece of ice with a diameter of 5mm or more.
[5] Thunder is reported when thunder is heard or lightning or hail is seen.
[6] Fog is a suspension of small water droplets in air that reduces the horizontal visibility at eye level to less than 1 kilometre.
[7] Freezing temperature is a temperature below 0.0°C.
[8] Freezing precipitation is rain or drizzle of any quantity, that freezes on impact.
[9] Rain is a measurable amount of liquid water (rain, showers, or drizzle) equal to or greater than 0.2 mm.
[10] Snow is a measurable amount of solid precipitation (snow, snow grains, ice crystals, or ice and snow pellets) equal to or greater than 0.2 cm.

Table: 4.2.2.4

Annual Degree-Days, Humidity, Wind and Precipitation for Selected Weather Stations

Station	Degree-Days (°C)[1]			Humidity	Wind	Precipitation		
	Heating (<18°C)	Cooling (>18°C)	Growing (>5°C)	Vapour pressure	Average speed[2]	Average rainfall	Average snowfall[3]	Total[4]
				kPa	km/hr	mm	cm	mm
Goose Bay	6 585.2	43.5	1 021.9	0.6	15.8	529.0	445.2	946.1
St. John's	4 824.4	29.1	1 196.1	0.8	24.3	1 157.3	359.4	1 513.6
Charlottetown	4 688.6	88.6	1 625.9	0.9	19.3	841.1	330.6	1 169.4
Halifax	4 424.7	88.0	1 693.8	0.9	18.2	1 223.8	271.0	1 490.6
Saint John	4 768.1	31.9	1 499.4	0.8	18.5	1 152.0	292.7	1 444.4
Kuujjuaq	8 560.7	5.5	509.1	0.5	16.2	263.5	245.2	504.2
Kuujjuarapik	8 160.1	11.2	548.4	0.5	18.3	401.3	241.2	636.9
Québec	5 165.2	122.9	1 689.7	0.8	16.0	836.4	343.4	1 174.0
Sept-Îles	6 154.0	10.6	1 015.6	0.7	17.3	710.7	426.9	1 124.9
Montréal	4 537.5	250.8	2 112.9	0.9	15.6	722.9	235.1	946.2
Ottawa	4 690.9	230.0	2 043.2	0.8	14.6	662.9	227.3	879.3
Thunder Bay	5 767.9	66.2	1 425.4	0.7	13.4	527.3	213.0	711.8
Toronto	4 143.8	246.0	2 126.8	0.9	15.4	637.2	131.2	761.5
Windsor	3 622.4	391.4	2 533.3	1.0	17.0	737.5	117.4	848.8
The Pas	6 831.4	72.3	1 361.2	0.6	15.4	315.0	170.0	453.7
Winnipeg	5 923.1	178.4	1 784.9	0.7	18.6	411.0	125.5	525.5
Churchill	9 189.9	14.3	554.6	0.5	22.7	221.1	195.5	402.3
Regina	5 876.6	136.5	1 677.2	0.7	20.8	287.2	115.7	384.0
Saskatoon	6 062.9	111.4	1 619.9	0.6	17.5	245.0	113.1	348.8
Calgary	5 365.0	38.1	1 387.2	0.6	16.2	300.0	152.5	423.8
Edmonton	5 483.0	69.7	1 560.4	0.6	14.1	345.6	135.7	466.1
Penticton	3 501.6	190.3	2 135.7	0.8	12.7	217.7	76.0	282.9
Vancouver	3 030.7	36.3	1 993.7	1.0	12.0	1 055.4	60.4	1 112.6
Prince Rupert	4 110.4	0.5	1 148.2	0.9	14.8	2 369.0	151.7	2 523.2
Alert	13 186.4	0.0	33.1	n/a	8.2	17.5	148.1	154.4
Inuvik	10 101.4	17.6	665.2	0.4	10.2	114.6	176.6	266.1
Yellowknife	8 529.6	28.2	1 027.1	0.5	15.5	150.2	135.4	266.7
Whitehorse	6 988.4	6.2	897.2	0.5	14.1	145.5	136.6	261.1
Resolute	12 593.8	0.0	33.0	0.3	21.5	52.7	83.8	131.4

Source:

Environment Canada. *The Climates of Canada*. David Phillips. Supply and Services Canada. Ottawa, 1990.

Environment Canada, Atmospheric Environment Service. *Canadian Climate Normals*.

Environment Canada, Atmospheric Environment Service. *Principal Station Data*.

Notes:

[1] Each degree of mean temperature below 18°C is counted as one heating degree-day; above 18°C, one cooling degree-day; and above 5°C, one growing degree-day.

[2] Average speed is the average of all winds and calms.

[3] Average snow on ground is for the last day of the month.

[4] Total precipitation is the total water equivalent of snowfall and rainfall.

Table: 4.2.2.5

Average Frost, Climatic Extremes and Climate Severity for Selected Weather Stations

Station	Average frost[1]			Record climatic extremes[2]			Climate severity[3]				
	Last frost (spring)	First frost (fall)	Frost-Free period	Wettest month (mm)	Highest temperature (°C)	Lowest temperature (°C)	Discom-fort factor	Psycho-logical factor	Hazard factor	Mobility factor	**Index (CSI)**
			days								
Goose Bay	June 1	Sept 18	104	Aug 1953 (230.1)	July 4, 1944 (37.8°)	Feb 17, 1973 (-39.4°)	49	32	32	59	**58**
St. John's	May 1	Oct 11	131	Dec 1909 (356.9)	July 7, 1949 (30.6°)	Feb 24, 1961 (-27.2°)	29	53	48	94	**59**
Charlottetown	May 16	Oct 15	151	Sept 1942 (315.0)	Aug 12, 1944 (34.4°)	Jan 18, 1982(-30.5°)	34	30	35	60	**48**
Halifax	May 12	Oct 15	155	Aug 1971 (387.1)	Aug 22, 1976 (34.4°)	Feb 4, 1971 (-26.1°)	31	36	25	74	**47**
Saint John	May 16	Oct 3	139	July 1950 (317.5)	Aug 22, 1976 (34.4°)	Feb 11, 1948 (-36.7°)	33	35	31	64	**48**
Kuujjuaq	June 27	Sept 2	66	Aug 1978 (139.3)	July 14, 1953 (32.2°)	Jan 15, 1957 (-46.7°)	63	31	34	35	**64**
Kuujjuarapik	June 25	Sept 11	77	July 1953 (189.2)	Sept 1, 1930 (33.9°)	Jan 14, 1957 (-49.4°)	63	39	42	45	**70**
Québec	May 13	Sept 28	137	Dec 1973 (239.0)	July 30, 1959 (35.6°)	Feb 2, 1962 (-38.1°)	38	29	40	60	**52**
Sept-Îles	May 27	Sept 19	114	Nov 1950 (252.0)	July 10, 1955 (32.2°)	Jan 21, 1950 (-43.3°)	49	23	43	51	**57**
Montréal	May 3	Oct 8	157	Sept 1975 (227.6)	Aug 1, 1975 (37.6°)	Jan 15, 1957 (-37.8°)	35	25	27	47	**43**
Ottawa	May 7	Oct 2	147	July 1972 (186.4)	Aug 14, 1944 (37.8°)	Feb 15, 1943 (-36.1°)	37	24	21	52	**44**
Thunder Bay	May 30	Sept 12	104	Sept 1977 (284.2)	Aug 7, 1983 (40.3°)	Jan 30, 1951 (-41.1°)	44	16	22	33	**44**
Toronto	May 8	Oct 5	149	Oct 1954 (213.9)	Aug 25, 1948 (38.3°)	Jan 4, 1981 (-31.3°)	31	20	19	40	**36**
Windsor	Apr 26	Oct 21	177	Sept 1981 (246.1)	July 27, 1941 (38.3°)	Jan 24, 1963 (-26.1°)	29	23	26	34	**37**
The Pas	May 27	Sept 19	114	June 1976 (169.4)	July 20, 1955 (36.7°)	Feb 18, 1966 (-49.4°)	58	11	24	28	**52**
Winnipeg	May 23	Sept 22	121	July 1953 (197.4)	Aug 7, 1949 (40.6°)	Feb 18, 1966 (-45.0°)	56	9	29	26	**51**
Churchill	June 24	Sept 9	76	June 1960 (135.1)	July 4, 1975 (33.9°)	Feb 13, 1979 (-45.4°)	74	26	66	58	**82**
Regina	May 24	Sept 11	109	July 1901 (207.0)	July 5, 1937 (43.3°)	Jan 1, 1885 (-50.0°)	49	6	41	29	**49**
Saskatoon	May 21	Sept 16	117	June 1942 (186.4)	July 30, 1946 (40.0°)	Feb 1, 1893 (-50.0°)	47	4	23	25	**42**
Calgary	May 25	Sept 15	112	July 1927 (245.4)	July 25, 1933 (36.1°)	Feb 4, 1893 (-45.0°)	35	6	25	22	**35**
Edmonton	May 6	Sept 24	140	July 1953 (190.8)	June 3, 1970 (34.4°)	Dec 28, 1938 (-48.3°)	48	8	20	27	**43**
Penticton	May 8	Oct 4	148	Aug 1976 (86.1)	July 17, 1941 (40.6°)	Dec 30, 1968 (-27.2°)	13	8	19	2	**16**
Vancouver	Mar 31	Nov 3	216	Nov 1983 (350.8)	Aug 9, 1960 (33.3°)	Dec 29, 1968 (-17.8°)	8	31	5	31	**19**
Prince Rupert	May 11	Oct 15	156	Oct 1974 (728.7)	Aug 14, 1977 (28.7°)	Jan 4, 1965 (-24.4°)	17	57	9	39	**34**
Alert	July 14	July 19	4	Aug 1954 (67.6)	Aug 8, 1956 (20.0°)	Feb 9, 1979 (-50.0°)	85	55	33	30	**84**
Inuvik	June 23	Aug 14	51	Aug 1969 (164.1)	June 21, 1958 (31.7°)	Feb 4, 1968 (-56.7°)	70	34	9	37	**63**
Yellowknife	May 27	Sept 16	111	Aug 1969 (141.4)	July 9, 1964 (32.2°)	Feb 4, 1947 (-51.2°)	66	20	15	30	**57**
Whitehorse	June 8	Aug 30	82	Aug 1974 (103.4)	June 14, 1969 (34.4°)	Jan 31, 1947 (-52.2°)	52	19	13	18	**48**
Resolute	July 10	July 20	9	Aug 1981 (77.4)	July 21, 1962 (18.3°)	Jan 7, 1966 (-52.2°)	85	52	69	42	**95**

Notes:

[1] Average, mean or normal refer to the value of the particular element averaged over the period from 1951-1980.

[2] Extremes are based on the full period of years in which observations have been made, generally to the end of 1985.

[3] The Climate Severity Index describes in a single number, many of the unfavourable aspects of the Canadian climate.

Source:

Environment Canada. *The Climates of Canada*. David Phillips. Supply and Services Canada. Ottawa, 1990.

Environment Canada. *Climate Severity Index for Canadians*. D.W. Phillips and R.B. Crowe. CLI-1-84. Atmospheric Environment Service. Downsview, 1984.

Environment Canada, Atmospheric Environment Service. *Canadian Climate Normals*.

Environment Canada, Atmospheric Environment Service. *Principal Station Data*.

4.3 Harvesting and Extraction

The harvesting and extraction of natural resources generate 6 percent of Canada's Gross Domestic Product. These natural resources sustain much of the country's manufacturing and service industry. Agricultural, forestry, fishery and mining production have generally been increasing over the past decade.

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Canada's wealth of natural resources is important to maintaining our standard of living and a healthy economy. Non-renewable resources, such as fossil fuels, minerals and soil cannot be replaced. Renewable resources, such as agricultural crops, forests, fish and wildlife are living resources and can be regenerated. The concern regarding non-renewable resources is that harvesting may exceed the natural replacement rate.

4.3.1 Land

Canada's agricultural production quadrupled between 1910 and 1988. Forest production increased by 91 percent between 1955 and 1986. The production of crude oil doubled between 1961 and 1989. Natural gas production increased five-fold over the same period. Coal production tripled between 1974 and 1988.

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This section focuses on the harvesting and extraction activities related to land: agriculture, forestry, minerals and energy.

Agricultural Production

Total crop production has more than quadrupled since 1910 (Figures 4.3.1.1 and 4.3.1.2). Many factors have contributed to the rise in agricultural crop production. New technologies such as mechanization, genetic research, nutrient science and irrigation have enabled the agricultural industry to be more productive than ever before. These increases in production do not come without costs to the environment. Nutrient pollution in waterways and land degradation are both direct results of higher production effort.

Forestry Production

Between 1955 and 1985, total forestry production almost doubled from 88 million cubic metres to 168 cubic metres (Figure 4.3.1.4). The area replanted has not kept pace with the area harvested, although the gap appears to be narrowing (Tables 4.3.1.1 and 4.3.1.2, Figure 4.3.1.3) due to improved regeneration rates.

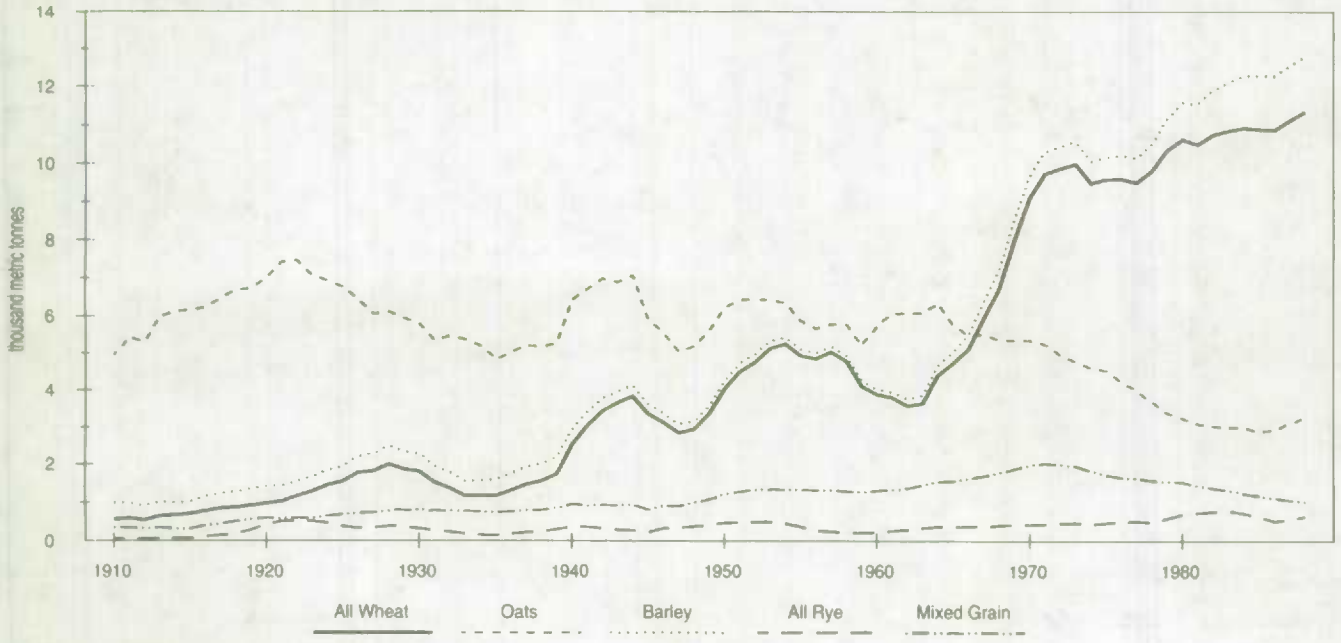
Minerals and Energy Production

Except for asbestos, the production of most minerals has been increasing or stable over the past 16 years (Table 4.3.1.3).

Figure: 4.3.1.1

Selected Grain Crop Production

5-year moving average, 1910-1988

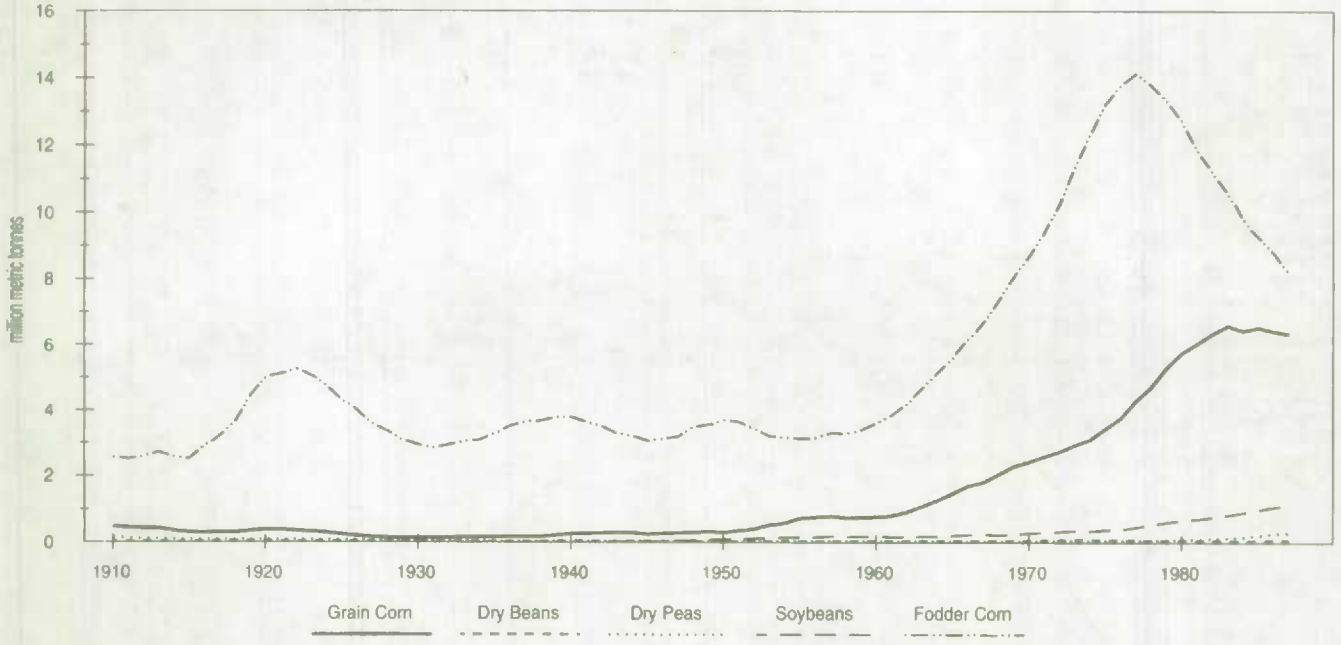


Source: Statistics Canada, Agriculture Division, 1991.

Figure: 4.3.1.2

Selected Field Crop Production

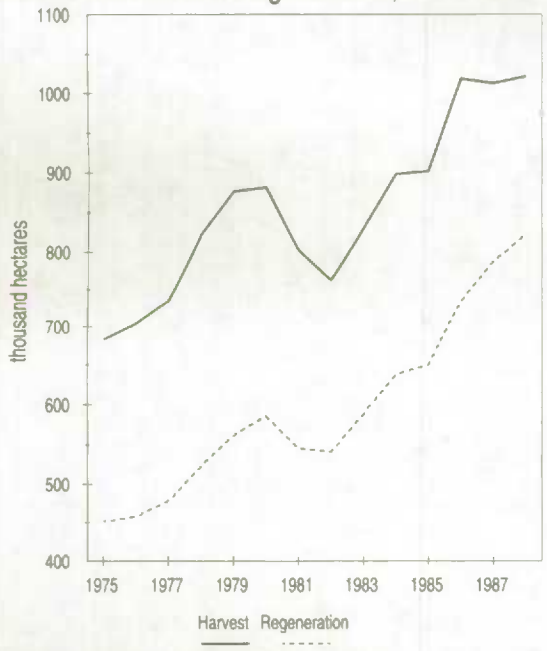
Five-year moving average, 1910-1988



Source: Statistics Canada, Agriculture Divsion, 1991.

Figure: 4.3.1.3

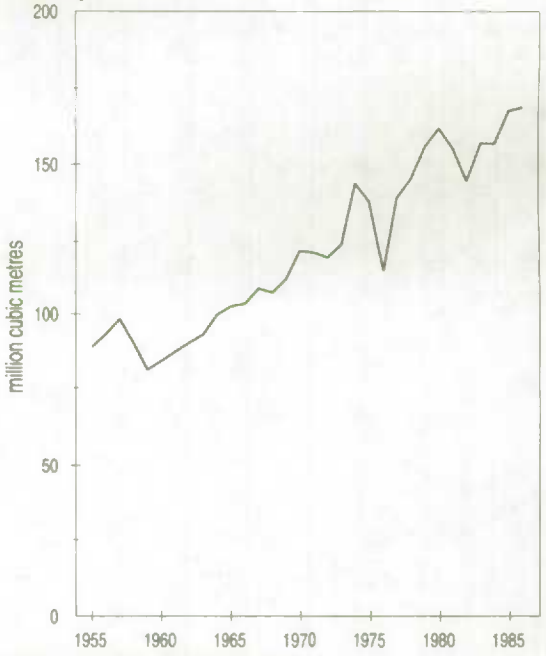
Forest Harvest and Regeneration, 1975-1988



Source: Forestry Canada, The State of Forestry in Canada, 1990.

Figure: 4.3.1.4

Primary Forest Production, 1955-1985



Source: Statistics Canada. Canadian Forestry Statistics. Catalogue 25-202.

Table: 4.3.1.1

Area of Forest Planted, by Province, 1985 to 1988

Province	Forest area planted				Change
	1985	1986	1987	1988	1985-1988
	hectares				percent
Newfoundland	2 762	779	5 057	4 240	53.5
Prince Edward Island	894	530	690	960	7.4
Nova Scotia	6 584	9 137	9 865	11 480	74.4
New Brunswick	19 453	20 517	18 916	19 123	- 1.7
Quebec	39 127	58 480	76 337	99 055	153.2
Ontario	72 084	73 857	73 253	81 025	12.4
Manitoba	4 169	4 146	5 694	6 870	64.8
Saskatchewan	5 276	4 482	3 110	7 020	33.1
Alberta	9 229	14 699	13 279	18 658	102.2
British Columbia	101 442	112 891	164 044	164 860	62.5
Canada	**261 020**	**299 518**	**370 245**	**413 291**	**58.3**

Source:
Forestry Canada, Northern Forestry Centre.
Note:
Not all forest area planted is successfully regenerated into forest.

Table: 4.3.1.2

Areas of Forest Harvested, by Province, 1985-1988

Province	Forest area harvested				
	1985	1986	1987	1988	Change 1985-1988
	hectares				percent
Newfoundland	16 400	16 529	16 617	17 000	3.7
Prince Edward Island	3 200	3 400	3 900	3 900	21.9
Nova Scotia	29 778	33 250	40 750	42 000	41.0
New Brunswick	87 070	85 780	87 547	87 200	0.1
Quebec	266 180	360 000	317 000	315 000	18.3
Ontario	217 984	223 517	228 464	237 188	8.8
Manitoba	15 900	11 128	12 362	12 378	- 22.2
Saskatchewan	19 693	19 358	25 742	22 089	12.2
Alberta	33 825	38 609	39 699	40 000	18.3
British Columbia	210 397	226 464	238 969	244 000	16.0
Yukon	135	299	1 172	465	244.4
Northwest Territories	990	400	672	399	- 59.7
Canada	**901 552**	**1 018 732**	**1 012 894**	**1 021 619**	**13.3**

Source:
Forestry Canada, Northern Forestry Centre.

Table: 4.3.1.3

Mineral Production in Canada, 1974-1990

Year	Cadmium	Cobalt	Copper	Silver	Iron ore	Lead	Mercury[1]
	thousand kg	thousand kg	thousand tonnes	thousand kg	million tonnes	thousand tonnes	thousand kg
1974	1 241	1 564	821	53	47	294	483
1975	1 192	1 354	734	51	45	349	414
1976	1 314	1 356	731	53	55	258	-
1977	1 185	1 485	759	54	54	281	-
1978	1 151	1 234	659	54	43	320	-
1979	1 209	1 640	636	51	60	311	-
1980	1 033	2 118	716	51	49	252	-
1981	834	2 080	722	52	50	269	-
1982	886	1 274	739	65	33	272	-
1983	1 107	1 410	698	74	33	272	-
1984	1 605	2 123	794	83	40	264	-
1985	1 717	2 676	739	88	40	268	-
1986	1 484	2 297	699	103	36	334	-
1987	1 481	2 490	794	116	38	373	-
1988	1 664	2 398	758	135	40	351	-
1989	1 711	2 344	704	159	39	269	-
1990	1 643	2 291	780	165	36	224	-

Year	Molybdenum	Nickel	Uranium	Zinc	Gold	Asbestos	Potash (K_2O)
	thousand tonnes	thousand tonnes	thousand kg	thousand tonnes	thousand kg	thousand tonnes	thousand tonnes
1974	14	269	5 124	1 127	1 331	1 644	5 480
1975	13	242	6 499	1 055	1 235	1 056	5 436
1976	15	241	7 554	982	1 281	1 538	4 996
1977	17	233	8 038	1 071	1 314	1 517	6 089
1978	14	126	8 211	1 067	1 267	1 422	6 110
1979	11	127	6 530	1 100	1 147	1 493	6 705
1980	12	185	6 739	884	1 070	1 323	7 303
1981	13	160	7 507	911	1 129	1 122	7 147
1982	14	89	8 080	966	1 314	834	5 352
1983	10	125	7 140	988	1 197	857	5 929
1984	12	174	11 170	1 063	1 327	837	7 794
1985	8	170	10 880	1 049	1 197	750	8 694
1986	11	164	11 720	988	1 088	662	6 678
1987	15	189	12 440	1 158	1 375	664	7 399
1988	13	199	12 066	1 370	1 443	710	8 154
1989	14	196	10 995	1 273	1 312	701	7 014
1990	13	197	9 458	1 285	1 400	665	7 015

Source:
Energy, Mines and Resources Canada. *Canadian Mineral Yearbook.*
Statistics Canada. *General Review of the Mineral Industries, Mines, Quarries and Oil Wells.* Catalogue 26-201.
Notes:
[1] There has been no mercury production since July, 1975; mercuric chloride is recovered from SO_2 gas in B.C.

4.3.2 Fish and Wildlife Harvesting

The harvesting of wildlife, fish and fur-bearing mammals, is only one of many pressures on natural populations. The long-term sustainability of some species may be threatened by this as well as by pollution, climate change and the destruction of their habitats.

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Fisheries

Canadian fish stocks are currently managed by establishing annual total allowable catch (TAC) quotas for most species. The concept of the TAC was applied and refined during the 1970s because of increases in fishing pressure that occurred during the 1960s[51]. TAC's are based on projections prepared by fishery scientists using the most recent assessment for each species. In practice, stocks vary from year to year because of the number of fish reaching maturity, changes in the growth and mortality of the fish, annual fluctuations in migration routes and losses to predation.

Data presented in this section show trends in catch of major fish species for the Atlantic and Pacific fisheries. Data are also presented for Atlantic shellfish, lobster landings and catch of freshwater fish.

For most species in the Atlantic fishery, landings peaked in the mid 1960s and early 1970s followed by close adherence to the TAC once it was implemented in the mid to late 1970s when Canada assumed responsibility for managing stocks within the 200 mile limit (Tables 4.3.2.1 through 4.3.2.4, Figures 4.3.2.1 through 4.3.2.15).

The peak in Atlantic salmon catch during the early 1970's was followed by a decline through the 1980's (Table 4.3.2.4, Figure 4.3.2.15). A new management plan implemented in 1984 is assisting the recovery of salmon stock levels in the Atlantic[52].

The catch of shrimp increased dramatically after the mid 1960s mainly owing to the expansion of fisheries into new areas and the full exploitation of existing stocks.

Landings of scallops has remained steady. Recent increases are the result of settling a boundary dispute with the USA concerning Georges Bank.

Snow crab catch peaked in the early 1980s and has decreased steadily since (Table 4.3.1.7, Figure 4.3.2.17).

The decline of the lobster catch in the early 1900s was due to overfishing of the lobster stock. The dip in the early 1970s was followed by a gradual increase owing to higher proportions of young lobsters reaching maturity and improved control of fishing effort (Table 4.3.2.6, Figure 4.3.2.16).

In the northeast Pacific, most landings exhibit a gradual increase after 1980. However hake landings fluctuated over the years 1984 to 1986 and continued to increase because of increased fishing effort (Tables 4.3.2.9 and 4.3.1.10, Figures 4.3.2.18 through 4.3.2.20).

In 1988, the Atlantic region accounted for 73 percent of total catch. The Pacific region accounted for 23 percent and the inland fishery, 4 percent (Table 4.3.2.11). Data on the commercial freshwater fish catch is presented in Table 4.3.2.12.

Commercial Hunting and Trapping

In Canada, the fur harvest has been a traditional source of livelihood since the early settlement days. Figures 4.3.2.21 through 4.3.2.23 show variation in value and numbers of beaver, marten, and muskrat pelts harvested. The changing demand for furs owing to fashion and the prevailing public attitude towards fur clothing may be seen. Table 4.3.2.13 presents provincial data for animal pelts harvested. Quebec, Ontario and Alberta are the main producers of pelts in Canada.

51. Department of Fisheries and Oceans, 1988. *Resource Prospects for Canadas Atlantic Fisheries 1989-1993.* Edited by D. Rivard, W.D. McKone and R.W. Elner. Supply and Services Canada. Ottawa, Canada.

52. *Ibid.*

Table: 4.3.2.1

Total Allowable Catch and Landings, Atlantic, 1960-1990

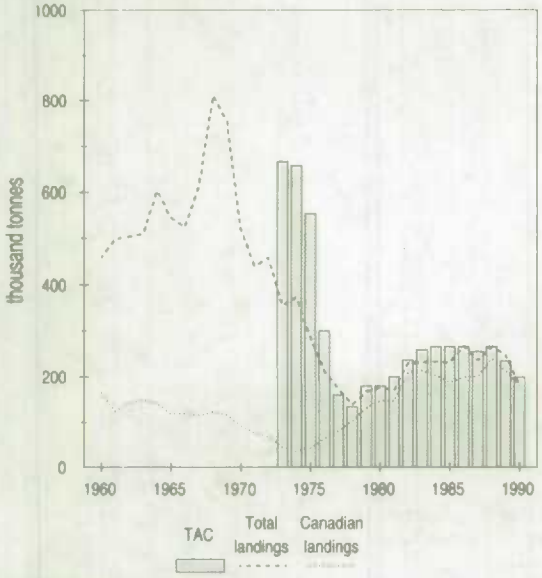
Year	Northern Cod			St. Pierre Bank Cod			Total Cod			Haddock		
		Landings			Landings			Landings			Landings	
	TAC	Total	Canadian	TAC	Total	Canadian	TAC	Total	Canadian	TAC	Total	Canadian
	thousand tonnes											
1960	..	459	165	..	73	47	..	861	335	..	90	31
1961	..	498	124	..	84	39	..	943	304	..	97	33
1962	..	503	143	..	53	48	..	879	336	..	96	32
1963	..	509	149	..	52	33	..	937	336	..	110	38
1964	..	603	142	..	57	26	..	1 047	315	..	129	49
1965	..	545	118	..	52	30	..	1 097	313	..	240	47
1966	..	524	119	..	66	30	..	1 107	309	..	193	59
1967	..	612	115	..	63	31	..	1 247	283	..	108	54
1968	..	810	123	..	78	30	..	1 477	323	..	89	48
1969	..	754	116	..	64	25	..	1 270	293	..	86	41
1970	..	520	91	..	77	30	..	1 040	263	..	40	24
1971	..	440	75	..	62	36	..	927	244	..	43	28
1972	..	458	67	..	44	23	..	920	220	19	26	17
1973	666	355	44	71	53	25	937	739	178	19	23	18
1974	657	373	36	70	47	20	1 056	735	156	0	20	14
1975	554	288	42	62	35	15	924	580	152	15	27	19
1976	300	214	63	47	37	23	614	479	193	23	24	18
1977	160	173	80	32	32	29	351	418	235	23	38	26
1978	135	139	102	25	27	22	342	427	289	23	61	43
1979	180	167	131	25	33	27	463	511	369	28	52	33
1980	180	176	148	28	38	33	485	537	418	76	79	53
1981	200	171	147	30	39	31	516	555	431	84	62	56
1982	237	230	208	33	34	27	607	642	510	88	57	45
1983	260	232	214	33	38	29	657	616	504	79	54	39
1984	266	233	203	33	37	26	669	594	470	67	42	31
1985	268	231	187	41	51	33	662	609	471	35	37	30
1986	268	267	199	41	58	32	616	646	467	37	39	35
1987	258	236	200	41	58	33	571	572	463	27	26	22
1988	266	266	240	41	43	25	562	554	474	24	23	21
1989[1]	235	249	213	35	28	28	509	533	479	20	19	10
1990[1]	199	180	180	35	23	23	439	457	348	11	28	16

Source:
Fisheries and Oceans Canada, Biological Sciences Directorate.
Note:
[1] 1989-90 figures are preliminary.

Figure: 4.3.2.1

Northern Cod TAC and Landings

Atlantic Region, 1960-1990

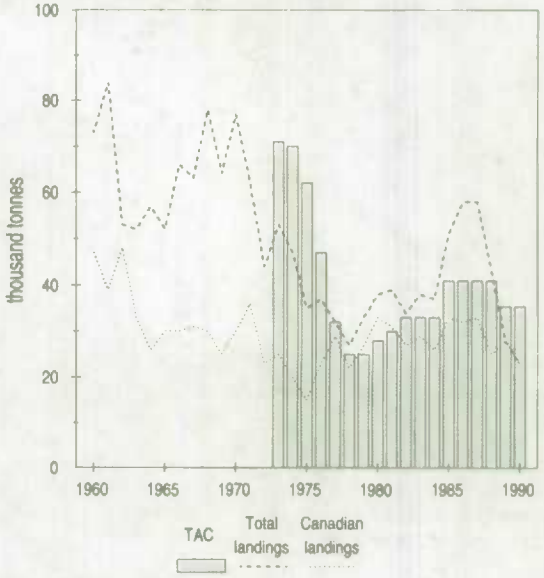


Note: 1989-90 values are preliminary.
Source: Fisheries and Oceans Canada

Figure: 4.3.2.2

St. Pierre Bank Cod TAC and Landings

Atlantic Region, 1960-1990

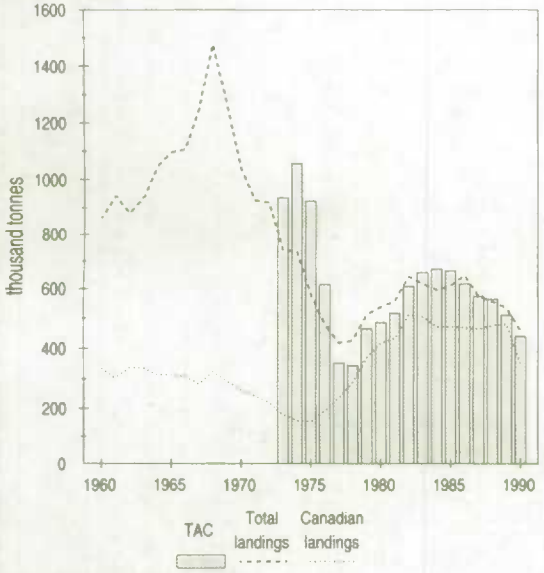


Note: 1989-90 values are preliminary.
Source: Fisheries and Oceans Canada

Figure: 4.3.2.3

Total Cod TAC and Landings

Atlantic Region, 1960-1990

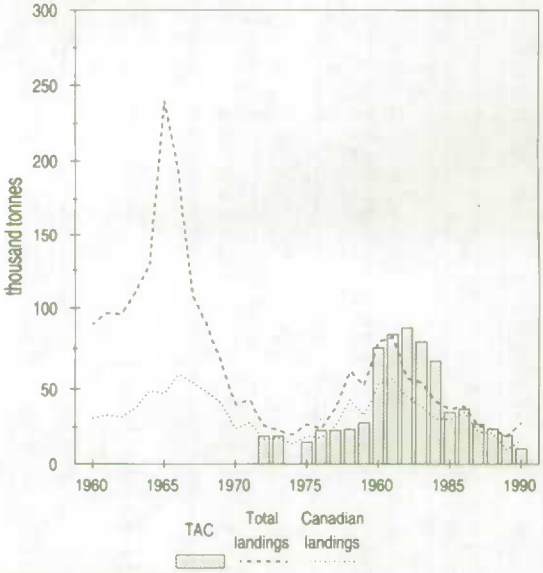


Note: 1989-90 values are preliminary.
Source: Fisheries and Oceans Canada.

Figure: 4.3.2.4

Haddock TAC and Landings

Atlantic Region, 1960-1990

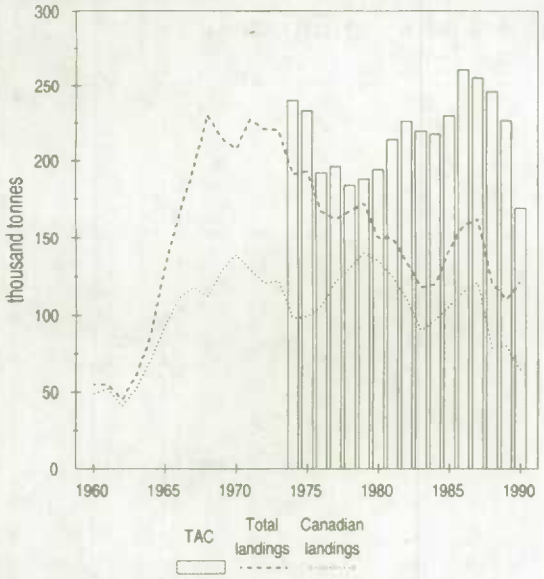


Note: 1989-90 values are preliminary.
Source: Fisheries and Oceans Canada

Figure: 4.3.2.5

Flatfish TAC and Landings

Atlantic Region, 1960-1990

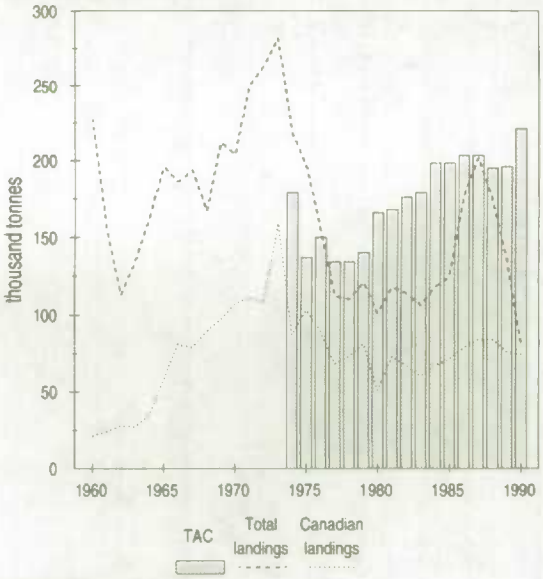


Note: 1989-90 values are preliminary.
Source: Fisheries and Oceans Canada

Figure: 4.3.2.6

Redfish TAC and Landings

Atlantic Region, 1960-1990



Note: 1989-90 values are preliminary.
Source: Fisheries and Oceans Canada

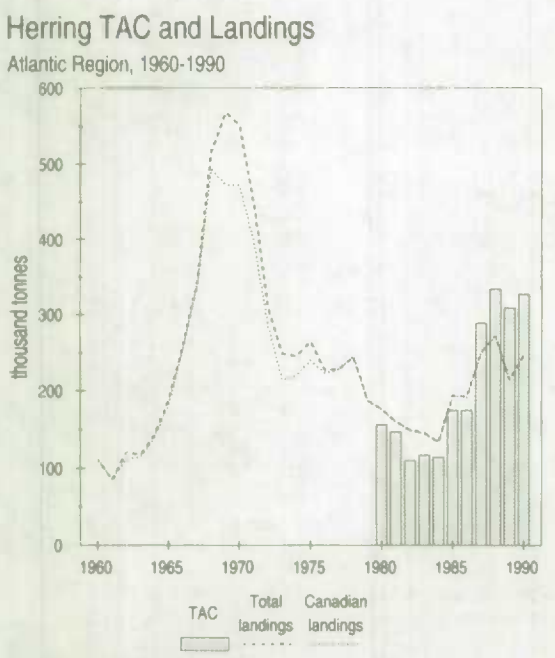
Table: 4.3.2.2

Total Allowable Catch and Landings, Atlantic, 1960-1990

Year	Flatfish			Redfish			Herring			Capelin		
		Landings			Landings			Landings			Landings	
	TAC	Total	Canadian	TAC	Total	Canadian	TAC	Total	Canadian	TAC	Total	Canadian
	thousand tonnes											
1960	..	55	49	..	227	21	..	111	111	..	0	..
1961	..	55	52	..	155	24	..	85	85	..	0	..
1962	..	45	41	..	113	28	..	121	112	..	0	..
1963	..	61	52	..	134	27	..	117	114	..	4	4
1964	..	87	71	..	163	35	..	143	140	..	4	4
1965	..	131	93	..	196	58	..	189	183	..	4	4
1966	..	164	111	..	186	81	..	259	256	..	4	4
1967	..	194	118	..	194	79	..	339	338	..	3	3
1968	..	230	112	..	167	89	..	516	493	..	2	2
1969	..	215	129	..	212	97	..	568	473	..	2	2
1970	..	208	139	..	204	107	..	551	472	..	3	3
1971	..	227	129	..	250	111	..	449	397	..	2	1
1972	..	221	121	..	263	108	..	309	285	..	68	1
1973	..	220	122	..	282	159	..	249	214	..	267	5
1974	240	191	98	179	218	67	..	246	220	258	285	13
1975	233	193	99	137	196	103	..	265	240	340	364	3
1976	192	167	106	150	154	89	..	227	223	340	360	9
1977	198	162	122	134	112	68	..	229	228	412	226	7
1978	184	167	130	134	110	73	..	245	245	412	85	9
1979	188	172	140	140	121	81	..	188	187	85	24	13
1980	194	150	135	166	101	51	156	176	176	51	28	16
1981	214	150	125	168	118	73	147	160	160	70	41	26
1982	226	134	110	176	114	67	110	149	149	73	42	31
1983	220	118	90	179	106	60	117	146	145	81	41	29
1984	218	120	97	199	116	67	115	134	134	82	60	41
1985	230	142	106	199	124	71	175	194	194	82	52	34
1986	260	158	115	204	177	79	175	192	192	123	83	66
1987	255	162	121	204	202	84	289	251	251	106	62	29
1988	245	121	79	195	175	84	333	272	272	128	112	88
1989[1]	228	110	80	196	136	76	308	215	213	131	110	83
1990[1]	169	121	64	221	81	74	326	247	..	..	..	..

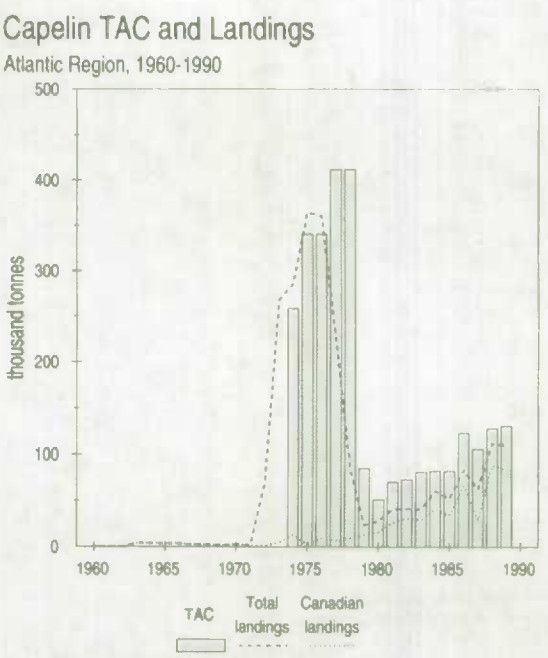
Source:
Fisheries and Oceans Canada, Biological Sciences Directorate.
Note:
[1] 1989-90 figures are preliminary.

Figure: 4.3.2.7



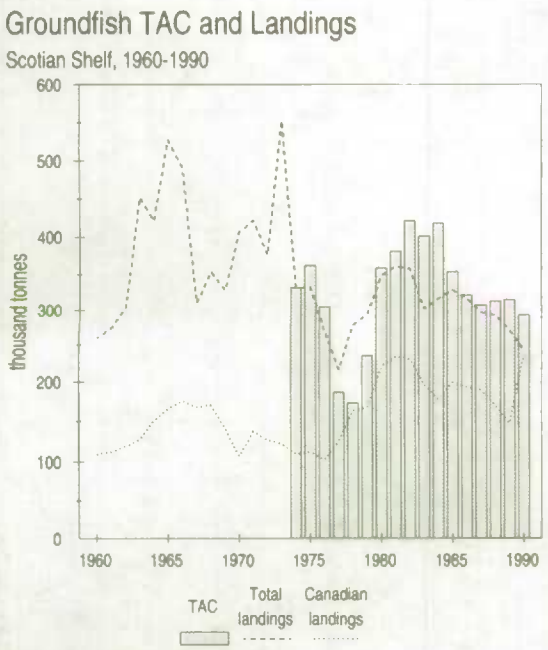
Note: 1989-90 values are preliminary.
Source: Fisheries and Oceans Canada

Figure: 4.3.2.8



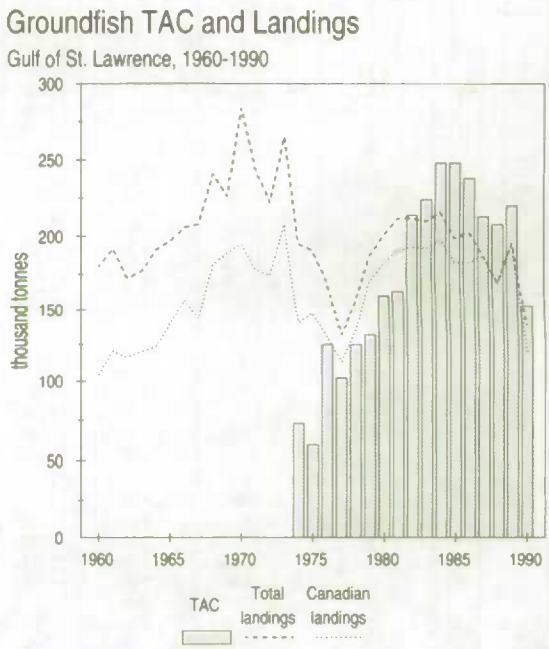
Note: 1989-90 values are preliminary.
Source: Fisheries and Oceans Canada.

Figure: 4.3.2.9



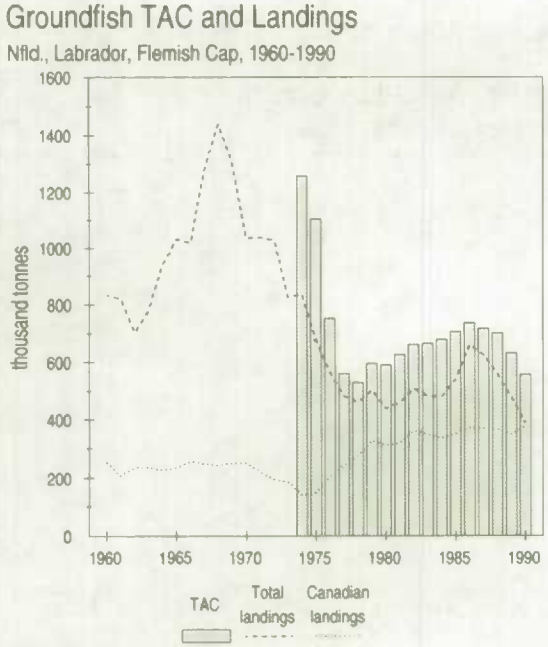
Notes: 1989-90 values are preliminary.
Source: Fisheries and Oceans Canada.

Figure: 4.3.2.10



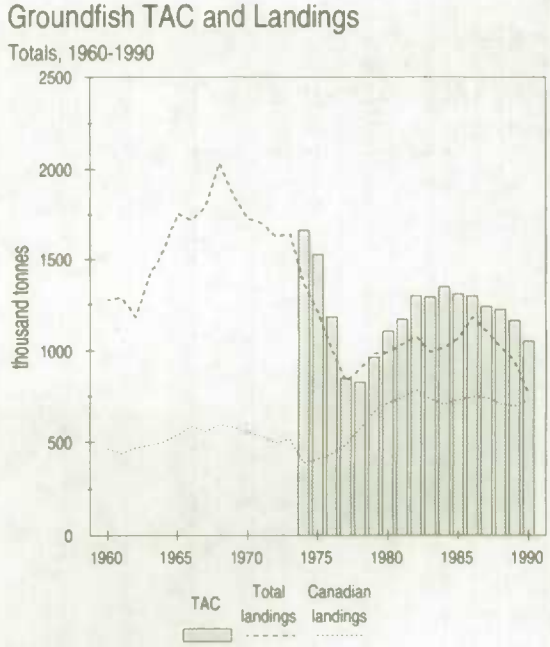
Note: 1989-90 values are preliminary.
Source: Fisheries and Oceans Canada.

Figure: 4.3.2.11



Note: 1989-90 values are preliminary.
Source: Fisheries and Oceans Canada.

Figure: 4.3.2.12



Note: 1989-90 values are preliminary.
Source: Fisheries and Oceans Canada.

Table: 4.3.2.3

Total Allowable Catch and Landings, Atlantic, 1960-1990

Year	Groundfish(Scotian Shelf)			Groundfish(Gulf)			Groundfish(Nfld and Lab.)			Groundfish(Total)		
		Landings			Landings			Landings			Landings	
	TAC	Total	Canadian	TAC	Total	Canadian	TAC	Total	Canadian	TAC	Total	Canadian
	thousand tonnes											
1960	..	260	109	..	180	104	..	833	253	..	1 273	466
1961	..	274	112	..	192	120	..	821	207	..	1 287	439
1962	..	304	119	..	172	116	..	705	234	..	1 181	469
1963	..	452	127	..	177	120	..	781	235	..	1 411	482
1964	..	421	150	..	191	123	..	941	227	..	1 553	500
1965	..	527	165	..	197	140	..	1 032	234	..	1 756	538
1966	..	491	175	..	206	157	..	1 020	255	..	1 717	587
1967	..	311	167	..	208	144	..	1 279	248	..	1 798	559
1968	..	354	170	..	241	181	..	1 440	243	..	2 036	595
1969	..	329	141	..	226	189	..	1 306	251	..	1 861	582
1970	..	407	107	..	284	195	..	1 036	251	..	1 727	553
1971	..	422	137	..	243	178	..	1 038	220	..	1 702	535
1972	..	376	127	..	222	174	..	1 029	195	..	1 626	495
1973	..	552	122	..	265	208	..	826	186	..	1 642	515
1974	332	332	109	73	195	141	1 257	836	139	1 662	1 363	389
1975	382	333	112	60	191	148	1 104	682	148	1 526	1 206	408
1976	305	271	102	125	170	130	753	562	205	1 183	1 003	437
1977	186	216	126	102	132	113	561	483	244	848	831	483
1978	172	278	163	125	156	135	530	462	276	827	895	573
1979	235	294	167	132	187	170	596	504	327	963	985	664
1980	359	349	220	160	201	182	590	439	311	1 108	989	714
1981	381	361	234	163	212	191	627	461	318	1 170	1 035	743
1982	421	358	230	214	212	193	663	509	362	1 299	1 079	785
1983	401	302	196	224	210	192	666	482	349	1 291	994	737
1984	418	317	177	248	216	198	680	483	334	1 346	1 016	709
1985	354	329	199	248	199	183	707	540	351	1 309	1 068	733
1986	322	317	193	238	203	183	738	662	373	1 298	1 182	749
1987	307	297	189	213	187	187	719	626	370	1 239	1 110	746
1988	313	293	169	208	169	169	703	558	367	1 224	1 020	709
1989[1]	315	271	147	220	196	196	632	479	348	1 164	946	698
1990[1]	293	242	236	153	139	120	557	386	376	1 052	787	734

Source:
Fisheries and Oceans Canada, Biological Sciences Directorate.
Note:
[1] 1989-90 figures are preliminary.

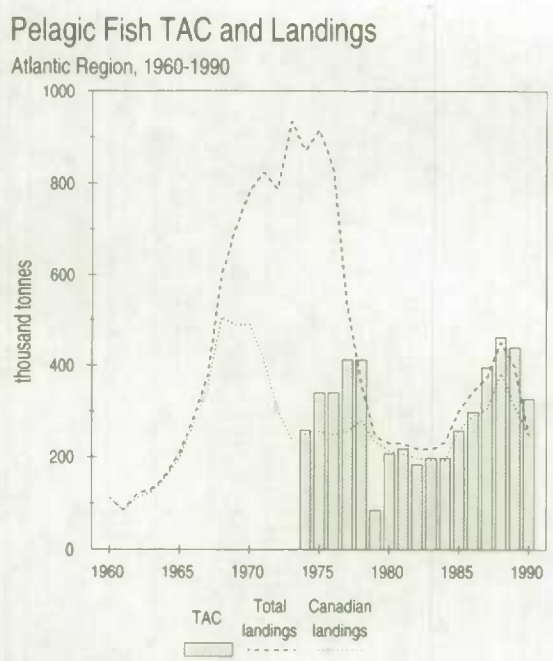
Table: 4.3.2.4

Total Allowable Catch and Landings, Atlantic, 1960-1990

Year	Pelagic Fish			Finfish[1]		
		Landings			Landings	
	TAC	Total	Canadian	TAC	Total	Canadian
	thousand tonnes					
1960	..	111	111	..	1 384	577
1961	..	85	85	..	1 372	524
1962	..	121	112	..	1 302	581
1963	..	130	125	..	1 541	607
1964	..	160	155	..	1 713	654
1965	..	209	198	..	1 965	736
1966	..	285	271	..	2 002	858
1967	..	376	352	..	2 173	911
1968	..	599	506	..	2 635	1 101
1969	..	702	488	..	2 563	1 070
1970	..	784	490	..	2 511	1 043
1971	..	824	413	..	2 526	948
1972	..	787	303	13	2 413	798
1973	..	935	240	174	2 577	755
1974	258	871	250	1 753	2 234	639
1975	340	916	256	1 669	2 122	664
1976	340	829	248	1 313	1 832	685
1977	412	533	256	1 121	1,364	739
1978	412	357	279	1 106	1 253	852
1979	85	244	231	875	1 229	894
1980	207	230	214	1 075	1 218	928
1981	217	229	206	1 160	1 263	949
1982	183	217	197	1 243	1 297	982
1983	198	216	194	1 280	1 209	931
1984	197	232	192	1 312	1 248	901
1985	257	301	258	1 369	1 369	992
1986	298	342	289	1 414	1 524	1 038
1987	395	373	304	1 449	1 483	1 051
1988	461	451	383	1 485	1 471	1 092
1989[2]	439	396	311	1 392	1 342	1 009
1990[2]	326	247	247	1 183	1 014	981

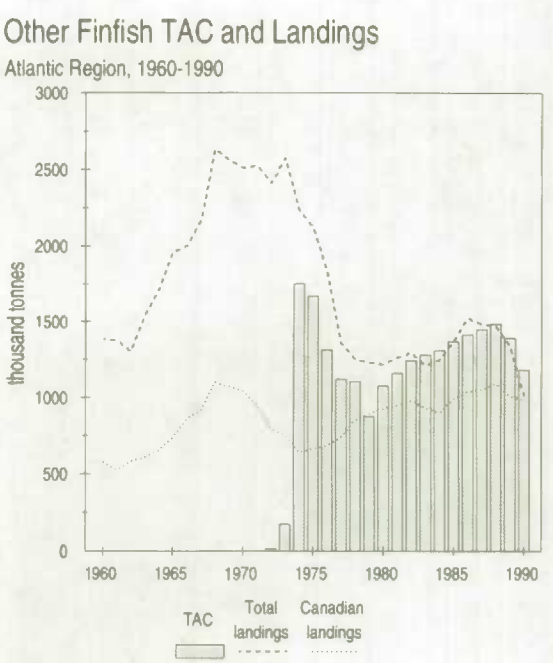
Source:
Fisheries and Oceans Canada, Biological Sciences Directorate.
Notes:
[1] Finfish does not include salmon.
[2] 1989-90 figures are preliminary.

Figure: 4.3.2.13



Note: 1989-90 values are preliminary.
Source: Fisheries and Oceans Canada.

Figure: 4.3.2.14



Note: 1989-90 values are preliminary.
Source: Fisheries and Oceans Canada.

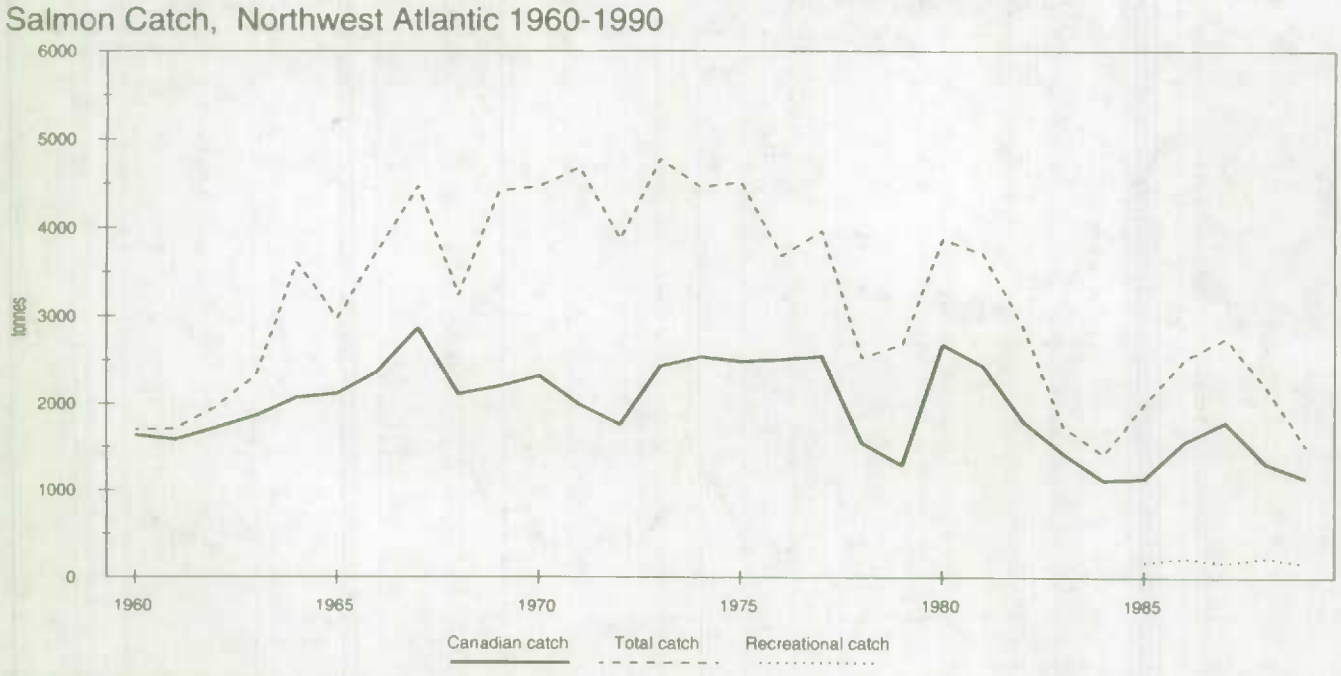
Table: 4.3.2.5

Catch of Salmon in the Northwest Atlantic, 1960 to 1990

Year	Canadian catch	Non-Canadian catch	Total catch[1]	Recreational catch[3]
	tonnes			
1960	1 636	60	1 696	..
1961	1 583	127	1 710	..
1962	1 719	244	1 963	..
1963	1 861	468	2 327	..
1964	2 069	1 539	3 608	..
1965	2 116	861	2 977	..
1966	2 369	1 370	3 739	..
1967	2 863	1 606	4 469	..
1968	2 111	1 127	3 238	..
1969	2 202	2 210	4 412	..
1970	2 323	2 146	4 469	..
1971	1 992	2 689	4 681	..
1972	1 759	2 113	3 872	..
1973	2 434	2 341	4 775	..
1974	2 539	1 917	4 456	..
1975	2 485	2 030	4 515	..
1976	2 506	1 175	3 681	..
1977	2 545	1 420	3 965	..
1978	1 545	984	2 529	..
1979	1 287	1 395	2 682	..
1980	2 680	1 194	3 874	..
1981	2 437	1 264	3 701	..
1982	1 798	1 077	2 875	..
1983	1 424	310	1 734	..
1984	1 112	297	1 409	..
1985	1 133	864	1 997	171
1986	1 559	960	2 519	222
1987	1 784	966	2 750	169
1988	1 311	893	2 204	222
1989[2]	1 139	364	1 503	159

Source:
Fisheries and Oceans Canada, Biological Sciences Directorate.
Notes:
[1] Canada, Denmark (Greenland and Faroe Islands) and Norway.
[2] 1989 figures are preliminary.
[3] Recreational catch values are included in Canadian catch.

Figure: 4.3.2.15



Note: 1989 values are preliminary.
Source: Fisheries and Oceans Canada.

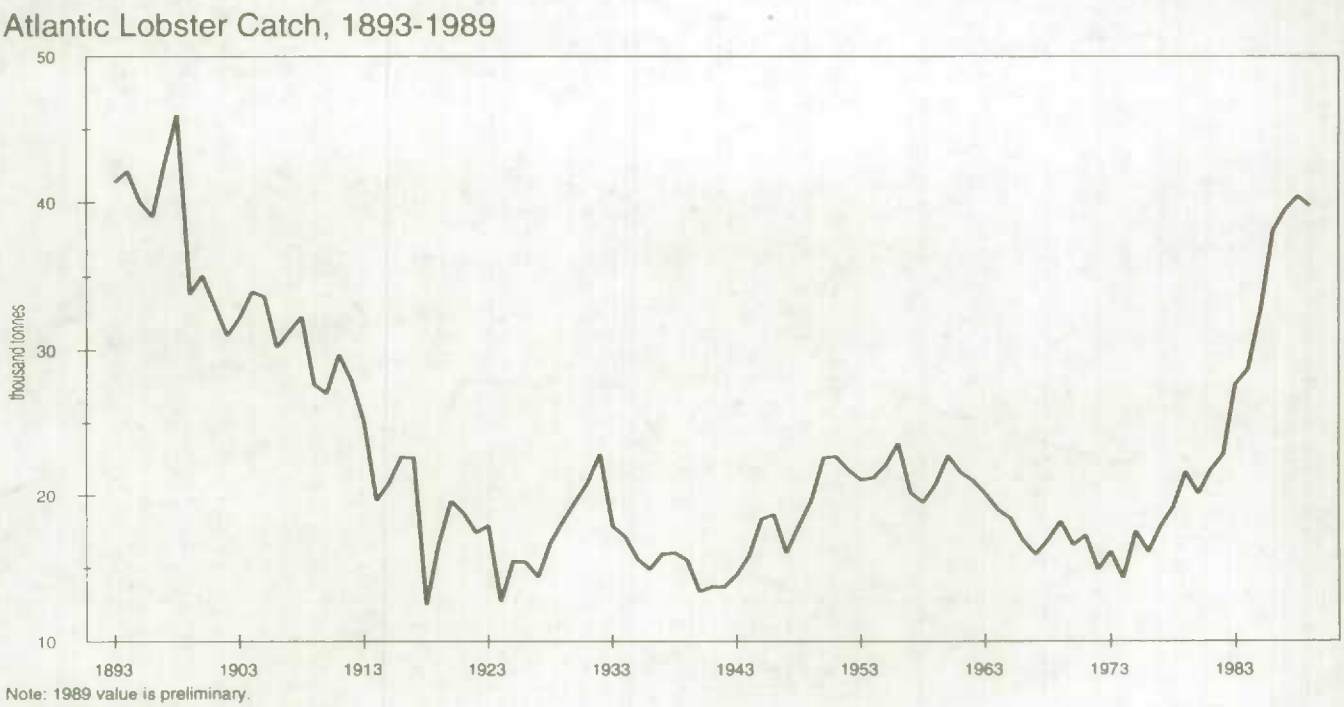
Table: 4.3.2.6

Atlantic Lobster Catch, 1893-1989

Year	Catch	Year	Catch	Year	Catch
	tonnes		tonnes		tonnes
1893	41 373	1926	15 404	1958	19 480
1894	42 116	1927	14 372	1959	20 723
1895	40 012	1928	16 724	1960	22 698
1896	39 032	1929	18 163	1961	21 545
1897	42 662	1930	19 562	1962	20 991
1898	46 010	1931	20 849	1963	20 095
1899	33 823	1932	22 837	1964	18 982
1900	35 075	1933	17 819	1965	18 367
1901	33 005	1934	17 136	1966	16 870
1902	30 973	1935	15 610	1967	15 904
1903	32 182	1936	14 902	1968	16 882
1904	33 984	1937	15 936	1969	18 156
1905	33 644	1938	16 022	1970	16 553
1906	30 181	1939	15 521	1971	17 210
1907	31 261	1940	13 373	1972	14 867
1908	32 276	1941	13 689	1973	16 092
1909	27 654	1942	13 680	1974	14 291
1910	27 033	1943	14 518	1975	17 493
1911	29 704	1944	15 851	1976	16 082
1912	27 909	1945	18 324	1977	17 831
1913	25 064	1946	18 642	1978	19 177
1914	19 649	1947	16 007	1979	21 577
1915	20 824	1948	17 855	1980	20 088
1916	22 605	1949	19 614	1981	21 694
1917	22 565	1950	22 564	1982	22 793
1918	12 454	1951	22 632	1983	27 655
1919	16 598	1952	21 708	1984	28 681
1920	19 605	1953	21 045	1985	32 639
1921	18 739	1954	21 172	1986	38 029
1922	17 399	1955	22 031	1987	39 513
1923	17 893	1956	23 569	1988	40 392
1924	12 691	1957	20 158	1989[1]	39 720
1925	15 462				

Source:
Fisheries and Oceans Canada, Biological Sciences Directorate.
Note:
[1] 1989 figure is preliminary.

Figure: 4.3.2.16

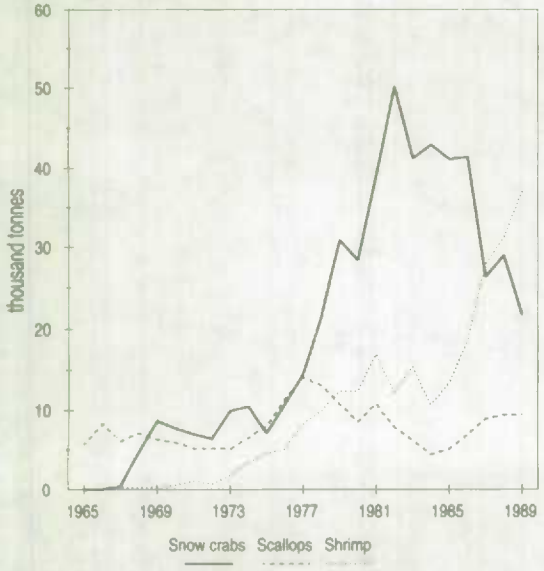


Note: 1989 value is preliminary.
Source: Fisheries and Oceans Canada

Figure: 4.3.2.17

Total Shellfish Landings

Atlantic Region, 1965-1989

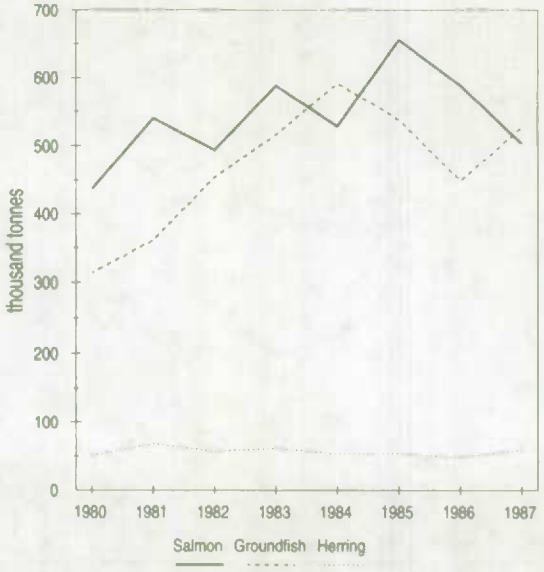


Note: 1989 values are preliminary.
Source: Fisheries and Oceans Canada.

Figure: 4.3.2.18

Total Catch by Species Group,

Northeast Pacific Region, 1980-1987

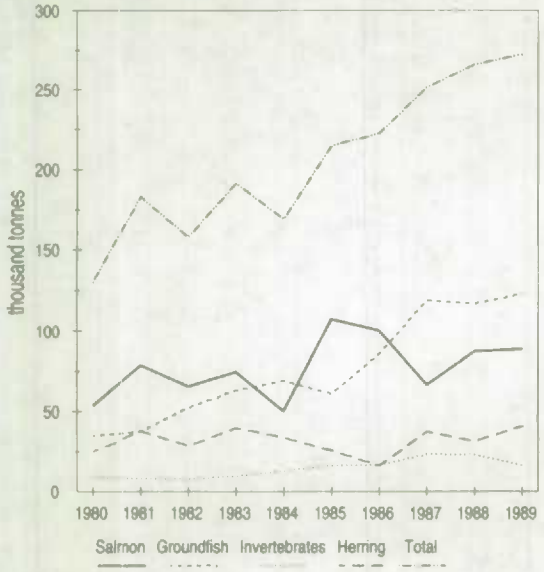


Note: 1987 values are preliminary.
Source: Fisheries and Oceans Canada.

Figure: 4.3.2.19

Canadian Commercial Catch

by Species Group, Northeast Pacific, 1984-1989

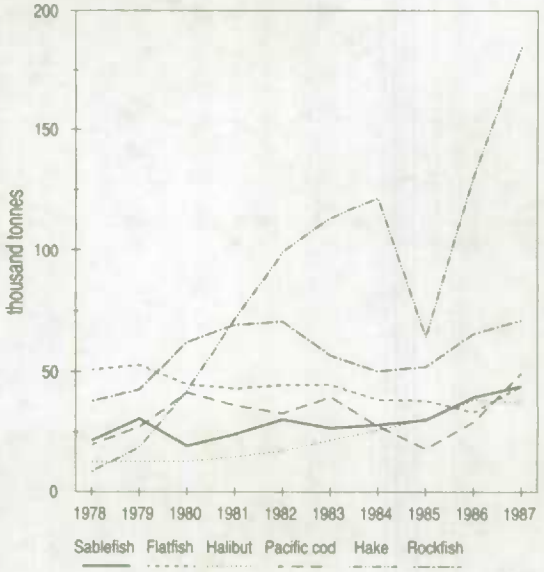


Note: 1989 values are preliminary.
Source: Fisheries and Oceans Canada.

Figure: 4.3.2.20

Groundfish Catch

Northeast Pacific Region, 1978-1987



Note: 1987 values are preliminary.
Source: Fisheries and Oceans Canada.

Table: 4.3.2.7

Total Snow Crabs, Scallops and Shrimp Landed in the Atlantic, 1965-1989

Year	Snow crab	Scallop	Shrimp
	tonnes		
1965	0	5 641	11
1966	30	8 284	95
1967	399	6 030	278
1968	4 652	7 057	271
1969	8 633	6 267	273
1970	7 677	5 894	572
1971	6 926	5 145	1 084
1972	6 360	5 173	665
1973	9 913	5 056	1 793
1974	10 456	6 517	3 317
1975	7 042	7 963	4 528
1976	10 743	11 394	5 037
1977	14 495	14 101	8 254
1978	21 479	13 102	9 904
1979	30 858	10 787	12 400
1980	28 359	8 491	12 394
1981	39 128	10 830	16 974
1982	50 195	7 843	12 224
1983	41 222	6 180	15 402
1984	42 875	4 395	10 644
1985	41 104	5 085	13 357
1986	41 384	6 855	18 602
1987	26 265	8 886	27 846
1988	28 949	9 367	31 214
1989[1]	21 680	9 367	37 078

Source:
Fisheries and Oceans Canada, Biological Sciences Directorate.
Note:
[1] 1989 figures are preliminary.

Table: 4.3.2.8

Catch[1] by Species Groups in the Northeast Pacific, 1980-1987

Year	Salmon	Groundfish	Herring
	tonnes		
1980	437 033	313 686	50 740
1981	540 173	361 210	67 963
1982	494 181	454 499	57 226
1983	587 616	516 672	61 387
1984	528 375	590 959	53 348
1985	655 346	538 897	53 558
1986	588 320	449 145	48 762
1987[2]	503 707	527 015	59 047

Source:
Fisheries and Oceans Canada, Biological Sciences Directorate.
Note:
[1] Catch includes Canada, United States, Japan, the USSR and European countries.
[2] 1987 figures are preliminary.

Table: 4.3.2.9

Canadian Commercial Catch by Species Groups in the Northeast Pacific[1], 1980-1989

Year	Salmon	Groundfish	Invertebrates	Herring	Total
	tonnes				
1980	53 817	35 023	8 878	25 155	**129 926**
1981	78 840	37 602	8 347	37 960	**183 137**
1982	65 600	52 404	7 850	28 598	**157 843**
1983	74 602	63 047	9 832	39 820	**191 543**
1984	50 281	69 023	13 031	33 703	**169 168**
1985	107 361	61 056	16 384	25 787	**214 736**
1986	100 242	85 476	16 729	16 341	**222 417**
1987	66 695	119 058	23 453	37 615	**251 440**
1988	87 455	116 910	23 118	31 601	**265 847**
1989[2]	88 723	122 847	16 456	41 006	**272 305**

Source:
Fisheries and Oceans Canada, Biological Sciences Directorate.
Note:
[1] Includes a small amount of pelagic fish in addition to the categories shown.
[2] 1989 figures are preliminary.

Table: 4.3.2.10

Catch[1] of Groundfish in the Northeast Pacific, 1978-1987

Year	Sablefish	Flatfish	Halibut	Pacific cod	Hake	Rockfish	Total
				tonnes			
1978	21 478	50 748	12 453	19 707	8 525	37 771	**211 073**
1979	30 633	52 748	12 784	27 191	18 713	42 587	**256 607**
1980	19 270	44 620	12 784	41 398	42 246	62 345	**313 686**
1981	24 154	43 090	14 807	36 028	71 918	69 422	**361 210**
1982	30 323	44 475	17 257	32 841	99 263	70 687	**454 499**
1983	26 683	44 624	21 730	39 619	113 376	56 725	**516 872**
1984	28 117	38 427	25 802	27 492	121 832	50 125	**590 959**
1985	30 183	38 032	30 664	18 062	64 410	52 123	**538 897**
1986	39 608	33 331	38 385	29 386	130 325	65 745	**449 145**
1987[2]	44 109	44 128	37 383	49 354	184 964	71 388	**527 015**

Source:
Fisheries and Oceans Canada, Biological Sciences Directorate.
Note:
[1] Catch includes Canada, United States, Japan, the USSR and European countries.
[2] 1987 figures are preliminary.

Table: 4.3.2.11

Nominal Catches and Landed Values of Fish by Area and Species, 1988

Species	Atlantic Coast		Pacific Coast		Canada	
	Quantity[1]	Value	Quantity[1]	Value	Quantity[1]	Value
	tonnes	thousand dollars	tonnes	thousand dollars	tonnes	thousand dollars
Groundfish						
Cod	467 871	239 199	11 014[2]	5 760	478 895	244 965
Haddock	30 954	28 288	...	...	30 954	28 288
Redfish	77 904	25 144	26 708	17 010	104 707	42 203
Halibut	2 566	10 811	7 780	23 122	10 368	34 028
Flatfishes	73 945	36 912	5 260	4 124	79 225	41 053
Turbot	16 192	9 024	340	88	16 532	9 112
Pollock	44 353	15 145	460	89	44 813	15 234
Hake	12 812	4 405	56 649[4]	8 822	69 147	13 314
Cusk	2 917	1 447	...	...	2 917	1 447
Catfish	2 283	620	...	...	2 283	620
Other	2 044	1 482	8 784	21 062	10 910	22 791
Total	**733 841**	**372 477**	**116 995**	**80 077**	**850 751**	**453 055**
Pelagic and other finfish						
Herring	263 252	42 164	31 601	80 564	294 853	125 687
Mackerel	23 849	6 385	...	...	23 849	6 385
Tuna	558	4 800	38	112	723	5 312
Alewife	9 040	2 710	...	...	9 040	2 710
Eel	941	3 535	...	...	941	3 535
Salmon	1 064	4 645	87 376	310 000	88 519	316 731
Skate	234	32	587	92	823	124
Smelt	1 778	1 500	1	3	1 779	1 503
Capelin	88 442	25 574	...	...	88 442	25 574
Other	1 749	7 268	5 255	2 356	7 757	9 658
Total	**390 907**	**98 613**	**124 858**	**393 127**	**516 726**	**497 219**
Shellfish						
Clams	7 495	7 796	9 516	18 481	16 955	26 154
Oysters	2 285	3 968	4 000	3 500	5 987	6 693
Scallop	77 799	85 690	88	293	77 866	85 979
Squid	318	92	1	1	319	93
Lobster	40 449	264 525	...	...	40 449	264 525
Shrimps	37 373	68 867	3 349	9 130	40 654	77 988
Crab	31 214	99 548	1 532	6 068	32 746	105 615
Other	2 616	2 603	5 029	4 750	7 691	7 483
Total	**199 549**	**533 089**	**23 495**	**42 223**	**222 667**	**574 530**
Miscellaneous items	...	5 237	...	12 798	...	18 171
Total sea fisheries	**1 324 297**	**1 009 416**	**265 348**	**528 225**	**1 590 144**	**1 542 975**
Inland fisheries	...	...	...	...	**52 000**	**91 000**
Grand total	**1 324 297**	**1 009 416**	**265 348**	**528 225**	**1 642 144**	**1 633 975**

Source:
Department of Fisheries and Oceans. 1990. *Canadian Fisheries - Statistical Highlights, 1988.*
Notes:
[1] Quantity in tonnes, live weight.
[2] Includes grey cod only.

Table: 4.3.2.12

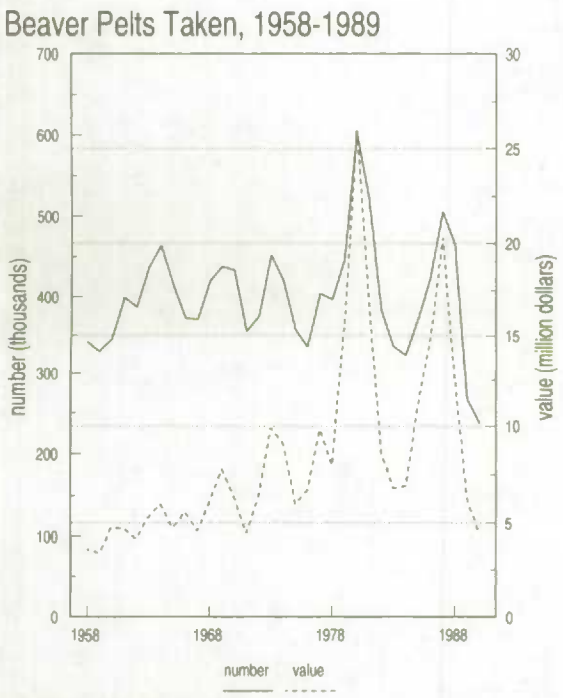
Commercial Catch[1] of Freshwater Fish, 1984-1988

Species	1984	1985	1986	1987	1988[2]
			tonnes		
Trout[3]	679	866	897	861	923
Pike	3 233	3 429	3 511	3 801	3 686
Chub[4]	1 803	1 079	1 197	1 073	1 514
Whitefish	8 352	9 279	9 186	9 034	9 660
Perch	5 412	5 026	6 081	6 213	7 470
Walleye	7 123	7 493	7 556	6 977	8 153
Sauger	2 069	1 933	1 339	2 252	2 907
Arctic char[5]	62	68	0	53	88
Total high value species	**28 733**	**29 173**	**29 767**	**30 264**	**34 401**
Sucker	1 450	1 985	2 290	1 934	2 115
Smelt[6]	7 490	11 119	8 072	11 596	9 274
Alewife[7]	986	1 117	687	1 025	0
Carp	757	436	573	673	511
Total low value species	**10 683**	**14 657**	**11 622**	**15 228**	**11 900**
Other fish[8]	4 008	4 684	4 136	3 867	2 924
Total all species	**43 424**	**48 514**	**45 525**	**49 359**	**49 225**

Source:
Department of Fisheries and Oceans, Biological Sciences Directorate. .

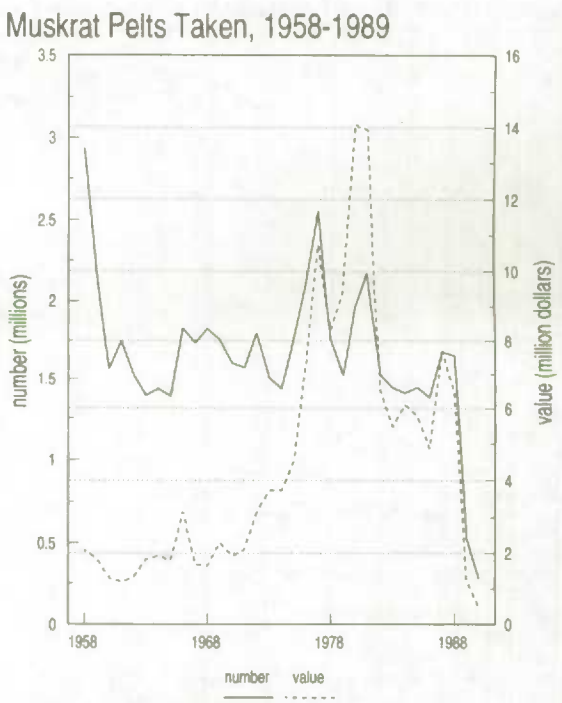
Notes:
[1] Live weight, i.e. weight of fish brought ashore.
[2] Preliminary figures.
[3] Includes lake and rainbow trout.
[4] Ciscos and lake herrings are marketed collectively as chub.
[5] Data are for the Northwest Territories only; however, this fish is also caught commercially in Quebec and Labrador.
[6] Over ninety-five percent of smelt caught are from Lake Erie.
[7] Some New Brunswick and all Great Lakes alewife are caught for animal feed and are not reported here.
[8] Other fish include tomcod, eel, salmon, shad, white bass, sturgeon, catfish, burbot, rock bass, sunfish, splake, bullhead, freshwater drum, bowfin.

Figure: 4.3.2.21



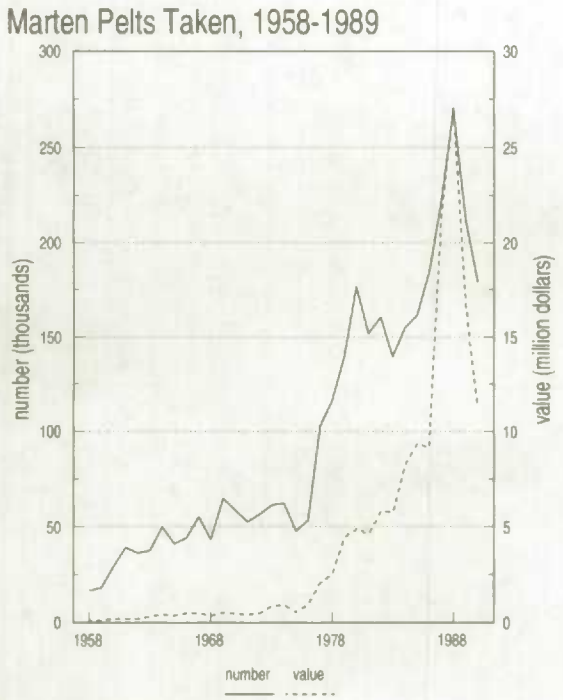
Source: Statistics Canada. Fur Production. Catalogue 23-207.

Figure: 4.3.2.22



Source: Statistics Canada. Fur Production. Catalogue 23-207.

Figure: 4.3.2.23



Source: Statistics Canada. Fur Production. Catalogue 23-207.

Table: 4.3.2.13

Animal Pelts Taken, 1989-90

Species	Canada	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	Yukon	N.W.T.
Badger	**648**	...	...	...	...	...	...	55	303	290	...	...	...
Black Bear	**3 110**	-	...	93	1 061	651	27	823	178	102	128	12	35
Grizzly Bear	**-**	...	...	...	...	...	...	...	...	-	-	...	...
Polar Bear	**379**	...	...	...	...	73	9	...	...	-	...	-	297
Beaver	**237 033**	2 468	325	2 400	4 379	49 463	90 384	15 868	28 021	34 554	7 412	403	1 356
Cougar	**-**	...	...	...	...	...	...	...	...	...	-	...	...
Coyote	**22 536**	...	5	406	347	2 022	1 092	2 431	5 418	10 201	577	24	13
Ermine	**28 841**	882	21	402	625	7 174	2 704	2 462	3 229	7 555	3 171	198	418
Fisher	**7 726**	...	...	4	72	1 191	2 318	1 454	1 599	856	172	...[4]	60
Blue Fox	**98**	...	...	...	...	-	93	...[3]	-	-	...	...	...[1]
Cross or Red Fox	**32 411**	2 719	531	678	773	10 919	6 144	3 455	4 854	1 372	202	125	641
Silver Fox	**341**	7	18	16	...	120	...	50	57	42	...	-	31
Arctic Fox	**2 164**	0	...	...	...	235	-	485	44	4	...	-	1 399
Other Foxes	**...[1]**	...	...	...	...	...	...[1]	-	...	-	...	-	...
Lynx	**9 793**	46	...	...[2]	...	781	526	446	385	1 807	1 230	1 749	2 823
Marten	**178 833**	2 438	...	...	1 993	27 739	63 446	6 991	3 916	12 004	29 242	8 241	22 823
Mink (wild)	**71 234**	4 348	442	1 445	1 623	12 337	16 374	11 922	10 782	4 288	2 867	367	4 439
Muskrat	**280 078**	3 413	4 968	14 178	9 686	78 510	95 143	13 103	30 337	21 665	3 287	361	5 427
Otter	**11 685**	557	...	218	210	2 554	5 547	1 265	728	259	293	7	47
Rabbit	**-**	...	...	-	...	...	...	-	-	-	...	...	-
Raccoon	**19 754**	...	181	1 390	476	4 038	12 240	696	516	63	134	...	...
Seal	**x**	...	x	x	x	x	...	...	...	...	...	...	1 817
Skunk	**130**	...	-	-	-	72	46	-	-	12	-	...	...
Squirrel	**80 615**	639	18	1 402	185	2 164	2 061	6 343	9 995	55 221	-	1 908	699
Wildcat	**731**	...	...	347	-	85	...	...	192	12	95	...	...
Wolf	**2 116**	25	...	...	...	353	391	181	10	268	79	75	734
Wolverine	**492**	...	...	...	...	-	9	31	-	40	113	206	93
Other (opossum)	**27**	...	-	...	...	...	27	...	...	...	...	...	...
Total	**990 775**	17 542	6 509	22 979	21 410	200 481	298 581	68 061	100 564	150 635	49 002	13 676	43 152

Source:
Statistics Canada. *Fur Production, 1988-89*. Catalogue 23-207.
Notes:
Trapping season in most cases is the winter.
Ranch-raised pelt data is not included.
[1] Data included with Cross and Red Fox.
[2] Data included with Newfoundland.
[3] Data included with Other Foxes.
[4] Data included with British Columbia.

4.3.3 Water Consumption

Water is a necessity of life. Human activities withdraw water, transfer it to other locations, disrupt natural hydrological cycles and pollute it with man-made contaminants and silt from erosion. As a nation, Canada is rich in water. Some regions, though, are experiencing shortages of surface and groundwater.

❑❑❑

Globally, both the monitoring of water quality and water control measures have been deemed to be inadequate[53]. Recently, the first global assessment of freshwater quality, carried out by GEMS (the Global Environmental Monitoring System), found that contamination of water resources is progressively increasing in much of the world.

As the human population increases so do water withdrawals for agriculture, industry and municipalities. These withdrawals include those from both surface water and groundwater supplies. Along with increased use comes increased effluents originating from human activities. The management of water resources, both water use and water quality, is becoming increasingly important.

Water Withdrawal and Consumption

Although the most obvious uses of water include instream activities such as fishing, shipping and hydroelectric power generation, the greatest variety of water uses are land based. These land-based uses are termed *withdrawal uses*[54].

Water withdrawn from its source is directed into a variety of uses, recollected, and redirected back into its original source, sometimes in a more contaminated state. Often, less water is returned than originally withdrawn because of the consumptive nature of the processing that it undergoes. Regionally the highest water withdrawals in 1986 occurred in Ontario (Table 4.3.3.1).

From 1981 to 1986 gross water use in Canada increased by 5.0 percent from 53.8 billion cubic metres in 1981 to 56.5 billion cubic metres in 1986 (Table 4.3.3.2). Gross water use represents the total amount of water used during a process, which is normally equal to water intake. However some sectors reuse the same water many times, in which case the gross water use could be equal to several times the water intake.

Gross water use is the sum of water intake plus recirculation. Table 4.3.3.3 presents gross water use by sector. The highest water use levels occur in the mining and manufacturing sectors. Table 4.3.3.4 provides a further breakdown of water use in the mining and manufacturing sectors for the years 1981 and 1986.

Groundwater

Groundwater, the saturated zone that exists below the water table, is an important renewable resource and is the sole source of water for almost a quarter of all Canadians (Table 4.3.3.5). One of the characteristics of groundwater is that it moves very slowly through water-bearing rock and soil. Therefore contaminants may not appear in the groundwater until long after they have been released.

Precipitation flows through the unsaturated zone and collects as groundwater. It is then circulated back to the surface and returned to the atmosphere by evaporation and transpiration. The length of time water spends in the groundwater portion of the hydrologic cycle can vary from a few days to more than 10,000 years. In comparison the average river requires only 2 weeks to completely replace itself.[55]

In 1981, about 26 percent of Canadians relied on groundwater for domestic use (Table 4.3.3.6). Provincially reliance on groundwater ranged from 100 percent in Prince Edward Island to less than 1 percent in the Northwest Territories.[56]

During 1981 over 1.4 billion cubic metres of groundwater was used in Canada. Table 4.3.3.7 shows that the municipal sector was the largest ground-water user nationally, at 31 percent, followed by the agriculture, industrial and rural sectors. Regionally, the reliance on groundwater varied by sector. In the Atlantic Region, rural users were the major consumer. In Ontario and Quebec, municipal consumption predominated. Agricultural uses were the prime consumer in in the Prairie region. In British Columbia, industrial uses ranked highest. Ontario accounts for 27 percent of the groundwater consumption in Canada.

Table 4.3.3.7 illustrates that during 1981 approximately 37.6 billion cubic metres of water was used in Canada. According to Environment Canada,[57] 51 percent of total water use was

53. World Resources Institute. *Op.cit.*

54. Environment Canada, 1990. *Water Works*, Fact Sheet No. 4, Supply and Services Canada. Ottawa, Canada.

55. Environment Canada, 1990. *Ground-water — Nature's Hidden Treasure*, Fact Sheet No. 5. Supply and Services Canada. Ottawa, Canada.

56. Environment Canada, 1986. *Ground-water Use in Canada, 1981* by P.J. Hess, National Hydrology Research Institute, IWD Technical Bulletin No. 140. Inland Waters Directorate, Ottawa, Canada.

57. *Ibid.*

for thermal power generation. Table 4.3.3.7 presents calculations of ground-water use to total water use with and without the influence of the thermal generation category (because of the large volume of water use by this category).

Owing to the great volumes of surface water used in agriculture, industry and the larger cities, the importance of groundwater may be underrated. Table 4.3.3.5 does not show that in the rural areas of the country, groundwater is of great importance.

Groundwater is an essential renewable resource in Canada. The contamination of ground water by industrial, agricultural and domestic activities is already a serious problem.

Interbasin Transfers

The wholesale restructuring of water systems affects a much larger geographic area than water withdrawal from a point source. Dams retain runoff for release when there is enough demand. Diversions, such as dykes, redirect water to where it is in demand. Both dams and dykes involve the transfer of large amounts of water between basins. In some cases, large tracts of land, including villages, hunting grounds and wildlife habitat are flooded.

Over the past 25 years Canada has become the worlds largest water diverter.[58] This change in status has occurred as a result of three large diversion projects — the Churchill Falls Project in Labrador; the Churchill-Nelson Diversion in Manitoba; and the La Grande River (James Bay Phase 1) Project in Quebec. These three projects account for two-thirds of all flow diverted in Canada (Table 4.3.3.8), with hydroelectric power generation dominating as the purpose behind most water diversions.

58. Day, J.C. and F. Quinn. 1987. *Dams and Diversions: Learning from Canadian Experience*, [in] Proceedings of the Symposium on Interbasin Transfers of Water: Impacts and Research Needs for Canada, National Hydrology Research Centre. Saskatoon, Saskatchewan, 9-10 November, pp. 43-56.

Table: 4.3.3.1

Regional Water Withdrawal and Consumption, 1981 and 1986

Region	Water withdrawals: Agriculture	Mining	Manufacturing	Thermal power	Municipal	Regional total	Regional change 1981-86	Water consumption	Percent of water consumption to water withdrawal
	million cubic metres (MCM)						percent	MCM	percent
Atlantic provinces									
1981	12	86	640	1 837	307	**2 882**		127	4.41
1986	13	212	958	2 490	339	**4 012**	39.2	193	4.81
Quebec									
1981	82	107	2 319	308	1 369	**4 185**		416	9.94
1986	89	52	1 521	986	1 484	**4 132**	- 1.3	387	9.37
Ontario									
1981	148	124	4 414	14 930	1 450	**21 066**		715	3.39
1986	166	100	3 763	19 967	1 602	**25 598**	21.5	794	3.10
Prairie Provinces									
1981	2 338	197	382	1 846	579	**5 342**		1 981	37.08
1986	2 688	142	357	1 867	675	**5 729**	7.2	2 254	39.34
British Columbia[1]									
1981	545	134	2 182	360	558	**3 779**		653	17.28
1986	603	87	1 384	54	617	**2 745**	- 27.4	651	23.72
Canada									
1981	**3 125**	**648**	**9 937**	**19 281**	**4 263**	**37 254**		**3 892**	**10.45**
1986	**3 559**	**593**	**7 983**	**25 364**	**4 717**	**42 216**	**13.3**	**4 280**	**10.14**
Percent of Total									
1981	8.39	1.74	26.67	51.76	11.44	**100.00**			
1986	8.43	1.40	18.91	60.08	11.17	**100.00**			

Source:
Environment Canada. Inland Waters Directorate (unpublished data).
Notes:
[1] Sectoral data for the Yukon and Northwest Territories are included with British Columbia.
[2] Figures for some sectors have been extrapolated and rounded.

Table: 4.3.3.2

Water Withdrawal and Consumption by Sector, 1981 and 1986

Sector	Water intake: Quantity	Change 1981-86	Recirculation: Quantity	Change 1981-86	Gross water use[1]: Quantity	Change 1981-86	Consumption: Quantity	Change 1981-86	Discharge[2]: Quantity	Change 1981-86
	MCM[3]	percent	MCM	percent	MCM	percent	MCM	percent	MCM	percent
Agriculture										
1981	3 125		0		3 125		2 412		713	
1986	3 559	13.9	0	0.0	3 559	13.9	2 752	14.1	807	13.2
Mining										
1981	648		2 792		3 440		178		470	
1986	593	- 8.5	2 038	- 27.0	2 631	- 23.5	164	- 7.9	429	- 8.7
Manufacturing										
1981	9 937		10 747		20 684		494		9 443	
1986	7 984	- 19.7	7 813	- 27.3	15 797	- 23.6	404	- 18.2	7 579	- 19.7
Thermal power generation										
1981	19 281		1 868		21 149		168	0.0	19 113	
1986	25 364	31.5	4 480	139.8	29 844	41.1	271	61.3	25 093	31.3
Municipal[4]										
1981	4 263		0		4 610		640		3 623	
1986	4 716	10.6	0	0.0	4 716	2.3	689	7.7	4 022	11.0
Total[5]										
1981	**37 254**		**15 407**		**53 008**		**3 892**		**33 362**	
1986	**42 216**	**13.3**	**14 331**	**- 7.0**	**56 547**	**6.7**	**4 280**	**10.0**	**37 930**	**13.7**

Source:
Environment Canada. Inland Waters Directorate (unpublished data).
Notes:
[1] Gross water use equals new water intake plus recycled water.
[2] Discharge equals water intake minus consumption.
[3] Millions of cubic metres.
[4] Excludes water supplied to Industry. Includes estimates for rural residential water use.
[5] Data may not add due to rounding.

Table: 4.3.3.3

Water Use by Sector, 1981 and 1986

Sector	Water intake[1]	Recirculation[2]	Gross water use[3]	Consumption[4]	Total water discharge[5]	Use rate[6]
	billion cubic metres					
Agriculture						
1981	3.1	0.0	3.1	2.4	0.7	1.0
1986	3.6	0.0	3.6	2.8	0.8	1.0
Mining						
1981	0.6	0.6	3.6	0.2	0.7	6.0
1986	0.6	2.0	2.6	0.2	0.4	4.3
Manufacturing						
1981	9.9	11.3	21.5	0.5	9.7	2.2
1986	8.0	7.8	15.8	0.4	7.6	2.0
Thermal power generation						
1981	19.3	1.9	21.2	0.2	19.2	1.1
1986	25.4	4.5	29.8	0.3	25.1	1.2
Municipal[7,8]						
1981	4.3	0.0	4.4	0.6	3.7	1.0
1986	4.7	0.0	4.7	0.7	4.0	1.0
Total[9]						
1981	**37.2**	**13.8**	**53.8**	**3.9**	**34.0**	**1.4**
1986	**42.3**	**14.3**	**56.5**	**4.4**	**37.9**	**1.3**

Source:
Environment Canada. Inland Waters Directorate (unpublished data).
Notes:
[1] Amount of water withdrawn for a particular activity over a given amount of time.
[2] Water used at least twice.
[3] Gross water use equals new water intake plus recycled water.
[4] Water lost during production.
[5] Discharge equals water intake minus consumption.
[6] The ratio of gross water use to water intake; represents an index of recirculation.
[7] Excludes water supplied to industry.
[8] Includes estimates for rural residential water use.
[9] Data may not add due to rounding.

Table: 4.3.3.4

Water Use by Industry Group for the Mining and Manufacturing Sectors, 1981 and 1986

Sector	1980 SIC Code[1]	Number of employees	Number of plants	Water intake[2]	Recirculation[3]	Gross water use[4]	Consumption[5]	Total water discharge[6]	Use rate[7]
				million cubic metres					
Mining Sector									
Mining Industries[8]									
1981		86 742	198	527.30	1 741.81	2 269.11	130.30	396.91	4.3
1986	6	65 734	228	507.35	1 163.77	1 671.12	121.45	385.90	3.3
Crude Petroleum and Natural Gas Industries									
1981		8 669	53	121.01	1 050.29	1 171.30	47.92	73.09	9.7
1986	7	8 372	49	86.02	873.45	959.47	42.92	43.10	11.2
Manufacturing Sector									
Food Industries[9]									
1981		140 976	1 273	352.12	101.52	453.64	17.08	335.04	1.3
1986	10	155 371	1 288	563.93	148.30	712.23	23.46	540.47	1.3
Beverage Industries									
1981		26 949	240	77.72	15.28	93.00	13.63	64.09	1.2
1986	11	23 138	217	62.62	106.83	169.45	12.09	50.53	2.7
Rubber Products Industry									
1981		21 623	86	27.99	59.62	87.62	3.38	24.61	3.1
1986	15	21 201	86	23.31	66.69	90.00	2.35	20.96	3.9
Plastic Products Industries									
1981		24 437	364	26.18	684.35	710.53	3.88	22.30	27.1
1986	16	31 745	438	29.93	66.37	96.30	2.62	27.31	3.2
Primary Textile Industries									
1981		26 634	106	106.50	49.85	156.34	4.45	102.05	1.5
1986	18	20 067	123	94.85	29.70	124.55	2.08	92.77	1.3
Textile Products Industry									
1981		7 128	56	17.17	0.73	17.91	0.74	16.43	1.0
1986	19	6 329	72	12.76	11.94	24.70	1.36	11.40	1.9
Wood Industries									
1981		43 594	360	72.84	57.29	130.13	4.30	68.54	1.8
1986	25	49 051	341	56.02	7.97	63.99	1.98	54.04	1.1
Paper and Allied Products Industries									
1981		96 331	271	2 899.35	4 611.76	7 511.11	159.52	2 739.83	2.6
1986	27	93 809	291	3 028.85	2 979.02	6 007.86	199.91	2 828.94	2.0
Primary Metal Industries[10]									
1981		111 972	171	2 718.60	1 692.26	4 410.86	37.68	2 680.92	1.6
1986	29	103 695	221	1 718.18	1 349.86	3 068.03	42.92	1 675.26	1.8
Fabricated Metal Products Industries									
1981		30 136	324	30.21	130.21	160.42	0.78	29.43	5.3
1986	30	47 711	537	25.18	113.56	138.73	0.95	24.23	5.5
Transportation Equipment Industries[11]									
1981		149 876	329	108.77	72.84	181.60	2.87	105.90	1.7
1986	32	173 371	435	117.30	236.94	354.24	3.72	113.58	3.0
Non-Metallic Mineral Products Industries									
1981		39 270	674	82.62	530.25	612.87	14.33	68.29	7.4
1986	35	38 930	588	89.67	69.90	159.57	18.04	71.63	1.8
Refined Petroleum and Coal Products Industries									
1981		11 785	42	563.07	1 456.97	2 020.04	34.18	528.89	3.6
1986	36	9 756	32	487.15	1 068.12	1 555.27	33.49	453.66	3.2
Chemical and Chemical Products Industries[12]									
1981		64 424	572	2 853.27	1 283.62	4 136.90	196.99	2 656.28	1.4
1986	37	56 276	566	1 673.87	1 557.66	3 231.54	59.24	1 614.63	1.9
Mining Sector Total									
1981		**95 411**	**251**	**648.31**	**2 792.10**	**3 440.41**	**178.22**	**470.00**	**7.0**
1986		**74 106**	**277**	**593.37**	**2 037.22**	**2 630.59**	**164.37**	**429.00**	**7.2**
Manufacturing Sector Total									
1981		**795 135**	**4 868**	**9 936.41**	**10 746.55**	**20 682.97**	**493.81**	**9 442.60**	**4.3**
1986		**830 450**	**5 235**	**7 983.62**	**7 812.86**	**15 796.46**	**404.21**	**7 579.41**	**2.5**

Source:
Environment Canada. Inland Waters Directorate (unpublished data).

Notes:
[1] For comparative purposes the 1981 SIC (Standard Industrial Classification) codes were aggregated to the 1986 SIC codes.
[2] Amount of water withdrawn for a particular activity over a given amount of time.
[3] Water used at least twice.
[4] Gross water use equals new water intake plus recycled water.
[5] Water lost during production.
[6] Discharge equals water intake minus consumption.
[7] The ratio of gross water use to water intake; represents an index of recirculation.
[8] Placer gold mines surveyed in 1986 were not surveyed in 1981.
[9] Bread and other bakery products industries surveyed in 1986 were not surveyed in 1981.
[10] Aluminum roll, cast and extruding industry surveyed in 1986 was not surveyed in 1981
[11] Motor vehicle fabric accessories industry surveyed in 1986 was not surveyed in 1981.
[12] Printing ink manufacturers surveyed in 1986 were not surveyed in 1981.

Table: 4.3.3.5

Estimated Population Reliant on Ground Water in Canada, 1981

Region	Groundwater use		Population reliant	
	Total	Proportion of national use	Total	Proportion of population reliant
	thousand cubic metres	percent	number	percent
Atlantic Provinces	153 336	10	1 116 741	50
Quebec	255 806	17	1 126 284	17
Ontario	397 769	27	1 985 279	23
Praine Provinces	341 958	23	1 377 134	33
British Columbia[1]	341 868	23	617 225	22
Canada	**1 490 737**	**100**	**6 222 663**	**26**

Source:
Environment Canada. Inland Waters Directorate, Technical Bulletin No. 140, 1986.
Notes:
[1] Sectoral data for the territories are included with British Columbia.

Table: 4.3.3.6

Estimated Ground-Water Use in Canada, 1981

Region	Total ground-water use	Regional ground-water use	Sector			
			Agriculture	Industrial[1,2]	Rural	Municipal
	thousand cubic metres	percent	percent			
Atlantic Provinces	153 336	10	7	18	41	34
Quebec	255 806	17	29	11	22	38
Ontario	397 769	27	23	8	18	51
Praine Provinces	341 958	23	50	14	21	15
British Columbia[3]	341 868	23	19	56	7	18
Canada	**1 490 737**	**100**	**28**	**22**	**19**	**31**

Source:
Environment Canada. Inland Waters Directorate, Technical Bulletin No. 140, 1986.
Notes:
[1] Includes mining, manufacturing, thermal power and fish enhancement facilities.
[2] Self-supplied only.
[3] Sectoral data for the territories are included with British Columbia.

Table: 4.3.3.7

Estimated Water and Groundwater Use, 1981

Region	Total water use including thermal generation		Total water use excluding thermal generation	
	Total	Percentage from ground water	Total	Percentage from ground water
	thousand cubic metres	percent	thousand cubic metres	percent
Atlantic Provinces	2 874 100	5	1 076 970	14
Quebec	4 239 074	5	3 931 384	6
Ontario	21 186 855	2	6 262 545	6
Praine Provinces	5 373 816	8	3 555 876	10
British Columbia[1]	3 878 942	11	3 520 762	10
Canada	**37 552 787**	**4**	**18 347 537**	**8**

Source:
Environment Canada. Inland Waters Directorate, Technical Bulletin No. 140, 1986.
Notes:
[1] Sectoral data for the territories are included with British Columbia.

Table: 4.3.3.8

Major Water Transfers, 1985[1]

Ecozone(s)	Province	Contributing water body (code)	Receiving water body (code)	Average annual transfer rate[2]	Uses	Date operational
				m^3/sec		
Mixed Wood Plain	Ontario	Lake Erie(2G)	Lake Ontario(2H)	250	navigation, hydro	1929
Boreal Shield	Newfoundland	Victoria, Whitebear, Grey and Salmon Rivers(2Y, 2Z)	Northwest Brook (Bay d'Espoir)(2Y,2Z)	185	hydro	1969
Boreal Shield to Taiga Shield	Quebec	Eastmain, Opinaca Rivers(3C,3D)	La Grande River(3C,3D)	845	hydro	1980
Boreal Shield to Mixed-Wood Plain	Ontario	Long Lake (Albany River)(4G,4H,4J)	Lake Superior(2A,2B)	42	hydro, logging	1939
Boreal Shield to Mixed-Wood Plain	Ontario	Ogoki River (Albany River)(4G,4H,4J)	Lake Nipigon(2A,2B)	113	hydro	1943
Boreal Shield	Ontario	Lake St.Joseph (Albany River)(4G,4H,4J)	Root River(5Q,5R,5S)	86	hydro	1957
Boreal Shield	Ontario	Little Abitibi River(4K,4L,4M)	Abitibi River(4K,4L,4M)	40	hydro	1963
Boreal Shield	Manitoba	Churchill River(6A,6B,6C,6D,6E)	Rat, Burntwood Rivers(5T,5U)	775	hydro	1976
Montane Cordillera to Pacific Maritime	British Columbia	Nechako River(8J,8K,8M)	Kemano River(8B,8C,8D,8F)	115	hydro	1952
Montane Cordillera	British Columbia	Bridge River(8J,8K,8M)	Seton Lake(8J,8K,8M)	92	hydro	1959
Pacific Maritime	British Columbia	Coquitlam Lake(8M)	Buntzen Lake(8G)	28	hydro	1912
Pacific Maritime	British Columbia	Cheakamus River(8G)	Squamish River(8G)	37	hydro	1957
Taiga Shield	Newfoundland	Julian, Unknown Rivers(3N,3O,3P,3Q)	Churchill River(3N,3O,3P,3Q)	196	hydro	1971
Taiga Shield	Newfoundland	Naskaupi River(3N,3O,3P,3Q)	Churchill River(3N,3O,3P,3Q)	200	hydro	1971
Taiga Shield	Newfoundland	Kanairiktok River(3N,3O,3P,3Q)	Churchill River(3N,3O,3P,3Q)	130	hydro	1971
Taiga Shield	Quebec	Caniapiscau River(3H,3J,3K,3L,3M)	La Grande River(3C,3D)	790	hydro	1983
Taiga Shield	Quebec	Lake Frégate(3C,3D)	La Grande River(3C,3D)	31	hydro	1982
Taiga Shield	Saskatchewan	Tazin Lake(7L,7M,7N,7O,7P,7Q,7R, 7S,7T,7U)	Lake Athabasca(7L,7M,7N,7O, 7P,7Q,7R,7S,7T,7U)	25	hydro	1958

Source:
Day, J.C. and F. Quinn. 1987. *Dams and Diversions: Learning from Canadian Experience*, in Proceedings of the Symposium on Interbasin Transfer of Water. Saskatoon, Saskatchewan. November 9-10, 1987. pp. 43-56.

Notes:
[1] This table updates Table 5.2.6 in *Human Activity and the Environment, 1986.*
[2] Estimates.

5. Appendices

5.1 The Population-Environment Process Framework

Any statistical activity, including collections of environmental statistics, requires a conceptual model of the structure or activity being represented. The model, or framework, may be used to simply organize a complex work into principal elements. A more sophisticated model will not only provide organizing principles but also enhance the readers understanding of the relationships between the elements.

For the purpose of environmental statistics at Statistics Canada, we require a framework which integrates our knowledge of the socio-economic system and its relationship to the environment and natural resources. A framework must be sufficiently comprehensive to include human activities, natural resources and the natural environment. It must also provide links to existing statistical frameworks, such as the National Accounts, Census and business surveys.

Existing frameworks were found to be insufficient for the purpose of organizing our work. As reported by Sheehy[59], environmental reports have been based upon some combination of the following types of organizing principles:

- **Issues.** Many publications are organized according to current policy issues. Therefore acid precipitation, global warming, and soil loss, for example, provide a skeleton for the report and the profusion of other environmental data is ordered according to these issues. This approach has the advantages of timeliness and topicality. What it lacks, however, is comprehensiveness and a systematic approach — it may overlook important, cross-cutting problems.
- **Resource sector.** A substantial portion of the work generated from this approach classifies resource activities: agriculture, forestry, fisheries, mineral extraction and energy production. This provides information that is readily related to the benefits we take from the environment as well as many of the economic implications of environmental change (decline in productive forests and fish stocks, for instance).
- **Environmental media.** The most traditional organizational framework for environmental data divides the world into the categories of biota, land, air and water. This has the advantage of familiarity — we can all relate to air that is unbreathable or water that is polluted — but is weak in categorizing cross-media and biological effects.
- **Environmental process.** This approach is based on the measurement of the physical and biological processes fundamental to natural ecosystems and the human activities that have impacts upon them. Concentrating on environmental processes is both systematic and integrative, in the sense that all human and natural agents of change will eventually produce alterations in ecosystem operation.
- **Combination Frameworks.** Using this approach, aspects of several organizing principles are applied. This can be seen quite clearly in the *State of Environment Report for Canada*[60] which combined resource sector and environmental process approaches.

The Population-Environment Process framework is an extension of the combination approaches applied previously. The framework divides the world into three major components: **population**, the **socio-economic system** and the **natural environment**. Each of these components consist of **states**, **activities**, and **interactions** with other components. The framework incorporates the following principles:

- The **socio-economic system** is an artificial system (in Herbert Simon's phrase[61]) embedded in a natural environment.
- The human-created and human-controlled processes within the socio-economic system have two types of direct impact on the environment: (a) **restructuring** as a byproduct of production and consumption, and (b) **extracting, harvesting** and using the natural environment as processes providing necessary **resources** for the socio-economic system.
- The **natural environment** is affected by the outputs and inputs to the socio-economic system, and the state of the environment changes as a result.
- The change in the state and quality of the environment, in turn, affects the quantity and quality of resources available to the socio-economic system.

Impacts on the natural environment resulting from human activities can be viewed as **restructuring** of the environment. This can have three basic expressions: (i) **physical** restructuring results from construction of dams, roads, power lines, mines, dump sites and other changes to the natural landscape; (ii) **chemical** restructuring results from the release of pollutants and wastes into the environment; (iii) **biological**

59. Sheehy, G. 1989. *Organizational and Spatial Frameworks for State of the Environment Reporting.* Environment Canada, SOE Reporting Branch, April 1989.

60. Environment Canada. 1986 *State of the Environment Report for Canada.* 1986.

61. Simon, H.A. 1982. *The Sciences of the Artificial, 2nd Edition.* MIT Press, Cambridge Mass., 1982.

restructuring is the result of harvesting and the introduction of exotic species.

The framework therefore closes the loop — the byproducts of socio-economic activity interact in the environment to produce changes in the resources (including air, water and wilderness) on which these activities depend (See Figure 1). Activity levels, restructuring, measures of environmental state and the quality and quantity of resources available for extraction and harvest are all important to measure.

In Figure 2, a structural representation of the framework, the population appears as a stock endowed with a set of population processes (birth, death, and migration). This population draws services and non-durable goods from a set of socio-economic processes (consisting largely of production and operation) based on a capital stock of durable human-made items.

The population also interacts directly with stocks of natural assets in the environment, in the form of breathing air, drinking water, engaging in activities such as fishing, hunting, canoeing, camping and hiking, and enjoying the aesthetics and amenities provided by the natural world. Direct use of the environment by the population inevitably leads to some restructuring, both physically and through the release of wastes.

Socio-economic processes depend on flows of resources (both living and non-living) and services from the stocks of natural assets. As byproducts of production and consumption the full range of restructuring of the natural environment occurs. Socio-economic processes depend as well on the capital stock of human-made assets.

Wastes are treated as a separate output of socio-economic processes. The generation of wastes does not necessarily have a direct environmental impact. These byproducts of production may be treated, stored or recycled to minimize their impact.

The stocks of natural assets change as a result of interactions with the population, socio-economic processes and natural processes (including growth and decline of living populations, other biological processes, and geochemical processes).

The interaction of natural processes and human-induced restructuring is the least understood portion of human-environment interactions. The measurement of current states and quality is a necessary input to policy questions on health, sustainability and aesthetic value. The systematic measurement of restructuring activities is required to increase our scientific understanding of environmental change — for instance, enforcing legislation concerning environmental quality will require measurement of these restructuring activities such as emissions to air and water.

The great strength of the PEP framework is the linkage it provides between disparate data sets. For example:

- There is a direct link between the framework and measures of socio-economic processes that are the subject matter of existing Statistics Canada surveys (e.g. agriculture, primary industries, manufacturing, services including transportation). Similarly, capital formation and capital stock are measured by existing surveys. Of particular interest is the investment in pollution abatement and control.
- Population state and population processes are measured in current health and demographic data.
- The natural asset component of the framework builds on existing natural resource data.
- Linkages to the System of National Accounts are quite explicit: consumption and investment (two of the flows associated with the socio-economic process component of the framework) make up a substantial portion of Gross Domestic Product; the capital stock constitutes a part of tangible assets in the National Balance Sheet. PEP suggests the desirability of measuring natural assets as another type of tangible asset within the National Balance Sheet Accounts.[61]

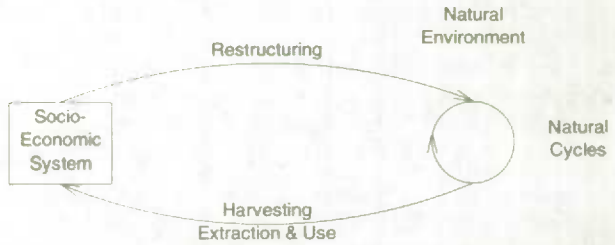


Figure 1. PEP Conceptual Framework Diagram

The purpose of including components which are not strictly "environmental" in the framework is to show how traditional environmental data (emissions, loadings in media and biota, measures of physical and biotic state) can integrate with socio-economic data to provide a more complete picture of: (i) how environmental quality may be related to socio-economic activities; and (ii) how socio-economic activities may be influenced by changing environmental quality.

From the diagram in Figure 2, three major components of PEP can be seen: stocks (represented by "barrels" in Figure 2), processes (represented by boxes) and interactions (represented by arrows). The variables relating to these components fall into four categories: states, activities, flows and restructuring. More detailed examples of the variables are provided in Table 1.

61. Statistics Canada. 1987. *Financial Flows and National Balance Sheet Accounts.* Catalogue 13-214.

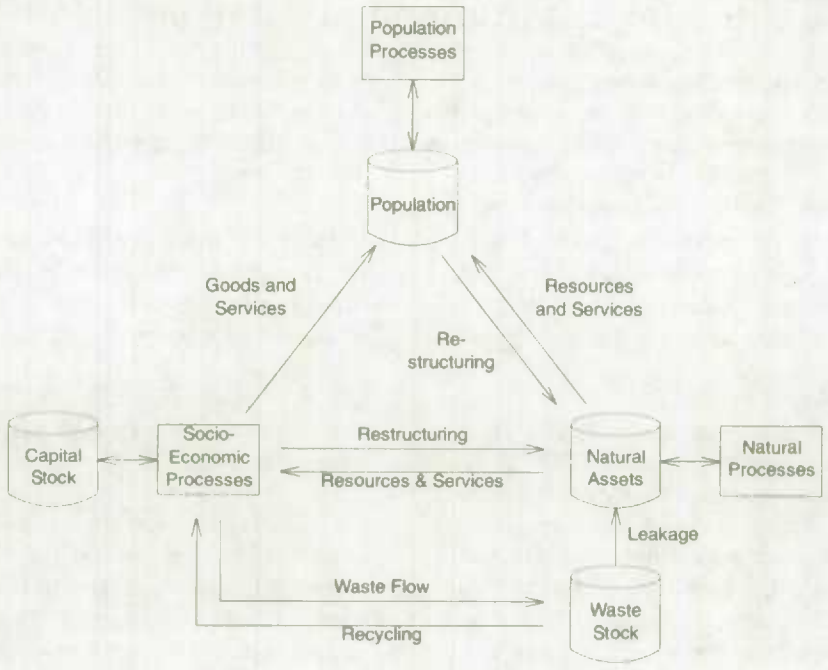


Figure 2. Population-Environment Process Framework

Table 1

The PEP Framework: Components

Component	Variable Type	Examples
Stocks		
Population	State	Number of people. Number of households. Health status.
Capital	State	Stocks of capital for pollution abatement and control, by sector, by material controlled. Built-up area. Transportation infrastructure including energy transport.
Natural Assets	State	Quantity and quality of minerals and energy. Quantity and quality of living resources. Air quality. Water quantity and quality. Amount and quality of wilderness.
Wastes	Stock	Quantity of wastes. Number of landfill sites.
Processes		
Population	Activity	Growth, migration.
Socio-economic	Activity	Outputs by sector. Production and consumption of environmentally dangerous substances. Energy consumption. Operation of transportation stock.
Natural	Activity	Rates of geochemical cycles. Natural events (storms, earthquakes, fires, pest infestations).
Interactions		
Socio-economic process with Population.	Flow	Contaminants in food and other goods.
Natural assets with Population.	Flow	Air quality in populated areas. Sport fishing and hunting. Ground water withdrawals.
Natural assets with Socio-economic processes.	Flow	Extraction of minerals and energy. Water use. Harvest of forests, fish and wildlife. Agricultural production.
Population with Natural assets.	Restructuring	Impacts of visits to wilderness and protected areas. Impacts of extracting local environmental resources (e.g. firewood).
Socio-econornic processes with Natural assets.	Restructuring	Physical restructuring through development of agriculture, mines, dams, and transport infrastructure. Biological restructuring through harvesting activities.
Wastes with Natural Environment	Flow	Release of pollutant emissions and wastes, breakdown of wastes.
Socio-econornic processes with Wastes	Flow	Generation of waste materials, recycling.

5.2 Geographic Units for Environmental Analysis

Data to assess the relationships between human activities and environmental conditions are usually more meaningful when organized by natural geographies rather than by administrative boundaries. These natural geographic units are physically defined, they remain consistent over long periods of time and many environmental qualities (e.g., climate or vegetation type) are uniform throughout one unit. This publication uses several natural spatial units for environmental analysis; drainage basins and ecozones are generally the most useful.

Drainage basins are water catchment areas delineated by heights of land. These are the natural units for all statistics dealing with water — for direct measures such as stream flow, water use, water quality and associated flora and fauna information. They are also useful for indirect measures of human activity as depicted by socio-economic statistics. Although activities such as water use or water pollution can be associated with specific administrative units, their impacts will generally extend to other parts of the drainage basin downstream.

Ecozones are large natural regions delineated by distinctive sets of biotic resources (flora and fauna) and physical resources (soil, bedrock, physiography, climate). Since each ecozone comprises a distinctive assemblage of biophysical characteristics, they constitute large, homogeneous geographic spaces, valuable for monitoring the impact of natural and man-made stress on the environment.

Actions to resolve environmental problems are usually undertaken by political administrations such as municipalities, provinces or countries. Therefore, environmental data by administrative units are of interest for management purposes, planning remedial measures, and assessing the effectiveness of policies. In this publication, statistics are presented by province/territory with subgroupings for ecozone and drainage basin.

Drainage Basins

The drainage basin classification presented here is consistent with the system used by the Water Survey of Canada, Environment Canada.[62] Drainage systems can be differentiated by the natural hierarchy of stream branching. Canada is part of the North American continental hydrological system of which five basins at the apex of the hierarchy are found in Canada. These are: (i) Atlantic Ocean Basin, (ii) Hudson Bay and Ungava Bay Basin, (iii) Arctic Ocean basin, (iv) Pacific Ocean basin and (v) Gulf of Mexico Basin. The Gulf of Mexico Basin extends over a small area of Alberta and Saskatchewan.

The drainage basin classification here is a revised version of the set originally published in the 1986 edition of *Human Activity and the Environment*. In this edition, the sub-basins as defined by the Hydrological Survey are maintained (Table 5.2.0.1).

Map 5.2.0.1 provides an outline of Canada's main basins and sub-drainage basins.

Many tables in this report present statistics for major drainage areas. These are groups of drainage basins and are designed for the illustration of broad patterns at a national scale. More detailed data or user-specified geographic aggregations are available on request.

Ecozones

The ecozones presented here were delineated by Lands Directorate of Environment Canada. See Table 5.2.0.2 for a brief description of ecozone biophysical characteristics. The ecozones are show in map form in Map 5.2.0.2.

Ecological land classification is the process of identifying areas with common landform, water, soil, vegetation, climate, wildlife and human factors. These can be further developed into a hierarchical system ranging from site-specific ecosystems (e.g., ponds, woodlots and meadows) to ecological zones encompassing large portions of the earth's surface (e.g., tundra, boreal forests, grasslands, deserts).

The Canada Committee on Ecological Land Classification has proposed a seven-level hierarchy, ranging from the eco-element, a small area with specific characteristics, to eco-provinces and ecozones, generalized ecological units covering large areas.

Ecological areas have been mapped at the more detailed level in various parts of Canada including Alberta, Quebec, Saskatchewan, Yukon and the Northwest Territories. The ecozone classification used here was one of the first attempts at a Canada-wide approach, although several regional breakdowns of Canada dealing with specific ecosystem elements had been carried out earlier (for example, forest regions, physiographic regions, and wetland regions).

Several organizing conventions were followed by Environment Canada in delineating these ecozones. Among these is a process termed complexing, which consists of

62. Environment Canada. Inland Waters Directorate. Water Resources Branch. 1986. *Water Survey of Canada. Hydrometric Map Supplement.*

grouping small spatially proximate units that might otherwise be considered as separate entities. This facilitates examination of patterns at a broad level. The Montane Cordillera Ecozone is illustrative, being composed of many very distinct ecological entities ranging from semi-desert environments, through grasslands and forests to alpine areas.

Another convention followed in delineating boundaries was that in transition areas where classifying elements intermixed, dominant components were identified and their distribution used to assist in placing the boundary line. For example, in southeastern Ontario, a mix of boreal and hardwood forest is present on the Canadian Shield. Here, landform was deemed to have the greatest impact on activities, forest type was disregarded and the boundary of the Boreal Shield was placed to coincide with the southern limit of the Canadian Shield.

Boundary lines often imply a degree of precision in demarcation of ecozones that does not actually exist. More realistically, the boundaries should perhaps be viewed as transition zones ranging from tens to hundreds of kilometres wide depending on the ecozones involved.

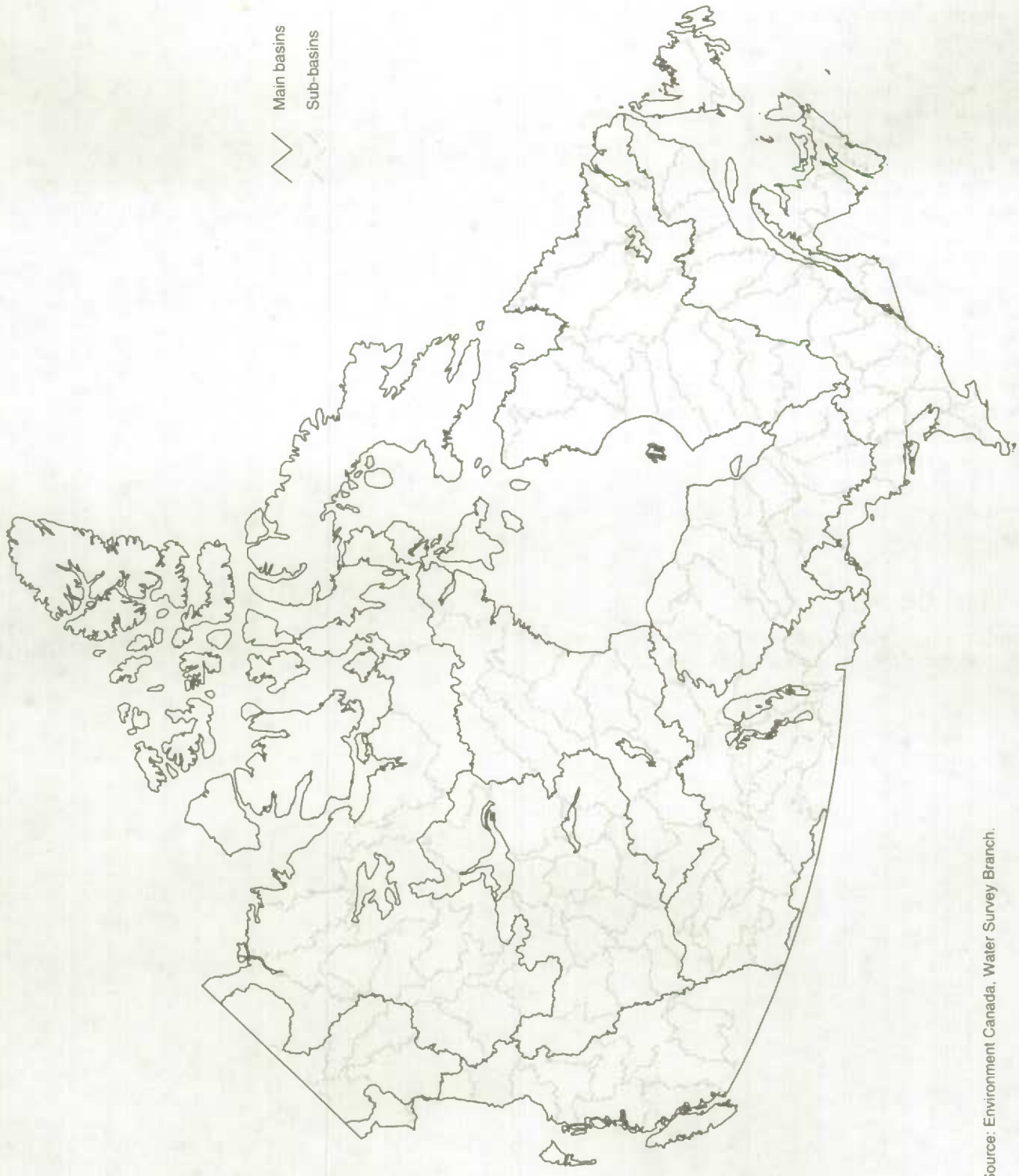
The fifteen ecozones presented here are further disaggregated by provinces and territories.

Population Centres

Locations for census metropolitan areas (CMAs) and weather stations used in this publication are provided in Map 5.2.0.3.

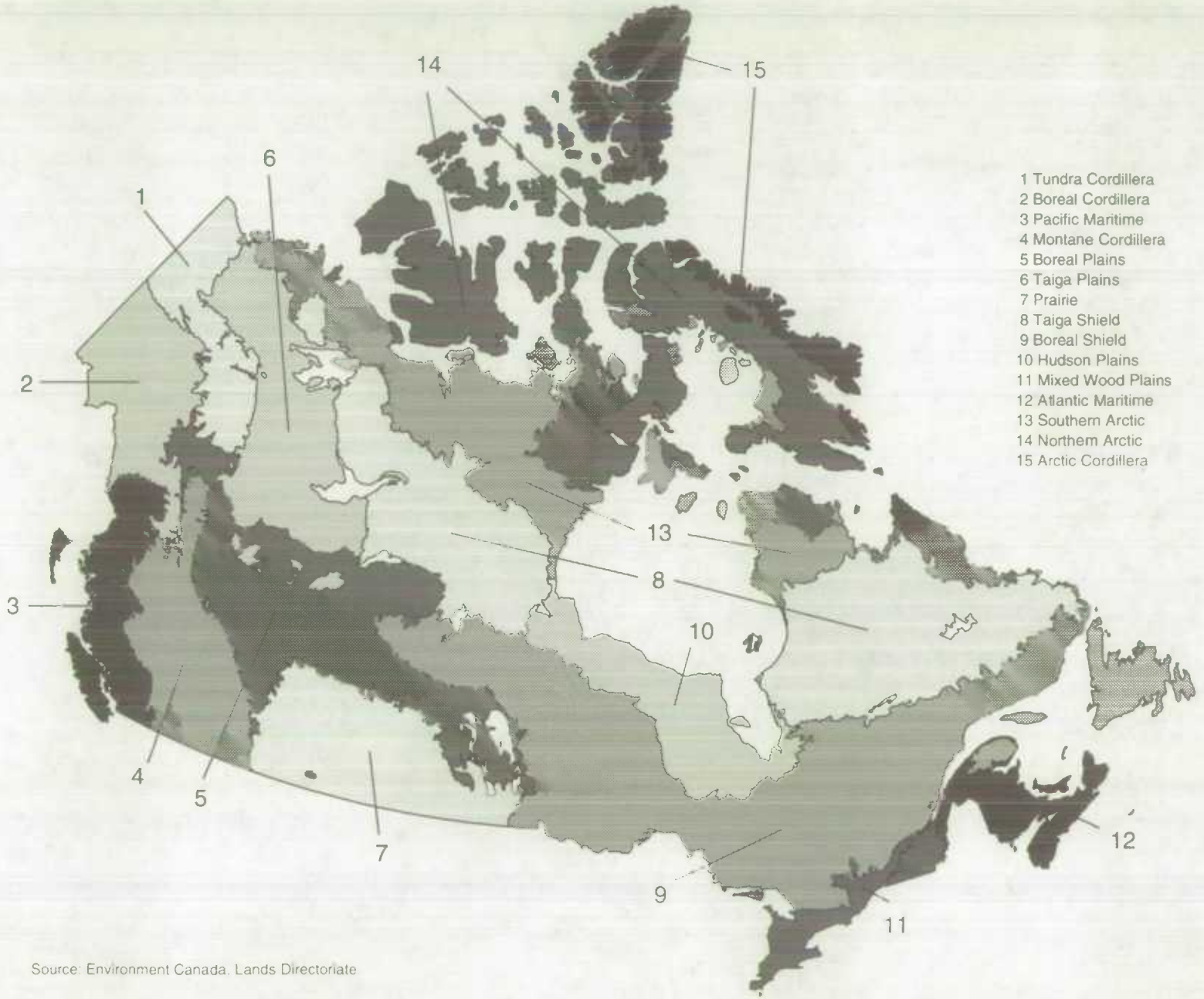
Map: 5.2.0.1

Sub-drainage Basins of Canada



Source: Environment Canada, Water Survey Branch.

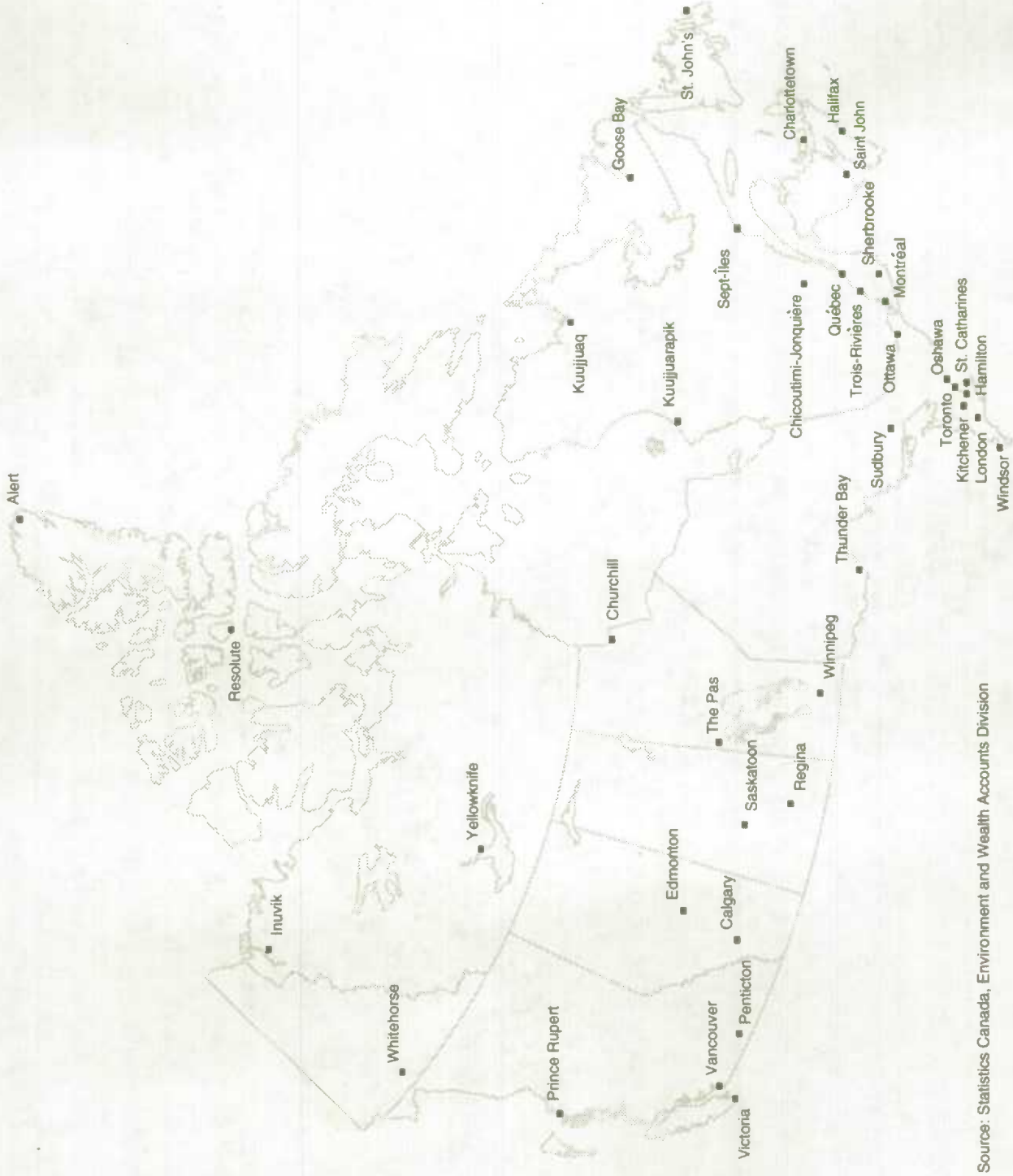
Ecozones of Canada



Source: Environment Canada, Lands Directorate

Map: 5.2.0.3

Location of CMAs and Weather Stations



Source: Statistics Canada, Environment and Wealth Accounts Division

Table: 5.2.0.1

Drainage Sub-basin Names and Areas

Province Code	Sub-basin Code	Sub-basin	Area
		Newfoundland	
10	2V	Romaine	2 709
10	2W	Natashquan	6 436
10	2X	Little Mecatina and Strait of Belle Isle	25 731
10	2Y	North Newfoundland	66 367
10	2Z	South Newfoundland	46 058
10	3N	North Labrador	86 701
10	3O	Churchill	83 035
10	3P	Naskaupi and Central Labrador	35 135
10	3Q	Eagle and South Labrador	47 022
10		Lakes	6 527
		Total	**405 720**
		Prince Edward Island	
11	1C	Prince Edward Island	5 660
		Total	**5 660**
		Nova Scotia	
12	1D	Bay of Fundy	20 860
12	1E	Southeast Atlantic Ocean	23 062
12	1F	Cape Breton Island	11 568
		Total	**55 490**
		New Brunswick	
13	1A	Saint John and South Bay of Fundy	34 627
13	1B	Gulf of St. Lawrence and North Bay of Fundy	38 736
13	2Q	North Gaspé Peninsula	77
		Total	**73 440**
		Quebec	
24	1A	Saint John	7 011
24	1B	Cascapédia and Gulf of St. Lawrence	21 809
24	2J	Upper Ottawa	33 256
24	2K	Coulonge and Central Ottawa	17 320
24	2L	Gatineau and Lower Ottawa	45 401
24	2M	Upper St. Lawrence	955
24	2N	St-Maurice	44 296
24	2O	Central St. Lawrence	34 539
24	2P	Lower St. Lawrence	37 577
24	2Q	North Gaspé Peninsula	13 795
24	2R	Saguenay	87 489
24	2S	Betsiamites	27 280
24	2T	Manicouagan and Aux Outardes	67 763
24	2U	Moisie and St. Lawrence Estuary	39 456
24	2V	Romaine and Gulf of St. Lawrence	34 260
24	2W	Natashquan and Gulf of St. Lawrence	47 262
24	2X	Little Mecatina	24 753
24	3A	Nottaway	65 559
24	3B	Broadback and Rupert	72 353
24	3C	Eastmain	53 040
24	3D	Fort George and Sakami	111 606
24	3E	Great Whale and Southeast Hudson Bay	63 541
24	3F	Little Whale and East Hudson Bay	37 691
24	3G	Northeast Hudson Bay	103 382
24	3H	West Ungava Bay	84 552
24	3J	Aux Feuilles	53 761
24	3K	Koksoak	46 222
24	3L	Caniapiskau	92 910
24	3M	East Ungava Bay	104 595
24	4M	Abitibi and North French	4 297
24	4N	Harricanaw	28 598
		Total	**1 506 350**

Province Code	Sub-basin Code	Sub-basin	Area
		Ontario	
35	2A	Nipigon and Northwest Lake Superior	43 038
35	2B	Northeast Lake Superior	40 068
35	2C	North Lake Huron	34 378
35	2D	Wanipitai and French	19 109
35	2E	East Georgian Bay	22 254
35	2F	East Lake Huron	14 810
35	2G	North Lake Erie	22 944
35	2H	Lake Ontario	28 709
35	2J	Montréal and Upper Ottawa	17 624
35	2K	Madawaska, Petawawa and Central Ottawa	22 903
35	2L	Rideau and Lower Ottawa	9 009
35	2M	Upper St. Lawrence	4 454
35	4A	Hayes	16 750
35	4B	Nisksibi and Central Hudson Bay	16 975
35	4C	Severn	89 407
35	4D	Winisk	78 477
35	4E	Ekwan	51 525
35	4F	Attawapiskat	56 098
35	4G	Upper Albany	63 815
35	4H	Lower Albany	39 259
35	4J	Kenogami	51 194
35	4K	Kwataboahegaa	9 047
35	4L	Moose	63 296
35	4M	Abitibi	32 707
35	4N	Harricanaw	15 894
35	5P	Upper Winnipeg	43 435
35	5Q	English	51 416
35	5R	East Lake Winnipeg	21 720
		Total	**980 315**
		Manitoba	
46	4A	Hayes	92 288
46	4B	Nisksibi and Central Hudson Bay	17 562
46	4C	Severn	3 227
46	5J	Qu'Appelle	59
46	5K	Saskatchewan	18 815
46	5L	Lake Winnipegosis and Lake Manitoba	54 912
46	5M	Assiniboine	24 874
46	5N	Souris	9 040
46	5O	Red	25 547
46	5P	Winnipeg	12 973
46	5R	East Lake Winnipeg	34 248
46	5S	West Lake Winnipeg	23 910
46	5T	Rat and Grass	42 413
46	5U	Nelson	49 164
46	6D	Reindeer Lake	10 744
46	6E	Central Churchill	43 360
46	6F	Lower Churchill and West Hudson Bay	55 298
46	6G	Seal and West Hudson Bay	75 813
46	6H	Nueltin Lake	19 159
46	6L	Kazan	807
46		Lakes	35 738
		Total	**649 950**

Drainage Sub-basin Names and Areas

Province Code	Sub-basin Code	Sub-basin	Area
		Saskatchewan	
47	5A	Upper South Saskatchewan	920
47	5C	Red Deer	199
47	5E	Central North Saskatchewan	13 562
47	5F	Battle	4 431
47	5G	Lower North Saskatchewan	41 103
47	5H	Lower South Saskatchewan	55 013
47	5J	Qu'Appelle	70 192
47	5K	Saskatchewan	58 186
47	5L	Lake Winnipegosis and Lake Manitoba	18 789
47	5M	Assiniboine	26 964
47	5N	Souris	29 449
47	6A	Beaver	32 379
47	6B	Upper Churchill	43 331
47	6C	Upper Central Churchill	45 496
47	6D	Reindeer Lake	48 425
47	6E	Central Churchill	8 124
47	6H	Nueltin Lake	147
47	6L	Kazan	7 849
47	7C	Lower Central Athabasca	14 382
47	7D	Lower Athabasca	2 446
47	7L	Fond du Lac	63 808
47	7M	Athabasca Lake	27 677
47	7Q	Taltson and Southeast Great Slave Lake	4 366
47	11A	Missouri	20 506
47		Lakes	14 585
		Total	**652 330**
		Alberta	
48	5A	Upper South Saskatchewan	45 921
48	5B	Bow	25 442
48	5C	Red Deer	49 135
48	5D	Upper North Saskatchewan	27 964
48	5E	Central North Saskatchewan	28 759
48	5F	Battle	25 703
48	5G	Lower North Saskatchewan	10 764
48	5H	Lower South Saskatchewan	129
48	6A	Beaver	16 973
48	6B	Upper Churchill	668
48	7A	Upper Athabasca	34 896
48	7B	Pembina and Central Athabasca	41 135
48	7C	Lower Central Athabasca	42 244
48	7D	Lower Athabasca	26 719
48	7F	Upper Peace	17 550
48	7G	Smoky	46 148
48	7H	Central Peace	35 731
48	7J	Lower Central Peace	58 730
48	7K	Lower Peace and Lake Claire	36 452
48	7M	Athabasca Lake	4 630
48	7N	Slave	11 584
48	7O	Upper Hay	39 721
48	7P	Buffalo	16 395
48	7Q	Taltson and Southeast Great Slave Lake	1 392
48	7U	West Great Slave Lake	521
48	10C	Fort Nelson	1 206
48	10D	Petitot	7 698
48	11A	Missouri	6 982
		Total	**661 190**
		Yukon	
60	8A	Alsek	25 931
60	9A	Upper Yukon	67 084
60	9B	Pelly	50 282
60	9C	Upper Central Yukon	44 091
60	9D	Stewart	51 882
60	9E	Central Yukon	29 927
60	9F	Porcupine	62 246
60	9G	Tanana	1 993
60	10A	Upper Liard	38 634
60	10B	Central Liard	19 284
60	10D	Petitot	2 366
60	10M	Peel and Northwest Arctic Ocean	89 730
		Total	**483 450**
		Canada Total	**9 848 015**

Province Code	Sub-basin Code	Sub-basin	Area
		British Columbia	
59	7E	Williston Lake	72 865
59	7F	Upper Peace	49 133
59	7G	Smoky	4 975
59	7O	Upper Hay	8 379
59	7U	West Great Slave Lake	124
59	8A	Alsek	8 478
59	8B	Taku and North Pacific Ocean	22 600
59	8C	Stikine	50 728
59	8D	Nass and North Central Pacific Ocean	30 022
59	8E	Skeena	56 521
59	8F	Gardner Canal and Central Pacific Ocean	52 379
59	8G	Knight Inlet and South Pacific Ocean	43 196
59	8H	Vancouver Island	34 786
59	8J	Nechako	46 939
59	8K	Upper Fraser	65 949
59	8L	Thompson	55 991
59	8M	Fraser	63 094
59	8N	Columbia	102 684
59	8O	Queen Charlotte Islands	9 644
59	8P	Skagit	1 019
59	9A	Upper Yukon	25 321
59	10A	Upper Liard	20 450
59	10B	Central Liard	53 988
59	10C	Fort Nelson	53 979
59	10D	Petitot	14 554
		Total	**947 800**
		North West Territories	
61	6G	Seal and West Hudson Bay	491
61	6H	Nueltin Lake	54 274
61	6J	Upper Thelon	71 481
61	8K	Dubawnt Lake	70 303
61	6L	Kazan	64 530
61	6M	Lower Thelon	80 171
61	6N	Northwest Central Hudson Bay	58 882
61	6O	Northwest Hudson Bay	92 210
61	6P	Southampton Island	61 218
61	7L	Fond du Lac	5 116
61	7N	Slave	4 896
61	7O	Hay	3 095
61	7P	Buffalo	18 028
61	7Q	Taltson and Southeast Great Slave Lake	89 349
61	7R	Aylmer Lake and MacKay Lake	27 446
61	7S	Yellowknife and Northeast Great Slave Lake	67 306
61	7T	Marian	26 306
61	7U	West Great Slave Lake	28 509
61	10D	Petitot	5 627
61	10E	Lower Liard	52 777
61	10F	Upper Mackenzie	51 276
61	10G	Upper Central Mackenzie	57 714
61	10H	Central Mackenzie	68 340
61	10J	Great Bear	126 946
61	10K	Lower Central Mackenzie	47 658
61	10L	Lower Mackenzie	73 459
61	10M	Peel and Northwest Arctic Ocean	18 633
61	10N	Anderson and West Arctic Ocean	98 328
61	10O	Amundsen Gulf	93 204
61	10P	Coppermine	54 708
61	10Q	Coronation Gulf and Dease Strait	131 595
61	10R	Back and Queen Maud Gulf	160 281
61	10S	Gulf of Boothia	164 767
61	10T	Arctic Islands	1 337 502
61		Lakes	59 894
		Total	**3 426 320**

Table: 5.2.0.2

Ecozone Biophysical Characteristics

Ecozone	Physiography	Vegetation	Soils and Surface Materials	Climate
Atlantic Maritime	Hills and coastal plains	Mixed broadleaf and conifer stands	Acid and well weathered soils (podzols) and soils with clay- rich sublayers (luvisols), moraine, marine bottom soils and rock debris	Cool to cold winters, mild summers, moderate to heavy precipitation
Mixed-Wood Plain	Plains, some interior hills	Mixed broadleaf and conifer stands	Temperate region soils with clay- rich sublayers (luvisols), marine bottom soils, moraine rock	Cool to cold winters, warm to hot summers, moderate precipitation
Boreal Shield	Plains, uplands, interior hills, many lakes and streams	Conifer and broadleaf boreal stands	Acid and well weathered soils (podzols), lake bottom soils, moraine, rock	Cold winters, warm to hot summers, moderate precipitation
Prairie	Plains, some foothills	Short and mixed grasslands, aspen parkland	Organically rich, relatively fertile grasslands soils (chernozems), moraine and lake bottom materials	Cold winters, warm to hot summers, moderate precipitation
Boreal Plain	Plains, some foothills	Conifer and broadleaf boreal stands	Temperate region soils with clay- rich sublayers (luvisols), moraine and lake bottom materials	Cold winters, warm summers, moderate precipitation
Montane Cordillera	Mountainous highlands, interior plains	Mixed vegetation, conifer stands to sage brush	Temperate regions soils with clay rich sublayers (luvisols), soils with minimal weathering (brunisols), moraine, rock, rock debris	Cool to cold winters, warm to hot summers, arid in lee areas, moist in montane areas
Pacific Maritime	Mountainous highlands, some coastal plains	Coastal western and mountain hemlock	Acid and well- weathered soils (podzols), moraine, rock, rock debris	Mild winters, mild summers, heavy precipitation in lee areas, moist in montane areas
Boreal Cordillera	Mountainous highlands, some hills and plains	Boreal, some alpine tundra and open woodland	Soil with minimal weathering (brunisols), moraine, rock	Cold winters, mild summers, minimal precipitation in lee areas, moist in montane areas
Tundra Cordillera	Mountainous hightands	Alpine and arctic tundra	Soils with minimal weathering (brunisols), frozen soils (cryosols), moraine, rock	Very cold winters, cool summers, minimal precipitation
Taiga Plain	Plains, some foothills	Open woodland, shrublands and wetlands	Soils with minimal weathering (brunisols), acid and well- weathered soils (podzols) some frozen soils (cryosols), organic materials, moraine	Cold winters, mild to warm summers, moderate precipitation
Taiga Shield	Plains, uplands, some interior hills, may lakes and streams	Open woodlands, some arctic tundra and lichen health	Soils with minimal weathering (brunisols), acid and well- weathered soils (podzols) some frozen soils	Cold winters, warm summers, minimal precipitation
Hudson Bay Plain	Plains	Wetlands, Arctic tundra and some conifer stands	Organic soils, sea bottom and beach materials	Cold winters, mild summers, minimal precipitation
Southern Arctic	Plains, some interior hills	Shrub/herb/heath Arctic tundra	Frozen soils (cryosols), moraine, rock marine bottom sediments	Cold winters, cool summers, minimal precipitation
Northern Arctic	Plains and hills	Herb-lichen Arctic tundra	Frozen soils (cryosols), moraine, rock marine bottom sediments	Very cold winters, cool summers, minimal precipitation
Arctic Cordillera	Mountainous highlands	Largely non- vegetated, some shrub/herb Arctic tundra	Frozen soils (cryosols), rock, rock debris, ice	Very cold winters, cool to cold summers minimal precipitation

Source:
Environment Canada, Lands Directorate, Terrestrial Ecozones of Canada, by E. Wiken, unpublished working paper, August 1983.
Note:
This list is meant to be illustrative only and is not a comprehensive presentation of the characteristics of these areas.

5.3 Jock River Environmental Assessment: A Case Study

The Jock River is a major tributary of the Rideau River flowing from the Rideau Lakes towards the city of Ottawa (Map 5.3.0.1). The Jock River Basin has been mainly farmland since it was cleared of forests in the early 1800s. 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. Residents and users of the Jock River basin have been aware of water quality problems making 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 a source of drinking water would prove hazardous.

In 1989 a group of concerned citizens formed *The Friends of the Jock River* committee. 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 Wealth Accounts Division, assisted this group with identifying potential environmental impacts in the Jock River Watershed. The Division operates and maintains a geographically referenced database known as the *Environmental Information System* **(EIS)**. The EIS can be used to analyze environmental problems on various scales ranging from national studies to assessing local watershed concerns. The system is particularly useful for re-aggregating data to spatial units appropriate to the level of analysis. Watersheds are a good example of these spatial units, where impacts within a river system transcend traditional political boundaries, and it is essential to describe 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 and combining the information layers in the **EIS**. These information layers provide 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. 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 hypothetical forested discharge curve on Figure 5.3.0.1 represents the same volume of water but shows the effects of a greater proportion of forest cover. In 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. The flooding and low summer flow in the river can be attributed to human activities in the basin. The Jock River's discharge pattern has changed over time as vegetative cover and drainage conditions have changed.

Historical discharge records do not go back to the pre-agricultural era, when the basin was under natural forested cover. The removal of forested land increases the run-off rate in a river basin, because forests intercept and store much of the moisture in the trees themselves and in soils beneath the forest. Tilled land does not store water as readily as forested land because tilled land is subject to evaporation from direct sunlight and is frequently cultivated. Tilling and cultivation 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 and, 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, 6,890 hectares of agricultural land in the Jock river basin were artificially drained. This amounts to more than 12 percent of the river basin area, and represents a substantial alteration of natural drainage patterns.

Physiography, Climate and Soils

Agriculture Canada's Land Potential Database **(LPDB)** contains details on Canadian land potential. In combination with the Environmental Information System, it is possible to analyse the soil and climate properties of the basin. The Jock River Basin consists of two soil types: an Orthic Melanic Brunisol, and a Humic Gleysol. These young soils have developed under a forested environment. The brunsolic soil is the better drained of the two soils. Fertility of these soils is

generally variable, but in the Jock River basin, the fertility of these soils is moderate to high. These soils developed from glacial parent materials, primarily from glacial till and lacustrine deposits.

The basin has a climate 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 centimetres 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 soil erosion potential.

Socio-economic Conditions

Historical data from the **EIS** was 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 percent agriculture, 10 percent urban / transportation, 10 percent wetlands, 15 percent forests. By 1986 the agricultural land area, had declined to 55 percent. Most of this land use change was from agricultural to urban uses (Table 5.3.0.1).

Agricultural practices in the basin have significant effect 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 from 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 (Map 5.3.0.2).

Other data indicate an intensification of land use. Total cropped area increased from 12,845 hectares to 15,075 hectares by 1986. The crop output potential has therefore increased 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 assessed using the Agricultural Practices Impact Model **APIM**. Results suggest that high stress monoculture cropping practices have been on the rise over the study period. Wide-row monoculture, the practice of planting the same 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 5.3.0.2 through 5.3.0.5, where these activities coincide.

According to Census of Population figures, the urban population has grown by 380 percent, 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 20,695 (Map 5.3.0.5). This population trend will likely continue as urban development proposals for both Nepean and Goulbourn are implemented.

The Environment and Natural Resources Section has developed a set of industrial impact classes used to classify manufacturing establishments into those with a high, medium or low impact on the environment. The industrial data from the 1986 Census of Manufactures indicates that there are 9 establishments in the Jock River Basin. Most of these industries are in low environmental impact classes.[62] Manufacturing likely has little environmental impact in the basin and stresses in the area are most likely from human settlements and agricultural activity.

Conclusions

The Jock River Basin has undergone many changes during the past two centuries. Historical statistical records show that over the last twenty years population has tripled, and that use of land, the main natural resource in the basin, has intensified significantly. Fertilizer and pesticide inputs, each of which have high environmental impact, have increased as well.

References

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62. See the Industry section for a discussion of Industry Impact Classes.

Map: 5.3.0.1

INDEX MAP - JOCK RIVER BASIN

Source: Statistics Canada, Environment and Wealth Accounts Division.

Table: 5.3.0.1

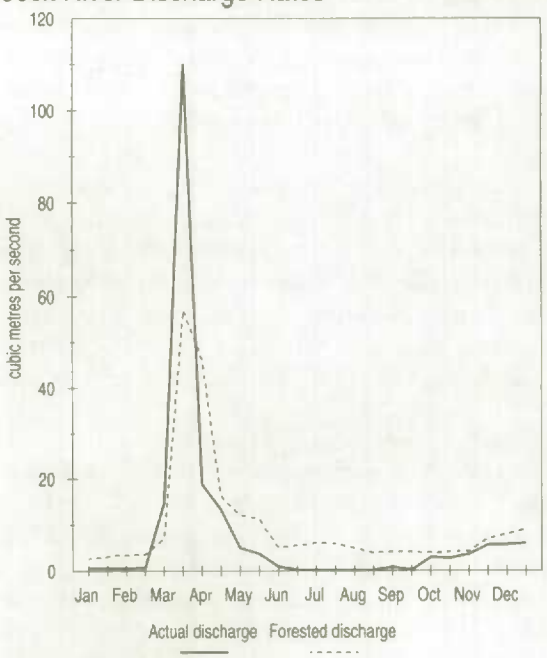
The Jock River Watershed, 1971-1986

	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.

Figure: 5.3.0.1

Jock River Discharge Rates

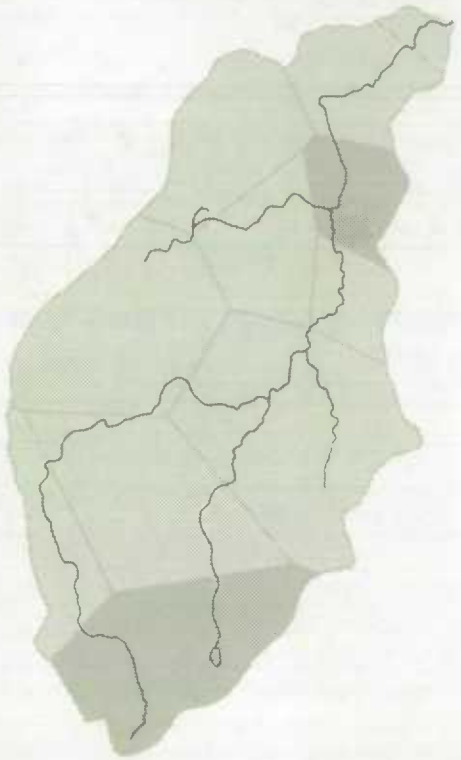


Source: Environment Canada. Inland Waters Directorate.

Agricultural Pesticide Application, 1970 and 1985
Jock River Basin

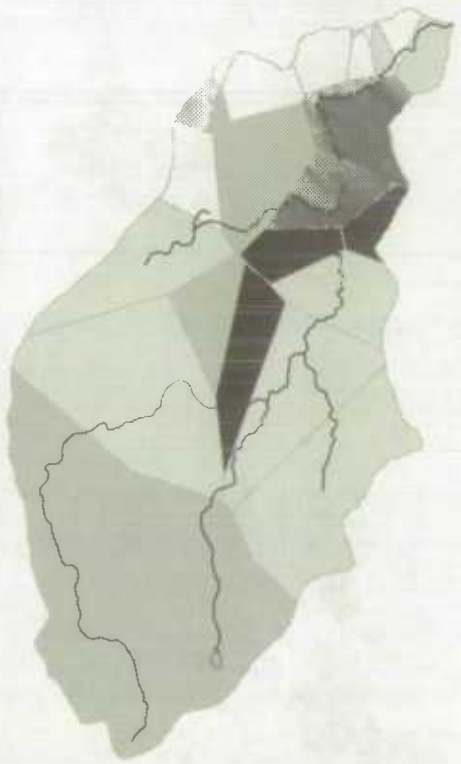
1970

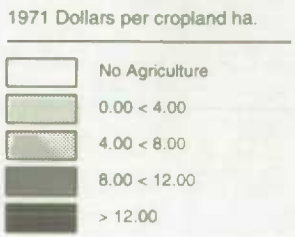
Total Value Applied = $33,330



1985

Total Value Applied = $75,526





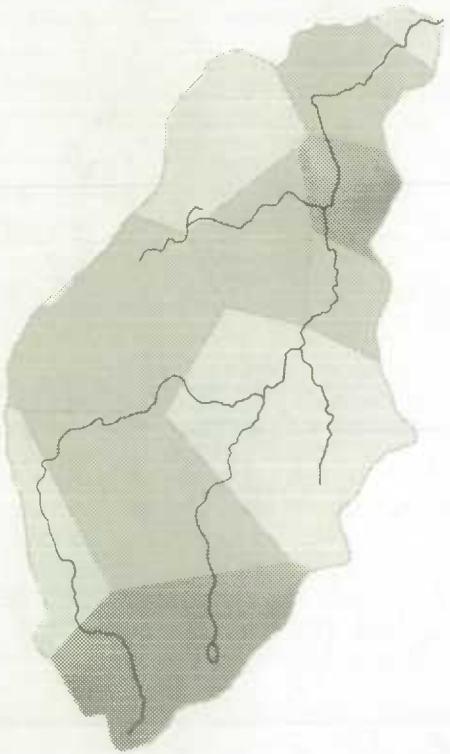
Source: Statistics Canada, Environment and Wealth Accounts Division, Agriculture Division.

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

Fertilizer Application Rates, 1970 and 1985
Jock River Basin

1970

Total Tonnage = 1,615

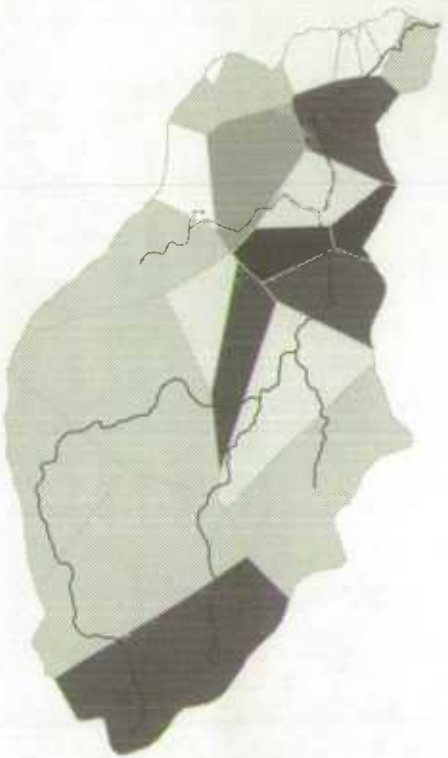


Kilograms per cropland hectare

- No Agriculture
- 0 < 100
- 100 < 200
- 200 < 300
- 300 < 500
- > 500

1985

Total Tonnage = 3,295



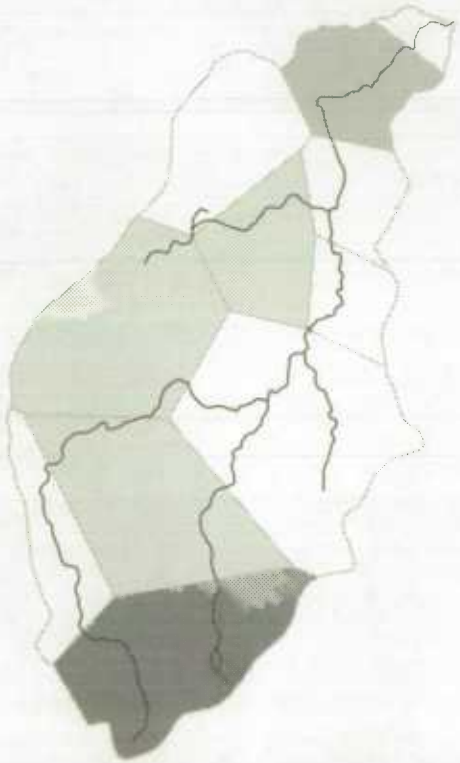
Source: Statistics Canada, Environment and Wealth Accounts Division.
Agriculture Division.

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

Wide-row Monoculture, 1971 and 1986
Jock River Basin

1971

Monoculture Area = 687 Ha.

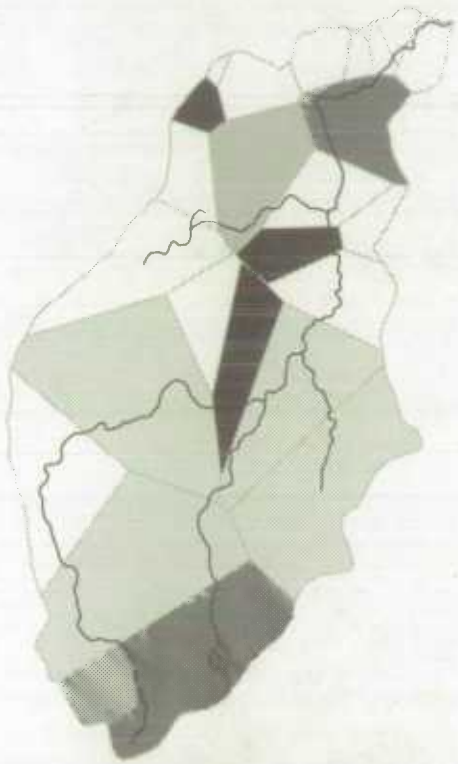


Percent of cropland

- No monoculture
- 0 < 8
- 8 < 16
- 16 < 24
- > 24

1986

Monoculture Area = 1820 Ha.

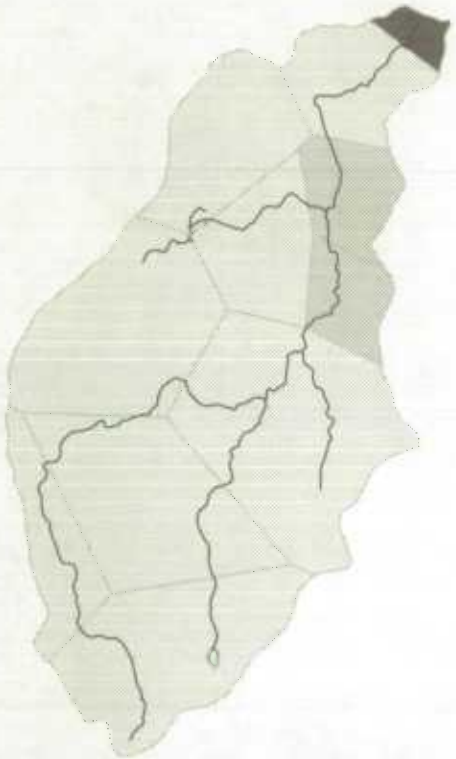


Source: Statistics Canada, Environment and Wealth Accounts Division. Agriculture Division.

Population Density, 1971 and 1986
Jock River Basin

1971

Population = 6,995

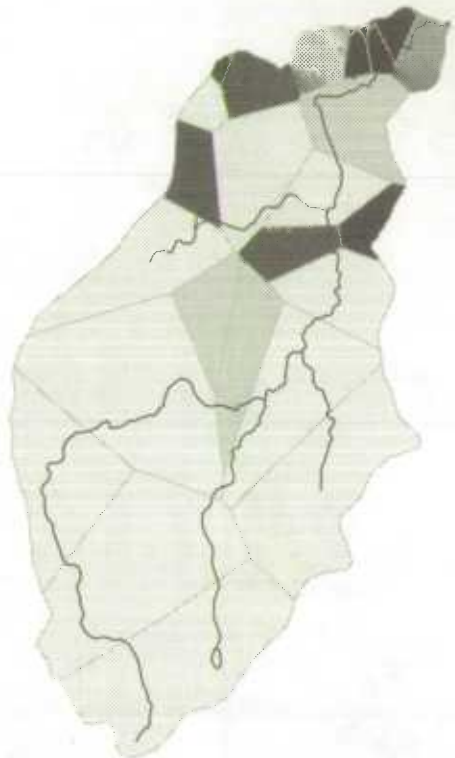


Persons per sq.km.

- 0 < 25
- 25 < 75
- 75 < 100
- 100 < 150
- > 150

1986

Population = 20,695



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

6. Index

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