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Environmental Perspectives

3

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Studies and Statistics

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Symbols

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
e	estimate
p	preliminary figures
r	revised figures
x	confidential to meet secrecy requirements of the *Statistics Act*

Prefixes of the Metric System

Prefix	Abbreviation	Multiplication factor
exa	E	10^{18}
peta	P	10^{15}
tera	T	10^{12}
giga	G	10^{9}
mega	M	10^{6}
kilo	k	10^{3}
hecto	h	10^{2}
deca	da	10^{1}
deci	d	10^{-1}
centi	c	10^{-2}
milli	m	10^{-3}
micro	µ	10^{-6}
nano	n	10^{-9}
pico	p	10^{-12}
femto	f	10^{-15}
atto	a	10^{-18}

Abbreviations

1986$	constant 1986 dollars
A	ampere
cm	centimetre
°C	degree Celsius
d	day
dB	decibel
EA	enumeration area
g	gram
GDP	Gross Domestic Product
ha	hectare
h	hour
Hz	hertz
J	joule
kg	kilogram
km	kilometre
km^2	square kilometre
km^3	cubic kilometre
km/h	kilometres per hour
kPa	kilopascal
kt	kilotonne
kWh	kilowatt hour
l	litre
m	metre
m^2	square metre
m^3	cubic metre
Mm^3	million cubic metres
mm	millimetre
min	minute
mol	mole
Mt	megatonne
µg	microgram
nec	not elsewhere classified
ng	nanogram
ppm	parts per million
ppb	parts per billion
ppt	parts per trillion
s	second
SIC	Standard Industrial Classification
t	tonne
TJ	terajoule
TAC	total allowable catch
W	watt

Preface

Environmental Perspectives: Studies and Statistics is devoted to disseminating the results of analytical projects and development of data detailing the relationship between the environment and the economy. This publication appears annually between issues of the quinquennial *Human Activity and the Environment*, which was last published in 1994.

Whereas *Human Activity and the Environment* is a comprehensive compendium of environmental-economic data, this publication presents a selection of data and analysis that reflect the current environmental statistics program at Statistics Canada.

This third volume of *Environmental Perspectives* presents new developments from the research program in the areas of environmental surveys and natural resource accounting. The environmental survey work focuses on environmental protection expenditures and the resource accounts examines Canada's land resource and its fishery. In addition, the annex of environmental statistics has been restructured and expanded and it now includes a section of summary statistics for the North American Free Trade Agreement (NAFTA) countries.

Environmental Surveys

- Chapter 1 provides an overview of the structure of the environmental satellite accounts, their relationship to the core elements of the Canadian System of National Accounts, and their correspondence with counterpart business financial accounts - with particular emphasis on the conventions for treatment of environmental protection expenditures.
- The challenges of measuring and interpreting environmental protection expenditures of the business and public sectors are explored in Chapter 2. An overview of current practices of other industrialised nations is provided for comparative reference.
- Chapter 3 presents an analysis of the environmental protection expenditures reported by the Canadian business sector over the period 1985 to 1993.
- Chapter 4 examines that part of the environment industry which provides consulting engineering and scientific and technical services to aid businesses develop and implement environmental management, protection and remediation activities.
- Environmental activities of the household sectors in Canada and Australia are examined in Chapter 5. Energy use, water use and waste management practices of households are compared.

Natural Resource Accounts

- Chapter 6 introduces the work on natural resource account development with a discussion of the importance of both physical stock and monetary measures to the examination of sustainability.
- Land Accounts: In Chapter 7, the recent history of land cover and land use data for Canada is examined from the perspective of policy shifts. A framework is proposed for the ordering of the existing mosaic of land information and for which new information can be developed. The application of the framework was piloted for New Brunswick, and the results are presented in Chapter 8. Chapter 9 explores the valuation of a subset of Canada's land, that devoted to agriculture.
- Chapter 10 presents a statistical profile of Canada's ocean fisheries.

Finally a set of broad economic, social and environmental statistics for NAFTA member countries are presented in Annex 1, while Annex 2 presents a similar range of statistics for Canada, the provinces and territories.

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The authors were:

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Michael Bordt
Alice Born
Giuseppe Filoso
Jeff Fritzsche
Pierre Gagnon
Craig Gaston
Ken Korporal
Anik Lacroix
Martin Lemire
Julie McAuley
Bruce Mitchell
Marcia Santiago
Doug Trant
Hélène Trépanier

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We are indebted for the contributions of Environment Canada, Fisheries and Oceans Canada and the Australian Bureau of Statistics.

1 A Comparison of Business Accounting and National Accounting from an Environmental Perspective

by Cynthia Baumgarten

Introduction

Until recently, the earth was assumed to be an infinite source of raw materials and an equally infinite receptacle for waste. The seemingly endless supply of free goods did not need to be counted. Resources were a natural endowment to be taken or used. There was no economic transaction associated with their taking or discard and no record of the remaining stock.

Increased awareness of the finitude of the earth's resource base, its ability to absorb waste and of the fragility of its ecosystems has changed this perception. This awareness is reflected everywhere. School children are being sensitized to the fragility of their natural surroundings, consumers are being warned about the impact of their wasteful attitudes, air pollution indexes and ozone depletion indexes are being published with associated health risk warnings, and environmental organizations are challenging the rights of current generations "to consume the earth" at a rate that will put at risk the ability of future generations to survive.

Government and non-government organizations have responded with both regulation and voluntary rules of self governance to preserve natural wealth and to protect the environment. "Sustainable development" is the rallying objective. Associated with this objective is a need for assessment of the remaining wealth, of the rate at which it is being depleted and of the impact on ecosystems. Statistical organizations around the world are determining how best to reflect the relationships between economic activity and the environment within their existing statistical and national accounting systems.

Like most accounting frameworks, the Canadian System of National Accounts (CSNA) reflects only market or monetary transactions. In a few instances, exceptions are made to extend the limits of the system to include non-market transactions, in order to ensure a consistent representation of a country's economic output. The Generally Accepted Accounting Principles of business accounting share a comparable philosophy. Business accounting is limited to economic events which for the most part are represented by market transactions. However, exceptions are made to ensure a meaningful representation of the "output", health and viability of the company. Steps are being taken to significantly expand the limits of both accounting systems to provide information that will reflect the "environmental perspective" in economic and financial assessment and analysis. The following paper outlines the components of the CSNA for which environmental satellite accounts are to be developed and draws links between them and the corresponding (and evolving) components of business accounts.

The CSNA

Statistics Canada has undertaken the development of a set of environmental statistics that will help both policy and economic analysts address environmental questions relating to sustainable development. The integrated economic accounts for Canada were taken as a model for the environmental accounts because of their utility as powerful analytical tools that support the examination of the interdependence of products and processes among all sectors of the economy. Since they are based on internationally accepted standards, they provide information which can be combined with that of other countries to assess the environmental issues which transcend international borders.

The CSNA provides a kind of statistical framework within which to formulate environmental policy and which links well to the framework for economic policy analysis. It is made up of 4 components:

- *the Input-Output Accounts* which measure productive activity and allow an overview of the relationship between the producers and purchasers in the economy;
- *the Income and Expenditure Accounts* which focus on income generated by productive activity and final expenditure on that production;
- *the Financial Flow Statements and the National Balance Sheet* which reveal the financing of economic activity in terms of flows of funds and levels of assets; and finally
- *the Balance of Payments and International Investment Position* which record transactions between Canadians and non-residents.

If a complete set of information describing the role of the environment in the economy were available, its incorporation in the CSNA would nevertheless be daunting. For example, this would require the addition of an environmental sector where the supply and absorption of environmental goods and services as well as resources supplied by mother nature would be accounted for in the various accounts of the

Table 1.1
An Abbreviated and Simplified Input-Output Table

	Intermediate expenditure				Final expenditure				
	Business sector				Household sector	Government sector	Business sector	Non-resident sector	
	Industry 1	Industry 2	...	Industry n					
Commodity 1	Intermediate inputs				Expenditure on goods and services	Expenditure on goods and services	Gross fixed capital formation and additions to inventory	Net exports of goods and services	= Gross business output
Commodity 2									
...									
Commodity n									
Primary inputs	Payments to labour, profits, investment income, depreciation				Payments to labour, depreciation	Payments to labour, investment income, depreciation			= Gross Domestic Product
	Total business inputs = Gross business output								

system. The nomenclature of commodities and assets used in the accounts would also have to be expanded to include resources and services provided by the environment to the business, personal, government and non-resident sectors. For example, the use of the environment as a dump for waste would be explicitly included as a service output of the environment sector, purchased by the other sectors.

Since it would take many years to develop a comprehensive and reliable set of data to implement such an extensive integration, Statistics Canada opted to start with a "satellite account" approach. The 1993 International System of National Accounts describes the role of satellite accounts in these terms (United Nations *et al.*, 1993; p. 489):

> Typically satellite accounts or systems allow for: (a) the provision of additional information on particular social concerns of a functional or cross-sector nature; (b) the use of complementary or alternative concepts, including the use of complementary and alternative classifications and accounting frameworks, when needed to introduce additional dimensions to the conceptual framework of national accounts; (c) extended coverage of costs and benefits of human activities; (d) further analysis of data by means of relevant indicators and aggregates; and (e) linkage of physical data sources and analysis to the monetary accounting system.

Although the measurement of physical stocks and flows of natural resources is relatively objective, complementary monetary assessments are quite challenging and controversial. The first objective in the development of the satellite accounts has been to measure in physical terms the stocks and flows of the natural assets which are directly affected by the economy, although some priority has been given to assessing their monetary value. The satellite accounts will allow integration of the environment into the two components of the CSNA that elaborate the stocks and flows; the Input-Output Tables and the National Balance Sheet.

The environmental satellite accounts: input-output component

The Input-Output Tables present information on the flows of goods and services in the economy between suppliers and users. Table 1.1 contains a schematic presentation of the Input-Output Tables prior to the introduction of environmental components. The rows titled "Commodity" identify the commodities used as intermediate input or for final consumption by the sectors identified along the columns: business, households, government and non-residents.

The set of columns under the general heading "Intermediate expenditures" presents the value of the commodities transformed into other products by the various industries of the business sector. This value includes the intermediate inputs, that is, the cost of the goods and services used in the production process, as well as the primary inputs, that is, the cost of labour and capital.

The set of columns under the general heading "Final expenditures" presents the value of the goods and services sold to households and governments for final consumption, to business for additions to fixed capital and inventory, and finally those traded with non-residents as exports and imports. The sum of all purchases (cells along a commodity row) adds up to a commodity gross output. The sum along the primary input rows adds up to Gross Domestic Product.

Some elements of the proposed environmental satellite accounts are already included in the Input-Output Tables. Items such as outlays for environmental protection are found in the intermediate inputs to production, in gross fixed capital formation and in additions to inventories. These will be identified separately to permit their inclusion in the satellite accounts.

Other elements of the proposed satellite accounts need to be developed. This is the case for the land use and the natural resource use accounts, recording the non-produced natural assets consumed by business, households and

Table 1.2
An Input-Output Table Adjusted to Include the Environment

	Intermediate expenditure				Final expenditure				
	Business sector				Household sector	Government sector	Business sector	Non-resident sector	
	Industry 1	Industry 2	...	Industry n					
Commodity 1	Intermediate inputs				Expenditure on goods and services	Expenditure on goods and services	Gross fixed capital formation and additions to inventory	Net exports of goods and services	Gross business output
Commodity 2									
...									
Commodity n									
Commodity	Intermediate inputs; outlays for environmental protection (M)				Outlays for environmental protection (M)	Outlays for environmental protection (M)	Gross fixed capital formation and additions to inventory for environmental protection (M)	Net exports of goods and services for environmental protection	
Non produced natural assets	Intermediate inputs (P)				Consumption (P)	Consumption (P)	Additions to inventory (P)		
Waste	Waste output (P)				Waste output (P)	Waste output (P)			
Primary inputs	Payments to labour, profits, investment income, depreciation				Payments to labour, depreciation	Payments to labour, investment income, depreciation			= Gross Domestic Product
	Total business inputs = Gross business output								

Note:
(P) indicates accounts for which only physical measures will be developed; (M) indicates accounts for which monetary measures will be developed.

governments, as well as the accounts showing the waste output from each of the sectors.

Table 1.2 illustrates how the satellite accounts - the shaded areas - relate to the standard Input-Output Tables. The lightly shaded cells in the rows entitled "Commodity" represent the elements already included in the CSNA since they are currently exchanged in the market for money. The cells in the rows with darker shading represent respectively the non-produced natural assets consumed and the waste returned to the environment, which are not currently traded in the market.

As satellite components, these resource use and waste outputs accounts will be expressed in physical units only (indicated by P in the table) and as such will not enter the core Input-Output Accounts. For all other satellite accounts, monetary measures (indicated by M in the table) and possibly some physical measures will be produced.

The environmental satellite accounts: asset component

At present, the CSNA provides measures of financial assets and produced assets including commercial land. These are found in the first two columns of Table 1.3. With the 1997 historical revision to the CSNA, the core accounts (i.e., the national balance sheet) will be expanded to include column 3: natural resources such as subsoil assets, timber and non commercial land. For these natural resources, opening stock, changes in volume, holding gains or losses and closing stock will be measured in monetary terms.

The stocks of natural resources incorporated in the balance sheet will also be expressed in physical terms. The shaded areas (both dark and light) in Table 1.3 identify the environmental satellite components of the CSNA asset accounts. The cells shaded in light grey represent the elements which will be common to both the core CSNA (the national balance sheet) and the environmental satellite accounts.

The CSNA and business accounting

Much of the information that Statistics Canada uses to build the Input-Output Tables and the stock - flow reconciliation accounts (which are currently implicit but will be published beginning with the 1997 historical revision) is derived from accounting statements. The information is collected from businesses with questionnaires whose wording and definitions, to the greatest degree possible, are consistent with Generally Accepted Accounting Principles. A close examination of the input-output table entries will reveal a similarity to the entries in business income statement. The Input-Output Accounts for the whole economy are basically derived from a summation of the income statements of individual businesses, although there are some basic differences.

Table 1.3

Asset Accounts and the Natural Resource Satellite Accounts in the CSNA

Stock - flow reconciliation accounts			
Assets expressed in monetary terms			Assets expressed in physical terms
Financial assets	Produced assets	Tangible non-produced assets (Natural resources)	Tangible non-produced assets (Natural resources)
Opening stock	Opening stock	Opening stock (M)	Opening stock (P)
Financial flows			
	Gross fixed capital formation		
	Gross fixed capital formation for environmental protection (M)		
Other changes in volume	Other changes in volume	Other changes in volume: natural resources (M)	Other changes in volume: natural resources (P)
Holding gains/losses	Holding gains/losses	Holding gains/losses (M)	
Closing stock	Closing stock	Closing stock (M)	Closing stock (P)

Note:
(P) indicates accounts for which only physical measures will be developed; (M) indicates accounts for which monetary measures will be developed.

Both macro-economic and financial analysts start with the same set of accounts, although the purpose, level and focus of their analyses differ. Macro-economic analysis focuses mainly on a measure of output or production for the overall economy. The economy is examined from the view of who (in very broad terms) uses the outputs or goods and services produced. It is also examined from the perspective of the inputs used to produce the output, namely primary inputs (the factors of production, labour and capital, plus other charges against production such as net indirect taxes) and intermediate inputs (the goods and services used). The analyst uses the input-output matrix format in which total business inputs equal total business outputs. The objective is to examine the relationship among the components of the economy as a whole.

Financial analysts also examine inputs and outputs, although they rarely rely on an input-output matrix format for their analysis. They use income statements of individual businesses and compare them to those of similar businesses. The objective is usually to identify the best candidate for investment. Revenue generation is a major facet. The analyst wants to know the relationship between the expenses and the revenues. What mix of inputs or expenses maximizes output for sale? Do revenues or sales cover expenses and still provide an expected return to the owners? To enhance the analysis, business accounting attempts to match expenses with associated revenues when building the income statement.

There are differences in treatment between the two approaches, with respect to inventory change and investment in the form of own account construction.

Inventories: For the economist, additions to inventory contribute to the supply of goods regardless of by whom they are produced, held or owned. They are included in the measure of output or production. For the financial analyst examining an individual business, it matters who owns the inventory. Until the inventory is sold and revenue generated, production costs associated with additions thereto are explicitly excluded from the expenses shown in the income statement. This approach ensures that the expenses charged against income or revenue for the period represent costs associated with that revenue. Although the accounting equivalence between total input (expenses plus return to owner's capital) and total output (revenues) is preserved, neither total includes a value for production added to inventory during the period.

Investment in fixed capital: When a business purchases equipment from another company, the value of the purchase does not appear as an expense in the income statement. Rather, it is capitalized, that is, added to the fixed asset account, and a counterbalancing adjustment is made to the cash account. In other words, it is directly recorded on the balance sheet and does not flow through the income statement. However, the proceeds from the sale of the fixed capital will appear in the income statement of the seller. On the other hand, when a business produces its own fixed capital, using its own workforce and supplies to build a storage facility for example, the expenses associated with this production are not included in the income statement. Since the resulting product is not to be sold but rather used on own account, there are no direct sales against which to match the expense. Therefore, it is treated as if it were purchased fixed capital; entries are made to the balance sheet, fixed capital and cash accounts to reflect the value of the additional facility. Unlike purchased capital, however, there is no seller on whose income statement the production is recorded. As a result, own account construction must be added explicitly to the measure of production for the economy.

The treatment of these two elements, additions to inventories and investment in fixed capital, is one of the main conceptual differences between economic or national accounting and financial accounting. The remaining accounts of the two systems correspond quite favourably. Table 1.4 compares the business input column of the Input

Table 1.4

Correspondence Between the CSNA Input-Output Account and the Business Income Statement

Input-output account in the CSNA (current expenses)					Business income statement (current expenses)
	Industry 1	Industry 2	...	Industry n	
Commodity 1	Intermediate inputs				Purchased materials and services (adjusted for change in inventories and own account additions to fixed capital) e.g., heat, light, telephone, rent, repairs and maintenance, transportation, advertising, legal and other consultative services, materials and supplies to be transformed, etc.
Commodity 2					
... Commodity n	Intermediate inputs: outlays for environmental protection (M)				Purchased materials and services (adjusted for change in inventories and own account additions to fixed capital) e.g., waste disposal charges; charges for pollution prevention and abatement; costs of remediation of damage; research and development; environmental assessments; environmental administration; resource conservation activities; environmental losses: fines, penalties, damage payments, shut down of installations
Non-produced natural assets	Intermediate inputs (P)				No corresponding financial accounts
Waste	Waste output (P)				No corresponding financial accounts
Other inputs	Payments to labour, indirect taxes, profits, investment income, depreciation				Payments to labour, indirect taxes, profits, investment income, depreciation
	Total business inputs				Total business costs and profits before interest payments and before direct taxes

Note:
(P) indicates accounts for which only physical measures will be developed; (M) indicates accounts for which monetary measures will be developed.

Output Table with the elements of the business income statement.

Table 1.5 presents a comparison of the stock - flow reconciliation in the CSNA and in business accounting. The correspondence between the two is a reflection of the sound business accounting framework upon which the CSNA was patterned.

Environmental satellite account data requirements: input-output component

Development of the environmental satellite input-output accounts will require information on the use of natural resources and production of all environmental goods and services. This implies that additions to inventories and revenues from sales will all need to be separated into categories of environmental and non environmental goods and services. Likewise, the natural resources and the goods and services used in the production of environmentally friendly goods and services, including environmental protection expenditures, will need to be identified.

The quality of the environmental protection expenditure satellite account, the light grey cells in Table 1.4, will depend largely on the ability of business to report environmental protection expenses in their books. The identification of exclusively environmental costs should be straightforward. The costs incurred for both environmental and other reasons will require some form of allocation. A Canadian Institute of Chartered Accountants (CICA) research study report suggests that "while the task of allocating costs between environmental and non-environmental categories may be very difficult, similar cost allocations are made in many other situations under the historical cost model (for example, research and development costs)" (CICA, 1993; p.11).

As noted earlier, the business accounting decision to capitalize an expenditure rather than treat it as a current expense is largely governed by the underlying principle of matching costs with associated economic benefits. The application of this matching principle to environmental protection expenditures gives rise to a whole range of options for prior period adjustments, current expenses and capitalization. For example, costs incurred in the current period to clean up environmental damage etc. caused in a prior period could be treated as prior period adjustments or current expenses. Current environmental expenses that are related to expected future economic benefits could be candidates for capitalization if they are "recoverable" by the firm.

Table 1.5

Stock and Flow Reconciliation: the CSNA Versus Business Accounting

CSNA: Capital account (excluding inventories)	Business: Capital account
Opening stock	Opening balance
Gross fixed capital formation	Additions to capital
Gross fixed capital formation for environmental protection (M)	Additions to capital and capitalized expenditures for environmental protection
Other changes in volume	Other changes in volume
Holding gains/losses	Valuation adjustments
Closing stock	Closing balance

Note:
(M) indicates accounts for which monetary measures will be developed.

In environmental accounting for businesses, the classification and treatment of an expenditure is governed by its nature or circumstances as well as by its ultimate beneficiary. Since environmental accounting is fairly new, guidelines are evolving as new situations arise. A CICA Study Group has reviewed the topic and has put forward a number of proposals for revisions to the CICA accounting guidelines.

Presently, the measure of gross fixed capital formation in the CSNA is closely linked to the measure of capital in business accounts. It includes new tangible assets, namely, plant and equipment, replacement and major alterations of capital installations, and various expenses which are capitalized along with the cost of the fixed assets. In only a few instances, do the guidelines of the two accounting systems differ significantly. The treatment of expenditures for environmental protection in the environmental satellite accounts should also closely follow the guidelines and standards established in business accounting for the capitalization of environmental expenditures. As these evolve, so too will those for investment on environmental protection in the environmental satellite accounts.

Statistics Canada is attempting to move forward with measures of environmental expenditures by developing a follow-up survey to its 1989 pilot survey of pollution control and abatement. Among the many challenges of developing the survey is the determination of an appropriate classification of categories for environmental expenditures - both current and capital.

As seen in Table 1.4, there are no corresponding business accounts which record the value or volume of natural resources used as input to production nor the value or volume of waste output.

Volumes of natural resource inputs used in production are currently collected from business' internal management records. This practice will continue.

Waste output will require special attention in the satellite accounts. Although the payments to the waste management industry to remove the waste are recorded as expenses, there are no entries for direct emissions into the environment. Waste by definition has no value and therefore its production and discard are not recorded. However, to analyse the impact of economic activity on the environment, measures of waste output are critical. Again, internal management records may provide some of this information. In addition, the environmental satellite accounts will rely on sources outside of business accounting to develop physical measures of waste output. Greenhouse gas emissions have already been derived for all sectors and similar plans are under way for other waste outputs.

Environmental satellite account data requirements: asset component

The development of satellite accounts for natural resource assets in monetary and physical terms will benefit only marginally from business accounting records. Information on the stocks of natural resources held by business will of course be used. However, the bulk of Canadian resources which belong to no one (or everyone) remain to be counted and valued. This exercise is the subject of other papers in this and other issues of *Environmental Perspectives*.

Conclusion

One of the critical elements to the successful development of the environmental satellite accounts will be the acceptance of the business sector to account for its transactions relating to the environment in a standard and consistent manner and its willingness to share that information with Statistics Canada. Another element will be the fit between business accounting with respect to the environment and the environmental satellite accounts. To date, the indications have been quite positive.

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2 Environmental Protection Expenditures: Conceptual Issues and Current Practices

by Craig Gaston and Anik Lacroix

For the past five years Statistics Canada has been involved in developing a system of environmental and natural resource accounts[1] that will be satellite components of the Canadian System of National Accounts. One of these accounts, the environmental protection expenditures account, remains one of the least complete sets of environmental information. Although much development work has been done internationally (Eurostat, 1994), difficult conceptual and practical problems remain for the development of consistent data for this account. Statistics Canada is currently developing data on environmental protection expenditures made in household, business and public sectors.

Text Box 2.1
Definition of Environmental Protection Expenditures

Environmental protection expenditures are defined in the *1994 Environmental Protection Expenditures Survey* as all operating and capital expenditures incurred in order to comply with environmental regulations or conventions which apply to Canada. Examples of environmental regulations include the Canada Fisheries Act Regulations on liquid effluents from the pulp and paper, metal mining and petroleum refining industries (e.g. regulations pertaining to the Environmental Effects Monitoring Programme such as assessments of aquatic effects of mining in Canada). Environmental conventions include any formal multi-party commitment to meet specific targets relating to habitat protection and waste and pollution abatement, such as the Canada-U.S. Air Quality Agreement.

Environmental protection expenditures consist of expenditures undertaken with the intention of preventing, reducing and remedying environmental degradation or preserving the environment. They include expenditures for pollution abatement and control and expenditures for restoring wildlife and habitat, along with associated expenditures for environmental monitoring, environmental assessments and audits, and expenditures for reclamation and decommissioning of sites. Expenditures to improve employee health, workplace safety and site beautification are excluded.

Conceptual issues

Two reasons are frequently cited for measuring environmental protection expenditures:

- to gauge the commitment of countries (of governments, businesses and households) to prevent environmental degradation;
- to measure the cost to economic agents of environmental regulation.

Environmental protection expenditures are of two types (Text Box 2.1): those that treat pollution (or any other degradation) once it has been generated and those that change the production (or consumption) process to reduce or prevent pollution from being generated, or to reduce the amount of resources used. The first type, end-of-pipe expenditures, are intended only to abate and control pollution. Since there is no immediate financial advantage for the polluter in introducing this type of solution, the purpose is unambiguous. The second type of expenditure, for integrated solutions, can save raw material, energy in some cases and labour costs. There can be, in this case, a financial advantage. Commitment to protection of the environment is therefore clear in the first case but ambiguous for the second.

This fact has been noted by environmentalists and businesses alike (Knight, 1995; p.8) and there is increasing agreement that environmental protection expenditures are not a good measure of commitment to environmental protection. For this purpose it is more meaningful to measure the actual reduction in the quantity of pollution generated rather than the amount of money spent. These physical measurements have their own conceptual difficulties, particularly when it is a question of producing an aggregate measure, yet it is possible to focus on individual pollutants or classes of pollutants to determine progress.

Environmental protection expenditures are, however, a useful measure of the economic cost to society of protecting the environment. There is no international consensus in resolving the problem of separating environmental from other investment purposes. The most common technique used by member countries of the European Union (Eurostat, 1994) is to determine, for each type of process considered, a standard or reference technology that does not meet the latest regulatory requirements. The difference in cost between

1. This system of satellite accounts will consist of a Natural Resource Stock Account, a Natural Resource Use Account, a Waste Account and an Environmental Protection Expenditures Account.

an investment that conforms to the latest standards and the reference technology investment is deemed to be the environmental protection expenditure. It should be emphasized that the cost of the reference technology is often hypothetical since it may no longer be marketed in a given country as technological evolution moves towards cleaner processes.

Underlying this approach is the assumption that the reference technology is less expensive than that which has been adapted for environmental purposes. Although this may hold for some investments, it is not always the case. For instance, experts agree that a new pulp mill that generates zero effluent "would cost essentially the same as a conventional mill to build and operate" (McCubbin, 1994; p. 15). In other words, if environmental protection is incorporated into the initial design important gains can be made. Also, in other areas new technologies are being developed that reduce waste and pollution by using resources more efficiently. Even if these investments are more substantial than investments in a reference technology, they may become cost effective in the long run. Consequently, under this profitability criteria there would be no environmental cost. In other words, if the savings from decreased operating costs outweigh the additional capital costs required, the environmental protection cost is zero. The Netherlands is one of the few countries that takes profitability into account in determining environmental cost (de Boo, 1993).

From the above discussion it would seem reasonable to make a distinction between expenditures for end-of-pipe and expenditures for integrated processes. The former can provide a clear indication of costs that have little or no economic benefit (except to the firms that specialized in the production of environmental protection goods and services). It is not always feasible for organizations to adopt the best solution, which is often one that changes the technological process. It can be much more expensive and difficult to implement even if its long-term payoff proves to be higher. End-of-pipe solutions provide, therefore, an indication of the cost of not adopting more efficient solutions which reduce the use of energy and materials. This is not to imply that it would be possible to avoid entirely end-of-pipe solutions. There will always be a need for sewage treatment facilities and some abatement requirements are too urgent to wait for the appropriate process change technology to be implemented.

Another area which poses conceptual difficulties is the allocation of environmental protection expenditures by environmental medium: air, surface water and land (including groundwater). The difficulty here is that pollutants do not necessarily remain in the medium to which they are released. Air emissions are eventually deposited on land or water and contaminated groundwater ultimately seeps into streams and rivers. There is no satisfactory solution to this problem but the distinction still has some use if for no other reason than it provides market information for broad categories of pollution abatement equipment.

Current practices

Business sector expenditures

Surveys on environmental protection expenditures are currently conducted by industrial associations in Austria, Germany and the United Kingdom and by the statistical offices of most member states of the European Union. Austria, Germany, the Netherlands, the United States and Japan have been conducting regular surveys since the 1970s and Australia began a regular survey in 1990.

Some countries, notably the United States and Australia, have chosen to leave the decision about which costs to include to the survey respondent. However, the United States has recently established some rules of thumb to help respondents determine what proportion of the cost of their process-change investments is for environmental protection. Provision of methodologies to help the respondent identify the environmental protection expenditure component of an investment would require considerable technical knowledge on the part of the surveyor. Furthermore, there would be many unique situations to address. Few statistical offices have been able to afford the cost of the necessary specialists and research.

Statistics Canada conducted a pollution abatement and control (PAC) survey for 1989 (Gaston, 1993). This survey requested information on end-of-pipe expenditures and although it covered all sectors of the economy, it was restricted to those firms that had previously reported PAC expenditures.[1]

Statistics Canada has just conducted an environmental protection expenditures survey for 1994. It was intended to measure the cost to companies of environmental regulations and conventions[2] and it covered a broader range of environmental activities than the 1989 survey, such as process changes for PAC, wildlife and habitat protection, cleanup, monitoring and environmental assessments and audits. No attempt was made however to define the environmental criteria with respect to process-change investments on the 1994 questionnaire because of the difficulties in estimating what share of total spending the environmental motive should have. Instead the survey left to the respondent the decision on what proportion of a multipurpose investment to include. This means that, for the time being, Canada's approach is more in line with that of the United States and Australia than with European Union countries.

A pilot survey was conducted during the summer of 1995 and the full survey was mailed in October. The survey cov-

1. Those establishments that received the long questionnaire in the *Capital and Repair Expenditure Survey* and reported having PAC expenditures in the previous 3 years.
2. A convention is defined as any multi-party agreement, with explicit targets, to reduce pollution. The main criteria is that the agreement reflect more than the intentions of an individual company.

ered establishments with fifty or more employees in forestry, mining, crude oil and natural gas, electric power and the manufacturing sectors deemed most likely to have substantial environmental protection expenditures. From the results of the pilot survey it was determined that smaller companies (with less than 50 employees) in the selected industries either had no environmental protection expenditures or they could not make reasonable estimates of these types of expenditures.

In addition to these surveys, regular information on capital expenditures for pollution abatement and control has been collected since 1985. Statistics Canada's *Capital and Repair Expenditure Survey* asks respondents to provide data on capital expenditures by type of asset, several of which pertain specifically to pollution abatement and waste and sewage disposal. The survey, which is restricted to capital expenditures, does not distinguish between end-of-pipe and integrated process investments. However, the survey provides the only historical PAC information available. Statistics Canada has prepared a time series on PAC expenditures from this survey.[1]

Apart from the above sources there is very little information available historically on environmental protection expenditures for Canada. Environment Canada commissioned a survey for the year 1989 to Dunn and Bradstreet. The definition of environmental protection expenditures was broader than that of Statistics Canada's 1989 PAC survey (Dun and Bradstreet, 1991) so the results are not comparable. This survey was notable for the information it provided on the use and prospective use of environmental protection technologies according to environmental media (air, water, solid waste land management).

Some administrative data do exist from Revenue Canada's Accelerated Capital Cost Allowance Program for air and water pollution abatement equipment (Classes 24 and 27). Firms that were in business prior to 1974 were allowed to write off the costs of pollution abatement equipment over three years rather than the longer write-off period that generally applied. This information is inadequate for statistical purposes for several reasons. The program did not apply to newer companies, thus there is no data on expenditures of newer companies. In years of low or no profitability, companies tend not to take advantage of these allowances thereby obscuring the timing of such expenditures. In some years of the program's existence, other tax provisions offered similar or more favourable write-off periods thereby reducing the apparent amount of expenditures for the pollution abatement equipment.

Other partial information exists for some industries; for example, *Pulp and Paper Canada* publishes an annual report of capital expenditures on pollution abatement and control by pulp and paper companies.

1. See Chapter 3 in this publication.

Public sector expenditures

The measurement of environmental protection expenditures by governments is complicated by a similar problem to that of the private sector. Many expenditures to protect the environment can also be viewed as industrial development expenditures, such as expenditures relating to forest or fish management, agricultural development or energy programs. An example is Fisheries and Oceans Canada's Atlantic Fisheries Adjustment Program (AFAP). One of its main elements is rehabilitation of northern cod species through adoption of new conservation measures, increased monitoring, scientific research for depleted fish stocks, and implementation of individual quotas and adjustment programs for workers affected by conservation measures. Should these adjustment programs be considered entirely as environmental protection programs? The AFAP also promotes economic diversification activities which stimulate the creation of new markets and the development of underutilised species with a focus on aquaculture. Even though economic diversification may help protect certain fish species, it is difficult to determine the pure environmental motivation of the program.

This problem is best exemplified in the Financial Management System (FMS) used to classify government expenditures where there is one broad category called "natural resource conservation and industrial development". Almost 75% of consolidated government capital and current expenditures for environmental protection in 1991 was in this category. How much of this expenditure ought to be considered as expenditure for environmental protection is very difficult to assess. To sort out the components would require a programme by programme assessment of the expenditure purpose. In the absence of such an evaluation mechanism, an alternative would be to develop an expenditure classification that is based on purpose. The implementation of the Federal Sustainable Development Initiative should provide an impetus to keep more accurate records on federal government expenditures for environmental protection.

Other challenges in preparing a time series of government expenditures on environmental protection include: different levels of detail over time and by level of government; difficulty in eliminating double counting because of lack of information on transfers between governments; and reporting delays from reliance on administrative data in lieu of direct surveys.

Despite these obstacles, Statistics Canada intends to produce an account of government expenditures on environmental protection. It will consist of a time series of current and capital expenditures by each level of government. Data sources include the public accounts, other administrative sources and surveys. Available data have been published recently on PAC expenditures as well as on conservation and natural resource development expenditures since 1970 (1965 in some cases) (Lacroix, 1995).

Conclusion

The difficulties associated with the isolation and measurement of integrated environmental protection expenditures remain to be resolved. If the expected evolution of environmental protection from end-of-pipe to process-integrated solutions occurs, it will be difficult to monitor. The Netherlands has reported some evidence to this effect but few countries have been able to demonstrate a statistical methodology sufficiently rigorous to confirm this. Nevertheless, the measurement of end-of-pipe expenditures remains important since these represent costs which are not offset by increased resource and energy efficiency. The environmental protection expenditures that we can measure with confidence represent not so much the progress in reducing pollution but rather, the failure to implement a more efficient and clean alternative to an end-of-pipe solution.

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3 Private Sector Investments in Pollution Abatement and Control

by Pierre Gagnon

Introduction

This chapter presents the results of an analysis of data obtained from Statistics Canada's survey of capital expenditures. The analysis involves business-sector capital expenditures for pollution abatement and control (PAC) from 1985 to 1993; current expenditures are excluded. Public-sector (federal, provincial and municipal governments) expenditures were analysed in a previous study (Lacroix, 1995).

Environmental regulations adopted by the various levels of government have played an important role in the evolution of private-sector PAC expenditures. However, it is difficult to attribute increases in PAC investments specifically to those regulations adopted in recent years. Many investments were made in anticipation of regulations soon to be imposed, such as the Municipal-Industrial Strategy for Abatement, which addressed water pollution in Ontario. Other significant expenditures were the result of a federal-provincial agreement on reducing sulphur dioxide emissions.[1] The agreement mainly targeted smelters and electrical power plants. There have also been a series of federal and provincial regulations targeting the paper and allied products industry and contributing to the increase in PAC investments in that industry since the late 1980s. Some of the federal regulations adopted in 1991 included the possibility, for some businesses, of an extension until 1995 to comply with environmental standards (Table 3.1). In addition to the regulatory framework, public pressure became an increasingly important factor during the 1980s and may also have contributed to the increase in PAC expenditures.

Analysis by industry

From 1985 to 1993, capital expenditures for pollution abatement and control (in the business sector) increased from $141 million to $1.1 billion. In 1990, those expenditures peaked at $1.3 billion (Table 3.2).

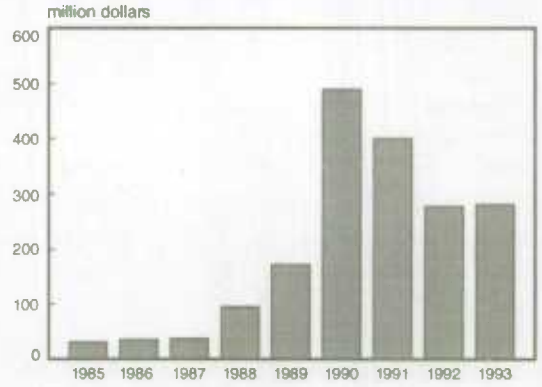
The manufacturing sector

Manufacturing is one of the most important sectors with respect to private-sector PAC investments. The percentage of manufacturing sector investments remained steady at about 80% to 90% of total investments between 1985 and 1987 (Table 3.3). After that year, the percentage fell from 80% to less than 60%, whereas environmental expenditures in the electricity, gas and other utilities industry grew. Ontario Hydro's large investment alone was a major contributor to the substantial decrease in the manufacturing sector's percentage of PAC investments. Manufacturing sector industries that account for the largest investments are mainly the paper and allied products industry (note that pulp and paper is the largest single contributor in this industry), primary metals and chemical and chemical products industries.

The paper and allied products industry

This industry expanded considerably in the late 1980s, resulting in a substantial increase in total investments. Between 1985 and 1989, investments increased from approximately $2 billion to $5.5 billion. In the early 1990s, the recession had a strong impact on pulp and paper production and total investments dropped from $5.5 billion to $2.2 billion. PAC investments increased from $31 million to $490 million from 1985 to 1990, and then fell to $282 million in 1993 (Figure 3.1 and Table 3.3). Despite this decrease,

Figure 3.1
PAC Investment in the Paper and Allied Products Industry, 1985-1993



Sources:
Statistics Canada, Investment and Capital Stock Division and National Accounts and Environment Division.

1. Sulphur dioxide, along with nitrogen oxides, combine with water in the atmosphere to form the main components of acid deposition.

Table 3.1
List of Federal Regulations

	Adopted
Canadian Environmental Protection Act	
Asbestos Mines and Mills Release Regulations	June 14, 1990
Chlor-Alkali Mercury Release Regulations	February 15, 1990
Chlorobiphenyl Regulations	February 21, 1991
Chlorofluorocarbon Regulations, 1989	February 15, 1990
Contaminated Fuel Regulations	August 14, 1991
Export and Import of Hazardous Wastes Regulations	November 12, 1992
Federal Mobile PCB Treatment and Destruction Regulations	December 14, 1989
Fuels Information Regulations No. 1	..
Gasoline Regulations	May 9, 1990
Mirex Regulations	November 23, 1978
Ocean Dumping Regulations	1975
Ozone-Depleting Substances Regulations No.1 (CFCs)	June 29, 1989
Ozone-Depleting Substances Regulations No.2 (certain BFCs)	August 28, 1990
Ozone-Depleting Substances Regulations No.3 (products)	August 28, 1990
Ozone-Depleting Substances Regulations No. 4 (Methyl Chloroform and Carbon Tetrachloride)	August 27, 1993
PCB Waste Export Regulations	July 27, 1990
Petroleum Refinery Effluent Regulations	..
Phosphorus Concentration Regulations	..
Polybrominated Biphenyls Regulations	February 15, 1990
Polychlorinated Terphenyls Regulations	February 15, 1990
Pulp and Paper Mill Defoamer and Wood Chip Regulations	May 7, 1992
Pulp and Paper Mill Effluent Chlorinated Dioxins and Furans regulations	May 7, 1992
Secondary Lead Smelter Release Regulations	February 21, 1991
Storage of PCB Material Regulations	August 27, 1992
Toxic Substances Export Notification Regulations	November 12, 1992
Vinyl Chloride Regulations	April 11, 1979
Fisheries Act	..
Alice Arm Tailings Deposit Regulations	April 10, 1979
Chlor-Alkali Mercury Liquid Effluent Regulations	..
Meat and Poultry Products Plant Liquid Effluent Regulations	..
Metal Mining Liquid Effluent Regulations	February 25, 1977
Petroleum Refinery Effluent Regulations	..
Port Alberni Pulp and Paper Effluent Regulations	November 12,1992
Potato Processing Plant Liquid Effluent Regulations	..
Pulp and Paper Effluent Regulations	May 7, 1992
International River Improvements Act	
International River Improvements Regulations	..
Weather Modification Information Act	
Weather Modification Information Regulations	..

Source:
Environment Canada, 1993.

the percentage of PAC investments compared to total investments remained steady. This percentage increased from 1.5% in 1985 to 12.6% in 1991, and remained near that level until 1993 despite the recession (Table 3.4).

The majority of these investments are in pollution abatement and control equipment. They represented between 65% and 93% of the industry's PAC investments over the 1985 to 1993 period.

In December 1990, British Columbia adopted pulp and paper mill effluent regulations. The primary goal of the regulations was mainly to reduce furan and dioxin contamination.[1] They mainly targeted mills not yet performing at an acceptable level. The mills had to improve their production processes to reduce pollution, and those not yet equipped with wastewater treatment systems had to install such systems.

In January 1992, the legislation was amended and stricter measures with respect to dioxins and furans in British Columbia's water were introduced. The amendment required pulp and paper mills to completely eliminate furan and dioxin emissions by the year 2002. In 1993, Ontario also adopted environmental regulations aimed at eliminating dioxin and furan emissions by the year 2002.

Overall, the purpose of these federal and provincial measures is to reduce dioxin and furan emissions, and improve the paper bleaching process. Quebec adopted a regulation aimed at reducing by 75% the biochemical oxygen demand

1. In laboratory tests, dioxin causes death in rainbow trout at concentrations above 40 parts per quadrillion. Together, furans and dioxins form a family of chemical compounds, some of which have been shown to be extremely toxic in laboratory animals.

Table 3.2
PAC Investments, 1985-1993

	1985	1986	1987	1988	1989	1990	1991	1992	1993
	thousand dollars								
Industrial and commercial construction	50 889	50 090	94 699	255 474	309 319	503 326	614 486	686 030	686 298
General machinery and equipment	89 676	142 920	129 456	231 274	475 008	762 608	625 619	559 228	394 529
Total	**140 565**	**193 010**	**224 155**	**486 748**	**784 327**	**1 265 934**	**1 240 105**	**1 245 258**	**1 080 827**

Note:
Ontario Hydro's and Nova Scotia Hydro's capital expenditures are combined under "Industrial and commercial construction".
Sources:
Statistics Canada, Investment and Capital Stock Division and National Accounts and Environment Division.

(the amount of dissolved oxygen required for bacterial decomposition of organic wastes in water), and which imposes a reduction in waste toxicity. The initial application deadline was established as December 31, 1993, with a second deadline established as December 31, 1996.

The primary metals industry

Growth in total investments in the primary metal industry in the late 1980s was much slower than that of the paper and allied products industry. Total investments decreased by over 60% during the recession. The percentage of those investments allocated to pollution abatement and control assets was slightly higher than for the paper and allied products industry in the mid 1980s (Table 3.4).

However, from 1990 to 1993, this percentage was similar to that observed in the paper and allied products industry, at between 11% to 14%. The two main assets are pollution abatement and control equipment and construction. These assets accounted for approximately 95% of all pollution control investments. The only exception was 1993, when the asset item "sewage treatment and disposal plants including pumping stations" accounted for approximately one-third of pollution abatement and control investments.

The primary metals industry invested heavily in pollution abatement and control equipment between 1989 and 1992, spending some $400 million in 1990 (Figure 3.2). Most of these expenditures were made in the context of the federal-provincial agreement to reduce sulphur dioxide emissions, which targets smelters and electrical power plants in Eastern Canada. The objective established for the four largest Ontario producers was to reduce sulphur dioxide emissions, which were over 1 million tonnes in 1990, by 50% from 1990 to 1994.

The chemical and chemical products industry

Investments made by the chemicals industry are more stable than those of the paper and allied products and primary metals industries (Figure 3.3). Nevertheless, the percentage of those PAC investments varied somewhat from one year to the next (fluctuating between 1% and 8%). This percentage reached approximately 5% in 1993, compared to 11% for primary metals and 13% for paper and allied products (Table 3.4).

In 1993, the members of the Canadian Chemical Manufacturers Association reduced chemical emissions from pro-

Table 3.3
PAC Investments by Industry, 1985-1993

Industry	1985	1986	1987	1988	1989	1990	1991	1992	1993
	thousand dollars								
Forestry	x	-	-	72	x	x	740	x	x
Mines	..	..	40 814	87 796	51 829	78 015	71 455	64 350	58 134
Food and beverages	x	x	12 846	4 973	x	x	9 724	33 501	15 149
Paper and allied products	31 204	35 671	37 759	95 394	171 625	489 810	400 052	278 539	281 795
Primary metals	54 511	57 721	73 419	121 427	258 519	395 750	259 860	198 926	107 483
Fabricated metal products	4 852	7 451	7 482	7 844	10 843	6 008	x	x	x
Transportation equipment	1 977	19 553	5 194	16 288	15 464	14 037	15 695	1 870	10 450
Non-metallic mineral products	2 536	3 693	x	3 287	4 137	1 568	x	x	x
Refined petroleum and coal products	1 236	x	3 028	3 201	x	12 699	17 935	16 423	22 955
Chemical and chemical products	11 642	31 448	24 120	31 122	123 991	29 081	37 777	68 967	77 388
Other manufacturing industries	3 139	10 830	7 004	9 340	20 843	26 817	26 329	23 153	14 301
Electricity, gas and other utilities	x	2 503	x	64 885	99 346	177 033	378 119	504 779	457 659
Other non-manufacturing industries	19 499	18 301	8 350	41 119	9 463	9 846	15 172	49 372	26 627
Total	**140 565 [1]**	**193 010 [1]**	**224 155**	**486 748**	**784 327**	**1 265 934**	**1 240 105**	**1 245 258**	**1 080 827**

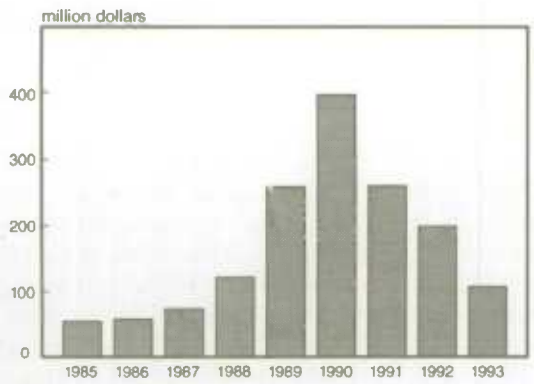
Note:
1. The totals prior to 1987 do not include the mining industry.
Sources:
Statistics Canada, Investment and Capital Stock Division and National Accounts and Environment Division.

Table 3.4
PAC Investments as a Proportion of Total Investments, 1985-1993

Industry	1985	1986	1987	1988	1989	1990	1991	1992	1993
	percent								
Forestry	-	-	-	-	-	x	0.6	x	x
Mines	..	..	3.9	5.9	3.9	7.2	8.9	4.5	3.7
Food and beverages	x	x	1.1	0.4	x	x	0.7	2.1	1.1
Paper and allied products	1.5	1.8	1.5	2.6	3.1	11.4	12.6	10.3	12.6
Primary metals	3.4	3.3	4.9	7.9	11.0	13.6	10.6	13.9	10.7
Fabricated metal products	0.8	1.0	1.6	1.7	2.6	1.8	x	x	x
Transportation equipment	0.2	0.7	0.2	0.6	0.6	0.9	0.8	0.1	0.3
Non-metallic mineral products	1.1	1.1	x	0.7	0.7	0.3	x	x	x
Refined petroleum and coal products	0.4	x	0.5	0.5	x	1.3	1.8	2.6	5.8
Chemical and chemical products	1.3	2.7	2.2	2.7	7.6	1.6	2.0	4.1	4.5
Electricity, gas and other utilities	x	x	x	0.6	0.9	1.5	3.0	17.1	13.9

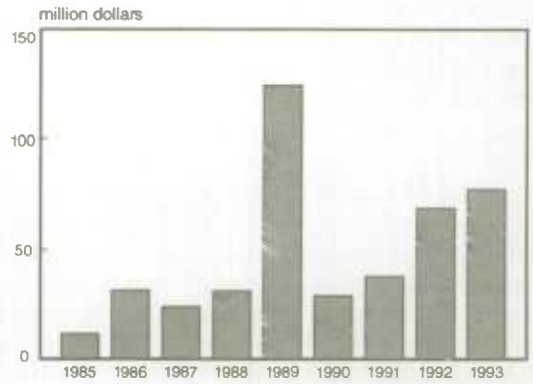
Sources:
Statistics Canada, Investment and Capital Stock Division and National Accounts and Environment Division.

Figure 3.2
PAC Investment in the Primary Metals Industry, 1985-1993



Sources:
Statistics Canada, Investment and Capital Stock Division and National Accounts and Environment Division.

Figure 3.3
PAC Investment in the Chemical and Chemical Products Industry, 1985-1993



Sources:
Statistics Canada, Investment and Capital Stock Division and National Accounts and Environment Division.

duction by 20% compared to 1992, as part of the industry's environmental initiative (Canadian Chemical Manufacturers Association, 1993)

The mining industry

The mining industry was not fully covered by the *Capital Expenditures Survey* by asset category until 1987. Since then, this industry has accounted for a considerable proportion of total PAC expenditures. In 1987, the industry invested $40.8 million in PAC (Table 3.3), or close to 4% of its total capital expenditures. This percentage peaked in 1991, when almost 9% of all capital investments were capital PAC expenditures (Table 3.4).

Electricity, gas and other utilities

PAC expenditures in this industry reached very high levels after 1988. Ontario Hydro's impact is significant: with $177 million in PAC expenditures in 1990, the industry's percentage of total PAC investments reached 14%. Ontario Hydro's expenditures had increased the industry's share of total PAC expenditures to 40% by 1993 (Table 3.3).

The Point Aconi plant in Nova Scotia, in operation since 1994, is an example of the type of expenditures made in this industry. The plant, with a total capacity of 165 megawatts, burns coal, using a more "environmentally friendly" process. The process produces 90% less sulphur dioxide emissions and over 65% less nitrogen oxide emissions than traditional plants (Environmental Digest, 1993).

Table 3.5
PAC Investments by Province and Territory, 1985-1993

Province/Territory	1985	1986	1987	1988	1989	1990	1991	1992	1993
	thousand dollars								
Newfoundland	x	2 628	9 266	x	x	20 242	x	x	x
Prince Edward Island	x	x	x	x	x	x	x	x	x
Nova Scotia	x	6 397	x	9 721	x	6 112	x	x	18 183
New Brunswick	1 935	3 288	11 825	25 333	13 105	9 408	x	78 417	31 085
Quebec	55 206	48 000	69 677	85 657	195 027	255 859	121 516	159 530	163 260
Ontario	59 421	106 981	84 809	226 230	386 824	501 272	678 566	577 388	481 893
Manitoba	x	1 677	3 072	14 183	10 703	x	5 566	12 298	18 209
Saskatchewan	353	1 556	3 487	5 865	6 161	x	24 219	x	x
Alberta	9 794	15 462	7 773	23 641	44 118	25 394	24 611	84 570	128 752
British Columbia	3 386	6 943	25 160	73 440	113 351	399 510	327 910	212 559	205 955
Yukon	x	x	x	102	x	2 231	x	x	x
North West Territories	x	x	6 482	15 991	1 423	7 080	1 351	x	571
Canada	**140 565**	**193 010**	**224 155**	**486 748**	**784 327**	**1 265 930**	**1 240 110**	**1 245 260**	**1 080 830**

Sources:
Statistics Canada, Investment and Capital Stock Division and National Accounts and Environment Division.

During the 1970s, the demand for electricity was increasing and acid-gas emissions peaked in 1982 at 531 thousand tonnes. At that point, the Ontario government began regulating these emissions. Between 1982 and 1990, Ontario Hydro reduced its emissions by 50%. This decrease continued into the early 1990s due to the imposition of a limit of 280 thousand tonnes for the years 1990-1993 and 215 thousand tonnes in 1994.

Results by province

The Atlantic provinces account for a relatively low proportion of pollution abatement and control capital expenditures. However, from 1985 to 1993, this percentage increased from 3% to 10% of total PAC expenditures (Table 3.5). In 1985, Quebec accounted for 39% of private-sector PAC investments. After 1986, this percentage dropped to 25% of private-sector investments and subsequently fluctuated between 10% and 25% of the national total. Ontario accounted for 40% to 60% of private-sector PAC investments. The British Columbia situation is interesting because in 1985, it accounted for only 2% of Canada's private-sector PAC investments and in 1990 was 32%, subsequently falling to approximately 19%. This result is largely due to paper and allied products industry investments.

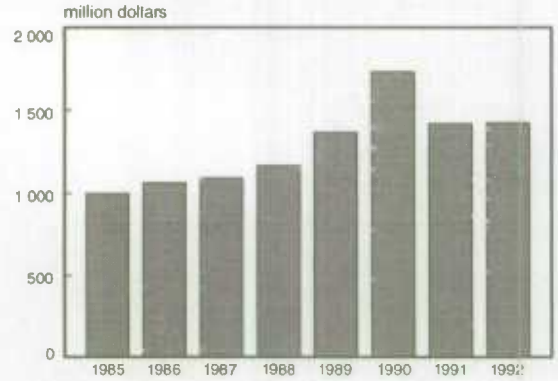
The public and private sectors in contrast

Although analysis of public-sector environmental expenditures is not the purpose of this study, it is interesting to note certain differences between private-sector and public-sector data. Governments invest mainly in anti-pollution activities, waste treatment facilities, sewer systems and sanitation equipment. These investments grew at an average rate of 6% per year between 1985 and 1992 (Figure 3.4). In comparison, there was an annual average increase of 29% in private-sector investments for the same period. In 1985, only 13% of PAC investments were made by the private sector. In 1989 and 1990, approximately 40% of PAC investments came from the private sector (Figure 3.5).

Methodology

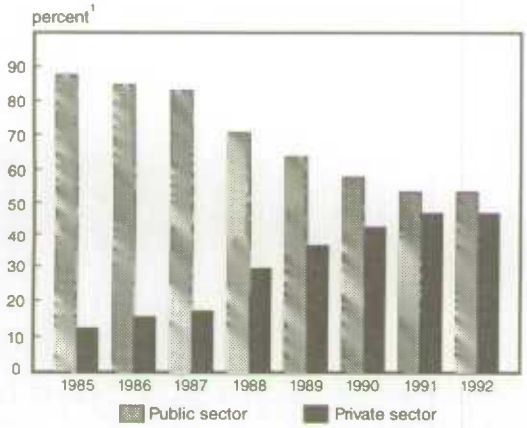
The data used in this article are from Statistics Canada's annual *Capital Expenditures Survey*. The survey is not specifically designed to assess environmental expenditures by companies but rather to estimate expenditures made by companies for certain assets. Some of those assets were considered to be PAC-related assets (Text Box 3.1). How-

Figure 3.4
Public-sector PAC Investments, 1985-1992



Sources:
Statistics Canada, Investment and Capital Stock Division and National Accounts and Environment Division.

Figure 3.5
Public and Private-sector PAC Investment, 1985-1992



Note:
1. Public or private PAC investment as a proportion of total PAC investment.
Sources:
Statistics Canada, Investment and Capital Stock Division and National Accounts and Environment Division

ever, some activities may fall within a category of assets deemed non-environmental but which have an environmental purpose (purchase of a ventilator, for example). These were not included as PAC expenditures. The expenditures assessed in this study are therefore assessed on the basis of a lower limit of environmental expenditures by companies.

Another Statistics Canada survey for the year 1989 asked respondents to indicate their PAC capital expenditures. The *1989 Pollution Abatement and Control Survey* estimated private-sector PAC expenditures at $1.1 billion, which is 40% higher than expenditures in the *Capital Expenditures Survey*. This difference can be explained by the nature of the 1989 survey. That survey specifically asked respondents to estimate their PAC expenditures. In such a case, one might expect to obtain higher expenditures than for a survey whose objective is to measure total capital expenditures per asset category, and for which PAC expenditures are estimated on the basis of the asset category data.

Conclusion

For several industries, pollution abatement and control capital expenditures have increased both in absolute terms and as a percentage of their total investments since the late 1980s. This increase occurred within a context of general public awareness of environmental problems. In addition, stricter regulation of certain industries that pollute was implemented in the early 1990s.

Nonetheless, the ability to interpret pollution abatement and control expenditures is limited. These expenditures represent a minimum value of total PAC expenditures. Several other expenditures cannot be isolated, given the complexity of the environmental decision-making process. Although investments made by companies are a useful indication, the real measure of changes in environmental activity is not the assessment of PAC expenditures, but rather the measurement of the quantities of polluting substances emitted by the industries.

Text Box 3.1
Asset Categories

To estimate capital expenditures, ten categories of assets specified in the *Capital Expenditures Survey* were used:

Industrial and commercial construction

- pollution abatement and control;
- waste disposal facilities;
- sewage treatment and disposal plants including pumping stations;
- sanitary and storm sewers;
- trunk and collection lines, open storm ditches and laterals;
- lagoons;
- other sewage system construction;
- mining residue processing system;

General machinery and equipment

- pollution abatement and control equipment;
- sanitary equipment.

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4 Environmental Aspects of Consulting Engineering and Scientific and Technical Services

by Craig Gaston

Until recently, public awareness of environmental issues was negligible. Today, communities, governments and businesses are called upon to act more responsibly towards the environment. This has given rise to a broad spectrum of goods and services which help government and business act in an environmentally responsible manner. The producers of these goods and services can be grouped under the general label of the "environment industry" (Text Box 4.1).

The environment industry is not identified as an industry in the Standard Industrial Classification (SIC) since it defines an industry as a group of establishments that produce a narrow and relatively homogenous range of goods or services. Rather, the environment industry consists of a broad range of companies involved in producing a wide variety of goods and services used to monitor, improve and protect the environment. In fact, for some companies, the majority of their production is in goods and services not exclusively used for environmental purposes. As a consequence, these companies are scattered throughout the industry classes of the SIC. Some SIC classes have concentrations of these companies. Such is the case of the two Standard Industrial Classification Industries featured in this chapter: the consulting engineering and the scientific and technical services industries.[1]

The type of environmental service provided by both the consulting engineering firm and the scientific services firm is usually geared to the needs of the client. For example, local government departments and businesses in the waste management industry use the services of these firms in: the selection of landfill sites, managing the incineration of solid and hazardous wastes, managing air and water pollution, the construction and management of transfer stations, the treatment of water and wastewater (physical separation, membrane filtration, etc.), the analysis of trends in waste management, the examination of energy alternatives and the development of environmental technologies for the future. Consulting engineers and scientific technicians are also involved in the development of pollution prevention methodologies, the identification of costs and liabilities of not initiating prevention programs, the assessment of contaminated sites, the clean-up of environmental disasters, the compliance to environmental regulations and the development of federal and provincial environmental regulations.

Text Box 4.1
The Environment Industry

The environment industry is not found as a separate industry in the Standard Industrial Classification (SIC). The structure of SIC reflects the production process and the make-up of the final good or service. It does not classify companies according to the end use of their products or services. In contrast, the environment industry is intended to include companies which produce goods and services which are used for environmental purposes. Membership in the industry is complicated by the fact that the goods and services produced are not exclusively used for environmental purposes - e.g., pumps. There is no official definition of this industry although there is increasing consensus on what types of goods and services should be included. The Organisation for Economic Co-operation and Development (1996) has proposed the following classification for companies producing environmental goods and services:

- waste water treatment equipment;
- waste management and recycling equipment;
- air pollution control equipment;
- noise reduction equipment;
- monitoring instruments, scientific, research and laboratory equipment;
- natural resource conservation/protection and urban amenities;
- waste-water operations;
- waste handling and facility operations;
- noise reduction operations;
- analytical, monitoring and related conservation and protection services;
- technical and engineering services;
- environmental research and development;
- environmental training and education;
- accounting and legal services;
- consulting services;
- other environmental business services;
- other: eco-tourism;
- clean production equipment;
- efficient energy generation and conservation equipment;
- eco-products.

1. Statistics Canada is developing a fuller data base on the environment industry that will provide more current and in-depth information. This project is part of the Environmental Industry Strategy coordinated by Industry Canada and Environment Canada.

Table 4.1
Consulting Engineering Firms: Summary Statistics, 1991

	Environmental specialists	Other firms
Total revenues ($000)	394 514.0	3 083 250.0
Number of employees	3 706.0	36 166.0
Number of firms	65.0	458.0
Revenue per employee ($000)	106.5	85.3
Revenue per firm ($000)	6 069.4	6 732.0
Number of employees per firm	57.0	79.0
Export share of fee income (percent)	8.2	13.5
	percent	
Type of service		
Turnkey projects	0.6	10.3
Environmental advisory services	42.1	2.6
Other advisory services	11.9	13.7
Environmental design services	20.3	3.1
Other design services	11.7	46.6
Construction management	6.7	4.8
Project management services	4.6	9.0
Supplementary services	0.8	2.8
Sale of software products	0.2	0.9
Other	1.3	5.2
Total	**100.0**	**100.0**

Note:
Figures may not add due to rounding.
Sources:
Statistics Canada, National Accounts and Environment Division and Services, Science and Technology Division.

Consulting engineering services

Consulting engineers provide a variety of services in the planning, design, advisory, construction and management of structures and processes. Consulting engineering firms supply services to almost every sector of the Canadian economy, and the structure of the industry is changing rapidly. In particular, growth is occurring in services that have not traditionally been provided by consulting engineering firms. These areas include, among others, environmental services. This movement has been mainly driven by government legislation to protect the environment and by public concern. Information on consulting engineering firms has been compiled from Statistics Canada's *Survey of Consulting Engineers.*[1]

Firms which specialized in environmental services[2] accounted for over 11% of the fee income of all consulting engineering firms in 1991 and for over 12% of all firms in the survey. Environmental consulting firms tended to be smaller, on average, than their counterparts but their revenues per employee were almost 25% higher than other consulting engineering firms.

1. The *Survey of Consulting Engineers* is conducted annually by Statistics Canada. It collects data on over 500 companies.
2. For the purpose of this paper, a firm specializes in environmental services if environmental services were the largest single source of fee income in the year examined and accounted for at least one-third of fee income.

Firms specializing in environmental services tended to provide advisory services (42% of fee income) whereas other consulting engineering firms were more inclined to provide design services (47%) (Table 4.1). This reflects the fact that many environmental services are of an advisory nature. In addition, the low percentage of revenues for design services in environmental service companies reflects the difficulty of isolating the environmental aspects of many engineering design projects. For this reason, environmental service revenues and indeed the number of companies specializing in environmental services, may be understated.

Although the occupational composition of the workforce was similar for firms specializing in environmental services and other firms, the percentage of full-time workers was much higher for the former in 1991 (Table 4.2). Other firms relied much more heavily on part-time and contract workers. It should also be noted that firms which specialize in environmental services used relatively more technicians and fewer engineers and other professionals.

Table 4.2
Employment in Consulting Engineering Firms, 1991

	Environmental specialists	Other firms
	percent	
Full-time employees	90.3	78.6
Part-time employees	5.4	13.5
Contract	4.3	7.7
Working owners	-	0.2
Total	**100.0**	**100.0**
Occupation		
Engineers, Professional	30.1	32.2
Engineers, Other	2.3	3.7
Other professionals	6.8	8.4
Technicians and technologists	39.3	33.4
Administrative	16.7	16.8
Other	2.8	5.5
Total	**100.0**	**100.0**

Note:
Figures may not add due to rounding.
Sources:
Statistics Canada, National Accounts and Environment Division and Services, Science and Technology Division.

In 1991, firms specializing in environmental services earned only 8.2% of their revenues from foreign projects compared to 13.5% for other consulting engineering firms (Table 4.1). Foreign projects carried out by firms specializing in environmental services were largely self-financed or financed from private Canadian sources. This contrasts with the more diverse sources of funding for other consulting engineering firms (Table 4.3).

Scientific and technical services

The scientific and technical services industry supplies a broad range of clients with a wide variety of activities from remote sensing services to the provision of environmental

Table 4.3
Source of Financing of Foreign Projects, 1991

Source	Environmental specialists	Other firms
	percent	
CIDA	3.1	16.9
Export Development Corporation	-	8.4
World Bank	-	5.7
Regional development banks	-	1.8
United Nations specialized agencies or programs	-	0.5
Foreign governments	-	11.8
Private foreign source	2.7	29.5
Private Canadian source	24.8	8.9
Self financed	69.3	15.9
Other	0.1	0.6
Total	**100.0**	**100.0**

Note:
Figures may not add due to rounding.
Sources:
Statistics Canada, National Accounts and Environment Division and Services, Science and Technology Division.

services. Specific environmental services include oceanography, meteorology, climatology, pollution research, laboratory testing and assessment and other environmental services.

The degree of specialization in environmental services within the scientific and technical services industry (STS) was much higher than the specialization within the consulting engineering industry. However, the total contribution to industry income of environmental STS firms was less than 5% in 1991. These firms provide the services listed in Table 4.4. The most important service is pollution and other environmental research, laboratory testing and assessments. Information presented here has been tabulated from Statistics Canada's *Survey of Scientific and Technical Services.*

Table 4.4
Scientific and Technical Services Firms: Summary Statistics, 1991

	Environmental specialists	Other firms
Total revenues ($000)	81 967	1 665 438
Number of employees	974	19 907
Number of firms	27	347
Revenue per employee ($000)	84	84
Revenue per firm ($000)	3 036	4 800
Number of employees per firm	36	57
	percent	
Type of service		
Oceanography	1.3	0.1
Meteorology	0.5	-
Climatology	0.3	-
Pollution and other environmental research, laboratory testing and assessment	39.9	0.3
Other environmental services	46.4	0.2
Other services	11.6	99.4
Total operating revenues	**100.0**	**100.0**

Note:
Figures may not add due to rounding.
Sources:
Statistics Canada, National Accounts and Environment Division and Services, Science and Technology Division.

Environmental STS firms relied more heavily on professionals than did environmental consulting engineering firms and within the STS industry, environmental specialist firms had relatively more professionals (46%) than other STS firms (37%) (Table 4.5).

Employee remuneration costs tended to be relatively higher for firms specializing in environmental services (53% of total

Table 4.5
Employment in Scientific and Technical Services Firms, 1991

	Environmental specialists	Other firms
	percent	
Full-time employees	82.4	80.5
Part-time employees	6.0	10.6
Contract	11.6	8.8
Working owners	-	0.2
Total	**100.0**	**100.0**
Occupation		
Professionals	46.2	36.9
Technicians	35.4	35.0
Administrative support	15.7	16.4
Other	2.7	11.4
Total	**100.0**	**100.0**

Note:
Figures may not add due to rounding.
Sources:
Statistics Canada, National Accounts and Environment Division and Services, Science and Technology Division.

expenses compared to 47%), possibly a result of the higher percentage of professionals in these firms. This difference was offset mainly by relatively lower share of materials and supplies and depreciation costs.

The distribution of revenues according to the industry of the client is a characteristic that distinguishes environmental specialists from the rest of the STS industry. The former earned 29% of their operating revenues from services to governments whereas the latter earned only 14% from this source in 1991 (Table 4.6).

Table 4.6
Source of Revenues of Scientific and Technical Services Firms, 1991

	Environmental specialists	Other firms
	percent	
Governments	28.6	14.0
Private sector	58.7	72.8
Individuals	1.7	1.8
Foreign	10.9	11.3
Total	**100.0**	**100.0**

Note:
Figures may not add due to rounding.
Sources:
Statistics Canada, National Accounts and Environment Division and Services, Science and Technology Division.

Conclusion

This brief review shows that environmental revenues were a small but important part of the consulting engineering industry and a very minor part of the scientific and technical services industry in 1991. An analysis of the period 1989-1994 is under way.

Reference

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5 Households and the Environment: Canada and Australia

by Bruce Mitchell

Introduction

Canada and Australia, despite being at opposite ends of the earth, share many common characteristics of culture, economy, geography and environment.

Canada and Australia are large countries with small populations. In each country those populations are locally concentrated with the great intervening expanses having few residents. The distances have shaped the evolution of social and economic interactions and the nature of transportation systems. The automobile, for example, plays an important part in the daily lives of many citizens of each country.

Both nations have European origins overlaid on a base of native aboriginal cultures. Multicultural influences in recent years have brought about major socio-cultural changes. Each country has the good fortune to be well endowed with a variety of natural assets including metals, hydro-carbons, forests, and fertile soils.The economies of Canada and Australia have traditionally been based on the extraction of natural resources and on agriculture. Strong manufacturing sectors utilising highly skilled labour forces developed to serve growing domestic and export markets by the mid part of this century. In each country the manufacturing sector has been under pressure lately in the face of strong international competition.

Environmental influences play a strong role in shaping activities in each country. In Canada, cold, snowy winters affect most things Canadians do and limit activities for much of the year. In Australia the limited availability of water in many areas and the frequent periods of drought have influenced the behaviours of farmers and other householders, as well as the patterns of settlement.

In both Canada and Australia, the natural environment[1] has a relatively high public profile. It appears frequently in art, literature and popular culture. In addition, environmental topics appear prominently in the curricula of Canadian and Australian schools. This widespread interest is also reflected in the degree of participation in environmentally related activities - as revealed by relevant surveys taken in each country.

In recent years, Statistics Canada and the Australian Bureau of Statistics have each undertaken new household surveys on the environment. These surveys look at some aspects of household facilities, products and behaviours that are considered to be relevant from an environmental perspective.

In each case, the survey was conducted as a supplement to the labour force activity survey of the population.[2] Environment surveys were conducted in Canada in May 1991 and May 1994. The Australian Bureau of Statistics ran environment surveys in May 1992 and June 1994.

Data are also collected in other surveys that provide useful information for environmental analysis. For example, a number of measures on energy use around the home that are collected by the Australian environment survey are gathered by the *Household Facilities and Equipment Survey* in Canada.

The purpose of this chapter is to examine the environmentally relevant behaviours of Canadian and Australian households, highlighting the many similarities as well as the differences that are the result of the unique environmental conditions present in the two countries.

The surveys themselves have enough commonality in terms of the questions asked, methodology, and sampling that comparisons are judged to be reasonable. Nevertheless, the reader is urged to remember that the data presented here were not collected using exactly the same procedures and were not originally intended to be compared. Caution in interpreting the results is advised.

The subjects covered in this paper include the 1) use of energy and selected energy intensive appliances around the home, 2) water use, and 3) waste management practices.

Energy use

Australia and Canada share the distinction of being among the largest per capita users of energy in the world. Among the 25 member countries of the Organisation for Economic Co-operation and Development (OECD) for 1993, Canada was the third highest consumer of energy[3] at 5.84 tonnes of oil equivalent per capita and Australia was tenth at 3.55 tonnes per capita (OECD, 1995a; p. 199, 283). These figures are influenced by the industrial economies and the small populations of each country. However, lifestyle considerations also come into play. Space heating and cooling,

1. Especially wilderness areas such as the Arctic and boreal forests in Canada and the Outback in Australia.

2. Titled the *Labour Force Survey* in Canada and the *Survey of Population* in Australia, these are sample surveys that regularly measure labour force participation.

3. Final consumption of energy. This is the end use sector's consumption and excludes energy used for own use by energy producing industries and for transformation.

household appliances, and motor vehicles are the major elements of the energy consumption by households.

Table 5.1 presents per capita information for OECD countries on the final consumption of energy, the use of motor gasoline and residential energy use.

Table 5.1
Energy Consumption Measures for Canada, Australia and Other OECD Countries, 1993

Country	Population	Final consumption of energy	Motor gasoline use	Residential energy use
	thousands	tonnes of oil equivalent per person		
Luxembourg[1]	395	9.25	1.42	1.40
Iceland[2]	262	6.87	0.54	2.39
Canada	**28 947**	**5.84**	**0.92**	**1.05**
United States	257 908	5.45	1.29	0.96
Finland	5 066	4.58	0.39	1.02
Norway	4 312	4.25	0.41	0.84
Sweden	8 718	3.93	0.51	0.95
Belgium	10 084	3.61	0.30	0.89
Netherlands	15 300	3.60	0.26	0.68
Australia	**17 657**	**3.55**	**0.76**	**0.45**
New Zealand	3 480	3.07	0.58	0.34
Germany	81 190	3.00	0.41	0.76
Denmark	5 189	2.89	0.38	0.88
Austria	7 991	2.83	0.34	1.05
France	57 667	2.64	0.31	0.42
United Kingdom	58 191	2.61	0.44	0.71
Japan	124 670	2.54	0.30	0.36
Ireland	3 560	2.22	0.29	0.55
Italy	57 070	2.13	0.30	0.56
Spain	39 083	1.61	0.24	0.20
Greece	10 368	1.49	0.27	0.28
Portugal	9 887	1.36	0.19	0.18
Mexico	91 210	1.11	0.26	0.20
Turkey	59 490	0.80	0.07	0.27

Notes:
1. Luxembourg's taxes on certain fuels are lower than in surrounding countries. This may be a factor involved in the apparently high per capita consumption rates.
2. Iceland includes geothermal power in the residential energy figures.

Sources:
OECD, 1995a, 1995b and 1995c.

Characteristics of climate in Australia and Canada lead to high levels of residential energy consumption. Necessity demands that extreme temperatures be moderated to allow people to survive, but our affluent lifestyles demand comfort over and above this. In the case of indoor temperatures, this means achieving a degree of stability year-round as afforded by efficient heating and cooling systems.

As Table 5.1 illustrates, Canada's per capita residential consumption of energy[1] is relatively high. This level of use also occurs in a number of cold climate countries including Finland, Sweden and the United States.

Compared to Canada's residential energy use per capita figure of 1.05 tonnes of oil equivalent per person, Australia's figure of 0.45 tonnes per person is modest. However, the Australian number exceeds that of all the other OECD countries with similar climates, Portugal, Spain, Turkey, and Greece. The Australian figure is also higher than several countries with cooler climates, including Japan, France and New Zealand.

All Canadian households and most Australian ones use some form of heating during the winter months. The colder Canadian winter sees Canadians consuming more energy per capita than Australians for space heating. However, in the parts of Australia with the lowest average winter temperatures, highland New South Wales and Victoria, the Australian Capital Territory (A.C.T.) and Tasmania, household heating requirements in winter probably approach the levels required in the mildest part of Canada[2].

In the summer months, periods of extreme heat are common in much of Australia and in many parts of Canada and air conditioning systems are used by many households in these areas.

Table 5.2
Heating and Cooling in Dwellings, 1994

	Canada	Australia
	percent	
Heating available in dwellings	100.0	83.8
Principal form of heating for heated dwellings		
Piped and bottled gas	47.5	38.0
Electricity	33.0	35.5
Oil	14.5	3.7
Wood	4.7	21.0
Other	0.3	1.8
Air conditioning in dwellings	26.8	32.5

Sources:
Statistics Canada, 1995a.
Australian Bureau of Statistics, 1995.

One hundred percent of Canadian homes had a source of space heating in 1994 while the figure for Australia was 83.8% (Table 5.2). However in the temperate Australian States of Victoria and Tasmania it was 99.4% and 99.8% respectively and 99.6% in the A.C.T. On the other hand, only 19.2% of dwellings in the tropical Northern Territory had some form of heating.

Some form of air conditioning was available in 32.5% of Australian homes while in Canada the figure was 26.8% in 1994. Again, there are regional variations related to climate. Ontario's hot, humid summers contribute to the fact that 48.1% of the province's homes had air conditioners. In the Northern Territory of Australia 76.4% of homes had air conditioning. Areas that have hot, but less humid summers, have lower levels of air conditioner ownership in both countries. For example, in the Australian Capital Territory only 16.7% of homes had air conditioners while in Alberta air conditioners were present in only 8.2% of homes.[3]

1. The residential consumption figures include all residential use of energy for space heating, space cooling, water heating, operation of appliances and lighting. They do not include energy used in the operation of motor vehicles; these figures are presented separately.

2. The southern coast of British Columbia.

3. The average mid-summer maximum temperature in Medicine Hat, Alberta is 26°C, 23°C in Calgary, and 28°C in Canberra in the A.C.T. Both Medicine Hat and Canberra have experienced extreme maximum temperatures of 42°C; however high humidity rarely accompanies the summer heat.

In both countries motor vehicles are major contributors to high per capita levels of energy consumption. In the face of low population densities in rural areas and relatively low urban densities especially in post-war suburbs, the automobile has been perceived to be the most efficient means of transportation in each country and a necessity for many households. Growing affluence in each country in the post WWII period has been accompanied by an increasing proportion of automobiles per capita.[1]

Table 5.1 presents consumption of motor vehicle gasoline[2] on a per capita basis[3] for a number of OECD countries. Among the countries presented, Canada and Australia rank third and fourth respectively behind Luxembourg and the United States.

Canada and Australia are also among the leaders in terms of passenger vehicles in use per capita. Canada has 470 vehicles per thousand persons while the Australian figure is 460. While Canada and Australia trail the United States in this regard (570 vehicles per thousand people), they lead all other OECD members including France (420 vehicles per thousand persons), Sweden (410 vehicles per thousand persons), the United Kingdom (350 vehicles per thousand persons) and Japan (330 vehicles per thousand persons) (OECD, 1995a; p. 217, 283).

Household appliances are also major consumers of residential energy. Table 5.3 illustrates the degree to which a number of energy intensive home appliances are present in Canadian and Australian households. Refrigerators are practically universal items in the households of each country. Additional fridges are also present in many homes. Freezers are also popular in both countries. About 45% of Australian households have freezers while the number is higher in Canada, at about 59%.

Washing machines are present in 79% of Canadian homes and 94% of Australian ones. Energy used in washing machines is dependent on the style of the machine (front vs. top loading) as well as the temperature of the water used in the washing and rinsing.

Clothes dryers are found in three out of four Canadian households while the number is about one out of two households in Australia. The difficulty of drying clothes outside in Canadian winters is probably a factor contributing to the difference.

Table 5.3
Households with Appliances, 1994

	Canada	Australia
	percent	
Refrigerators	99.4	99.7
Two or more refrigerators	19.4	23.9
Freezers	58.8	44.9
Dishwashers	46.4	25.1
Clothes dryers	75.4	51.7
Washing machines	79.3	94.2

Sources:
Statistics Canada, 1995b; p. 18.
Australian Bureau of Statistics, 1995; p. 46.

Dishwashers use energy not only to operate the motor and pump but also to heat the water and dry the dishes. Automatic dishwashers are somewhat more popular in Canadian households than Australian ones. Forty-six percent of Canadian homes have dishwashers compared to 25% of Australian homes.

Water use

The amounts of water used by residential activities are usually relatively small when compared to uses by agriculture and industry. For example, in 1991 in Canada (Johnson, 1995) only 7% of total water withdrawals were for domestic use while agriculture, manufacturing and thermal power generation accounted for 88% of withdrawals. Only 11% of the water withdrawn came from municipal sources, the rest was self supplied. However, because water must meet high standards of quality to be usable for human consumption, most of the water used for domestic purposes comes from municipal sources and more than half of the treated water produced by municipalities is used by the personal sector (54.8%).

In Australia, figures available for 1987[4] indicate that domestic use accounted for about 7% of total water use (Australian Water Resources Council, 1987).

Water conservation at the household level is an issue both because of overall limitations of water availability in Australia and Canada[5] and because increases in demand require the expansion of water and sewage treatment capacity.

According to Environment Canada estimates, about 75% of water used in the home is for bathroom and toilet use, 20% is used for laundry and 5% for cooking and drinking. Watering lawns and gardens would have a significant seasonal impact on these figures. In Australia, for example, an esti-

1. The number of passenger vehicles per thousand persons in Canada increased from 140 in 1950 to 230 in 1960 and to 420 in 1980. In 1993 there were 470 passenger vehicles per 1000 persons. In Australia there were 90 passenger vehicles per thousand people in 1950, 190 in 1960, 400 in 1980 and 460 in 1993.
2. Diesel is also used to fuel private and commercial vehicles. In some European countries, diesel is somewhat more popular for private vehicles than in Canada or Australia. In Canada 0.21 tonnes oil equivalent (toe) of diesel per capita were used in 1993. This is about the same as the figures for the United Kingdom, Sweden, Ireland and Japan. In Australia, 0.26 toe of diesel per capita were used in the same year. In Germany the figure was 0.27, in France 0.31 and in Belgium 0.39 toe diesel per capita were used (OECD, 1995a).
3. It should be noted that this figure covers all gasoline consumption by motor vehicles and will therefore include a portion of commercial use as well as amounts used by households.
4. Because the Australian and Canadian estimates of domestic water consumption were developed independently using different methodologies, caution should be used in any comparisons of the numbers.
5. Although this is more of a concern in Australia, parts of Canada, the southern Prairies in particular, often face shortfalls in water availability due to low flow rates in rivers and limitations of groundwater supplies.

mated 55% of the total household water consumed by Canberra households is used outside around the home. In Melbourne the figure is 38% while in Perth it is 42% (CSIRO, 1992).

Water conservation practices at the household level in both Canada and Australia are targeted at the more efficient use of water in the bathroom, laundry and around the home.

Conventional North American toilets use about 18 litres of water per flush and are major household water users. Significant savings in water can be made by reducing the amount of water that toilets use. This can be done by modifying the water volume held in the tank of the existing toilet (by adding an object to displace water, a brick in a plastic container, for example) or by installing a toilet that uses less water in the first place. Some of the new low flush models use as little as 6 litres of water.

In several Australian States new toilets installed must be of the low or dual-flush[1] type. Consequently the *1994 Australian Environment Survey* found that 39% of households in Australia have dual flush toilets, with the percentage reaching 51% in the State of Victoria and 48% in South Australia. In addition, 2% of Australian households reported adding an object to the toilet tank to reduce flows in that way.

In Canada, the degree of adoption of this water saving technology is more modest.[2] As Table 5.4 shows, the *1994 Household Environment Survey* found that 15% of Canadian households had a low-flow toilet or had made modifications to the tank to reduce the flow. Alberta households have the highest rate of use of these items at 21%.

Water use for bathing can be reduced in several ways including taking shorter showers or using less water in the bath tub. Another way is to reduce the flow rate of the shower by using a low-flow showerhead. A typical showerhead uses about 20 litres of water a minute (Australian Bureau of Statistics, 1995; p. 75). Low-flow showerheads can reduce the flow down as low as 7 litres per minute while still maintaining a degree of washing efficiency. In addition, by reducing the amount of hot water consumed, low-flow showerheads also reduce the energy used to heat water.

In Australia, about 22% of households use low flow showerheads with the figure being highest in the Australian Capital Territory at about 29%.

In Canada the figure is somewhat higher with 42% of households reporting low-flow showerheads. The energy saving aspect of low-flow showerheads has been promoted widely by some Canadian energy suppliers.

Because water-use concerns have a high profile in Australia, the Australian Bureau of Statistics environment survey asked additional questions that have not been asked in the Canadian survey. For example, 13% of Australian households said they reuse or recycle water, 15% said they used a suds saver on the washing machine, 8% had timers installed on garden taps, and 53% used mulch on garden beds to reduce the need for watering. In summary, 45.7% of households said they used some method of conserving water in the dwelling while 84.1% of households with gardens said they used at least one water conservation measure in the garden.

1. Dual flush toilets have dual controls and allow the user to choose between a moderate or a low volume flush.
2. The building code in Ontario now requires that newly installed toilets must be low volume ones.

Table 5.4
Water Saving Technology in Households, 1994

	Low-flush toilet or object in tank	Low-flow showerheads
	percent	
Canada	**14.8**	**42.3**
Newfoundland	6.0	27.9
P.E.I.	--	33.3
Nova Scotia	12.6	40.7
New Brunswick	11.4	42.4
Quebec	8.7	46.0
Ontario	18.0	44.9
Manitoba	19.4	34.0
Saskatchewan	12.5	26.6
Alberta	20.6	32.2
British Columbia	15.9	43.4
Australia	**40.8**	**21.8**
New South Wales	32.8	19.5
Victoria	51.9	21.2
Queensland	32.9	22.5
South Australia	49.8	26.1
Western Australia	48.8	26.1
Tasmania	32.8	20.6
Northern Territory	--	14.6
A.C.T.	35.7	28.6

Sources:
Statistics Canada, 1995a.
Australian Bureau of Statistics, 1995.

Waste management practices

The consumer orientation of Canadian and Australian societies is reflected by the high levels of household waste generated. Household waste statistics collected in Canada and Australia are not strictly comparable, however estimates produced by the OECD place the two countries among the top per capita generators of municipal waste (OECD, 1995a; p. 151).

In response to environmental concerns and the difficulty of developing new disposal sites, local governments in both Canada and Australia have been active in developing recycling programs to reduce the amounts of municipal waste that is ultimately sent for disposal.

Canadian and Australian household waste management practices are difficult to compare because the questions and definitions used in Canadian and Australian household environmental surveys are slightly different. In addition, the Australian survey rotates the subjects examined from sur-

Table 5.5

Access to, and Use of Services for Paper Recycling by Canadian Households, 1991 and 1994

	Access to program		Use program where available[1]		Households recycling paper[2]	
	1991	1994	1991	1994	1991	1994
	percent					
Canada	**52.6**	**69.6**	**85.8**	**83.1**	**45.2**	**57.9**
Newfoundland	11.3	19.7	--	44.4	--	33.3
P.E.I.	10.6	20.8	--	70.0	--	--
Nova Scotia	38.8	50.3	70.0	72.5	25.6	36.4
New Brunswick	17.5	46.7	65.9	58.8	11.6	27.5
Quebec	33.8	57.2	76.5	74.0	25.9	42.3
Ontario	72.1	83.5	94.5	92.9	68.2	77.6
Manitoba	40.4	61.0	50.3	48.3	20.3	29.5
Saskatchewan	37.6	69.3	69.6	73.2	26.2	50.7
Alberta	51.1	71.2	77.1	75.8	39.4	54.0
British Columbia	64.2	74.5	87.3	88.2	56.1	65.7

Notes:
1. Households reporting use of paper recycling service as a percentage of those with access to the service.
2. Households reporting use of paper recycling service as a percentage of all households.

Sources:
Statistics Canada, 1992 and 1995a.

vey to survey. The 1992 survey contained questions on waste management practices but the 1994 survey did not.

Nevertheless a broad picture of practices and services present does emerge from the data sets that are available. Tables 5.5 and 5.6 present statistics on paper recycling by Canadian and Australian households. Paper is most commonly collected by recycling programs in the two countries and is therefore included in the two tables.

Recycling programs that include paper among the products gathered are now quite common in Canada with almost 70% of households having access to them in 1994, a figure that was up 17% from three years earlier. The relative enthusiasm with which the Canadian public has adopted these programs is reflected in the high participation rates where these services are available.

In Australia as well, participation in paper recycling is popular with 53% of households involved in this activity in 1992. As in Canada, regional availability of services is a major determinant in the level of recycling participation. The numbers range from a high of 67% in the state of Victoria where recycling facilities were widely available at the time of the survey, to 27% in the Northern Territory where they were not as wide spread.

The type of service available probably also has an impact on participation rates. For example, in Ontario curbside recycling is widely available. Compared to neighbourhood or regional recycling depots, curbside recycling demands much less of an effort from the participant so higher participation rates might be expected. In fact Ontario featured the highest rates in Canada in both 1991 and 1994.

Table 5.6

Recycling by Australian Households, 1992

	Paper recycling	No recycling done by the household
	percent	
Australia	**52.8**	**15.6**
New South Wales	57.5	17.3
Victoria	67.1	10.2
Queensland	36.0	19.0
South Australia	43.1	16.7
Western Australia	61.0	12.5
Tasmania	38.4	19.4
Northern Territory	27.1	31.3
A.C.T.	63.3	12.5

Source:
Australian Bureau of Statistics, 1993.

Recycling programs operate most effectively if there is a market for the goods collected. In the case of paper, the products created from the materials collected include paper towels, toilet paper, newsprint, and stationary. For paper towels and toilet paper, especially, advertising on packaging and elsewhere reminds consumers that the products have recycled content and makes the point that these items are "environmentally friendly".

Tables 5.7 and 5.8 present figures on the use of recycled paper in households. Again, readers are advised that because the Australian and Canadian tables are not precisely comparable only general conclusions can be made.

There are only modest regional variations in the use of recycled paper products in both Canada and Australia. In Canada the use of the products increased from 1991 to 1994.

Tables 5.7 and 5.8 also present information on composting, another method to reduce the amount of solid waste disposed. British Columbia, with a milder climate amenable to

Table 5.7

Selected Environmentally Friendly Practices in Canadian Households, 1991 and 1994

	Regularly purchase paper towels and/or toilet paper made from recycled paper		Use a compost heap, compost container or composting service	
	1991	1994	1991	1994
	percent			
Canada	**45.3**	**58.3**	**17.4**	**22.7**
Newfoundland	46.9	68.3	6.2	9.3
P.E.I.	48.9	56.3	10.6	16.7
Nova Scotia	54.0	65.7	16.6	19.0
New Brunswick	50.6	66.3	11.2	16.1
Quebec	38.5	60.7	5.3	7.9
Ontario	51.2	59.9	21.3	30.3
Manitoba	40.9	46.8	15.2	18.1
Saskatchewan	40.7	49.3	20.1	21.6
Alberta	40.6	51.5	17.5	21.2
British Columbia	45.4	53.9	34.9	37.9

Sources:
Statistics Canada, 1992 and 1995a.

Table 5.8
Selected Environmental Practices by Australian Households, 1992

	Use recycled paper products	Compost or mulch
	percent	
Australia	**68.0**	**45.1**
New South Wales	66.4	39.3
Victoria	67.3	48.9
Queensland	67.5	47.5
South Australia	69.9	45.7
Western Australia	73.3	42.2
Tasmania	62.4	53.7
Northern Territory	64.1	44.3
A.C.T.	73.8	50.7

Source:
Australian Bureau of Statistics, 1993.

outdoor activities such as composting, has the largest percentage of Canadian households composting.

As Table 5.8 shows, almost half of Australian households reported that they compost.

Mulching garden beds with composted materials is a popular way of reducing evaporation and thus water use. In 1994 53% of Australian households with gardens reported mulching garden beds to conserve water (Australian Bureau of Statistics, 1995; p. 74).

Conclusion

The data presented in this chapter illustrate many similarities between Australian and Canadian households with respect to their consumption of energy, use of water and management of wastes. The majority of residents in each country have expressed strong support for environmental concerns. For example, the 1994 Australian environment survey found that 69% of Australians were concerned about environmental problems, although this is down from 75% in 1992. In a 1992 survey for Environment Canada, 90% of Canadians said they were at least somewhat concerned about the environment (Statistics Canada, 1995b; p. 63). However, is the commitment to the environment strong when placed in competition with economic concerns and elements of individual lifestyle?

Research in Canada questions the existence of a relationship between the environmental attitudes people express and their actual behaviour to reduce their environmental impacts (Ungar, 1994). The results that have been presented in this paper seem to show that Canadians and Australians are willing to take limited actions that they perceive to be environmentally significant including recycling and doing some things to reduce energy and water use. However, the measures that would have a major impact on resource consumption, for example, a large reduction in motor vehicle use, would also have a major impact on the lifestyles of Canadians and Australians. Would Canadians and Australians be prepared to do more?

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6 Measuring Canada's Natural Wealth: Why We Need Both Physical and Monetary Accounts[1]

by Alice Born

Introduction

There is growing interest in sustainable development and expanded wealth accounts are seen as a one of the tools in its measurement (see World Bank, 1995 and Hamilton, 1994). Whether it is a measure of wealth per capita or a measure of a nation's total capital over time, wealth accounts and national balance sheets will include the value of natural capital as well as the value of produced capital in the future. Estimation of the value of human capital is still in the early stages of development but the World Bank has recently provided some estimates (World Bank, 1995). The development of natural resource accounts has focused on placing a monetary value on known physical quantities of the resource in order to obtain a wealth value for natural capital.

At Statistics Canada, *Natural Resource Stock Accounts* which are aimed at measuring Canada's natural wealth, are one of four environmental accounts being currently developed. The other three accounts are *Natural Resource Use Accounts*, *Waste Output Accounts* and *Environmental Protection Expenditure Accounts*.[2] The natural resource use and waste output accounts are recorded in physical terms and the environmental protection expenditure accounts, in monetary terms. Only the natural resource stock accounts are recorded in both physical and monetary terms.

This paper reviews some of the preliminary results of the Natural Resource Stock Accounts in the context of Canada's wealth accounts which currently only include the values of produced capital and land. In accordance with the 1993 International System of National Accounts (1993 SNA)[3], Canada plans to add the value of natural wealth (e.g. subsoil and timber assets) to the national balance sheet accounts beginning in 1997. The results presented here are limited to subsoil assets.

The first part of the paper discusses the uncertainty of measuring Canada's resource base and its effects on physical accounting. The second part of the paper focuses on the *linkages* between the physical and monetary accounts, and the 1993 SNA and the System of Economic and Environmental Accounts (United Nations, 1993). Finally, the last part of the paper examines the usefulness of the expanded wealth accounts with respect to the concept of sustainable development.[4] Partial results of Canada's wealth accounts are presented as well.

Physical accounts: resource base and uncertainty

Physical accounting of subsoil assets shows that the assumption of a "fixed and non-renewable" mineral stock can be limiting in determining the size of a nation's resource base. What we observe are "inventories" of proven reserves which are being constantly renewed by investment in exploration and development. Furthermore, in the case of metals, the rate of depletion is impacted by the rate of recycling as well. The size of the resource that is considered "economic" and therefore currently recoverable depends on costs and prices, including the prices of substitutes (Adelman *et al.*, 1991). This suggests that we cannot know how much of mineral resources should be shared with future generations or what is the optimal depletion rate by simply estimating when supplies will be exhausted at current rates of depletion (Mikesell, 1994). Since resource base and reserve estimates are revised from year to year as extraction continues, new discoveries are made and the overall understanding of the resource base improves, physical accounts of fuel and non-fuel minerals should reflect these changes.

Physical accounts should present a range of available resources and not be restricted to only "proven reserves" as suggested by the 1993 SNA. For example, mineral resources can be divided into two components: discovered or known recoverable resources and undiscovered recoverable resources. *Discovered recoverable (or known) resources* are those resources that are estimated to be recoverable from known deposits using current technology and under current economic conditions. Included in this category are: cumulative production,[5] remaining established (or devel-

1. Revised version of a paper presented in Session V: Valuation and Aggregation at the International Association for Research in Income and Wealth Special Conference on Integrated Environmental and Economic Accounting organized by the Economic Planning Agency of Japan, United Nations University and Keio University, Tokyo, Japan, March 5-8, 1996.
2. For a review of natural resource and environmental accounting at Statistics Canada see Smith (1994).
3. Major modifications were made to the System of National Accounts in1993 (United Nations *et al.*, 1993). The balance sheet accounts now include the value of subsoil and other natural assets. The change in the value of these assets is recorded as a reconciliation item and therefore does not affect net product aggregates.
4. Many concepts and definitions of sustainable development are currently being explored and discussed. The concept of sustainability used in this paper suggests that "each generation should maintain the capital value of the natural resources it inherits." In the case of non-renewable resources, this condition can be approximated by saving and reinvesting resource rents from mineral extraction into other forms of capital (Mikesell, 1994).
5. The total amount of hydrocarbon or metal extracted to a given date.

Table 6.1
Energy Resource Estimates, 1992

	Discovered recoverable resources				Undiscovered recoverable resources	Ultimately recoverable resources[2]
	Cumulative production	Remaining established reserves	Yet-to-be established reserves	Total[1]		
Crude oil (millions of m^3)	2 394	680	1 113	4 207 [3]	4 361	8 568 [3]
Crude bitumen[4] (millions of m^3)						
Surface mineable	210	434	9 356	10 000	-	10 000
In situ	59	48	38 893	39 000	-	39 000
Total crude bitumen	269	482	48 249	49 000	-	49 000
Natural gas (billions of m^3)						
Western Canada	2 163	1 909	-	4 072	3 144	7 216
Frontier areas	32	9	1 187	1 228	8 055	9 283
Total	2 195	1 918	1 187	5 300	11 199	16 499
Coal[5,6] (megatonnes)						
Lignite	..	2 236	..	..	..	44 360 [7]
Subbituminous coal	..	871	..	..	..	
Bituminous coal	..	3 471	..	..	..	34 245
Total	..	6 578	..	..	..	78 875
Uranium (kilotonnes)	155 [8]	309	163	627	..	..

Notes:
1. Sum of cumulative production, remaining established reserves and yet-to-be established reserves.
2. Sum of total discovered reserves and undiscovered recoverable resources.
3. Totals in source data.
4. Occurs in oil sands.
5. Reserve definition used is *recoverable* rather than *established*, however the definitions are similar.
6. As of 1985.
7. Lignite plus subbituminous coal.
6. Approximated

Sources:
Natural Resources Canada, 1993a and 1993b.
National Energy Board, 1994.

oped) reserves and yet-to-be established (or undeveloped)[1] reserves. *Undiscovered recoverable resources* are those that are estimated to be recoverable from resources that are believed to exist on the basis of available geological and geophysical evidence but not yet been shown to exist by drilling, testing or production. The sum of discovered and undiscovered mineral resources is referred to as *ultimately recoverable resources* (Table 6.1).

For the purpose of monetary valuation, we focus on that part of the resource base which is estimated to be recoverable using existing machinery and equipment and structures in place, and under current economic conditions. These are defined as *remaining established* (or recoverable) *reserves* in Table 6.1. Established reserves represent a conservative estimate of the available stocks, given changing technology and markets. Nevertheless, based on this definition, it is apparent that rapid depletion has been occurring over a short time period (figures 6.1 to 6.5), particularly for oil and nickel reserves. Yet, these represent only a small portion of Canada's known reserves and ultimately recoverable resources of fossil fuels and metals. In the case of crude oil, remaining established reserves represent 38% of the known reserves and 11% of the total ultimately recoverable resources. For crude bitumen, we are placing a monetary value on only 1% of known reserves and for natural gas, on 62% of known reserves and 13% of the total ultimately recoverable resources.

The importance of physical accounts is demonstrated here. While we are placing a monetary value on only a small part of Canada's known reserves, a large part of the resource remains unvalued. "Option values" based on transaction values might be used to value undeveloped reserves to reflect more closely the total wealth of a nation.[2] A broader definition of resources in the physical accounts shows the resources that are available in the long term.

Physical and monetary accounting

A comprehensive description of the interrelationship between the environment and the economy is not possible without using physical data. In many cases, they are more suitable than monetary data. This is especially true for the flow of materials within the natural environment, and from the natural environment to the economy and back into the environment as wastes (United Nations, 1993). Thus, Statistics Canada's Natural Resource Use and Waste Output Accounts, which are based on input-output models, are expressed in physical terms. Linking those data to the monetary data of the national accounts, however, is necessary for

1. By definition, *developed reserves* are estimated to be recoverable through produced capital already in place (e.g. machinery and equipment and structures). In case of *undeveloped reserves*, additional exploratory and development work would be required in order to classify them as developed reserves.

2. This was suggested by the U.S. Bureau of Economic Analysis (1994).

Table 6.2
Physical and Monetary Assets Accounts

	Produced assets	Non-produced assets				
		Biological resources	Land (including ecosystems)	Subsoil assets	Water	Air
Physical accounts	Economically produced	Economically produced	Economically used	Developed reserves	Economically stored	Non-economic
		Wild	Uncultivated, protected	Undeveloped reserves	Other bodies of water	
Monetary valuation	Market value	Market value	Market value	Market value (developed reserves)	Market value	Non-market value
		Non-market value	Non-market value	"Option values" (undeveloped reserves)	Non-market value	

the development of other environmental-economic accounting systems.

Table 6.2 compares physical and monetary accounts of produced and non-produced assets. At Statistics Canada, both developed and undeveloped reserves appear in the physical accounts while only developed reserves are valued in the corresponding monetary accounts.

Physical data are difficult or impossible to aggregate across the range of natural resources because of the different statistical units used. Trying to assess the sustainability of an economy or a set of human activities based on inventories of a stock of natural capital also raises the problem of incomparability of physical units. For example, if a stock of timber increases and a stock of natural gas decreases at the same time, how can it be determined if the total stock of natural capital has fallen or risen, or remained the same (Victor, 1990)?

In many cases, the only way to obtain comparable results is to make a monetary valuation. Such a valuation is the norm for produced assets and is necessary to value natural (as well as human) capital in the balance sheet. Using current prices simplifies the valuation of natural capital but can give a distorted view of equilibrium prices in the longer term. In the case of subsoil assets, negative externalities generated by the production of marketed goods, like environmental protection and restoration costs, may not be adequately reflected in market prices.[1] Furthermore, if the price or the net price rises as the resource stock declines, the value of the resource stock as an indicator of sustainability may give the wrong policy signal to government.

Figures 6.1 to 6.5 show the physical quantity of remaining reserves of oil, natural gas, coal, uranium and nickel[2] and the present value of the stocks from 1975 to 1992. While monetary values provide a common numeraire to compare these commodities, the physical quantities sometimes reflect a different picture of the remaining reserves.

Physical quantities of oil reserves have declined almost by half since 1975 while values of the stock increased until 1986 and declined thereafter, reflecting the major drop in world oil prices in that year. Natural gas shows a similar trend to oil, however physical depletion of the stock is less dramatic. Since 1982, coal reserves have been maintained between 6.0 and 6.5 billion tonnes with their present value peaking at $19 billion in 1984 and declining to $13 billion in 1992.[3] Physical reserves of uranium have declined by 200 kilotonnes since 1979 reflecting a price drop from $135 per kilogram[4] in 1980 to $71 per kilogram by 1990. Recent increases in reserves are due to the opening of higher quality mines in Saskatchewan. The changes in present value over time reflect both the price changes discussed above and long-term contracts above world prices for Ontario uranium in the 1980s. Quantities of nickel have been declining since

1. For a more complete discussion on mineral prices and their impact on the value of subsoil assets, see Born (1995).

2. In Canada, the term *established* reserves is used for oil, crude bitumen and natural gas reserves, *recoverable* reserves for coal and uranium reserves and *proven and probable* reserves for nickel. While these definitions reflect reporting conventions in Canada, they are considered to be similar.

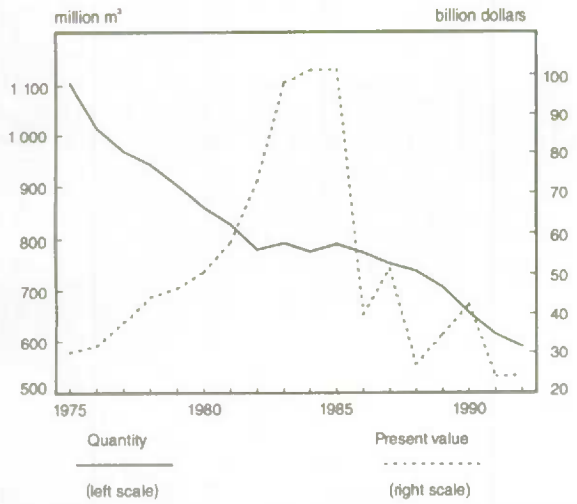
3. For a more complete discussion of the quantity and value of Canada's coal reserves, see Born *et al.* (1995).

4. The price quoted here is per kilogram U (uranium).

1979. The value shows declines from 1979 to 1986, increases in the late 1980s followed by a strong decline in 1989 due to large deliveries of former U.S.S.R. nickel into the market and the effects of the recession.

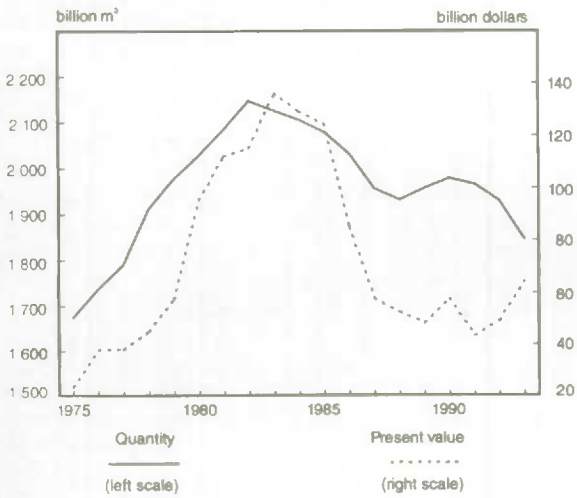
While monetary valuation of developed mineral reserves is necessary in order to calculate wealth, these values alone do not clearly indicate trends in the remaining reserves from which income is to be derived, nor do they show whether "resource rents" are being consumed or reinvested elsewhere in the economy. Physical accounting provides a measure of resource availability in the medium or long term depending on the reserve definition used. Monetary valuation is only one aspect of natural resource accounting, and it is just as useful to measure a resource in physical terms than in monetary ones. From a national accounts' perspective, a natural resource is as much an economic as a physical concept.

Figure 6.1
Quantity and Present Value of Established Oil Reserves, 1975-1992



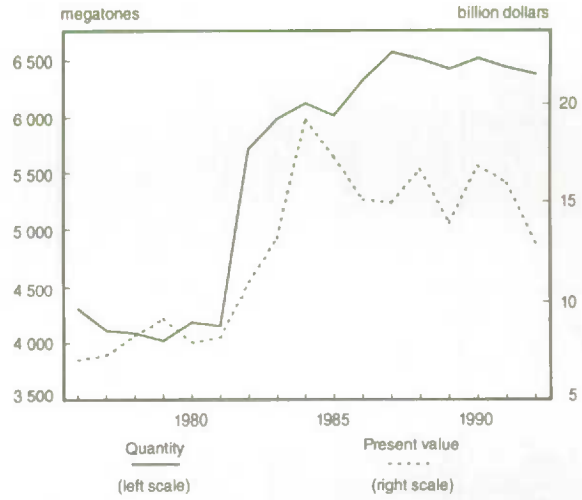
Source:
Statistics Canada, National Accounts and Environment Division.

Figure 6.2
Quantity and Present Value of Established Natural Gas Reserves, 1975-1992



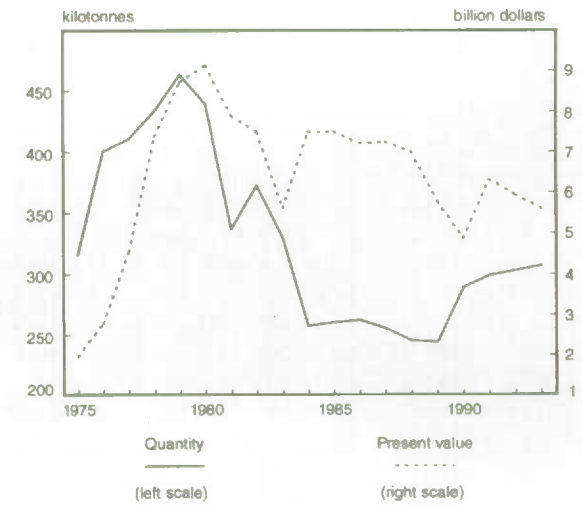
Source:
Statistics Canada, National Accounts and Environment Division.

Figure 6.3
Quantity and Present Value of Recoverable Coal Reserves, 1975-1992



Source:
Statistics Canada, National Accounts and Environment Division.

Figure 6.4
Quantity and Present Value of Recoverable Uranium Reserves,1975-1992



Source:
Statistics Canada, National Accounts and Environment Division.

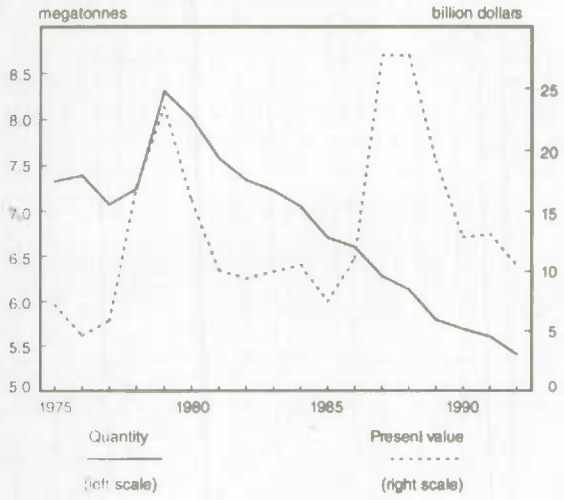
Text Box 6.1
Sustainability and Capital Maintenance

In order to make the concept of sustainability operational, it is usually reduced to that of capital maintenance as "a reasonable indicator of baseline sustainability" (Bartelmus, 1996). Several definitions of sustainability reflecting different approaches to capital maintenance have been proposed (Bartelmus, 1996; Daly, 1995; and Serageldin and Steer, 1994):

- *Weak sustainability* seeks to maintain income flows without regard to composition of capital (e.g. produced, natural, human and social). It assumes that produced and natural capital are substitutable and thus, that only their sum need remain intact.
- *Sensible sustainability* requires that, in addition to maintaining the total level of capital, its composition should be taken into account (i.e. ensuring that the levels of the different types of capital are maintained). Oil may be depleted if the receipts it yields are invested in other forms of capital. According to this definition, produced and natural capital are substitutable but also complementary.
- *Strong sustainability* requires the full preservation of the natural resource or at least that the different types of capital remain intact, that is, receipts from oil extraction should be invested in renewable types of energy. It assumes that produced and natural capital are complementary, which requires that each be maintained intact separately.

The focus of weak sustainability is income maintenance, by reinvesting returns in other production processes rather than looking for substitutes of the resource being depleted. The question is how much income derived from resource extraction should go to consumption, saving, or investment in other forms of capital (weak sustainability) or in substitutes for the resource (sensible sustainability). For natural assets that are non-renewable, such as subsoil assets, the criterion of strong sustainability must be relaxed. In its most extreme form, strong sustainability is not a viable approach, since the non-use of a nation's natural resource can be considered squandering part of a country's economic potential. In this paper, indicators reflecting both sensible and weak sustainability are examined.

Figure 6.5
Quantity and Present Value of Proven and Probable Nickel Reserves, 1975-1992



Source:
Statistics Canada, National Accounts and Environment Division.

Sustainable development and mineral resources

The most familiar definition of sustainable development is that of the Brundtland Commission: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." It follows that the national accounts should provide an indication of the extent to which a country meets the basic material needs of its inhabitants and will be able to do so in the future (Schrecker, 1995).

The *economic* approach to sustainable development is based on the principle of generating a maximum income flow while maintaining the stock of capital (Text Box 6.1). The controversy over the degree of substitution of produced capital for natural capital translates into a continuum of conditions for sustainable development, between what is known as *weak* and *strong* sustainability. However, it is this maintenance of capital or a nation's wealth, both produced and natural, that is at the heart of sustainable development, no matter how it is defined (Hamilton, 1994).

If it is accepted that rents from natural capital depletion (both renewable and non-renewable) should be shared with future generations, then sufficient assets should be maintained to ensure a non-decreasing flow of income or welfare (per capita). Total capital stock, in monetary terms, may be preserved if revenues from the resources being depleted are invested in other forms of productive capital. However,

it is difficult to identify the types of capital to be maintained (e.g. produced, natural, intangible or human capital) and to value some of these assets (Munasinghe, 1993; Born, 1992).

Sustainable development requires that consumption by present generations should not be at the expense of future generations. For subsoil assets, this imposes two conditions. First, investments should be made in alternative wealth-generating assets as a substitute for the depleting mineral asset. Second, the environmental damage caused by mining and smelting and by consumption should be minimized (Auty and Warhurst, 1993). For subsoil assets, especially fossil fuels, the limited carrying capacity of the environment implies that the second constraint is more important than the first one (the depletion of the resources).

The sustainable development of subsoil assets raises a number of questions such as the valuation of annual depletion, the substitutability of produced capital for depleted mineral resources and the mechanism for transferring the "capital value" of the depletion to future generations. Some environmentalists suggest that sustainable development requires limiting the rate of mineral extraction to the rate at which their renewable substitutes are developed. Since the exact physical volume of mineral stocks can vary from year to year with discoveries, technological change, depletion and resource evaluation, we do not know the optimal depletion path for these resources (Mikesell, 1994). The problem of sharing mineral resources with future generations is estimating when supplies will be exhausted at current rates of depletion.

Physical stocks of minerals are depleted by each generation even though additional reserves are added to the "recoverable" stock. However, extraction does not represent a loss of "capital value" if an equivalent value of additional reserves is discovered. It would suffice to maintain the capital value of mineral reserves for future generations to be assured an income equal to that earned from the reserves by the present generation.

However, this assumes that produced capital financed by the rent from mineral depletion is a substitute for the depleted mineral. It also raises the issue whether sustainable development requires a constant stock of both produced capital and natural capital or just total capital stock. If there is a high degree of substitutability between produced capital and natural capital such as minerals, the reinvestment of the rent from the extraction of subsoil assets should prevent future economic output from being constrained by depletion of minerals (Mikesell, 1994). The assumption of strong sustainability, on the other hand, implies the need to maintain both produced and natural capital.

Wealth accounts are one measure of weak sustainable development, and could be complemented by others. Such accounts would help to answer the question of how human activities impact the potential of natural resources to generate income in the future (Schrecker, 1995).

Table 6.3 presents wealth accounts and wealth per capita for Canada including preliminary estimates of subsoil assets. Increases in the value of the latter are mainly attributable to the revaluation of resource prices and costs over the period, the value of reserve additions being less than that of depletion. The physical accounts, however, show a different picture. Except for uranium, all recoverable reserves are being depleted and not being replaced (Table 6.4). At this time, we cannot determine whether the owners of subsoil assets, mainly provincial and federal governments, employ the rent derived from their extraction to produce other assets. However, Canada's wealth and wealth per capita are being maintained and are increasing over time.

Government revenues from the extraction of natural resources represented approximately 3.5% to 4.0% of total provincial and territorial government revenues between 1990 and 1995. For a province such as Alberta which produces about 80% of Canada's oil and natural gas, the percentage increases to about 20%. Since most natural resources in Canada are owned by provincial and federal governments, it is likely that most of the returns from the extraction/harvesting of these resources are invested in health care or education and therefore human capital. In Alberta, 30% of oil and natural gas revenues were put into its Heritage Savings Trust Fund for a number of years and reinvest-

Table 6.3
Expanded Wealth Accounts, 1992[1]

		Non-produced assets		Wealth per capita	
	Produced assets	Land[3]	Subsoil assets	Excluding subsoil assets	Including subsoil assets
	billion dollars			dollars per capita	
Opening stock (December, 1991)	**1 897.7**	**559.9**	**118.7**	**86 788**	**90 979**
Depletion of non-produced assets	...	..	6.4	...	...
Use of produced assets	..	...	...	...	...
Other volume changes[2]	..	..	5.6	...	...
Revaluation due to market price changes	..	..	-	...	...
Closing stock (December, 1992)	**1 940.1**	**567.5**	**117.9**	**87 942**	**92 044**

Notes:
1. Includes the value of Canada's oil, natural gas, crude bitumen, coal, uranium, and nickel reserves. Excluded are the value of iron, potash, gold, silver, copper, zinc, lead, and molybdenum.The results presented here are preliminary.
2. Includes changes in technological progress, prices, costs and estimation methods.
3. The value of land includes residential, non-residential and agricultural land.
Source:
Statistics Canada, National Accounts and Environment Division.

Table 6.4
Physical Accounts of Subsoil Assets, 1992

	Crude oil	Natural gas	Crude bitumen	Coal	Uranium	Nickel
	million m^3	billion m^3	million m^3	megatonnes	kilotonnes	kilotonnes
Opening stock (December, 1991)	**614.1**	**1 965.3**	**501.7**	**6 434.2**	**305.0**	**5 691**
Depletion of sub-soil assets	69.8	125.7	23.8	79.0	9.1	231
Other volume changes[1]	44.4	89.7	4.3	23.0	13.1	145
Closing stock (December, 1992)	**589.8**	**1 929.5**	**482.2**	**6 378.3**	**309.0**	**5 605**

Notes:
Figures may not add due to rounding.
1. Includes changes in technological progress, prices, costs and estimation methods.
Source:
Statistics Canada, National Accounts and Environment Division.

ed in other forms of capital. In Alberta's case, some of the resource rents were converted to other forms of assets through investments in public infrastructure, public enterprises and human capital (health and education expenditures). However, in recent times, no revenues have been placed in the fund. Calculations by Smith (1992) suggest that from 1963 to 1988, the Alberta government was consuming revenues from oil and gas extraction at a rate that may have resulted in a decrease in the wealth over time.

Conclusion

If sustainability is going to be more than a slogan, it requires a definition, some quantitative objectives and some indicators for measuring progress or regression. Sustainable development is a macroeconomic issue since it concerns all resources: produced, natural and human capital. The aim is to sustain welfare, i.e. the consumption of economic and environmental goods and services, for present and future generations. A more accurate picture of the capital base on which future income and consumption depend, requires the inclusion of natural capital in wealth accounts.

It is the availability of natural capital and the absorptive capacity of the environment that will pose limits to sustainable economic growth. Developing alternative growth indicators and including measures of natural capital and its depletion in economic growth models could provide tools to determine what is sustainable economic growth (Bartelmus, 1992). The definition of sustainability in terms of capital maintenance requires that the owners of natural capital invest the rent in the production of other assets.

Does the concept of capital maintenance refer to the "capital value" of mineral resources or to the physical volume of natural resource stocks? As suggested by Peskin (1996), the distinction is important in the case of natural capital, since there may be little association between an asset's physical condition and its value. As shown in this paper, there is a need for both physical and monetary accounts. Yet if one talks about economic sustainability, it is economic value that is used to measure total national wealth (produced, human and natural capital).

If the measure of national wealth is expanded to include the value of subsoil assets and timber resources, then total wealth per capita may become a useful indicator of sustainability. If wealth per capita does not decline, then (economic) development is considered to be sustainable. Whether or not GDP or an adjusted "green" GDP per capita adequately measure short-run economic performance, wealth per capita does give a picture of how wealth creation and population growth influences future income per capita.[1] This is, for Statistics Canada, an area of future work in natural resource and environmental accounting.

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7 Land Statistics for Canada

by Michael Bordt, Doug Trant, Giuseppe Filoso, Hélène Trépanier and Jeff Fritzsche, National Accounts and Environment Division; Ken Korporal, Agriculture Division

Introduction

The objective of this chapter is to provide an assessment of the current status of land statistics in Canada. Broadly defined, land statistics concern land cover, use, potential and value. There is no harmonized source for this information for all of Canada. This paper describes the existing sources of land information and proposes a methodology for estimating several national-level land statistics which are currently not regularly reported.

The need for land statistics

Land statistics have been of importance mainly to track ownership, local land-use plans and resource potential. National statistics on agricultural land use have been collected since the first *Census of Agriculture* in 1881. The advent of land-use planning brought about the need for additional information to take into account as many factors as possible in order to harmonize local land uses and thereby avoid future conflicts.

More recent environmental and resource concerns require more extensive and detailed information. The natural landscape is constantly being modified either intentionally to suit human purposes or as a by-product of our activities. As the nature of the land changes, so does its ability to provide the necessary functions for humans and natural ecosystems alike.

Except for lands used for agriculture and forestry there are no detailed national-level data on land use. *The State of Canada's Environment* (Government of Canada, 1992; p. 5-17) well states the current situation:

> At every level – national, provincial, regional and local – our knowledge of the land base itself is inadequate. In many instances, basic resource inventories, from which land-use interpretations can be made, remain incomplete or are outdated. Following the termination of the Canada Land Use Monitoring Program of Environment Canada, in place from 1978 to 1988, there is a need for national data indicating how much land is used and how land use changes from year to year. Nationally, Canada has not determined how much land will be needed for different purposes in the future, nor is there agreement on how to establish the true value of land uses, to compare with those established by the market.

Land issues

The Federal/Provincial Committee on Land Use (1996) sponsored a forum in 1995 to discuss common issues in land use. The issues were classified according to four key land-use categories: agriculture, forestry, shore zone/coastal zone, and urban. The detailed issues that were discussed are listed below.

Agriculture:

- degradation of agri-ecological resources through agricultural practices;
- on and off-farm effects;
- lack of an agricultural land policy;
- loss of the agricultural land base;
- competing uses on rural lands.

Forestry:

- multiple-use conflicts;
- impact of forest management practices on production and the environment;
- inclusion of aboriginal needs and interests in forest management.

Shore zone/coastal zone:

- impact of land sources of pollution;
- competing use of shore areas (such as aquaculture and recreation);
- restriction of public access to the shore.

Urban:

- planning and financing of hard services and infrastructure;
- protection of water supplies;
- impact of urban related development in rural areas (such as urban sprawl and ribbon development).

Issues common to all categories:

- present governance systems unable to identify and solve problems (or take advantage of opportunities);
- lack of current data and measurable indicators of land-use patterns and change;
- inadequate valuation of common resources; and
- lack of integrated planning and communication.

Besides providing a useful overview of common land-use issues, the above list emphasizes the importance of applying information, common indicators and approaches to valuation. The Federal/Provincial Committee also highlighted

the shore/coastal zone issues which are generally not considered in land-use discussions.

Land-related policies range from general statements of intent to subsidies for specific activities. One of the confounding factors in land policy, and therefore supporting statistics and information, is that often three or more jurisdictions (federal, provincial/regional, municipal, private, non-governmental) may influence the use of a given tract of land.

Jurisdiction: In general, the Parliament of Canada controls the lands that are owned by the Federal Government including national parks, aboriginal reserves, airports, defence establishments, harbour sites, government buildings, Sable Island, and 99% of the land in the Yukon and Northwest Territories. Federal agricultural, transportation, defence, housing and energy policies also directly influence the use of land in many areas. The main policies cited in *Land Use in Canada* (Environment Canada, 1980) are listed below:

- **Fiscal Policies:** federal monetary, taxation, and trade and tariff policies;
- **Sectoral Support Programs:** income support and credit-assistance programs in various economic sectors, particularly agriculture and industry;
- **Regional Development Programs:** development programs to stimulate economic growth in less-developed regions;
- **Federal Lands and their Management:** public lands under the administration of the Federal Government, mostly (97%) in the Yukon and Northwest Territories (the remaining 3% is used to support the programs of federal agencies);
- **Regulatory Powers in Transportation:** Regulatory powers over transportation rates affect the viability of resource industries (agriculture, forestry, and mining) and related secondary industries; and
- **Research and Information Activities:** programs that include land inventories; soil, geological and wildlife surveys; National Research Council activities; the Canada Mortgage and Housing Corporation.

Land-use planning on privately-owned land is a municipal or regional function supervised by the provinces. Land taxes are levied by most municipalities (Environment Canada, 1980).

Many policy areas transcend jurisdictions. Issues such as sustainable development, biodiversity, resource use, financial policy and land-use planning often involve many levels of government.

Sustainable development: Many approaches to understanding the sustainability of our actions relate to the carrying capacity of the environment. Wackernagel (1993) calculates the "ecological footprint" of various activities by estimating the area of land required to support one person or one city. The broader issues require information on land use and land-use changes, land quality and land cover. With better land statistics critical areas could be more easily identified and priorities could be more easily set.

Canada's Green Plan (Government of Canada, 1990) cited land issues in many of the priority objectives for Canadians including:

- clean air, water and land;
- sustainable use of renewable resources (including sustainable agriculture and sustainable forestry);
- preserving the integrity of our North; and
- protection of our special spaces and species (i.e. protected areas and biodiversity).

The more recent federal govemment statement of its sustainability objectives (Government of Canada, 1995) urged federal departments to adopt "best practices" for the management of federal lands including:

> The identification, classification and assessment of sites of concern on departmental lands should be undertaken using the CCME (Canadian Council of Ministers of the Environment) National Classification System or a similar tool; and the management of the risk to human health and the environment [on federal lands] should include risk assessment and techniques for containment, mitigation and remediation.

Biodiversity: Information on the extent and quality of special habitats is an essential component to understanding the current and potential state of Canada's wildlife. One direction of Statistics Canada's Wildlife Accounting Project is to account for habitats of species that are difficult to enumerate (migratory birds, small mammals and insects).

Statutory protection of a unique habitat is often seen as an adequate approach to ensuring the protection of important species. However, risks imposed by activities on land surrounding the protected areas should also be considered. Trant (1993) provides a detailed assessment of agricultural activities for the surroundings of Riding Mountain National Park in Manitoba.

Resource use: Statistics on forests and agricultural land are relatively well developed since they feed into important economic sectors. Canada's Forest Inventory (Natural Resources Canada, Canadian Forest Service, 1995), and the Agricultural Land Potential Database (Agriculture Canada, 1991) are updated frequently and workable classification systems are in effect. Statistics on the land aspects of other resource uses such as mining, water use and wildlife are lacking.

Ownership and taxation: The extent of land and its ownership has always been important for taxation purposes. Some of the best information on land use exists in municipal registry offices. New needs for land statistics are suggested by new policies on liability of lenders for environmental clean up. Insurers are also concerned about environmental

risk assessment before lending money for real estate purchases.

Economic policy: Most economic policies relating to land include the establishment of agricultural subsidies, definition of transportation corridors, initiation of major infrastructure projects and delineation of settlement areas. One indicator of Canada's national wealth is Canada's National Balance Sheet (Statistics Canada, 1995), which includes annual estimated values of agricultural, residential and commercial land.

Land-use planning: This type of planning is normally conducted at the municipal or regional level under guidelines from the provincial government. The assembly of land-use and zoning data is often the first stage of planning at this level.

Research: Although research and analysis often feeds into policy, their overall objective is more often to contribute to the general scientific understanding of environmental processes and systems.

The analysis of land-use change and its impacts has typically been conducted on a local scale. Beginning in the 1950s, the Geographical Branch of the Department of Energy, Mines and Resources Canada and, afterwards, the Lands Directorate of Environment Canada issued a series of Geographical Papers, many of which focused on land and water use.[1]

One of the major research issues today is the understanding of land surface ecosystem processes and global change. The BOREAS[2] project investigated these relationships through extensive monitoring of two 20 km^2 study areas in the boreal zone of Manitoba and Saskatchewan. The main objective of the work was to collect data that would provide insight into the relationship between land processes (for example, ecosystems, climate and geology) and the sustainable use of resources. The general conclusion after two years of detailed research was that the detailed information collected for two small areas as part of this study cannot be readily applied to the rest of the country. This detailed information, which is required to understand the complex interactions, is available for a few isolated sites (Post-BOREAS Task Group, 1995).

Land Information is internationally regarded as a key to understanding and predicting global change. Turner, Moss and Skole (1993) write:

> Gaining a better understanding of the ways that land cover and land-use practices are evolving is a priority concern of the global change research community. The characteristics of land cover have important impacts on climate, biogeochemistry, hydrology, and the diversity and abundance of terrestrial species. Hence, being able to project future states of land cover is a requirement for making numerical predictions about other global changes.

Despite general agreement on the importance of land information, Canada is losing land information rather than generating it. Several key historical datasets, the Canada Land Inventory (CLI) and Canada Land Use Monitoring Program (CLUMP) have been archived and are no longer available to support policy decisions and research.

The development of land statistics

Canada Land Inventory: Until the 1960s, detailed national information on land cover and land use was available mainly for agricultural and forested areas. The CLI was initiated in 1963 under federal-provincial agreement. The program coordinated the mapping of 2.5 million km^2 of Canada's settled lands. By interpreting local maps and air photos, an extensive database of land capability was built up at a 1 : 50 000 scale. The resulting database provided an assessment of the potential of the land for agriculture, forestry, recreation, and wildlife (waterfowl and ungulates). Current land use, generally for 1967, was also recorded. These data have been widely used for land-use planning at the regional level and were housed in the Canada Geographic Information System (CGIS), one of the world's first GISs, developed specifically for this purpose (Environment Canada, 1981).

In 1974, an **Interdepartmental Task Force on Land Use** was established by the federal government. This group concluded that the main role of the federal government was to establish guidelines for its own activities as they affect the use of land (Environment Canada, 1980). This led to the development of the Federal Policy on Land Use in 1980.

Map 7.1
The CLUMP Framework

1. Examples include Vancouver, Victoria, Ottawa, Georgian Bay (Energy, Mines and Resources Canada, 1968, 1969a, 1969b, 1970); and the Gulf of St. Lawrence, Prince Edward Island and the Musquodoboit Valley in Nova Scotia (Environment Canada, 1973a, 1973b, 1974a, 1974b).
2. The Boreal Ecosystem-Atmosphere Study (BOREAS) is jointly managed by NASA in the United States and Natural Resources Canada.

Canada Land Use Monitoring Program (1980-85): The Canada Land Use Monitoring Program (CLUMP, Map 7.1), which was intended to maintain an updated national database of land-use/land-cover data, existed for only a few years in the early 1980s. During this period, Environment Canada's Lands Directorate generated some of the most detailed and informative analyses of land use and land-use changes ever published in Canada. This includes a series on specific land-use issues (such as agricultural land value, land used for mining) and assessments of land-use programs in each province (for example, Environment Canada, 1977 and Environment Canada, 1982). One perspective on land use available from this series is presented in Table 7.1.

Another major output from CLUMP was a highly detailed classification of land use and a separate one for land cover. In many classification systems, these are combined to form a hybrid. Separating land use from land cover allows the distinction between ecological state of the land and the human uses.

In 1981, Statistics Canada (1981) issued a report which summarized the current status of land statistics in Canada. The report detailed sources (and potential sources) of land information from Statistics Canada, other federal departments, provincial governments and municipalities and proposed the CLUMP framework as a working model.

Federal Policy on Land Use: In 1980, a statement was issued by Environment Canada which defined *Federal Policy on Land Use* (Government of Canada, 1981). This policy was directed at minimizing environmental impacts of decisions related to federally managed lands. The document also proposed that the federal government provide a coordinated program of surveys and socio-economic, scientific and technical research on land capability, characteristics, tenure and use. It further stated that:

> Surveys and research in the fields of:
>
> - geological surveys
> - topographical mapping
> - soils
> - ecological mapping
> - social, economic and environmental aspects of land use
> - identification of critical lands
> - land-use monitoring
> - forest inventories
> - water surveys
> - collection of socio-economic data relating to land use
>
> are key elements in the formulation of sound land management strategies by all who influence the use of land.

Although CLUMP was designed to achieve these objectives, the program ended in 1988 with the dissolution of Environment Canada's Lands Directorate. Some of the Directorate's responsibilities, staff and data holdings became part of Environment Canada's State of the Environment Reporting Branch where the work initiated on ecological land classification continued.

Table 7.1
National Land Use, 1976-1979

	Area	Proportion of area
	thousand ha	percent
Land resource base		
Agricultural areas	73 000	7.3
Forestry		
Productive	207 900	20.8
Unproductive	94 800	9.5
Unclassified	39 000	3.9
Wildland	503 700	50.5
Urban		
Built up	1 569	0.2
Roads, parks, greenbelts	1 831	0.2
Fresh water areas	75 516	7.6
Canada total	**997 316**	**100.0**
	thousand ha	
Special land and water uses[1]		
Transport		
Railways	506	
Highways, roads, streets	2 590	
Airports	613	
Marine transport	44	
Mining		
Claims, grants, leases	39 600	
Land disturbed and alienated	285	
Energy		
Petroleum leases (onshore)	65 600	
Petroleum pipelines	60	
Natural gas pipelines	80	
Electrical transmission lines	340	
Hydroelectric headpond storage	1 620	
Protected lands		
Parks and park reserves	39 590	
Wildlife protection areas	56 879	
Indian reserves	2 927	
Military bases and reserves		
Owned	597	
Leased	1 206	

Note:
1. These special land use categories overlap and should not be summed.
Source:
Environment Canada, 1982.

Recent Canadian initiatives

Natural Resources Canada – Canada's Forest Inventory: The forest inventory is conducted on an on-going basis through cooperation with provincial governments. The coverage of the inventory and its match with actual land-cover information is shown in Map 7.2.[1] The inventory includes estimates of the area of several different land and forest

1. Maps 7.2 through 7.8 are found at the end of the chapter.

conditions that occur in each of about 58 thousand map cells (Gray and Neitman, 1989). The national inventory is taken from provincial and territorial forest inventories. For Canada's timber-productive, non-reserved forest land (245 million hectares or 27% of the total land area), a significant amount of detail is available on ownership and use (Canadian Council of Forest Ministers, 1993). Table 7.2 provides a provincial perspective on land use based on these statistics.

Agriculture Canada – National Soil Database (NSDB): The National Soil Database covers soil, landscape and climatic data collected over the past 80 years. The most detail is available for Canada's agricultural land but non-agricultural areas are covered as well. Its major components include:

- the Land Potential Database (LPDB), which covers all of Canada at a scale of 1 : 5 million (Map 7.3 shows land use/land cover based on the LPDB);
- Soil Landscapes of Canada, which includes more detail on major soil and landscape attributes at a scale of 1 : 1 million;
- National Ecological Framework (1 : 2 million scale);
- Agroecological Resource Areas, covers the three Prairie Provinces at a scale of 1 : 2 million and includes details on climate, economy, crop, soil and landscape attributes; and
- Detailed Soil Surveys, conducted at varying scales.

Environment Canada/Agriculture and Agri-Food Canada – National Ecological Framework: This framework is based on a common system of classifying and mapping terrestrial ecosystems. It was developed in the 1970s and 1980s by professionals from government, non-government organizations, universities, and industry through the Canadian Committee on Ecological Land Classification. The framework describes ecologically distinct areas of the earth's surface at different levels of generalization, ranging from the broad scale ecozones to more detailed ecodistricts.

The framework serves as a common ground for interpreting existing and new information about ecosystems independently of jurisdictional boundaries. The framework also contains marine and international components.

The terrestrial component of the National Ecological Framework (ecozones, ecoregions and ecodistricts) has been recently revised in cooperation with federal and provincial agencies and other stakeholders. The revision was conducted to enhance the capability of both government and non-government organizations to assess and report on environmental conditions and the sustainability of ecosystems in Canada. This has resulted in refinement to boundaries of the original Ecozone map published in the first State of the Environment Report for Canada (Environment Canada, 1986; Wiken, 1986). Map 7.4 and Table 7.3 show the revised Ecozone map for Canada (Ecostratification Working Group, 1995). Major features of the terrestrial component include:

- a map of ecozones and ecoregions of Canada, at a scale of 1 : 7.5 million;
- a map of ecodistricts on a separate series of six regional maps at a scale of 1 : 2 million (Atlantic Provinces, Quebec, Ontario, Prairie Provinces, British Columbia, and the Yukon and Northwest Territories);
- the National Ecological Framework Database, which includes information on biophysical attributes for ecodistricts at a scale of 1 : 2 million; and
- a national report that includes narrative descriptions of ecozones and ecoregions.

Federal/Provincial Committee on Land Use: This group has been active since 1974 in coordinating federal, provincial and territorial government cooperation in inter-jurisdictional land-use issues. Recent activities have focused on information exchange and issue identification. Major questions addressed at a recent forum include:

- What are the major land-use issues facing the country over the next decade?
- What are the broad options for resolving these issues?
- What roles does and should land-use planning play in the implementation of sustainable development?

Natural Resources Canada – National Atlas of Canada: The National Atlas has been presenting invaluable information on Canada's land since 1906 (Energy, Mines and Resources Canada, 1993). Several unique perspectives on land have been developed within this program. One example is the land-cover map synthesized from remote sensing data collected over a three-year period. Table 7.4 is derived from this map. Map 7.5 is a further generalization of the original vegetation cover map which contained 12 land-cover classes:

- forest land
  - continuous forest
    - coniferous forest
    - broadleaf forest
    - mixed forest
  - transitional forest
- tundra
- sparsely vegetated/barren land
- agricultural land
  - cropland
  - rangeland and pasture
- nonvegetated land
  - perennial snow or ice
  - built-up area
- water/sea ice
  - open water
  - sea ice.

Table 7.2

Land Classification by Province and Territory, 1991

Land class	Canada	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	Yukon	N.W.T.
	thousand hectares												
A. Forest land													
Reserved	12 054	93	-	97	-	377	1 699	261	678	4 358	3 268	118	1 105
Timber-productive	8 661	59	-	96	-	345	1 485	245	647	2 443	2 685	73	583
Timber-unproductive	2 877	34	-	1	-	32	214	16	31	1 621	567	45	316
Unspecified timber-productivity	516	-	-	-	-	-	-	-	-	294	16	-	206
Non-reserved	401 415	22 431	294	3 736	6 106	82 054	55 981	26 016	28 011	31 734	57 289	27 431	60 332
Timber-productive	234 534	11 212	278	3 671	5 954	54 390	40 674	14 994	11 986	21 194	49 046	7 397	13 738
Timber-unproductive	164 049	11 219	16	65	152	27 664	15 307	11 022	16 007	10 347	8 243	19 976	44 031
Unspecified timber-productivity	2 832	-	-	-	-	-	-	-	18	193	-	58	2 563
Unclassified	2 706	-	-	90	-	54	315	-	117	2 122	8	-	-
Timber-productive	2 175	-	-	-	-	54	45	-	-	2 068	8	-	-
Timber-unproductive	531	-	-	90	-		270	-	117	54	-	-	-
Unspecified timber-productivity	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	416 175	22 524	294	3 923	6 106	82 485	57 995	26 277	28 806	38 214	60 565	27 549	61 437
Timber-productive	245 370	11 271	278	3 767	5 954	54 789	42 204	15 239	12 633	25 705	51 739	7 470	14 321
Timber-unproductive	167 457	11 253	16	156	152	27 696	15 791	11 038	16 155	12 022	8 810	20 021	44 347
Unspecified timber-productivity	3 348	-	-	-	-	-	-	-	18	487	16	58	2 769
B. Nonforest land	505 368	14 645	272	1 361	1 103	53 194	31 124	28 559	28 264	26 225	32 408	20 348	267 865
Agricultural	67 753	47	259	397	376	3 430	5 451	7 725	26 865	20 811	2 392	-	-
Other	437 615	14 598	13	964	727	49 764	25 673	20 834	1 399	5 414	30 016	20 348	267 865
C. Total land	921 543	37 169	566	5 284	7 209	135 679	89 119	54 836	57 070	64 439	92 973	47 897	329 302
D. Fresh water	75 518	3 403	--	265	135	18 389	17 739	10 159	8 163	1 680	1 807	448	13 330
E. Total area	**997 061**	**40 572**	**566**	**5 549**	**7 344**	**154 068**	**106 858**	**64 995**	**65 233**	**66 119**	**94 780**	**48 345**	**342 632**

Land class	Canada	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	Yukon	N.W.T.
	percent of total area												
A. Forest land													
Reserved	1.2	0.2	-	1.7	-	0.2	1.6	0.4	1.0	6.6	3.4	0.2	0.3
Timber-productive	0.9	0.1	-	1.7	-	0.2	1.4	0.4	1.0	3.7	2.8	0.2	0.2
Timber-unproductive	0.3	0.1	-	0.0	-	--	0.2	--	--	2.5	0.6	0.1	0.1
Unspecified timber-productivity	0.1	-	-	-	-	-	-	-	-	0.4	--	-	0.1
Non-reserved	40.3	55.3	51.9	67.3	83.1	53.3	52.4	40.0	42.9	48.0	60.4	56.7	17.6
Timber-productive	23.5	27.6	49.1	66.2	81.1	35.3	38.1	23.1	18.4	32.1	51.7	15.3	4.0
Timber-unproductive	16.5	27.7	2.8	1.2	2.1	18.0	14.3	17.0	24.5	15.6	8.7	41.3	12.9
Unspecified timber-productivity	0.3	-	-	-	-	-	-	-	--	0.3	-	0.1	0.7
Unclassified	0.3	-	-	1.6	-	--	0.3	-	0.2	3.2	--	-	-
Timber-productive	0.2	-	-	-	-	--	--	-	-	3.1	--	-	-
Timber-unproductive	0.1	-	-	1.6	-	-	0.3	-	0.2	0.1	-	-	-
Unspecified timber-productivity	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	41.7	55.5	51.9	70.7	83.1	53.5	54.3	40.4	44.2	57.8	63.9	57.0	17.9
Timber-productive	24.6	27.8	49.1	67.9	81.1	35.6	39.5	23.4	19.4	38.9	54.6	15.5	4.2
Timber-unproductive	16.8	27.7	2.8	2.8	2.1	18.0	14.8	17.0	24.8	18.2	9.3	41.4	12.9
Unspecified timber-productivity	0.3	-	-	-	-	-	-	-	--	0.7	0.0	0.1	0.8
B. Nonforest land	50.7	36.1	48.1	24.5	15.0	34.5	29.1	43.9	43.3	39.7	34.2	42.1	78.2
Agricultural	6.8	0.1	45.8	7.2	5.1	2.2	5.1	11.9	41.2	31.5	2.5	-	-
Other	43.9	36.0	2.3	17.4	9.9	32.3	24.0	32.1	2.1	8.2	31.7	42.1	78.2
C. Total land	92.4	91.6	100.0	95.2	98.2	88.1	83.4	84.4	87.5	97.5	98.1	99.1	96.1
D. Fresh water	7.6	8.4	-	4.8	1.8	11.9	16.6	15.6	12.5	2.5	1.9	0.9	3.9
E. Total area	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Note:
Figures may not add due to rounding.
Source:
Canadian Council of Forest Ministers, 1994.

Table 7.3

Ecozone Area by Province and Territory, 1991

Ecozone	Canada	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	Yukon	N.W.T.
	thousand hectares												
Atlantic Maritime	20 375	-	706	6 918	9 156	3 595	-	-	-	-	-	-	-
Mixed Wood Plains	19 443	-	-	-	-	7 093	12 350	-	-	-	-	-	-
Boreal Shield	194 637	14 761	-	-	-	72 853	69 659	27 680	9 682	-	-	-	-
Prairies	47 811	-	-	-	-	-	-	6 780	26 140	14 891	-	-	-
Boreal Plains	73 780	-	-	-	-	-	-	8 679	18 995	32 653	10 365	2 923	164
Montaine Cordillera	49 211	-	-	-	-	-	-	-	-	4 942	44 269	-	-
Pacific Maritime	21 898	-	-	-	-	-	-	-	-	-	21 898	-	-
Boreal Cordillera	46 460	-	-	-	-	-	-	-	-	-	14 741	31 719	-
Tundra Cordillera	26 484	-	-	-	-	-	-	-	-	-	-	16 405	10 079
Taiga Plains	64 700	-	-	-	-	-	-	-	-	9 268	4 380	1 831	49 222
Taiga Shield	136 640	20 466	-	-	-	53 254	-	10 228	5 486	807	-	-	46 399
Hudson Plains	36 236	-	-	-	-	2 432	24 854	8 662	-	-	-	-	288
Southern Arctic	83 239	4 600	-	-	-	12 392	-	169	-	-	-	-	66 078
Northern Arctic	151 088	-	-	-	-	7 106	-	-	-	-	-	-	143 982
Arctic Cordillera	25 059	975	-	-	-	725	-	-	-	-	-	-	23 359
Total	**997 061**	**40 802**	**706**	**6 918**	**9 156**	**159 452**	**106 863**	**62 198**	**60 304**	**62 561**	**95 654**	**52 877**	**339 571**

Ecozone	Canada	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	Yukon	N.W.T.
	percent of area												
Atlantic Maritime	2.0	-	100.0	100.0	100.0	2.3	-	-	-	-	-	-	-
Mixed Wood Plains	2.0	-	-	-	-	4.4	11.6	-	-	-	-	-	-
Boreal Shield	19.5	36.2	-	-	-	45.7	65.2	44.5	16.1	-	-	-	-
Prairies	4.8	-	-	-	-	-	-	10.9	43.3	23.8	-	-	-
Boreal Plains	7.4	-	-	-	-	-	-	14.0	31.5	52.2	10.8	5.5	–
Montaine Cordillera	4.9	-	-	-	-	-	-	-	-	7.9	46.3	-	-
Pacific Maritime	2.2	-	-	-	-	-	-	-	-	-	22.9	-	-
Boreal Cordillera	4.7	-	-	-	-	-	-	-	-	-	15.4	60.0	-
Tundra Cordillera	2.7	-	-	-	-	-	-	-	-	-	-	31.0	3.0
Taiga Plains	6.5	-	-	-	-	-	-	-	-	14.8	4.6	3.5	14.5
Taiga Shield	13.7	50.2	-	-	-	33.4	-	16.4	9.1	1.3	-	-	13.7
Hudson Plains	3.6	-	-	-	-	1.5	23.3	13.9	-	-	-	-	0.1
Southern Arctic	8.3	11.3	-	-	-	7.8	-	0.3	-	-	-	-	19.5
Northern Arctic	15.2	-	-	-	-	4.5	-	-	-	-	-	-	42.4
Arctic Cordillera	2.5	2.4	-	-	-	0.5	-	-	-	-	-	-	6.9
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Notes:
Figures may not add due to rounding.
Numbers have been adjusted to match Environment Canada's totals.
Sources:
Environment Canada, Agriculture and Agri-Food Canada, National Ecological Framework.

Provincial Governments: Several provinces have developed or are in the process of developing sophisticated land-use monitoring programs. For example, British Columbia has recently introduced Regional Land-use Plans for several key areas: Vancouver Island, the Cariboo-Chilcotin region in central British Columbia, and the Kootenay-Boundary Region in southeastern British Columbia.

New Brunswick has recently produced a detailed land-cover/land-use map in digital form. This was assembled from their forest inventory database (New Brunswick Natural Resources and Energy, 1996).

Statistics Canada – Land Accounting, *Census of Agriculture, Human Activity and the Environment, Environmental Perspectives*: Statistics Canada has a substantial history in integrating and reporting on land information. The *Census of Agriculture* is one of the primary sources of information on agricultural land and management practices. Since 1978, publications such as *Human Activity and the Environment* have been bringing together information on land use and land cover.

Statistics Canada has recently begun developing a Land Account which would more systematically deal with classifications and data on land. Some of the most recent results are reported in this volume. Chapter 8 applies land-cover data generated from satellite imagery (Energy, Mines and Resources Canada, 1993) to understanding land use in New Brunswick. Also for New Brunswick, Chapter 9 investigates an environmental-economics approach to determining an alternative definition of "agricultural land value". Previous outputs included a land accounting approach applied to the assessment of environmental changes around Waterton Lakes National Park in Alberta (Trant *et al.*, 1995).

Table 7.4

Land Cover Estimates Based on NRCan Vegetation Cover, 1988-1991

Cover class	Canada	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	Yukon	N.W.T.
	thousand hectares												
Mixed forest	108 104	4 098	127	1 328	4 188	24 830	25 368	3 188	4 491	14 131	14 443	789	11 123
Broadleaf forest	29 630	-	41	869	951	4 917	2 390	4 415	2 748	9 180	3 451	23	645
Water	51 355	1 873	14	92	76	6 514	12 683	6 636	3 115	1 509	1 773	474	16 595
Transitional forest	134 557	12 769	-	69	-	36 948	23 516	12 954	3 465	-	27	1 963	42 846
Coniferous forest	253 641	11 471	88	2 842	1 903	38 987	37 069	23 521	22 608	17 712	55 703	24 076	17 660
Tundra	136 834	6 268	-	-	-	26 238	-	5 302	1	-	4 973	12 784	81 269
Barren land	167 046	3 177	11	111	98	6 388	13	31	-	1 406	8 474	4 113	143 224
Ice/Snow	18 999	-	-	-	-	-	-	-	-	31	2 133	1 314	15 521
Cropland	50 021	-	321	282	134	3 228	6 193	5 910	20 846	12 570	537	-	-
Rangeland	14 670	-	-	-	-	-	-	684	5 918	7 422	646	-	-
Built-up area	507	8	1	22	12	73	181	29	15	80	84	-	1
Total Area	**965 364**	**39 664**	**604**	**5 616**	**7 363**	**148 123**	**107 413**	**62 670**	**63 207**	**64 041**	**92 243**	**45 536**	**328 885**
Land	914 009	37 791	590	5 524	7 287	141 609	94 730	56 034	60 092	62 532	90 470	45 062	312 290
Water	51 355	1 873	14	92	76	6 514	12 683	6 636	3 115	1 509	1 773	474	16 595

Cover class	Canada	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	Yukon	N.W.T.
	percent												
Mixed forest	11	10	21	24	57	17	24	5	7	22	16	2	3
Broadleaf forest	3	-	7	16	13	3	2	7	4	14	4	0	0
Water	5	5	2	2	1	4	12	11	5	2	2	1	5
Transitional forest	14	32	-	1	-	25	22	21	6	-	--	4	13
Coniferous forest	26	29	15	51	26	26	34	38	36	28	60	53	5
Tundra	14	16	-	-	-	18	-	8	--	-	5	28	25
Barren land	17	8	2	2	1	4	--	--	-	2	9	9	44
Ice/Snow	2	-	-	-	-	-	-	-	-	--	2	3	5
Cropland	5	-	53	5	2	2	6	9	33	20	1	-	-
Rangeland	2	-	-	-	-	-	-	1	9	12	1	-	-
Built-up area	0	--	-	0	0	--	0	--	--	0	0	-	--
Total Area	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Land	95	95	98	98	99	96	88	89	95	98	98	99	95
Water	5	5	2	2	1	4	12	11	5	2	2	1	5

Note:
Figures may not add due to rounding.
Source:
Natural Resources Canada, National Atlas.

Statistics Canada/Environment Canada – National Urban Land Information Base (NULIB): The objective of NULIB is to develop a standardized, nationally-consistent environmental database to determine land use and land-use change statistics for the urban and urban-fringe regions of Canada using high-resolution satellite imagery. The program identifies:

- changes in urban land activity (1986 to 1991);
- broad land-cover information (wooded vegetation, non-wooded vegetation, water and non-vegetated surfaces); and
- the amount and distribution of green space within the urban core.

NULIB began with a pilot study of the Ottawa-Hull Census Metropolitan Area (CMA) to determine the optimal image, processing and methodology steps required to meet the program objectives (Statistics Canada and Environment Canada, 1993). The pilot clearly demonstrated that high-resolution satellite imagery could provide land use and land-use change information for the urban and rural-fringe in an accurate and cost-effective manner. With further funding obtained since the pilot study, operational processing of other CMAs had been completed. These urban centres include Toronto, Vancouver (Map 7.6), Victoria, Montréal, Québec, Halifax, London and Saskatoon.

NULIB products facilitate the analysis of land-use change between CLUMP 1986 and NULIB 1991, prediction of land-use trends, monitoring of green space within the urban core, and evaluation of government programs which have an impact on land use, national land budgeting and resource planning. The next stage for NULIB involves seeking additional funding partners for the processing of remaining CMAs and updating the database on a regular cyclical basis.

Statistics Canada/Pest Management Regulatory Agency – The Delineation Of Agricultural Field-trial Regions: The chemical registration process requires that field-trial studies be conducted in regions that have crops, soils, climatic and other bio-physical parameters that are representative of the regions where the new chemicals are intended

for use. In order to reduce the cost and time to register products, NAFTA agreements state that Canada and the United States accept the results of field studies conducted in regions that have similar characteristics in either country. The objective of this project was to develop a methodology to delineate field-trial regions for Canada while also retaining, wherever possible, regions that correspond to the previously delineated U.S. field-trial regions.

The delineation of the field-trial regions first required development of Canadian coverages that depict where crops are currently grown (and which crops are growing where) and where crops could be grown (arable land). Current crop maps were derived from the Statistics Canada's Agriculture Ecumene of Canada and *1991 Census of Agriculture*. Many data sources from various federal departments were used to delineate the field-trial regions; the most important included:

- Terrestrial Ecozones and Ecoregions of Canada (Environment Canada);
- Soil Landscape of Canada Database (Agriculture and Agri-Food Canada);
- Soils of Canada Map (Agriculture and Agri-Food Canada);
- Canada Land Inventory for Agriculture (Agriculture and Agri-Food Canada);
- National Atlas (Natural Resources Canada);
- Ecoclimatic Regions of Canada Map (Environment Canada);
- Level II Ecological Regions of North America - Draft (Agriculture and Agri-Food Canada);
- Climatic Characteristics of Canada (Natural Resources Canada);
- Crop Maps (Statistics Canada); and
- Agriculture Ecumene of Canada (Statistics Canada).

This project highlights an application that has required considerable interaction and cooperation of four federal departments and numerous contacts in provincial departments and other agencies. As well, U.S. counterparts responsible for delineation of the American field-trial regions were consulted. The resulting maps (Map 7.7 for example) and digital coverages include Canadian and North American level major and minor field-trial regions.

International activities

Canada is noted internationally for the quality of its agricultural and forestry statistics. Other countries have made substantial progress in assembling general national perspectives on land and in linking that information to policy decisions. Examples are given here for the land accounting activities of the European Community, Germany, France, the Netherlands and the United Kingdom.

The European Community

In 1985, the European Community initiated the Coordination of Information on the Environment (CORINE) program. The objective of CORINE is to develop a framework for the collection, coordination and harmonization of information on the state of the environment and the natural resources in the Community. The data collection permits a stock of land-use data to be visualized as a computer map. Today, CORINE represents the environmental information system of the European Union—a system based on land-cover and land-use geographical data for all of Europe. A task force which is in charge of the CORINE Information System has been created within the Commission of the European Community's Directorate General for the Environment (Federal Statistical Office of Germany, 1990).

CORINE data are based on satellite images, topographical maps and aerial photographs. Land is classified into 44 categories of land use and cover, with the smallest unit covering 25 hectares. The entire CORINE project is expected to cover 2.3 million km^2 in 12 countries, at a scale of 1 : 100 000. Each country within Europe will eventually work towards implementing CORINE using a method particular to its own area (Institut français de l'environnement, 1994a).

Germany

In the Federal Republic of Germany, land statistics are collected for data mapping through CORINE and the Statistical Information System on Land Use (STABIS). Using STABIS, land-use/land-cover maps will be created for three different dates (1952, 1972, 1992), while only two different land-cover/land-use maps (1984, 1992) can be created using CORINE. From these data, a system will be set up for accounting for land use/land cover. Stock accounts will be available for certain periods and flow accounts will show changes in stocks between periods. The effects of natural processes and human activity on land cover/land use will also be estimated, with an analysis of the interaction between economic activity and land use. Currently a pilot project is being carried out to test the applicability and procedure of using CORINE (Federal Statistical Office of Germany, 1994).

France

In France, CORINE is accompanied by Ter-Uti as a data source for land-cover accounting. Ter-Uti is an annual land-use survey which is based on remote sensing and conducted mainly to monitor agricultural land. Similar accounts to those described for Germany will be created wherein

land-use/land-cover change data will be presented in matrix form (Institut français de l'environnement, 1994b).

The Netherlands

Data pertaining to land cover/land use have been entered into a GIS for selected years. Changes in land cover/land use will be analysed and presented in table or matrix format for 35 land categories.

The land accounting procedure in The Netherlands will also incorporate land valuation. Land is classified according to 35 categories of mixed land use and land cover. The accounting procedure will place a value on land categorized under this classification scheme and values will be entered as part of the first National Balance Sheet for the Netherlands. Such values are averages of values provided through a survey of municipalities.

The United Kingdom

Information on land cover, landscape features and habitats in Great Britain is provided by the Countryside Survey (CS), carried out in 1990 by the Institute of Terrestrial Ecology (ITE). This survey identifies land change by reference to earlier surveys, and establishes a new baseline for the measurement of future change. The land classes used in the CS1990 field survey will be linked with the ITE's 17 land-cover map classes and those of CORINE to produce a CORINE land-cover map for Great Britain. Land-cover change matrices will continue to be produced.

Detailed changes in land use are studied frequently by the Department of the Environment in Great Britain, with such statistics being suited to analyses of changes to urban and rural uses and of the recycling of land. The classification for recording land-use change is based on 24 separate categories of land use, which are combined under the divisions of "urban" and "rural" uses (United Kingdom Department of the Environment, 1994).

Estimating land cover and land use for Canada

Two key elements of land statistics are the cover and the use of the land. Land cover is what can be seen on the land. This is not always directly associated with a specific use. The cover may be "coniferous trees" but the use can be either "production forest" or "conservation area". Land use is traditionally defined as the uses humans make of the land (residential, commercial, industrial, forestry, agriculture, and mining, etc.). To understand the effects our human activities are having on the land and its support functions, it is useful to have detailed information on changes in land cover and land use over time.

An initial assessment of the national and provincial data shows that there is a substantial quantity of land statistics in Canada. Much of this exists in disparate datasets in federal and provincial government departments. A comprehensive set of land statistics will require the integration of existing information as well as the estimation of important statistics (such as detailed cover, use, potential, value) that are not measured at the national level.

The proposed framework for the development of land accounts for Canada is based on the estimation of basic land cover, use, potential and value statistics on the level of ecoregion. Statistics on land cover have already been estimated on an ecoregion basis and show that the resolution of the land-cover information results in appropriate estimates at this level.

Land-use information exists for periods in the past (such as from the CLI and CLUMP) but a recent national perspective does not exist. Data are available for certain components of land use (residential, agricultural and forestry) and these will form the basis for a current national land use estimate.

Estimating land cover

Land-cover information for Canada is available for recent years from remote sensing imagery. As shown in Map 7.5, the data were originally synthesized from three years of satellite images. The digital data for this map were tabulated by province, and ecozone. The results are presented in Table 7.4. In this table, the areas of the provinces and territories do not exactly match the official areas. This is mainly due to the resolution of the satellite image. At one kilometre resolution, many of the smaller features (shoreline details, islands, lakes and rivers) are not visible. The estimates for water area and total area will be adjusted using more detailed shoreline and hydrographic data.

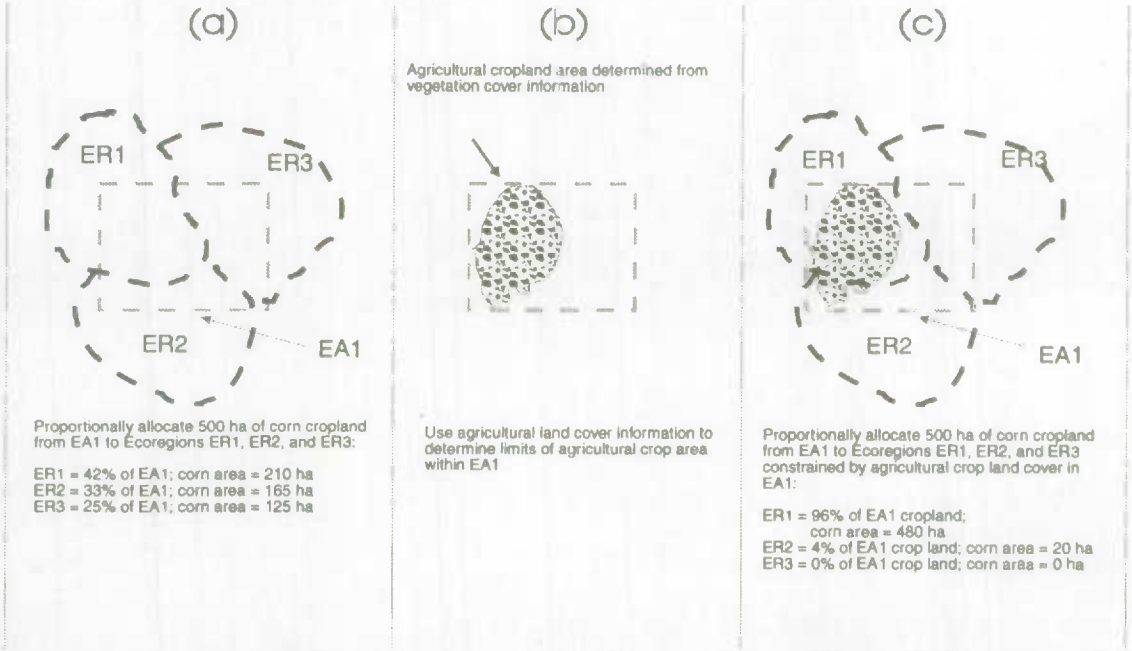
It is not certain that a picture, comparable in scope and detail to the National Atlas Vegetation Cover, could be generated for any period in the past.

Estimating land use

The following methodology is based on proportionally allocating land-use statistics between geostatistical areas and environmental geographies. The first stage allocates data on Census Enumeration Areas (EAs) to ecoregions. This poses some problems in that EAs do not always fit into ecoregions. In urban areas, EAs are relatively small compared to ecoregions. However in rural regions, one EA may span several ecoregions (Statistics Canada, 1994).The distribution of agricultural land within the EA is not known from the *Census of Agriculture*. Therefore, simple proportional allocation introduces statistical figments into the ecoregion estimates. In Figure 7.1a, for example, an initial estimate would allocate 42% of the area of corn planted in EA1 to Ecoregion 1, 33% to Ecoregion 2 and 25% to Ecoregion 3. It is unlikely that agricultural land is evenly distributed within the EA.

The location of agricultural crop area within EAs can be determined more accurately by superimposing land-cover and land-potential information. Figure 7.1b shows the distribu-

Figure 7.1
Example of Using Land Cover Data to Determine Extent of Land Use



tion of agricultural crop area within EA1 derived from a satellite image. By applying the land-cover information, the allocation of crop area to ecoregion is improved. Figure 7.1c shows that since most of the crop area of EA1 was in Ecoregion 1, this ecoregion receives a greater share of the area of corn.

For each of the 217 ecoregions in Canada, it is possible to use this general approach to estimate land use according to the following classes.

- **Urban**: For Urban EAs[1], the total area of the as EA is considered as urban. When EAs straddle an ecoregion boundary, the urban area is proportionally allocated between overlapping ecoregions. Map 7.8 shows the distribution of Canada's population for 1991. Each dot represents about 300 persons.
- **Agriculture**: From the *Census of Agriculture*, major agricultural land-use classes (cropland, summerfallow, improved pasture) are calculated for EAs and assigned to ecoregions. Areas are proportionally allocated between ecoregions when EAs straddle an ecoregion boundary. Vegetation cover information is used to assign agricultural land use within large EAs and to cross-check statistics within ecoregions.
- **Forestry**: Canada's Forest Inventory assembles information for about 48 thousand map cells. The major forest land category information is aggregated from these cells to ecoregions. Vegetation cover information on forest type is used to allocate forested area within large map cells.
- **Other**: This class is characteristically large during this first approximation.

This approach generates a database of approximately eight land-use types and eight land-cover types for each ecoregion. Other useful statistics are also available at this level. Data on population, occupation, dwellings, and agricultural details (such as land value, major crop type, quantities of fertilizer applied) have been estimated for each ecoregion.

Initially, this database has been created using 1991 information. It allows an initial estimation of land use by province and ecoregion. The estimate will also be performed for 1981 thereby providing a basis for estimating land-use change over the decade.

Future work

The next stage in developing the Land Account will incorporate data on other land uses such as wildlife sanctuaries, transportation, industry, mines, and wetlands. It is also expected that some estimates, such as detailed land use and land cover can be derived from provincial inventories.

The Canada Land Inventory will be applied to provide a perspective on land potential. Besides assessing land potential, the CLI also classified the land as to the reason for a limitation for a specific use. For example, if a tract of land was in Class 3 (moderate to severe limitations), the reason for not being in Class 1 (prime agricultural land) could be specified as "unsuitable climate". This information can be

1. An urban EA is defined in Statistics Canada's *1991 Census of Population* as having a population of 1 000 or greater and a population density of more than 400 persons per km^2.

applied to each ecoregion to estimate limitations for particular land uses.

More detailed forest inventory data are available from certain provinces such as New Brunswick and British Columbia. Similarly, more detailed land-use, value and ownership data are available from municipal registries. These are only beginning to become available in digital format.

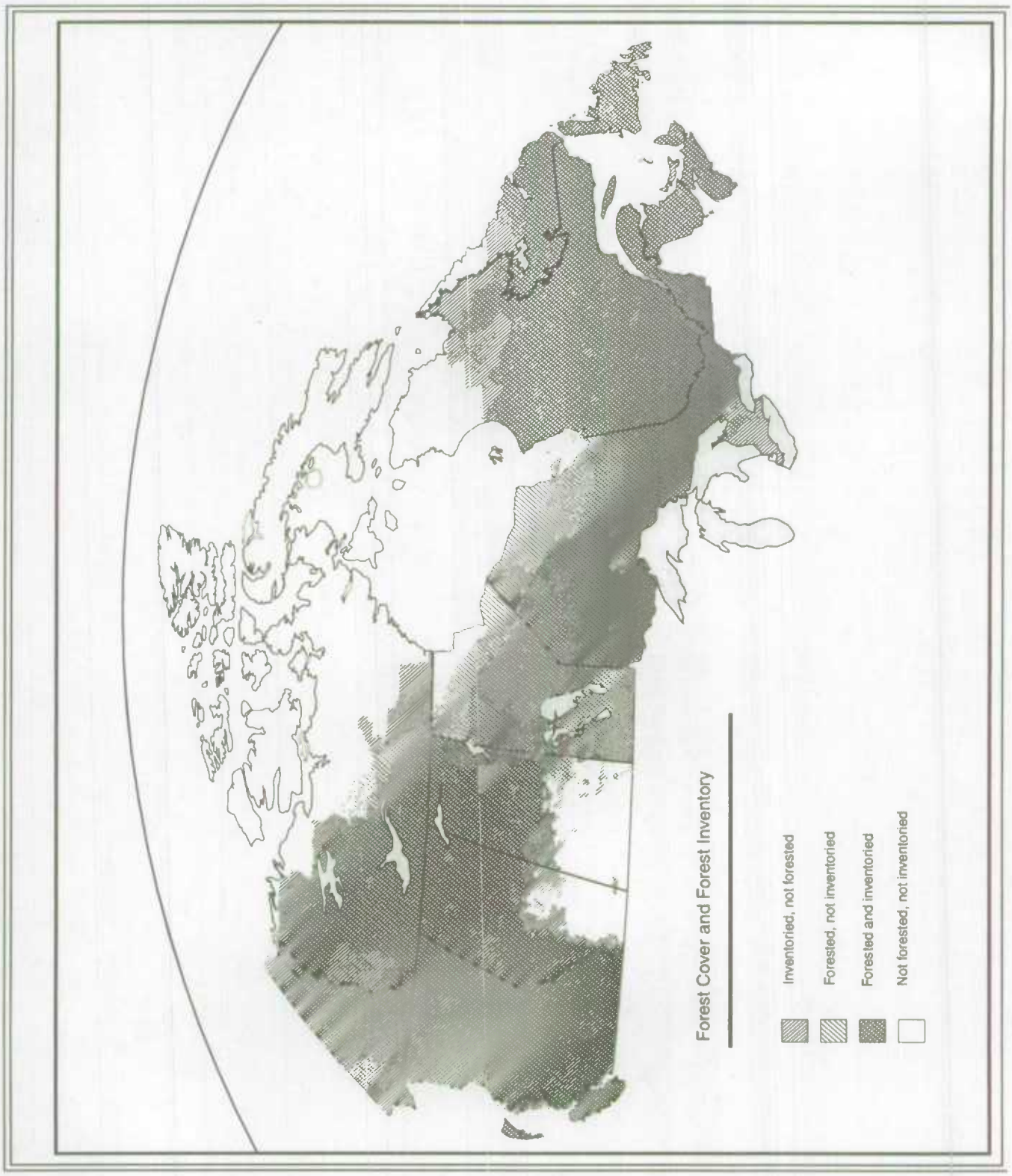
Other sources of land information which will be investigated for inclusion in the Statistics Canada Land Account include: street networks (Statistics Canada), Digital Chart of the World (Environmental Systems Research Institute, ESRI), and the Conservation Areas Database (Environment Canada). These will not only enhance the richness of data in the account but also help improve the quality and detail of future estimates.

Conclusion

Land information provides a valuable basis for many environmental, economic and scientific policy issues. Collecting land information at the national level has not been a priority since land is mainly a provincial jurisdiction. Past approaches have been expensive and labour-intensive. Statistics Canada's Land Accounting program will develop many key national-level land statistics through the assembly of existing information.

Map 7.2

Forest Cover and Forest Inventory, 1991



Sources:
Natural Resources Canada, Canadian Forestry Service and National Atlas.

Map 7.3

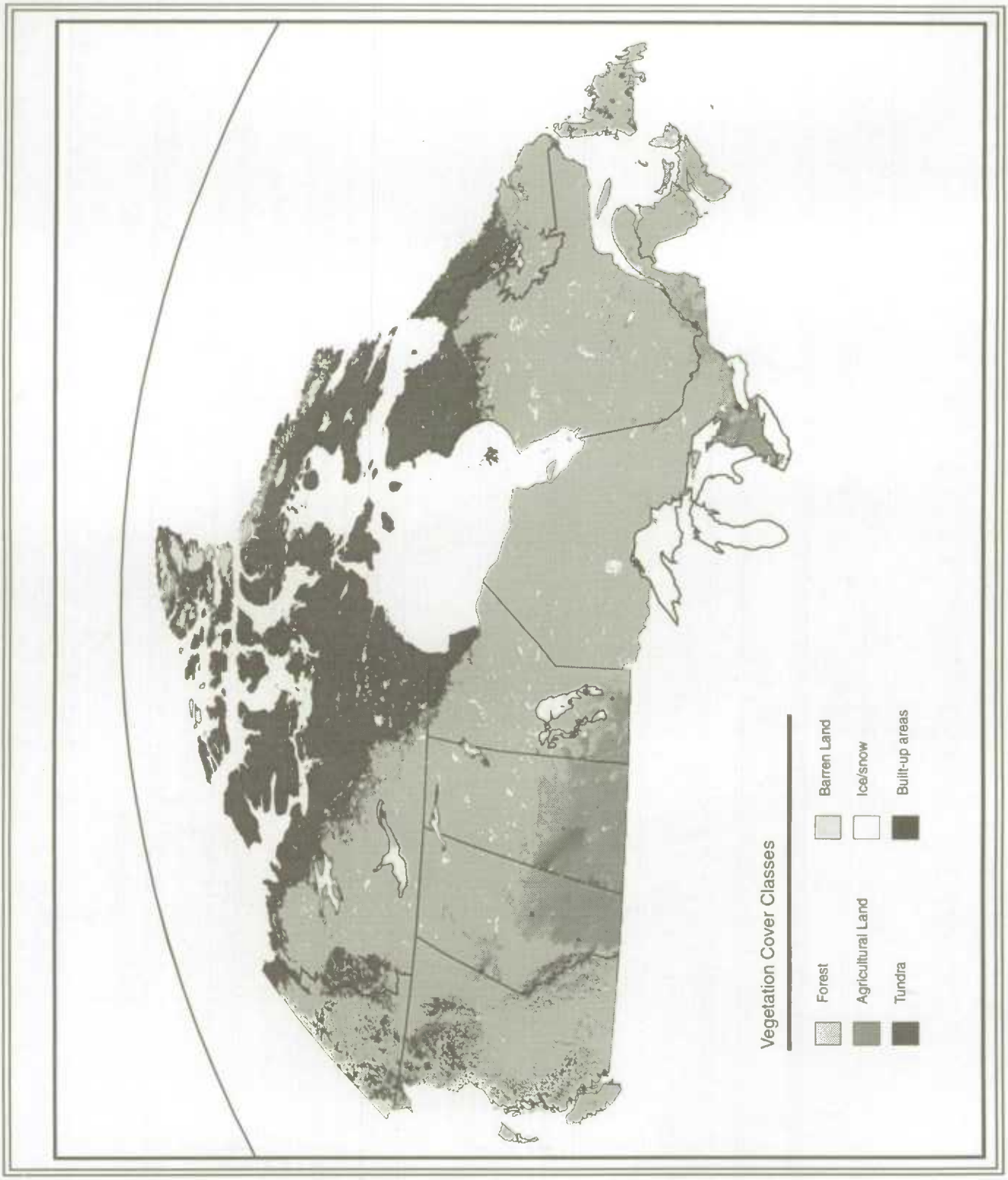
Land Classification from Land Potential Database, 1991

Sources:
Agriculture and Agri-food Canada, Land Resource Research Centre.

Map 7.4
Terrestrial Ecozones

Source:
Ecological Stratification Working Group, 1995.

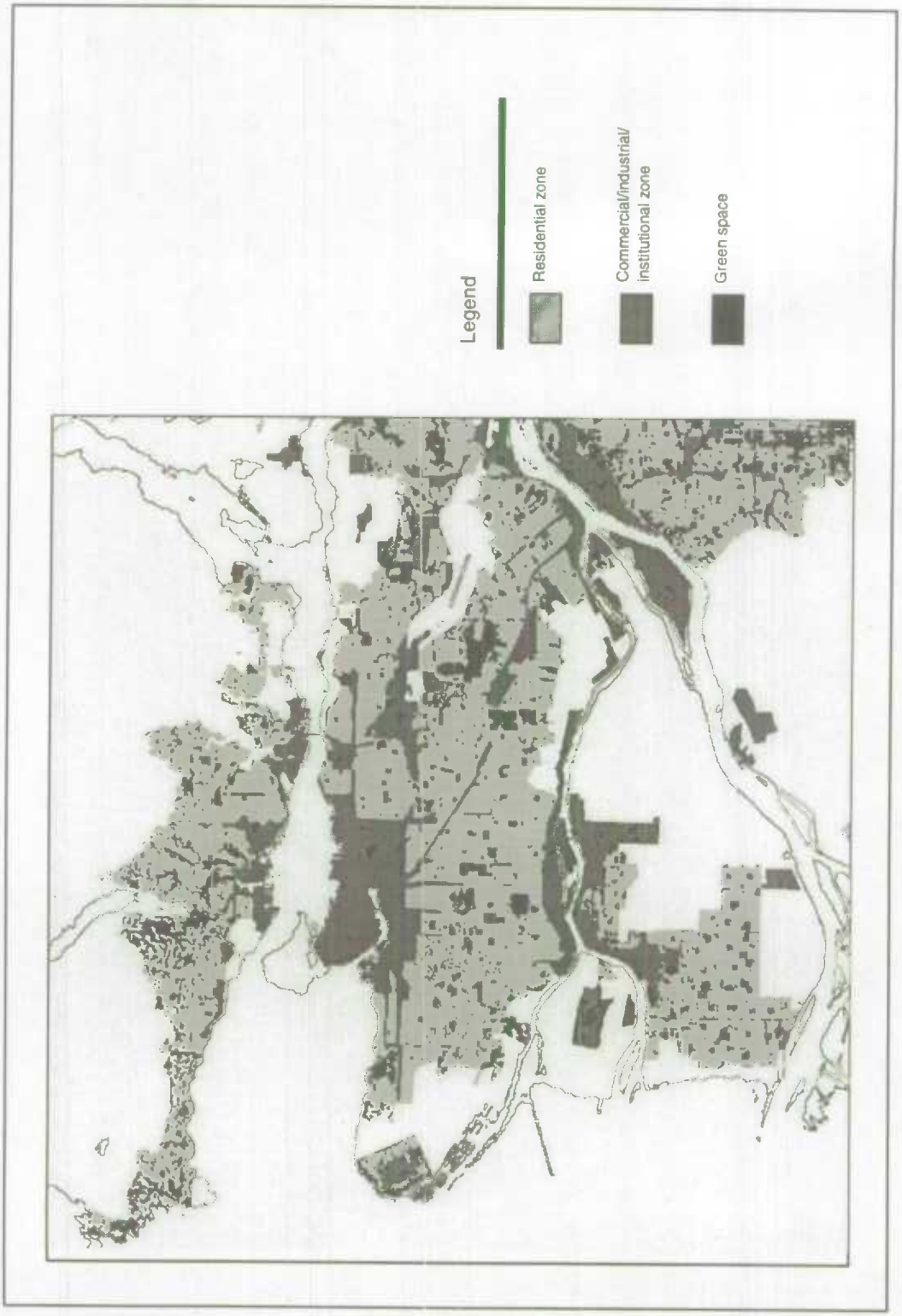
Map 7.5
Vegetation Cover, Composite 1988-1991



Source:
Natural Resources Canada, National Atlas of Canada.

Map 7.6

Vancouver Green Space Within an Urban Environment, 1991

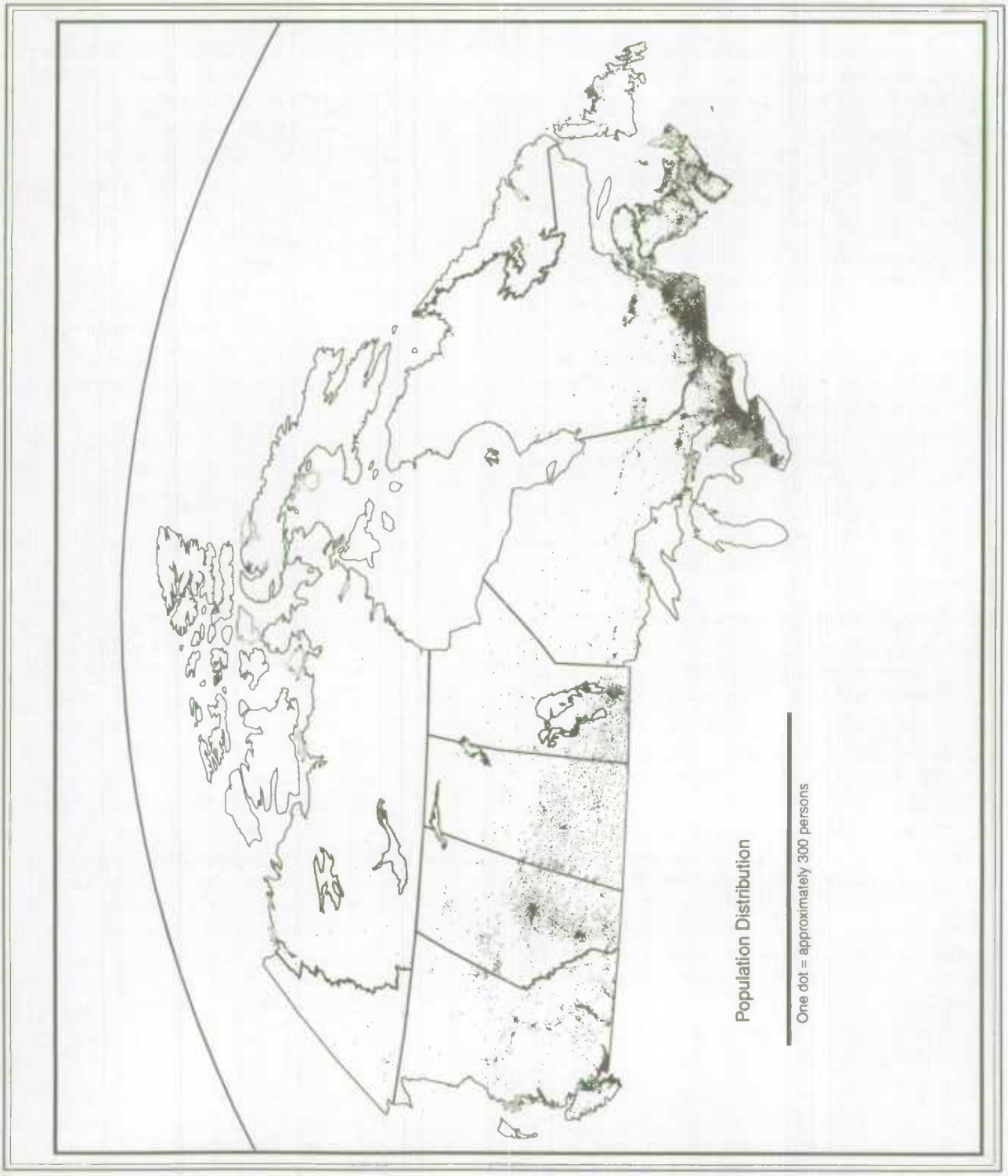


Source:
Statistics Canada, Agriculture Division, National Urban Land Information Base, Spatial Analysis and Geomatics Applications.

Map 7.7
Major and Minor Crop Field Trial Regions

Source:
Statistics Canada, Agriculture Division, National Urban Land Information Base, Spatial Analysis and Geomatics Applications. Prepared for Pest Management Regulatory Agency, Health Canada.

Map 7.8
Population Distribution, 1991



Sources:
Statistics Canada, Census of Population and National Accounts and Environment Division

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8 Pilot Land Accounts for New Brunswick

by Douglas Trant and Giuseppe Filoso

Introduction

Canada is the second largest country in the world with an area of more than 9.97 million square kilometres. If Canada's population was distributed evenly across this area there would be fewer than three people per square kilometre. Despite Canada's size, 90% of Canadians live in a narrow band along its southern border where population densities can exceed 1 000 people per square kilometre in larger urban centres.[1] Land use competition is intense in this corridor and this is reflected in high land values and rapidly changing land uses. In Toronto, Canada's largest city, land values in the central business district have ranged as high as $12 500 per square metre.[2]

Most human activities use land: agriculture, forestry, transportation, trade and housing. Table 8.1 provides a snapshot of how Canada's land was used in 1985.

Table 8.1 indicates that most of Canada is not intensively used. Only one percent of land area is used for the most intense urban/industrial land use, while only seven percent is used for agriculture the next most intense use category.

Sixty five percent of Canada's area is wilderness.[3] (This definition of wilderness refers to land that shows no indication of development but may be used for hunting or forest harvest). Wilderness abounds in Canada because much of the country has little or no land use competition. This is due primarily to physiographic and climatic factors that make much of the country unsuitable for economic development and settlement.

Land use conflicts are most prevalent in Canada's southern populated areas. Here data on changing land cover and use can provide excellent environmental indicators for important issues such as changing wildlife habitats, land degradation and many others. Spatially accurate and temporally consistent information on land is essential to quantify the impacts of human activity on biodiversity and to provide answers to long term sustainability questions.

For some time now Canada has not had a national program to look at land use issues (see Chapter 7). Statistics Canada's Land Accounting Program should help fill this gap. The main goal of the land accounts is to provide an integrated set of land statistics which is consistent nationally and updated annually.

Table 8.1
Economic Land Uses in Canada, 1985

Land use category	Description	Area[1]	Share of total
		thousand km²	percent
Forestry	Active forest harvesting or potential for future harvest	2 440	24
Recreation and conservation	Recreation and conservation within national, provincial and territorial parks, wildlife reserves, sanctuaries, etc.	708	7
Agriculture	Agriculture on improved farmland (cropland, improved pasture, summerfallow) and unimproved farmland	678	7
Urban/industrial[2]	Residential and industrial activities of urban environments	72	1
Other activities	Includes hunting and trapping, mining, energy developments and transportation	6 072	61
Total		**9 970**	**100**

Notes:
1. Includes the area of all land and fresh water.
2. Includes only the 25 major metropolitan areas.
Source:
Government of Canada, 1991.

The land accounts are being developed on a geographic information system (GIS) platform, which will facilitate analysis of issues at geographic levels ranging from local to national.

The development of detailed land accounts will harmonize data now collected by numerous jurisdictions and for many different purposes. For example, many of the provinces and territories have their own land use classifications. Much of the land tenure and land use information resides within the registry offices in thousands of municipalities across the country. A national land classification is required to permit comparisons among jurisdictions and to utilize information from a variety of sources.

At the national level, these data will support comparative descriptions and analyses of land use patterns. For example, the benefits and costs associated with converting agricultural land to urban land can be evaluated, this same information can then be used to assess important environmental issues such as long-term sustainability and biodiversity.

This report will present currently compiled land accounts for the province of New Brunswick, and will discuss conceptual and methodological issues that relate to this process.

1. Statistics Canada, 1994, p. 54.
2. Regional Assessment Commission, Ontario Ministry of Finance.
3. World Resources Institute, 1990, p. 274.

Methodology and data sources

A relatively small portion of Canada was selected for development and testing of methodologies and classifications. New Brunswick was chosen as an ideal test site not only due to its manageable size, but because of its diverse mix of land cover types and uses.

New Brunswick occupies an area of 74 498 km^2, or approximately 0.7% of Canada's total area. Table 8.2 indicates the main land cover types in New Brunswick.

New Brunswick is primarily forestland with pockets of agricultural land and settled areas. This mix of large wilderness areas interspersed with smaller population centres is representative of much of Canada.

At this stage the New Brunswick pilot accounts are being completed by ecoregion at a 1 : 1 million scale. This scale is the most practical level at which to work because much of the contributing information is available at this level of detail.

Data sources for the pilot land accounts project were divided into two main types: 1) digital geographic boundary datasets 2) tabular databases.

Digital geographic datasets

Several digital boundary files were assessed to see if they could provide the required information. When deciding which datasets to use three main factors were considered: 1) comparable datasets should be available at the national level, 2) a dataset must be at a constant scale and 3) a dataset should have suitable map projection parameters to make it consistent with other information already gathered.

With these criteria in mind, several datasets were identified, these were: 1) the 1991 Vegetation Cover from Natural Resources Canada, 2) the 1991 enumeration areas (EA) from Statistics Canada, 3) the 1994 ecoregion areas from Environment Canada, and 4) the topographic boundary datasets were obtained from the Digital Chart of the World Project (DCW). Text Box 8.1 lists the features available in each digital map.

Table 8.2
Land Cover[1] in New Brunswick, 1992

Land cover category	Area	Share of total
	km^2	percent
Mixed forest	42 009	56
Coniferous forest	18 960	25
Broadleaf forest	9 510	13
Agricultural cropland[2]	1 353	2
Barren land	1 613	2
Water	928	1
Built-up area	125	- -
Total	**74 498**	**100**

Notes:
Figures may not add due to rounding.
1. Land cover is a physical measure which describes what is covering the land surface. Land use data describe activities that are taking place on land. A given parcel of land can have many different land uses.
2. Agricultural cropland areas represented in this table are not consistent with the census cropland areas reported in Table 8.13. The estimates in this table, which are from satellite data, tend to over-estimate cropland areas because open meadow is easily mistaken for forage crops.
Source:
Natural Resources Canada, 1994b.

Text Box 8.1
Feature Class List for Selected Digital Boundary Files

Digital boundary file	Feature class
Vegetation cover	Mixed forest
	Broadleaf forest
	Water
	Coniferous forest
	Barren land
	Agriculture cropland
	Built-up area
Enumeration area cover	Enumeration area boundaries
	Enumeration area centroids
Ecoregion cover	Ecozone boundaries
	Ecoregion boundaries
Digital Chart of the World Cover	Rivers, streams
	Roads
	Railroads
	Land use
	Urban areas
	Inland water bodies

One of the problems with the digital datasets is that the outer boundaries such as shorelines do not overlay exactly. After an initial review of the available shorelines a decision was made to use the New Brunswick's shoreline boundary from the DCW dataset. This dataset has a much higher resolution shoreline and as a result will reproduce statistically valid area estimates.

All other datasets were matched to the DCW shoreline to make them spatially consistent. This was accomplished by using the vector editing capabilities of the GIS.

This study uses Environment Canada's State of the Environment Reporting ecoregions, as the principal geographic frame for land accounting in New Brunswick. Ecoregions represent areas of common biophysical characteristics and are naturally distinct units, making them valuable for monitoring and comparing the relative impact of human activity in each ecoregion. The other advantage these units provide is that they are fixed over time unlike typical administrative or politically bounded areas which can change significantly from one year to the next.

Tabular datasets

In conjunction with the digital boundary datasets, various socio-economic data from Statistics Canada were also used for the pilot. These were: 1) *Census of Agriculture* 1971, 1976, 1981, 1986, 1991, 2) *Census of Population* 1971, 1976, 1981, 1986, 1991. These datasets were aggregated from the enumeration area level to the ecoregion level by overlaying the digital ecoregion boundary with the enumeration area file.

Land cover and socio-economic profiles of New Brunswick and its ecological regions

New Brunswick has a total of seven ecoregions which are all part of the Atlantic Maritime ecozone. These ecoregions are delineated by distinctive sets of non-living (abiotic) and living (biotic) resources that are ecologically related. Changes in land cover and use have major environmental impacts in these ecoregions.

This section will examine each ecoregion in New Brunswick and profile its major land cover attributes. It will also examine a selection of land use indicators that have been derived from census information.

Population size, distribution and density are major factors determining the impact that human activities have on the environment. For this reason it is useful to know actual population counts and the urban/rural composition of a given region. Population trends provide a useful indication of changing environmental stress levels.

Trends in experienced labour force[1] reflect employment patterns in each area. The resource sector sub-totals provided are useful land use indicators in that they reflect employment reliance on land use intensive activities.

Agricultural land areas provide a measure of how intensively a particular area is being cultivated.

Map 8.1 is a digital image of New Brunswick compiled from satellite information.The map divides New Brunswick into seven land cover classes (coniferous forest, broadleaf forest, mixed forest, barren land, cropland, built-up area and water)

New Brunswick occupies a total of 74 498 km^2. Mixed forests cover an area of 42 009 km^2 or 56% of the province while coniferous and broadleaf forests occupy an additional 25% and 13% respectively. New Brunswick is 94% forested.

1. The experienced labour force refers to persons who during the week prior to the census were employed or unemployed, and had worked during the 18 month period leading up to the census. Experienced labour force statistics by ecoregion reflect occupation by place of residence and not occupation by place of work.

As Table 8.3 indicates, the experienced labour force in New Brunswick was more than 350 000 strong in 1991, representing an increase of 17.5% over 1981.

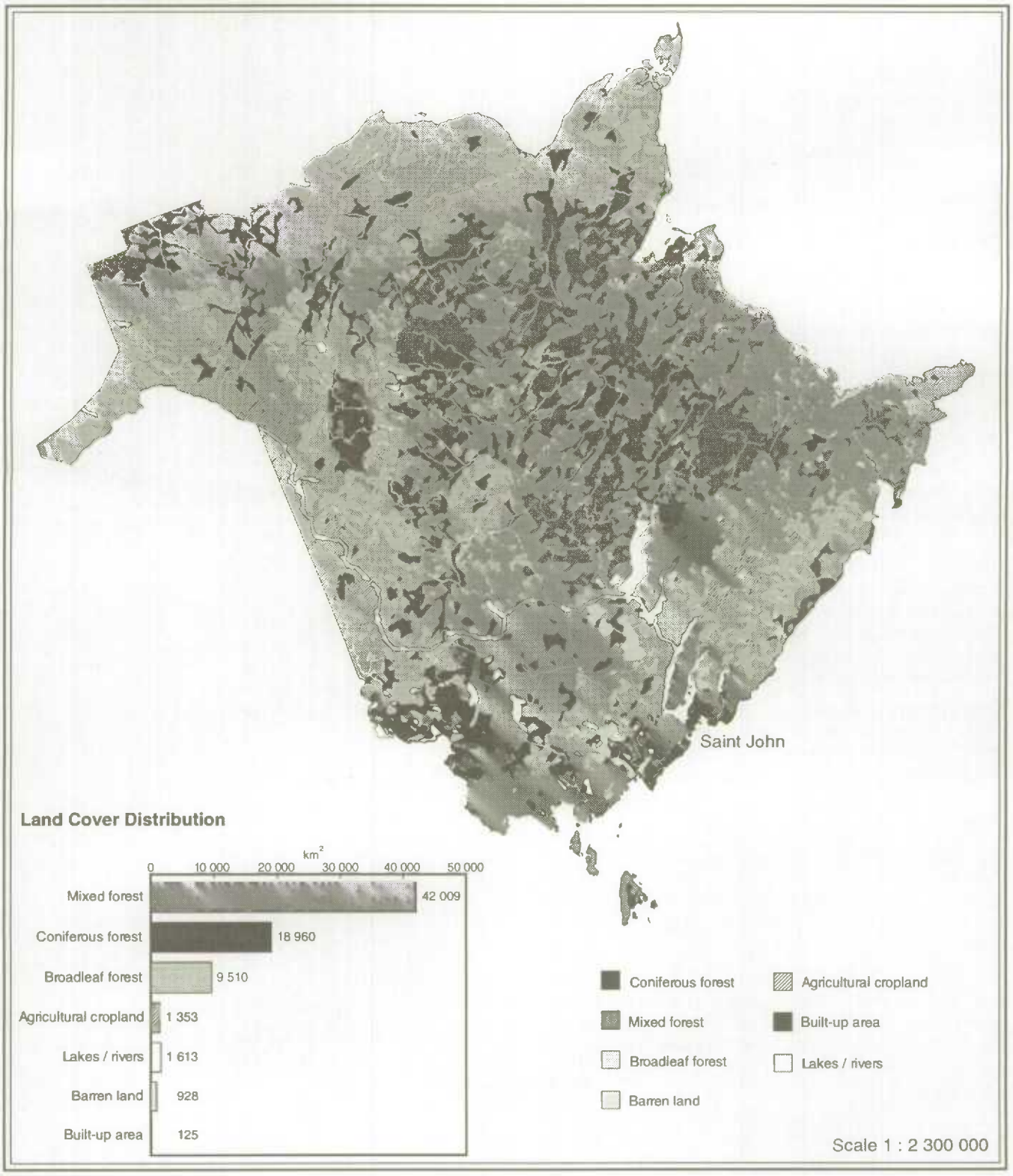
The resource sector of the experienced labour force rose by only 0.2% for the province as a whole between 1981 and 1991.

Table 8.3
Socio-economic Profile of New Brunswick, 1971-1991

	1971	1976	1981	1986	1991	Change 1981-91
	persons					percent
Experienced labour force						
Agriculture	..	..	7 263	8 111	8 154	12.3
Forestry	..	..	9 242	8 752	7 146	-22.7
Fishing and hunting	..	..	3 336	4 315	4 116	23.4
Mining	..	..	3 883	3 978	4 367	12.5
Resource sector	..	..	**23 724**	**25 156**	**23 783**	**0.2**
Manufacturing	..	..	48 156	45 667	46 849	-2.7
Construction	..	..	21 304	21 002	23 552	10.6
Transport and storage	..	..	16 474	17 398	16 189	-1.7
Communication	..	..	6 346	6 040	6 357	0.2
Public utilities	..	..	3 755	3 818	4 758	26.7
Wholesale and retail	..	..	49 173	52 921	57 420	16.8
Finance	..	..	10 510	11 338	12 602	19.9
Services	..	..	80 141	94 675	109 808	37.0
Public administration	..	..	28 121	31 531	35 010	24.5
Not defined	..	..	10 313	9 698	13 774	33.8
Total	..	..	**298 017**	**319 244**	**350 102**	**17.5**
Population	634 557	677 249	696 403	709 442	723 900	3.9
Urban proportion (%)	56.9	52.3	50.7	49.4	47.7	-6.0
Number of farms	5 485	4 551	4 063	3 554	3 252	-20.0
Farmland area (km^2)	5 419	4 668	4 379	4 089	3 756	-14.2

Source:
Statistics Canada, National Accounts and Environment Division.

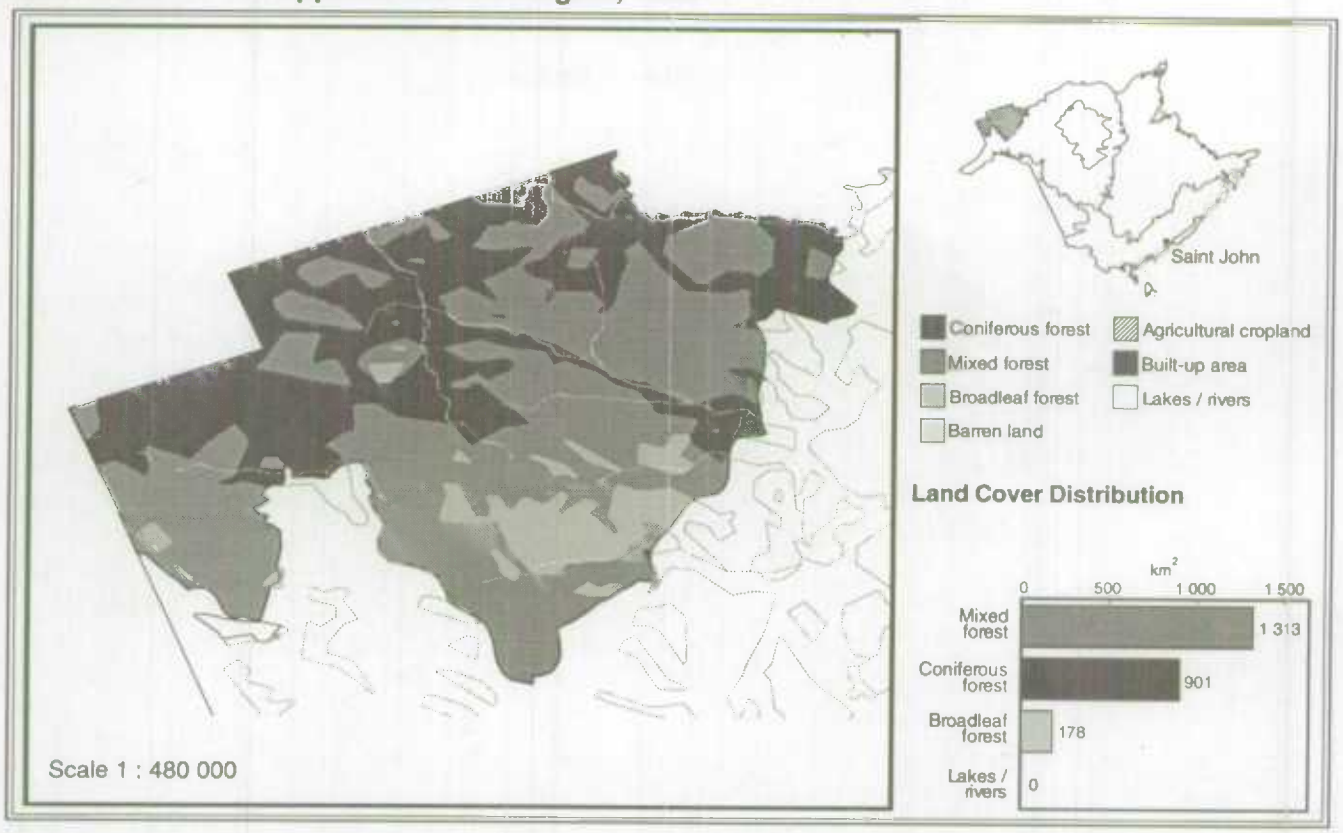
Map 8.1
Land Cover for New Brunswick, 1992



Source:
Natural Resources Canada, 1994a.

Map 8.2

Land Cover for the Appalachians Ecoregion, 1992



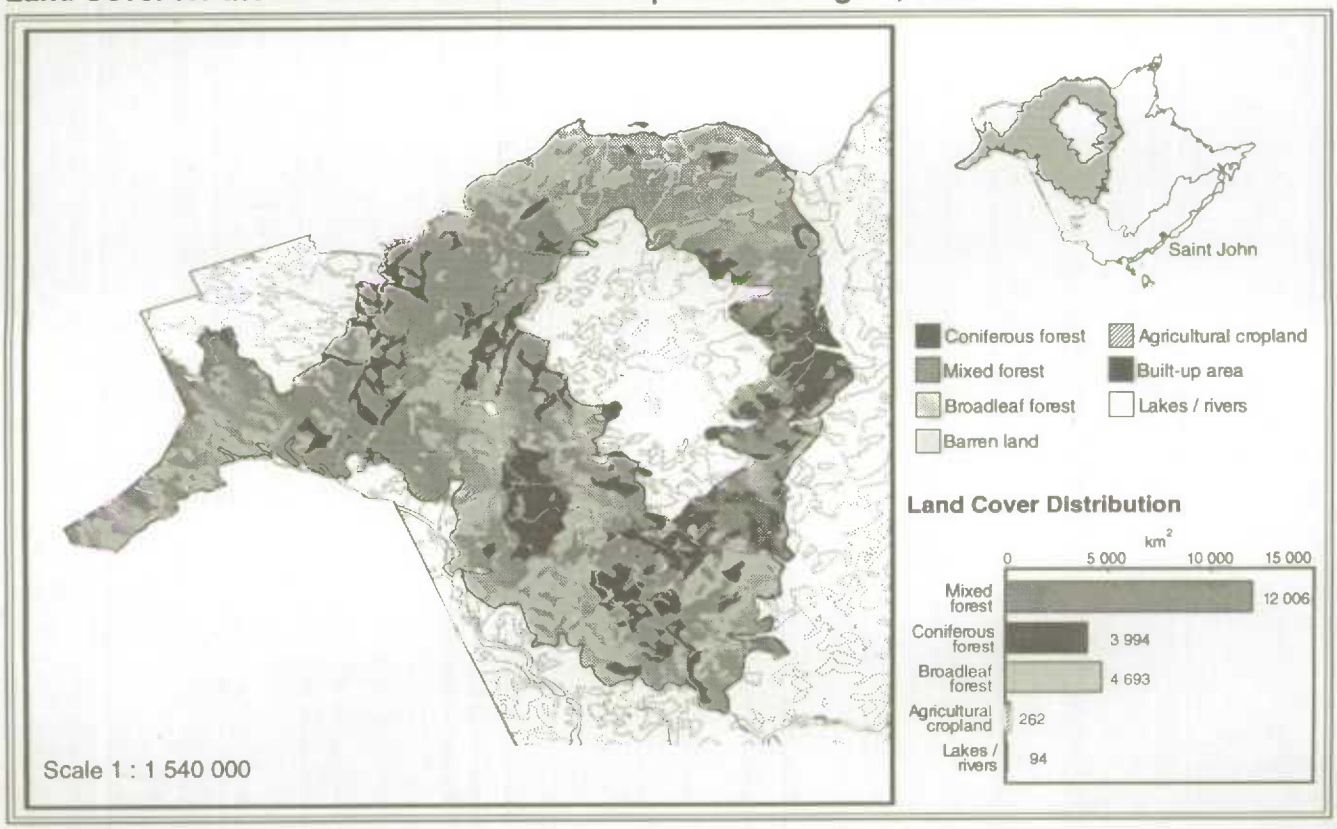
Source:
Natural Resources Canada, 1994a.

The Appalachians Ecoregion

Map 8.2 provides a snapshot of the New Brunswick portion of the Appalachian Ecoregion. This area is mountainous and is primarily wilderness. It has no recorded permanent residents.

The region occupies an area of 2 392 km^2, which represents 3.2% of New Brunswick's land area. Of this total area 1 313 km^2 or 55% is mixed forest, while coniferous and broadleaf stands make up the remaining 45% of the area.

Map 8.3
Land Cover for the Northern New Brunswick Uplands Ecoregion, 1992



Source:
Natural Resources Canada, 1994a.

The Northern New Brunswick Uplands Ecoregion

The Northern New Brunswick Uplands Ecoregion occupies 21 049 km^2 in the northwestern corner of New Brunswick. This region is characterized by rolling hills and large forest stands interspersed with tiny pockets of agricultural land, particularly along river valleys.

In the Northern New Brunswick Uplands, mixed forest covers an area of 12 006 km^2 or 57% of the region while broadleaf and coniferous forests occupy an additional 22% and 19% respectively. The region is 98% forested and contains the majority of New Brunswick's most productive forestland. On average, forest volumes exceed 100 cubic metres per hectare in this region.

The experienced labour force in the region was more than 45 000 strong in 1991, representing an increase of 17% over 1981.

The resource sector of the experienced labour force declined by 3% between 1981 and 1991.

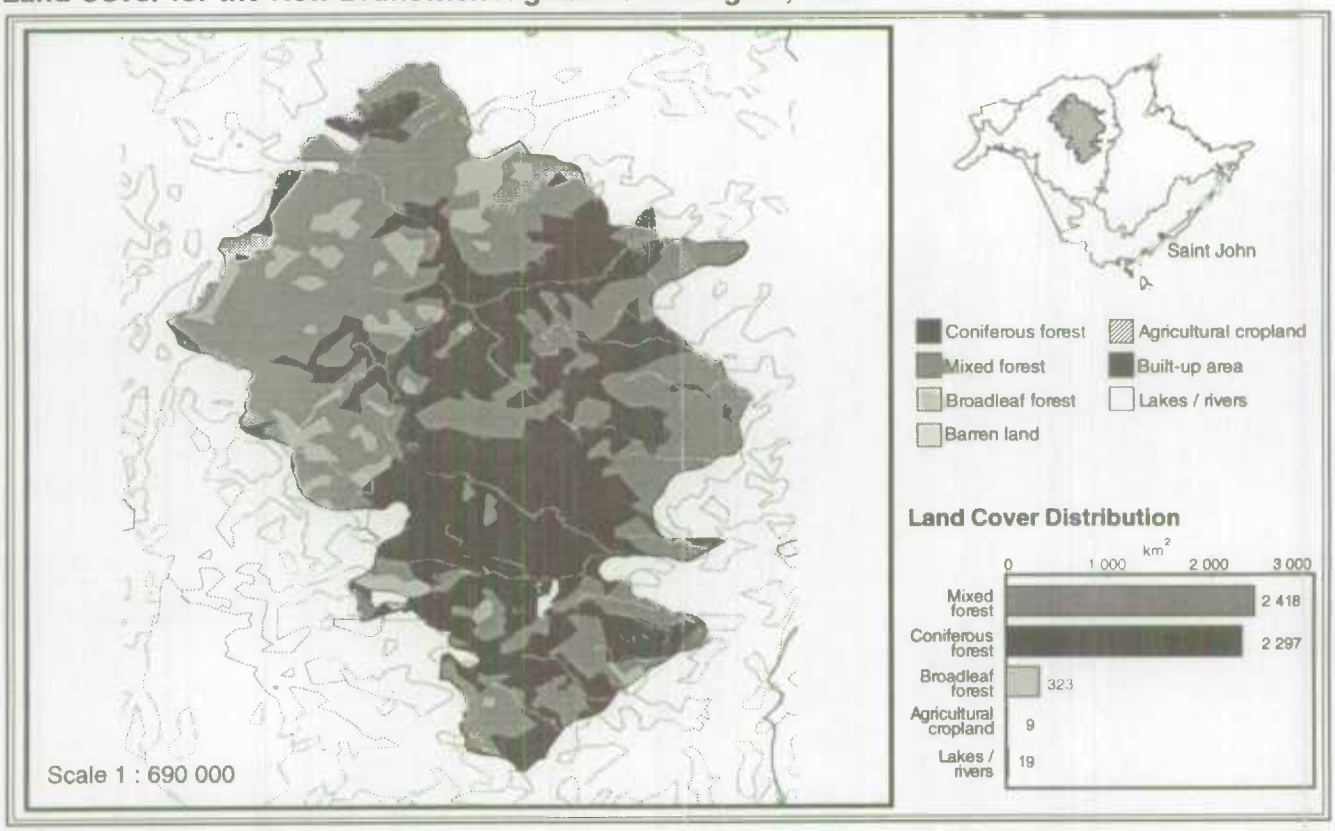
Table 8.4
Socio-economic Profile, 1971-1991

	1971	1976	1981	1986	1991	Change 1981-91
	persons					percent
Experienced labour force						
Agriculture	..	..	1 024	1 127	1 067	4.2
Forestry	..	..	2 471	2 423	2 324	-5.9
Fishing and hunting	..	..	153	136	141	-7.8
Mining	..	..	825	758	778	-5.7
Resource sector	..	..	**4 473**	**4 444**	**4 310**	**-3.6**
Manufacturing	..	..	7 637	7 184	7 042	-7.8
Construction	..	..	2 555	2 596	3 004	17.6
Transport and storage	..	..	1 656	1 851	1 865	12.6
Communication	..	..	632	494	478	-24.4
Public utilities	..	..	339	351	569	67.8
Wholesale and retail trade	..	..	5 520	6 005	6 286	13.9
Finance	..	..	986	1 169	1 277	29.5
Services	..	..	11 169	12 425	14 368	28.6
Public administration	..	..	2 302	2 861	3 302	43.4
Not defined	..	..	1 473	1 305	2 815	91.1
Total	..	..	**38 742**	**40 685**	**45 316**	**17.0**
Population	93 131	93 174	96 950	98 175	100 104	3.3
Urban proportion (%)	50.2	44.9	43.4	41.8	38.1	-12.1
Number of farms	806	592	534	476	438	-18.0
Farmland area (km^2)	778	607	551	562	569	3.3

Source:
Statistics Canada, National Accounts and Environment Division.

Map 8.4

Land Cover for the New Brunswick Highlands Ecoregion, 1992



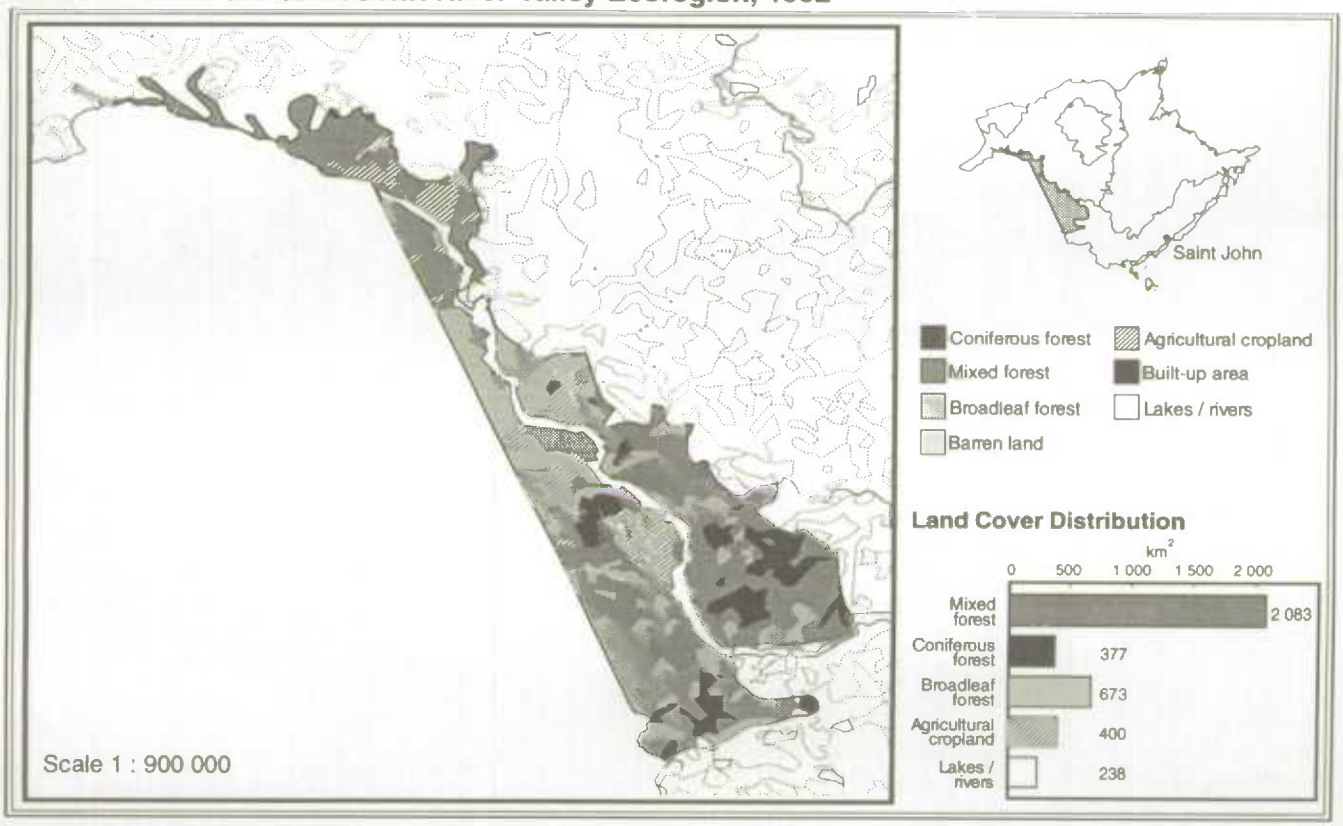
Source:
Natural Resources Canada, 1994a.

The New Brunswick Highlands Ecoregion

This unpopulated region is quite isolated from other areas of the province, and like the Northern New Brunswick Uplands it is primarily a forested area. It is characterized by steep slopes and hilly terrain. New Brunswick's highest point - Mount Carleton (817 metres) is located here.

The region occupies an area 5 066 km^2, of which 2 418 km^2 is mixed forest, 2 297 km^2 is coniferous forest and 323 km^2 is broadleaf forest. The southern-most portion of the region has a small parcel of agricultural land.

Map 8.5
Land Cover for the Saint John River Valley Ecoregion, 1992



Source:
Natural Resources Canada, 1994a.

The Saint John River Valley Ecoregion

This region of New Brunswick which is bordered by the United States on its western side, is characterized by the St. John River and its rich alluvial soils.

The region is covered primarily by forests which occupied 3 133 km^2 or 83% of the ecoregion area in 1992. Agricultural land and water cover the remainder of the region, occupying 11% and 6% of the area respectively.

The region covers an area of 3 771 km^2 and had a population of 47 879 in 1991. The rural/urban population split was 69% rural, 31% urban in 1991. Population has declined marginally in this area, from 48 665 in 1971.

The experienced labour force in the region grew by 8.6%, from 20 620 to 22 401, between 1981 and 1991.

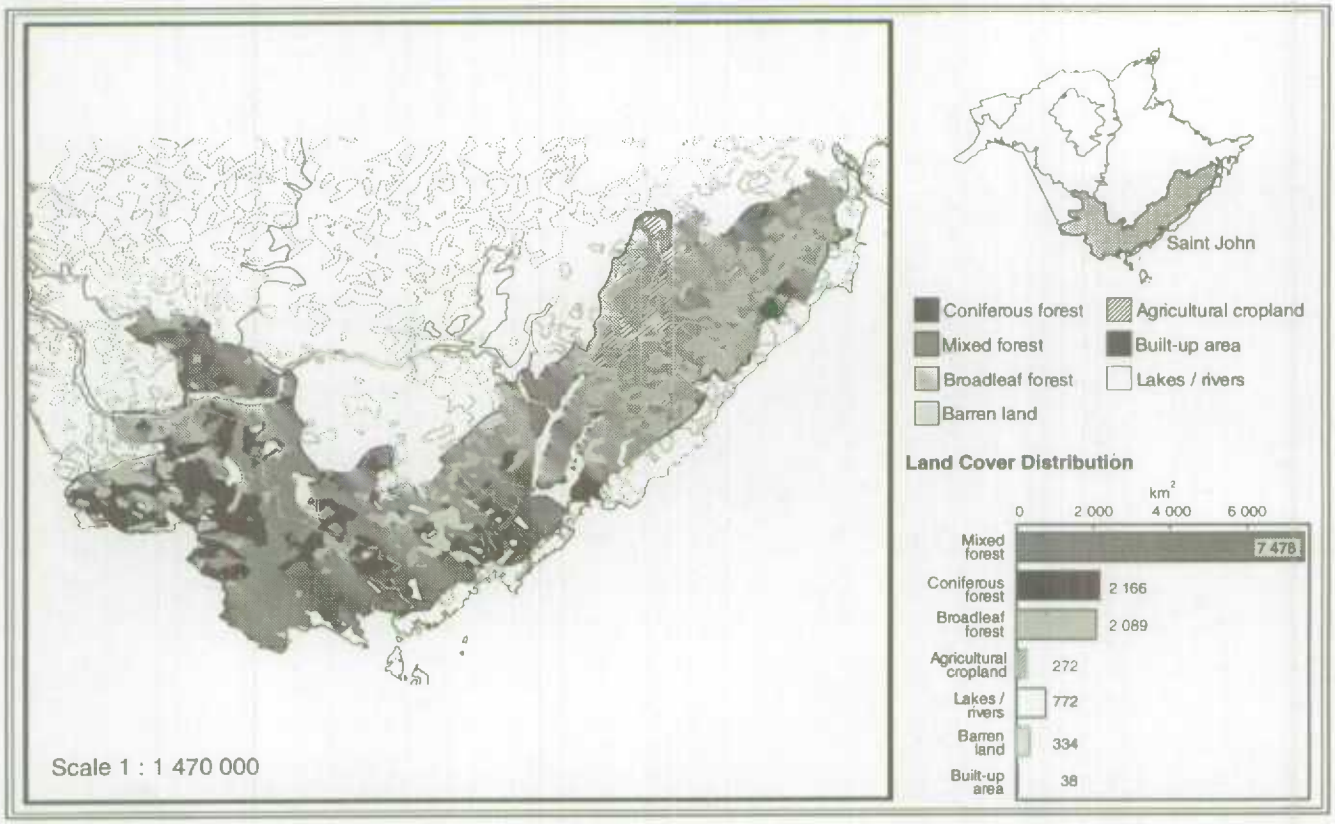
The experienced labour force in the land use intensive resource sector declined by 7.6% between 1981 and 1991.

Table 8.5
Socio-economic Profile, 1971-1991

	1971	1976	1981	1986	1991	Change 1981-91
	persons					percent
Experienced labour force						
Agriculture	..	..	2 024	2 379	2 055	1.5
Forestry	..	..	1 011	1 001	764	-24.4
Fishing and hunting	..	..	8	0	0	...
Mining	..	..	25	65	17	-32.0
Resource sector	..	..	**3 068**	**3 445**	**2 836**	**-7.6**
Manufacturing	..	..	4 240	3 964	4 146	-2.2
Construction	..	..	1 343	1 228	1 390	3.5
Transport and storage	..	..	1 125	1 124	1 171	4.1
Communication	..	..	284	275	258	-9.2
Public utilities	..	..	267	222	259	-3.0
Wholesale and retail trade	..	..	3 153	3 237	3 283	4.1
Finance	..	..	434	532	620	42.9
Services	..	..	4 823	5 462	8 149	27.5
Public administration	..	..	1 049	1 191	1 238	18.0
Not defined	..	..	834	694	1 051	26.0
Total	..	..	**20 620**	**21 374**	**22 401**	**8.6**
Population	48 665	50 018	50 587	48 617	47 879	-5.4
Urban proportion (%)	40.3	35.6	35.9	32.3	30.8	-14.1
Number of farms	1 218	1 122	950	789	837	-32.9
Farmland area (km^2)	1 327	1 290	1 215	1 101	983	-19.1

Source:
Statistics Canada, National Accounts and Environment Division.

Map 8.6
Land Cover for the Southern New Brunswick Uplands Ecoregion, 1992



Source:
Natural Resources Canada, 1994a.

The Southern New Brunswick Uplands Ecoregion

This ecoregion is located in southern New Brunswick and is characterized by a maritime climate, and rolling topography. This area occupies 13 149 km^2 or 18% of New Brunswick.

The region is covered primarily by forests which occupied 11 733 km^2 or 89% of the ecoregion in 1992. Water, barren land, agricultural cropland and built up areas occupied the remaining 11% of the region.

The rural/urban population split was 42% rural and 58% urban in 1991. Population increased significantly in this area which had a 1971 population of 126 281.

The experienced labour force in the region grew by 16.8%, from 61 714 to 72 110, between 1981 and 1991.

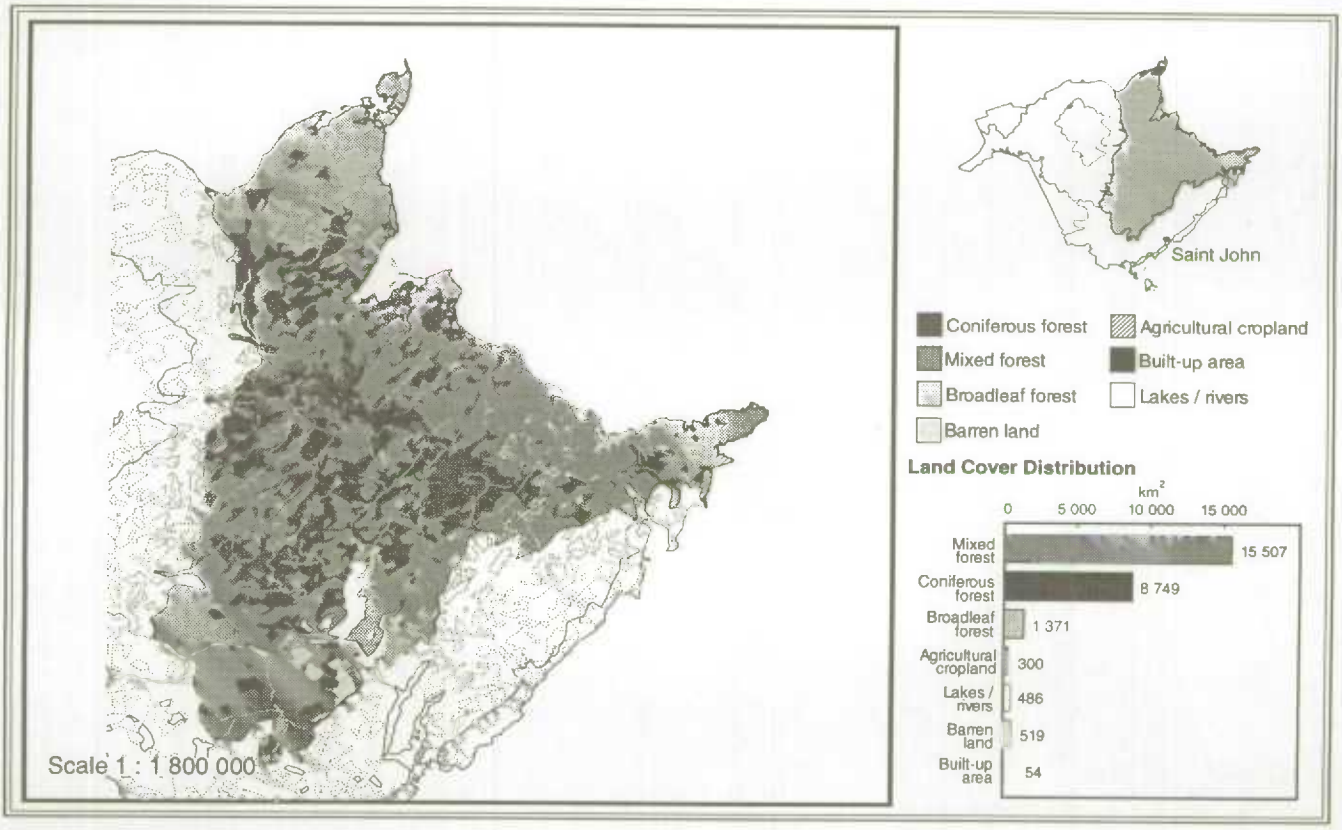
The experienced labour force in the land use intensive resource sector increased by 2.1% between 1981 and 1991. Workers with experience in forestry declined by 85%, while workers in mining and fishing/hunting increased by 258% and 89.4%, respectively.

Table 8.6
Socio-economic Profile, 1971-1991

	1971	1976	1981	1986	1991	Change 1981-91
	persons					percent
Experienced labour force						
Agriculture	..	..	1 620	1 589	1 752	8.1
Forestry	..	..	1 133	1 201	166	-85.3
Fishing and hunting	..	..	94	127	178	89.4
Mining	..	..	317	934	1 135	258.0
Resource sector	..	..	**3 164**	**3 851**	**3 231**	**2.1**
Manufacturing	..	..	9 995	9 283	10 559	5.6
Construction	..	..	4 873	4 446	4 850	-0.5
Transport and storage	..	..	3 600	3 542	3 336	-7.3
Communication	..	..	2 132	2 085	2 317	8.7
Public utilities	..	..	1 048	952	1 039	-0.9
Wholesale and retail	..	..	11 078	11 387	12 757	15.2
Finance	..	..	2 825	2 782	3 073	8.8
Services	..	..	16 982	19 917	23 285	37.1
Public administration	..	..	3 865	4 179	5 160	33.5
Not defined	..	..	2 152	1 975	2 503	16.3
Total	..	..	**61 714**	**64 399**	**72 110**	**16.8**
Population	126 281	132 988	140 107	143 534	150 766	7.6
Urban proportion (%)	69.2	61.9	61.3	59.8	57.7	-5.9
Number of farms	1 231	1 082	1 033	864	859	-18.8
Farmland area (km^2)	1 263	1 118	1 082	972	941	-13.0

Source:
Statistics Canada, National Accounts and Environment Division.

Map 8.7
Land Cover for the Maritime Lowlands Ecoregion, 1992



Source:
Natural Resources Canada, 1994a.

The Maritime Lowlands Ecoregion

This ecoregion is located in eastern New Brunswick and is characterized by a maritime climate, and relatively flat topography. The region occupies 26 986 km^2 or 36% of New Brunswick. This is New Brunswick's largest ecoregion.

This region is covered primarily by forests which occupied 25 627 km^2 or 95% of the ecoregion area in 1992. Barren land, water, agricultural cropland and built up areas occupied the remaining 5% of the region.

In 1991 the rural/urban population split was 52% rural, 48% urban. Population increased by 5.4% in this area since 1971.

The experienced labour force in the region grew by 21.4%, from 155 746 to 186 999, between 1981 and 1991.

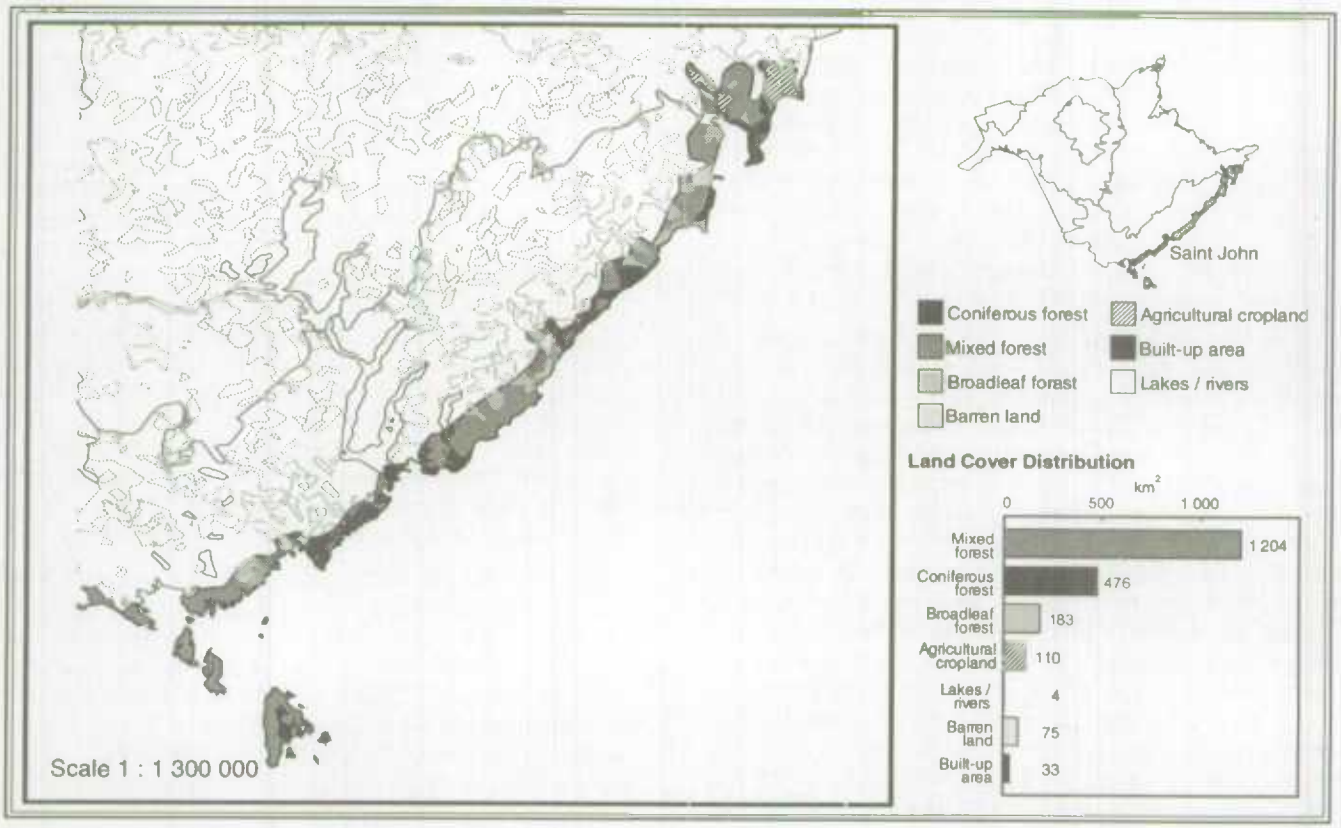
The experienced labour force in the land use intensive resource sector increased by 0.4% between 1981 and 1991. Workers with experience in forestry declined by 15.7%, while workers in fishing/hunting increased by 28.9%. Experienced agricultural workers also increased by 15.2%.

Table 8.7
Socio-economic Profile, 1971-1991

	1971	1976	1981	1986	1991	Change 1981-91
	persons					percent
Experienced labour force						
Agriculture	..	..	2 461	2 918	2 835	15.2
Forestry	..	..	4 447	4 010	3 747	-15.7
Fishing and hunting	..	..	2 306	3 187	2 972	28.9
Mining	..	..	2 696	2 191	2 409	-10.6
Resource sector	..	..	**11 910**	**12 306**	**11 963**	**0.4**
Manufacturing	..	..	22 159	21 654	21 195	-4.4
Construction	..	..	10 891	11 565	12 937	18.8
Transport and storage	..	..	8 714	9 672	8 717	0.0
Communication	..	..	2 750	2 665	2 794	1.6
Public utilities	..	..	1 672	1 958	2 530	51.3
Wholesale and retail	..	..	26 345	29 192	32 285	22.5
Finance	..	..	5 478	6 084	7 046	28.6
Services	..	..	41 491	50 291	59 411	43.2
Public administration	..	..	19 141	21 556	23 448	22.5
Not defined	..	..	5 195	5 009	6 673	28.5
Total	..	..	**155 746**	**171 952**	**188 999**	**21.4**
Population	319 803	351 776	360 745	372 033	380 280	5.4
Urban proportion (%)	55.7	53.1	50.6	49.6	48.3	-4.6
Number of farms	2 073	1 635	1 444	1 330	1 213	-16.0
Farmland area (km^2)	1 873	1 520	1 425	1 344	1 182	-17.0

Source:
Statistics Canada, National Accounts and Environment Division.

Map 8.8
Land Cover for the Fundy Coast Ecoregion, 1992



Source:
Natural Resources Canada, 1994a.

The Fundy Coast Ecoregion

This ecoregion is located in a narrow strip along the south eastern coast of New Brunswick and is characterized by a maritime climate, and relatively flat topography. The region occupies 2 085 km^2 or 3% of New Brunswick.

This region is covered primarily by forests which occupied 1 863 km^2 or 89% of the ecoregion area in 1992. Barren land, water, agricultural cropland and built-up areas occupied the remaining 11% of the region.

The 1991 population in this area was 44 871. The rural/urban population split was 48% urban, 52 % rural.

The experienced labour force in the region grew by 0.4%, from 21 195 to 21 276, between 1981 and 1991.

The experienced labour force in the land use intensive resource sector increased by 30.1% between 1981 and 1991. Workers with experience in forestry declined by 19.4%, while workers in fishing/hunting increased by 6.5%.

Table 8.8
Socio-economic Profile, 1971-1991

	1971	1976	1981	1986	1991	Change 1981-91
	persons					percent
Experienced labour force						
Agriculture	..	..	134	98	445	232.1
Forestry	..	..	180	117	145	-19.4
Fishing and hunting	..	..	775	865	825	6.5
Mining	..	..	20	30	28	40.0
Resource sector	..	..	**1 109**	**1 110**	**1 443**	**30.1**
Manufacturing	..	..	4 125	3 582	3 907	-5.3
Construction	..	..	1 642	1 167	1 371	-16.5
Transport and storage	..	..	1 379	1 209	1 100	-20.2
Communication	..	..	548	521	510	-6.9
Public utilities	..	..	429	335	361	-15.9
Wholesale and retail	..	..	3 077	3 100	2 809	-8.7
Finance	..	..	787	771	586	-25.5
Services	..	..	5 676	6 580	6 595	16.2
Public administration	..	..	1 764	1 744	1 862	5.6
Not defined	..	..	659	715	732	11.1
Total	..	..	**21 195**	**20 834**	**21 276**	**0.4**
Population	46 677	49 293	48 014	47 083	44 871	-6.5
Urban proportion (%)	62.7	52.3	51.1	49.6	48.3	-5.5
Number of farms	157	120	102	95	105	2.9
Farmland area (km^2)	178	133	106	110	81	-23.9

Source:
Statistics Canada, National Accounts and Environment Division.

Land use profiles from Statistics Canada census information

New Brunswick's land is used for many different purposes. Every square metre of land has a host of natural processes taking place upon it. Examples include, water absorption or evaporation, vegetation growth or decay, or even seasonal heat loss or gain. Recently, human activities have begun to use greater and greater amounts of land. These activities range from low intensity uses like a recreational hike through an area, to more intense activities such as the cultivation of an agricultural field or the clear cutting of a forest.

Economic activities that use land have a lasting effect on the landscape. The economic infrastructure we see today originates upon land that once supported only natural habitats. Examples of natural habitat conversion include the construction and maintenance of paved roadways through forested areas as well as the development of towns and cities along these transportation corridors. Most changes in the economy have an immediate land use change implication. An intensification of a particular land use activity requires more resource inputs and tends to displace competing activities, particularly if the competing activities are natural processes. This is because natural processes operate independently of the economy and are seldom given a price and are often given only aesthetic value. For example, opening up new land for agricultural production modifies existing natural habitat and requires that nutrients and energy be imported to offset those consumed by the crop which is harvested. The opposite can also be true when a decline in an economic activity allows competing activities to re-build and intensify. One example of this set of circumstances would be the re-population of a stream with salmon after a newly regenerated forest takes root in a logged watershed.

Information from Statistics Canada's censuses is ideally suited for analysis of broad socio-economic trends which affect land. The census data do not provide sufficient detail to address issues such as a change in micro-habitat, but they do provide important insight into the impact of larger scale human activities on the environment.

Population

The intensity of many economic land use activities is related to the distribution of human populations. In 1991, the province of New Brunswick had a population of 723 900 people, with an average density of 9.7 people per km^2 (Table 8.9). Provincial population grew by 14.1%, between 1971 and 1991.

In 1991, the Maritime Lowlands ecoregion had the highest population of any ecoregion in New Brunswick, with more than 380 thousand inhabitants. The major urban centres of Fredericton, Moncton and Miramichi are located within this ecoregion. The next most populous region is the Southern New Brunswick Uplands. This region was home to more than 150 thousand individuals in 1991. The remaining three populated ecoregions the Northern New Brunswick Uplands, the Saint John River Valley and the Fundy Coast had 100 thousand, 48 thousand and 45 thousand inhabitants respectively. There are two ecoregions with no recorded permanent residents in recent census years, The Appalachian ecoregion and the New Brunswick Highlands ecoregion.

The population density figures in Table 8.9 indicate the distribution of people relative to the supporting land base. The Fundy Coast ecoregion is the most densely populated, with densities ranging from 22 to 24 people per km^2, between 1971 and 1991. The Maritime Lowlands and Saint John River Valley regions were the second and third most densely populated regions in 1991, with an average of 14.1 and 12.7 people per km^2 respectively. Trends that indicate increasing densities indicate areas where land use competition is likely on the rise as well. This is particularly true in the Maritime Lowlands where the urban centres of Fredericton and Moncton have been expanding over the past 20 years.

Table 8.10 examines the urban/rural composition of New Brunswick's population by ecological region. Unlike most other provinces and territories in Canada, the general trend in New Brunswick is towards an increasingly rural population. Rural population has increased by 38.5%, while urban population has declined by 4.4% for the province as a whole. In New Brunswick, the rural non-farm population is increasing while the farm population appears to be declining. Most of the rural population increase is occurring in the

Table 8.9
Population by Ecoregion, 1971-1991

Ecoregion	Ecoregion area	Population					Population change	Average population density				
		1971	1976	1981	1986	1991	1971-1991	1971	1976	1981	1986	1991
	km^2	persons					percent	persons per km^2				
Appalachians	2 392	-	-	-	-	-	-	-	-	-	-	-
Northern New Brunswick Uplands	21 049	93 131	93 174	96 950	98 175	100 104	7.5	4.4	4.4	4.6	4.7	4.8
New Brunswick Highlands	5 066	-	-	-	-	-	-	-	-	-	-	-
Saint John River Valley	3 771	48 665	50 018	50 587	48 617	47 879	-1.6	12.9	13.3	13.4	12.9	12.7
Southern New Brunswick Uplands	13 149	126 281	132 988	140 107	143 534	150 766	19.4	9.6	10.1	10.7	10.9	11.5
Maritime Lowlands	26 986	319 803	351 778	360 745	372 033	380 280	18.9	11.8	13.0	13.4	13.8	14.1
Fundy Coast	2 085	46 677	49 293	48 014	47 063	44 871	-3.9	22.4	23.6	23.0	22.6	21.5
Total	**74 498**	**634 557**	**677 249**	**696 403**	**709 442**	**723 900**	**14.1**	**8.5**	**9.1**	**9.3**	**9.5**	**9.7**

Sources:
Statistics Canada, National Accounts and Environment Division and Demography Division.

Table 8.10
Rural and Urban Population by Ecoregion, 1971-1991

Ecoregion	Ecoregion area	Rural population 1971	1976	1981	1986	1991	Change 1971-1991	Urban population 1971	1976	1981	1986	1991	Change 1971-1991
	km²	persons					percent	persons					percent
Appalachians	2 392	-	-	-	-	-	-	-	-	-	-	-	-
Northern New Brunswick Uplands	21 049	46 374	51 346	54 885	57 315	61 922	33.5	46 757	41 828	42 065	40 860	38 182	-18.3
New Brunswick Highlands	5 066	-	-	-	-	-	-	-	-	-	-	-	-
Saint John River Valley	3 771	29 073	32 215	32 438	32 901	33 132	14.0	19 592	17 803	18 149	15 716	14 747	-24.7
Southern New Brunswick Uplands	13 149	38 876	50 660	54 220	57 738	63 812	64.1	87 405	82 328	85 887	85 796	86 954	-0.5
Maritime Lowlands	26 986	141 677	165 115	176 168	187 481	196 625	38.8	178 126	186 661	182 577	184 552	183 655	3.1
Fundy Coast	2 085	17 410	23 495	23 472	23 704	23 195	33.2	29 267	25 798	24 542	23 379	21 676	-25.9
Total	**74 498**	**273 410**	**322 831**	**343 183**	**359 139**	**378 686**	**38.5**	**361 147**	**354 418**	**353 220**	**350 303**	**345 214**	**-4.4**

Note:
An urban area is an area which has attained a population of at least 1 000 and a population density of at least 400 per square kilometre, at the previous census. Rural areas include all areas that do not meet the urban definition.
Sources:
Statistics Canada, National Accounts and Environment Division and Demography Division.

Table 8.11
Number of Farms and Average Farm Size by Ecoregion, 1971-1991

Ecoregion	Ecoregion area	Number of farms 1971	1976	1981	1986	1991	Change 1971-1991	Average farm size 1971	1976	1981	1986	1991	Change in size 1971-1991
	km²	number					percent	hectares per farm					percent
Appalachians	2 392	-	-	-	-	-		-	-	-	-	-	-
Northern New Brunswick Uplands	21 049	806	592	534	476	438	-45.7	96.6	102.6	103.2	118.0	129.9	34.6
New Brunswick Highlands	5 066	-	-	-	-	-		-	-	-	-	-	-
Saint John River Valley	3 771	1 218	1 122	950	789	637	-47.7	109.0	114.9	127.9	139.5	154.3	41.6
Southern New Brunswick Uplands	13 149	1 231	1 082	1 033	864	859	-30.2	102.6	103.3	104.7	112.5	109.6	6.8
Maritime Lowlands	26 986	2 073	1 635	1 444	1 330	1 213	-41.5	90.3	93.0	98.7	101.0	97.5	7.9
Fundy Coast	2 085	157	120	102	95	105	-33.1	113.6	110.5	103.8	116.2	78.8	-32.4
Total	**74 498**	**5 485**	**4 551**	**4 063**	**3 554**	**3 252**	**-40.7**	**98.8**	**102.6**	**107.8**	**115.0**	**115.5**	**16.9**

Sources:
Statistics Canada, National Accounts and Environment Division and Agriculture Division.

rural fringes of larger urban centres and in a selection of small rural centres.

Individual ecoregions that are showing large urban declines are the Fundy Coast and the Saint John River Valley with 25.9% and 24.7% declines, respectively.

These statistics indicate that land use competition associated with increases in urban core populations are not as pronounced in New Brunswick as they are elsewhere in Canada. For the most part New Brunswick's ecoregions, with perhaps the exception of the Maritime Lowlands, show stable or declining urban populations.

Agriculture

Agriculture is a major user of quality land in New Brunswick. All of the most fertile lands in the province are now fully utilized by agriculture.

New Brunswick's agricultural industry has been undergoing significant changes over the last 20 years. Most of these changes have land use implications. Table 8.11 indicates that the total number of farms has declined significantly. The number of farms shrank from 5 485 in 1971, to 3 252 in 1991, representing a 40.7% decline. At the same time average farm sizes have been increasing going from 98.8 hectares in 1971, to 115.5 hectares in 1991, for a 16.9% increase in average size.

The land use implications of an increasing farm size are clear. Fewer and fewer people are operating more and more land, indicating that land use decisions are now being made at a larger scale relative to a larger farm size. This increasing size trend also signals the decline of the traditional individual family farm. In fact, the number of individual family farms dropped from 93% of New Brunswick farms in 1976, to an all time low of 68% of farms in 1991.

The area of farmland in operation in New Brunswick declined in all ecoregions (Table 8.12). The relative declines ranged from 25% in the Southern New Brunswick Uplands to 55% in the Fundy Coast. The region with the largest absolute decline in area was the Maritime Lowlands, losing 691 km² or approximately one third of its farmland area since 1971. Declining farmland areas do not imply that all of the land that was farmland is now essentially abandoned, but rather that much of it may have moved to other main uses such as residential, commercial, recreational, or even to newly forested land.

Table 8.12
Farmland by Ecoregion, 1971-1991

Ecoregion	Ecoregion area	Farmland area 1971	1976	1981	1986	1991	Change 1971-1991	Proportion of ecoregion in farmland 1971	1976	1981	1986	1991
	km²						percent					
Appalachians	2 392	-	-	-	-	-	-	-	-	-	-	-
Northern New Brunswick Uplands	21 049	778	607	551	562	569	-26.9	4	2.89	2.62	2.67	2.70
New Brunswick Highlands	5 066	-	-	-	-	-	-	-	-	-	-	-
Saint John River Valley	3 771	1 327	1 290	1 215	1 101	983	-26.0	35	34.20	32.23	29.20	26.07
Southern New Brunswick Uplands	13 149	1 263	1 118	1 082	972	941	-25.4	10	8.50	8.23	7.39	7.16
Maritime Lowlands	26 986	1 873	1 520	1 425	1 344	1 182	-36.9	7	5.63	5.28	4.98	4.38
Fundy Coast	2 085	178	133	106	110	81	-54.8	9	6.36	5.08	5.29	3.87
Total	**74 498**	**5 419**	**4 668**	**4 379**	**4 089**	**3 756**	**-30.7**	**7**	**6.27**	**5.88**	**5.49**	**5.04**

Sources:
Statistics Canada, National Accounts and Environment Division and Agriculture Division.

Table 8.13
Cropland by Ecoregion, 1971-1991

Ecoregion	Ecoregion area	Cropland area 1971	1976	1981	1986	1991	Change 1971-1991	Proportion of farmland in cropland 1971	1976	1981	1986	1991	Change 1971-1991
	km²						percent						
Appalachians	2 392	-	-	-	-	-	-	-	-	-	-	-	-
Northern New Brunswick Uplands	21 049	219	205	195	212	197	-10.4	28.2	33.7	35.5	37.6	34.5	22.6
New Brunswick Highlands	5 066	-	-	-	-	-	-	-	-	-	-	-	-
Saint John River Valley	3 771	484	522	492	480	457	-5.7	36.5	40.5	40.5	43.6	46.5	27.4
Southern New Brunswick Uplands	13 149	226	246	241	233	234	3.3	17.9	22.0	22.3	24.0	24.8	38.6
Maritime Lowlands	26 986	340	365	353	340	314	-7.5	18.1	24.0	24.8	25.3	26.6	46.6
Fundy Coast	2 085	35	32	24	30	21	-39.8	19.4	24.2	22.3	27.4	25.8	33.1
Total	**74 498**	**1 304**	**1 371**	**1 305**	**1 295**	**1 222**	**-6.3**	**24.1**	**29.4**	**29.8**	**31.7**	**32.5**	**35.2**

Sources:
Statistics Canada, National Accounts and Environment Division and Agriculture Division.

One useful land use intensity measure that can be derived from census data is the proportion of an ecoregion's area that is used for farmland. This measure combined with other land use information (industrial, residential, commercial) would provide an indication of the degree to which human activity has altered natural ecosystems and potentially influenced biodiversity in an area.

Table 8.12 summarizes findings for New Brunswick and its ecoregions. The province has a relatively low proportion of its land in agriculture. In 1991 only 5% of land in New Brunswick was used for agriculture, in contrast, Saskatchewan used 47% of its land for agriculture. The divergence in these figures is due primarily to the supply of arable land available in each province. New Brunswick has a very limited supply of quality agricultural land which can be seen in Table 8.12.

From an ecoregion perspective, of the five ecoregions that have agriculture, four have less than 10% of their area in agriculture. The exception is the Saint John River Valley which had 35.2% farmland in 1971, declining to 26.1% by 1991. Most of New Brunswick's highest quality agricultural land is located in this region.

In general, this decline in farmland proportions can be seen as beneficial from an environmental perspective. The reduced extent of active agriculture allows competing natural processes such as the growth of wildlife populations to expand. Declines in farmland area also indicate that pressure on marginally productive farmland which cannot sustain long term production is likely declining.

Table 8.13 presents New Brunswick's cropland distribution by ecoregion. The distribution of cropland within an area, provides an indicator of how intensively a particular ecoregion's farmland is being utilized. Cropland tends to be the most highly cultivated land, demanding more tillage, fertilizer and pesticides than other types of farmland.

The total area of cropland declined by 6.3%. This is a modest decline, relative to the more dramatic 30.7% decrease in farmland area. Table 8.13 presents the area of cropland and the proportion of farmland devoted to crops. A greater proportion of farmland is being utilized to produce crops. Over the longer term there is a clear indication that land use intensity on farmland in each ecoregion is on the rise.

Trends in cropping practice indicate changing levels of environmental stress, and help to answer questions about the long term sustainability of agriculture and the soils which support it. Table 8.14 presents trends in the area of wide-row monoculture for the province of New Brunswick. Wide-row monoculture is the continual planting of wide-row crops on a year after year basis. This practice is often damaging

and is often carried out in an effort to maintain cash flow on farms.

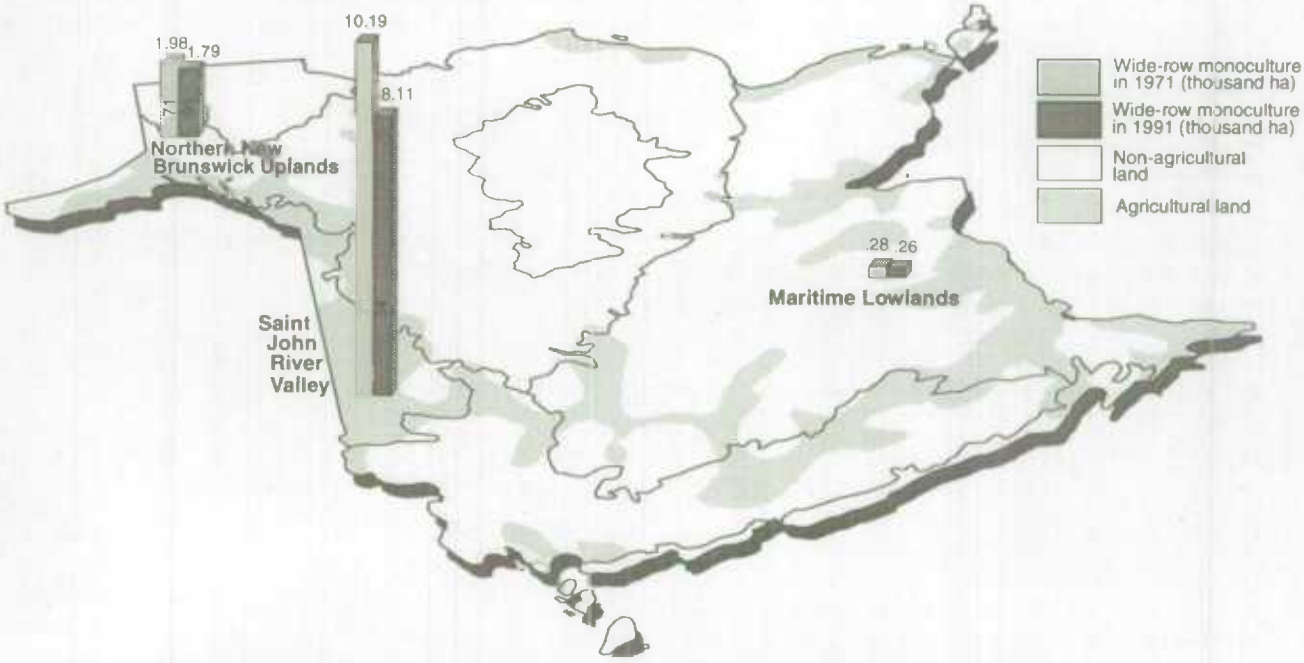
From an ecological perspective, the most stable biotic communities are very complex with countless species interacting to form a diverse community network. The tropical rain forest is perhaps the most stable ecological community, deriving its stability from a multitude of checks and balances that serve to suppress the domination of any particular species, while at the same time preventing the extinction of other species. In contrast, monoculture cropping systems are inherently unstable; they are more susceptible to outbreaks of insects, disease, weeds and micro-nutrient imbalances. Despite these high ecological costs, monoculture cropping systems are the most productive. They create their own economies of scale and use specialisation to increase production levels. Monoculture levels can be measured from census data by looking at the land use information reported on census questionnaires.

Table 8.14
Cropland in Wide-row Monoculture Crops by Ecoregion, 1971-1991

Ecoregion	Ecoregion area	Wide-row monoculture cropland area					Change	Proportion of total cropland in wide-row monoculture				
		1971	1976	1981	1986	1991	1971-1991	1971	1976	1981	1986	1991
	km²	hectares						percent				
Appalachians	2 392	-	-	-	-	-	-	-	-	-	-	-
Northern New Brunswick Uplands	21 049	1 979	2 479	2 212	2 258	1 793	-9.4	9.0	12.1	11.3	10.7	9.1
New Brunswick Highlands	5 066	-	-	-	-	-	-	-	-	-	-	-
Saint John River Valley	3 771	10 193	11 287	7 922	8 249	8 107	-20.5	21.0	21.6	16.1	17.2	17.7
Southern New Brunswick Uplands	13 149	-	-	-	-	-	-	-	-	-	-	-
Maritime Lowlands	26 986	276	270	892	249	255	-7.6	0.6	0.7	2.5	0.7	0.8
Fundy Coast	2 085	-	-	-	-	-	-	-	-	-	-	-
Total	**74 498**	**12 448**	**14 036**	**11 026**	**10 756**	**10 154**	**-18.4**	**9.5**	**10.2**	**8.4**	**8.3**	**8.3**

Note:
Wide-row monoculture is defined as the planting of wide-row crops, on a continual year after year basis, on the same parcel of land.
Sources:
Statistics Canada, National Accounts and Environment Division and Agriculture Division.

Map 8.9
Wide-row Monoculture by Ecoregion, 1971 and 1991



Note:
Wide-row monoculture is defined as the planting of wide-row crops, on a continual year after year basis, on the same parcel of land.
Sources:
Statistics Canada, National Accounts and Environment Division and Agriculture Division.

Wide-row monoculture demands high levels of agricultural inputs. Pesticide expenses per hectare on wide-row monoculture farms are 5 times those on other farms, while fertilizer expenses are more than 4 times higher. Wide-row monocultures have an erosion rate 2-3 times that of a grain crop.

The practice of wide row monoculture is most common in the Saint John River Valley (Map 8.9).

In New Brunswick wide-row monoculture trends are in decline after reaching a maximum extent of more than 14 thousand hectares in 1976. From 1971 to 1991 wide-row monoculture areas have declined by more than 18%. This is indeed a positive environmental trend and indicates that farmers in New Brunswick are now employing their land in less stressful cropping systems, allowing the soil some respite from continual cash crop production.

Table 8.15 presents information on cropland under crop rotation by ecoregion. As the table indicates, most cropland in New Brunswick falls into this general category indicating a healthier mix of crops.

Other relevant agricultural land use statistics derived from census data relate to farm chemical inputs which are applied to farmland on a large scale. Both pesticides and fertilizers which have high potential environmental impact, are included on this list.

Agricultural pesticides are applied to control insects, weeds and crop diseases in an effort to maintain crop quantity and quality. Table 8.16 shows expenditures on pesticide being applied on improved farmland. Pesticide expense data provide an indication of the amount of pesticide entering the environment. Many factors influence the environmental impacts of pesticides. These include the time of application, rainfall, stability of the pesticide, method of application, and many others. The application rate for pesticides applied on farmland in New Brunswick increased by more than 93% between 1970 and 1990 (Table 8.16). The ecoregion with the highest application rate is again the Saint John River Valley where wide-row crop production is also highest.

On a national basis, New Brunswick pesticide application rates in dollar terms are quite high. New Brunswick's 1990 rate of 49 dollars per hectare is triple the national average of 16 dollars.

The application of commercial fertilizers can also pose some unique impacts on the environment. Ideally, the majority of agricultural fertilizers are consumed by crops shortly after application. However, residual fertilizer nutrients can be lost to the atmosphere, absorbed by wild plant species or be released from the soil into both surface and ground-

Table 8.15
Cropland in Crop Rotation by Ecoregion, 1971-1991

Ecoregion	Ecoregion area	Rotational cropland area					Change	Proportion of total cropland in rotational crops				
		1971	1976	1981	1986	1991	1971-1991	1971	1976	1981	1986	1991
	km²	hectares						percent				
Appalachians	2 392	-	-	-	-	-	-	-	-	-	-	-
Northern New Brunswick Uplands	21 049	14 499	15 359	13 109	13 151	13 207	-8.9	66.1	75.0	67.1	62.2	67.2
New Brunswick Highlands	5 066	-	-	-	-	-	-	-	-	-	-	-
Saint John River Valley	3 771	20 150	32 619	32 705	33 077	30 718	52.4	41.6	62.5	66.4	68.9	67.2
Southern New Brunswick Uplands	13 149	16 517	23 038	21 202	20 523	20 980	27.0	73.1	93.5	88.0	88.0	89.8
Maritime Lowlands	26 986	28 036	33 387	30 614	28 946	24 836	-11.4	82.5	91.4	86.8	85.3	79.0
Fundy Coast	2 085	3 086	2 832	1 977	1 950	1 374	-55.5	89.2	88.1	83.6	64.4	66.1
Total	**74 498**	**82 287**	**107 234**	**99 606**	**97 646**	**91 114**	**10.7**	**63.1**	**78.2**	**76.3**	**75.4**	**74.5**

Sources:
Statistics Canada, National Accounts and Environment Division and Agriculture Division.

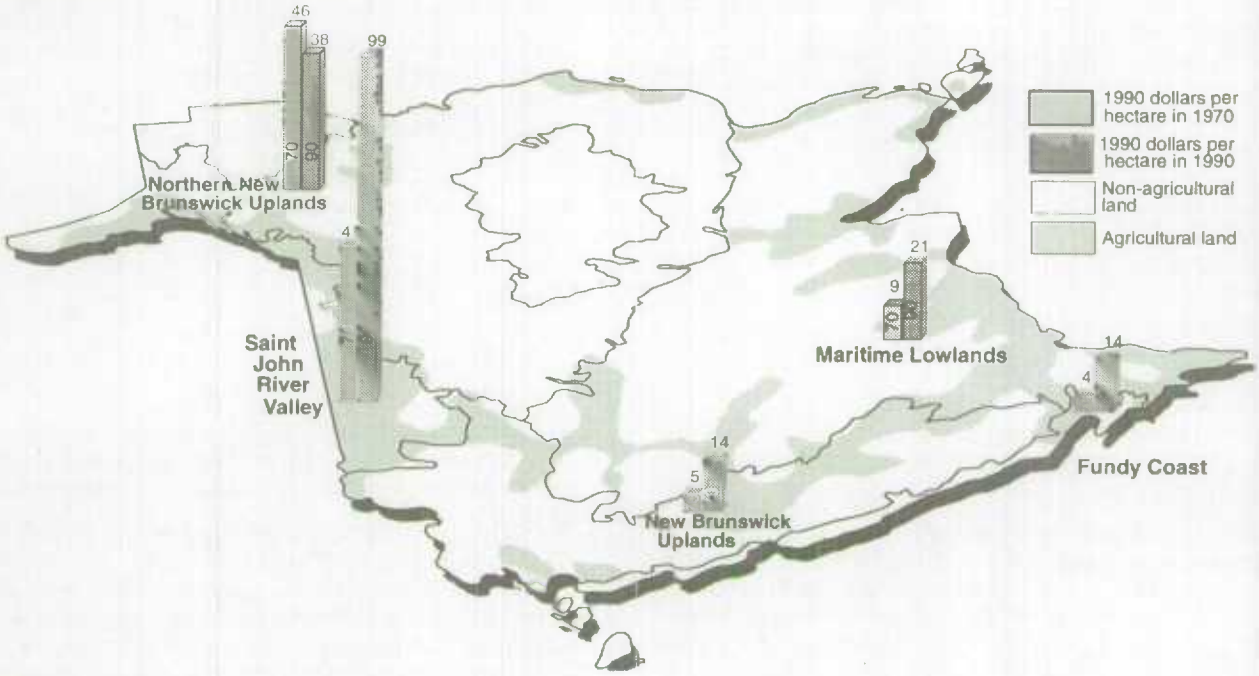
Table 8.16
Agricultural Pesticide Expenditures by Ecoregion, 1970-1990

Ecoregion	Ecoregion area	Agricultural pesticide expenditure					Change	Application rate					Change
		1970	1975	1980	1985	1990	1970-1990	1970	1975	1980	1985	1990	1970-1990
	km²	thousand 1991 dollars					percent	1991 dollars per hectare of improved land					percent
Appalachians	2 392	-	..	-	-	-	-	-	..	-	-	-	-
Northern New Brunswick Uplands	21 049	1 292	..	755	1 035	832	-35.6	46	..	31	43	38	-17.5
New Brunswick Highlands	5 066	-	..	-	-	-	-	-	..	-	-	-	-
Saint John River Valley	3 771	2 518	..	3 906	4 235	5 010	99.0	44	..	67	78	99	125.1
Southern New Brunswick Uplands	13 149	158	..	185	256	430	171.1	5	..	5	8	14	193.1
Maritime Lowlands	26 986	451	..	543	746	841	86.2	9	..	11	17	21	133.3
Fundy Coast	2 085	24	..	25	28	37	51.8	4	..	6	6	14	272.8
Total	**74 498**	**4 444**	**..**	**5 394**	**6 300**	**7 149**	**60.9**	**25**	**..**	**31**	**40**	**49**	**93.2**

Sources:
Statistics Canada, National Accounts and Environment Division and Agriculture Division.

Map 8.10

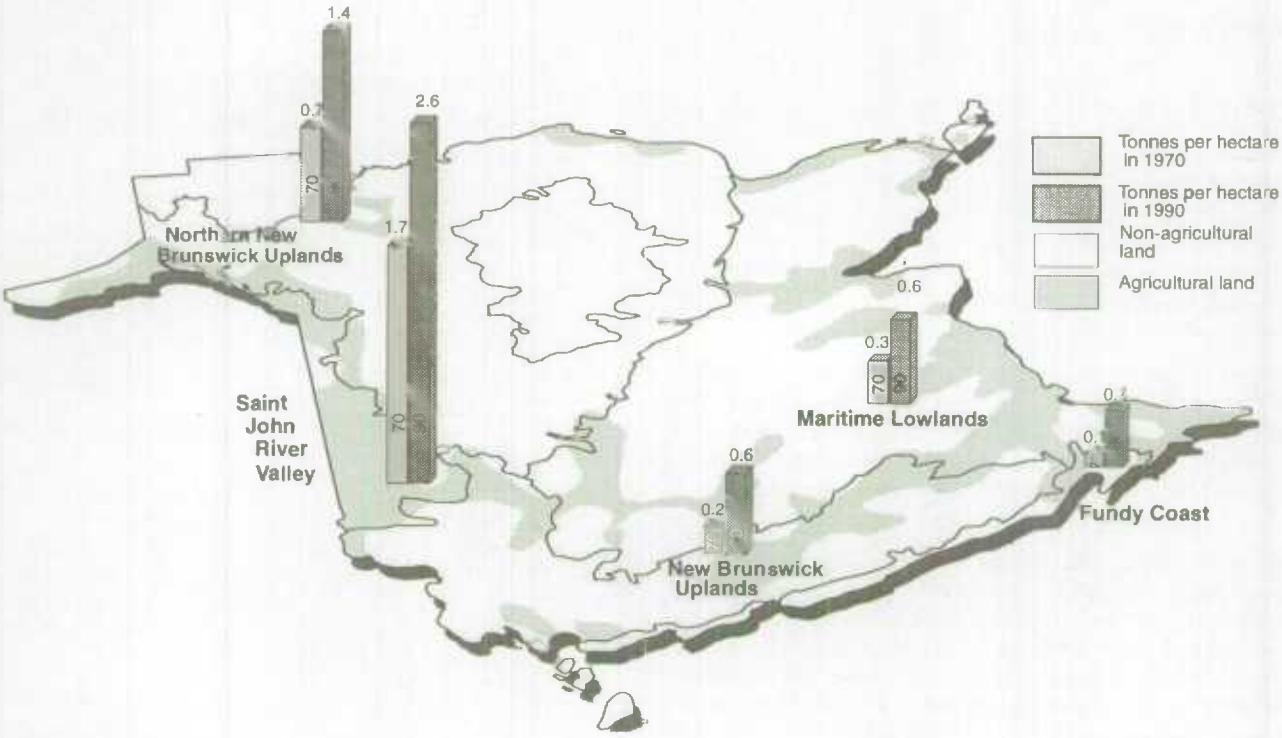
Value of Agricultural Pesticides Applied, by Ecoregion, 1970 and 1990



Sources:
Statistics Canada, National Accounts and Environment Division and Agriculture Division.

Map 8.11

Fertilizer Use by Ecoregion, 1970 and 1990



Sources:
Statistics Canada, National Accounts and Environment Division and Agriculture Division.

Table 8.17
Agricultural Fertilizer Application by Ecoregion, 1970-1990

Ecoregion	Ecoregion area	Commercial fertilizer 1970	1975	1980	1985	1990	Change 1970-1990	Application rate 1970	1975	1980	1985	1990	Change 1970-1990
	km²	tonnes					percent	tonnes per hectare of improved land					percent
Appalachians	2 392	-	..	-	-	-	-	-	..	-	-	-	-
Northern New Brunswick Uplands	21 049	6 194	..	7 099	8 488	6 001	-3.10	0.74	..	1.01	1.76	1.40	89.7
New Brunswick Highlands	5 066	-	..	-	-	-	-	-	..	-	-	-	-
Saint John River Valley	3 771	23 046	..	32 296	27 091	24 487	6.26	1.68	..	2.29	2.41	2.57	53.0
Southern New Brunswick Uplands	13 149	2 986	..	4 227	4 383	5 543	85.60	0.23	..	0.32	0.45	0.55	144.8
Maritime Lowlands	26 986	5 774	..	8 569	7 419	7 207	24.83	0.28	..	0.47	0.59	0.57	104.8
Fundy Coast	2 085	316	..	352	563	310	-1.90	0.09	..	0.15	0.31	0.39	322.2
Total	**74 498**	**38 316**	**..**	**52 543**	**47 944**	**43 549**	**13.66**	**0.64**	**..**	**0.96**	**1.19**	**1.17**	**81.5**

Sources:
Statistics Canada, National Accounts and Environment Division and Agriculture Division.

water supplies. The degree to which fertilizers impact the environment is largely dependent on local conditions at the time of application.

Table 8.17 presents the tonnes of fertilizer applied in each ecoregion and the average rate at which it was applied. The Saint John River Valley ecoregion uses more than half of the province's agricultural fertilizer largely because of the crop types that are grown there. The application rates in this region are also much higher than they are in the other regions of New Brunswick.

Maps 8.10 and 8.11 provide graphic evidence of the differences in both pesticide and fertilizer use for the ecoregions of New Brunswick. The magnitude of the differences in application rates is quite apparent from the varying heights of the bars presented.

Conclusion

Results from the Pilot Land Accounts for New Brunswick illustrate that the estimation techniques learned and applied in New Brunswick will have value when applied elsewhere in Canada. The large national data sets that were selected for this study were able to provide relevant land accounting information for small sub-provincial areas.

This study found that population pressures and associated land use competition that have persisted around many Canadian cities were generally absent throughout most of New Brunswick. In fact, trends indicate that more and more people are choosing to live at lower densities outside cities, in a rural setting.

From an agricultural land use perspective, the area of agricultural land operated in New Brunswick has declined, indicating that land use competition between agriculture and other uses has also declined over the last 20 years. Other findings indicate that land use intensity on remaining farmland increased because a greater and greater share of farmland was being cropped.

Environmentally stressful wide-row monoculture trends appear to be in decline, while pesticide and fertilizer application rates both increased over the 20 year study period.

The land cover picture emphasizes New Brunswick's status as a forested province. More than 95% of the province is forested. Limitations to the land cover analysis come largely from the fact that historical land cover data have not yet been utilized, making it difficult to address the important environmental change questions that are associated with changing land cover types. Future land accounting initiatives will hopefully overcome this shortfall.

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9 Valuation of Canada's Agricultural Land

by Julie McAuley

Introduction

Quality agricultural land is a scarce resource in Canada. Even though 100 million hectares out of a land area of 922 million hectares are capable of supporting any kind of agricultural production, only 45 million hectares are capable of supporting field crops, and only 4 million hectares, or 0.5% of the land area (about the size of Prince Edward Island), are considered prime agricultural land. The conservation of land for the future requires that today's land valuation take into account all the costs associated with its use.

The purpose of this paper is to outline an alternative method for valuing Canada's agricultural land. The first part examines current methods of agricultural land valuation, while the remainder outlines a new technique in which the value of land is derived from agricultural inputs and outputs. The case study deals with the province of New Brunswick and offers a first estimation based on available data.

Land in the national accounts

In the latest international guidelines on national accounting,[1] land is defined as the ground itself, with the soil and associated surface water, to the exclusion of everything else that may be related to it (buildings, crops, trees, subsoil assets, etc.). It is classified as a tangible non-produced asset and divided into broad categories, on the basis of utilization: (1) land underlying buildings and structures; (2) land under cultivation (covered by crops or timber); (3) recreational land (national parks for instance); and (4) other land (undeveloped or unexploited).

Since the SNA is a framework designed for the purposes of economic analysis, it focuses mainly on economic production and economic assets. Natural assets (i.e., land, subsoil assets, timber, water resources) are called tangible non-produced assets and are included in the balance sheet accounts when they are subject to effective ownership and are capable of bringing economic benefits to their owners. In other words, only resources which can be put to an economic use are deemed to contribute to national wealth. Environmental assets on which no property can be established, such as air or the high seas, are ignored.

Presently, in the Canadian System of National Accounts (CSNA), the only tangible non-produced asset appearing on the national balance sheet is "commercial" land, subdivided into residential, non-residential and agricultural land. The value of agricultural land is derived from farm real estate values reported to the quinquennial *Census of Agriculture*, which are then split between land and buildings. Estimates for intercensal years are based on real estate transactions of farm holdings. Public land is ignored.

In accordance with the recommendations of the 1993 SNA, Statistics Canada will incorporate natural resources in the national balance sheet, beginning with the historical revision of 1997. In the case of land, the task that lies ahead is twofold. First, there is a need to establish a value for all land presently excluded, which is mostly publicly-owned and undeveloped. Secondly, existing valuation methods must be re-examined, especially for agricultural land.

The problem is that the market value of farm real estate reported to the Census tends to reflect the potential for alternative use - usually for urban development - rather than the intrinsic value of the farmland. A valuation methodology is needed to capture this intrinsic value.

Statistics Canada's Land Account

Statistics Canada will develop a land account that will systematically classify land, by type of vegetation cover and by use. All land will eventually be valued in the land account according to its use. Statistics Canada is debating whether these values will replace the existing ones in the National Balance Sheet. A separate set of estimates will also provide values according to potential (refer to Chapter 7).

Agricultural land in Canada

The geographic distribution and value of agricultural land is far from uniform. Land uniquely suited for growing certain crops like corn, fruit, tobacco, and most vegetables (approximately 4.4 million hectares) is found mainly in southern Ontario, the Annapolis Valley in Nova Scotia and the Lower Fraser Valley in British Columbia. According to the Canada Land Inventory, 71% of the country's good land (Classes 1-3) is located in the Prairie Provinces. Roughly 87% of Canada's very best farmland (Class 1) is located within 160 kilometres of the 23 largest cities, and 57%, within 80 kilometres of these centres (Statistics Canada, 1994a; Environment Canada, 1980).

Historical statistics on the number of farms and use of farmland are presented in Table 9.1. The total area devoted to farmland has been fairly constant since the 1940s. Less farmland is being left idle, however, as the share of improved farmland has been on the increase. The number of farms has decreased from a peak of 733 thousand in 1941

1. United Nations *et. al.*, 1993; para. 10.121 (hereafter abbreviated as 1993 SNA).

Table 9.1
Farms and Farmland, 1901-1991

Year	Improved farmland: Cropland	Improved farmland: Improved pasture	Improved farmland: Summer fallow	Improved farmland: Other land[1]	Unimproved farmland	Total farmland	Number of farms	Average farm size
	million hectares						thousands	hectares per farm
1901	8.1	--	--	4.1	13.5	25.7	511.1	50.3
1911	14.4	--	1.0	4.3	24.4	44.1	682.8	64.6
1921	20.2	3.1	4.8	0.5	28.4	57.0	711.1	80.2
1931	23.6	3.2	6.8	1.1	31.3	86.0	728.6	90.6
1941	22.8	3.4	9.5	1.4	33.1	70.2	732.9	95.8
1951	25.2	4.0	8.9	1.1	31.2	70.4	623.1	113.0
1961	25.3	4.1	11.4	1.0	28.0	69.8	480.9	145.1
1971	27.8	4.1	10.8	1.0	25.0	68.7	366.1	187.7
1976	28.3	4.1	10.9	0.9	24.2	68.4	338.6	202.0
1981	30.9	4.1	9.7	1.4	19.8	65.9	318.4	207.0
1986	33.2	3.6	8.5	0.7	21.6	67.8	293.1	231.3
1991	33.5	4.1	7.9	..	..	67.8	280.0	242.1

Note:
1. Other land refers to barn yards, laneways and other unclassified lands.
Source:
Statistics Canada, Agriculture Division.

to 280 thousand in 1991. At the same time, the average farm size has increased five-fold, from approximately 50 hectares in 1901 to 242 hectares in 1991. Reasons for these changes include larger, more specialized operations (agribusiness) and increased mechanization.

As the population grows and the economy expands, more space is required for housing, transportation, recreation and industry. The buffer areas surrounding cities, commonly referred to as the rural-urban fringe, experience competing demands for land that result from urban expansion. Land values in urban fringe areas often increase due to their proximity to cities rather than from their potential as agricultural land. This growing development is driving up the market price for farmland and is causing farmland to be fragmented. The smaller fragments of land are often removed from agricultural production, due to access limitations or conflicts with residents.

Much of the information on agricultural land value comes from Statistics Canada census and survey vehicles. In the *Census of Agriculture*, the value of land used for agriculture is collected as a part of the measure of the value of farm capital. This amount refers to the market value of the farm capital employed in the production of agricultural commodities, whether owned or leased. Historical statistics are shown in Table 9.2.

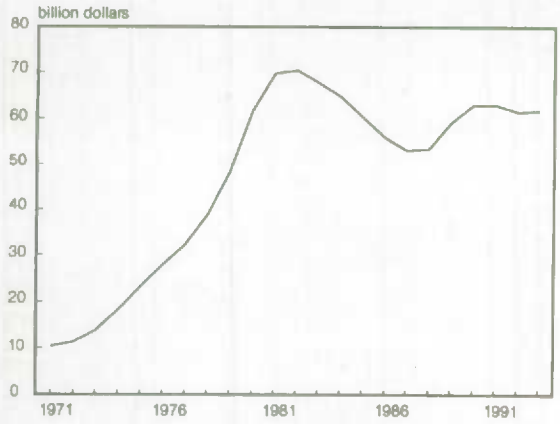
The three components of farm capital are livestock and poultry, land and buildings, and farm implements and machinery. Livestock and poultry include cattle, hogs, sheep, chickens, turkeys, mink and fox on farms. Separate estimates are made for autos, trucks and other farm machinery. The market value of land and buildings used in agricultural

Table 9.2
Value of Agricultural Capital by Province, 1971-1994

Year	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.[1]	Canada
	million dollars										
1971	..	161	205	172	2 167	6 868	2 047	5 465	5 202	1 594	**23 882**
1976	71	327	449	350	4 196	16 963	4 534	12 687	13 863	3 602	**57 043**
1981	116	702	907	669	9 513	31 286	10 463	31 355	36 855	8 532	**130 397**
1986	106	735	959	754	9 423	23 663	9 533	29 224	28 531	6 473	**109 400**
1987	116	746	992	769	9 915	23 806	9 328	27 430	27 925	6 277	**107 303**
1988	129	759	1 032	789	10 207	26 528	8 984	26 584	27 656	6 547	**109 216**
1989	143	820	1 094	811	10 782	32 297	9 564	26 745	29 984	7 140	**119 381**
1990	159	927	1 155	872	11 592	35 603	10 290	26 711	31 434	7 891	**126 633**
1991	176	938	1 149	913	11 771	37 517	10 179	25 638	30 559	8 539	**127 379**
1992	178	958	1 145	901	11 777	35 387	10 230	24 934	29 457	8 762	**123 729**
1993	180	963	1 154	905	12 173	34 727	10 661	25 253	30 293	9 843	**125 952**
1994	187	1 053	1 186	915	12 696	34 638	11 154	26 553	32 516	10 693	**131 570**

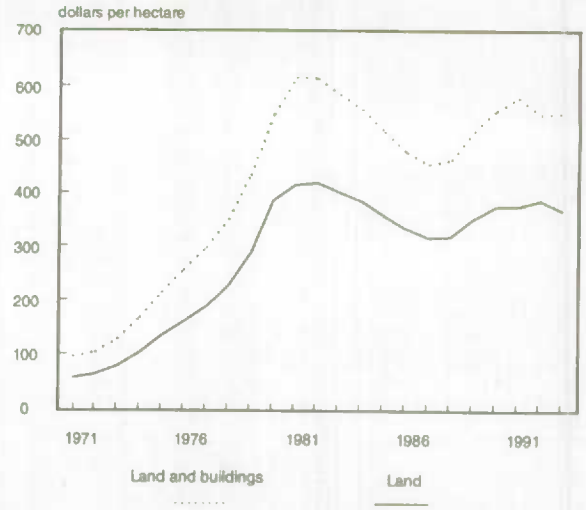
Notes:
Figures may not add due to rounding.
Farm capital includes the value of livestock and poultry, implements and machinery, and land and buildings.
1. The data for British Columbia include values for the Yukon and North West Territories.
Sources:
Statistics Canada, National Accounts and Environment Division and Agriculture Division.

Figure 9.1
Value of Agricultural Land, 1971-1993



Sources:
Statistics Canada, National Accounts and Environment Division and Agriculture Division.

Figure 9.2
Value of Land and Buildings and Value of Land per Hectare, 1971-1993



Sources:
Statistics Canada, National Accounts and Environment Division and Agriculture Division.

production is reported for holdings with minimum gross sales of $250. It covers the value of all property operated by the holding, whether owned or rented from others, and excludes the value of property rented to others. It also excludes the value of offices not located on the farm, even though these are assets of the farm holding. Current capital values of land and buildings is shown in Table 9.3. Per hectare values are shown in Table 9.4.

The total value of agricultural land has more than quadrupled since 1971 (Figure 9.1). Farmland values steadily increased during the 1970s, peaking at $70.4 billion in 1982. They have since levelled off, reaching $61.7 billion in 1993. However, in heavily populated areas like southern Ontario and southwestern British Columbia, the value of land and buildings has risen by over six hundred percent. In the vicinity of some urban centres, value changes of over two thousand percent have been reported for some farms. Such increased land values make entry into farming prohibitively expensive for new farmers, as increases in agricultural land value and farm purchase prices are typically unmatched by commensurate increases in food prices.

The per-hectare value of agricultural land is shown in Table 9.5. Figure 9.2 shows the value per hectare of agricultural land versus that of land and buildings.

Pilot test area: New Brunswick

Agriculture in Canada occupies a vast area and is very diversified. In order to test a method for land valuation, it is important to choose an area of suitable size and with a variety of characteristics. New Brunswick was chosen for the agricultural land valuation project because of its manageable size (less than 1% of the country's total area) and its diverse mix of land cover and use. Its agriculture industry is sufficiently strong and diversified.

Agricultural land valuation

The farmland values shown in Tables 9.3 to 9.5 are based on the values reported for land and buildings to the *Census of Agriculture*. These values reported by farmers include a speculative element and do not reflect inherent resource quality or the costs associated with using the land resource (i.e. pollution and degradation). To overcome these shortcomings, an alternative approach using the concept of economic rent was employed to value agricultural land.

The use of resources to satisfy human needs has both positive and negative impacts on the environment. These interactions are outlined in Text Box 9.1 and can be related to agricultural production. They are, however, difficult to measure in the context of agriculture because of the many complex externalities. In theory, the summation of the positive and negative effects of the four types of interactions should yield a value of agricultural land in which environmental impacts are considered. For the purposes of this paper, the *environmental hazards and risks* are not

Table 9.3

Value of Agricultural Land and Buildings by Province, 1971-1994

Year	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.[1]	Canada
						million dollars					
1971	..	102	132	107	1 322	5 183	1 374	3 868	3 530	1 293	**16 912**
1976	59	218	312	232	2 718	13 822	3 208	9 298	10 628	3 052	**43 547**
1981	94	479	633	444	6 224	25 299	7 836	25 048	29 961	7 261	**103 278**
1986	78	490	655	489	5 951	17 972	6 584	21 830	20 774	5 264	**80 088**
1987	87	498	678	496	6 194	17 842	6 222	19 649	19 744	4 955	**76 367**
1988	97	506	703	503	6 384	20 481	5 817	18 863	19 159	5 186	**77 698**
1989	107	545	757	520	6 776	26 064	6 266	18 882	21 092	5 704	**86 713**
1990	119	646	813	562	7 366	29 127	6 864	18 807	22 169	6 412	**92 883**
1991	133	656	801	599	7 781	31 022	6 814	17 589	21 291	7 038	**93 724**
1992	134	683	793	588	7 820	28 973	6 814	16 745	20 312	7 242	**90 104**
1993	135	676	785	576	7 929	27 998	7 005	16 474	20 170	8 045	**89 796**
1994	139	775	777	569	8 191	27 448	7 236	17 482	21 441	9 011	**93 068**

Notes:
Figures may not add due to rounding.
Reflects the value of all farm land, including pasture and unimproved land, plus the value of farm houses, buildings, and other structures.
1. The data for British Columbia include values for the Yukon and North West Territories.
Sources:
Statistics Canada, National Accounts and Environment Division and Agriculture Division.

Table 9.4

Value of Agricultural Land and Buildings per Hectare by Province, 1971-1994

Year	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.[1]	Canada
						dollars per hectare					
1971	..	326	247	198	301	803	178	146	175	549	**247**
1976	1 616	736	650	499	677	2 207	418	351	526	1 245	**635**
1981	2 800	1 693	1 359	1 006	1 646	4 188	1 013	944	1 483	2 943	**1 520**
1986	2 145	1 796	1 574	1 196	1 636	3 183	850	820	1 006	2 184	**1 181**
1987	2 259	1 846	1 646	1 233	1 722	3 183	803	736	954	2 056	**1 127**
1988	2 382	1 895	1 720	1 273	1 796	3 679	751	707	924	2 157	**1 147**
1989	2 511	2 063	1 671	1 339	1 930	4 715	811	707	1 016	2 377	**1 280**
1990	2 646	2 469	2 026	1 470	2 123	5 305	887	702	1 067	2 676	**1 371**
1991	2 807	2 535	2 016	1 594	2 268	5 691	882	655	1 023	2 941	**1 384**
1992	2 750	2 666	2 016	1 594	2 308	5 352	882	623	976	3 032	**1 329**
1993	2 696	2 666	2 016	1 594	2 367	5 209	907	610	969	3 375	**1 327**
1994	2 696	2 965	2 016	1 594	2 474	5 142	937	645	1 028	3 788	**1 374**

Notes:
Reflects the value of all farm land, including pasture and unimproved land, plus the value of farm houses, buildings, and other structures.
Values are held constant in some years for some provinces when survey results indicate virtually no change.
1. The data for British Columbia include values for the Yukon and Northwest Territories.
Sources:
Statistics Canada, National Accounts and Environment Division and Agriculture Division.

Table 9.5

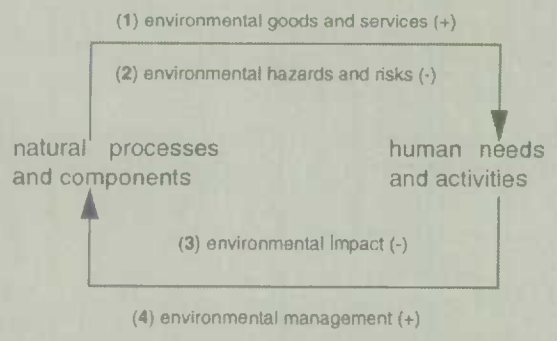
Value of Agricultural Land per Hectare by Province, 1971-1994

Year	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.[1]	Canada
						dollars per hectare					
1971	..	131	79	82	121	390	126	111	124	334	**151**
1976	860	383	252	257	341	1 191	306	277	371	736	**405**
1981	1 661	993	586	573	872	2 313	764	756	1 070	1 693	**1 028**
1986	1 527	1 176	749	744	922	1 873	660	662	741	1 231	**825**
1987	1 609	1 208	786	766	971	1 873	623	598	702	1 159	**783**
1988	1 695	1 240	818	791	1 013	2 160	588	573	680	1 213	**788**
1989	1 787	1 352	939	833	1 087	2 768	628	573	746	1 339	**872**
1990	1 885	1 616	964	912	1 196	3 114	687	568	786	1 507	**929**
1991	1 999	1 661	959	991	1 280	3 341	684	531	754	1 656	**932**
1992	1 957	1 747	959	991	1 302	3 311	684	504	719	1 708	**959**
1993	1 920	1 747	959	991	1 334	3 314	702	494	714	1 900	**912**
1994	1 920	1 942	959	991	1 490	3 020	726	524	756	2 182	**993**

Notes:
Values are held constant in some years for some provinces when survey results indicate virtually no change.
1. The data for British Columbia include values for the Yukon and Northwest Territories.
Sources:
Statistics Canada, National Accounts and Environment Division and Agriculture Division.

Text Box 9.1

Interrelations between Human Activity and the Environment



The four identified interactions have either a positive or negative effect on the system. The use of *environmental goods and services* benefits human needs and activities in a positive manner. *Environmental hazards and risks*, such as droughts, storms, floods, earthquakes, etc., negatively affect humans. Through numerous activities involving physical, chemical and biological elements, humans negatively affect the natural environment, through the *environmental impact* function. On the other hand, humans can undertake management processes which enhance the environment, through the *environmental management* function.

We can relate this to economic rent by essentially summing the positive and negative effects of each interaction (outlined above) as shown below:

Rent = (1)+(2)+(3)+(4)

Source:
de Groot, 1992, p. 8.

addressed. The *environmental management practices* are reflected in the model in theory, but left out in practice due to data limitations.

Economic rent is the return to a factor of production, or essentially the profit which relates to the use of the resource in production. By classifying the inputs to and the outputs of agricultural production according to the framework in Text Box 9.2, it is possible to estimate an economic rent associated with land in agricultural production.

Methodology

In the case of agricultural production, the difference between outputs and inputs can loosely be considered rent, as shown below:

(a) Outputs - Inputs = Rent

Text Box 9.2

Outputs and Inputs (Market and Non-market) Associated with Agricultural Production

Outputs:

Market production: grains, vegetables, fruits, cattle, poultry, eggs, dairy products, lambs, goats, animal products, plants products, etc.

Positive non-market outputs: farm income in kind, environmental amenities, scenic amenities, land preservation, rural lifestyle, etc.

Negative non-market outputs: fertilizer and manure runoff, soil erosion and sedimentation, water and air pollution, reduction in soil productivity, etc.

Inputs:

Market goods and services: seeds, animal feed, tools, machinery, fuel, electricity, insurance, veterinary care, quotas, labour, etc.

Non-market resources: air, water, time (associated with the opportunity cost of labour), etc.

Farm management irrigation and drainage, contour tillage, crop rotation, cover crops, salinity control. monoculture, summerfallowing, etc.

Note:
The list is not meant to be exhaustive.

Outputs are defined to include all tangible products, as well as the environmental amenities and pollution externalities associated with agricultural production. Inputs are defined to include the market inputs which are paid for, free resources such as air, rain, water and the soil's mineral resources as well as farm management practices. Some of these outputs and inputs are difficult to measure, as can be seen from the sample list in Text Box 9.2. The return to land, or economic rent associated with the land, is equal to difference between the outputs and inputs.Theoretically, if the market value of land reflected the complete social and economic value of the land, then the present value of equation (a) over time would be close to the market value of the land.

Some economic data are readily available for the inputs and outputs. Equation (b) below represents the subset of (a) which can be easily measured:

(b) Revenues - Expenditures = Profits

Revenues include proceeds from sales and other revenues such as rental income, insurance proceeds, quota sale income, and recaptured capital consumption allowances. Expenses include all expenses incurred in the production of

crops, livestock and other agricultural products, as well as general costs such as insurance and wages.

Since the focus of this research is to isolate a return to agricultural land, the value for profit calculated by deducting the expenses from revenues (as identified above) represents only a first step. The set of expenses must be expanded to include those for improvements to the land (e.g., irrigation and drainage systems). The capital cost allowances for buildings and machinery must also be included as they represent a return to the non-land portion of farm capital. Interest payments for loans to purchase or improve the farm must also be deducted from revenue so that what remains as profit is an estimate of the return to the land or economic rent associated with the land.

For the same reason, certain variables should be excluded from the rent equation, namely, subsidy program payments received by the farmer and income and expenses not related to agricultural production. All revenue and expense variables taken into account in the rent equation are listed in Text Box 9.3.

Data requirements

The theoretical model proposed in this paper underscores the importance of both physical and monetary data. Monetary data come from the Taxation Data Program (TDP) of the Whole Farm Data Base (WFDB) (Agriculture Division, Statistics Canada). The TDP consists of a sample of approximately 70 thousand income tax records. The sampling frame covers all provinces and includes all individuals who claim either a positive gross farm income or a non-zero net farm income. Research stations, institutional farms, Hutterite colonies and Indian Reserves are excluded.

The TDP contains detailed information on operating revenues and expenses, additions and disposals of depreciable assets, and off-farm income of farm operators and their families (Statistics Canada, 1994c). The information comes from two sources - a random sample of unincorporated income tax filers (taken from the Self-Employment File for Agriculture) and a random sample of incorporated farm holdings with annual sales over $25 000.

In the WFDB, New Brunswick farms are divided into seven types typically found in the province - dairy, cattle, hogs, poultry, potato, fruit and vegetable, and other - and seven revenue classes. The information is further split between the four *Census of Agriculture* Regions (CARs) of New Brunswick. Confidentiality constraints precluded the calculation of estimates by region.

The model was implemented for 1991, the last available census year.

Text Box 9.3

Variables and Underlying Methodology of Land Valuation Equation

Revenues include:

(1) *Proceeds from sale of:*

a) grains and oilseeds: wheat, oats, barley, canola, soybeans, corn, other small grains, other grains and oilseeds.

(b) *Other crops*: potatoes, fruits and vegetables, tobacco, greenhouse and nursery products, forage crops, other crops, unspecified crops.

(c) *Livestock and livestock products*: cattle and semen, swine, poultry and eggs, sheep and goats, dairy products, other livestock products.

(2) *Other revenue*[1]: custom work and machine rental, rental income, insurance proceeds, forest and maple products, cash advances (net).

(3) *Income adjustments:* quota sale income, capital cost allowance recaptured, inventory adjustments, excluding income from the sale of non-farm products.

Expenses include:

(1) *Crop expenses:* fertilizer, lime, pesticides, seed and plants, containers, twine, baling wire, etc.

(2)*Livestock expenses:* animal purchases, feed, supplements, veterinary, medicine and breeding fees, etc.

(3) *Machinery expenses*: small tools, repairs, licenses, insurance, machinery, truck and auto expenses.

(4) *General expenses:* salaries, rent, insurance, phone, electricity, fuel, property tax, building and fence repairs, marketing, miscellaneous expenses.

(5) *Expense adjustments:* clearing and improving land, inventory adjustments, capital cost allowance (depreciation and estimated return on investment in fixed capital) interest payments on mortgage and improvement loans.

If only revenues and expenses associated with agricultural production are taken into account, including an estimated return on investment in fixed capital, the difference between the two is the intrinsic value, or rent, of agricultural land:

Revenues less Expenses = Land Rent

Note:
1. This excludes both *program payments* and *miscellaneous revenues*. Program payments include stabilization payments such as Net Income Stabilization Account (NISA), Gross Revenue Insurance Program (GRIP), Special Grains Programs, Christmas tree grants, subsidies other than dairy, and other payments and reimbursements. Miscellaneous revenues include GST refunds, horse racing income, etc.

Results

The results of the two methods of valuing New Brunswick's agricultural land for 1991 are dramatically different:

i) The value of agricultural land estimated on the basis of farm real estate values reported to the *Census of Agriculture* is **$371.6 million**.

ii) The present value of rent on land estimated with the model (discounted at a 5% interest rate over a 25 year period) is **$5.5 million**.

The first estimate, which is presently incorporated in the national balance sheet, is over sixty times larger than the alternative one based on rent. The large discrepancy between the two can be attributed to several factors.

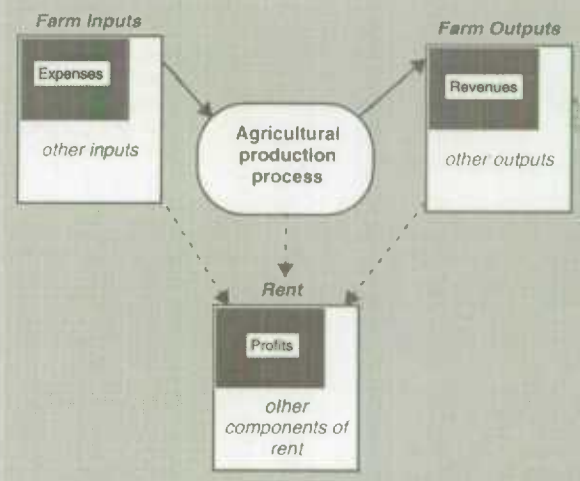
First, farm income was abnormally low in New Brunswick in 1991, and this depressed the model results. The difference would likely have been smaller if another year's farm income or an average of many years had been used instead. However, this will account for only part of the difference.

Second, the real estate values reported to the Census reflect the proximity to urban areas. The value of farms close to urban areas is driven up by the need of cities for additional land. Also, farm ownership is a long-term investment. The farmer expects to sell or liquidate his farm at a value that has appreciated over time. This will influence the property value he reports to the Census. The model purposely excludes these factors.

Third, as shown in Text Box 9.2, there are several inputs and outputs associated with agricultural production which cannot be measured, either because they are not traded in the market place or data are simply unavailable. The inputs (that is, farm expenses) and outputs (that is, farm revenues) used in the model – represented by the shaded portions of the boxes in Text Box 9.4 – are only a subset of the actual inputs and outputs of agricultural production. The profit used as a proxy for rent to land is derived from this subset and is also a subset of the actual rent. If the model were based on a more complete set of inputs and outputs, the rent would be more comprehensive.

There are more outputs than inputs which are difficult to measure with market scenarios, for example, the socio-economic benefits associated with agriculture. Inputs are typically more measurable, although items such as agricultural management practices may be hard to quantify in an economic framework. Data are available, however, at both the provincial and regional levels on farm participation in certain agricultural practices. Although difficult to integrate in the model, participation in these practices is known to change the value of agricultural land.

Text Box 9.4
Illustration of the Model



Note:
This diagram is not intended to represent the magnitude of undercoverage in the model.

Conclusion

The purpose of this paper was primarily to develop a model for land valuation. The benefits were twofold: (1) a preliminary estimate of the rent, or value, associated with land employed in agricultural production, and (2) an indication of data needed to ensure that the model yielded a representative value for agricultural land.

The model determined land rents by relating revenues and expenses to the inputs and outputs associated with agricultural production. Although the results were much lower than those based on the *Census of Agriculture*, they are conceptually more compatible with the definition of economic rent.

There are a number of factors which affect the value of land employed in agricultural production, some of which are either immeasurable or not currently measured. However, estimates could be developed to reflect the value of the land as a resource employed in production. An example would be the information on soil conservation practices found in the Environment Information System. In the future, the EIS may be used to develop meaningful data which could be added to the model. Data for additional years and more complete estimates of social and environmental costs and benefits would also enhance the reliability of the model.

The agricultural land valuation initiative should now focus on developing statistics to fill the information gaps. The model should also be applied to other provinces.

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10 Canada's Commercial Fishery: A Statistical Profile

by Dale Austin[1]

Introduction

Canada's natural resources include forests, sub-soil deposits, abundant and varied land and water types, fish and other wildlife. Produced assets, such as roads or machinery, are taken into consideration for the calculation of national wealth but, with the exception of some of Canada's land, natural resources are currently left off the balance sheet.

In recent years, there has been an increased awareness of the social and economic costs associated with utilizing natural resources. The failure of economic indicators such as Gross Domestic Product (GDP) to take account of environmental quality issues has been criticised. Part of the solution to these issues is to measure the effects of human and economic activity on the environment by explicitly including the value of natural resources and their depletion as part of the national balance sheet.

A physical stock account for the fishery would include population counts for all economically important species in a given geographic location for any year. Monetary accounts would show the value of the stocks and harvest. The stock value would be included in Canada's balance sheet as part of the nation's wealth. The stock that is relevant to national wealth is what is considered an economic asset, the part which can be "owned" by Canada and which is economically exploitable.

Physical stock data

Ideally, a physical account for the fishery would provide population estimates for all species. However, population estimates are sporadic at best. There is a lack of comprehensive, systematic quantitative data relating to productivity, biotic composition, disease outbreaks and contaminants for all species. There is a scarcity of long-term indicators as data gathering has been restricted to specific regions and/or short-term studies. Canadian scientists do not have the technology or resources to regularly study the many species of aquatic life that inhabit Canada's vast oceanic and fresh water territory. When counts do exist they are often separated by many years and occur in different years for different species.

In general, there are abundant and high quality data for fish harvests but a lack of data reporting the status of Canada's fish stocks. More frequent and reliable stock data, ideally for all species but most significantly for commercial species, would allow the development of time-series data and the ability to identify trends in stock status. A more complete set of fisheries statistics would allow a more comprehensive examination of the status of the fishery.

Table 10.1 illustrates the fluctuations in harvest volume of the Canadian fishery for the period 1961-1994. The steady decline in the catch between 1971-1974 can be explained to some extent by implementation of total allowable catch (TAC) restrictions in an effort to reduce the harvest and preserve fish stocks. Some of the increase that begins in 1977 can be attributed to the extension of Canada's Exclusive Economic Zone to the present 200-mile limit. The sharp decline in harvests in the last four years represents the decline of the groundfish stocks off Canada's east coast.

Economic trends in the fishery industries

Resource rent

The concept of rent is the basis of valuation of a natural resource. Rent is the value of the resource itself, the residual left when all the costs of bringing the resource to a market are subtracted from the selling price. The annual rent earned by the fishery can be used to estimate the value of the resource stock. The stock could be valued as an asset which will provide an indefinite flow of rent in the future. The value would be the present value of the future rent. This method in effect assumes that the annual harvest rate on which the rent calculation is based can be sustained, although recent history in the Canadian fishery has shown that harvest levels have not been sustainable. Using such a method would overestimate the value of the asset.

Due to the lack of detailed data, calculating a value based on the characteristics of the fish stocks is impractical. Instead, a rent residual has been calculated using annual historical data for the fishing and trapping industry. GDP includes all costs (labour cost and capital cost allowance) as well as a return to entrepreneurship and to the resource. Depreciation and profit are not calculated separately, but are part of industry's operating surplus. A residual rent calculation, subtracting estimated data for depreciation and a return to capital from the industry surplus time series at the national total level, gave results that were judged unacceptable. A rent residual was also calculated for the year 1990 by province. This calculation showed that a low national aggregate was made up of negative and positive provincial

1. The author would like to thank Gerry Gravel, Rob Smith, Alice Born and Rick Moll for their patience and guidance in the preparation of this paper.

Table 10.1

Ocean Fishery Harvest by Province, 1961-1994

	Newfoundland		Prince Edward Island		Nova Scotia		New Brunswick		Quebec		British Columbia		**Canada**	
Year	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	**Quantity**	**Value**
1961	253 469	14 922	17 947	4 489	253 185	27 741	70 035	7 625	53 694	4 228	297 000	39 700	**945 330**	**98 705**
1962	276 719	17 454	18 584	4 649	262 073	32 063	95 767	9 038	65 495	5 170	319 800	49 100	**1 038 440**	**117 474**
1963	295 218	20 423	18 789	4 625	267 379	36 228	111 020	9 287	84 915	5 623	357 700	40 500	**1 115 020**	**116 686**
1964	289 348	22 873	20 598	5 751	309 667	42 436	119 248	10 263	64 754	6 132	332 300	48 400	**1 135 920**	**135 855**
1965	303 796	24 101	23 514	7 083	354 207	49 371	136 182	10 546	70 860	6 458	294 100	47 500	**1 182 660**	**145 059**
1966	332 680	26 575	28 434	6 504	404 446	49 456	159 471	11 067	70 259	6 939	271 500	60 700	**1 266 790**	**161 241**
1967	383 613	28 922	22 163	8 187	380 677	48 211	183 243	10 838	90 971	7 417	159 800	49 600	**1 200 470**	**153 175**
1968	465 626	28 843	24 428	8 571	429 024	54 601	250 356	15 564	98 105	8 148	131 100	57 400	**1 398 640**	**173 127**
1969	484 743	30 786	25 274	8 832	364 757	56 529	235 643	15 874	97 132	8 712	88 400	47 400	**1 295 950**	**168 133**
1970	471 846	36 123	48 909	11 174	320 790	55 557	206 768	17 639	125 646	10 914	117 000	60 300	**1 290 960**	**191 707**
1971	418 866	36 811	46 923	10 361	347 559	59 433	165 868	16 089	115 528	10 559	113 400	58 600	**1 208 140**	**191 853**
1972	315 512	36 512	28 214	10 136	338 305	67 949	161 214	19 810	87 989	10 716	162 300	75 100	**1 093 530**	**220 223**
1973	324 686	47 877	30 312	12 414	328 019	75 972	130 532	22 041	74 929	12 755	183 800	130 400	**1 072 280**	**301 459**
1974	249 605	42 874	17 715	12 031	344 475	81 166	112 431	21 852	56 777	13 650	141 100	101 000	**922 103**	**272 573**
1975	255 576	45 785	16 313	12 416	356 457	92 648	120 496	25 327	56 503	14 643	133 000	79 700	**938 345**	**270 519**
1976	339 211	64 716	17 134	12 719	367 883	106 686	114 709	24 838	41 955	15 131	180 900	141 800	**1 061 790**	**365 890**
1977	392 786	85 479	19 801	15 164	407 074	133 145	129 117	34 069	54 296	20 377	204 350	167 905	**1 207 420**	**456 139**
1978	483 959	118 364	25 660	23 376	444 869	195 388	151 393	49 616	67 350	29 255	198 703	252 192	**1 351 930**	**668 191**
1979	569 107	159 258	31 059	29 377	421 154	225 527	137 217	53 620	79 165	40 017	155 276	332 468	**1 392 980**	**840 267**
1980	499 199	161 286	33 463	26 772	436 822	510 075	105 356	48 575	81 248	41 870	129 926	182 281	**1 286 010**	**970 859**
1981	498 721	170 765	38 515	31 786	467 473	264 124	102 257	54 586	87 591	46 790	183 137	236 181	**1 377 690**	**804 232**
1982	504 458	176 287	36 788	35 841	460 792	259 593	109 001	67 067	86 593	50 387	157 843	240 010	**1 355 480**	**829 185**
1983	455 839	167 419	40 424	42 926	425 854	276 512	107 919	79 375	78 403	55 952	191 543	209 787	**1 299 980**	**831 971**
1984	450 583	..	54 300	..	402 778	..	99 130	..	83 877	..	166 906	..	**1 257 570**	**..**
1985	468 693	..	54 582	..	466 341	..	136 024	..	90 189	..	214 934	..	**1 430 760**	**..**
1986	515 998	..	60 264	..	462 787	..	143 204	..	89 973	..	225 889	..	**1 498 120**	**..**
1987	499 727	..	56 723	..	493 442	..	151 595	..	97 277	..	251 531	..	**1 550 300**	**..**
1988	554 414	292 096	57 909	68 997	514 474	436 904	151 668	118 411	88 231	99 193	271 304	533 559	**1 638 000**	**1 549 160**
1989	506 724	245 310	34 432	62 918	463 603	437 805	150 844	97 457	79 098	82 491	284 036	453 664	**1 518 740**	**1 379 650**
1990	537 369	279 516	43 009	45 567	449 725	444 868	153 108	91 929	74 330	74 140	301 293	478 192	**1 558 830**	**1 414 210**
1991	426 829	261 378	49 037	69 118	503 009	495 474	116 780	96 324	73 870	85 487	310 282	405 740	**1 479 810**	**1 413 520**
1992	280 539	199 121	47 330	79 715	491 460	511 572	126 059	104 850	70 425	88 881	292 991	416 126	**1 308 800**	**1 400 270**
1993	226 688	..	32 985	..	400 930	..	115 482	..	58 307	..	275 081	422 463	**1 109 470**	**..**
1994	133 511	..	32 372	..	307 999	..	124 754	..	48 006	..	137 626	..	**784 268**	**..**

Notes:
All quantities are expressed in tonnes.
All values are expressed in thousand dollars.
Sources:
Department of Fisheries and Oceans Canada, Biological Sciences and Industry Development and Programs directorates.

components. This indicates that while the rent value may be low in aggregate at the national level, there could be regions where the fishery rents are relatively important. The provincial calculation was based on the same data as the national calculation and so, it too was considered unacceptable.

A low or zero rent value for fish resources would not be unexpected. In the absence of (worldwide) regulation, common property resources can be exploited to the point where the market price of the resource falls below the full cost of exploitation. A time series of the value of Norway's fish stocks was recently estimated as consistently near zero (Statistics Norway, 1995). A study by the Economic Council Of Canada concluded:

> If the administration costs associated with the Canadian fishery are subtracted it would be difficult to conclude that the net Canadian wealth generated annually by the regulated fishery is even positive. There is no compelling evidence that the Canadian fisheries, taken together, yield a net surplus. In short, the potential wealth of the Canadian fishery has been dissipated (Scott and Neher, 1981; p. 26).

Value added

The fishing industry contributes directly and indirectly to the Canadian economy in a variety of ways. Harvesting, transportation, processing and other margins related to both fish and fish products all contribute to employment and GDP. Statistics Canada defines two industries related directly to fishing in its Standard Industrial Classification: the fishing and trapping industry and fish products industry. The fishing and trapping industry's value added (contribution to GDP) was approximately $1 billion in 1993, while that of the fish products industry was just under 800 million (Table 10.2).

Together these industries represented about 0.35% of total GDP in 1993. This percentage was lower than it had been at some points in the past however. Figure 10.1 shows a decline of these industries as a percentage of GDP between 1961 and 1993 from around 0.75% in the early 1960s to the 0.35% just mentioned. The lowest point in the time series came in 1975, when these industries' share of GDP was just 0.27% Since that time, their share has fluctuated between 0.31% and 0.35%.

Employment

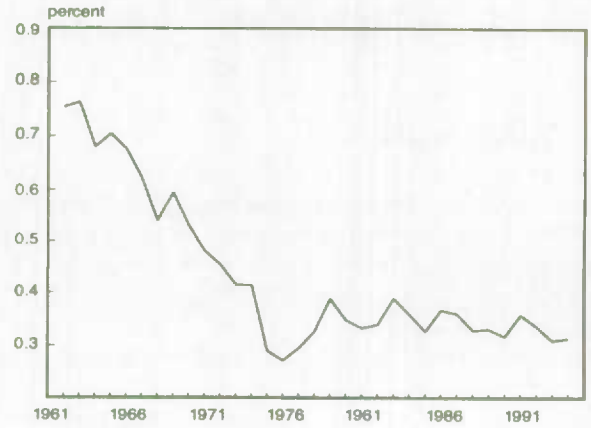
In 1993, total Canadian employment was close to 13 million persons. In the same year, there were approximately 62 thousand people employed in the fishing industries, representing about 0.48% of the work force. This was essentially

Table 10.2
Fishery Industries - Employment and Value Added, 1961-1993

	Employment			Value added		
Year	Fishing and trapping industry	Fish products industry	Total	Fishing and trapping industry	Fish products industry	Total
	workers			million 1986 dollars		
1961	16 223	..	..	772	502	1 274
1962	19 426	..	..	799	582	1 381
1963	22 396	..	..	780	515	1 296
1964	23 047	..	..	788	643	1 431
1965	20 039	..	..	741	724	1 466
1966	23 118	..	..	821	618	1 439
1967	22 125	..	..	752	537	1 289
1968	22 135	..	..	926	565	1 491
1969	18 891	..	..	750	654	1 404
1970	18 174	19 254	37 428	761	526	1 307
1971	20 149	18 510	38 659	725	579	1 304
1972	20 157	20 100	40 257	666	598	1 264
1973	22 848	21 424	44 272	678	678	1 357
1974	21 564	18 774	40 338	575	418	993
1975	21 138	16 987	38 123	536	420	956
1976	19 622	19 568	39 190	610	488	1 098
1977	19 834	21 937	41 771	722	538	1 260
1978	23 257	25 231	48 488	785	782	1 567
1979	29 175	27 995	57 170	706	752	1 458
1980	33 588	27 084	60 672	728	690	1 417
1981	35 076	27 486	62 562	834	662	1 496
1982	33 115	25 382	56 497	900	762	1 662
1983	36 240	24 577	60 817	852	727	1 580
1984	32 848	24 372	57 220	777	753	1 530
1985	33 161	26 964	80 125	945	854	1 800
1986	36 637	28 934	65 571	980	846	1 826
1987	37 044	31 171	68 215	886	852	1 738
1988	41 562	31 086	72 648	946	889	1 836
1989	39 751	30 496	70 249	1 023	780	1 803
1990	41 219	27 617	68 836	1 129	898	2 027
1991	43 721	25 643	89 364	1 023	849	1 873
1992	38 271	24 409	82 680	992	747	1 739
1993	40 157	21 839	61 996	1 020	779	1 799

Note:
Figures may not add due to rounding.
Source:
Statistics Canada, National Accounts and Environment Division.

Figure 10.1
Fishery Industries' Share of GDP, 1961-1993



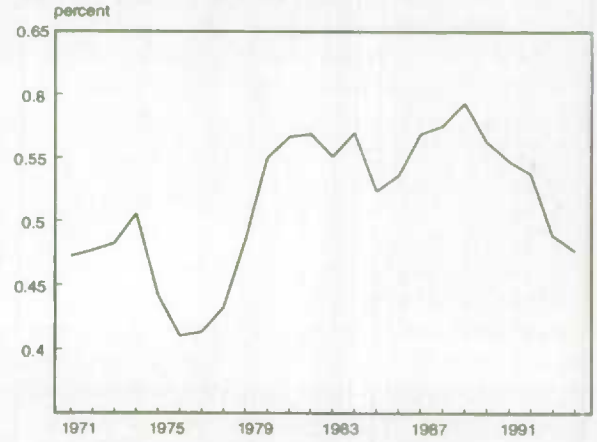
Source:
Statistics Canada, National Accounts and Environment Division.

the situation that existed in 1970 as well, when 37.5 thousand people, or about 0.47% of the total work force, earned their living from these industries (Table 10.2). Figure 10.2 shows employment in these industries as a percentage of the employed work force for the period 1970-1993. As was noted above with respect to value added, the percentage of the total employment represented by the fisheries industries declined to its lowest value (0.41%) in 1975.

Imports and exports

Canada is a net exporter of fish products. During the period 1971-1993, the value of fish product exports was consistently 3-5 times higher than the value of imports. Put in the context of the nation's total external trade, fish products represented a substantial 1.6% of merchandise exports in

Figure 10.2
Fishery Industries' Share of Total Employment, 1970-1993



Source:
Statistics Canada, National Accounts and Environment Division.

1971. This figure had dropped only slightly to 1.5% by 1993. Over the period 1971-1993, fish product exports as a percentage of total merchandise exports peaked at 2.3% in 1987; their smallest export share, 1.3%, occurred in 1974 and 1975 (Table 10.3).

Aquaculture[1]

In an effort to mitigate the effects of resource depletion in the traditional fishery, some fishers have been turning to aquaculture as a viable alternative source of income. As fisheries world-wide reach their catch limits there will be increased pressure to find new sources of fish. The unpredictable rise and fall of fish stocks from season to season, as well as the long-term decline in some species, has led to aquaculture as an attempt at ensuring an alternative, sustainable supply of fish.

Table 10.3
Imports and Exports of Fish Products, 1971-1993

	Exports		Imports	
Year	Total	Percentage of total merchandise exports	Total	Percentage of total merchandise imports
	million dollars	percent	million dollars	percent
1971	276	1.6	60	0.4
1972	340	1.7	81	0.4
1973	484	1.9	110	0.5
1974	418	1.3	119	0.4
1975	451	1.3	134	0.4
1976	590	1.5	182	0.5
1977	795	1.8	220	0.5
1978	1 111	2.1	248	0.5
1979	1 271	1.9	310	0.5
1980	1 265	1.6	354	0.5
1981	1 494	1.8	360	0.5
1982	1 591	1.9	352	0.5
1983	1 564	1.7	417	0.6
1984	1 595	1.4	488	0.5
1985	1 849	1.6	494	0.5
1986	2 554	2.1	613	0.6
1987	2 906	2.3	691	0.6
1988	2 841	2.1	679	0.5
1989	2 564	1.8	738	0.5
1990	2 624	1.8	679	0.5
1991	2 455	1.8	736	0.5
1992	2 504	1.6	777	0.5
1993	2 650	1.5	996	0.6

Source:
Statistics Canada, International Trade Division.

Aquaculture is the managed rearing of aquatic organisms including fish, molluscs, crustaceans and plants. The process requires regular intervention in the rearing process to enhance production. Interventions include regular stocking, feeding and protection from predators (Department of Fisheries and Oceans, 1995).

Commercial aquaculture takes place in all 10 provinces and the Yukon territory. In 1994, over four thousand aquaculture sites were in operation across the country. The principal species produced by the industry are salmon, trout, mussels and oysters. Atlantic salmon, mussels, quahogs and steelhead trout (salmo gairdneri) are farmed primarily in the Atlantic provinces. Trout production is concentrated in the central provinces (mainly Ontario), salmon and oyster production primarily in British Columbia and New Brunswick, and mussel production off Prince Edward Island.

Over the past decade, the relative importance of aquaculture has been steadily increasing in the fishing industry. The aquaculture industry grew from a $13 million business in 1983 to nearly $300 million in 1994 (Table 10.4). In 1992, the industry represented roughly 3.5% of the total harvest of the traditional fishery and almost 18% of the total landed value. Despite these gains, aquaculture remains relatively small when compared with the traditional fishery. The total harvest of the traditional fishery at its peak in 1990 was more than 40 times the size of the aquaculture harvest in that year. However, we now know that harvest levels in some of the traditional fisheries were unsustainable; aquaculture's importance seems likely to grow as a result.

Factors often cited as retarding the growth of aquaculture in Canada are our cold-water environment and the abundant wild fishery resources available, notwithstanding the apparent shortages of Atlantic groundfish and Pacific salmon. Inadequate treatment of municipal and industrial wastes can also pose a threat to a viable aquaculture industry in certain regions (Department of Fisheries and Oceans, 1995).

Conclusion

The attempt at valuing Canada's fish stocks made for this study indicates a very small contribution to wealth at the na-

Table 10.4
Aquaculture Production, 1983-1994

Year	Quantity	Value
	kilotonnes	thousand dollars
1983	5.7	12 551
1984	6.9	18 247
1985	8.4	23 724
1986	10.5	35 106
1987	13.9	61 669
1988	21.5	105 355
1989	30.3	139 137
1990	38.5	195 955
1991	44.6	257 087
1992	46.9	259 957
1993	50.4	289 274
1994	53.6	296 878

Source:
Davies, 1996.

1. Unless otherwise noted, this section is drawn from Statistics Canada (1994; p. 268-269).

tional level. It appears though that these stocks do contribute significantly to regional economic wealth on the east and west coasts. Without improved data on which to base the estimates, nothing more than these qualitative statements is possible.

The other economic indicators presented in this chapter point to a small but stable contribution by the fisheries to economic life in Canada. The landed value of the ocean fishery harvests has grown considerably over the last three decades, although recent years have seen declines in both Newfoundland and British Columbia. The share of GDP represented by the fishing industries was considerably smaller in the early 1990s than it had been 30 years previous, though most of this decline took place before 1975. Between 1975 and 1993, the share of GDP represented by these industries was quite stable. The latter is also mainly true of their share of employment and of the export share held by fish products. The aquaculture industry stands in stark contrast to this constancy, having shown remarkable growth since the early 1980s.

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Annex 1: Selected Environment Statistics for Canada, Mexico and the United States

Table A1.1

Selected Population, Economic, Waste and Natural Resource Statistics, 1993

Characteristic	Source	Canada	Mexico	United States
Total area (thousand km^2)	g	9 971	1 958	9 373
Land area (thousand km^2)	b,g	9 215	1 953	9 167
Population (thousands)	c,m	28 947	91 210	257 908
Population growth rate 1988-1993 (annual percent)	i	1.2	2.2	1.0
Population density (persons per km^2)	b,c,g	3.1	46.7	28.1
Urbanization (percent)[1]	k	78.1	75.3	76.2
Life expectancy[2] (years)	k,n	78.0	70.3	75.9
Males	a,n	74.9	69.7	72.8
Females	a,n	81.0	77.1	79.7
Infant mortality (per 1000 live births)	i,n	6.3	35.4	8.6
Literacy rate[3] (percent)	b,h	99.0	87.1	99.0
Male	k	99.0	90.0	99.0
Female	k	99.0	85.0	99.0
Expenditures on education[4] (percent of GDP)	b,j	6.1	6.2	6.3
Economy				
GDP (million C$)[5]	d,f	705 952	466 877	8 075 271
GDP, PPP method (million C$)[6]	d,f	704 340	802 998	7 887 474
Average annual GDP growth 1981-93 (percent)	d	2.2	1.3	2.5
GDP per capita, PPP method (thousand C$)[6]	c,d	24 332	8 804	30 583
GDP distribution by sector (percent)[7]				
Agriculture and mining[8]	e	5.3	8.2	3.5
Manufacturing and utilities[9]	e	20.0	21.1	20.7
Services, etc.[10]	e	74.6	70.7	74.2
Exports[11] (million C$)	d,f	187 282	39 011	599 553
Exports as a proportion of GDP (percent)	d,j	26.5	8.4	7.4
Motor vehicles (per 1000 persons)	c	594	130	752
Road network (kilometres)	c	930 000	245 000	6 287 000
Wastes				
Municipal waste generated[12] (thousand tonnes)	c	18 800	28 090	187 790
Municipal waste generated (kilograms per capita)	c	660	310	730
Household waste generated[13] (kilograms per capita)	c	360	250	..
Hazardous wastes (kilograms per million C$ GDP) (PPP)	c,k	11 054	9 589	34 992
SO_x emissions (kilograms per million C$ GDP) (PPP)	c,k	4 302	1 370	2 475
NO_x emissions (kilograms per million C$ GDP) (PPP)	c,k	2 753	575	2 672
CO_2 emissions[14] (tonnes of carbon per capita)	k	15.21	3.92	19.53
Greenhouse gas emissions (global per capita rank[15])	l	12	67	8
Global share (percent)	l	1.7	2.0	18.4
Emissions of greenhouse gases[16] (thousand tonnes)	c	459 390	336 724	5 128 734
Consumption of CFC's and halons[17] (tonnes)	h	15 302	14 793	145 593
Per capita (kilograms)	h	0.58	0.17	0.88
Particulate emissions[18] (thousand tonnes)	c	1 855	354	7 080
Volatile organic compound emissions[18] (thousand tonnes)	c	2 014	231	20 287
Resources				
Water				
Renewable supply (km^3)	c	2 792.0	414.0	2 478.0
Per capita (thousand m^3)	a,b,c	96.5	4.5	9.6
Total use[19] (km^3)	c	45.1	77.6	468.6
Per capita (m^3)	a,b,c	1 557.9	851.0	1 817.0
Irrigation, share of cropland area[20] (percent)	k	2	21	10
Water withdrawal (percent of available resources)	h	2	15	19
Minerals				
Metal reserve index[21] (world = 100)	b,l	6.1	1.9	8.7
Forest products				
Roundwood production (million m^3)	c	180	23	496
Fish				
Fish catches - inland and marine (thousand tonnes)	c	1 172	1 201	5 939

Table A1.1

Selected Population, Economic, Waste and Natural Resource Statistics, 1993 (continued)

Characteristic	Source	Canada	Mexico	United States
Energy				
Energy production[22] (PJ)	k	11 851	8 053	67 936
Solid	k	1 620	220	22 084
Liquid	k	3 819	6 574	18 055
Gas	k	4 374	948	19 509
Electricity				
Geothermal and wind	k	0	190	568
Hydro	k	1 111	87	1 038
Nuclear	k	926	33	6 683
Energy production per capita (GJ)	k	409.4	88.3	263.4
Energy consumption[22] (PJ)	k	8 779	4 834	80 839
Energy consumption per capita (GJ)	k	303.3	53.0	313.4
Energy consumption per C$ GDP (MJ) (PPP)	d,k	12.5	6.0	10.2
Energy production/consumption (ratio)	k	1.3	1.7	0.8
Land[23]				
Protected areas (percent of total)	k	5.0	5.1	10.5
Protected areas (thousand km^2)	k	494.5	99.0	984.6
Expenditure on environmental protection as a percent of GDP[24]	h	0.9	..	0.6
Marine and coastal protected areas[25](thousand hectares)	k	7 106	1 119	54 317
Major protected areas[26]				
Number of sites[27]	c	640	65	1 466
Total size (km^2)	c	892 749	97 287	1 041 069
Percentage of national territory	c	8.9	5.0	10.6
Protected area (hectares per thousand inhabitants)	c	3 105	107	404
International protection systems[28]				
National parks				
Number	c	251	33	176
Area (km^2)	c	366 169	15 978	219 952
Percentage of national territory	c	3.7	0.8	2.2
Protected area (hectares per thousand inhabitants)	c	1 273.5	17.5	85.3
Biosphere reserves				
Number	c	6	8	47
Area (km^2)	c	10 500	12 885	270 291
Heritage sites				
Number	k	6	1	10
Area (km^2)	k	14 710	528	4 357
Wetlands of international importance				
Number	k	30	1	11
Area (km^2)	k	13 016	47	1 192
Land use				
Cropland (thousand km^2)	c	414.29	247.30	1 877.76
Permanent pasture (thousand km^2)	c	263.25	744.99	2 391.72
Forest and woodland (thousand km^2)	c	4 181.75	487.00	2 981.36
Other (thousand km^2)	c	4 381.68	429.40	2 322.27
Wilderness[29] (thousand km^2)	l	6 406	31	441
Land use (percent of total land area)				
Cropland	b,c	4.5	12.7	20.5
Permanent pasture	b,c	2.9	38.1	26.1
Forest and woodland	b,c	45.2	24.9	32.5
Other	b,c	47.5	22.0	25.3

Table A1.1

Selected Population, Economic, Waste and Natural Resource Statistics, 1993 (concluded)

Characteristic	Source	Canada	Mexico	United States
Wilderness[30] (percent of total land area)	b,g,l	69.5	1.6	4.8
Percent change, 1979/81-1989/91				
Cropland	k	0.5	0.7	-1.5
Permanent pasture	k	0.9	0.0	0.7
Forest and woodland	k	5.4	-11.4	-2.5
Other	k	-3.7	12.1	4.4
Average annual fertilizer use, 1989-1991 (kilograms per hectare of cropland)	k	46	69	99
Wildlife				
Threatened species[31]				
Mammals	c	15	143	49
Birds	c	23	339	79
Vascular plants	c	83	902	118
Fish	c	47	140	64
Reptiles	c	30	476	26
Amphibians	c	10	199	8
Invertebrates	c	..	51	..
Extinct[32]	h	4	17	87

Notes:

The reader should note that data collection methods vary considerably from country to country. Caution should be used when interpreting the information. Although many countries adhere to United Nations guidelines for economic, demographic and social data collection, most have adapted these definitions and methods to better suit the local conditions. In addition, the collection of environmental data has often not reached the level of standardization that is found in these other fields. Attention should be given to the footnotes accompanying the table.

1. 1995 estimate.
2. 1990-1995 estimate.
3. 1990 estimate. Adult literacy is only regularly monitored in developing countries. For industrial countries where the adult literacy rate is near 100%, values of 99% are substituted.
4. 1990: Canada and United States; 1995: Mexico.
5. GDP calculated using United Nations definitions.
6. PPP - Purchasing Power Parity, using United Nations definitions.
7. 1991 figures: Canada and the United States; 1993: Mexico. GDP does not include imputed bank service charge, import duties, value added tax and other adjustments.
8. Includes agriculture, hunting, forestry, fishing, mining and quarrying.
9. Utilities include electricity, gas and water.
10. Includes wholesale and retail trade, restaurants, hotels, transport, storage, communication, finance, insurance, real estate, business services, community, social and personal services, producers of government services and other services.
11. Million C$ f.o.b. (free on board).
12. Municipal waste is waste collected by, or on the order of, municipalities. It includes waste originating from households, commercial activities, office buildings, institutions such as schools and government buildings, and small businesses that dispose of waste at the same facilities used for municipally collected waste. Household waste is waste generated by the domestic activity of households.
13. Includes garbage, bulky waste and separately collected waste.
14. 1991 data. Total metric tons from solid, liquid and gaseous fuels, from gas flaring and from cement manufacture.
15. 1989 data. Where number one is the highest per capita producer of greenhouse gases.
16. 1993 data or latest available year from 1990 on.
17. 1990 data.
18. Man made emissions. Data refer to 1993 or to the most recent year from 1990.
19. 1993 data: Canada and Mexico; 1990: United States.
20. 1989-1991 data.
21. 1990 figures: Canada and United States; 1994: Mexico.
22. 1991 data.
23. IUCN categories I-V.
24. 1989 data: Canada; 1990: United States.
25. 1989 data.
26. IUCN management categories I-V. National classifications may differ. Includes only areas greater than 10 km^2 except for islands.
27. Number of sites for which size is known.
28. IUCN category II: national parks and equivalent reserves.
29. Mid-1980s data.
30. Wilderness is not mutually exclusive from the other land use categories and therefore the land area should not be compared with the other categories.
31. Early 1990s data. "Threatened" refers to the sum of the number of species in the "endangered" and "vulnerable" categories.
32. 1990 data. U.S.: excludes the Hawaiian Islands.

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Table A1.2

Selected Water Quality Statistics, 1979-1993

Pollutant	River	Period 1979-1981	1982-1984	1985-1987	1988-1990	1991-1993
CANADA						
Dissolved oxygen (milligrams O_2 per litre)	Lake Ontario (mid-lake)	12.5	12.6	12.3	12.8	..
	Roseau River	7.9	8.0	8.3	..	6.9
	Saskatchewan River	10.8	10.6	10.4	10.3	9.9
	Slave River	..	..	..	..	11.2
Dissolved fluoride (milligrams F per litre)	Fraser River	0.1	--	0.1	0.1	..
	Mackenzie River	0.1	0.1	0.1	0.1	..
	Roseau River	0.1	0.1	0.1	0.2	..
	Saskatchewan River	0.1	0.1	0.1	0.2	..
	Slave River	0.1	0.1	0.1	0.1	..
Fecal coliform (number per 100 millilitres)	Roseau River	13.0	39.0	19.0	24.0	20.0
	Saskatchewan River	4.0	11.0	..	4.0	4.0
Total mercury (micrograms Hg per litre)	Fraser River	..	..	0.021	0.032	..
	Mackenzie River	0.037	..	..	..	..
	Roseau River	0.041	0.036	..	..	..
	Saskatchewan River	0.046	..	..	..	..
	Slave River	0.029	..	..	..	..
Nitrate + Nitrite (milligrams N per litre)	Fraser River	0.10	0.09	0.10	0.12	0.16
	Lake Ontario (mid-lake)	0.29	0.32	0.37	0.32	..
	Mackenzie River	0.08	0.08	..	0.07	0.07
	Roseau River	0.12	0.13	0.24	0.11	0.17
	Saskatchewan River	0.13	0.13	..	0.12	0.15
	Skeena River	..	..	0.09	..	..
	Slave River	0.04	0.08	0.05	0.05	0.07
Dissolved phosphorous (milligrams P per litre)	Mackenzie River	0.008	0.008	0.006	..	..
	Roseau River	0.035	0.043	..	..	..
	Saskatchewan River	0.010	0.017	0.011	..	..
	Slave River	0.016	0.021	..	..	..
Dissolved orthophosphate (milligrams P per litre)	Saskatchewan River	..	0.015	..	..	..
Particulate phosphorous (milligrams P per litre)	Mackenzie River	..	0.079	..	..	..
	Roseau River	..	0.027	..	..	..
	Saskatchewan River	..	0.046	0.060	..	..
	Slave River	..	0.274	..	..	..
Total phosphorous (milligrams P per litre)	Fraser River	0.014	0.094	0.068	0.046	..
	Lake Ontario (mid-lake)	0.013	0.014	0.011	0.010	..
	Mackenzie River	0.088	0.086	..	..	..
	Roseau River	0.062	0.068	0.075	0.067	..
	Saskatchewan River	..	0.057	..	0.043	..
	Slave River	0.213	0.348	0.219	0.111	..
Orthophosphate (milligrams P per litre)	Lake Ontario (mid-lake)	0.024	0.018	0.010	0.004	..
Suspended solids (milligrams per litre)	Fraser River	34	79	39	36	..
	Mackenzie River	97	74	..	33	35
	Roseau River	7	8	11	11	10
	Saskatchewan River	51	43	43	34	26
	Skeena River	..	..	33	..	..
	Slave River	153	406	41	24	34

Table A1.2
Selected Water Quality Statistics, 1979-1993 (continued)

Pollutant	River	Period 1979-1981	1982-1984	1985-1987	1988-1990	1991-1993
MEXICO						
Dissolved oxygen (milligrams O_2 per litre)	Rio Atoyac	..	4.3	1.8	1.1	..
	Rio Balsas	..	7.3	6.4	..	..
	Rio Blanco	..	4.4	3.6	3.7	..
	Rio Colorado	..	..	8.6	..	..
	Rio Lerma	1.9	1.0	1.3	..	..
	Rio Panuco	7.5	8.5	..	8.0	..
Fecal coliform (number per 100 millilitres)	Rio Atoyac	310 000	190 000	386 631	1 000 000	..
	Rio Balsas	14 000	40 000	99 986	..	..
	Rio Blanco	41 000	40 000	112 400	40 000	..
	Rio Colorado	674	344	246	69	..
	Rio Lerma	300 000	300 000	159 920	..	..
	Rio Panuco	1 280	161	1 028	..	..
Nitrate + Nitrite (milligrams N per litre)	Rio Atoyac	..	..	0.18	0.98	..
	Rio Blanco	..	..	2.13	1.28	..
	Rio Colorado	..	..	0.30	..	..
Dissolved orthophosphate (milligrams P per litre)	Rio Panuco	..	..	..	0.072	..
Total orthophosphate (milligrams P per litre)	Rio Balsas	..	..	0.248	..	..
	Rio Panuco	..	..	0.049	..	..
Total phosphorous (milligrams P per litre)	Rio Balsas	..	..	0.529	..	..
	Rio Panuco	..	..	0.060	..	..
Orthophosphate (milligrams PO_4 per litre)	Rio Atoyac	6.130	3.236	4.794	1.305	..
	Rio Balsas	0.836	0.070	0.356	..	..
	Rio Blanco	0.265	0.224	0.174	..	..
	Rio Colorado	0.129	..	0.072	..	..
	Rio Lerma	1.552	0.839	1.679	..	..
	Rio Panuco	0.065	..	..	..	..
Total phosphate (milligrams per litre)	Rio Atoyac	12.092	6.542	5.934	2.048	..
	Rio Balsas	1.226	0.698	0.729	0.419	..
	Rio Blanco	0.545	0.452	0.392	0.927	..
	Rio Colorado	0.216	0.211	0.147	0.033	..
	Rio Lerma	3.424	23.811	2.244	..	..
	Rio Panuco	0.080	..	..	..	..
Suspended solids (milligrams per litre)	Rio Atoyac	411	1 175	..	275	..
	Rio Balsas	4 641	3 221	2 123	..	..
	Rio Blanco	74	156	..	25	..
	Rio Colorado	59	37	..	21	..
	Rio Lerma	273	214	..	..	..
	Rio Panuco	337	55	217	77	..

Table A1.2

Selected Water Quality Statistics, 1979-1993 (concluded)

Pollutant	River	Period				
		1979-1981	1982-1984	1985-1987	1988-1990	1991-1993
UNITED STATES						
Dissolved oxygen (milligrams O_2 per litre)	Delaware River	11.4	11.0	12.0	8.4	10.1
	Hudson River	10.5	11.4	..	10.8	10.8
	Mississippi River	..	8.8	8.5	..	9.4
	Rio Grande	8.2	8.9	8.8	8.3	8.2
	Saint Lawrence River	10.7	11.4	9.1	10.3	11.4
Dissolved fluoride (milligrams F per litre)	Delaware River	0.1	0.1	..	0.1	0.1
	Hudson River	0.1	..	..	..	..
	Mississippi River	0.2	0.2	0.2	0.2	0.2
	Rio Grande	0.7	0.8	0.7	0.7	0.7
	Saint Lawrence River	0.1	0.2	0.2	0.2	..
Fecal coliform (number per 100 millilitres)	Delaware River	403	178	56	138	87
	Hudson River	1 102	1 070	..	..	519
	Mississippi River	457	1 145	2 989	..	590
	Rio Grande	3 830	2 567	1 404	2 136	1 418
	Saint Lawrence River	7	10	8	9	10
Dissolved mercury (micrograms Hg per litre)	Delaware River	..	0.23	..	..	..
	Rio Grande	0.11	..	..	..	..
Total mercury (micrograms Hg per litre)	Rio Grande	0.27	..	..	..	..
Nitrate + Nitrite (milligrams N per litre)	Delaware River	0.97	1.22	1.04	6.00	0.91
	Hudson River	0.63	0.65	..	0.55	0.48
	Mississippi River	1.40	..	1.48	1.19	1.63
	Rio Grande	0.14	..	..	..	0.26
	Saint Lawrence River	0.20	0.25	0.21	0.28	0.22
Total phosphorous (milligrams P per litre)	Delaware River	..	..	..	..	0.11
	Hudson River	..	..	..	..	0.05
	Mississippi River	..	..	..	..	0.18
	Rio Grande	..	..	..	..	0.11
	Saint Lawrence River	..	..	..	..	0.02
Dissolved phosphorous (milligrams P per litre)	Delaware River	..	..	..	..	0.05
	Hudson River	..	..	..	..	0.03
	Mississippi River	..	..	..	..	0.08
	Rio Grande	..	..	..	..	0.04

Notes:
The reader should note that data collection methods vary considerably from country to country. Caution should be used when interpreting the information. Although many countries adhere to United Nations guidelines for economic, demographic and social data collection, most have adapted these definitions and methods to better suit the local conditions. In addition, the collection of environmental data has often not reached the level of standardization that is found in these other fields.
Data are three-year averages.
Source:
Environment Canada, National Water Research Institute, Gems/Water Database.

Table A1.3

Concentrations of Selected Air Pollutants, 1980-1993

Pollutant	City	Number of stations	Base year value	Base year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
			µg/m³		index													
CANADA																		
SO_2	Canada	58-65	16	1985	163	132	132	99	115	100	100	81	100	100	100	75	81	..
	Montréal, Que.	7	14	1988	..	..	..	..	..	..	..	..	100	136	107	71	86	..
	Hamilton, Ont.	3	25	1988	..	..	..	..	..	..	..	..	100	124	96	96	88	..
	Vancouver, B.C.	4	26	1988	..	..	..	..	..	..	..	..	100	94	125	81	75	..
	Dorset, Ont.	1	3	1985	..	..	..	..	..	100	100	100	100	..	192	..	..	..
NO_2	Canada	34-47	41	1985	115	106	106	101	110	100	100	95	98	105	98	90	83	..
	Montréal, Que.	3	48	1988	..	..	..	..	..	..	..	..	100	108	106	98	73	..
	Hamilton, Ont.	2	46	1988	..	..	..	..	..	..	..	..	100	100	83	89	80	..
	Vancouver, B.C.	3	51	1988	..	..	..	..	..	..	..	..	100	94	92	94	92	..
	Dorset, Ont.	1	11	1985	..	..	..	..	166	100	66	34	34	..	35	..	..	..
Particulates	Canada	85	43	1985	156	136	120	111	107	100	100	112	102	102	91	91	84	..
	Montréal, Que.	6	46	1988	..	..	..	..	..	..	..	..	100	102	80	83	83	..
	Hamilton, Ont.	2	81	1988	..	..	..	..	..	..	..	..	100	99	89	83	70	..
	Vancouver, B.C.	8	35	1988	..	..	..	..	..	..	..	..	100	100	91	94	91	..
MEXICO																		
SO_2	Mexique, D.F.	5	163	1988	..	..	..	..	..	..	..	..	100	88	95	103	88	39
NO_2	Mexique, D.F.	5	228	1986	..	..	..	..	..	..	100	60	72	71	74	69	73	69
Particulates	Mexique, D.F.	5	619	1985	86	89	87	85	93	100	95	88	73	94	127	148	89	71
UNITED STATES																		
SO_2	United States	234	25	1985	120	113	107	104	107	100	99	96	98	95	88	87	81	80
	New York, NY	15	34	1985	111	113	105	98	105	100	92	94	100	95	84	83	75	67
	Los Angeles, CA	6	16	1985	116	115	118	103	121	100	87	77	76	57	46	46	43	40
	Steubenville, OH	2	52	1985	120	109	109	103	111	100	106	106	111	122	116	103	88	..
	Denver, CO	2	16	1985	142	158	132	153	126	100	99	107	106	91	91	102	109	99
	Dunn, CO	1	4	1985	69	82	133	100	92	100	95	77	79	82	79	77	79	87
NO_2	United States	83	46	1985	106	104	102	100	101	100	101	100	102	98	93	94	89	88
	Los Angeles, CA	12	88	1985	110	110	106	100	98	100	99	92	101	99	90	92	65	80
	New York, NY	3	53	1985	107	105	114	115	107	100	103	114	112	101	101	102	97	100
	Chicago, IL	1	67	1985	93	93	106	97	95	100	90	89	91	98	88	92	86	88
	Washington, D.C.	5	56	1985	97	97	94	95	98	100	102	97	92	85	93	90	87	88
	Mercer, CO	4	7	1985	99	103	91	88	87	100	120	96	91	90	96	93	97	97
Particulates	United States	241	34	1988	..	..	..	..	..	..	..	..	100	99	90	90	82	79
	Los Angeles, CA	13	58	1988	..	..	..	..	..	..	..	..	100	100	88	87	73	70
	New York, NY	14	31	1988	..	..	..	..	..	..	..	..	100	97	96	99	81	78
	Steubenville, OH	5	43	1988	..	..	..	..	..	..	..	..	100	104	92	97	88	..
	Denver, CO	6	35	1988	..	..	..	..	..	..	..	..	100	100	86	85	87	102
	Fargo Moorhead, ND	1	21	1988	..	..	..	..	..	..	..	..	100	98	101	89	100	84

Note:
The reader should note that the data collection methods vary considerably from country to country. Caution should be used when interpreting the information. Although many countries adhere to United Nations guidelines for economic, demographic and social data collection, most have adapted these definitions and methods to better suit the local conditions. In addition, the collection of environmental data has often not reached the level of standardization that is found in these other fields.

Source:
Organisation for Economic Co-operation and Development, *OECD Environmental Data, Compendium 1995*, Paris, 1995.

Annex 2: Environment and Natural Resource Statistics, Canada, Provinces and Territories

Table A2.1

Selected Environmental Quality Statistics, 1961-1995

	Source	1961	1966	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
AIR QUALITY															
Urban ground level[1]															
Average station exceedances for SO_2, NO_x and CO	a	..	..	..	..	..	..	..	..	..	..	..	9.8	6.6	10.3
Average station exceedances for ozone	a	..	..	..	..	..	..	..	..	..	..	..	25.4	23.7	23.8
Average station exceedances for particulates	a	..	..	..	..	..	..	..	..	..	..	..	8.2	8.0	5.8
Ozone layer[2] (Dobson units[3])															
Toronto	b	341	361	358	354	360	332	352	351	347	355	337	348	351	346
Edmonton	b	335	369	346	345	346	339	355	352	338	354	333	343	349	341
Resolute	b	361	395	382	398	408	387	382	366	371	371	380	377	375	371
Production of CFCs (kt)	b	..	..	..	..	..	..	..	..	..	..	..	17.3	14.0	15.2
Production of other ozone depleting substances (kt)	b	..	..	..	..	..	..	..	..	..	..	..	3.4	2.8	2.8
Air emissions															
Nitrogen dioxide (kt)	c	..	..	1 364	..	..	..	..	1 756	..	..	..	..	1 959	1 907
Sulphur dioxide (kt)	c	..	..	6 677	..	..	..	..	5 319	..	..	..	..	4 643	4 291
Carbon monoxide (kt)	c	..	..	10 057	..	..	..	..	10 594	..	..	..	..	10 273	..
Carbon dioxide from fossil fuel combustion (Mt)	d	194	265	334	342	363	376	379	381	396	390	394	412	414	402
Particulates (kt)	c	..	..	1 850	..	..	..	..	1 787	..	..	..	..	1 907	..
LAND															
Agricultural land use (million hectares)															
Cropland	e,f	25.3	27.9	..	27.8	..	..	..	..	28.3	..	..	..	..	30.9
Improved pasture	e,f	4.1	4.4	..	4.1	..	..	..	..	4.1	..	..	..	..	4.1
Summerfallow	e,f	11.4	10.4	..	10.8	..	..	..	..	10.9	..	..	..	..	9.7
Other land	e,f	1.0	1.0	..	1.0	..	..	..	..	0.9	..	..	..	..	1.4
Unimproved farmland	e,f	28.0	26.7	..	25.0	..	..	..	..	24.2	..	..	..	..	19.8
Total farmland	e,f	69.8	70.5	..	68.7	..	..	..	..	68.4	..	..	..	..	65.9
Proportion of Canada's land area in agriculture (%)	d	7.6	7.6	..	7.5	..	..	..	..	7.4	..	..	..	..	7.2
Grain crop production (all types) (thousand tonnes)	f	15 961	36 784	25 863	35 892	32 938	33 799	28 205	33 441	40 931	37 947	37 342	30 643	35 564	44 096
Total cattle inventory (thousands)[4]	f	11 934	12 879	12 826	13 271	13 644	14 128	15 101	15 260	14 384	13 619	12 807	12 650	12 764	12 764
Agricultural fertilizer use (thousand tonnes)															
Nitrogen	g	73	218	268	323	334	410	513	531	586	599	755	831	831	916
Phosphate	g	161	333	281	326	341	415	494	502	503	503	594	630	628	635
Potash	g	93	142	175	184	189	191	202	207	242	234	273	330	349	363
Total fertilizer sold (thousand tonnes)[5]	g	709	1 811	1 694	1 915	1 972	2 261	2 608	2 676	2 780	2 829	3 267	3 671	3 572	3 758
Value of agricultural pesticides applied (million $1986)	e	..	..	169	..	..	..	..	..	..	..	..	..	398	..
Forest land harvested (thousand ha)	l	..	..	..	..	..	..	..	680	704	735	823	876	873	795
Forest land defoliated by insects (thousand ha)[6]	l	..	..	..	..	..	..	..	..	64 658	68 494	55 178	48 646	41 690	43 781
Forest land burned, all causes (thousand ha)	l	..	..	1 059	1 695	780	1 184	849	1 032	1 814	1 438	289	2 701	4 777	5 393
Rural to urban land conversion (hectares)[7]	i	..	..	..	68 090	..	..	..	..	61 164	..	..	..	..	98 976
ATLANTIC FISH CATCH[8] (thousand tonnes)															
Groundfish	j	1 365	1 743	1 738	1 701	1 627	1 646	1 359	1 195	998	820	848	934	930	980
Pelagic	j	85	285	764	824	787	935	871	916	829	533	326	236	242	255
Salmon	j	2	4	4	5	4	5	4	5	4	4	3	3	4	4
Total finfish	j	1 452	2 032	2 526	2 530	2 418	2 586	2 234	2 116	1 831	1 357	1 177	1 173	1 176	1 239
ENERGY USE (petajoules)															
Coal	k,d	548	635	708	673	635	654	665	658	709	773	789	876	928	946
Oil	d	1 803	2 328	2 860	3 119	3 425	3 771	3 931	3 806	3 770	4 004	4 011	4 297	4 196	3 990
Natural gas	d	566	938	1 370	1 462	1 644	1 749	1 787	1 800	1 841	1 643	1 664	1 734	1 785	1 710
Nuclear	d,e	...	1	4	15	26	54	53	45	63	95	112	127	137	136
Total non-renewable energy	d	2 917	3 902	4 942	5 269	5 730	6 228	6 416	6 308	6 383	6 514	6 576	7 034	7 046	6 762
Hydroelectricity	d,e	364	463	555	564	615	641	709	699	729	725	766	761	797	826
Wood[9]	k	178	107	106	342	353	377	391	326	346	346	357	374	405	393
Total renewable energy	d	542	570	661	906	968	1 018	1 100	1 025	1 075	1 071	1 123	1 135	1 202	1 219
Total energy	d	3 459	4 472	5 603	6 175	6 698	7 246	7 516	7 333	7 458	7 586	7 698	8 169	8 248	8 001
Energy per capita (gigajoules per capita)	d	180	220	260	267	288	308	315	305	305	307	307	324	322	310
Energy per $ of real GDP (megajoules per 1986 $)	d	19.5	19.0	20.4	20.5	21.1	21.2	21.1	20.2	19.3	18.9	18.3	18.8	18.7	17.5

Notes:

1. This information provides a measure of the number of times the oxides, ozone or particulates exceeded maximum acceptable levels each year.
2. From 1961 to 1992 figures are averaged from six readings per year while 1994 figures are averaged from three readings.
3. Dobson unit: a unit measure used to estimate the thickness of the ozone layer. 100 Dobson units represents a quantity equivalent to a 1mm thick layer of ozone at sea level.
4. Changes in surveying dates and methods between 1975 and 1976 may cause some inconsistencies.
5. Total fertilizer sold includes all nutrients as well as fertilizer filler materials.
6. Any forested area may be defoliated by more than one insect. Therefore, there can be considerable overlap in the reported figures.
7. These figures represent rural to urban land use conversion over the preceding five years. Data were not collected after 1986.
8. Includes surveillance estimates of catches in the NAFO regulatory area and foreign catches made outside the 200-mile zone on straddling stocks and the Flemish Cap.
9. Includes spent pulping liquor, wood waste and residential firewood.

Sources:

a. Environment Canada, State of the Environment Directorate, *Technical Supplement to the Environmental Indicator Bulletin on Urban Air Quality*, Ottawa, 1994.
b. Environment Canada, State of the Environment Directorate, *Technical Supplement to the Environmental Indicator Bulletin on Stratospheric Ozone Depletion*, Ottawa, 1993.
c. Organisation for Economic Cooperation and Development, *OECD Environmental Data Compendium 1993*, Paris, 1993.
d. Statistics Canada, National Accounts and Environment Division.
e. Statistics Canada, *Human Activity and the Environment, 1994*, Catalogue No. 11-509E, Ottawa, 1994.
f. Statistics Canada, Agriculture Division.
g. Statistics Canada, *Fertilizer Trade*, Catalogue No. 46-207, Ottawa, various issues, and Agriculture Canada, Farm Policy Development Branch.
h. Natural Resources Canada, Canadian Forest Service, Canada's Forest Inventory 1981, 1986, 1991.
i. Environment Canada, State of Environment Directorate, *Technical Supplement to a Report on Canada's Progress Towards a National Set of Environmental Indicators*, Ottawa, 1991.
j. Department of Fisheries and Oceans Canada, Biological Sciences Directorate.
k. Environment Canada, State of the Environment Directorate, *Technical Supplement to the Environmental Indicator Bulletin on Energy Consumption*, Ottawa, 1994.
l. Natural Resources Canada, Canadian Forest Service.

Table A2.1

Selected Environmental Quality Statistics, 1961-1995 (concluded)

	Source	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AIR QUALITY															
Urban ground level[1]															
Average station exceedances for SO_2, NO_x and CO	a	6.8	5.4	2.2	2.6	4.4	1.8	2.5	1.3	3.3	1.0	0.2	..	..	..
Average station exceedances for ozone	a	13.8	35.6	17.9	11.6	10.0	15.8	57.8	19.8	10.6	19.0	8.7	..	..	..
Average station exceedances for particulates	a	4.4	2.7	3.1	2.0	2.0	2.5	2.4	1.9	0.9	1.1	0.8	..	..	..
Ozone layer[2] (Dobson units[3])															
Toronto	b	344	333	339	340	336	345	342	339	330	338	333	319	333	..
Edmonton	b	359	334	340	335	334	339	330	334	332	337	328	311	326	..
Resolute	b	370	360	357	371	424	360	359	367	354	364	342	328	364	..
Production of CFCs (kt)	b	14.2	15.6	16.9	18.5	19.9	21.2	21.0	18.8	13.1	8.8	10.7	4.0	..	..
Production of other ozone depleting substances (kt)	b	3.2	3.7	4.7	4.6	5.0	6.6	6.6	5.4	4.1	3.5	2.5	1.0	..	..
Air emissions															
Nitrogen dioxide (kt)	c	1 897	1 884	1 871	1 984	1 934	2 037	2 117	2 120	1 999	1 976	1 939	..	..	..
Sulphur dioxide (kt)	c	3 612	3 625	3 955	3 692	3 627	3 762	3 838	3 695	3 323	3 306	3 030	..	..	..
Carbon monoxide (kt)	c	..	..	..	10 781	..	..	..	..	..	..	..	..	..	..
Carbon dioxide from fossil fuel combustion (Mt)	d	387	380	393	385	376	404	432	452	432	422	436	443	456	..
Particulates (kt)	c	..	..	..	1 709	..	..	..	..	1 855	..	..	..	..	..
LAND															
Agricultural land use (million hectares)															
Cropland	e,f	..	..	..	..	33.2	..	..	..	..	33.5	..	..	..	..
Improved pasture	e,f	..	..	..	..	3.6	..	..	..	..	4.1	..	..	..	..
Summerfallow	e,f	..	..	..	..	8.5	..	..	..	..	7.9	..	..	..	..
Other land	e,f	..	..	..	..	0.7	..	..	..	..	..	..	..	..	..
Unimproved farmland	e,f	..	..	..	..	21.8	..	..	..	..	..	..	..	..	..
Total farmland	e,f	..	..	..	..	67.8	..	..	..	..	67.8	..	..	..	..
Proportion of Canada's land area in agriculture (%)	d	..	..	..	..	7.4	..	..	..	..	7.4	..	..	..	..
Grain crop production (all types) (thousand tonnes)	f	46 728	41 415	35 933	41 209	50 670	44 477	30 250	41 881	49 530	46 314	44 605	45 802	46 805	49 517
Total cattle inventory (thousands)[4]	f	12 591	12 290	12 031	11 651	11 299	11 264	11 512	11 780	11 907	12 172	12 473	12 715	13 263	15 100
Agricultural fertilizer use (thousand tonnes)															
Nitrogen	g	966	1 002	1 157	1 254	1 221	1 145	1 188	1 160	1 196	1 158	1 253	1 306	1 406	1 448
Phosphate	g	636	652	713	724	695	626	634	614	814	578	592	637	641	628
Potash	g	344	338	377	400	370	370	404	356	360	338	310	328	328	310
Total fertilizer sold (thousand tonnes)[5]	g	3 742	3 842	4 243	4 435	4 300	4 069	4 241	4 048	4 105	3 922	4 071	4 218	4 536	4 566
Value of agricultural pesticides applied (million $1986)	e	..	..	..	694	..	..	..	..	705	..	..	..	..	..
Forest land harvested (thousand ha)	l	753	828	895	898	972	1 051	1 086	1 018	893	856	906	969	..	..
Forest land defoliated by insects (thousand ha)[6]	l	25 641	27 359	19 851	27 267	16 429	13 009	15 528	18 854	20 493	33 896	41 943	20 521	..	..
Forest land burned, all causes (thousand ha)	l	1 706	1 194	765	755	950	1 086	1 336	7 560	931	1 575	869	1 967	..	..
Rural to urban land conversion (hectares)[7]	i	..	..	..	..	55 210	..	..	..	..	..	..	..	..	..
ATLANTIC FISH CATCH[8] (thousand tonnes)															
Groundfish	j	1 032	949	983	1 062	1 157	1 120	1 031	1 026	998	886	659 p	455 p	192 p	..
Pelagic	j	217	231	270	302	379	412	493	423	516	331	286 p	258 p	203 p	..
Salmon	j	3	2	1	2	3	3	2	1	1	1	1 p	- p	- p	..
Total finfish	j	1 252	1 182	1 254	1 366	1 539	1 535	1 526	1 450	1 515	1 218	946 p	713 p	395 p	..
ENERGY USE (petajoules)															
Coal	k,d	1 002	1 048	1 167	1 122	1 040	1 118	1 200	1 198	1 077	1 104	1 137	1 044	1 086	..
Oil	d	3 332	3 183	3 170	3 077	3 038	3 155	3 339	3 402	3 463	3 249	3 175	3 462	3 604	..
Natural gas	d	1 718	1 754	1 880	2 361	2 317	2 358	2 593	2 790	2 676	2 705	2 863	2 886	3 010	..
Nuclear	d,e	130	166	177	206	242	262	281	271	246	288	274	319	366	..
Total non-renewable energy	d	6 182	6 151	6 394	6 766	6 637	6 893	7 413	7 660	7 465	7 346	7 449	7 711	8 066	..
Hydroelectricity	d,e	806	817	881	939	989	972	996	1 005	1 057	1 033	1 038	1 055	1 018	..
Wood[9]	k	421	459	391	473	498	503	503	483	473	485	491	493	537	..
Total renewable energy	d	1 227	1 276	1 272	1 412	1 487	1 475	1 499	1 488	1 530	1 518	1 529	1 548	1 555	..
Total energy	d	7 409	7 427	7 666	8 178	8 124	8 368	8 912	9 148	8 995	8 864	8 978	9 259	9 821	..
Energy per capita (gigajoules per capita)	d	280	277	288	304	297	304	321	325	314	306	308	314	329	..
Energy per $ of real GDP (megajoules per 1986 $)	d	16.6	16.1	15.9	16.1	15.4	15.4	15.7	15.7	15.4	15.5	15.8	15.9	18.1	..

Notes:

1. This information provides a measure of the number of times the oxides, ozone or particulates exceeded maximum acceptable levels each year.
2. From 1961 to 1992 figures are averaged from six readings per year while 1994 figures are averaged from three readings.
3. Dobson unit: a unit measure used to estimate the thickness of the ozone layer. 100 Dobson units represents a quantity equivalent to a 1mm thick layer of ozone at sea level.
4. Changes in surveying dates and methods between 1975 and 1976 may cause some inconsistencies.
5. Total fertilizer sold includes all nutrients as well as fertilizer filler materials.
6. Any forested area may be defoliated by more than one insect. Therefore, there can be considerable overlap in the reported figures.
7. These figures represent rural to urban land use conversion over the preceding five years. Data were not collected after 1988.
8. Includes surveillance estimates of catches in the NAFO regulatory area and foreign catches made outside the 200-mile zone on straddling stocks and the Flemish Cap.
9. Includes spent pulping liquor, wood waste and residential firewood.

Sources:

a. Environment Canada, State of the Environment Directorate, *Technical Supplement to the Environmental Indicator Bulletin on Urban Air Quality*, Ottawa, 1994.
b. Environment Canada, State of the Environment Directorate, *Technical Supplement to the Environmental Indicator Bulletin on Stratospheric Ozone Depletion*, Ottawa, 1993.
c. Organisation for Economic Cooperation and Development, *OECD Environmental Data Compendium 1993*, Paris, 1993.
d. Statistics Canada, National Accounts and Environment Division.
e. Statistics Canada, *Human Activity and the Environment, 1994*, Catalogue No. 11-509E, Ottawa, 1994.
f. Statistics Canada, Agriculture Division.
g. Statistics Canada, *Fertilizer Trade*, Catalogue No. 46-207, Ottawa, various issues, and Agriculture Canada, Farm Policy Development Branch.
h. Natural Resources Canada, Canadian Forest Service, Canada's Forest Inventory 1981, 1986, 1991.
i. Environment Canada, State of Environment Directorate, *Technical Supplement to a Report on Canada's Progress Towards a National Set of Environmental Indicators*, Ottawa, 1991.
j. Department of Fisheries and Oceans Canada, Biological Sciences Directorate.
k. Environment Canada, State of the Environment Directorate, *Technical Supplement to the Environmental Indicator Bulletin on Energy Consumption*, Ottawa, 1994.
l. Natural Resources Canada, Canadian Forest Service.

Table A2.2

Selected Statistics on Land by Province and Territory, 1986-1996

	Year	Source	Canada	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	Yukon	N.W.T.
Total area (km^2)		a	9 970 610	405 720	5 660	55 490	73 440	1 540 680	1 068 580	649 950	652 330	661 190	947 800	483 450	3 426 320
Water area (km^2)		a	755 180	34 030	--	2 650	1 350	183 890	177 390	101 590	81 630	16 800	18 070	4 480	133 300
Land area (km^2)		a	9 215 430	371 690	5 660	52 840	72 090	1 356 790	891 190	548 360	570 700	644 390	929 730	478 970	3 293 020
Area of farms (km^2)	1986	a	678 258	366	2 724	4 165	4 089	36 388	56 466	77 402	265 994	206 553	24 111	-	-
	1991	a	677 537	474	2 569	3 970	3 756	34 296	54 514	77 250	268 655	208 110	23 923	-	-
Forest land[1] (km^2)	1991	d	4 161 770	225 250	2 950	39 230	61 060	824 860	579 950	262 770	288 060	382 140	605 640	275 500	814 360
Other land (km^2)	1991	d	4 376 123	145 966	121	9 640	7 274	497 634	256 726	208 340	13 985	54 140	300 167	203 470	2 678 660
Land use distribution															
Area of farms (% of land area)	1986	a	7.4	0.0	0.0	0.0	0.0	0.4	0.6	0.8	2.9	2.2	0.3	0.0	0.0
	1991	a	7.4	0.0	0.0	0.0	0.0	0.4	0.6	0.8	2.9	2.3	0.3	0.0	0.0
Forest land (% of land area)	1991	d	45.2	2.4	0.0	0.4	0.7	9.0	6.3	2.9	3.1	4.1	6.6	3.0	6.7
Other land (% of land area)	1991	d	47.5	1.6	0.0	0.1	0.1	5.4	2.8	2.3	0.2	0.6	3.3	2.2	29.1
Use of farmland															
Cropland (km^2)	1986	a	331 812	49	1 565	1 095	1 295	17 444	34 580	45 193	133 258	91 625	5 708	-	-
	1991	a	335 078	63	1 541	1 062	1 222	16 385	34 117	47 610	134 589	92 920	5 568	-	-
Improved pasture (km^2)	1986	a	35 592	38	226	362	272	3 011	4 313	2 749	8 787	13 768	2 064	-	-
	1991	a	41 412	46	193	307	250	2 709	3 902	3 413	10 757	17 425	2 410	-	-
Summerfallow (km^2)	1986	a	84 990	4	26	39	43	318	803	5 092	56 583	21 270	812	-	-
	1991	a	79 209	1	10	12	16	147	637	2 970	57 126	17 714	575	-	-
Cropland tilled[2] (percent)	1991	b	80.9	97.7	99.4	98.9	98.7	99.1	98.2	94.1	70.2	64.0	90.6	-	-
Protected land															
Area (km^2)	1996	e	756 319	7 358	78	3 187	3 957	158 050	62 648	63 938	28 558	66 518	69 191	49 452	243 384
Proportion of total area (%)	1996	b	7.6	1.8	1.4	5.7	5.4	10.3	5.9	9.6	4.4	10.1	7.3	10.2	7.1
Road network															
Two-lane equivalent length[3] (km)	1990-91	f	674 155	12 290	4 935	25 779	20 670	119 321	167 500	64 965	193 923	173 473	62 158	5 238	3 903
Density (km/thousand km^2)	1990-91	f	95	33	872	488	267	88	168	155	340	269	67	11	1

Notes:
Figures may not add due to rounding.
See Chapter 7 for more detail on land cover and use statistics.
1. Values in 1966 include estimates of non-inventoried forest land.
2. Cropland in this definition excludes no-till and permanent cropland areas such as tree fruit orchards.
3. Canada figures includes 14 743 km under federal jurisdiction.

Sources:
a. Statistics Canada, *Canada Year Book 1994*, Catalogue No. 11-402E, Ottawa, 1994.
b. Statistics Canada, National Accounts and Environment Division.
c. Natural Resources Canada, *Canada's Forest Inventory, 1986*, Ottawa, 1987.
d. Natural Resources Canada, Canadian Forest Service, Canadian Council of Forest Ministers, *Compendium of Canadian Forestry Statistics 1993*, Ottawa, 1994.
e. Environment Canada, State of the Environment Directorate, *1996 State of the Environment Report*, Ottawa, 1996.
f. Transportation Association of Canada.

Table A2.3

Selected Statistics on Forestry by Province and Territory, 1986-1993

Year	Canada	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	Yukon[1]	N.W.T.[1]
Total production[2] (million $)													
1986	5 775.5	95.4	0.6	147.2	365.3	1 096.4	1 015.0	53.7	91.4	114.2	2 796.2	--	..
1987	7 538.3	107.7	--	173.5	439.1	1 441.4	1 146.9	74.7	107.3	138.8	3 907.3	--	..
1988	8 061.9	122.1	1.5	203.9	546.8	1 540.3	1 201.0	68.7	119.1	152.7	4 105.5	0.6	..
1989	8 696.8	132.0	2.0	203.9	603.4	1 732.9	1 290.5	72.9	122.4	183.9	4 351.7	1.4	..
1990	8 113.8	135.9	2.6	196.2	557.9	1 649.3	1 168.4	78.9	102.6	203.4	4 017.7	0.9	..
1991	7 702.0	132.6	3.3	198.2	492.2	1 520.6	1 092.6	61.7	78.3	273.4	3 848.5	0.6	..
1992	8 358.5	126.4	1.7	220.1	475.1	1 580.7	1 188.3	76.3	99.3	293.9	4 294.3	0.6	..
1993	9 030.9	141.4	4.2	206.1	461.4	1 579.9	1 154.5	76.3	112.2	317.3	4 976.1	1.2	..
Total roundwood harvested (thousand cubic metres)													
1986	177 190	2 408	424	4 004	8 720	38 127	30 186	1 703	3 529	10 387	77 503	199	..
1987	191 685	2 524	479	4 789	7 869	39 503	29 692	1 887	3 666	10 496	90 591	188	..
1986	190 616	2 513	475	5 039	9 199	39 381	29 338	1 883	3 818	11 990	86 807	172	..
1989	188 254	2 535	416	4 772	9 281	38 192	29 642	1 848	3 685	12 293	87 414	176	..
1990[r]	162 952	2 876	448	4 639	8 824	30 524	25 420	1 563	2 758	11 911	73 861	82	46
1991[r]	161 538	2 680	452	4 348	8 643	29 595	23 829	1 278	2 957	12 926	74 706	79	46
1992[r]	170 304	2 821	510	4 248	9 205	31 171	24 286	1 598	3 081	14 594	78 579	182	49
1993[p]	175 799	3 131	534	4 585	8 959	34 604	25 432	1 539	4 433	14 183	78 004	193	203
Area harvested (hectares)													
1986	971 813	17 440	2 350	34 121	86 898	297 616	223 517	11 128	19 356	38 611	239 877	299	400
1987	1 050 849	18 940	2 725	42 286	88 976	329 300	228 464	12 362	25 742	40 246	259 982	1 172	672
1988	1 086 098	19 628	2 731	41 421	99 192	337 668	237 188	12 378	22 089	42 538	270 401	465	399
1989	1 017 618	19 449	2 421	38 733	90 114	342 231	230 308	12 205	22 281	41 688	218 384	1 554	450
1990[r]	892 869	22 100	2 317	39 310	80 109	253 325	238 213	10 349	16 538	48 387	181 530	366	325
1991[r]	856 403	18 661	2 091	37 566	91 916	236 725	199 720	8 518	17 522	49 213	193 654	350	467
1992[r]	905 755	18 391	2 550	33 932	103 335	248 491	190 876	11 414	18 471	55 852	221 599	639	405
1993[p]	968 584	20 640	2 976	42 780	100 650	311 623	206 000	10 993	19 456	44 565	207 748	634	519
Area burned - stocked timber-productive forest land[3] (hectares)													
1986	311 387	23 511	85	268	37 216	173 296	50 598	5 495	4 031	1 587	9 474	3 132	11
1987	308 518	10 622	16	312	895	27 849	5 461	84 266	129 332	24 295	22 308	1 150	10
1988	839 777	7	2	89	1 778	273 066	35 994	295 930	24 187	5 149	3 284	288	3
1989	3 877 394	2 651	2	159	280	2 108 206	4 990	1 539 180	137 404	2 994	11 089	70 439	..
1990	281 831	2 801	4	477	5 198	76 825	3 200	8 727	71 198	21 281	52 575	16 704	..
1991	375 130	9 576	23	1 022	2 732	101 305	5 025	55 266	118 850	2 222	16 658	61 227	..
1992[r]	265 727	1 015	8	805	4 686	24 298	10 331	187 890	12 768	1 006	17 212	3 785	..
1993	417 995	21	6	120	535	125 211	2 116	44 545	227 208	13 858	1 376	-	..
Area seeded and planted (hectares)													
1986	334 918	802	863	9 180	20 517	64 888	94 782	4 146	4 482	19 539	115 739	-	..
1987	430 456	5 604	1 092	9 880	18 918	92 437	101 488	5 721	3 110	23 226	169 002	-	..
1988	459 865	4 468	1 077	11 655	19 123	99 880	111 251	7 061	7 020	28 845	169 485	-	..
1989	476 440	4 691	744	9 780	20 272	103 230	118 256	8 264	6 106	30 807	174 310	-	..
1990[r]	510 828	3 548	833	11 255	22 148	106 388	107 961	6 282	6 012	35 253	209 168	..	80
1991[r]	513 784	2 891	1 032	8 198	19 529	108 095	120 827	8 041	6 545	39 363	199 422	..	41
1992[r]	466 914	3 531	1 161	7 502	16 526	98 892	96 258	7 142	6 403	44 520	184 922	..	57
1993[p]	451 965	2 790	1 227	5 213	13 089	86 048	101 864	5 659	6 679	39 168	190 178	174	80

Notes:
Figures may not add due to rounding.
One square kilometre contains 100 hectares.
1. Data for Northwest Territories included in data for Yukon when not available separately.
2. Total production is the value of shipments of the logging industry.
3. Canada total includes areas burned in National Parks.

Sources:
Statistics Canada, *Canadian Forestry Statistics*, Catalogue No. 25-202, Ottawa, various issues.
Natural Resources Canada, Canadian Forests Service, Canadian Council of Forest Ministers, *Compendium of Canadian Forestry Statistics 1994*, Ottawa, 1995.

Table A2.4

Nominal Catches and Landed Values of Fish by Species and Region, 1993 and 1994

	1993[p]						1994[p]					
	Atlantic coast		Pacific coast		Canada		Atlantic coast		Pacific coast		Canada	
Species	Quantity[1]	Value	Quantity[1]	Value	Quantity[1]	Value	Quantity[1]	Value	Quantity[1]	Value	Quantity[1]	Value
	tonnes	thousand dollars	tonnes	thousand dollars	tonnes	thousand dollars	tonnes	thousand dollars	tonnes	thousand dollars	tonnes	thousand dollars
Groundfish												
Cod[2]	71 889	59 936	7 700	4 377	**79 589**	**64 313**	22 550	29 417	3 500	2 300	**26 050**	**31 717**
Haddock	13 131	20 997	-	-	**13 131**	**20 997**	6 955	13 965	-	-	**6 955**	**13 965**
Redfish	77 734	21 070	22 527	16 031	**100 261**	**37 101**	50 774	15 716	23 372	20 100	**74 146**	**35 816**
Halibut	1 482	6 979	5 688	27 000	**7 170**	**33 979**	1 206	7 654	5 326	33 618	**6 532**	**41 272**
Flatfishes	38 597	23 659	9 341	6 712	**47 938**	**30 371**	15 165	17 974	7 980	6 639	**23 145**	**24 613**
Turbot	18 909	16 153	3 932	1 002	**22 841**	**17 155**	10 964	14 279	4 000	1 000	**14 964**	**15 279**
Pollock	21 970	12 370	5 744	1 877	**27 714**	**14 247**	15 584	10 885	3 626	1 152	**19 210**	**12 037**
Hake[3]	35 368	22 146	62 509	6 664	**97 897**	**30 810**	14 656	9 041	109 546	15 467	**124 202**	**24 508**
Cusk	2 948	2 347	-	-	**2 948**	**2 347**	1 692	1 400	-	-	**1 692**	**1 400**
Catfish	1 003	283	-	-	**1 003**	**283**	485	183	-	-	**485**	**183**
Other	3 583	1 281	9 127	23 325	**12 710**	**24 606**	3 948	2 417	9 011	29 135	**12 959**	**31 552**
Total	**286 634**	**187 221**	**126 568**	**88 988**	**413 202**	**276 209**	**143 979**	**122 931**	**166 361**	**109 411**	**310 340**	**232 342**
Pelagic and other finfish												
Herring/sardines	194 126	24 572	40 669	67 999	**234 795**	**92 571**	205 562	27 328	40 218	80 000	**245 780**	**107 328**
Mackerel	26 124	7 208	-	-	**26 124**	**7 208**	19 961	6 797	2	2	**19 963**	**6 799**
Swordfish	..	..	..	..	..	..	1 675	14 050	-	-	**1 675**	**14 050**
Tuna	524	5 878	322	755	**846**	**6 433**	608	9 467	634	1 444	**1 242**	**10 911**
Alewife	5 680	1 306	-	-	**5 680**	**1 306**	5 825	1 824	-	-	**5 825**	**1 624**
Eel	393	1 650	-	-	**393**	**1 650**	568	2 333	-	-	**568**	**2 333**
Salmon	134	625	81 743	189 338	**81 877**	**189 963**	107	548	65 399	250 485	**65 506**	**251 033**
Skate	293	47	224	38	**517**	**85**	6 362	2 250	378	218	**6 740**	**2 466**
Smelt	889	923	1	3	**890**	**926**	1 363	1 751	3	8	**1 366**	**1 759**
Capelin	47 441	13 409	-	-	**47 441**	**13 409**	2 140	554	-	-	**2 140**	**554**
Other	5 427	18 739	886	797	**6 313**	**13 409**	5 133	5 153	986	1 044	**6 119**	**6 197**
Total	**281 031**	**74 157**	**123 845**	**258 930**	**404 876**	**326 960**	**249 305**	**71 856**	**107 619**	**333 201**	**356 924**	**405 057**
Shellfish												
Clams/quahaug	24 081	24 530	3 582	27 980	**27 663**	**52 510**	26 046	27 007	3 955	37 360	**30 001**	**64 367**
Oysters	621	1 193	5 250	4 200	**5 871**	**5 393**	2 630	4 604	5 000	4 400	**7 630**	**9 004**
Scallop	88 586	115 718	-	-	**88 586**	**115 718**	91 347	138 592	107	504	**91 454**	**139 096**
Squid	2 701	568	-	-	**2 701**	**568**	5 778	2 972	165	187	**5 943**	**3 158**
Mussels	..	..	..	..	..	..	6 118	6 496	-	-	**6 118**	**6 496**
Lobster	40 098	293 718	-	-	**40 098**	**293 718**	41 122	351 109	-	-	**41 122**	**351 109**
Shrimps	38 037	81 299	4 262	12 140	**42 299**	**93 439**	48 830	99 107	4 185	15 577	**53 015**	**114 684**
Crab	62 611	112 544	6 242	18 550	**68 853**	**131 094**	64 870	271 972	5 645	24 158	**70 515**	**296 129**
Other	3 295	5 025	7 454	10 815	**10 749**	**15 640**	3 555	5 462	7 096	11 624	**10 651**	**17 086**
Total	**260 030**	**634 595**	**26 790**	**73 485**	**286 820**	**708 080**	**290 295**	**907 320**	**26 151**	**93 808**	**316 446**	**1 001 128**
Miscellaneous items[4]	17 931	6 271	200	1 060	**18 131**	**7 331**	32 379	14 488	277	17 201	**32 656**	**31 689**
Total sea fisheries	**845 626**	**902 244**	**277 403**	**422 463**	**1 123 029**	**1 318 580**	**715 958**	**1 118 595**	**300 408**	**553 621**	**1 016 366**	**1 670 216**
Total inland fisheries	...	...	...	...	**36 757**	**69 754**	...	...	...	...	..	..
Grand total	**845 626**	**902 244**	**277 403**	**422 463**	**1 159 786**	**1 388 334**	**715 958**	**1 116 595**	**300 408**	**553 621**	**1 016 366**	**1 670 216**

Notes:
Figures may not add due to rounding.
1. Quantity in tonnes, live weight.
2. Pacific cod includes grey cod only.
3. Hake catches include over-the-side sales to foreign vessels.
4. Contains marine plants and lumpfish roe. May contain other miscellaneous items.

Source:
Department of Fisheries and Oceans Canada, Biological Sciences and Industry Development and Programs Directorate.

Table A2.5

Reserves of Crude Oil and Natural Gas by Province and Territory, December 31, 1986-1994

	Year	Canada	Eastern Canada	East coast offshore	Ont.	Man.	Sask.	Alta.	B.C.	Mainland territories	Mackenzie Delta/ Beaufort Sea	Arctic Islands
Crude oil (thousand cubic metres)												
	1986	**944 411**	2	83 000	904	10 522	106 296	632 743	18 500	27 460	64 950	34
	1987	**940 162**	2	83 000	794	10 485	106 146	631 315	17 013	26 358	64 950	99
	1988	**975 148**	5	133 000	1 311	8 838	112 838	611 518	17 934	24 610	64 950	144
	1989	**937 993**	5	138 600	1 324	8 349	111 909	582 531	18 490	22 734	53 950	101
	1990	**887 957**	5	138 600	1 414	8 351	116 896	530 205	17 566	20 893	53 950	77
	1991	**841 302**	5	138 600	1 323	7 806	110 336	489 959	17 662	21 609	53 950	52
	1992	**809 734**	5	138 020	1 224	7 144	119 515	452 143	17 911	19 748	53 950	74
	1993	**800 586**	5	137 017	1 169	6 534	131 213	435 003	17 549	17 979	53 950	167
	1994	**778 793**	5	135 695	2 046	6 477	135 283	409 543	19 431	16 249	53 950	114
Natural gas (million cubic metres)												
	1986	**2 745 510**	141	-	17 444	-	61 305	1 749 997	240 307	11 636	258 310	406 370
	1987	**2 692 783**	125	-	17 949	-	60 705	1 727 725	210 327	11 272	258 310	406 370
	1988	**2 670 545**	98	-	18 311	-	56 283	1 688 054	210 094	11 205	280 130	406 370
	1989	**2 732 449**	90	-	17 529	-	74 791	1 705 559	218 393	10 987	298 730	406 370
	1990	**2 725 390**	72	-	16 903	-	78 880	1 689 884	223 638	10 913	298 730	406 370
	1991	**2 710 869**	72	-	16 718	-	71 182	1 678 553	229 215	10 029	298 730	406 370
	1992	**2 671 554**	71	-	16 881	-	70 409	1 621 675	247 335	9 883	298 730	406 370
	1993	**2 232 256**	111	-	17 217	-	80 927	1 578 959	246 957	9 355	298 730	-[1]
	1994	**1 897 990**	111	-	13 415	-	85 301	1 547 640	242 227	9 297	-[2]	-[1]

Notes:
Figures may not add due to rounding.
1. Reserves of natural gas in the Arctic Islands are no longer considered as economically recoverable.
2. Reserves of natural gas in the Mackenzie Delta and Beaufort Sea are no longer considered as economically recoverable.
Source:
Canadian Petroleum Association, *Statistical Handbook*, Calgary, various issues.

Table A2.6

Quantity of Production of Crude Oil and Natural Gas by Province and Territory, 1986-1994

	Year	Canada	Eastern Canada	East coast offshore	Ont.	Man.	Sask.	Alta.	B.C.	Yukon[1]	N.W.T.[1]
Crude oil (thousand cubic metres)											
	1986	**69 226**	--	-	138	823	11 688	53 082	2 020	-	1 478
	1987	**71 823**	--	4	138	782	12 078	55 170	2 084	-	1 570
	1988	**74 495**	-	-	191	769	12 168	57 653	1 882	-	1 833
	1989	**70 977**	-	-	244	723	11 633	54 605	1 888	-	1 884
	1990	**70 179**	-	-	247	738	12 431	52 973	1 926	-	1 864
	1991	**69 362**	-	-	235	713	12 390	52 085	2 013	-	1 927
	1992	**71 898**	-	576	224	656	13 355	53 175	2 033	-	1 878
	1993	**75 233**	-	1 016	253	635	14 939	54 548	2 004	-	1 838
	1994	**78 382**	-	1 313	263	658	17 184	55 197	1 987	-	1 779
Natural gas (million cubic metres)											
	1986	**91 667**	1	-	504	-	2 204	80 303	8 374	-	282
	1987	**99 490**	1	-	508	-	2 751	86 259	9 724	-	249
	1988	**114 135**	-	-	509	-	4 156	98 577	10 687	-	205
	1989	**118 706**	-	-	492	-	5 506	99 747	12 788	-	171
	1990	**121 696**	-	-	449	-	6 552	102 748	11 800	-	147
	1991	**129 596**	-	-	428	-	7 172	106 851	14 712	-	434
	1992	**143 205**	-	-	427	-	7 030	118 895	16 134	506	213
	1993	**155 030**	-	-	411	-	7 372	129 129	17 399	491	228
	1994	**166 531**	-	-	429	-	8 157	138 265	19 025	470	185

Notes:
Figures may not add due to rounding.
1. From 1986 to 1991, production data for the Yukon and N.W.T. are reported together under the N.W.T.
Source:
Statistics Canada, *The Crude Petroleum and Natural Gas Industry*, Catalogue No. 26-213, Ottawa, various issues.

Table A2.7

Selected Metal Reserves by Province and Territory, December 31, 1986-1993

	Year	Canada	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	Yukon	N.W.T.
Copper (thousand tonnes)														
	1986	**13 331**	-	-	62	330	623	6 260	492	5	-	5 560	-	-
	1987	**12 939**	-	-	62	311	806	6 103	475	5	-	5 177	-	-
	1988	**12 693**	-	-	34	302	838	5 866	515	5	-	5 133	-	-
	1989	**12 258**	-	-	21	471	844	5 514	519	2	-	4 889	-	-
	1990	**11 203**	-	-	11	375	775	5 050	538	-	-	4 454	-	-
	1991	**11 115**	-	-	-	238	1 601	4 695	422	3	-	4 156	-	-
	1992	**10 818**	-	-	-	234	1 503	4 960	421	-	-	3 699	-	-
	1993	**9 784**	-	-	-	230	930	4 735	425	-	-	3 466	-	-
Nickel (thousand tonnes)														
	1986	**6 704**	-	-	-	-	-	4 908	1 796	-	-	-	-	-
	1987	**6 605**	-	-	-	-	-	4 822	1 784	-	-	-	-	-
	1988	**6 279**	-	-	-	-	-	4 546	1 733	-	-	-	-	-
	1989	**6 132**	-	-	-	-	-	4 461	1 672	-	-	-	-	-
	1990	**5 792**	-	-	-	-	-	4 208	1 584	-	-	-	-	-
	1991	**5 691**	-	-	-	-	-	4 162	1 529	-	-	-	-	-
	1992	**5 605**	-	-	-	-	-	4 160	1 445	-	-	-	-	-
	1993	**5 409**	-	-	-	-	-	4 036	1 372	-	-	-	-	-
Lead (thousand tonnes)														
	1986	**7 167**	-	-	-	3 648	-	133	25	--	-	1 256	1 275	831
	1987	**6 694**	-	-	-	3 551	-	104	25	--	-	1 180	1 212	621
	1988	**6 969**	-	-	-	3 482	-	101	20	-	-	1 071	1 755	540
	1989	**6 941**	-	-	68	3 839	9	100	17	-	-	999	1 404	506
	1990	**6 317**	-	-	29	3 383	28	94	13	-	-	957	1 358	456
	1991	**4 954**	-	-	-	2 463	23	63	9	-	-	908	1 093	397
	1993	**4 348**	-	-	-	2 264	20	53	11	-	-	786	856	358
	1993	**4 152**	-	-	-	2 176	24	66	9	-	-	728	825	325
Zinc (thousand tonnes)														
	1986	**22 423**	58	-	104	8 964	987	3 972	641	1	-	2 516	1 958	3 222
	1987	**20 636**	95	-	104	8 736	897	3 454	612	1	-	2 435	1 765	2 538
	1988	**21 116**	36	-	60	8 575	836	3 265	1 016	2	-	2 270	2 816	2 239
	1989	**21 688**	16	-	160	9 704	1 414	2 999	1 084	1	-	1 934	2 250	2 126
	1990	**20 091**	-	-	76	8 700	1 224	2 689	1 145	-	-	1 942	2 419	1 897
	1991	**16 448**	-	-	-	6 156	1 732	2 213	887	4	-	1 889	1 957	1 609
	1992	**15 067**	-	-	-	5 738	1 710	1 819	938	-	-	1 835	1 502	1 524
	1993	**14 213**	-	-	-	5 566	1 097	1 973	969	-	-	1 810	1 451	1 348
Silver (tonnes)														
	1986	**26 694**	-	-	-	9 759	1 506	6 893	721	2	-	5 838	1 849	126
	1987	**25 648**	-	-	-	9 699	1 501	6 057	729	2	-	5 621	1 896	143
	1988	**26 959**	-	-	-	9 933	1 200	5 802	812	3	-	6 140	2 943	127
	1989	**26 790**	4	-	-	10 761	1 620	5 504	787	1	-	5 624	2 349	141
	1990	**23 227**	4	-	-	9 498	1 311	5 027	757	1	-	4 162	2 339	127
	1991	**19 069**	2	-	-	7 003	2 074	4 422	654	3	-	2 838	1 953	121
	1992	**16 300**	3	-	-	6 456	2 008	4 106	398	-	-	2 098	1 119	113
	1993	**15 667**	2	-	-	6 227	1 424	4 106	451	-	-	2 017	1 324	117
Gold (tonnes)														
	1986	**1 496**	43	-	-	72	229	882	40	2	-	163	7	57
	1987	**1 727**	41	-	-	59	297	998	58	1	-	167	13	91
	1988	**1 914**	38	-	2	74	373	1 017	50	7	-	172	40	142
	1989	**1 748**	41	-	1	69	352	951	40	4	-	124	29	136
	1990	**1 548**	39	-	-	59	343	812	34	13	-	117	26	105
	1991	**1 443**	27	-	-	46	342	766	29	14	-	103	24	95
	1992	**1 367**	27	-	-	42	319	746	29	2	-	88	18	97
	1993	**1 337**	23	-	-	40	268	761	37	5	-	72	18	113

Note:
Figures may not add due to rounding.
Source:
Natural Resources Canada, *Canadian Minerals Yearbook, Review and Outlook*, Ottawa, various issues.

Table A2.8

Production of Selected Metals by Province and Territory, 1986-1995

	Year	Canada	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	Yukon	N.W.T.
Copper (tonnes)	1986	**698 527**	-	-	-	6 298	51 622	264 870	65 369	3 506	-	306 855	6	1
	1987	**794 149**	-	-	x	7 233	66 848	287 354	66 121	2 335	-	364 134	x	2
	1988	**758 478**	-	-	-	7 966	47 633	286 536	53 072	2 168	-	360 570	x	1
	1989	**704 432**	-	-	x	7 802	65 135	271 914	50 484	x	-	308 348	-	-
	1990	**771 433**	-	-	x	8 620	99 138	273 448	55 506	x	-	333 883	-	-
	1991	**780 362**	-	-	x	10 476	113 931	261 899	54 875	x	-	338 642	-	-
	1992	**761 694**	-	-	-	13 697	91 950	272 242	60 024	-	-	323 781	-	-
	1993	**709 650**	231	-	-	11 190	78 973	277 461	56 502	-	-	285 293	-	-
	1994	**590 784**	548	-	-	8 562	69 150	224 801	41 293	-	-	246 430	-	-
	1995[p]	**704 863**	2 414	-	-	13 617	110 000	250 587	46 754	-	-	281 492	-	-
Nickel (tonnes)	1986	**163 639**	-	-	-	-	-	121 851	41 788	-	-	-	-	-
	1987	**189 086**	-	-	-	-	-	130 171	58 915	-	-	-	-	-
	1988	**198 744**	-	-	-	-	-	128 558	70 186	-	-	-	-	-
	1989	**195 554**	-	-	-	-	-	130 632	64 922	-	-	-	-	-
	1990	**195 004**	-	-	-	-	-	128 828	66 176	-	-	-	-	-
	1991	**188 098**	-	-	-	-	-	125 790	62 309	-	-	-	-	-
	1992	**177 555**	-	-	-	-	-	118 860	58 695	-	-	-	-	-
	1993	**178 529**	-	-	-	-	-	125 833	52 696	-	-	-	-	-
	1994	**141 974**	-	-	-	-	-	106 852	35 122	-	-	-	-	-
	1995[p]	**166 842**	-	-	-	-	-	127 828	39 014	-	-	-	-	-
Lead (tonnes)	1986	**334 342**	-	-	-	66 590	-	8 288	590	-	-	91 947	35 091	133 836
	1987	**373 215**	-	-	x	66 485	-	6 092	x	-	-	57 078	x	131 744
	1988	**351 148**	-	-	-	74 543	-	2 485	457	-	-	105 103	117 058	51 502
	1989	**268 887**	-	-	-	65 180	-	1 074	1 365	-	-	67 006	94 529	39 734
	1990	**233 372**	-	-	x	56 244	-	x	1 755	-	-	19 312	104 181	46 588
	1991	**248 102**	-	-	x	51 957	-	x	2 286	-	-	63 385	93 912	35 388
	1992	**339 626**	-	-	834	80 885	-	-	1 487	-	-	81 591	135 688	39 141
	1993	**183 105**	-	-	-	72 108	-	-	1 933	-	-	52 030	27 857	29 178
	1994	**167 584**	-	-	-	76 019	-	-	422	-	-	57 017	-	34 126
	1995[p]	**203 050**	-	-	-	85 105	-	-	-	-	-	59 403	27 000	31 542
Zinc (tonnes)	1986	**988 173**	5 712	-	-	161 807	37 126	265 248	61 463	3 527	-	137 583	50 634	285 073
	1987	**1 157 936**	7 643	-	-	180 298	91 139	294 309	63 551	1 764	-	114 117	147 045	258 070
	1988	**1 370 000**	31 817	-	x	261 089	82 031	326 698	53 746	x	-	142 833	143 939	325 321
	1989	**1 272 854**	27 362	-	x	201 550	100 638	266 158	72 096	x	-	119 376	154 709	329 001
	1990	**1 179 372**	16 463	-	x	233 933	120 599	276 110	77 507	x	-	59 346	168 846	218 241
	1991	**1 083 008**	-	-	x	209 790	117 404	213 599	88 486	x	-	125 980	149 487	173 154
	1992	**1 195 736**	-	-	582	301 020	107 466	190 523	89 211	-	-	133 149	202 304	171 481
	1993	**990 727**	-	-	-	303 985	131 852	179 049	89 658	-	-	107 457	35 204	143 521
	1994	**976 309**	-	-	-	291 796	139 898	163 658	93 607	-	-	115 510	-	171 840
	1995[p]	**1 093 541**	-	-	-	334 853	163 000	157 118	79 680	-	-	138 924	41 000	178 965
Silver (tonnes)	1986	**1 088**	-	-	-	163	62	348	37	3	--	380	73	22
	1987	**1 475**	-	-	--	182	163	441	41	2	--	401	133	13
	1988	**1 443**	x	-	x	203	140	434	32	x	-	447	159	26
	1989	**1 312**	x	-	x	191	148	349	36	x	-	498	71	18
	1990	**1 381**	x	-	x	145	164	330	41	x	-	598	84	19
	1991	**1 261**	x	-	x	158	164	294	43	x	-	497	87	17
	1992	**1 169**	x	-	--	254	143	248	40	x	-	345	124	16
	1993	**879**	x	-	-	223	143	232	38	x	-	201	30	11
	1994	**740**	x	-	-	226	139	196	34	x	-	127	1	17
	1995[p]	**1 195**	x	-	-	283	164	245	35	x	-	448	1	18
Gold (kilograms)	1986	**102 899**	-	-	-	374	28 342	46 279	2 555	14	36	9 249	3 547	12 503
	1987	**115 818**	x	-	x	420	29 543	52 917	3 697	1 048	43	11 224	4 874	11 740
	1988	**134 813**	x	-	x	393	33 536	62 463	4 469	1 480	27	13 067	5 052	11 880
	1989	**159 494**	x	-	x	359	36 966	78 675	4 056	2 829	25	15 635	5 652	12 208
	1990	**167 373**	x	-	x	x	40 675	79 968	2 680	3 374	32	16 105	4 639	15 557
	1991	**175 282**	x	-	-	x	51 923	77 170	2 921	2 899	34	17 467	3 865	16 752
	1992	**160 351**	x	-	-	490	44 589	74 836	3 106	x	34	16 773	3 737	13 518
	1993	**153 129**	x	-	-	361	41 843	72 441	3 001	x	65	13 865	3 538	13 205
	1994	**146 428**	x	-	-	365	40 932	69 155	2 608	x	34	12 191	3 345	13 140
	1995[p]	**149 026**	x	-	-	401	39 011	63 200	3 529	x	21	19 188	4 563	13 758

Note:
Figures may not add due to rounding.
Sources:
Statistics Canada, *General Review of the Mineral Industries, Mines, Quarries and Oil Wells*, Catalogue No. 26-201, Ottawa, various issues.
Statistics Canada, *Canada's Mineral Production, Preliminary Estimates*, Catalogue No. 26-202, Ottawa, various issues.

Table A2.9

Value of Mineral Production, 1986-1995

Year	Canada	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	Yukon	N.W.T.
							million dollars						
1986	**32 446**	817	2	367	502	2 191	4 825	764	2 525	16 331	3 160	176	788
1987	**36 361**	743	3	407	624	2 780	5 652	1 000	3 151	17 080	3 615	437	870
1988	**36 955**	865	2	446	911	2 712	6 895	1 627	3 043	15 062	3 943	492	957
1989	**39 333**	897	2	442	859	2 878	7 308	1 668	3 017	16 456	4 123	534	1 149
1990	**40 778**	866	3	459	878	3 037	6 446	1 311	3 183	19 110	3 954	542	988
1991	**35 190**	772	3	460	671	2 930	5 101	1 125	2 863	16 373	3 840	349	703
1992	**35 414**	706	2	523	910	2 694	4 776	1 082	3 158	16 885	3 500	496	681
1993	**36 564**	699	1	558	772	2 692	4 535	862	3 238	18 925	3 538	140	603
1994	**41 151**	837	1	610	862	2 956	4 921	820	4 225	21 085	4 066	86	680
1995[p]	**43 368**	906	1	566	1 002	3 082	5 833	1 052	4 634	20 830	4 523	185	753

Notes:
Figures may not add due to rounding.
Figures include the shipments of fuels, metals and structural materials of all establishments in Canada, regardless of their industrial classification.
Source:
Statistics Canada, *Canada's Mineral Production, Preliminary Estimates*, Catalogue No. 26-202, Ottawa, various issues.

Table A2.10

Selected Statistics on Energy by Province and Territory, 1986-1994

	Year	Canada	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	Yukon and N.W.T.
Production[1] (petajoules)													
	1986	**9 736.4**	141.0	-	82.7	44.7	535.5	410.3	117.7	693.3	6 486.5	1 152.0	72.7
	1987	**10 250.4**	136.1	-	83.6	41.2	566.4	400.3	99.8	732.0	6 852.5	1 262.6	75.9
	1988	**11 175.4**	143.0	-	101.9	43.6	537.8	421.4	85.2	820.7	7 577.3	1 359.5	85.0
	1989	**11 349.7**	118.1	-	103.6	41.6	518.0	424.1	94.0	845.9	7 637.6	1 482.0	84.7
	1990	**11 392.6**	125.0	-	101.6	46.7	482.4	402.2	100.1	901.1	7 669.7	1 478.7	85.2
	1991	**11 789.0**	127.5	-	121.8	43.8	512.9	436.6	108.8	887.3	7 869.0	1 588.6	92.6
	1992	**12 217.5**	125.6	-	131.1	39.0	527.7	421.6	120.6	969.2	8 388.3	1 394.1	100.3
	1993	**12 995.2**	141.2	-	107.2	40.7	557.5	461.6	121.4	1 021.1	8 893.2	1 553.3	98.0
	1994	**13 890.2**	135.2	-	103.8	37.8	587.9	499.3	127.1	1 166.0	9 470.1	1 666.2	96.8
Total domestic consumption[1,2,3] (petajoules)													
	1986	**7 844.6**	129.7	17.5	221.6	175.7	1 421.5	2 700.6	240.7	408.0	1 769.4	725.6	34.2
	1987	**8 070.2**	137.8	19.2	227.8	190.1	1 444.4	2 771.4	234.4	420.7	1 824.8	768.2	31.3
	1988	**8 585.6**	143.2	20.5	236.5	214.6	1 540.1	2 919.7	260.0	454.7	1 943.3	821.1	31.9
	1989	**8 947.0**	155.6	22.2	243.4	234.4	1 574.4	3 033.7	260.6	460.0	2 053.6	877.9	31.2
	1990	**8 590.8**	158.1	22.5	243.2	225.6	1 521.4	2 785.3	257.5	457.3	2 019.2	871.1	31.6
	1991	**8 515.6**	145.7	22.1	236.1	221.6	1 473.5	2 788.0	255.8	443.9	2 042.2	855.6	31.0
	1992	**8 756.7**	142.8	21.9	243.4	228.3	1 523.8	2 859.1	257.8	513.9	2 084.2	649.1	32.5
	1993	**8 830.5**	142.8	22.4	242.3	223.7	1 555.5	2 828.4	263.1	520.0	2 102.1	897.1	33.0
	1994	**9 056.7**	126.9	22.1	235.5	232.3	1 578.2	2 838.2	266.4	563.5	2 235.2	920.5	37.9
Consumption per capita (gigajoules)													
	1986	**299.4**	224.4	135.9	248.4	241.4	211.1	285.0	220.0	395.0	725.6	240.2	426.4
	1987	**304.0**	239.0	148.8	254.2	260.2	212.2	286.2	213.0	405.9	746.8	250.7	383.1
	1988	**319.2**	248.5	158.1	262.7	292.7	224.5	295.4	235.4	440.7	789.0	262.5	383.4
	1989	**326.8**	269.5	170.0	268.4	317.6	226.6	298.9	235.6	449.7	820.0	273.6	367.5
	1990	**309.1**	269.6	171.8	266.5	303.6	216.7	269.3	232.3	452.4	789.9	264.0	361.6
	1991	**302.8**	251.1	169.0	257.2	296.1	208.1	266.2	229.9	441.1	785.1	253.2	342.9
	1992	**306.6**	244.6	166.4	263.1	303.1	213.0	268.6	230.5	509.6	786.8	244.1	349.8
	1993	**305.1**	244.3	168.2	260.3	296.0	215.2	261.4	233.9	514.1	761.9	251.0	350.7
	1994	**309.6**	218.2	164.2	251.8	306.3	216.7	259.6	235.5	555.9	822.1	251.0	401.9

Notes:
1. Total for Canada is the sum of all provinces and territories.
2. Domestic consumption data are equivalent to gross availability data in Statistics Canada Catalogue No. 57-003.
3. Includes consumption of energy commodities for non-energy purposes.
Source:
Statistics Canada, *Quarterly Report on Energy Supply-Demand in Canada*, Catalogue No. 57-003, Ottawa, various issues.

Table A2.11

Federal Government Environmental Protection Expenditures, 1986-1994

	1986	1987	1988	1989	1990	1991	1992	1993[e]	1994[e]
	thousand dollars								
Pollution abatement and control									
Sewage collection and disposal	-	-	-	-	-	-	150	275	-
Pollution control	61 983	67 297	87 142	113 085	118 855	20 221	4 329	1 004	5 870
Other environmental services	383 744	430 794	442 869	497 185	571 471	682 955	709 679	749 906	929 389
Total[1]	**445 727**	**498 091**	**530 011**	**610 270**	**690 326**	**703 176**	**714 158**	**751 185**	**935 259**
Natural resource conservation and development									
Agriculture	3 238 420	4 720 870	3 614 210	3 011 500	2 592 670	4 622 130	3 237 910	2 881 500	2 436 520
Fish and game	388 334	328 401	393 464	402 070	470 382	483 973	693 646	692 158	573 942
Forests	224 701	660 250	311 776	284 463	215 421	206 653	236 048	237 655	225 869
Mines, oil and gas	1 094 980	708 981	767 246	365 551	383 426	325 310	321 573	497 388	568 992
Other resource conservation and development	702 999	650 481	707 769	760 003	725 538	623 016	620 308	591 718	522 337
Total	**5 649 440**	**7 068 990**	**5 794 400**	**4 823 590**	**4 387 440**	**6 261 080**	**5 109 490**	**4 900 420**	**4 327 660**

Notes:
Figures may not add due to rounding.
includes transfer payments to other levels of government.
1. There are no federal government expenditures on waste collection and disposal.
Source:
Statistics Canada, Public Institutions Division.

Table A2.12

Provincial and Territorial Government Environmental Protection Expenditures, 1988-1992

Year	Canada	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	Yukon	N.W.T.
	thousand dollars												
Pollution abatement and control													
Sewage collection and disposal[1]													
1988	77 526	-	2 018	-	9 663	-	-	3 594	-	-	61 156	-	1 094
1989	72 412	-	-	720	9 554	-	-	-	-	-	59 729	2 409	-
1990[r]	75 327	-	-	127	9 367	-	-	-	95	-	63 557	2 181	-
1991[r]	100 597	-	-	92	8 191	-	-	-	64	-	89 873	2 377	-
1992	97 741	-	933	47	6 730	-	-	-	49	-	67 715	2 268	-
Waste collection and disposal													
1988	54 022	330	2 098	2 878	3 899	-	27 488	2 039	-	262	15 028	-	-
1989	114 495	163	2 150	8 817	4 579	-	36 648	5 481	-	31 029	25 425	202	-
1990[r]	121 947	296	2 268	12 546	5 850	-	50 234	5 415	-	38 515	6 687	158	-
1991[r]	156 545	261	3 170	12 672	5 907	-	73 066	6 493	8	40 108	14 657	202	-
1992	161 330	361	3 710	7 483	8 483	-	60 391	6 659	-	42 575	11 446	223	-
Other pollution control													
1988	226 639	2 754	128	-	9 320	23 766	134 829	263	4 009	47 997	2 685	-	689
1969	280 066	3 679	113	4 601	13 802	19 820	168 239	393	4 314	40 973	3 437	32	662
1990	296 300	2 559	176	5 312	13 834	-	202 993	399	29 465	40 754	11	8	789
1991	341 901	2 956	348	6 103	18 420	-	240 212	746	29 730	42 626	-	-	759
1992	295 129	3 014	286	2 248	16 910	-	220 643	393	4 579	44 687	1 684	-	705
Other environmental services													
1988	164 641	-	1 644	3 222	1 247	58 377	4 269	8 586	67 188	21 142	-	-	966
1989	202 524	1 525	2 585	15 722	1 840	74 925	4 530	8 537	71 500	7 813	12 936	500	111
1990[r]	373 895	16	3 117	18 029	6 045	147 799	12 813	9 351	74 464	9 410	92 408	444	-
1991[r]	451 019	22	3 012	18 437	17 627	157 476	12 430	10 100	121 699	11 500	98 067	589	62
1992	382 309	1 799	2 277	21 115	12 142	170 805	14 221	14 203	43 859	7 397	93 758	722	10
Total pollution abatement and control													
1988	522 828	3 083	5 687	6 101	24 129	80 143	166 586	14 482	71 197	69 401	79 069	-	2 748
1989	669 496	5 367	4 848	29 861	29 776	94 745	229 416	14 410	75 814	79 815	101 527	3 143	774
1990[r]	667 469	2 871	5 561	36 014	35 096	147 799	266 040	15 165	104 023	88 679	162 642	2 790	789
1991[r]	1 050 062	3 239	6 530	37 304	50 145	157 476	325 708	17 339	151 500	94 234	202 597	3 168	621
1992	936 508	5 174	7 206	30 893	44 264	170 805	315 255	21 255	48 486	94 639	194 604	3 212	715

Table A2.12

Provincial and Territorial Government Environmental Protection Expenditures, 1988-1992 (concluded)

Year	Canada	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	Yukon	N.W.T.
						thousand dollars							
Natural resource conservation and development													
Agriculture													
1988	2 726 916	16 943	31 592	42 838	25 308	654 287	340 495	242 983	636 169	636 311	99 634	346	10
1989	2 834 386	18 629	34 309	40 853	30 577	638 860	329 100	278 030	611 185	755 443	97 062	326	11
1990[r]	2 895 463	15 921	33 580	42 658	35 308	717 880	385 949	177 829	656 309	723 411	106 453	347	18
1991[r]	4 146 636	13 101	42 660	39 741	37 910	835 784	393 517	473 086	1 174 851	1 043 009	92 449	485	42
1992	3 850 594	14 400	36 509	40 360	46 520	840 706	484 498	287 978	851 669	1 175 665	71 708	580	-
Fish and game													
1988	302 864	43 445	3 313	10 713	14 830	87 862	63 249	6 797	5 593	25 668	28 889	6 008	6 496
1989	342 942	50 158	3 363	8 562	27 608	95 092	70 067	10 403	6 876	27 198	29 529	6 462	7 624
1990[r]	346 447	44 750	3 742	6 903	23 905	111 413	77 668	9 686	9 621	28 907	16 092	5 814	7 943
1991[r]	336 311	32 444	4 066	7 628	20 956	99 392	85 151	8 538	10 819	31 457	21 852	5 796	8 212
1992	348 585	39 960	3 836	7 180	23 108	104 159	75 375	11 149	10 836	33 468	22 805	5 923	10 787
Forests													
1988	1 247 665	25 560	5 120	42 272	26 773	288 803	284 927	13 670	11 748	113 933	416 771	10	18 079
1989	1 394 897	29 767	5 739	80 212	21 765	292 842	266 760	15 699	69 916	111 643	468 092	788	31 674
1990[r]	1 416 206	31 032	6 603	51 736	26 445	298 156	286 626	19 589	50 442	140 452	481 048	875	23 202
1991[r]	1 485 726	26 602	6 722	50 064	30 629	310 038	293 912	17 834	81 156	117 001	524 565	848	26 356
1992	1 352 564	26 794	7 095	48 338	28 077	295 670	225 904	14 754	32 616	115 320	533 811	1 455	22 729
Mines, oil and gas													
1988	977 089	12 456	-	14 436	3 483	79 996	36 437	10 753	17 268	704 543	54 875	1 690	41 153
1989	1 340 073	13 385	-	9 741	3 229	76 756	41 753	10 203	379 331	707 789	48 868	3 037	45 983
1990[r]	982 137	18 030	-	10 640	3 886	81 812	41 592	9 782	126 073	603 688	37 330	1 271	48 031
1991[r]	1 138 269	40 810	-	11 567	2 871	78 486	41 690	10 950	316 613	531 617	53 027	1 331	49 308
1992	676 355	47 136	-	10 787	2 751	59 719	37 414	8 280	17 671	432 216	7 515	2 617	50 250
Other resource conservation and development													
1988	837 672	4 470	5 101	4 834	28 103	76 748	212 819	52 283	22 579	366 462	45 786	9 101	9 386
1989	860 072	3 711	6 979	5 454	35 271	80 178	224 993	74 531	26 831	269 099	110 895	5 568	16 562
1990[r]	760 292	4 540	6 013	5 053	33 160	78 907	263 169	45 359	22 768	212 998	61 890	7 013	19 422
1991[r]	791 669	4 043	5 441	9 369	29 465	65 955	312 277	28 114	22 042	213 629	74 132	6 534	20 668
1992	845 821	4 391	5 630	10 922	30 883	79 761	329 424	22 428	22 323	230 147	84 799	8 095	17 018
Total natural resource conservation and development													
1988	6 092 206	102 874	45 126	115 093	98 496	1 187 696	937 927	326 485	693 357	1 846 917	645 955	17 156	75 124
1989	6 772 370	115 650	50 390	144 823	118 450	1 183 728	932 672	388 865	1 094 139	1 871 171	754 447	16 180	101 855
1990[r]	6 400 545	114 273	49 938	116 991	122 704	1 288 168	1 055 004	262 045	865 213	1 709 458	702 814	15 321	98 616
1991[r]	7 898 611	117 000	58 889	118 368	121 832	1 389 655	1 126 547	538 522	1 605 480	1 936 712	766 027	14 994	104 586
1992	7 073 919	132 681	53 069	117 587	131 339	1 380 014	1 152 616	344 589	935 118	1 986 817	720 637	18 670	100 784
Parks													
1988	192 326	7 207	3 040	4 652	8 905	29 730	51 609	17 516	3 749	35 820	30 086	11	-
1989	227 059	6 458	3 293	15 289	9 575	30 048	57 660	17 157	16 402	33 074	37 243	861	-
1990[r]	225 894	6 442	3 663	7 186	10 053	31 707	68 408	18 278	17 072	33 020	31 500	565	-
1991[r]	204 653	6 644	3 654	6 838	9 450	32 569	57 154	16 374	15 449	27 559	28 550	412	-
1992	212 048	6 607	4 903	7 156	7 067	36 496	51 421	16 591	14 494	30 953	34 540	1 820	-

Notes:
Figures may not add due to rounding.
Fiscal years. Provincial and territorial government expenditures include intergovernmental transfer payments.
1. Some provinces and territories may report their sewage expenditures under water supply expenditures; these are considered as health protection expenditures and are therefore excluded. As an example, provincial government expenditures on water supply in 1992 were equal to $61 million in Newfoundland, $420 million in Quebec, $325 million in Ontario and $98.6 million in Alberta.
Source:
Statistics Canada, Public Institutions Division.

Table A2.13

Local Government Environmental Protection Expenditures, 1986-1994

Year	Canada	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	Yukon	N.W.T.
						thousand dollars							
Pollution abatement and control													
Sewage collection and disposal													
1986	1 138 023	15 870	1 861	19 523	27 222	298 598	446 513	55 779	34 313	116 101	114 158	1 234	4 851
1987	1 206 602	19 216	1 797	25 389	31 212	287 120	476 460	39 115	35 169	130 956	152 517	1 078	8 573
1988	1 413 609	19 426	1 796	38 941	30 740	377 887	597 643	40 072	36 301	118 368	142 171	1 483	8 781
1989	1 734 756	19 028	1 945	31 176	30 702	531 371	723 837	49 106	41 358	138 229	154 934	1 061	12 009
1990	2 001 997	24 951	2 165	38 281	40 240	659 991	778 073	52 055	42 458	181 963	185 334	2 074	14 412
1991	1 954 272	19 420	2 580	63 118	42 898	537 628	838 006	55 495	37 362	146 430	192 799	4 216	14 320
1992[p]	1 899 753	18 450	2 558	40 592	40 963	471 149	826 209	89 248	37 129	139 037	213 709	6 105	14 604
1993[p]	1 869 010	19 996	2 127	72 645	45 536	433 920	750 029	61 193	43 356	188 897	227 954	5 549	17 808
1994[1]	2 357 364	11 959	1 972	87 295	45 805	699 218	835 099	58 384	97 687	178 087	315 847	9 490	16 521
Waste collection and disposal													
1986	627 753	12 110	549	17 372	6 514	143 005	267 841	19 445	16 066	47 835	93 584	799	2 633
1987	714 493	11 264	480	46 967	8 229	154 344	297 685	21 613	20 583	50 146	99 156	488	3 536
1988	817 079	10 576	497	21 941	9 824	178 308	391 866	24 526	17 841	53 813	103 199	625	4 063
1989	935 818	11 915	581	24 059	12 156	195 986	462 601	26 080	16 786	58 925	122 472	580	3 697
1990	1 125 905	12 044	612	31 928	13 305	223 016	584 145	25 682	17 595	66 592	146 467	640	3 879
1991	1 226 222	14 183	667	41 172	14 825	267 306	607 933	26 043	17 993	72 961	160 562	684	3 893
1992[p]	1 274 745	13 405	882	41 401	15 258	292 196	606 829	31 123	20 787	81 615	166 224	831	4 194
1993[p]	1 228 072	12 300	825	40 843	16 066	300 507	548 422	30 220	19 761	60 626	172 373	883	7 246
1994[1]	1 355 882	12 379	928	52 737	16 130	334 091	609 580	34 156	19 555	90 494	180 227	948	4 657
Other environmental services[2]													
1986	76 909	5	-	200	-	33 978	39 960	471	58	163	2 058	-	16
1987	87 911	14	139	60	514	35 427	48 508	514	124	264	2 331	-	16
1988	75 200	14	151	107	404	32 988	37 769	676	193	273	2 614	-	11
1989	82 615	11	160	225	15	31 674	45 901	668	225	204	3 514	-	18
1990	82 331	6	176	286	1 854	32 024	43 182	733	274	-	3 695	-	101
1991	80 949	4	183	1 332	1 844	18 387	54 307	884	205	-	3 742	1	60
1992[p]	84 166	4	193	447	1 881	14 775	61 624	764	307	-	4 111	-	60
1993[p]	86 396	4	189	467	1 972	24 852	53 559	755	301	-	4 237	-	60
1994[1]	91 560	4	189	425	1 998	34 799	46 603	754	300	-	4 428	-	60
Total pollution abatement and control													
1986	1 842 685	27 985	2 410	37 095	33 736	475 581	756 314	75 695	50 437	164 099	209 800	2 033	7 500
1987	2 011 006	30 494	2 416	72 416	39 955	476 891	822 653	61 242	55 876	181 368	254 004	1 566	12 125
1988	2 305 888	30 016	2 444	60 989	40 968	589 183	1 027 278	65 274	54 335	172 454	247 984	2 108	12 855
1989	2 753 189	30 954	2 686	55 460	42 873	759 031	1 232 339	75 854	58 349	197 358	280 920	1 641	15 724
1990	3 210 233	37 001	2 953	70 495	55 399	915 031	1 405 400	78 470	60 327	228 555	335 496	2 714	18 392
1991	3 263 443	33 607	3 430	105 622	59 567	823 321	1 500 246	82 422	55 560	219 391	357 103	4 901	18 273
1992[p]	3 258 664	31 859	3 633	82 440	58 102	778 120	1 494 662	121 135	58 223	220 652	384 044	6 936	18 858
1993[p]	3 163 478	32 300	3 141	113 955	63 574	759 279	1 350 010	92 168	63 418	269 523	404 564	6 432	25 114
1994[1]	3 804 806	24 342	3 089	140 457	63 933	1 068 108	1 493 282	93 294	117 542	268 581	500 502	10 438	21 238
Natural resource conservation and development													
Agriculture													
1986	184 946	-	-	260	-	-	26 166	6 517	20 581	127 487	3 911	-	24
1987	170 102	284	-	259	-	-	27 041	6 792	20 420	111 012	4 261	-	33
1988	124 297	36	-	296	-	-	20 872	7 247	11 875	79 431	4 524	4	12
1989	163 413	-	-	346	3	1 912	22 126	7 864	20 632	105 507	4 995	17	11
1990	156 099	-	-	377	-	2 368	19 771	8 302	20 735	99 351	5 051	3	141
1991	168 376	-	-	373	-	2 645	26 245	7 601	25 811	99 764	5 610	6	121
1992[p]	155 243	-	-	331	-	56	13 489	7 692	27 113	101 010	5 540	1	11
1993[p]	156 775	-	-	341	-	17	13 204	7 736	27 271	102 652	5 469	1	64
1994[1]	157 570	-	-	341	-	-	13 460	7 604	27 299	103 244	5 821	1	0

Table A2.13

Local Government Environmental Protection Expenditures, 1986-1994 (concluded)

Year	Canada	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	Yukon	N.W.T.
	thousand dollars												
Other resource conservation and development													
1986	153 199	139	181	537	2 090	34 051	73 469	8 162	3 750	17 392	13 104	-	324
1987	196 185	184	190	657	4 730	38 488	108 173	8 868	3 340	9 961	21 421	36	137
1988	225 945	533	148	953	5 273	41 905	119 391	9 888	4 349	8 223	35 204	23	55
1989	252 980	723	-	1 934	4 535	61 826	139 722	9 944	3 371	10 815	19 671	100	339
1990	316 331	789	-	837	4 898	76 782	173 697	11 103	4 050	10 327	33 488	194	166
1991	328 878	818	-	1 060	4 817	84 100	170 408	12 262	8 191	10 157	36 747	186	132
1992[p]	325 906	806	-	1 501	4 049	69 278	184 919	13 677	7 986	10 061	33 365	206	58
1993[p]	352 645	747	-	1 517	3 655	93 580	183 793	12 297	7 954	15 344	33 544	156	58
1994[1]	301 805	762	-	1 201	3 587	48 400	183 348	10 786	7 663	11 819	34 021	156	62
Total natural resource conservation and development													
1986	338 145	139	181	797	2 090	34 051	99 635	14 679	24 331	144 879	17 015	-	348
1987	366 287	468	190	916	4 730	38 488	135 214	15 660	23 760	120 973	25 682	36	170
1988	350 242	569	148	1 249	5 273	41 905	140 263	17 135	16 224	87 654	39 728	27	67
1989	416 393	723	-	2 280	4 538	63 738	161 848	17 808	24 003	116 322	24 666	117	350
1990	472 430	789	-	1 214	4 898	79 150	193 468	19 405	24 785	109 678	38 539	197	307
1991	497 254	818	-	1 433	4 817	86 745	196 653	20 063	34 002	109 921	42 357	192	253
1992[p]	481 149	806	-	1 832	4 049	69 334	198 408	21 369	35 099	111 071	38 905	207	69
1993[p]	509 420	747	-	1 858	3 855	93 597	196 997	20 033	35 225	117 996	39 013	157	142
1994[1]	459 375	762	-	1 542	3 587	48 400	196 808	18 390	34 962	115 063	39 642	157	62

Notes:
Figures may not add due to rounding.
Fiscal years.
Transfers between municipalities and expenditures for parks are excluded.
1. Data for 1994 are forecasts.
2. Local government expenditures on other environmental services may include expenditures specific to pollution control.
Source:
Statistics Canada, Public Institutions Division.

Table A2.14

Selected Statistics on Population by Province and Territory, Selected Years

	Source	Canada	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	Yukon	N.W.T.
Total population[1] (thousands)														
1981	a	24 900.0	576.5	124.0	856.4	708.4	6 568.0	8 837.8	1 038.5	978.2	2 303.8	2 836.5	24.1	47.9
1986	a	26 203.8	578.1	128.8	892.1	727.7	6 733.8	9 477.2	1 094.0	1 032.9	2 438.7	3 020.4	24.8	55.4
1991	b	28 120.1	580.3	130.8	917.9	748.5	7 080.6	10 471.5	1 112.5	1 006.3	2 601.3	3 379.8	29.1	61.3
1992	b	28 542.2	583.7	131.6	925.1	753.3	7 154.8	10 645.6	1 118.3	1 008.5	2 649.0	3 479.1	30.3	62.6
1993	b	28 947.0	584.6	133.2	930.4	755.8	7 229.1	10 820.6	1 124.8	1 011.4	2 688.5	3 574.0	30.4	63.7
1994	b	29 251.3	581.7	134.6	935.1	758.4	7 294.0	10 931.4	1 131.2	1 013.6	2 719.0	3 667.9	29.6	64.7
1995	b	29 606.1	575.6	136.2	938.2	760.3	7 329.9	11 103.3	1 138.0	1 016.2	2 748.3	3 764.2	30.1	65.8
2016[2]	c	39 883.4	606.1	160.7	1 067.4	850.7	8 924.9	16 055.6	1 255.5	980.4	4 020.2	5 801.2	52.5	106.4
Average annual growth (percent)														
1981 to 1995	d	1.5	--	0.8	0.7	0.6	0.9	2.0	0.7	0.3	1.5	2.5	1.9	2.9
Total fertility rate[3]														
1981	e	1.70 [4]	..	1.91	1.64	1.71	1.61	1.63	1.66	2.14	1.94	1.71	2.14	3.00
1986	e	1.65	1.55	1.84	1.62	1.59	1.43	1.69	1.89	2.09	1.93	1.72	2.04	3.61
1991	f	1.70	1.44	1.85	1.58	1.54	1.65	1.66	1.97	2.03	1.89	1.67	2.14	2.86
1992	f	1.69	1.40	1.82	1.58	1.53	1.65	1.67	1.91	2.03	1.85	1.65	1.93	2.69
1993	f	1.66	1.31	1.72	1.56	1.50	1.61	1.64	1.95	1.96	1.79	1.61	1.91	2.67
Life expectancy at birth (years)														
1981 - Male	c	72.1	72.1	72.9	71.0	71.2	71.3	72.5	72.3	72.5	72.2	72.9	67.0 [5]	67.0 [5]
Female	c	79.3	78.8	80.5	78.6	79.2	78.9	79.2	78.9	79.9	79.3	79.8	74.9 [5]	74.9 [5]
1986 - Male	c	73.3	72.9	72.9	72.5	72.7	72.2	73.8	73.2	73.8	73.7	74.4	69.8 [5]	69.8 [5]
Female	c	80.2	79.3	80.4	79.5	80.1	79.7	80.0	80.0	80.5	80.3	80.8	77.5 [5]	77.5 [5]
1991 - Male	g	74.6	73.7	73.2	73.7	74.3	73.8	75.0	74.6	75.3	75.1	75.3	74.0	70.3
Female	g	81.0	79.5	80.8	80.3	80.9	80.9	81.0	80.8	81.6	81.2	81.4	76.8	76.2
1992 - Male	f	74.8	74.0	73.6	74.0	74.4	74.0	75.1	74.6	75.4	75.3	75.4	73.0	69.8
Female	f	81.0	79.9	80.7	80.6	60.9	81.0	61.0	80.8	81.7	81.2	81.5	77.5	74.6
1993 - Male	f	74.9	73.8	74.3	74.3	74.4	74.0	75.3	74.6	75.4	75.5	75.4	71.0	69.8
Female	f	81.0	80.3	80.1	80.6	80.6	80.9	81.0	80.7	81.8	81.8	81.4	80.9	74.3
Age-standardized mortality rate (deaths per 1 000 population)														
1981 - Male	f	10.5	10.3	10.0	11.4	10.8	11.0	10.4	10.6	9.5	10.2	9.6	15.5	10.2
Female	f	6.1	6.0	5.4	6.4	6.0	6.1	6.1	6.2	5.6	6.1	5.8	8.9	6.8
1986 - Male	f	9.8	10.1	10.3	10.6	10.4	10.7	9.6	9.9	9.3	9.3	6.6	11.0	10.5
Female	f	5.9	6.4	5.9	6.2	5.9	6.0	5.9	5.9	5.5	5.7	5.5	8.7	6.0
1991 - Male	f	9.1	9.8	10.4	9.6	9.2	9.7	8.9	8.9	8.5	8.6	8.4	10.3	10.0
Female	f	5.4	6.1	5.4	5.6	5.3	5.4	5.5	5.4	5.0	5.2	5.1	6.3	7.9
1992 - Male	f	8.9	9.5	9.4	9.8	9.2	9.3	8.8	8.9	8.1	8.4	8.3	7.4	12.2
Female	f	5.2	6.1	5.4	5.6	5.3	5.3	5.3	5.2	4.7	5.1	5.0	8.7	8.5
1993 - Male	f	8.9	9.8	9.5	9.6	9.1	9.5	8.7	9.1	8.3	8.4	8.4	11.4	12.0
Female	f	5.4	5.8	5.5	5.5	5.5	5.5	5.4	5.4	4.9	5.3	5.1	6.3	9.4
Infant mortality rate (deaths per 1 000 live births)														
1981	f	9.6	9.7	13.2	11.5	10.9	8.5	8.8	11.9	11.8	10.6	10.2	14.9	21.5
1986	f	7.9	8.0	6.7	8.4	8.3	7.1	7.2	9.2	9.0	9.0	8.5	24.8	18.6
1991	f	6.4	7.8	6.9	5.7	6.1	5.9	6.3	6.4	8.2	6.7	6.5	10.8	12.2
1992	f	6.1	7.1	1.6	6.0	8.3	5.4	5.9	6.8	7.3	7.2	6.2	3.8	16.7
1993	f	6.3	7.8	9.1	7.1	7.2	5.7	8.2	7.1	8.1	6.7	5.7	7.9	9.6
Urbanization (percent)														
1981	h	75.7	58.8	57.1	50.7	55.1	77.6	81.7	71.2	58.2	77.2	78.0	64.0	48.1
1986	i	76.5	58.9	38.1	54.0	49.4	77.9	82.1	72.1	61.4	79.4	79.2	64.7	46.4
1991	j	76.6	53.6	39.9	53.5	47.7	77.6	81.8	72.1	63.0	79.8	80.4	58.8	36.7

Table A2.14

Selected Statistics on Population by Province and Territory, Selected Years (concluded)

	Source	Canada	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	Yukon	N.W.T.
Households (thousands)														
1981	k	8 281.5	148.4	37.7	273.2	214.9	2 172.9	2 969.8	358.0	332.7	758.2	996.6	7.6	11.5
1986	k	8 991.7	159.1	40.7	295.8	231.7	2 357.1	3 221.7	382.3	358.3	836.1	1 087.1	8.0	13.8
1991	k	10 018.3	174.5	44.5	324.4	253.7	2 634.3	3 638.4	405.1	363.1	910.4	1 243.9	9.9	16.1
1992[6]	l	10 056.0	177.0	46.0	329.0	256.0	2 656.0	3 647.0	396.0	359.0	912.0	1 278.0	..	..
1993[6]	l	10 247.0	182.0	47.0	336.0	256.0	2 688.0	3 765.0	387.0	361.0	923.0	1 302.0	..	..
1994[6]	l	10 387.0	183.0	48.0	332.0	255.0	2 720.0	3 820.0	397.0	361.0	928.0	1 344.0	..	..
1995[6]	l	11 244.0	194.0	50.0	357.0	286.0	2 937.0	4 143.0	419.0	385.0	1 009.0	1 464.0	..	..
Expenditures on education[7] (million dollars)														
1980-81	m	22 201.6	462.0	92.2	707.0	530.5	6 754.0	7 497.0	849.3	871.0	1 956.8	2 224.4	31.7	66.9
1985-86	n	34 564.1	741.3	150.0	1 134.0	873.2	9 442.7	12 073.4	1 425.3	1 382.0	3 603.8	3 246.0	45.8	131.3
1990-91	n	48 679.6	1 038.3	193.8	1 475.2	1 205.6	11 969.1	18 471.7	1 959.9	1 757.1	4 565.1	5 279.6	79.1	219.1
1991-92	n	53 075.7	1 083.3	209.9	1 532.0	1 274.2	12 974.6	20 571.7	2 048.5	1 816.1	4 802.4	5 956.5	89.0	247.7
1992-93	n	55 760.3	1 161.8	220.0	1 563.1	1 365.5	13 796.9	21 221.1	2 100.4	1 826.3	5 130.7	6 336.7	112.9	326.7
1993-94[p]	o	56 398.3	1 291.8	224.1	1 623.6	1 375.7	13 790.5	21 331.6	2 101.4	1 807.3	5 234.5	6 523.5	105.8	342.6
1994-95[e]	o	57 124.2	1 247.9	219.2	1 625.5	1 346.2	14 193.6	21 280.0	2 112.5	1 855.6	5 199.3	6 917.3	108.1	375.5
Land area (thousand km^2)														
	p	9 215.4	371.7	5.7	52.8	72.1	1 356.8	891.2	548.4	570.7	644.4	929.7	479.0	3 293.0
Population density (persons per km^2)														
1981	d	2.7	1.6	21.9	16.2	9.8	4.8	9.9	1.9	1.7	3.6	3.1	0.1	--
1986	d	2.8	1.6	22.6	16.9	10.1	5.0	10.6	2.0	1.8	3.8	3.2	0.1	--
1991	d	3.1	1.6	23.1	17.4	10.4	5.2	11.8	2.0	1.8	4.0	3.6	0.1	--
1993	d	3.1	1.6	23.5	17.6	10.5	5.3	12.1	2.1	1.8	4.2	3.8	0.1	--
1994	d	3.2	1.6	23.8	17.7	10.5	5.4	12.3	2.1	1.8	4.2	3.9	0.1	--
1995	d	3.2	1.5	24.1	17.8	10.5	5.4	12.5	2.1	1.8	4.3	4.0	0.1	--
2016	d	4.3	1.6	28.4	20.2	11.8	6.6	18.0	2.3	1.7	6.2	6.2	0.1	--

Notes:
Figures may not add due to rounding.
1. Total population as of July 1st of each year.
2. Projection 3 - Medium growth.
3. The total fertility rate is based on the age-specific fertility rates for a particular year and refers to the number of children that each woman would, on average, bear in her lifetime. A generation would be replaced if, on average, each woman bore 2.1 children.
4. Excluding Newfoundland.
5. The Yukon and Northwest Territories are combined, their estimates are subject to random fluctuations due to small numbers.
6. The total number of households for 1992 to 1995 are estimated figures. Estimates are unavailable for the Yukon and Northwest Territories.
7. The sum of the expenditures on education of the 12 provinces and territories is not equal to Canada's total because the latter also includes Canada's spending on education in foreign countries and undistributed expenditures.

Sources:
a. Statistics Canada, *Annual Demographic Statistics*, Catalogue No. 91-213, Ottawa, 1994.
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d. Statistics Canada, National Accounts and Environment Division.
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p. Statistics Canada, *Canada Year Book, 1994*, Catalogue No. 11-402E, Ottawa, 1994.

Table A2.15

Selected Statistics on the Economy by Province and Territory, 1981-1995

	Source	Canada	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	Yukon	N.W.T.
Gross Domestic Product[1] (million 1986 dollars)														
1981	a	440 127	6 247	1 309	10 585	8 534	103 506	167 431	15 667	15 053	52 786	54 365	456	1 149
1986	a	505 666	6 938	1 516	13 155	10 307	116 622	205 643	18 562	17 364	56 617	55 527	599	1 470
1991	a	555 052	7 789	1 710	14 136	11 111	126 156	222 106	18 816	19 269	64 231	66 349	799	1 779
1992	a	559 305	7 824	1 749	14 407	11 528	126 510	224 330	19 039	18 301	64 434	67 918	862	1 659
1993	a	571 722	7 952	1 771	14 605	12 001	129 621	226 954	19 210	18 865	66 130	69 522	678	1 730
1994	a	597 936	8 148	1 881	14 793	12 247	134 046	239 622	19 763	19 410	72 157	72 872	673	1 756
1995	a	611 300	8 138	1 975	14 886	12 393	136 407	246 990	20 252	19 512	73 381	74 227	746	1 806
GDP per capita (thousand 1986 dollars per person)														
1981	b	17 676	10 845	10 556	12 366	12 054	15 757	18 942	15 093	15 392	22 911	19 170	19 000	23 938
1986	b	19 297	12 003	11 752	14 748	14 158	17 318	21 699	16 967	16 809	23 213	18 386	23 960	26 727
1991	b	19 739	13 429	13 053	15 399	14 834	17 816	21 212	16 906	19 154	24 695	19 630	27 552	29 164
1992	b	19 596	13 420	13 250	15 575	15 309	17 667	21 074	17 030	18 156	24 342	19 534	28 733	26 333
1993	b	19 751	13 618	13 316	15 704	15 874	17 906	20 985	17 091	18 660	25 365	19 447	22 600	27 031
1994	b	20 442	14 024	13 933	15 838	16 157	16 395	21 913	17 489	19 180	26 577	19 862	22 433	27 015
1995	b	20 648	14 153	14 522	15 870	16 307	18 599	22 251	17 796	19 205	26 713	19 710	24 867	27 364
Average annual real GDP growth 1986-95: Goods producing industries (1986$) (percent)														
Primary	c	2.6	-2.1	1.5	0.3	3.0	2.5	0.5	-1.1	1.2	5.0	2.8	2.8	-3.3
Manufacturing	c	2.0	-2.2	8.9	-0.4	1.6	2.0	1.8	1.1	1.4	6.4	1.5	11.6	1.7
Other goods producing industries	c	0.3	0.2	2.9	-1.1	0.3	0.1	-0.7	0.2	-1.0	1.0	4.6	2.3	-1.2
GDP distribution at factor cost by industry (1992): Goods producing industries (percent)														
Primary	c	17.3	21.2	32.1	19.7	21.5	8.6	6.9	24.8	56.4	49.1	20.4	69.4	61.4
Manufacturing	c	51.9	29.1	34.7	44.6	40.5	58.6	65.5	42.8	16.7	22.9	40.4	2.3	1.6
Other goods producing industries	c	30.8	49.7	33.2	35.7	38.0	32.8	27.6	32.4	26.9	28.0	39.2	28.3	37.0
Personal income per capita (1986 dollars per person)														
1981	b	15 597	10 679	10 296	12 284	11 564	14 656	16 361	14 079	14 829	17 513	16 927	..	..
1986	b	18 305	11 590	12 279	13 737	12 841	15 339	17 850	14 957	14 700	17 069	16 184	17 000	14 345
1991	b	17 075	13 910	13 388	14 675	13 874	16 138	18 394	15 298	14 221	17 581	17 911	19 870	17 099
1992	b	17 006	14 039	13 600	14 793	14 229	16 044	18 273	15 521	14 305	17 507	17 700	20 390	16 916
1993	b	18 780	13 947	13 828	14 826	14 250	15 881	17 845	15 165	14 240	17 632	17 410	19 714	18 451
1994	b	16 928	14 001	13 712	14 641	14 192	16 263	16 019	15 333	13 962	17 490	17 458	19 507	17 282
1995	b	16 918	14 021	14 504	14 657	14 296	16 340	17 852	15 331	14 303	17 473	17 473	19 816	17 208
Passenger automobiles[2] (thousands)														
1981	d	10 199	142	49	350	252	2 379	3 831	460	392	1 216	1 116	7	6
1986	d	11 477	176	56	337	286	2 614	4 244	526	389	1 296	1 527	8	17
1991	d	13 061	202	64	426	312	2 978	4 847	544	416	1 424	1 807	20	20
1992	d	13 322	207	62	422	318	3 031	4 925	551	441	1 482	1 852	9	20
1993	d	13 478	207	65	429	324	3 070	5 002	551	414	1 507	1 879	10	20
1994	d	13 639	216	65	392	328	3 107	5 069	557	421	1 546	1 918	11	10
Passenger automobiles per capita (vehicles per thousand persons)														
1981	b	409.6	245.6	391.8	409.2	355.0	362.2	433.5	443.4	400.5	528.0	393.4	278.1	128.3
1986	b	438.0	305.1	436.5	377.9	393.1	388.2	447.8	482.2	376.3	531.3	505.5	302.8	309.1
1991	b	464.5	348.3	486.9	464.1	417.3	420.6	462.8	489.3	413.8	547.5	534.6	671.0	331.2
1992	b	466.8	354.7	474.5	456.6	421.8	423.7	462.7	493.1	437.3	559.6	532.4	296.1	322.0
1993	b	465.6	354.5	484.6	461.4	429.1	424.7	462.2	489.9	409.5	560.6	525.7	319.9	309.1
1994	b	466.3	371.9	484.8	419.4	432.6	426.6	463.7	492.2	415.2	568.6	522.4	382.7	148.1
Gasoline net sales[3] **for automotive purposes** (million litres)														
1981	e	30 782.5	587.1	171.3	1 141.1	1 070.8	8 104.6	12 610.2	1 323.7	1 460.3	..[4]	4 224.7	57.9	30.8
1986	e	25 859.2	521.9	165.1	1 039.8	914.1	6 578.4	11 715.6	1 296.2	..[4]	..[4]	3 551.8	54.6	21.7
1991	e	31 209.1	573.6	168.8	1 065.9	904.5	6 823.6	11 887.3	1 250.2	1 169.7	3 746.7	3 527.6	59.0	32.1
1992	e	31 786.6	578.3	172.1	1 082.1	929.8	8 868.3	11 982.5	1 244.5	1 445.5	3 718.7	3 668.9	65.4	32.7
1993	e	32 563.4	585.1	174.0	1 085.3	961.1	7 037.7	12 255.2	1 253.9	1 373.5	3 873.7	3 869.5	61.3	33.1
1994	e	33 297.0	591.5	182.3	1 104.5	1 001.0	7 199.9	12 530.0	1 278.4	1 297.6	3 924.6	4 083.0	66.4	37.8
Gasoline net sales[3] **per capita** (litres per person)														
1981	b	1 236.2	1 018.4	1 381.7	1 332.5	1 511.6	1 233.9	1 426.8	1 274.6	1 492.8	..	1 489.4	2 401.4	643.1
1986	b	986.9	902.8	1 281.9	1 165.6	1 256.2	976.9	1 236.2	1 184.8	..	..	1 175.9	2 201.2	391.3
1991	b	1 109.6	988.5	1 290.2	1 161.3	1 208.4	963.7	1 135.2	1 123.8	1 162.4	1 440.3	1 043.7	2 029.1	524.1
1992	b	1 113.7	990.7	1 308.1	1 169.8	1 234.3	960.0	1 125.6	1 112.8	1 433.3	1 403.8	1 054.0	2 157.0	522.5
1993	b	1 124.9	1 000.8	1 303.4	1 166.5	1 271.7	973.5	1 132.6	1 114.8	1 358.0	1 440.8	1 082.7	2 015.7	520.0
1994	b	1 138.3	1 016.8	1 354.8	1 181.1	1 319.9	988.5	1 146.2	1 130.1	1 280.2	1 443.4	1 113.2	2 242.3	584.1

Notes:
Figures may not add due to rounding.
1. The sum of the GDPs of the 12 provinces and territories is not equal to Canada's total GDP because the latter also includes wages and salaries of public servants working abroad.
2. Includes taxis and for-hire cars.
3. Net sales refer to those sales of gasoline, diesel and liquefied petroleum gas on which taxes were remitted at road-use rates.
4. Net sales statistics are not available because the road tax was removed in both Alberta (April 1978) and Saskatchewan (April 1982).

Sources:
a. Statistics Canada, *Provincial Economic Accounts: Annual Estimates, 1961-1995*, Catalogue No. 13-213-XDB, Ottawa, 1996.
b. Statistics Canada, National Accounts and Environment Division.
c. Statistics Canada, *Provincial Gross Domestic Product by Industry, 1984-1995*, Catalogue No. 15-203-XPB, Ottawa, 1996.
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e. Statistics Canada, *Road Motor Vehicles Fuel Sales*, Catalogue No. 53-218, Ottawa, various issues.

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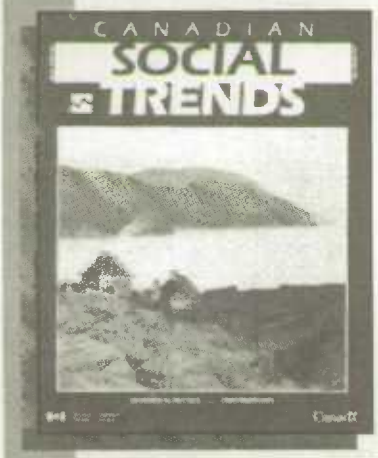

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