Population and Family Estimation Methods at Statistics Canada

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Symbols

The following standard symbols are used in Statistics Canada's publications:

.   not available for any reference period
..   not available for a specific reference period
…   not applicable
p   preliminary
r   revised
x   suppressed to meet the confidentiality requirements of the *Statistics Act*
E   use with caution
F   too unreliable to be published

Acknowledgements

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Introduction

Population and Family Estimation Methods at Statistics Canada

Every five years, Statistics Canada conducts a national census of population, through which a wide range of demographic data is collected on the Canadian population. The census collects information on Canadian citizens, landed immigrants and non-permanent residents residing in Canada. Unlike some countries, Canada does not have a system of continuous population registration from which to obtain basic demographic data on the state and movement of the population for non-census years.

To fill this gap in the information system, Statistics Canada has developed a Population and Family Estimates Program that uses census data collected by Statistics Canada and administrative data provided by other government departments to estimate the Canadian population between censuses. Moreover, Statistics Canada has developed a Population Projections Program. Based on extrapolations of past trends, these projections reflect informed hypotheses of Canada's demographic future.

In 1987, Statistics Canada published its first manual detailing the procedures used for estimating population, called *Population Estimation Methods, Canada* (Catalogue no. 91-528). The manual represented a direct response to a long-standing policy at Statistics Canada that requires the methods used to produce the Bureau's statistical information to be open to public inspection.

In an effort to constantly improve the estimates of population, conceptual and methodological changes have been made to estimation procedures since the publication of the 1987 manual. In 1993, the decision to adjust the population counts for net census undercoverage and to add non-permanent residents to the calculation of population estimates were two of the major methodology modifications. Other changes that necessitated updating the 1987 manual include the new approach to the calculation of preliminary postcensal estimates at subprovincial levels, and modifications to the calculation of certain components of population change which are not readily available and require estimation, such as emigration.

Until now, literature on these methodological changes for estimates calculations were spread throughout various Statistics Canada publications. This manual is a comprehensive compilation of the current procedures used by Statistics Canada to prepare population and family estimates.

What Are Estimates and Projections?

Population estimates and projections are similar in that they both indicate the size of the population for a given time. The distinction between them is related to their underlying concepts. Population estimates are approximate counts of the current (or recent) population, whereas population projections are expected population counts based on a defined set of assumptions.

Estimates

Essentially, there are two categories of estimates produced by Statistics Canada: postcensal and intercensal. The first category, postcensal estimates, are produced by using data from the most recent census (adjusted for net census undercoverage) and estimates of the components of demographic change since that last census. These components include births, deaths, immigration, total emigration, change in non-permanent residents, and interprovincial migration. Another component, subprovincial migration is relevant for estimates within subprovincial areas in Canada. All the elements of the production of population estimates will be discussed in this manual.

Three types of postcensal estimates are produced: preliminary, updated and final estimates, referring to the time frame in which they become available. Preliminary estimates are typically available within three to four months after the reference date while updated estimates are usually available within one year. Final estimates, the most accurate postcensal estimates available, typically take two years to complete. The production of three types of estimates, while sometimes confusing to users, is the strategy that best satisfies the commitment of Statistics Canada to produce data in a timely and accurate manner.

Intercensal estimates are produced every five years and reconcile previous postcensal estimates with the latest census counts adjusted for net undercoverage. They are generated as soon as census population counts become available. This process typically takes two years after census data collection to complete.

Projections

Population projections produced by Statistics Canada are hypotheses of the future size and geographical distribution of the Canadian population. Projections are not predictions; they are calculations of future population derived from a base population and stated assumptions regarding the components of population change. The base population is the July 1, current year, postcensal estimate of population.

The combinations of component assumptions provide plausible maximum, medium, and minimum population growth levels, for each province/territory and for Canada as a whole. The use of various assumptions may seem confusing, but it provides the user with different scenarios of population change. Projections are developed on the basis of analysis of past trends and are thought to represent reasonable alternatives for the future movement of the component values. It is not claimed, however, that the values will always remain within the range implied by the assumptions. Year-to-year fluctuations in the relevant parameters can be expected.

This manual focuses only on the methods used to produce population estimates. For information on population projection methods, please refer to ***Population Projections for Canada, Provinces and Territories, 2000-2026*** (Catalogue no. 91-520), for long-term projections and ***Annual Demographic Statistics, 2001*** (Catalogue no. 91-213), for short-term projections.

At What Level of Detail Are Estimates and Projections Available?

Estimates

Population estimates are produced at three geographic levels: Canada, province and territory, and census division and census metropolitan area. For each geography, estimates are calculated according to different demographic characteristics of the population, including age or sex; marital status is also calculated for Canada, the provinces and territories. Demographic estimates and projections at custom-defined subprovincial levels (e.g., economic regions, urban centres, health regions, etc.) are available by special request. Table I shows the level of detail and the reference period for which population estimates are readily available.

Table I
Availability of Population Estimates

Geography	Grouping	Category	Description
Canada, Provinces and Territories	Total Population	Postcensal and Intercensal	Quarterly and annual estimates (including all components of demographic growth)
	Age and Sex	Postcensal	Quarterly and annual estimates (including all components of demographic growth)
	Age, Sex and Marital Status	Postcensal	Annual estimates (including all components of demographic growth)
		Intercensal	Annual estimates
	Family	Postcensal and Intercensal	Annual Census family estimates distributed by: 1. Family size and structure (i.e. husband-wife; lone-parent; and total) 2. Structure and age group of children 3. Age of husband and age of wife (husband-wife families only) 4. Age and sex of parent and family size (lone-parent families only) 5. Persons in families and average family size by sex of parent (lone-parent families)
Census Divisions/Census Metropolitan Areas	Total Population and Age and Sex	Postcensal and Intercensal	Annual estimates (including all components of demographic growth)

Projections

Population projections are available on an annual basis, but with less detail than estimates. They are produced at two levels of geography, province and territory, and census division and census

metropolitan area. Furthermore, there are fewer breakdowns by demographic characteristic. Table II shows the level of detail and the reference period for which population projections are available.

Table II
Availability of Population Projections

Geography	Grouping	Description
Canada, Provinces and Territories	Total Population and Age and Sex	Annual long-term projections (including all components of demographic growth)
Census Divisions/Census Metropolitan Areas	Total Population and Age and Sex	Annual long-term projections (including all components of demographic growth)

Who Uses Population and Family Estimates?

Current estimates of Canada's population have wide ranging applications in the areas of planning and program evaluation in both the public and private sectors. For example, the calculation of revenue transfers and grants under various federal statutory programs, as well as cost-sharing agreements between federal, provincial, territorial and municipal governments are highly dependent on demographic data. Statistics Canada is under statutory obligation to provide the federal government with annual population figures as well as various economic indicators (e.g., gross domestic product) that have been certified by the Chief Statistician of Canada. These figures are used to determine the amounts payable under various federal-provincial fiscal arrangements, such as the Equalization Program and the Canada Health and Social Transfer (CHST), according to per capita funding formulae.

Equalization payments are important for the reduction of fiscal disparities among provinces. These payments, made by the federal government, enable less prosperous provincial governments to provide their residents with public services that are reasonably comparable to those in other provinces, at reasonably comparable levels of taxation. Payments are made to entitled[1] provinces in the form of a block grant, which allows the recipient provincial governments to spend the funds according to their own priorities. Equalization payments for the 2002-2003 fiscal year are currently calculated to be $10.3 billion[2].

The CHST (the largest federal transfer to provinces and territories) is also a block-funding program, allowing each of the provinces and territories to allocate spending among social programs such as health care, post-secondary education, social assistance and social services, according to their own priorities. In the 2002-2003 fiscal year, CHST payments to provincial and territorial governments totalled approximately $35.7 billion[2].

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[1] Equalization entitlements are calculated using a measure of "fiscal capacity" which compares each province's ability to generate revenues at national average tax rates to those of a threshold or "standard". The current standard (which has been used since 1982) uses the five "middle-income" provinces: Quebec, Ontario, Manitoba, Saskatchewan and British Columbia. Provinces with fiscal capacities below the standard are entitled to equalization payments to bring their capacity up to the standard (Department of Finance Canada, 2002).

[2] "Federal Transfers to Provinces and Territories (February 2002)", on the Department of Finance Canada's website (http://www.fin.gc.ca).

Population is a key variable in allocation formulae used by the federal government in defining its annual spending. As billions of dollars depend directly upon these allocation formulae, timely and accurate estimates are extremely important.

Figure I
Total Federal Transfers[1] to Provinces and Territories, 2002-2003

Total = $47.6 billion

Other[2]
$1.7 billion

Equalization
$10.3 billion

Territorial Formula
Financing
$1.3 billion

Canada Health
and
Social Transfer
$35.7 billion
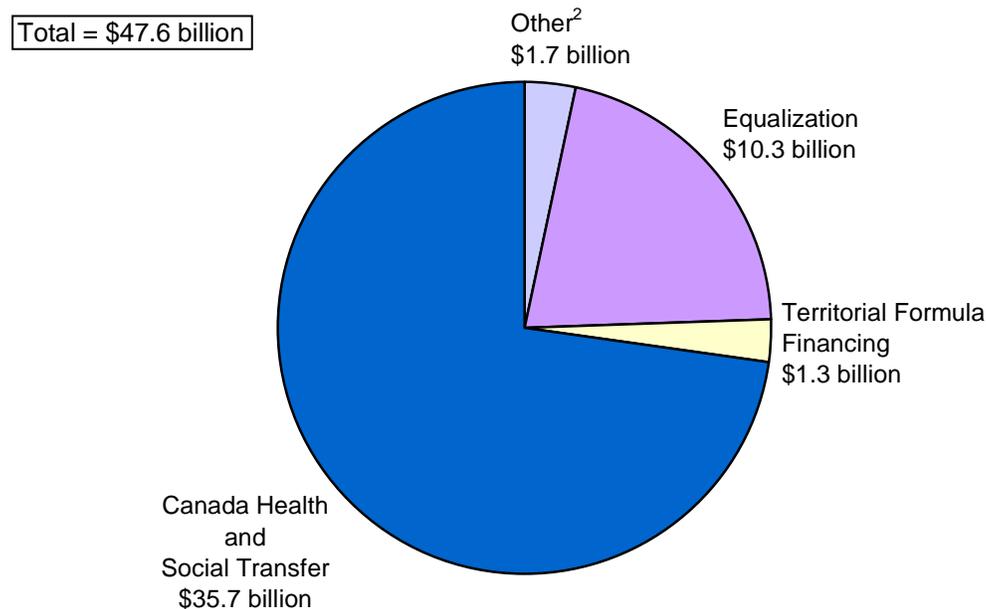
[1] Equalization associated with the tax transfers under CHST is included in both CHST and Equalization. Total has been reduced by $1.4 billion to avoid double-counting.

[2] The federal government provides assistance to provinces and territories under other programs, such as official languages and grants-in-lieu of municipal taxes.

Source: Department of Finance Canada website, www.fin.gc.ca/FEDPROV/FTPTe.html

The Government of Canada relies upon population data to also inform some of its most fundamental policies. For example, up-to-date information on the evolving demographic situation in Canada is useful in informing cabinet on its decisions relating to immigration policy. In the administration of public policy, current population figures also serve to increase the cost-effectiveness of program spending.

Provincial and municipal governments also use demographic estimates for planning social programs. These governments further use estimates to establish cost-sharing agreements on the basis of per capita spending formulae. Among the public service users of Statistics Canada's estimates, are education and public health planners, public administrators responsible for policing, criminal justice, municipal administration, and waste and environmental management.

Demographic estimates are fundamental in the calculation of social and economic indicators, including birth rates, death rates, school enrolment rates, unemployment rates, life expectancy, etc. Population serves directly as the denominator in many of these indicators. Survey researchers, whether at Statistics Canada, academia, or in private polling agencies, must use up-to-date population figures in the planning of survey research and in the calculation of sampling weights.

The private sector also uses demographic estimates for business planning, marketing research and investment demographics. The estimates help companies to properly segment and target their market, or make sound investment decisions.

How Are Estimates and Projections Made Available to the Public?

The Daily delivers the first and official release of statistical data and publications produced by Statistics Canada. All data releases must be published in *The Daily*. This official release bulletin is available by the Official Release and Media Relations Section, Communications Division, Statistics Canada, Catalogue no. 11-001. An electronic copy of *The Daily* is available in three ways: on Statistics Canada's official website, www.statcan.ca, from Statistics Canada's gopher service, Talon, at *gopher gopher.statcan.ca,* and from the FTP site by typing *ftp ftp.statcan.ca* (at the login prompt type anonymous and at the password prompt enter your e-mail address).

Population estimates are released quarterly and annually. Quarterly estimates are produced for the first day of January, April, July and October, and are available in the Statistics Canada publication *Quarterly Demographic Statistics*, Catalogue no. 91-002. Annual estimates are referenced to July 1 and are available in the Statistics Canada publication *Annual Demographic Statistics*, Catalogue no. 91-213.[3] Custom extractions are also available.

The most current population estimates and projections, as well as other demographic statistics, are also available from Statistics Canada's Canadian Socio-Economic Information Management System (CANSIM II). CANSIM II is a time series database containing more than 650,000 items. CANSIM II can be accessed on Statistics Canada's website, www.statcan.ca, CD-ROM (Catalogue no. 10F0007XCB), and on Directory Disc (Catalogue no. 10F0005XCB). Data retrieved through the www.statcan.ca commercial services are subject to specific conditions of use detailed in the Limited Use Data Products Licence Agreement statement associated with these services.

A printed version of the latest statistics published by Statistics Canada, *Infomat* (11-002-XPE) is published every Friday and offers a concise review of the week's economic and social releases.

You can order or subscribe to any of the above by sending an email to order@statcan.ca, by calling toll-free 1-800-267-6677, or by contacting the Statistics Canada Regional Reference Centre nearest to you.

Outline of the Manual

The manual follows a pattern dictated by the movement from aggregate estimates into the various disaggregations for which estimates are provided. Since disaggregation is possible only through the application of increasingly numerous and more complex techniques, the manual can also be seen as following a path toward increasing complexity of methods.

Individual chapters include discussions on data sources and relevant concepts, methodology, and data quality evaluation. Each chapter will describe how estimates are produced, what data are used in

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[3] A more comprehensive publication of long-term projections, entitled *Population Projections for Canada, Provinces and Territories*, Catalogue no. 91-520, is available occasionally.

the calculations and where they come from, and how reliable the results are in light of various validation criteria. This will give the reader a clear picture of the strengths and weaknesses of each procedure.

Chapter 1 presents the methods used to produce population estimates, including postcensal and intercensal estimates, for Canada and the provinces and territories.

Chapters 2 to 7 describe the components of population for Canada, the provinces and territories. In particular, Chapter 2 describes and evaluates the base populations. Chapter 3 focuses on information on births and deaths. Chapters 4 through 6 present the components of international migration (immigration is presented in Chapter 4, non-permanent residents in Chapter 5, and Chapter 6 deals with the total emigration component). Interprovincial migration is discussed in Chapter 7.

Chapters 8, 9 and 10, respectively, describe subprovincial population estimates, population estimates by age, sex and marital status, and census family estimates. These are dealt with independently to adequately discuss the components used to calculate these estimates.

The final chapter, Chapter 11, presents the choices of population estimates and projection series available in publication as well as examples of possible custom requests. This chapter also outlines some of the ongoing and future research and development in the area of population estimation methods.

A glossary of principal terms is included at the end of this manual (Appendix I), followed by notations used in formulae presented herein (Appendix II). An attempt was made to simplify and standardize the notation system in the formulae throughout this manual. As such, notations in the manual may differ from those in previous publications of population estimates.

Chapter 1

Postcensal and Intercensal Population Estimates, Canada, Provinces and Territories

The introduction to this manual provided a brief description of the definitions, users, uses and availability of population and family estimates produced by Statistics Canada. This chapter will describe the methods used for calculating postcensal and intercensal estimates for the total population and for the population by age and sex at the provincial and territorial, and subprovincial levels. The data sources for each are identified, followed by a discussion of the quality of the estimates.

Postcensal Population Estimates, Canada, Provinces and Territories

Postcensal population estimates are population counts, which are derived using data from the most recent census (adjusted for net census undercoverage) and estimates of the components of population change since that census. These adjusted census data, forwarded to July 1, are referred to as "censal estimates". Postcensal estimates are then obtained using the *component method*. This method can be equated to a population accounting system, where modifications are made to the censal estimate by adding and subtracting the components of population change that occurred between July 1st and the reference date of the estimate. The components can be divided into two groups, according to the type of data used: those components for which data are readily available, including births, deaths and immigration, and those that have to be estimated, including interprovincial migration, total emigration and changes in non-permanent residents (NPRs).

For each of the three types of postcensal estimates, preliminary, updated and final, component data have varying levels of completeness, hence the requirement of estimation procedures. In this sense, preliminary estimates, available typically three to four months after the reference date, are similar to short-term projections as they are based on the least complete sources for components. Updated estimates are produced usually within one year, to account for availability of more complete data for at least some of the components. It takes typically two years to finalise postcensal estimates but they are considered the most accurate population numbers available until the next census.

Table 1.1 shows the sources and references of component data used to generate the postcensal population.

Estimates of the population are produced first for each province and territory, then summed to get an estimate of the population of Canada.

The component method used in estimating total provincial/territorial populations is expressed as follows:

Equation 1.1: $\quad P_{(t+i)} = P_t + B_{(t,t+i)} - D_{(t,t+i)} + I_{(t,t+i)} - E_{(t,t+i)} + \Delta NPR_{(t,t+i)} + IM^{net}_{(t,t+i)}$

where for any given province and territory

$P_{(t+i)}$	=	estimate of population at time $(t + i)$;
$\mathbf{P}_t$	=	population at time t (censal estimate or postcensal estimate);
$B_{(t,t+i)}$	=	number of births between time t and $(t + i)$;
$D_{(t,t+i)}$	=	number of deaths between time t and $(t + i)$;
$I_{(t,t+i)}$	=	number of immigrants between time t and $(t + i)$;
$E_{(t,t+i)}$	=	number of total emigrants (permanent, temporary and returning emigrants) between time t and $(t + i)$;
$\Delta NPR_{(t,t+i)}$	=	change in the number of NPRs between time t and $(t + i)$ (can be either positive or negative);
$IM^{net}_{(t,t+i)}$	=	net interprovincial migration between time t and $(t + i)$ (can be either positive or negative);
$(t, t + i)$	=	interval between July 1st and the reference date of the estimate.

Table 1.1
Sources and References of Postcensal Population Estimates – Component Data

Component	Sources and References (if applicable)
Base Population (Censal Estimate)	Census population counts (Census of Canada, Catalogue no. 93-357-XPB)
	Data from Reverse Record Check (RRC) (in *Coverage, 1996 Census Technical Reports*, Statistics Canada, Catalogue no. 92-370)
Births and Deaths	Health Statistics Division, Statistics Canada
	Demography Division, Statistics Canada (Catalogue nos. 91-002-XPB and 91-002-XIB, Quarterly, Table 2)
Marriages and Divorces	Health Statistics Division, Statistics Canada
Immigration	Citizenship and Immigration Canada (CIC) data
Total Emigration	*Permanent Emigrants* Data from the Canada Child Tax Benefit program (CTB) from Canada Customs and Revenue Agency (CCRA), and Data from the U.S. Department of Justice, Immigration and Naturalization Service
	Returning Emigrants Data from the CTB program, CCRA
	Temporary Emigrants Data from the RRC, 1991 and 1996 Censuses of Canada (in *Coverage, Census Technical Reports* for 1991: Catalogue no. 92-341, and 1996: Catalogue no. 92-370)
Net Change in Non-permanent Residents	CIC data
Interprovincial and Subprovincial Migration	Data from the CTB program, CCRA Data processed from Income Tax file by Small Area and Administrative Data Division (SAADD), Statistics Canada

Estimates by Age and Sex

Postcensal estimates of population by age and sex are produced using the *cohort component approach*, where the population is aged from year to year and the components are organized according to age and sex cohorts. A cohort is a group of persons who experience a certain event in a specified period of time. For the calculation of age and sex estimates, birth cohorts (those persons born during the same year) by sex are used. Therefore the data required for the cohort component method includes demographic events, such as deaths, immigration, emigration, that can be directly linked to persons belonging to the same birth cohorts by sex.

Chapter 9 describes the application of the cohort component approach in greater detail. The chapters on the individual components will elaborate upon the manner in which the components are organized by age and sex.

Intercensal Population Estimates, Canada, Provinces and Territories

Intercensal estimates are estimates of population for reference dates between censuses. They are produced following each census in order to reconcile postcensal estimates with the census counts adjusted for net undercoverage, thus assuring the internal consistency of the estimation system.

The production of intercensal estimates involves two basic steps:

(i)   the calculation of the error of closure; and
(ii)   the distribution of the error of closure by intercensal year.

The error of closure is defined as the difference between the enumerated population of the most recent census (after adjustments for census coverage error) and the most current postcensal population estimate for census day.

More specifically, the error of closure is calculated as:

Equation 1.2: $$\varepsilon = P - \mathbf{P}$$

where

ε = error of closure;
P = postcensal population estimate; and
$\mathbf{P}$ = census population after adjustment for coverage error (censal estimate).

The error of closure comes from two sources; differences in the amount of undercoverage or overcoverage in successive censuses and errors in the components of population change over the intercensal period.

This can be calculated for any disaggregated group, or for any summation of such disaggregations up to and including the total population. With each 5-year intercensal period, the error of closure can only be calculated with the release of census data and estimates of net undercount in the enumeration.

For the production of intercensal estimates it is assumed that the error of closure is a linear function of the time elapsed since the previous census. The production of intercensal estimates of total population involves two steps: the calculation of the error of closure (ε) as in Equation 1.2, and the distribution of this error among the estimates

Intercensal estimates of total population are obtained using the following formulae:

Equation 1.3: $$\text{IP}_t = \text{P}_t - \varepsilon$$

Equation 1.4: $$\text{IP}_{t-1} = \text{P}_{t-1} - \frac{4}{5}\varepsilon$$

Equation 1.5: $$\text{IP}_{t-2} = \text{P}_{t-2} - \frac{3}{5}\varepsilon$$

Equation 1.6: $$\text{IP}_{t-3} = \text{P}_{t-3} - \frac{2}{5}\varepsilon$$

Equation 1.7: $$\text{IP}_{t-4} = \text{P}_{t-4} - \frac{1}{5}\varepsilon$$

where

t	=	the most recent Census year;
IP	=	intercensal population estimate;
P	=	postcensal population estimate;
ε	=	error of closure.

This same linear method applies also to the quarterly intercensal estimates of total population.

Population Estimates by Age and Sex

The error of closure for each sex and single year of age is the difference between the enumerated (and adjusted for coverage error) and estimated populations, calculated using the same method as is applied to the total population. The production of the intercensal estimates by age and sex involves three steps:

(i)   the calculation of the error of closure by age and sex;
(ii)   the distribution of this error; and
(iii)   a final adjustment to ensure consistency with total population figures estimated independently.

With the exception of ages between 0 and 4 years, and "90+", the error of closure associated with each sex and single year of age is distributed linearly, as a function of the time elapsed since the previous census. Distributing the closure error between censuses following specific cohorts generates intercensal estimates. Figure 1.1 shows the method for distributing the error of closure.

For the 0-4 age group, the error of closure can only be distributed over the number of years elapsed since birth, since these children were not born at the time of the previous census, taken five years earlier. Accordingly, the error of closure for children aged 4 is distributed over nine half-year periods

(4 ½ years), using 1/9, 3/9, 5/9, 7/9 and 9/9 for the first, second, third, fourth and fifth year from the year of the earlier census. For children aged 3, the error of closure is distributed using 1/7, 3/7, 5/7 and 7/7 over seven half-year periods, or 3 ½ years, and for those aged 2, using 1/5, 3/5 and 5/5. Finally for 1-year-old children, the error of closure is divided using the factors 1/3 and 3/3, covering a 1½-year period.

Figure 1.1
Method of Distributing the Error of Closure by Cohort

(ε_a = **Closure error at age** a)
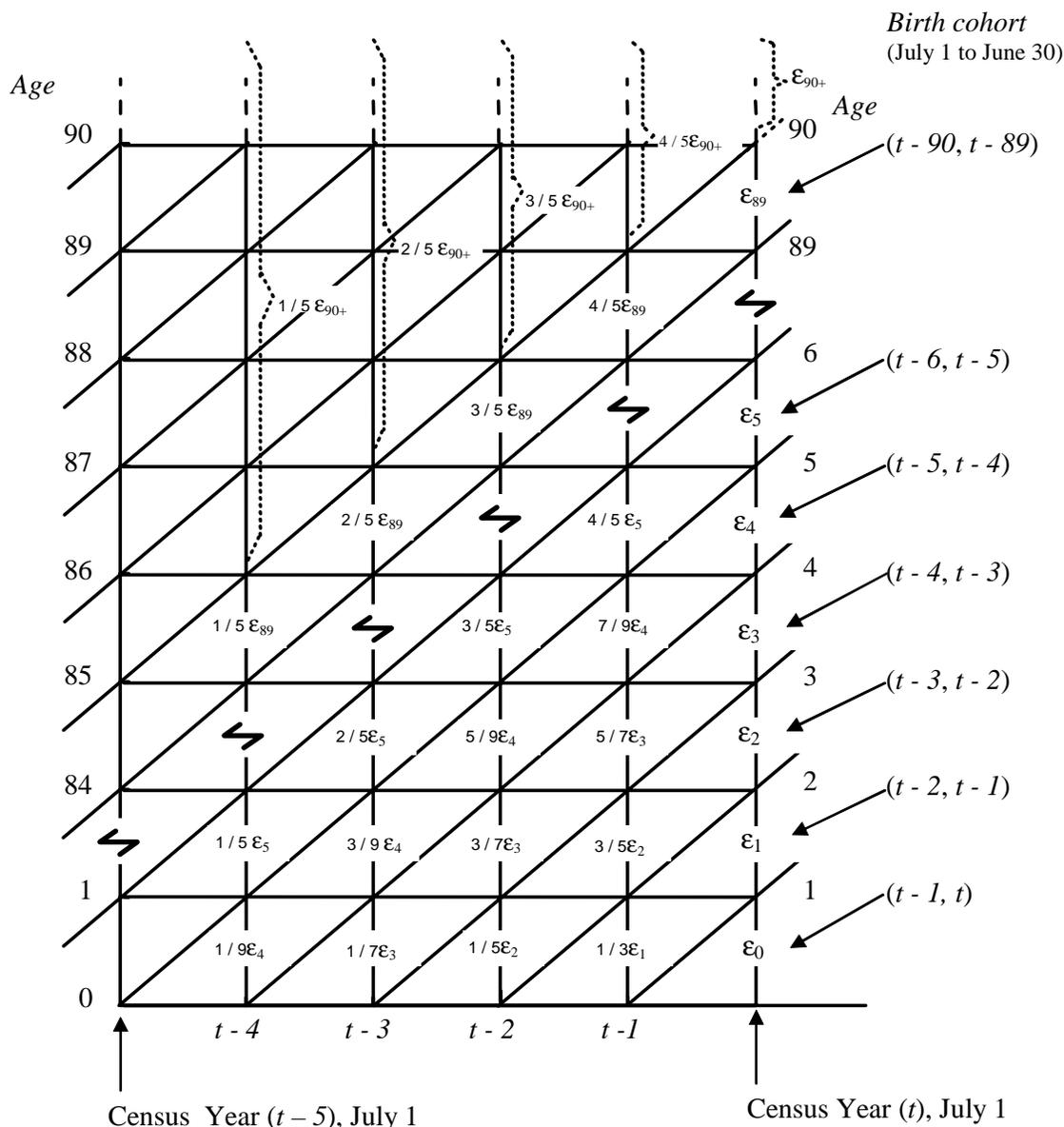
Distribution of the error term for the 90+ age group must take the open-ended nature of the age interval into account. The error of closure for the 90+ age category at the reference date, t, relates to the cohort that was aged 85 at $(t - 5)$, 86 at $(t - 4)$, and so on. Error must be broken down for the

period for the single years of age 86 through 89 and the 90+ age group. Error is therefore distributed in proportion to the number of years elapsed since the most recent census (i.e. 1/5, 2/5…) and by single years of age prorated over the population in the various age categories (86+ at $(t-4)$, 87+ at $(t-3)$, etc.) as reflected in the postcensal estimates.

For example, the error of closure (ε_{year}^{age}) for the year $(t-3)$, at age 88, is calculated as:

Equation 1.8:
$$\varepsilon_{(t-3)}^{88} = \left(\frac{P_{(t-3)}^{88}}{P_{(t-3)}^{87+}}\right) \times \left(\frac{2}{5}\varepsilon^{90+}\right)$$

and for age 90+:

Equation 1.9:
$$\varepsilon_{(t-3)}^{90+} = \left(\frac{P_{(t-3)}^{90+}}{P_{(t-3)}^{87+}}\right) \times \left(\frac{2}{5}\varepsilon^{90+}\right)$$

Having determined the error of closure for each age and sex for the year $(t-4)$ through to t, the intercensal estimates are obtained by subtracting this error from the postcensal estimate for the corresponding year. When summed, the series of intercensal estimates by age and sex, produced by taking the error of closure into account, differ slightly from the intercensal estimates of total population. These differences are then proportionally distributed among the age cohorts, accounting for the final adjustment made to the intercensal estimates at the provincial and territorial level.

Data Quality

In this section, a comparison will first be made between the consecutive sets of estimates – preliminary, updated and final, for the years 1996 and 1997, as presented in Table 1.2. At the national level, comparisons of the series of estimates show very small differences (less than or equal to 1%). However, provincial/territorial comparisons of the series of estimates show some variation, with differences ranging from ±0.01% up to ±1.98%. Five provinces (Prince Edward Island, Manitoba, Saskatchewan, Alberta and British Columbia) consistently yielded differences of less than 1% for both years, most actually falling under 0.5%. Also noteworthy, in 1996, preliminary population estimates for five provinces or territories were closer to the final estimates than the updated. However, for 1997, updated estimates for all provinces and territories were much closer to the final population estimates.

Given their closeness, the need for the three sets of population estimates might be questioned. While the preliminary estimates would be quite acceptable for many purposes, even very small understatements or overstatements of the population may entail considerable fund misallocations under cost-sharing programmes. Furthermore, while minimal at the aggregate level, differences between preliminary and final estimates may be quite significant at various sub-aggregate levels. The production of three estimates with different time-lags satisfies the requirements of timeliness, accuracy and consistency.

Table 1.2
Percent Differences between Preliminary, Updated and Final Postcensal Estimates, Canada, Provinces and Territories, July 1, 1996 and 1997

Province/territory	Percent Differences					
	Preliminary and Updated		Updated and Final		Preliminary and Final	
	1996	1997	1996	1997	1996	1997
Canada	**-0.02**	**0.93**	**1.00**	**0.07**	**0.98**	**1.00**
Newfoundland and Labrador	-0.17	1.71	1.98	0.01	1.81	1.73
Prince Edward Island	0.42	0.30	0.41	-0.01	0.83	0.29
Nova Scotia	-0.04	1.43	1.29	0.00	1.24	1.43
New Brunswick	0.06	1.09	1.20	-0.05	1.26	1.04
Quebec	0.02	1.53	1.57	0.08	1.58	1.61
Ontario	-0.05	1.29	1.42	0.12	1.37	1.41
Manitoba	0.27	0.77	0.53	-0.01	0.81	0.76
Saskatchewan	0.28	0.13	0.02	0.02	0.30	0.14
Alberta	-0.13	0.31	0.45	0.04	0.32	0.35
British Columbia	-0.06	-0.71	-0.63	0.04	-0.69	-0.67
Yukon	0.16	-1.91	-1.68	0.03	-1.52	-1.89
Northwest Territories	-0.42	-0.37	-1.07	0.06	-1.48	-0.31
Mean Absolute Error[1]	**0.17**	**0.96**	**1.02**	**0.04**	**1.10**	**0.97**
Weighted[2] Mean Absolute Error	**0.07**	**1.12**	**1.18**	**0.07**	**1.14**	**1.18**

[1] Mean absolute error is the sum of the absolute values of the percent differences, divided by the number of categories.

[2] Weighted mean absolute error is the sum of the absolute error for each province/territory weighted by the relative size of the provincial/territorial population.

Source: Demography Division, Statistics Canada

The quality of preliminary estimates of components is analysed using precocity errors. Precocity error is defined as the difference between preliminary and final estimate of a particular component in terms of its relative proportion of the total population for the relevant geographical area. It is calculated as follows for each component:

Equation 1.10:
$$\vartheta^{CPG}_{(t-1,t)} = \frac{\left| {}^{p}\mathrm{CPG}_{(t-1,t)} - {}^{f}\mathrm{CPG}_{(t-1,t)} \right|}{{}^{f}\mathrm{P}_{t}} \times 100$$

where

ϑ = precocity error;
CPG = component of population growth;
p = preliminary estimate;
f = final estimate;
P = population estimate;
t = July 1st of year of estimate.

Table 1.3
Precocity Errors (%) for Selected Components of Growth, Canada, Provinces and Territories, 1992-1993 to 1999-2000

Components	Newfoundland and Labrador	Prince Edward Island	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	Saskatchewan	Alberta	British Columbia	Yukon	Northwest Territories[1]
Births												
1992-1993	0.114	0.061	0.039	0.032	0.054	0.031	0.063	0.059	0.032	0.010	0.020	0.082
1993-1994	0.010	0.019	0.009	0.001	0.016	0.005	0.000	0.009	0.001	0.014	0.261	0.068
1994-1995	0.027	0.001	0.043	0.031	0.006	0.009	0.005	0.014	0.014	0.004	0.010	0.064
1995-1996	0.042	0.050	0.005	0.049	0.005	0.029	0.046	0.037	0.024	0.030	0.045	0.005
1996-1997	0.010	0.059	0.026	0.007	0.008	0.033	0.051	0.011	0.027	0.038	0.019	0.047
1997-1998	0.014	0.121	0.048	0.021	0.005	0.047	0.078	0.003	0.036	0.067	0.105	0.168
1998-1999	0.034	0.014	0.018	0.004	0.001	0.009	0.008	0.010	0.013	0.037	0.092	0.162
1999-2000	0.062	0.041	0.021	0.001	0.005	0.018	0.017	0.011	0.002	0.002	0.006	0.183
Deaths												
1992-1993	0.018	0.090	0.002	0.020	0.004	0.012	0.007	0.045	0.007	0.018	0.017	0.034
1993-1994	0.006	0.040	0.008	0.001	0.013	0.003	0.016	0.000	0.012	0.071	0.042	0.020
1994-1995	0.021	0.027	0.004	0.015	0.014	0.010	0.003	0.005	0.018	0.017	0.070	0.045
1995-1996	0.040	0.062	0.030	0.042	0.004	0.039	0.005	0.008	0.027	0.011	0.000	0.020
1996-1997	0.042	0.021	0.016	0.013	0.009	0.004	0.015	0.066	0.003	0.012	0.000	0.084
1997-1998	0.070	0.090	0.016	0.021	0.013	0.009	0.017	0.044	0.004	0.021	0.016	0.030
1998-1999	0.063	0.036	0.059	0.001	0.004	0.025	0.015	0.001	0.019	0.025	0.019	0.044
1999-2000	..	..	..	..	..	..	..	..	..	..	..	..
Natural Increase												
1992-1993	0.096	0.029	0.041	0.052	0.050	0.043	0.055	0.014	0.039	0.007	0.003	0.115
1993-1994	0.004	0.021	0.000	0.002	0.003	0.008	0.016	0.008	0.013	0.057	0.304	0.047
1994-1995	0.006	0.028	0.039	0.016	0.008	0.019	0.002	0.019	0.004	0.013	0.060	0.020
1995-1996	0.002	0.011	0.025	0.007	0.008	0.010	0.052	0.028	0.003	0.019	0.045	0.024
1996-1997	0.052	0.038	0.042	0.020	0.017	0.030	0.037	0.055	0.024	0.026	0.019	0.132
1997-1998	0.084	0.031	0.064	0.001	0.008	0.038	0.062	0.047	0.032	0.046	0.090	0.198
1998-1999	0.030	0.050	0.041	0.003	0.003	0.016	0.007	0.008	0.032	0.012	0.111	0.206
1999-2000	..	..	..	..	..	..	..	..	..	..	..	..
Immigration												
1992-1993	0.000	0.002	0.011	0.002	0.012	0.030	0.017	0.010	0.024	0.081	0.046	0.024
1993-1994	0.008	0.003	0.004	0.002	0.019	0.035	0.008	0.004	0.023	0.036	0.003	0.008
1994-1995	0.004	0.010	0.022	0.001	0.007	0.028	0.006	0.007	0.012	0.034	0.033	0.003
1995-1996	0.002	0.005	0.010	0.002	0.023	0.034	0.012	0.006	0.022	0.053	0.003	0.006
1996-1997	0.004	0.001	0.011	0.004	0.019	0.025	0.072	0.000	0.006	0.058	0.009	0.021
1997-1998	0.003	0.001	0.015	0.003	0.006	0.002	0.001	0.001	0.007	0.005	0.019	0.010
1998-1999	0.001	0.003	0.000	0.002	0.002	0.001	0.001	0.001	0.001	0.002	0.019	0.000
1999-2000	0.002	0.001	0.000	0.001	0.000	0.000	0.003	0.002	0.002	0.002	0.013	0.006
Change in NPRs												
1992-1993	0.307	0.011	0.166	0.055	0.081	0.047	0.139	0.072	0.081	0.156	0.079	0.056
1993-1994	0.199	0.001	0.010	0.014	0.053	0.370	0.013	0.003	0.112	0.241	0.470	0.159
1994-1995	0.174	0.012	0.123	0.072	0.055	0.049	0.114	0.089	0.082	0.041	0.256	0.037
1995-1996	0.006	0.026	0.030	0.008	0.031	0.066	0.011	0.009	0.028	0.031	0.074	0.017
1996-1997	0.122	0.005	0.063	0.050	0.043	0.059	0.056	0.064	0.099	0.179	0.009	0.018
1997-1998	0.026	0.033	0.014	0.009	0.026	0.043	0.003	0.004	0.015	0.053	0.115	0.035
1998-1999	0.000	0.039	0.004	0.006	0.016	0.027	0.000	0.001	0.003	0.010	0.051	0.001
1999-2000	..	..	..	..	..	..	..	..	..	..	..	..
Net Interprovicial Migration												
1992-1993	0.075	0.037	0.223	0.002	0.094	0.091	0.058	0.240	0.006	0.044	5.281	0.530
1993-1994	0.077	0.011	0.115	0.119	0.053	0.015	0.003	0.247	0.116	0.105	0.712	0.527
1994-1995	0.250	0.393	0.008	0.003	0.088	0.069	0.094	0.051	0.130	0.085	0.582	0.103
1995-1996	0.024	0.180	0.038	0.019	0.008	0.025	0.143	0.140	0.070	0.038	0.767	0.065
1996-1997	0.205	0.141	0.162	0.086	0.011	0.061	0.184	0.118	0.056	0.114	0.244	0.608
1997-1998	0.351	0.318	0.264	0.018	0.007	0.023	0.009	0.140	0.130	0.146	0.295	0.412
1998-1999	0.013	0.020	0.006	0.042	0.036	0.002	0.069	0.173	0.202	0.166	1.664	0.982
1999-2000	0.324	0.635	0.099	0.226	0.057	0.022	0.190	0.161	0.368	0.185	0.158	1.530

Note: Precocity errors are defined as the difference between preliminary and final estimates in terms of its relative proportion to the total population (at July 1), expressed in percent for the relevant geographical area.

[1] As preliminary estimates for Nunavut are not available for all years, precocity errors have been calculated for Northwest Territories and Nunavut combined.

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Precocity error allows for useful comparisons between components, as well as between provinces and territories or geographical areas of different population size. Table 1.3 presents the precocity errors for the selected components of population growth, by province and territory for 1992-1993 to 1999-2000.[4] Note that when compared to the total population for an area, the differences between preliminary and final estimates of the components are quite small (generally less than 0.1%). There are, however, differences in the amount of impact on the population estimates between components and between provinces and territories. Generally speaking, net interprovincial migration yields the greatest precocity errors (with the exception of Ontario, where in three of the five years, errors for estimates of non-permanent residents were higher). This is likely the result of the use of different data sources for preliminary and final estimates of interprovincial migration.[5] In most years and for most provinces, births, deaths and immigration estimates yielded the smallest precocity errors. For immigration estimates, this reflects the completeness of the data source and the ready availability of data for the more timely preliminary estimates. In the case of births and deaths, small precocity errors support the use of short-term projections for preliminary estimates.

Table 1.4
Error of Closure of the Estimates of Population, Canada, Provinces and Territories, July 1, 1986, 1991 and 1996

Province/territory	1986		1991		1996	
	Number	Percent	Number	Percent	Number	Percent
Canada	**82,773**	**0.32**	**40,820**	**0.15**	**181,365**	**0.61**
Newfoundland and Labrador	10,522	1.82	6,704	1.16	8,768	1.56
Prince Edward Island	339	0.26	2,909	2.23	63	0.05
Nova Scotia	3,024	0.34	4,789	0.52	8,536	0.92
New Brunswick	7,025	0.97	-865	-0.12	5,411	0.72
Quebec	50,443	0.75	-4,304	-0.06	94,403	1.30
Ontario	-4,752	-0.05	-3,003	-0.03	107,133	0.97
Manitoba	-1,929	-0.18	10,485	0.95	1,307	0.12
Saskatchewan	-548	-0.05	13,143	1.31	-4,846	-0.48
Alberta	25,182	1.03	16,388	0.63	608	0.02
British Columbia	-2,995	-0.10	-1,997	-0.06	-38,196	-0.99
Yukon	-1,466	-5.92	-948	-3.30	-741	-2.33
Northwest Territories	-2,072	-3.74	-2,481	-4.09	-1,081	-1.60

Note: The error of closure is equal to the July 1 postcensal estimate minus the census count adjusted to July 1 and for net undercount. The percentage is: error of closure, divided by the census count adjusted to July 1 and for net undercount, multiplied by 100.

Source: Demography Division, Statistics Canada

The Census is considered to be a reliable benchmark for validating the postcensal population estimates. The error of closure (the difference between the postcensal estimate and the enumerated census population, adjusted for net undercoverage) provides a measure of accuracy for the postcensal estimates.[6] It should be noted that it represents errors that have accumulated over the five-year period since the previous census.

Table 1.4 presents the errors of closure for 1986, 1991 and 1996. At the national level, the differences are small (0.32% for 1986, 0.15% for 1991 and 0.61% for 1996). At the provincial/territorial level, however, the differences are understandably larger, since the provincial/territorial estimates are affected by errors in estimating interprovincial migration, in addition

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[4] Precocity errors are not available for the total emigration component due to a change in the method of estimation.

[5] For further information on the data sources used and the associated data quality issues for internal migration, see Chapter 7.

[6] Values of the error of closure are provided on an annual basis in text tables in *Annual Demographic Statistics*, Statistics Canada, Catalogue no. 91-213-XPB.

to the other components which affect the total population estimates. Nevertheless, excluding the territories, the provincial postcensal estimates fall within 1% of the census counts with few exceptions (Newfoundland and Labrador in 1986, 1991 and 1996; Alberta in 1986; Prince Edward Island and Saskatchewan in 1991; and Quebec in 1996.

Table 1.5
Error of Closure, with and without Net Census Undercoverage Adjustment, Canada, Provinces and Territories, July 1, 1996

Province/territory	With Adjustment		Without Adjustment	
	Number	Percent	Number	Percent
Canada	**181,365**	**0.61**	**248,839**	**0.86**
Newfoundland and Labrador	8,768	1.56	7,439	1.35
Prince Edward Island	63	0.05	675	0.50
Nova Scotia	8,536	0.92	14,980	1.65
New Brunswick	5,411	0.72	-1,108	-0.15
Quebec	94,403	1.30	57,841	0.81
Ontario	107,133	0.97	97,753	0.91
Manitoba	1,307	0.12	3,031	0.27
Saskatchewan	-4,846	-0.48	9,800	0.99
Alberta	608	0.02	35,926	1.33
British Columbia	-38,196	-0.99	24,394	0.65
Yukon	-741	-2.33	-630	-2.04
Northwest Territories	-1,081	-1.60	-1,262	-1.95
Mean Absolute Error[1]		**0.92**		**1.05**
Weighted Mean Absolute Error[2]		**0.91**		**0.88**

[1] Mean absolute error is the sum of the absolute values of the percent differences divided by the number of categories.

[2] Weighted mean absolute error is the sum of the absolute error for each province/territory weighted by the relative size of the provincial/territorial population.

Source: Demography Division, Statistics Canada

The comparison of the error of closure calculated using the adjustment for census undercoverage versus using the unadjusted census count demonstrates the complexity of this measure. When using the adjusted census counts, in addition to errors and biases in the components of population change accumulated over the 5-year period, it comprises errors related to the estimates of net undercoverage in the base census of population estimates and the most recent census used as a reference for the error of closure. Table 1.5 compares the error of closure for adjusted and unadjusted census figures with Demography Division's population estimates for July 1, 1996. For half of the provinces and territories, the differences between population estimates and the census numbers diminished when census counts were adjusted for net undercoverage, while in the other half they widened. Additionally, with the coverage adjustment, the error of closure indicates that New Brunswick's population was overestimated, while the unadjusted census figures yielded opposite results (i.e., underestimation). The reverse was the case for Saskatchewan and British Columbia, whose errors of closure were negative with the adjustment (i.e., underestimation by Demography Division), and positive without it. At the Canada level, the precision of the population estimates, as measured against the census, increased substantially.

Contributing to the overall error, each component carries its own degree of bias and error. A method of explaining a portion of the error of closure with respect to individual components involves the use of the Reverse Record Check (RRC).[7] In addition to its ability to estimate coverage error, it is also possible to extend the RRC classification results to obtain an alternate estimate of demographic growth, potentially decomposed by component. In allowing for a decomposition of the error of closure, the RRC may provide some insight as to which demographic components are most problematic in the postcensal estimates, both nationally and across provinces and territories. (Lachapelle, R. and Kerr, D. (1998)).

In the most general sense, the population change of the intercensal period is calculated by summing those classification results which have a positive effect on the population, and subtracting those which have a negative effect, as estimated by the RRC. Note the similarity to the component method for postcensal estimates in the equation below.

Equation 1.11:

$$^{RRC}P_t - {}^{RRC}P_{(t-5)} = B_{(t-5,t)} + I_{(t-5,t)} + NPR^{in}_{(t-5,t)} - D_{(t-5,t)} - D^{NPR}_{(t-5,t)} - E_{(t-5,t)} - E^{NPR \to I}_{(t-5,t)} - NPR^{out}_{(t-5,t)} + RE_{(t-5,t)}$$

where

(t, t - 5)	=	the period between two consecutive censuses (i.e., intercensal period);
$^{RRC}P_t - {}^{RRC}P_{(t-5)}$	=	population growth during the intercensal period, according to the RRC;
$B_{(t-5,t)}$	=	number of births during the intercensal period who were in the census universe of t;
$I_{(t-5,t)}$	=	number of landed immigrants during the intercensal period who were in the census universe of t;
$NPR^{in}_{(t-5,t)}$	=	number of non-permanent residents entering Canada during the intercensal period who were in the census universe of t;
$D_{(t-5,t)}$	=	number of deaths of Canadian citizens and landed immigrants during the intercensal period who were in the census universe of $(t-5)$;
$D^{NPR}_{(t-5,t)}$	=	number of deaths of non-permanent residents during the intercensal period who were in the census universe of $(t-5)$;
$E_{(t-5,t)}$	=	number of Canadian citizens and landed immigrants who were in the census universe at $(t-5)$ but emigrated from Canada during the intercensal period;
$E^{NPR \to I}_{(t-5,t)}$	=	number of non-permanent residents at $(t-5)$, who during the intercensal period subsequently received landed immigrant status and then emigrated during the period;

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[7] The Reverse Record Check (RRC) is a coverage study, conducted after the Census, which provides estimates of census coverage error, including independent estimates of census undercoverage and census overcoverage. Basically, the RRC begins by working with a sample of all persons who were enumerated (or missed) in the previous census, along with all persons who were either born or entered into Canada over the intercensal period. With the exception of a very small sub-population of returning emigrants, the RRC sampling frame includes all persons who could potentially be part of the census target universe. For a more detailed description of the RRC study, please refer to Chapter 2 – Base Populations.

$\text{NPR}_{(t\text{-}5.t)}^{out}$ = number of non-permanent residents at $(t - 5)$, who did not receive landed immigrant status, but left Canada during the intercensal period;

$\text{RE}_{(t-5,t)}$ = number of landed immigrants and Canadian citizens who were outside of the census universe at $(t - 5)$, but in the census universe at t (i.e., returning emigrants).

While the postcensal and RRC based estimates of demographic growth should theoretically lead to an equivalent estimate of overall population increase, the specific components are not directly comparable. For example, births in the postcensal estimates denote all births occurring in a population over an intercensal period, irrespective of whether such persons move or die; whereas births in the RRC method denote all births occurring to a specific population and are still with that population at the end of the intercensal period. Regardless, if differences exist between RRC-based estimates and postcensal estimates, it is still possible, through an expansion of the RRC-based equestion, to determine how much of the difference in estimated growth can be traced back to differences in migration and how much can be traced to differences in natural increase. (Lachapelle, R. and Kerr, D. (2000)).

Table 1.6 presents a comparison of Demography Division's postcensal estimates of the components of population change with the alternative RRC estimates. Note that there is considerable variation by component. For example, estimates of births and immigration from both sources are quite comparable, with identical estimates in several cases. Despite the differences in the number of deaths, it is accepted that the Demography Division estimates are of high quality since they rely upon vital statistics which are considered a highly reliable data source, whereas the RRC survey estimates are based on classification procedures, making them consequently less reliable.

The administrative data source used for Demography Division's estimates of interprovincial migration is considered to be of comparable quality to the classification procedures used by the RRC, whereas Demography's NPR estimates based on administrative data are considered of higher quality. It is the postcensal estimates of the total emigration component that is clearly of lower quality. Since direct information on persons leaving Canada does not exist, the RRC's exhaustive tracing, record linkage and direct interviewing procedures are considered an improvement over the other data sources currently available. An acceptance of the RRC estimates for these more difficult to estimate migratory flows likely explains a large part of the 1996 error of closure, especially for Canada. (Lachapelle, R. and Kerr, D. (2000) and Lachapelle, R. and Kerr, D. (1998)).

Table 1.6
Estimates of Components of Population Change, Demography Division and Reverse Record Check, Canada and Provinces, 1991-1996

Province	Births			Deaths			Immigration		
	Demography	RRC	Difference	Demography	RRC	Difference	Demography	RRC	Difference
Canada	**1,905,927**	**1,905,927**	**0**	**1,009,853**	**1,081,605**	**-71,752**	**1,161,726**	**1,165,113**	**-3,387**
Newfoundland and Labrador	31,748	31,779	-31	19,286	18,530	756	3,411	3,538	-127
Prince Edward Island	8,803	8,782	21	5,692	6,913	-1,221	771	820	-49
Nova Scotia	55,994	55,984	10	37,677	43,820	-6,143	14,489	14,058	431
New Brunswick	44,444	44,444	0	28,567	29,354	-787	3,359	3,614	-255
Quebec	453,556	454,332	-776	252,628	273,617	-20,989	189,905	189,905	0
Ontario	730,520	729,744	776	376,760	400,047	-23,287	618,869	618,870	-1
Manitoba	81,485	81,485	0	45,858	56,108	-10,250	22,004	22,129	-125
Saskatchewan	70,382	70,382	0	40,652	40,143	509	11,282	11,157	125
Alberta	199,484	199,484	0	75,798	74,640	1,158	84,130	84,130	0
British Columbia	229,511	229,511	0	126,935	138,433	-11,498	213,506	216,892	-3,386

	Emigration			Interprovincial Migration			Non-permanent Residents		
Canada	**115,431**	**321,659**	**-206,228**	**984**	**1,076**	**-92**	**-152,722**	**-101,448**	**-51,274**
Newfoundland and Labrador	671	2,227	-1,556	-23,074	-32,767	9,693	-1,406	455	-1,861
Prince Edward Island	206	455	-249	1,643	-886	2,529	164	236	-72
Nova Scotia	2,297	7,334	-5,037	-5,288	-1,479	-3,809	-950	-549	-401
New Brunswick	2,429	3,889	-1,460	-3,255	-2,933	-322	-455	-606	151
Quebec	15,490	55,766	-40,276	-51,176	-49,395	-1,781	-23,353	-13,445	-9,908
Ontario	48,609	168,556	-119,947	-40,850	-37,505	-3,345	-116,602	-86,934	-29,668
Manitoba	5,684	10,871	-5,187	-25,336	-29,765	4,429	-1,630	-582	-1,048
Saskatchewan	2,493	7,133	-4,640	-26,644	-25,095	-1,549	-777	144	-921
Alberta	19,718	33,689	-13,971	7,155	-10,321	17,476	-8,267	-5,057	-3,210
British Columbia	17,834	31,739	-13,905	167,809	191,222	-23,413	554	4,890	-4,336

	Total*		
Canada	**1,790,631**	**1,567,404**	**223,227**
Newfoundland and Labrador	-9,278	-17,752	8,474
Prince Edward Island	5,483	1,584	3,899
Nova Scotia	24,271	16,860	7,411
New Brunswick	13,097	11,276	1,821
Quebec	300,814	252,014	48,800
Ontario	766,568	655,572	110,996
Manitoba	24,981	6,288	18,693
Saskatchewan	11,098	9,312	1,786
Alberta	186,986	159,907	27,079
British Columbia	466,611	472,343	-5,732

* Total = Births - Deaths + Immigration - Emigration + Interprovincial Migration + Non-permanent Residents
Source: Lachapelle, R. and Kerr, D. (2000). "Census Coverage Error: A Demographic Evaluation", in *Survey Methodology, June 2000*. Ottawa: Statistics Canada, Vol. 26, No. 1, pp. 43-52.

Chapter 2

Base Population (Censal Estimates)

A *base population* is the population at the beginning of a period used as a reference or starting point for the estimation process. For postcensal estimates, the base population is the population enumerated in the most recent census, adjusted for net undercoverage (also referred to as the "censal estimate"). The base population for intercensal estimates is the postcensal-estimated population.

Since net undercoverage is an important aspect of estimating population counts used in the population estimates and projections program, this chapter focuses on the census population, adjusted for net undercoverage. It begins with a brief description of census collection procedures, followed by procedures used for adjusting census counts and postcensal estimates and concludes with a discussion on other errors associated with census counts.

Censal Estimates as the Base Population

The census requires the participation of the entire population of Canada. Every Census of Canada up to and including the 1966 Census was conducted by interview. In 1971, there was a major change in collection method, which allowed respondents to complete the questionnaires themselves.

Since then, two collection methods have been used: self-enumeration and interview. The self-enumeration methodology is used in about 98% of the country except for some core areas of large urban areas, remote and northern areas, and most Indian reserves and settlements, where people are more difficult to enumerate. The census representative (CR) drops off a questionnaire, with instructions for an adult in the household to complete it for all persons living in the household on Census Day and to return it through the mail.

The remaining 2% of households are enumerated by personal interviews. With this method, the CR visits the household and completes the questionnaire during the interview.

Following the completion of collection by the CR, the work is checked by the CR's supervisor, the Census Commissioner, and by a Quality Control Technician. Once the work is approved, the questionnaires and visitation records are forwarded to the data processing operations. Details about these operations are provided in the **Census Technical Reports** and in the **Census Handbook**, published following each census.

The following groups of persons are included in the population universe of the census:

- Canadian citizens and landed immigrants with a usual place of residence in Canada;
- Canadian citizens and landed immigrants who are outside Canada as employees of the Canadian government (federal or provincial) or members of the Canadian Armed Forces, and their families;

- Canadian citizens and landed immigrants at sea or in port aboard merchant vessels under Canadian registry; and
- Non-permanent residents:
    - persons in Canada claiming refugee status;
    - persons in Canada who hold a student authorisation (foreign students, student visa holders);
    - persons in Canada who hold an employment authorisation (foreign workers, work permit holders);
    - persons in Canada who hold a Minister's permit (including extensions); and
    - all non-Canadian born dependants of persons claiming refugee status or of persons holding student authorisation, employment authorisation, or Minister's permit.

The following groups of persons, known collectively as foreign residents, are not included in the population universe of the census:

- government representatives of another country attached to the embassy, high commission, or other diplomatic body of that country in Canada, and their families;
- members of the Armed Forces of another country who are stationed in Canada and their families; and
- residents of another country visiting temporarily in Canada.

Each base population ($\mathbf{P}_t$, where t = the census year) is obtained starting from census counts as follows:

- adjustment of population by age and sex from Census day to July 1. From 1996 onward, adjustment between Census Day and July 1 is done using the cohort component approach[8];
- adjustment of the population for net undercoverage;
- addition of independent estimates of incompletely enumerated Indian reserves;
- adjustment for early enumeration in parts of northern Quebec, Newfoundland and Labrador, and the territories; and
- adjustment for population challenges.

Adjustment for Net Undercoverage

Coverage errors are defined as errors caused by the miscounting of the population on Census Day. There are two types of coverage errors: undercoverage and overcoverage. Undercoverage occurs when a person who is a part of a census universe is missed by the census. Overcoverage, on the other hand, may occur in two ways. First, and most common, is the situation when a person who is part of a census universe is enumerated more than once. Second, a person outside the census universe, such as a foreign resident or a fictitious person, may be erroneously enumerated.

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[8] Prior to 1996, the adjustment for the few days between Census Day and June 1 (the reference day for the base population for this period) was made using a proportion of growth method, except for the 1971 and 1976 Censuses, where no adjustment was necessary because they were held on June 1. Since the change in reference date of estimates to July 1, adjustments were made to the base population for years prior to 1996 for comparability purposes. Also, as described in Chapter 1, estimates of non-permanent residents were added to the base populations from 1971 to 1991, consequential to their introduction to the Census target population in 1991.

A geographic error alone does not constitute a coverage error. That is, a person who is enumerated in the wrong geographic area does not constitute overcoverage for the area in which the person was enumerated and undercoverage for the area in which the person should have been enumerated.

Coverage Error Measurement Program[9]

Four studies comprise the Coverage Error Measurement Program, including:

(i) Vacancy Check (VC);
(ii) Reverse Record Check (RRC);
(iii) Automated Match Study (AMS); and
(iv) Collective Dwelling Study (CDS).

Together, these studies provide estimates of census coverage error that are independent of the census itself.

The VC produces estimates of undercoverage arising from the incorrect classification of dwellings as unoccupied. The RRC measures undercoverage from all sources, including the undercoverage measured by the VC. The RRC, AMS, and CDS all measure overcoverage. The AMS focuses on persons counted more than once on the census database within the same region (Atlantic, Quebec, Ontario, rest of Canada) while the CDS estimates overcoverage resulting from persons enumerated as usual residents in a collective dwelling who were also enumerated in a private dwelling. Although the RRC is designed to measure overcoverage from all sources, only the overcoverage not measured by either the AMS or the CDS contributes to the estimates of coverage error.

The data resulting from these four studies are used in the following ways:

(i) estimates from the VC are included in the final census counts to account for this specific source of undercoverage;
(ii) estimates from the RRC, the AMS, and the CDS are only included in the base population for the postcensal estimates produced by Statistics Canada;
(iii) information on the causes and characteristics of coverage errors is used in the planning of the next census to identify areas or subgroups of the population where the level of coverage error is particularly high;
(iv) supplementary information collected by the studies is used to evaluate the quality of selected census questions. The RRC, for example, provides the means of linking an individual's answers over two consecutive censuses thereby enabling the calculation of response error for questions such as date of birth, sex, and mother tongue; and
(v) the results serve to inform users about the nature and levels of coverage errors in the census so that they are better informed when drawing conclusions or making decisions based on census data.

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[9] It should be noted that a number of changes have been made to the coverage studies for the 2001 Census as well as the methodology used for the calculation of net undercoverage by single year of age and sex.

The Vacancy Check

One of the potential sources of error in the census is the misclassification of dwellings. The erroneous inclusion of marginal dwellings or dwellings under construction in the unoccupied dwellings classification results in overcoverage of the housing stock, whereas the incorrect classification of occupied dwellings as unoccupied results in undercoverage of both households and persons. The purpose of the Vacancy Check is to study these two types of classification error.

The population targeted by the VC includes all unoccupied dwellings identified on Census Day except those in collective enumeration areas (EAs), canvasser EAs and Indian reserves. These areas were excluded from the sampling frame mainly because of cost and operational considerations. The sampling frame included all self-enumeration EAs, which are then split into separate urban and rural frames for sample selection.

After data from the VC have been collected and verified, they are adjusted on the census databases. These adjustments are called *random additions*. This is accomplished by first producing a national level profile of misclassified dwellings for both urban and rural areas, using the type of dwelling and the number of persons missed because of the misclassification. These national profiles are used to create estimates of the number of misclassified dwellings by number of persons in the household, type of dwelling, and rural/urban parts at the province and territory level. On the basis of these estimates, enumerated households with the same characteristics, such as number of persons and type of private dwelling, are selected at random, and their weights[10] are increased by one unit. For each household selected, the weight of one unoccupied dwelling from the same EA was set to zero so that the total number of dwellings would not be increased.

Reverse Record Check

The Reverse Record Check (RRC) measures both gross undercoverage and gross overcoverage. Its results are combined with the findings of the other coverage studies to calculate net undercoverage. In 1996, for the first time, the Private Dwelling Study carried out for 1991 to measure overcoverage, was incorporated into the RRC.

The RRC sample, consisting of persons who should have been enumerated in the census, was selected from sources independent of the census. Shortly after the census, tracing operations are undertaken to contact and interview the persons in the sample and find out where they were living on Census Day. Subsequently, census documents are searched to determine whether the Selected Person (SP) had been enumerated and, if so, whether they had been enumerated more than once or erroneously. Deceased persons, for example, who were enumerated, are considered to have been enumerated erroneously.

The sample is selected from six different sources known as 'sampling frames'. The first five sampling frames are used to estimate undercoverage in the 10 provinces, whereas estimates for the territories are calculated on the basis of samples from the sixth frame. The six sampling frames are:

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[10] Weights indicate the number of units that each unit in a sample represents in the total population. In the case of misclassified dwellings, randomly selected enumerated households may represent more than one household for incorrect classification of occupied dwellings as unoccupied. Similarly, the weight may be adjusted to 0 to represent an erroneous inclusion of an unoccupied dwelling.

(i)   Census: All persons enumerated in the previous census;

(ii)   Missed: All persons not enumerated in the previous census;

(iii)   Births: All children born between the day after Census Day of the previous census and the day before Census Day of the most recent census;

(iv)   Immigrants: All landed immigrants who arrived in Canada between the day after Census Day of the previous census and the day before Census Day of the most recent census;

(v)   Permit holders and refugee status claimants: All persons holding employment or student authorisations or Minister's permits, including extensions, and persons claiming refugee status who were in Canada on Census Day; and

(vi)   Health Care Files: All persons listed in the health insurance files of the Yukon and the Northwest Territories who were in Canada on Census Day.

Sample design and selection is performed separately on each frame. Sampling rates from each of these frames depends on the size of the frame, the expected rate of tracing, and the expected gross undercoverage and gross overcoverage.

A problem that exists with using multiple frames is the possibility that persons may be listed on more than one frame. For example, a person in the Immigrants frame may have been in Canada on a work permit at the time of the second-most recent Census and thus would have been enumerable for that Census. Consequently, this person would then be in the Immigrants frame and in the Census frame if he or she were enumerated, or represented in the Missed frame if they were not enumerated. All potential cases of frame overlap must be identified to avoid double-counting.

The purpose of the various RRC operations is to classify each SP as one of the following:

(i)   enumerated once in the census;

(ii)   enumerated more than once in the census;

(iii)   missed in the census;

(iv)   died before the census;

(v)   emigrated before the census;

(vi)   temporarily abroad at the time of the census;

(vii)   out of scope, that is, the SP should not be included in the census (for example, babies born after census day, permit holders and refugee status claimants who were no longer in Canada on Census Day) or covered by more than one frame;

(viii) not identified: an identifier such as name, date of birth or sex is missing, resulting in insufficient information to initiate or validate the tracing process;

(ix)   not traced: the SP was not contacted and interviewed to determine whether he or she belonged to the census target population and, if so, what his or her usual residence was on census day; or

(x)   not classified: it is determined through contact that the SP was part of the target population but there was insufficient information to assign a final classification because the addresses were too vague.

This classification is achieved by two operations: collection and address searching. The purpose of collection is to establish the SP's address and status on Census Day as enumerable or not enumerable. This is accomplished through conducting telephone interviews with each SP. All addresses where the SP could have been enumerated on Census Day are also collected. Collection begins with sending sampling frame data and other data such as previous phone numbers and addresses to Statistics

Canada's Regional Offices. Interviewers then make every effort to trace the SP and conduct a telephone interview.

Address searching consists of checking the census database and census documents, such as visitation records (VRs) and questionnaires from the most recent census for each address provided by the SP to determine whether the SP had been enumerated there.

A new operation, known as the "mega-match", was introduced in the 1996 RRC. This operation helped classify SPs as enumerated at addresses not identified during tracing or at unsearchable addresses. It consisted of matching the SPs household against the 1996 Census database, using the date of birth and sex, and identifying all households in the database with two or more matching members.

Prior to final classification, additional searching is done for all SPs that have not yet been found enumerated. Efforts are made to identify addresses using electronic telephone books or a Revenue Canada database.

Finally, all SPs are classified into one of the categories mentioned at the beginning of this section, and the creation of a final database can begin. Data from the interview provide the basis for classifying SPs as contacted, emigrated, temporarily abroad, or not traced. Data obtained from the interview and a second source are required to classify an SP as deceased. On the basis of the address search results, enumerable SPs are classified as enumerated once, enumerated more than once, or missed.

The process of creating the final database consists of five main steps:

(i)   capture and edit of selected data from the RRC questionnaire;
(ii)   imputation of item non-response for the RRC questionnaire;
(iii)   incorporation of address search and classification results;
(iv)   processing for total non-response and other weight adjustments; and
(v)   calculation of final estimates of undercoverage and standard errors.

All data in the RRC questionnaires are captured. In cases where data for one or more questions are missing or inaccurate, an attempt is made to obtain the required information from other sources such as sample frames and administrative records. The results of address processing and SP classification are then added to the final database.

The first step in producing estimates from the final classification of the RRC sample is to adjust the sampling weights of respondents to account for all types of non-respondents ("not identified", "not traced" and "not classified"). The adjustment consists in redistributing the weight of groups of non-respondents among groups of respondents assumed to have a similar probability of being missed in the census. A major criterion in forming the groups is the SP's potential mobility, since it is reasonable to assume that a person changing residence is more likely to be missed than a person who is not mobile.

The final step is a post-stratification, or "weight adjustment," which ensures compatibility with known totals in the sample frame populations. First, the incomplete coverage of the Health Care Files of the territories is taken into account. Second, an adjustment is made for non-permanent residents using more precise figures. Finally, age and sex differences between the census database and the RRC database are addressed as outliers.

An extra weight adjustment is carried out for those SPs classified as enumerated more than once. In some cases, the addresses provided by the SP are too vague to identify a particular address. The weight adjustment accounts for this type of non-response.

Although the RRC measures the same types of overcoverage as the Automated Match Study and the Collective Dwelling Study, it does so with much less accuracy. Thus, the weights of the RRC overcoverage cases are higher than the weights for the AMS or CDS overcoverage cases.

Automated Match Study

Persons who are included more than once cause most of the overcoverage on the census database. The Automated Match Study (AMS) was designed to detect and estimate overcoverage between private dwellings by searching the census database for pairs of households containing persons that have the same sex and full date of birth in the same geographic region (Atlantic, Quebec, Ontario, rest of Canada).

Two sets of programs are in place in the AMS. The first set identifies pairs of census households in the same region with at least two exact person matches, whereas the second set identifies pairs in the same Federal Electoral District (FED) with only one exact person match. The pairs of households are stratified and within each stratum, a sample of pairs of households is selected and their census documents are reviewed. If the same person is on both questionnaires, overcoverage has occurred. Since the Census Day address is unknown, the weight of the sample unit is split between the households where overcoverage occurred.

Collective Dwelling Study

This study covers all persons enumerated as usual residents in a collective dwelling and measures overcoverage resulting from respondent error when two census questionnaires have been completed at different dwellings. A collective dwelling is a dwelling of commercial, institutional, or communal nature. Collective dwellings are of two types: institutional dwellings such as hospitals and jails, and non-institutional dwellings such as hotels, YMCAs, and school residences (Statistics Canada (1999d)).

During the enumeration of collective dwellings on Census Day, the census representatives assigned to institutional collective dwellings record an alternative address for all residents, such as patients or inmates, using information from the institutions' administrative records. Live-in staff of institutional collective dwellings and usual residents of non-institutional collective dwellings complete an individual census form on which they are asked to report an alternative address. These addresses provide a sampling frame for the Collective Dwelling Study (CDS).

The CDS consists of two components: the institutional and non-institutional. Optimal allocation based on the number of usual residents is used to split the sample between the two components.

For the institutional component, the sample is allocated to each province according to the number of usual residents in institutional collective dwellings. The sample is selected in two stages. First, a sample of institutions is chosen and then a sample of usual residents is taken from the selected institutions.

For the non-institutional component, the sample is also allocated to each province according to the number of usual residents in non-institutional collective dwellings. A sample of enumeration areas is chosen and all of the usual residents of the non-institutional collective dwellings in the selected enumeration areas form the non-institutional sample (Statistics Canada (1999d)).

The data are processed through steps similar to those applied to the RRC. For each individual in the sample, the questionnaires completed at their alternative address are verified to determine if they were enumerated a second time. If they were found on the questionnaire, overcoverage occurred.

Calculating Net Undercoverage

The net coverage error is defined as:

Equation 2.1:
$$NU = \mathbf{P} - \mathbf{C}$$

where

NU = net coverage error;
$\mathbf{P}$ = censal estimate (total number of persons who should have been enumerated in the census);
$\mathbf{C}$ = census count.

Furthermore:

Equation 2.2:
$$\mathbf{P} = U + EN$$

where

U = total undercoverage (number of persons missed in the census);
EN = number of persons who were enumerated at least once.

Therefore:

Equation 2.3:
$$\begin{aligned} NU &= (U + EN) - \mathbf{C} \\ &= U - (\mathbf{C} - EN) \\ &= U - O \end{aligned}$$

where the term $(O = \mathbf{C} - EN)$ is defined as overcoverage. This error results not only from counting units more than once, but also from counting units that are outside the universe in question.

Undercoverage, overcoverage, and the net of the two, net undercoverage, are most usefully expressed as rates of the population that should have been enumerated in the census. The rates of coverage error are:

Equation 2.4:   Undercoverage rate:
$$R^U = \frac{U}{\mathbf{P}}$$

Equation 2.5:   Overcoverage rate: $R^O = \dfrac{O}{P}$

Equation 2.6:   Net undercoverage rate: $R^{NU} = \dfrac{NU}{P}$

or:

Equation 2.7:   Net undercoverage rate: $R^{NU} = \dfrac{(U - O)}{P}$

$$= R^U - R^O$$

The estimated population undercoverage rate $\hat{R}^U$, indicating the proportion of persons missed by the census as a proportion of the total number of persons who should have been enumerated, is calculated as follows:

Equation 2.8: $\hat{R}^U = \dfrac{\hat{M}P - \hat{V}C}{C + (\hat{M}P - \hat{V}C) - \hat{O}}$

where

$\hat{M}P$ =   estimate of the number of persons not enumerated at their usual place of residence, as obtained from the RRC;

C =   census count;

$\hat{V}C$ =   estimate of the number of persons not enumerated because they occupied dwellings classified by the census representative as unoccupied, as obtained from the Vacancy Check;

$\hat{O}$ =   estimate of the number of persons enumerated more than once or in error

where

$$\hat{O} = \hat{O}^{AMS} + \hat{O}^{CDS} + \hat{O}^{RRC}$$

       where

       $\hat{O}^{AMS}$ =   estimate of overcoverage measured by the Automated Match Study;

       $\hat{O}^{CDS}$ =   estimate of overcoverage measured by the Collective Dwelling Study;

       $\hat{O}^{RRC}$ =   estimate of overcoverage measured by the Reverse Record Check, net of the overcoverage included in the Automated Match Study and the Collective Dwelling Study.

The denominator of $\hat{R}^U$ estimates the number of persons who should have been enumerated as:

- the total number of persons actually enumerated ($C - \hat{V}C$); plus
- the number of persons who should have been enumerated but were not ($\hat{M}P$); minus
- the number of persons enumerated who should not have been enumerated ($\hat{O}$).

$\hat{V}C$ is subtracted from C because the published census count includes an estimate of the number of persons who were erroneously excluded because they occupied dwellings misclassified as vacant.

The estimated population overcoverage rate $\hat{R}^{O}$ is calculated as follows:

$$\hat{R}^{O} = \frac{\hat{O}}{C + (\hat{M}P - \hat{V}C) - \hat{O}}$$

The estimated population net undercoverage rate $\hat{R}^{NU}$ is calculated as follows:

$$\hat{R}^{NU} = \hat{R}^{U} - \hat{R}^{O}$$

$$= \frac{(\hat{M}P - \hat{V}C) - \hat{O}}{C + (\hat{M}P - \hat{V}C) - \hat{O}}$$

A positive net undercoverage rate indicates that undercoverage is larger than overcoverage, whereas a negative net undercoverage rate indicates that undercoverage is smaller than overcoverage. In most cases, undercoverage is larger than overcoverage. Thus, most net undercoverage rates will be positive.

Other Coverage Adjustments

Adjustments for Non-Enumerated Indian Reserves and Settlements

Enumeration is sometimes not permitted on some Indian reserves and settlements or it is interrupted before it can be completed. The impact of this missing data is small at the national level, but becomes more significant at smaller levels of geography, if they contain one of these reserves or settlements. Consequently, estimation models developed by Statistics Canada generate independent estimates of the population size for these reserves and settlements. These estimates are subsequently added to the adjusted census figures for the base population.

The estimation strategy for these reserves involves a series of simple linear regression models, which systematically relate population figures for reserves successfully enumerated in the most recent census against figures for these same reserves in earlier censuses. The resulting parameters from these regressions are used to estimate the size of non-enumerated reserves for the most recent census.

For those reserves where the last successful enumeration occurred on or before 1981, additional information from the Indian Registrar was compiled by the Department of Indian and Northern Affairs to estimate their size. Population counts were adjusted by the aforementioned estimates for net undercount rates at the provincial and territorial level prior to running the simple regressions. Additionally, certain transformations of input data were necessary in order to improve the "descriptive" power of estimation models. These transformations are described in detail in Hamel (1997).

To estimate by single year of age and sex distribution on these reserves, the age and sex distribution of larger geographical regions is applied to the population estimates for the non-enumerated reserves. For all successfully enumerated reserves, the age and sex distributions of the following three broad regions are available:

> (i)   Atlantic Canada, Quebec and Ontario;
> (ii)   Manitoba, Saskatchewan and Alberta;
> (iii)   British Columbia and the Territories.

These distributions are then assigned to each non-enumerated reserve within that region.

<u>Adjustments for Early Enumeration</u>

Some remote northern areas are enumerated in February or March of the Census Year. These are areas where communities disperse in the spring and migrate to hunting and fishing grounds. Census counts for these regions are adjusted for population growth up to the Census Day by adding births and subtracting deaths for all pertinent communities, thus bringing population figures forward. The results from the Reverse Record Check are adjusted similarly. This adjustment has a minor impact on the base population.

Estimates of Net Undercoverage by Single Year of Age and Sex

Provinces and Territories

For its Population Estimation Program, Demography Division also requires detailed provincial and territorial estimates of net undercoverage by single years of age and sex. These are derived using various procedures which combine:

> (i)   direct estimates of total net undercount by province and territory;
> (ii)   national estimates of net undercount by single years of age and sex; and
> (iii)   Empirical Bayes estimates of net undercount at the provincial and territorial level, for broad age and sex categories.

The first two series of estimates remain unmodified, whereas estimates based on the Empirical Bayes model are first converted into single year of age estimates, then raked to eliminate inconsistencies with the other two series. Since the Bayes estimates are formed in broad age groups (0-19, 20-29, 30-44, and 45+), they are first transformed to single years of age using a constant rate of net undercount within each of the age groups. The Bayes model is then applied to calculate estimates of net undercoverage.

The resulting estimates of net undercoverage are not consistent with direct estimates of net undercoverage available for the provinces and territories or with national age and sex estimates after graduation. Thus, a two-way raking[11] procedure is introduced to eliminate these discrepancies. Raking procedures can eliminate inconsistencies by introducing slight, systematic revisions to the initial estimates without seriously distorting the pattern of estimates as documented.

Direct estimates of net undercount at this level of disaggregation can be shown to have unacceptably high standard errors due to insufficient sample sizes. To deal with this problem, a series

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[11] Two-way raking has also alternatively been referred to as the "Deming method" and the "method of iterative proportions" in the literature. Shryock, H.S., J.S. Siegel and Associates. ***Studies in Population: The Methods and Materials in Demography***. Orlando, Florida, Academic Press Inc, 1976. pp 542-544.

of small area modelling, smoothing and raking techniques to obtain the necessary detail has been applied.

An Empirical Bayes model was applied for the first time in 1991 to derive broad age and sex estimates of net undercount at the provincial and territorial level. A Whittaker-Henderson graduation operator was introduced to improve the quality of these estimates at the national level. These procedures are described in Dick and You (1997a; 1997b) and Gambino and Dick (2000).

Empirical Bayes Model

The Empirical Bayes model is used as a small area modelling procedure to reduce the overall variance of estimates which initially suffer from high sampling errors. This is based on a fundamental understanding in statistics, that it is possible to reduce the variance of small domain estimates by borrowing strength from related domains. In generating small area estimates, the Empirical Bayes Model is initially applied to "adjustment factors" (θ_i) defined such that in the ith small domain:

Equation 2.11:
$$\theta_i = \frac{MP_i + \mathbf{C}_i}{\mathbf{C}_i}$$

where

θ = adjustment factor;
MP_i = net number of persons missed;
$\mathbf{C}_i$ = number of persons enumerated in the census.

Working with these adjustment factors, the Empirical Bayes model is capable of generating provincial and territorial estimates, by sex, for 4 broad age groups, including 0-19, 20-29, 30-44, and 45+.

The method is best described as a two-stage regression, which combines a sampling model and a regression model. Theoretically, with known sampling variances, the sampling model relates observed adjustment factors to true adjustment factors, assuming that observed factors equal the true factors plus random error. The regression model expresses true adjustment factors as a linear combination of the explanatory variables and random error. The joint model estimates regression coefficients using a weighted least squares method, which ensures that those from large provinces with small standard errors are respected more than direct estimates from the small provinces with large standard errors. The resulting estimates (θ_i^{EB}) can be shown to have lower overall mean square error than the initial direct estimates (θ_i). The by-product of this small area modelling procedure are detailed estimates (θ_i^{EB}) that can be converted to net number of persons missed (MP_i^{EB}), by each domain i as:

Equation 2.12:
$$MP_i^{EB} = \left(\theta_i^{EB} \times \mathbf{C}_i\right) - \mathbf{C}_i$$

where

MP_i^{EB} = net number of persons missed, after application of the Empirical Bayes model;

θ_i^{EB} = adjustment factors produced by Empirical Bayes model.

Whittaker-Henderson Graduation

Following the estimation of the age and sex data, the Whittaker-Henderson graduation method is applied. The basic idea with the Whittaker-Henderson method, or with any graduation technique, is that it is possible to obtain a smooth and consistent set of data by single year of age from an irregular set of observed data.

Estimates of net undercount by single years of age obtained directly from Census Coverage Studies have large standard errors at the national level that, consequently, reflect chance fluctuations. This is compounded by the impact of non-sampling error, including biases potentially introduced through imputation on non-traced cases. Empirical observations that differ from the graduated pattern are assumed to reflect random noise and sampling variation.

The goal of using the Whittaker-Henderson method is to provide the smoothest series of data with the best possible "fit." Therefore, a Whittaker-Henderson Type B graduation formula is applied to test the net undercount rates for these two characteristics. The sum of the weighted squares of the difference of graduated values from ungraduated values represents the "goodness of fit", where a smaller sum indicates a closer fit. The summation of squared second order finite differences observed in the graduated series represents the "smoothness", where a smaller sum indicates a smoother series.

The first step in obtaining a smooth and consistent set of data is to calculate the initial net undercount rates by single year of age.

Equation 2.13:
$$\mathrm{R}^{NU,a} = \frac{MP^a}{\mathbf{C}^a + MP^a}$$

where

$\mathrm{R}^{NU,a}$ = net undercount rate for age a;
MP^a = estimated net number of persons missed at age a;
$\mathbf{C}^a$ = Census counts for age a;
a = 0, 1, 2, 3, ..., 90+ years.

In the second step, the following function is minimized:

Equation 2.14:
$$F + kS = \sum w^a \left(\mathrm{R}^{NU,a} - \mathrm{R}^{NU_g,a} \right)^2 + k \sum \left(\Delta^2 \mathrm{R}^{NU_g,a} \right)^2$$

where

F = goodness of fit;
k = a constant referred to as "the coefficient of smoothness", that determines the relative importance placed on smoothness as compared to fit;
S = smoothness;
a = single years of age, ranging from 0 – 90+;

w^a =   optional weights assigned to each value of $R^{NU,a}$;

$R^{NU,a}$ =   direct estimates of net undercount for age a;

$R^{NU_g,a}$ =   graduated estimates of net undercount for age a;

Δ^2 =   second differences ($\Delta^2 R^{NU_g,a} = R^{NU_g,a+2} - 2R^{NU_g,a+1} + R^{NU_g,a}$).

The minimization of the above function involves a trade-off between "goodness of fit" and "smoothness", which are influenced by the k coefficient and appropriate weights. The "goodness of fit" is reduced at the expense of increasing the "smoothness" in the graduation, and vice versa. The selection of weights (w^a) and the setting of the k coefficient introduces considerable judgement into the graduation. In 1996, the weight assigned to each age was equal to total population estimated at that age ($C^a + MP^a$). Thus, the weighted average of the smoothed series was equal to the weighted average of the unsmoothed series. The k coefficient was chosen that ensured the graduated series:

(i)   respected the peak of net undercount historically observed for ages 20-29;

(ii)   assumed no differential by sex of net undercoverage for ages less than 15; and

(iii)   respected the relatively flat distribution of net undercount for ages 40+, although differences persist at these ages by sex.

The end product of this graduation is a series of single year of age estimates, by sex, available at the national level. This is the second step in deriving the detailed age and sex data necessary for the 1996 base population.

Subprovincial Areas

Base populations for census metropolitan areas and census divisions are obtained by applying the corresponding provincial and territorial net undercount rates, available by age and sex. Late enumeration and non-enumerated Indian reserves were adjusted by adding the provincial and territorial estimates to the appropriate geographic regions. All figures sum to provincial and territorial and national totals.

Estimates of Net Undercoverage by Marital Status (and Age and Sex)

Provinces and Territories

At this point, estimates of net undercoverage are available by single year of age and sex for each province and territory. These, along with the estimates of gross undercoverage by age group, sex, marital status and province and territory are used to obtain the estimates of provincial/territorial net undercoverage estimates by age, sex and marital status.

The estimation process is done in three general steps, according to broad age groups: 0-19 years, 20-69 years, and 70 years and over.

0 to 19 years

The estimation of missed persons by age, sex and legal marital status in the 0-19 years age group is the most straightforward. All missed persons are assumed to be single. Therefore, the provincial/territorial estimates of net undercoverage by single year of age and sex are simply assigned to single status.

20 to 69 years

Since a matrix of estimates of missed persons for each province and territory by age group, sex and marital status results in a large number of cells with zero observations, the provinces and territories were grouped to create 5 regions:

(i)   Atlantic Provinces (Newfoundland and Labrador, Prince Edward Island, Nova Scotia and New Brunswick);
(ii)   Quebec;
(iii)   Ontario;
(iv)   Prairies and Territories (Manitoba, Saskatchewan, Alberta, Yukon, and Northwest Territories, including Nunavut); and
(v)   British Columbia.

To estimate the net undercoverage by marital status for persons aged 20-69 years, the age group is broken down into seven smaller groups: 20-24, 25-29, 30-34, 35-39, 40-49, 50-59 and 60-69 years.

Two matrices are used in the estimation procedure for each region – one for males and the other for females. The estimates of gross undercoverage are raked to age group and legal marital status margins. The age group margin is obtained by summing the estimates of net undercoverage by single year of age to the seven age groups. The legal marital status margin is formed by multiplying the proportion of the total gross undercoverage in each legal marital status class for each region by the sum of the age group margins.

From the raked matrix (for each sex and region), the proportion of missed persons by each age group for each legal marital status class is calculated. These proportions are then applied to the estimates of net undercoverage by single year of age and province/territory to arrive at the final estimate of missed persons by legal marital status and single year of age and province/territory for persons aged 20-69 years.

70 years and over

For persons aged 70 years and over, the same regions used for the 20-69 years age group are used, however, raking procedures are not used. Rather, for each sex, the proportion of gross undercoverage for each legal marital status class is assumed constant over all ages (i.e., 70, 71, 72,…,90+) within the same region. The legal status proportions are multiplied by the provincial/territorial estimates of net undercoverage for each single year of age to obtain the net undercoverage estimate for each province and territory by sex, single year of age and legal marital status class (Statistics Canada internal document, not dated).

1991 Base Population

The 1991 Census Coverage Error Program was very similar to 1996. As with 1996, the Reverse Record Check (RRC) was the most important of all the coverage studies, with sufficient sample size to generate reliable estimates of coverage error by province/territory. Relative to earlier censuses   (1971 to 1986), many important innovations were introduced, including the generation of estimates of overcount by province and age and sex for the first time. Furthermore, 1991 was the first year that the territories were included in the RRC sample.

Revised estimates of the number of persons missed in the 1991 Census have been produced as a result of analysing the 1996 Census Coverage studies results. They reflect the correction of some cases erroneously classified as missed, removal of the estimate of persons missed in incompletely enumerated Indian reserves, better estimates of the number of non-permanent residents, and a better measure of overcoverage based on the 1996 results.

1971-1986 Base Populations

In 1993, for the first time, Statistics Canada made available intercensal population estimates (1971-1991) adjusted for census coverage error. Although population estimates had been produced for many decades, these intercensal estimates were the first to be fully adjusted for census net undercount.

For the first revision, the 1971 to 1986 base populations were revised on the basis of research on coverage error in 1991, to account for the misstatement of the character and magnitude of coverage error in past censuses, by assuming the same methodological problems detected in the 1991 coverage studies. For an overview of these earlier coverage error measurement programs, see Burgess (1988).

The 1971-1991 intercensal population estimates were revised again as a result of the 1996 Census Coverage studies. This time, the levels of the 1991 net undercoverage were modified. Provincial and territorial estimates of undercount prior to 1991 were revised using the following:

Equation 2.15:
$$_p\mathrm{U}_t^r = {_p\mathrm{U}_t} \times \left(\frac{_c\mathrm{U}_{91}^r}{_c\mathrm{U}_{91}} \right)$$

where

$_p\mathrm{U}_t^r$ = revised undercount for province p in census t (t= 1971, 1976, 1981, 1986);

$_p\mathrm{U}_t$ = direct estimate of undercount for province p in census t;

$_c\mathrm{U}_{91}^r$ = revised estimate of 1991 undercount for 10 provinces, revised for misclassification error;

$_c\mathrm{U}_{91}$ = original estimate of 1991 undercount for 10 provinces prior to revision.

Since 1991 was the first Census to include non-permanent residents (NPRs) as part of the population universe, the 1971 to 1986 time series of estimates required additional adjustments, using administrative files.

Before 1991, Statistics Canada's census coverage studies did not produce reliable information on census overcount. Thus, relatively simple procedures were applied to obtain estimates of overcount, which included the 1991 observed ratios of overcount to undercount, on the assumption that these ratios did not change (Michalowski, M. (1993b)). Following the results of the 1996 Census coverage studies, the same technique was applied with revised estimates of both undercount and overcount for 1991.

Overcoverage for the 10 provinces has been estimated as:

Equation 2.16:
$$_p O_t = {}_p U_t^r \times \left(\frac{{}_c O_{91}^r}{{}_c U_{91}^r} \right)$$

where

$_p O_t$	=	overcoverage for province p in census t;
$_p U_t^r$	=	revised undercount for province p in census t;
$_c O_{91}^r$	=	revised estimate of 1991 overcount for 10 provinces;
$_c U_{91}^r$	=	revised estimate of 1991 undercount for 10 provinces.

An independent estimate of non-enumerated reserves was added to the 1986 base population, analogous to 1991, whereas earlier censuses did not include these adjustments.

After obtaining estimates of net undercount for provincial populations, net undercoverage for the Northwest Territories and Yukon Territory were estimated. Net undercount for each territory by census year "t" was obtained by multiplying net undercount for the rest of the country by the 1991 ratio of net undercount for each territory to the net undercount of all 10 provinces.

Equation 2.17:
$$_{terr} NU_t = {}_c NU_t^r \times \left(\frac{{}_{terr} NU_{91}^r}{{}_c NU_{91}^r} \right)$$

where

$_{terr} NU_t$	=	net undercount for territory $terr$ in census t;
$_c NU_t^r$	=	net undercount in census t for all Canada ($_c U_t^r - {}_c O_t$), excluding the territories and NPRs;
$_{terr} NU_{91}^r$	=	revised net undercount for territory $terr$ in 1991;
$_c NU_{91}^r$	=	revised net undercount for all Canada in 1991, excluding the territories.

Estimates of Net Undercount, by Age and Sex, 1971-1986

To derive estimates of coverage error by age and sex, the Empirical Bayes model was used. Unlike 1991 and 1996, the model was applied only to direct estimates of undercount because of the absence of overcount estimates prior to 1991. After obtaining estimates of undercount for broad age and sex

groups at the provincial and territorial level, additional procedures were applied to derive estimates by five-year age groups. For ages 60+, the age and sex distribution in the corresponding census was used to proportionally allocate missed persons into five-year age groups. For ages 0-59, separation factors were applied based on direct national estimates of undercount by five-year age groups and sex.

Estimates of overcount by age and sex were obtained the same way as estimating total provincial overcount. The ratio of overcount to undercount for specific age and sex groups was assumed to be equal to those in 1991. Estimates of net undercount were obtained by province and territory by subtracting overcount from undercount.

To interpolate five-year estimates to single-year estimates, Sprague multipliers were applied to the grouped data. This method, commonly employed by Demography Division, is explained in greater detail in Shryock et al (1976). All age and sex data were prorated and raked to ensure consistency with provincial and territorial estimates of net undercount.

On April 1st 1999, the newly formed territory of Nunavut was created. The census divisions making up the Northwest Territories and Nunavut were separately corrected following the coverage studies for each of these territories. Net census undercoverage by age and sex was calculated by applying provincial rates of net undercoverage by single years of age and sex to all geographic regions in the territory. The same age and sex distribution of net undercount was applied to both Nunavut and the Northwest Territories.

Data Quality

Although considerable effort is made throughout the entire process to ensure high standards of data quality, resulting data are subject to a certain degree of inaccuracy. Rigorous quality standards are set for data collection and processing, and the Census Communications Program assists in minimising non-response. A Data Quality Measurement Program is in place to provide users with information on the quality and limitations of census data. To assess the usefulness of census data for their purposes, users should be aware of their inaccuracies and appreciate their origin and composition.

Errors in Census Data

The accuracy of a statistical estimate is a measure of how much the estimate differs from the correct or "true" figure. Departures from true figures are known as errors. Some degree of error is the inevitable result of decisions taken to control the cost of the census. Many kinds of errors can be anticipated and controlled by building special procedures into the census. Some errors occur more or less at random and tend to cancel out when individual responses are aggregated for a sufficiently large group.

Errors can arise from many sources, but can be grouped into a few broad categories:

(i)   coverage errors;
(ii)   non-response errors;
(iii)   response errors;
(iv)   processing errors; and

(v)   sampling errors.

Coverage Errors

Coverage errors and their detection play a very important role in the production of the base population, which is why they were discussed in detail in the body of this chapter, in addition to descriptions of the coverage studies (Vacancy Check, Reverse Record Check, Automated Match Study, and the Collective Dwelling Study).

Recent censuses have proven to be of exceptional quality, particularly in terms of completeness of enumeration.   The coverage studies for the 1986, 1991 and 1996 censuses has revealed a net undercoverage rate in the order of 2.6% for the whole of Canada, with variations among provinces ranging between 0.8% and 3.8% (see Table 2.1). For the territories, the net undercoverage is usually higher. Net undercoverage varies not only by province and territory, but also by age, sex and marital status, as well as from census to census.

Table 2.1
Estimated Net Population Undercoverage in the 1986, 1991 and 1996 Censuses, Canada, Provinces and Territories

Province/territory	1986 [1,2]		1991 [2]		1996	
	Number	Rate (%)	Number	Rate (%)	Number	Rate (%)
Canada	**674,956**	**2.59**	**797,665**	**2.85**	**772,839**	**2.61**
Newfoundland and Labrador	9,695	1.68	13,374	2.31	9,427	1.68
Prince Edward Island	2,445	1.90	1,035	0.79	1,324	0.97
Nova Scotia	15,699	1.77	18,060	1.98	20,821	2.24
New Brunswick	16,693	2.30	23,721	3.18	14,743	1.96
Quebec	149,457	2.22	182,201	2.58	129,253	1.78
Ontario	258,025	2.74	362,517	3.48	322,217	2.91
Manitoba	29,072	2.66	21,570	1.94	19,196	1.69
Saskatchewan	21,165	2.06	18,799	1.87	28,637	2.81
Alberta	61,215	2.52	53,388	2.06	77,614	2.80
British Columbia	107,189	3.57	98,319	2.92	145,579	3.76
Yukon Territory	1,150	4.72	1,256	4.38	1,024	3.21
Northwest Territories	3,151	5.75	3,425	5.65	3,004	4.45

[1] Included as overcoverage is an estimate of 6,000 non-permanent residents enumerated in 1986 but not part of the universe.

[2] Includes temporary residents as estimated independently from the coverages studies. In 1996, the temporary resident study was integrated with the coverage studies.

Source: Demography Division data based on 1986, 1991 and 1996 Census coverage studies, Statistics Canada.

Non-response Errors

Non-response errors occur when a questionnaire is not returned from a household, even though the dwelling was identified as occupied and a questionnaire was dropped off, or when the questionnaire is returned but information is missing for some questions or individuals. The household members may be away over the entire census period or may refuse to complete the form. Census representatives (CRs) edit the questionnaires and follow up on selected missing information. Both a supervisor and a quality control technician check the CR's work. However, some non-response is inevitable and, although certain adjustments for missing data can be made during processing, there is loss of accuracy.

Response Errors

A response error occurs when a response is not entirely accurate. The respondent may have misinterpreted the question or may not know the answer, especially if it is given for an absent household member. Occasionally, the CR causes a response error when following up for a missing response or when recording items such as the structural characteristics of a dwelling.

Processing Errors

Processing errors are caused by mistakes incurred when the answers from the questionnaires are being recorded in the census databases. After collection has been completed, questionnaires are sent to the regional processing sites. Some of the write-in entries on the form are numerically coded. Mistakes can occur in coding, especially when the written information is ambiguous, incomplete or difficult to read. The coded information and the remaining write-ins are key-entered onto a computer file. Keying errors can occur despite rigorous quality checks on each key operator's work.

Census data files are sent to Ottawa, where the remaining write-ins are coded with the assistance of a computer. Since additional coding mistakes can occur, all the data undergo a series of computer checks to identify missing or inconsistent responses. Responses are created or "imputed" for missing or unacceptable information. The computer cannot, of course, impute a correct response every time, but when results are tabulated for sufficiently large geographic areas or subgroups of the population, imputation errors will likely cancel out.

Sampling Errors

Some census questions are asked of all Canadian residents, but most of the cultural and economic information is obtained from a sample of one in five households. The information collected from these households is "weighted" to produce estimates for the whole population. The simplest weighting procedure would be to multiply the results for the sampled households by five, since each household in the sample represents five households in the total population. The actual weighting procedure is much more complex, but similar in principle.

Naturally, the results of the weighted sample differ somewhat from the results that would have been obtained from the total population. The difference is known as sampling error. The actual sampling error is of course unknown, but it is possible to calculate an "average" value.

If several samples of the same size were selected using a random process similar to that used in the actual census, the weighted results would tend to vary around the true result for the total population. The standard error is a measure of the average size of this variation. Fortunately, it is not necessary to actually generate a number of samples to estimate the standard error for the census; it can be estimated from the single sample actually taken.

<u>Content Errors</u>

A number of studies evaluate the quality of data for each question. Response rates, edit failure rates and a comparison of estimates before and after imputation are among the data quality measures used. Tabulations from the current census are also compared with corresponding data from past censuses and from other surveys and administrative sources. Detailed cross-tabulations are checked for consistency and accuracy. Some of these checks are conducted prior to the release of census data in a process known as certification.

Influence of Error on the Base Population

During the process of developing the bases for estimates, an attempt is made to correct only for coverage errors in the population base. This correction is based on the results of the coverage studies and on modelling of provincial overcoverage and territorial net undercoverage prior to 1991 as well as by age and sex. Furthermore, it is subject to sampling, collection, response and processing errors and uncertainty in the assumptions underlying the models.

Statistical analysis shows that the adjustment for coverage error, although not without errors itself, improves the quality of census data. The selection of the particular modelling assumption was based on the analysis of a simulation of several feasible approaches (Michalowski, M. (1993)), deemed to be consistent over time, across geographical areas, and to provide logical results. When calculating undercoverage rates for small areas, it is likely that the underlying assumptions may be violated. If this is true, the resulting undercoverage rate could be misleading. Unfortunately, errors associated with these assumptions are very difficult to quantify.

Nevertheless, corrections for net undercoverage improve the quality of the estimates by compensating for the differential undercoverage by age, along the cohort, sex and by province and territory across censuses. They have a direct impact on:

- the error of closure and its distribution by age and sex within provinces and territories; by province and territory since the net undercoverage and its distribution vary from one census to another;

- the within-cohort consistency of population estimates. For example, the size of male cohort aged 20-24 in the 1996 census is smaller than it was at age 15-19 in the previous census. Since Canada accrues many immigrants at this age cohort, the opposite is expected. After adjusting for net census undercoverage, the cohort size increases between the two censuses.

Overall, the quality of age and sex data from the census, once adjusted for net undercoverage, is very good. For detailed information on the census counts and estimates, consult the **Census Technical Reports**, available from Statistics Canada.

Chapter 3

Births and Deaths

The recording of births and deaths has been a regular practice in Canada since 1921. Since registering all births and deaths is required by law, these data are readily available and are of very high degree of completeness.

Births are added to and deaths are subtracted from the base population (along with the migration components) to derive the postcensal population estimates. This chapter presents information related to the data sources for births and deaths, as well as the methods of estimation for preliminary estimates.

Data Sources and Relevant Concepts

Information on births and deaths is obtained from the vital statistics database maintained by Health Statistics Division of Statistics Canada. The database was created in collaboration with provincial and territorial ministries responsible for the collection of data related to births and deaths within their respective jurisdictions. The registration of all live births and deaths and the provision of this information to Statistics Canada is mandated by provincial and territorial Vital Statistics Acts (and other equivalent legislation).

Consistent with the Census universe, the vital statistics database includes births and deaths of all Canadians, landed immigrants and non-permanent residents. That is to say that vital statistics are provincially registered for anyone living in the province or territory whether on a permanent or temporary basis. In principle, births and deaths are also recorded for Canadian citizens and landed immigrants working, studying or visiting abroad. In practise, almost all deaths for these people can be found in databases but only a very small proportion of births is recorded. The data are available at national, provincial/territorial, CD, and CMA levels.

The excess number of births over deaths during a given period is known as the "natural increase" of a population. If the number of births during a particular reference period is less than the number of deaths during the same period, the natural increase will be a negative result. In recent years, though the number of births has exceeded the number of deaths, as Table 3.1 indicates, the natural increase has been steadily decreasing since 1990-1991.

Table 3.1
Births, Deaths, Natural Increase, Canada, 1971-1972 to 2000-2001

Period (July 1 - June 30)	Births	Deaths	Natural Increase	Year to Year Change	Natural Increase/ Population (July 1) x 100
1971-1972	351,256	159,533	191,723	…	0.87
1972-1973	345,815	162,618	183,197	-8,526	0.82
1973-1974	339,888	166,284	173,604	-9,593	0.77
1974-1975	353,513	168,751	184,762	11,158	0.81
1975-1976	364,278	166,428	197,850	13,088	0.85
1976-1977	358,261	165,747	192,514	-5,336	0.82
1977-1978	359,954	169,030	190,924	-1,590	0.80
1978-1979	362,226	165,805	196,421	5,497	0.82
1979-1980	367,286	171,460	195,826	-595	0.81
1980-1981	372,139	170,535	201,604	5,778	0.82
1981-1982	372,472	172,352	200,120	-1,484	0.81
1982-1983	373,594	176,522	197,072	-3,048	0.78
1983-1984	374,533	174,159	200,374	3,302	0.79
1984-1985	376,265	179,085	197,180	-3,194	0.77
1985-1986	375,381	183,353	192,028	-5,152	0.74
1986-1987	373,021	182,599	190,422	-1,606	0.73
1987-1988	370,033	189,917	180,116	-10,306	0.68
1988-1989	384,035	188,408	195,627	15,511	0.73
1989-1990	403,280	192,608	210,672	15,045	0.77
1990-1991	402,924	192,437	210,487	-185	0.76
1991-1992	403,107	196,968	206,139	-4,348	0.74
1992-1993	392,181	201,808	190,373	-15,766	0.67
1993-1994	386,159	206,465	179,694	-10,679	0.63
1994-1995	381,998	209,388	172,610	-7,084	0.59
1995-1996	372,453	209,746	162,707	-9,903	0.55
1996-1997	357,313	217,220	140,093	-22,614	0.47
1997-1998	345,123	217,688	127,435	-12,658	0.42
1998-1999	338,295	217,632	120,663	-6,772	0.40
1999-2000	336,912	218,836	118,076	-2,587	0.39
2000-2001	326,303	223,789	102,514	-15,562	0.33

Note: Revised estimates of births are for 2000-2001, and of deaths for 1999-2000 and 2000-2001.
Source: Demography Division, Statistics Canada

Birth and Death Estimates, Canada, Provinces and Territories

Final Estimates

Because the vital statistics database is a complete source of data on births and deaths[12], adjustments are not required to the data received from Health Statistics Division (HSD), with one exception. Provincial and territorial birth and death data provided by HSD are presented in terms of where the birth or death took place. However, for the purpose of population estimates, where a mother has given birth out-of-province (i.e., a province other than her place of residence), the birth will be counted in the mother's province of residence. Similarly, in the event of the death of a person outside of their province of residence, the death is counted in the province of residence. This is because the birth or death affects the population of residence rather than that of where the event occurred.

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[12] There are minor exclusions from the vital statistics database which consequently are omitted from the population estimates. These include late registrations of births and deaths, as well as some numbers of the events occurring outside of Canada. For more information on these exclusions, please see the Data Quality section of this chapter.

Using the component approach, the number of births between the date of the base population and the reference date of the estimate are simply added to the base population and the number of deaths during this period are subtracted.

Preliminary Estimates

Complete data on births and deaths are not available at the time the preliminary estimates are prepared, therefore another approach is required. With the exception of Quebec, Alberta and British Columbia, where preliminary birth and death estimates are provided by provincial statistical agencies, the fertility and death rates from the most recent reference period for which final estimates are available are assumed for the reference period of the estimate to derive estimates of births and deaths.

The following formulae are used to obtain preliminary estimates of births and deaths at the national and provincial/territorial levels on a quarterly basis:

For births:
By quarter for each province and territory, by age group of mother at the beginning of the quarter:

Equation 3.1:
$$B_{(t,t+i)}^{a_M} = \left(\frac{{}^f B^{a_M}}{{}^f P^{a_F}} \right) \times P_t^{a_F}$$

where

$B_{(t,t+i)}^{a_M}$ $=$ estimate of number of births from mother age a during time $(t,\ t+i)$;

${}^f B^{a_M}$ $=$ number of births from mother age a during the corresponding quarter for which final estimates are available;

${}^f P^{a_F}$ $=$ population estimate of females age a at the beginning of the corresponding quarter for which final birth estimates are available;

$P_t^{a_F}$ $=$ population estimate of females age a at the beginning of the quarter of estimation.

And then, the estimate of total number of births:

Equation 3.2:
$$B_{(t,t+i)} = \sum_a B_{(t,t+i)}^{a_M}$$

For deaths:
By quarter for each province and territory, by age at the beginning of the quarter, for each sex:

Equation 3.3:
$$D_{(t,t+i)}^{a,s} = \left(\frac{{}^f D^{a,s}}{{}^f P^{a,s}} \right) \times P_t^{a,s}$$

where

$D_{(t,t+i)}^{a,s}$ $=$ estimate of number of deaths of persons age a and sex s during time $(t,\ t+i)$;

${}^f D^{a,s}$ $=$ number of deaths of persons age a and sex s during the corresponding quarter for which final death estimates are available;

$^f\mathbf{P}^{a,s}$ =   population estimate of persons age a and sex s at the beginning of the corresponding quarter for which final death estimates are available;

$\mathbf{P}_t^{a,s}$ =   population estimate of persons age a and sex s at the beginning of the quarter of estimation.

And then, the estimate of total number of deaths:

Equation 3.4:
$$D_{(t,t+i)} = \sum_s \sum_a D_{(t,t+i)}^{a,s}$$

Monthly estimates are obtained by using the most current final monthly distribution of births (or deaths) for the given quarter.

The preliminary estimates are finalized when the vital statistics are available from Health Statistics Division.

The Use of Birth and Death Estimates in Other Population Estimates

Information from the Vital Statistics Registry on births and deaths is used to produce other types of population estimates. For example, birth and death data (in addition to the other components of population change) are used to produce the population estimates by age, sex and marital status, which will be discussed in Chapter 8.

Births and deaths are also used to obtain census family estimates. Births may contribute to the formation of a family, whereas deaths may contribute to family dissolution. For a description of how birth and death estimates are used in the production of census family estimates, see Chapter 10.

Data Quality

Since law requires that all provinces and territories maintain records of vital statistics, data on births and deaths are of high standards in terms of coverage and overall quality. In comparison with the other components of demographic estimates, births and deaths are considered the most complete and accurate.

However, there are omissions from vital statistics, which include late registrations of births and deaths (including those occurring outside of Canada). Late registrations are those that are reported after deadlines for data submissions to Health Statistics Division. These data are maintained in the vital statistics database, however the released data on births and deaths are not revised (for both Health Statistics Division and Demography Division's population estimates). As Table 3.2 indicates, though, these numbers are relatively minor.

Preliminary vital statistics are less accurate than final data since they are based on recent fertility and mortality rates, which may be subject to fluctuations. For example, as Table 3.3 shows, the difference between the annual preliminary and final estimates for Canada vary no more than 3% for both births and deaths over the 1993-1994 to 1998-1999 period. However, at the provincial/territorial level, the percentage deviations of preliminary data from the final data were more significant. Overall,

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they were larger for deaths than for births and for smaller provinces and for territories than for the larger ones. In extreme cases, the preliminary data was higher than the final data by 18% for births and deaths in Yukon for 1993-1994 and 1994-1995, respectively, and 20% lower for deaths in the Northwest Territories for 1996-1997.

Table 3.2
Late Reported Births and Deaths, Canada, Provinces and Territories, 1990 to 1994[1]

Province/territory	Births					Deaths				
	1990	1991	1992	1993	1994	1990	1991	1992	1993	1994
Canada	**2,248**	**1,405**	**193**	**205**	**1,720**	**631**	**344**	**178**	**114**	**180**
Newfoundland and Labrador	131	0	0	0	0	14	6	28	29	48
Prince Edward Island	0	0	0	0	0	0	0	1	0	0
Nova Scotia	135	126	109	79	73	1	4	4	7	12
New Brunswick	19	12	5	0	1	101	133	95	13	8
Quebec	0	0	0	0	537	0	0	0	0	0
Ontario	1,629	1,021	..	..	971	454	136	..	..	24
Manitoba	29	24	0	0	0	4	2	0	0	0
Saskatchewan	184	156	38	94	65	42	43	44	58	56
Alberta	1	6	0	0	0	0	0	0	0	0
British Columbia	39	32	0	0	36	5	3	0	1	27
Yukon	0	2	0	0	0	1	0	1	0	0
Northwest Territories	81	26	41	32	37	9	17	5	6	5

[1] As of April 1997.

Source: *Births and Deaths, 1995*. Health Division, Statistics Canada

Table 3.3
Preliminary and Final Statistics on Births, Deaths and Natural Increase, Canada, Provinces and Territories, 1993-1994 to 1998-1999

Province/territory	Period (July 1 to June 30)	Births			Deaths			Natural Increase		
		Preliminary	Final	Ratio Preliminary/ Final	Preliminary	Final	Ratio Preliminary/ Final	Preliminary	Final	Ratio Preliminary/ Final
Canada	**1993-1994**	**388,496**	**386,159**	**1.01**	**209,515**	**206,465**	**1.01**	**178,981**	**179,694**	**1.00**
	1994-1995	**382,870**	**381,998**	**1.00**	**212,830**	**209,388**	**1.02**	**170,040**	**172,610**	**0.99**
	1995-1996	**379,295**	**372,453**	**1.02**	**215,740**	**209,746**	**1.03**	**163,555**	**162,707**	**1.01**
	1996-1997	**364,765**	**357,313**	**1.02**	**216,491**	**217,220**	**1.00**	**148,274**	**140,093**	**1.06**
	1997-1998	**355,290**	**345,123**	**1.03**	**217,860**	**217,688**	**1.00**	**137,430**	**127,435**	**1.08**
	1998-1999	**340,891**	**338,295**	**1.01**	**222,425**	**217,632**	**1.02**	**118,466**	**120,663**	**0.98**
Newfoundland and Labrador	1993-1994	6,367	6,423	0.99	3,943	3,977	0.99	2,424	2,446	0.99
	1994-1995	6,295	6,140	1.03	4,110	3,987	1.03	2,185	2,153	1.01
	1995-1996	6,085	5,846	1.04	4,180	3,954	1.06	1,905	1,892	1.01
	1996-1997	5,599	5,542	1.01	3,947	4,181	0.94	1,652	1,361	1.21
	1997-1998	5,320	5,245	1.01	3,950	4,340	0.91	1,370	905	1.51
	1998-1999	5,084	4,899	1.04	4,441	4,095	1.08	643	804	0.80
Prince Edward Island	1993-1994	1,750	1,725	1.01	1,173	1,120	1.05	577	605	0.95
	1994-1995	1,685	1,686	1.00	1,175	1,139	1.03	510	547	0.93
	1995-1996	1,720	1,788	0.96	1,115	1,198	0.93	605	590	1.03
	1996-1997	1,697	1,616	1.05	1,221	1,192	1.02	476	424	1.12
	1997-1998	1,695	1,530	1.11	1,255	1,132	1.11	440	398	1.11
	1998-1999	1,558	1,539	1.01	1,059	1,108	0.96	499	431	1.16
Nova Scotia	1993-1994	11,433	11,354	1.01	7,621	7,544	1.01	3,812	3,810	1.00
	1994-1995	11,205	10,806	1.04	7,885	7,851	1.00	3,320	2,955	1.12
	1995-1996	10,825	10,776	1.00	7,980	7,698	1.04	2,845	3,078	0.92
	1996-1997	10,404	10,158	1.02	7,833	7,979	0.98	2,571	2,179	1.18
	1997-1998	10,290	9,843	1.05	7,915	8,063	0.98	2,375	1,780	1.33
	1998-1999	9,657	9,490	1.02	8,282	7,734	1.07	1,375	1,756	0.78

Table 3.3
Preliminary and Final Statistics on Births, Deaths and Natural Increase, Canada, Provinces and Territories, 1993-1994 to 1998-1999 (concluded)

Province/territory	Period (July 1 to June 30)	Births			Deaths			Natural Increase		
		Preliminary	Final	Ratio Preliminary/ Final	Preliminary	Final	Ratio Preliminary/ Final	Preliminary	Final	Ratio Preliminary/ Final
New Brunswick	1993-1994	8,951	8,961	1.00	5,881	5,873	1.00	3,070	3,088	0.99
	1994-1995	8,960	8,729	1.03	6,010	5,899	1.02	2,950	2,830	1.04
	1995-1996	8,705	8,338	1.04	6,180	5,866	1.05	2,525	2,472	1.02
	1996-1997	8,123	8,072	1.01	5,984	6,081	0.98	2,139	1,991	1.07
	1997-1998	7,795	7,952	0.98	5,970	6,132	0.97	1,825	1,820	1.00
	1998-1999	7,704	7,674	1.00	6,143	6,133	1.00	1,561	1,541	1.01
Quebec	1993-1994	92,448	91,303	1.01	52,481	51,581	1.02	39,967	39,722	1.01
	1994-1995	89,525	89,092	1.00	53,190	52,204	1.02	36,335	36,888	0.99
	1995-1996	86,445	86,089	1.00	51,835	52,094	1.00	34,610	33,995	1.02
	1996-1997	83,494	82,914	1.01	53,520	54,205	0.99	29,974	28,709	1.04
	1997-1998	77,020	77,395	1.00	53,410	54,365	0.98	23,610	23,030	1.03
	1998-1999	74,205	74,292	1.00	54,141	54,465	0.99	20,064	19,827	1.01
Ontario	1993-1994	147,636	147,147	1.00	76,951	77,302	1.00	70,685	69,845	1.01
	1994-1995	146,230	147,234	0.99	79,215	78,151	1.01	67,015	69,083	0.97
	1995-1996	146,310	143,090	1.02	82,055	77,726	1.06	64,255	65,364	0.98
	1996-1997	140,047	136,335	1.03	80,848	80,423	1.01	59,199	55,912	1.06
	1997-1998	138,505	133,240	1.04	81,175	80,146	1.01	57,330	53,094	1.08
	1998-1999	131,812	130,789	1.01	83,163	80,265	1.04	48,649	50,524	0.96
Manitoba	1993-1994	16,621	16,618	1.00	9,367	9,184	1.02	7,254	7,434	0.98
	1994-1995	16,395	16,452	1.00	9,450	9,480	1.00	6,945	6,972	1.00
	1995-1996	16,260	15,738	1.03	9,445	9,506	0.99	6,815	6,232	1.09
	1996-1997	15,592	15,009	1.04	9,791	9,626	1.02	5,801	5,383	1.08
	1997-1998	15,305	14,414	1.06	9,765	9,573	1.02	5,540	4,841	1.14
	1998-1999	14,381	14,473	0.99	9,754	9,926	0.98	4,627	4,547	1.02
Saskatchewan	1993-1994	14,157	14,068	1.01	8,277	8,273	1.00	5,880	5,795	1.01
	1994-1995	13,935	13,795	1.01	8,290	8,344	0.99	5,645	5,451	1.04
	1995-1996	13,765	13,392	1.03	8,550	8,466	1.01	5,215	4,926	1.06
	1996-1997	13,001	13,114	0.99	8,214	8,886	0.92	4,787	4,228	1.13
	1997-1998	12,740	12,711	1.00	8,410	8,859	0.95	4,330	3,852	1.12
	1998-1999	12,776	12,677	1.01	8,866	8,851	1.00	3,910	3,826	1.02
Alberta	1993-1994	40,121	40,093	1.00	15,440	15,757	0.98	24,681	24,336	1.01
	1994-1995	39,435	39,064	1.01	16,170	15,691	1.03	23,265	23,373	1.00
	1995-1996	39,110	38,451	1.02	16,625	15,886	1.05	22,485	22,565	1.00
	1996-1997	38,001	37,250	1.02	16,727	16,635	1.01	21,274	20,615	1.03
	1997-1998	38,390	37,369	1.03	16,930	16,815	1.01	21,460	20,554	1.04
	1998-1999	37,779	38,154	0.99	17,424	16,860	1.03	20,355	21,294	0.96
British Columbia	1993-1994	46,930	46,422	1.01	28,029	25,476	1.10	18,901	20,946	0.90
	1994-1995	47,160	47,000	1.00	26,935	26,292	1.02	20,225	20,708	0.98
	1995-1996	47,995	46,853	1.02	27,380	26,970	1.02	20,615	19,883	1.04
	1996-1997	46,792	45,314	1.03	28,050	27,599	1.02	18,742	17,715	1.06
	1997-1998	46,245	43,587	1.06	28,710	27,878	1.03	17,535	15,709	1.12
	1998-1999	44,076	42,587	1.03	28,758	27,765	1.04	15,318	14,822	1.03
Yukon	1993-1994	520	440	1.18	115	128	0.90	405	312	1.30
	1994-1995	465	462	1.01	140	119	1.18	325	343	0.95
	1995-1996	445	459	0.97	145	145	1.00	300	314	0.96
	1996-1997	463	469	0.99	127	127	1.00	336	342	0.98
	1997-1998	455	421	1.08	135	130	1.04	320	291	1.10
	1998-1999	431	402	1.07	128	134	0.96	303	268	1.13
Northwest Territories[1]	1993-1994	1,562	1,605	0.97	237	250	0.95	1,325	1,355	0.98
	1994-1995	1,580	1,538	1.03	260	231	1.13	1,320	1,307	1.01
	1995-1996	1,630	1,633	1.00	250	237	1.05	1,380	1,396	0.99
	1996-1997	1,552	1,520	1.02	229	286	0.80	1,323	1,234	1.07
	1997-1998	1,530	1,416	1.08	235	255	0.96	1,295	1,161	1.12
	1998-1999	1,428	1,319	1.08	266	296	0.90	1,162	1,023	1.14

[1] As preliminary estimates for Nunavut are not available for all years presented, data for the Northwest Territories and Nunavut have been combined.
Source: Demography Division, Statistics Canada

Chapter 4

Immigration

This chapter is the first of three chapters focusing on international migration, the other two being non-permanent residents and total emigration. International migration flows can be categorized as either permanent or temporary. Permanent flows are composed of persons arriving in Canada for permanent residence (first time immigrants), Canadian citizens returning after emigrating with the intention of residing permanently in another country, and Canadian citizens or landed immigrants leaving Canada permanently (i.e., emigrants). Temporary flows relate to foreigners arriving for temporary stay in Canada and leaving after their stay ends (non-permanent residents), as well as Canadian citizens who leave the country temporarily and come back at a later time. Net international migration is equal to immigration plus the change in non-permanent residents, minus total emigration.

Figure 4.1 illustrates international migration flows for Canada.

Figure 4.1
International Migration Flows for Canada
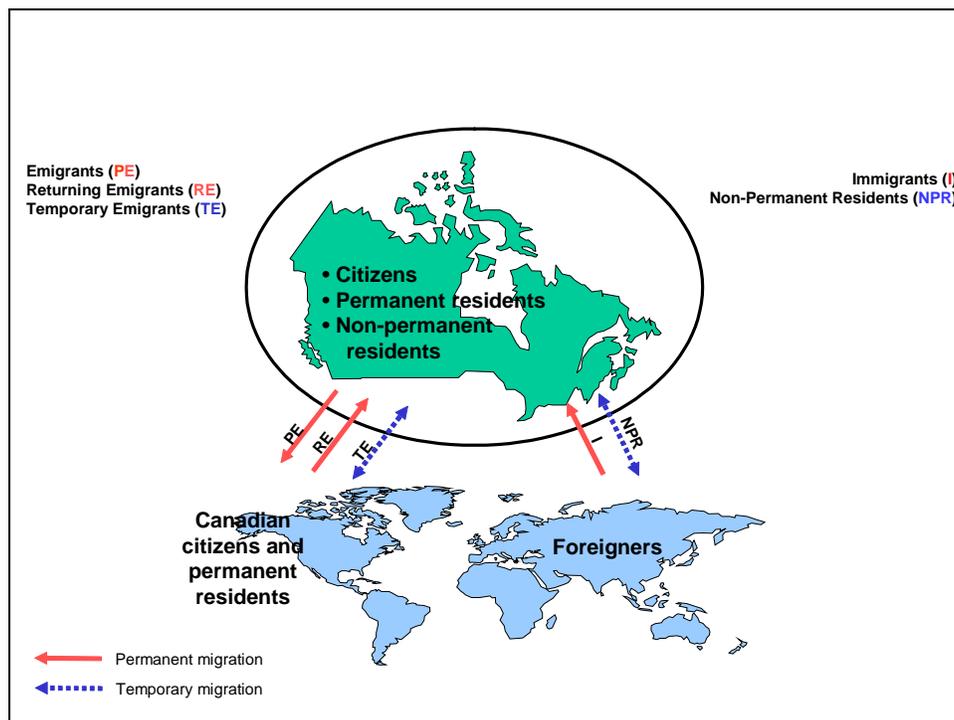
The immigrant population refers to people who are landed immigrants in Canada. A landed immigrant is a person who is not a Canadian citizen by birth and has been granted the right to live in Canada permanently by immigration authorities, falling under one of four classes (independent,

business, family and refugees), as identified in Canada's *Immigration Act*.[13] As with births and deaths, legal requirements dictate the collection of information on immigration to Canada.

In Canada, the number of births has been decreasing steadily since 1990, as the number of deaths has been increasing. Given the country's ageing population, this trend is expected to continue, with the number of deaths projected to outnumber births by the year 2018.[14] For this reason, the Canadian government has noted the importance of immigration as the basis of sustaining population growth. Figure 4.2 shows the provincial/territorial distribution of the population of immigrants. This is an accumulated stock of immigrants, resulting from the flows of new arrivals, departures and returns of those new arrivals who subsequently left Canada. In 1996, immigrants represented 17.4% of the total population of Canada. Note that, at about 25%, Ontario and British Columbia have a proportion of immigrant population much above the Canadian average.

Figure 4.2
Immigrants as a Percentage of Total Provincial/Territorial Population, 1996
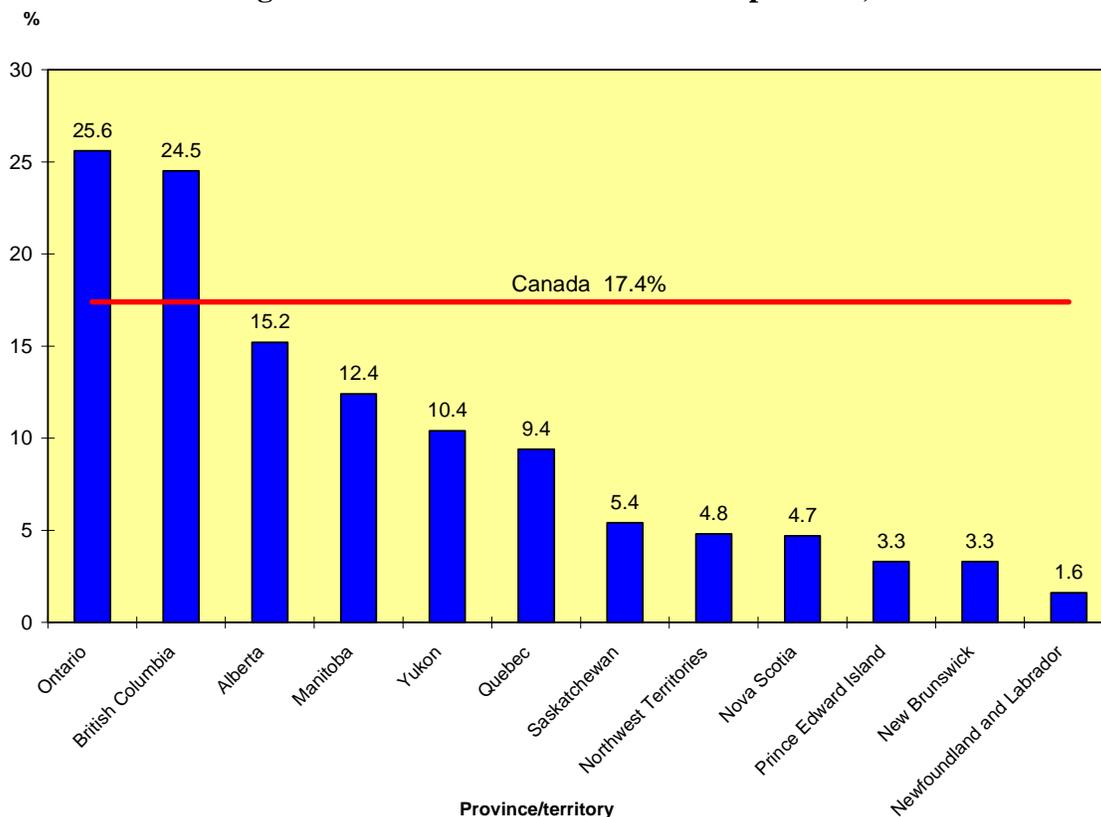
Source: 1996 Census of Canada

In terms of recent immigration flows since the Census of 1996, Canada received over 1,050,000 new immigrants (during the 1996-1997 to 2000-2001 period). Ontario, which accounts for 38% of the Canadian population, attracted almost 56% of these new arrivals, followed by British Columbia (19%)

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[13] Children born abroad to Canadian parents who are out of the country are, by definition Canadian citizens, and therefore are not included in estimates of immigration. Included however, are those persons who change status from non-permanent residents (i.e., permit/authorisation holders or refugee status claimants) to landed immigrant status from within Canada. Although their migrations do not involve crossing Canadian borders, they are counted as non-permanent residents, upon their initial entry to Canada.

[14] Source: Statistics Canada, ***Population Projections, 2000-2026*** (2001).

and Quebec (14%). Excluding the territories, Prince Edward Island received the fewest immigrants during this period (0.07%), followed by Newfoundland and Labrador (0.21%).[15]

Data Sources and Relevant Concepts

Immigration flow data are obtained from administrative files which are maintained by Citizenship and Immigration Canada (CIC). These files are comprised of information pertaining to Immigrant Visas and Records of Landing, documents which all immigrants are required to submit upon landing in Canada.

Information about the characteristics of immigrants upon landing in Canada is available. In addition to basic demographic information about the age, sex and marital status and the intended province of destination of immigrants, information is also available on the occupation, country of birth and country of last permanent residence, mother tongue, level of education, official language abilities, etc.

Estimates of Immigration, Canada, Provinces and Territories

Since CIC's Landed Immigrant file is a complete inventory of landed immigrants to Canada, the measurement of the number of immigrants in a given period (inflows) is straightforward, and adjustments to the data are not required. Information is available for each person entering Canada under landed immigrant status.

Each month, CIC makes available to Statistics Canada, a data file containing the records of landed immigrants for the previous month, as well as any additions or updates to data already received. Given that there are typically few changes to the CIC data, the difference between preliminary and final estimates is very small (see Table 4.1).

For provincial/territorial level estimates, the file obtained from CIC identifies the province or territory of intended destination upon arrival, rather than the province or territory in which the immigrant actually settles. In a small number of cases, information on the province of destination is lacking. For these cases, the province of destination is distributed proportionately between the provinces and territories.

Immigration estimates by age, sex and marital status

The distribution of immigrants by age, sex and marital status is also straightforward, as these variables are available from the CIC file. Basic tabulation by age, sex and marital status is all that is required. In the event of missing information, these cases are prorated according to the distribution for immigrants for which the information is available.

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[15] Source: Demography Division, Statistics Canada.

Data Quality

Since the registration of immigrants is required by law, the coverage and quality of these data obtained from administrative sources (i.e., CIC files) are very high, especially at the national level. These are also very timely data, which is illustrated by the small differences between preliminary and final estimates.

As Table 4.1 shows, the difference between preliminary and final estimates of the total number of immigrants to Canada in 1993-1994 to 1999-2000 is almost negligible, with very little variance at the provincial/territorial level. Where the preliminary to final ratio is less than 1, this means that the preliminary estimate was lower than the final estimate, likely due to incomplete data. Where the ratio is greater than 1, the preliminary estimate was greater than the final. The largest difference was noted in Manitoba in 1996-1997 (20%), but this is an exceptional case. The majority of other provincial/territorial differences between preliminary and final estimates vary by less than 5%.

Table 4.1
Preliminary and Final Statistics on Immigration, Canada, Provinces and Territories, 1993-1994 to 1999-2000

Province/territory	Period (July 1 to June 30)	Type of Estimate		Ratio Preliminary/ Final
		Preliminary	Final	
Canada	**1993-1994**	**227,226**	**234,457**	**0.97**
	1994-1995	**215,652**	**220,123**	**0.98**
	1995-1996	**208,791**	**216,988**	**0.96**
	1996-1997	**219,183**	**224,881**	**0.97**
	1997-1998	**194,351**	**194,452**	**1.00**
	1998-1999	**173,011**	**173,200**	**1.00**
	1999-2000	**205,468**	**205,686**	**1.00**
Newfoundland and Labrador	1993-1994	663	707	0.94
	1994-1995	607	630	0.96
	1995-1996	561	570	0.98
	1996-1997	461	483	0.95
	1997-1998	404	421	0.96
	1998-1999	382	378	1.01
	1999-2000	435	425	1.02
Prince Edward Island	1993-1994	141	137	1.03
	1994-1995	184	197	0.93
	1995-1996	130	123	1.06
	1996-1997	185	186	0.99
	1997-1998	124	126	0.98
	1998-1999	123	127	0.97
	1999-2000	143	142	1.01
Nova Scotia	1993-1994	3,034	3,075	0.99
	1994-1995	3,513	3,713	0.95
	1995-1996	3,677	3,585	1.03
	1996-1997	3,248	3,149	1.03
	1997-1998	2,764	2,624	1.05
	1998-1999	1,624	1,626	1.00
	1999-2000	1,671	1,674	1.00
New Brunswick	1993-1994	572	586	0.98
	1994-1995	660	667	0.99
	1995-1996	627	639	0.98
	1996-1997	704	677	1.04
	1997-1998	743	722	1.03
	1998-1999	778	765	1.02
	1999-2000	615	608	1.01

Table 4.1
Preliminary and Final Statistics on Immigration, Canada, Provinces and Territories, 1993-1994 to 1999-2000 (continued)

Province/territory	Period (July 1 to June 30)	Type of Estimate		Ratio Preliminary/ Final
		Preliminary	Final	
Quebec	1993-1994	34,457	35,851	0.96
	1994-1995	26,943	26,466	1.02
	1995-1996	27,402	29,101	0.94
	1996-1997	26,426	27,811	0.95
	1997-1998	26,695	27,155	0.98
	1998-1999	27,598	27,750	0.99
	1999-2000	30,211	30,247	1.00
Ontario	1993-1994	115,924	119,624	0.97
	1994-1995	116,761	119,750	0.98
	1995-1996	111,649	115,416	0.97
	1996-1997	116,761	119,572	0.98
	1997-1998	106,289	106,485	1.00
	1998-1999	91,933	91,850	1.00
	1999-2000	116,721	116,733	1.00
Manitoba	1993-1994	4,435	4,527	0.98
	1994-1995	3,723	3,790	0.98
	1995-1996	3,482	3,619	0.96
	1996-1997	4,885	4,066	1.20
	1997-1998	3,132	3,117	1.00
	1998-1999	3,289	3,299	1.00
	1999-2000	4,172	4,207	0.99
Saskatchewan	1993-1994	2,244	2,281	0.98
	1994-1995	2,107	2,182	0.97
	1995-1996	1,745	1,810	0.96
	1996-1997	1,778	1,779	1.00
	1997-1998	1,607	1,614	1.00
	1998-1999	1,748	1,756	1.00
	1999-2000	1,648	1,670	0.99
Alberta	1993-1994	17,555	18,159	0.97
	1994-1995	16,361	16,681	0.98
	1995-1996	13,553	14,150	0.96
	1996-1997	13,683	13,847	0.99
	1997-1998	11,892	11,689	1.02
	1998-1999	11,220	11,253	1.00
	1999-2000	12,809	12,864	1.00
British Columbia	1993-1994	47,963	49,266	0.97
	1994-1995	44,570	45,816	0.97
	1995-1996	45,790	47,795	0.96
	1996-1997	50,879	53,121	0.96
	1997-1998	40,551	40,336	1.01
	1998-1999	34,199	34,273	1.00
	1999-2000	36,877	36,942	1.00
Yukon	1993-1994	104	105	0.99
	1994-1995	88	98	0.90
	1995-1996	78	79	0.99
	1996-1997	89	92	0.97
	1997-1998	74	80	0.93
	1998-1999	61	67	0.91
	1999-2000	75	79	0.95

Table 4.1
Preliminary and Final Statistics on Immigration, Canada, Provinces and Territories, 1993-1994 to 1999-2000 (concluded)

Province/territory	Period (July 1 to June 30)	Type of Estimate		Ratio Preliminary/ Final
		Preliminary	Final	
Northwest Territories[1]	1993-1994	134	139	0.96
	1994-1995	135	133	1.02
	1995-1996	97	94	1.03
	1996-1997	84	80	1.05
	1997-1998	76	71	1.07
	1998-1999	56	56	1.00
	1999-2000	91	95	0.96

[1] Preliminary estimates were not available for Nunavut, and are included in estimates for the Northwest Territories. As such, the calculation of the preliminary/final estimates ratio includes final estimates for Nunavut in the final Northwest Territories.

Source: Demography Division, Statistics Canada

Though provincial/territorial level estimates of immigration are of very good quality, their quality is slightly lower than at the national level. This is related to the fact that the intended local area of destination indicated by immigrants on their forms is used to distribute immigrants by province or territory. Since some immigrants coming to Canada are not certain of their actual destination, their eventual place of residence does not always correspond to their reported intended destination.

The statistics on immigrants obtained from CIC files can also be compared with the census data on immigrants. Table 4.2 shows that the census counts of new immigrants to Canada, by year of immigration are consistently lower during the 1991 to 1996 period (between 15% and 26%, and 18% overall). Results from the Reverse Record Check reveal that immigrants have considerably higher rates of undercoverage than the general population (Statistics Canada (1999c)), and is likely even higher in the case of newer immigrants (see Table 4.3 for a comparison of CIC data and adjusted census data).

Census data are also a source for comparing the provincial/territorial distribution of immigrants by their actual place of residence. Table 4.2 presents also a comparison of CIC's provincial/territorial distribution of immigrants (by their intended destination) with the Census distribution (self-reporting by census respondents) by place of residence, by year of immigration for the years 1991 to 1996. CIC's provincial/territorial distributions result in a smaller share of immigrants intending to land in Ontario and British Columbia than the census distributions of actual residence, for each year presented (with the exception of 1995 and 1996 for Ontario, and 1996 for British Columbia). In general, for all other provinces and territories, their share of new immigrants to Canada is higher according to the CIC distribution, compared to that of the census.

A comparison of the index of dissimilarity over the 1991 to 1996 period reveals that the CIC and census distributions were much closer for the years 1994 to 1996 than for 1991 to 1993. In addition to differences between immigrants' intended destinations versus their place of residence at the time of the census, after their arrival, and prior to the census, immigrants may migrate to another province or territory. For example, a family immigrating to Canada in 1993 declares to CIC, their intentions to reside in Ontario. Upon arrival to Canada, they actually initially settle in British Columbia, then move to Alberta a year later, where they are still living at the time of the 1996 Census. Under these circumstances, these people would be counted as immigrants to Ontario by CIC data, and to Alberta by the census.

Table 4.2
Comparison of Provincial and Territorial Proportion of Total Immigration, by Year of Immigration, CIC and Census, 1991 to 1996[1]

Province/territory	Source	Total Immigration						
		1991	1992	1993	1994	1995	1996 [1]	1991 to 1996 [1]
Canada	**CIC**	**230,834**	**252,842**	**255,747**	**223,759**	**212,030**	**90,313**	**1,265,525**
	Census	**177,900**	**212,695**	**211,520**	**188,860**	**181,260**	**66,760**	**1,038,995**
	% difference	**22.93**	**15.88**	**17.29**	**15.60**	**14.51**	**26.08**	**17.90**
		Percent of Total						
Canada	**CIC**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
	Census	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Newfoundland and Labrador	CIC	0.28	0.31	0.32	0.25	0.28	0.32	0.29
	Census	0.13	0.11	0.16	0.10	0.17	0.29	0.15
Prince Edward Island	CIC	0.06	0.06	0.06	0.07	0.08	0.06	0.07
	Census	0.02	0.03	0.04	0.08	0.04	0.04	0.04
Nova Scotia	CIC	0.65	0.93	1.18	1.55	1.78	1.21	1.20
	Census	0.40	0.61	0.61	0.64	0.83	0.70	0.62
New Brunswick	CIC	0.30	0.30	0.27	0.28	0.30	0.28	0.29
	Census	0.23	0.19	0.27	0.26	0.30	0.22	0.25
Quebec	CIC	22.40	19.13	17.56	12.52	12.53	13.44	16.73
	Census	17.12	14.52	13.76	12.51	14.64	15.47	14.53
Ontario	CIC	51.46	54.66	52.52	52.40	54.50	53.41	53.13
	Census	54.43	55.79	54.79	52.62	53.79	52.01	54.19
Manitoba	CIC	2.45	2.01	1.91	1.84	1.67	1.66	1.96
	Census	1.88	2.09	1.65	1.91	1.63	1.98	1.85
Saskatchewan	CIC	1.06	0.99	0.94	1.01	0.91	0.79	0.97
	Census	0.68	0.51	0.73	0.83	0.88	1.13	0.75
Alberta	CIC	7.36	7.00	7.26	8.04	6.99	6.21	7.24
	Census	7.37	6.44	6.75	6.90	6.20	6.36	6.70
British Columbia	CIC	13.90	14.51	17.87	21.92	20.88	22.54	18.03
	Census	17.63	19.62	21.16	24.07	21.43	21.70	20.85
Yukon	CIC	0.04	0.05	0.04	0.05	0.04	0.03	0.04
	Census	0.04	0.03	0.02	0.03	0.04	0.04	0.03
Northwest Territories	CIC	0.05	0.04	0.07	0.07	0.05	0.05	0.05
	Census	0.06	0.05	0.06	0.06	0.05	0.05	0.06
Index of dissimilarity		6.74	6.33	5.55	2.44	2.65	2.84	3.88

[1] Data for 1996 are for January to June only, for both Census and Demography Division estimates.
Source: Statistics Canada (2001). *Annual Demographic Statistics, 2000*, and 1991 and 1996 census data, custom tabulation

There are several other intervening factors which may explain the inconsistencies between the CIC and census provincial/territorial distributions of recent immigrants, as well as the differences between the total numbers for Canada. They include (but are not limited to) the following:

(i)   deaths of immigrants between landing in Canada and the time of the census;
(ii)   emigration of immigrants (i.e., left Canada after their arrival) prior to the census;
(iii)   census undercoverage;
(iv)   sample error.

In cases of (i) and (ii) above, immigrants who died or emigrated after their arrival in Canada, but before the census, would be included in CIC's numbers, but not in the census data. The number of

deaths between landing and the time of the census is small, and as reference periods are closer to a census year, the less impact both death and emigration of immigrants will have on the overall census data.

Additionally, census undercoverage (iii), explains in part, the lower numbers of immigrants as given by the census, in that a small proportion of the population is missed during enumeration. This proportion is traditionally higher among recent immigrants.

Finally, the numbers of immigrants may also be affected by sample error[16]. Census immigration data are based on a 20% sample of households in Canada receiving a more detailed questionnaire about the characteristics of the persons in the household, whereas CIC's data are based on administrative records of all immigrants landing in Canada.

Table 4.3 illustrates the effect of each factor on the total number of new immigrants. In this table, the census data have been adjusted for missed persons, using estimates from the RRC, and deaths and emigration. When adjustments are made for these three factors, the total difference between CIC and census data are reduced from 17.3% to 3.5% for the 5-year period. The remaining difference between the two data sources may be attributed to sample error in the census, or other factors not discussed here. These comparisons show that census data would require substantial adjustments to derive annual numbers of immigrants for population estimation purposes (George, M.V., 2001).

Table 4.3
Comparison of Total Immigration, CIC Data and Adjusted Census Data, 1991-1995

| Year | Census | | | | CIC | Difference (%) | | | |
| | Unadjusted | Adjusted for Missed Persons | Adjusted for Missed Persons and Deaths | Adjusted for Missed Persons, Deaths and Emigration | | [(1)-(5)]/(5) x 100 | [(2)-(5)]/(5) x 100 | [(3)-(5)]/(5) x 100 | [(4)-(5)]/(5) x 100 |
	(1)	(2)	(3)	(4)	(5)				
1991	177,900	194,801	195,316	207,485	230,834	-22.9	-15.6	-15.4	-10.1
1992	212,695	232,901	233,518	248,066	252,842	-15.9	-7.9	-7.6	-1.9
1993	211,520	231,614	232,228	246,696	255,747	-17.3	-9.4	-9.2	-3.5
1994	188,860	206,807	207,355	220,273	223,759	-15.6	-7.6	-7.3	-1.6
1995	181,260	198,480	199,005	211,404	212,030	-14.5	-6.4	-6.1	-0.3
Total 1991-1995	**972,235**	**1,064,603**	**1,067,422**	**1,133,924**	**1,175,212**	**-17.3**	**-9.4**	**-9.2**	**-3.5**

Sources: George, M.V. (2001). Statistics Canada (2001). ***Annual Demographic Statistics, 2000***., Statistics Canada, 1996 Census data, and ***Coverage: 1996 Census Technical Reports***.

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[16] Sample error is the error attributed to studying a fraction of the population rather than carrying out a study of the complete population.

Chapter 5

Non-permanent Residents

Non-permanent residents (NPRs) are defined by Statistics Canada as persons who have been legally granted the right to live in Canada on a temporary basis and include refugee status claimants[17], persons holding a student authorisation, an employment authorisation or a Minister's permit. Permits and authorisations may include coverage for family members of the principal document holder, and these persons are also included in the NPR population. Children born in Canada to parents of non-permanent resident status are considered Canadian by birth and have all rights and privileges associated with citizenship.

In 1991, NPRs were included in the target population of the Census for the first time[18]. Despite their relatively small representation in the Canadian population (about 338,000 or 1.1% of the total population, July 1, 2002[19]), NPRs have been recognized by the government as playing an increasingly important role in economic development of the country.[20] Information on NPRs is useful for the review of employment policies and programs, as well as to plan education, health and other services. Consequently, the category of NPRs forms part of the international migration component used to produce estimates of the population of Canada and the provinces and territories.[21]

Data Sources and Relevant Concepts

The data required to produce the NPR estimates are obtained from files from Citizenship and Immigration Canada (CIC)'s Field Operations Support System (FOSS). They include data on visitor permits, work authorisations, student authorisations, special ministerial permits, refugee status claims, landings[22], deportations, applications for landing and proof of identity information for persons making refugee status claims.

Movements into and out of the NPR population are referred to as "flows", as are status changes from permit/authorisation holders to refugee status claimants or from permit/authorisation holders or

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[17] Internationally, the term "asylum seekers" is more commonly used.

[18] The only exception was the 1941 Census, in which Statistics Canada also included non-permanent residents in its population counts to account for persons entering Canada during World War II.

[19] Preliminary estimate. Source: Demography Division.

[20] This is not unique to Canada, as other countries such as Australia, New Zealand, Singapore and the United States have noted the importance of temporary migration (Viccars, 1993).

[21] The United Nations has emphasized the importance of international migration and the maintenance of statistics on this topic. Thus, the inclusion of NPRs in Canadian population statistics also responds, in part, to UN recommendations which aim at establishing a universal definition of international migration for the purpose of internationally comparable statistics.

[22] "Landings" refers to lawful permission to establish permanent residence in Canada. (*Immigration Act*, Chapter 2 – Interpretation), http://laws.justice.gc.ca/

refugee status claimants to landed immigrant status[23]. "Stocks" represent the number of NPRs in the country at any given time. As Figure 5.1 illustrates, from the most general perspective, persons can enter into the current stock of NPRs (i.e., 'inflows') either from abroad or from non-resident status within Canada (e.g. visitors). When a person leaves the NPR population (i.e., 'outflows'), it is assumed that they have either left the country, become a non-resident, or become a landed immigrant.

Figure 5.1
NPR Flows by Broad Type
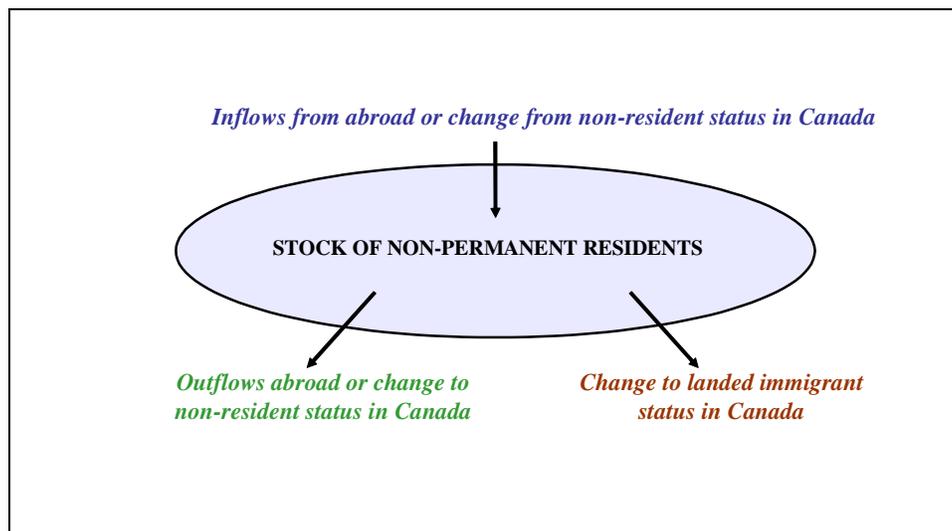
NPRs may be in Canada under any one of the following situations: (i) as holders of only permits or authorisations (they may concurrently hold more than one type); (ii) as persons who have only ever lodged refugee status claims; and (iii) as refugee status claimants who also possess one or more of the three types of permits or authorisations that would qualify them for NPR status. In cases where refugee status claimants concurrently hold some type of permit or authorisation (e.g., a refugee status claimant is granted an employment authorisation to help support themselves and their dependants within Canada), the refugee status overrides the other entitlements to the NPR status. Consequently, references to "permit/authorisation holders" represent persons who have not also made refugee status claims, and only the two major sub-groups of permit/authorisation holders and refugee status claimants are used for estimation purposes. Dependants who were born abroad to members of these two sub-groups of NPRs are also included, however children born in Canada to persons of NPR status are not.

All persons in possession of a permit/authorisation or claiming refugee status are assigned a Client Identification Number (CID) by Citizenship and Immigration Canada (CIC). This identification number is a key variable as it is unique for each person holding a permit/authorisation or claiming refugee status and is maintained for every document issued by CIC. It is used in the production of estimates of NPRs.

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[23] Persons leaving the NPR population by obtaining landed immigrant status change the size of the NPR population, but have no impact on the size of the total population of Canada, as these persons become a part of the permanent resident population.

Estimates of Stocks of Non-permanent Residents

The two major subgroups of the NPR population (permit/authorisation holders and refugee status claimants) are administratively different, therefore, their estimates must be produced separately. The methods used in the production of estimates for permit/authorisation holders are discussed first, followed by those used for refugee status claimants.

Stocks of Permit/Authorisation Holders

Permit/authorisation holders (PHs) must either have had an official document signed in advance or have it signed upon entry to Canada, allowing them to reside in Canada on a temporary basis. Therefore, a person is considered part of this population if they possess a valid employment, student or Ministerial document on the date of reference for the estimates. This means that the document must have been in effect prior to the reference date and valid until or past the reference date. If a person possesses more than one valid permit/authorisation, the information from the permit/authorisation for which the effective date[24] is closest to the reference date is used.

Since dependants of permit/authorisation holders are not required to obtain their own permits (though some do), the number of permit/authorisation holders and their dependants is equal to the total number of persons covered by the documents.

Status as a permit/authorisation holder terminates upon the expiry of the valid document, or when a PH is granted landing status (i.e., becoming a permanent resident), deported, or claims refugee status.[25] Though the latter case affects the populations of the sub-groups of NPRs, the total NPR population is unaffected by this type of change in status.

The province of residence for each PH is obtained from the valid document. If a person has more than one valid permit/authorisation, then the province of residence is taken from the permit/authorisation for which the effective date is closest to the reference date. In some circumstances, the province of residence is not indicated on the document. In these cases, the province of the Canada Immigration Centre where the permit/authorisation was issued is used. There are a small number of cases for which there is neither a province of residence nor a Canada Immigration Centre indicated. These cases are prorated according to the provincial distribution of PHs for which the province of residence is known or has been derived. In all cases, the province of residence for the principal PH is assumed for the dependants.

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[24] The effective date is the date (or an approximation of) when the PH entered Canada as an NPR, or the date as of which a permit or authorisation is extended.

[25] Occasions arise where there appears to be a short interruption in a PH's temporary stay in Canada. That is to say, a permit/authorisation expires and there is a brief time lag between the expiry date and the effective date of the next permit/authorisation. Since this is likely due to administrative delays in the issuance of permits/authorisations and extensions, interruptions of less than 31 days are disregarded and these persons are considered as having been continuously residing in Canada.

Stocks of PHs can be expressed as follows:

For each province/territory:

PH = sum of all PHs and their dependants covered by the valid document on the reference date, as defined above

Stocks of Refugee Status Claimants

A person is considered part of the refugee status claimant (RSC) population once a claim has been filed at a Canadian Immigration Centre. Effective with the proclamation of Bill C-86 on February 1, 1993, each person claiming refugee status is treated as a separate "case" (i.e., all claimants, including dependants are considered of separate identity and each is represented by a separate case, identified by a unique CID). Under the previous legislation (Bill C-55), it was not necessary for dependants to submit independent claims, therefore the number of RSCs was equal to the total number of persons represented by the claim of principal claimants.

Those persons who held legal temporary status in Canada as PHs prior to making a refugee status claim are included in the PH population until the date of their refugee status claim, at which time they are considered to be RSCs.

Since refugee status claims do not have expiry dates, if none of a withdrawal of claim, deportation or landing occurs, it is not known when claimants leave the NPR population. For this reason, some assumptions are necessary.

For those RSCs having applied for landed immigrant status:

(i)   it is assumed that they will leave the NPR population 2 years after their application for landing date (unless they do not possess acceptable proof of identity, as in (ii) below). This assumption is based on the fact that these applications typically take no longer than 2 years to process;

(ii)   and do not have valid proof of identity[26], it is assumed that they left the NPR population 5 years after the date of application for landing. This assumption is in accordance with the recommendation of the Minister of Immigration.

For those RSCs who have not applied for landed immigrant status:

(iii)   it is assumed that they will leave the NPR population 2 years after their last contact with CIC. Records of every communication with each client are kept, whether it be a request for information on their status, to file a new application, to make an administrative change (e.g., change of address), etc. If there has been no activity for a 2 year period for an RSC, it is assumed that they are no longer an NPR by virtue of having left the country, or death.

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[26] Cases of persons arriving in Canada without proof of identity may arise in situations where they have left a country involved in civil unrest or war, with little or no belongings, including identification. Depending on the circumstances in their last country of residence, they may not be capable of obtaining appropriate identification even after they have entered Canada.

The province of residence for each RSC may be obtained from the claim record. If it is missing or invalid, then information from permit/authorisations is used (if it exists), as described in the previous section. If there is no information on the province of residence from these sources, then as with PHs, the province of the Canada Immigration Centre where the claim was made is used. If this is not available, these remaining cases are prorated according to the provincial distribution for RSCs where the province of residence is available (or derived). The province of residence for the principal RSC (of claims made under Bill C-55) is assumed for the dependants of claimants.

Given the above, stocks of RSCs can be expressed as follows:

For each province/territory:

(a)   the total number of persons covered by the claim for claims submitted under Bill C-55 (between January 1, 1989 and January 31, 1993); plus

(b)   the number of individual claims for those submitted under Bill C-86 (effective February 1, 1993).

Adjustments for the Backlog of RSCs

Persons without status and living in Canada (i.e., non-citizens or non-immigrants, and neither permit/authorisation holders or refugee status claimants) prior to January 1, 1989, were offered the opportunity to come forward to CIC and claim refugee status without penalty. Over 100,000 persons made such claims, which created a backlog of RSCs due to the lengthy processing associated with refugee status claims. In the interim, CIC issued these persons with work permits, valid from January 1, 1989 to September 30, 1991, under the assumption that it would take approximately 2 years to clear the backlog.

These individuals had been included in the PH estimates until the expiry of the permits (September, 1991), therefore only the July 1, 1991 to September 30, 1991 estimates required revisions.[27] Since these persons were identifiable by the effective and expiry dates of the permits, they were removed from the PH estimates and added to the RSCs for this period.

However, upon expiry of the permits for the backlogged RSCs, a backlog still existed. After September 30, 1991 (and until June 30, 1993, when the backlog was cleared), these individuals were included in the RSC estimates using information from CIC's Backlog Clearance Program. CIC provided Demography Division with an electronic file containing counts of outstanding claims of RSCs on January 1 and July 1 of each year during this period, by province and territory.

Since the counts obtained from CIC did not include the dependants of the claimants, these had to be estimated. The average number of persons covered by a claim as determined by CIC was used, and assumed to be the same for all provinces and constant for the 1991 to 1993 period.

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[27] By the time data related to the backlog became available to Demography Division, intercensal estimates of NPRs for the January 1, 1989 to June 30, 1991 period had already been produced, therefore did not require adjustments for the backlog.

NPR Estimates by Age, Sex and Marital Status

Permit/Authorisation Holders

Though permits and authorisations include information on the number of persons the document covers, data related to the age, sex and marital status are only available for the principal PH. Therefore, the information for principal applicants is obtained directly from the CIC files, while estimation is required for characteristics of their dependants.

Since data are available for all RSCs who filed under Bill C-86 (i.e., one application equals one person), the age, sex and marital status distributions of dependants of principal claimants who also hold permits, are used for the dependants of PHs.

Refugee Status Claimants

Since data are available for all RSCs who filed under Bill C-86, the data on sex, age and marital status for these claimants are obtained directly from their valid claim.

For refugee status claims made under Bill C-55, the number of dependants were included in the claim for the principal claimant, however other data for these persons were not collected. As with PHs, the age, sex and marital status distributions of dependants for Bill C-86 RSCs are used for the dependants of Bill C-55 claimants.

Stocks of NPRs as a Component of Total Population Estimates

The change in NPRs from one period to another is determined by subtracting the NPR stock of the previous reference date from the current NPR stock.

Equation 5.1: $$\Delta NPR_{(t,t+i)} = NPR_{(t+i)} - NPR_t$$

where

$\Delta NPR_{(t,t+i)}$ = change in NPR stocks over the period $(t, t + i)$;

$NPR_{(t+i)}$ = NPR stocks at time $(t + i)$;

NPR_t = NPR stocks at time t.

Estimates of NPRs Stocks for the Period Prior to 1991

The introduction of NPRs to the target population of the 1991 Census, together with the decision to use the Census counts adjusted for net undercoverage as the base for population estimates, led to the consideration of revising intercensal population estimates back to 1971 to provide a consistent

historical time series.[28] This revision required the development of a methodology to produce estimates of NPRs by single year of age, sex and marital status, by province and territory for the 1971-1991 period.

Though data on NPRs were available from Citizenship and Immigration Canada's (at that time called Employment and Immigration Canada) Visitor's Immigration Data System (VIDS) from 1971, due to changes in immigration laws in 1976-1977, comparable data were only available from 1978. Consequently, different data sources and procedures were required for the 1971-1980 and 1981-1991 periods.

NPR Estimates for the 1981-1991 Period

Estimates of NPRs for the 1981-1991 period were based on information from the VIDS. A person was considered to be part of the NPR population based on the date of arrival in Canada, the permit issue date and permit expiry date for PHs. RSCs could not be directly identified in VIDS unless they received a student, employment or ministerial permit. Unless other information was available (e.g., a permit extension), the expiry date was assumed to be the date of departure from Canada for permit holders.

The VIDS-based counts of NPRs required inflation by a coverage factor to adjust for administrative delays (e.g., data entry and transmission of updates). The coverage factor was based on the assumption that for a given time lag between the reference date and the update file from CIC, the file would always have the same level of completeness. Based on this assumption, factors to adjust the underestimated data on the observed time lags in adding new information to the file were calculated and applied to the VIDS-based counts.

The age/sex distribution was first obtained for principal PHs and RSCs, by five-year age group, sex and province/territory. Non-permanent residents without their own document, but included on the principal holder's document (i.e., dependants) were distributed using the same age and sex groupings for each province/territory distribution based on the 1991 Census distribution of NPRs (adjusted for net undercoverage).

To produce NPR estimates by age, sex and marital status, two methods were used:

(i)   the 1991 census distributions were used for estimates of single and married NPRs;
(ii)   estimates for widowed and divorced NPRs were also based on the census distributions of marital status, however the small numbers required additional manipulation of data.

Estimates for the 1971-1980 Period

Because the VIDS was not a complete source of data on NPRs for the 1971-1980 period, alternate data sources were required. Estimates of the NPR population for this period were produced using different sources of information for specific sub-groups of this population.

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[28] See Chapter 2 on Base Populations for further details on revisions to the 1971 to 1986 base populations and intercensal estimates.

Estimates of the number of foreign students were obtained from two data sources. For 1975-1980, the estimates were provided by Education, Culture and Tourism Division (ECTD), Statistics Canada. For the 1971-1974 period, estimates were derived from a comparison between the number of student authorisations issued by CIC and the estimates from ECTD for 1975-1980, and applied to the CIC 1971-1974 student authorisations.

The number of foreign workers for the entire 1971-1980 period was derived from the ratio of the number of foreign workers based on VIDS and CIC data on employment authorisations issued at the beginning of the 1980's to the number of authorisations issued in 1971-1980.

Additionally, the 1971 to 1974 NPR estimates were adjusted to account for NPRs who became permanent residents of Canada on account of the 1973-1974 administration review.

Based on analyses of trends, estimates of the NPR population by age, sex, province and territory for the 1971-1980 period were based on the provincial/territorial tendencies of proportional distribution observed during the 1981 to 1985 period. To obtain the more-detailed estimates of age, sex and marital status, by province and territory, it was also assumed that the marital status distribution of NPRs was consistent with the average of the 1981-1985 period.

Data Quality

Estimates of NPRs originate from an administrative source, which has both advantages and disadvantages. Since persons residing in Canada on a temporary basis are required by law to obtain a permit/authorisation or make a claim for refugee status, the CIC database is a complete inventory of this population.

However, there are also limitations associated with using this administrative data source. There may be missing or erroneous data which may be difficult or impossible to correct. For example, the province of residence obtained from the CIC files is not always known or valid, which may bias estimates at the provincial/territorial level. However, other data may provide a reasonable proxy of the province where the person resides (e.g., the province of the Canada Immigration Centre where the permit/authorisation was obtained or refugee status claim was made).

The total number of dependants for PHs is obtained from a field that indicates the total number of persons covered by each document. It is possible that this approach might result in some double-counting for persons who enter the NPR population as a dependant of a principal PH, then later obtain their own permit. Consequently, PH stocks and flows including dependants may provide a slight overestimation of the actual numbers.

Data on the characteristics for PHs and Bill C-55 RSCs are limited to the principal document holders. Stock estimates make use of age and sex and marital status distributions available from Bill C-86 RSCs. However, this practice may lead to issues of the generalizability of characteristics from one population to another. Since the introduction of Bill C-86 in 1993, the above shortcoming of the NPR's estimates by characteristics concerns only the PHs population.

Table 5.1 presents the comparison of preliminary and final estimates of change in stocks of NPRs for 1993-1994 to 1998-1999. Compared to preliminary estimates of births, deaths and immigration,

preliminary estimates of NPR flows vary considerably from the final estimates. This is partially the result of modifications to the methodology, including certain assumptions about when NPRs leave this subpopulation. These assumptions were implemented to more accurately reflect reality, which should result in more stable estimates over time. However, because of the relatively small numbers, the preliminary estimates, which mostly overstated the decrease of the stock of NPRs for 1993-1994 to 1998-1999, had little effect on the overall population estimates at both the national and provincial/territorial levels.

Though there seems to be some degree of instability between preliminary and final estimates of NPRs, because of the legal requirement for proper documentation with CIC, the final estimates should still be considered to be of fairly reliable quality.

Table 5.1
Change in Non-permanent Resident Population, Preliminary and Final Estimates, Canada, Provinces and Territories, 1993-1994 to 1998-1999

Province/territory	Period (July 1 to June 30)	Type of Estimate		Ratio Preliminary/ Final
		Preliminary	Final	
Canada	**1993-1994**	**-76,381**	**-22,196**	**3.44**
	1994-1995	**-7,318**	**-14,152**	**0.52**
	1995-1996	**625**	**-4,192**	**-0.15**
	1996-1997	**-23,041**	**-682**	**33.78**
	1997-1998	**-9,048**	**-4,818**	**1.88**
	1998-1999	**2,922**	**26,283**	**0.11**
Newfoundland and Labrador	1993-1994	-531	-1,687	0.31
	1994-1995	4	-802	0.00
	1995-1996	-688	-654	1.05
	1996-1997	-696	-10	69.60
	1997-1998	-143	-288	0.50
	1998-1999	238	452	0.53
Prince Edward Island	1993-1994	35	34	1.03
	1994-1995	36	55	0.65
	1995-1996	130	95	1.37
	1996-1997	-62	-55	1.13
	1997-1998	-84	-39	2.15
	1998-1999	26	148	0.18
Nova Scotia	1993-1994	-146	-235	0.62
	1994-1995	308	-376	-0.82
	1995-1996	-154	126	-1.22
	1996-1997	-475	116	-4.09
	1997-1998	188	321	0.59
	1998-1999	1,462	2,161	0.68
New Brunswick	1993-1994	-119	-16	7.44
	1994-1995	56	-233	-0.24
	1995-1996	-87	-26	3.35
	1996-1997	-351	29	-12.10
	1997-1998	80	9	8.89
	1998-1999	1,207	1,381	0.87
Quebec	1993-1994	-6,639	-2,826	2.35
	1994-1995	2,227	1,855	1.20
	1995-1996	403	2,665	0.15
	1996-1997	-4,286	-1,185	3.62
	1997-1998	-3,593	-1,707	2.10
	1998-1999	-1,478	4,096	-0.36

Table 5.1
Change in Non-permanent Resident Population, Preliminary and Final Estimates, Canada, Provinces and Territories, 1993-1994 to 1998-1999 (concluded)

Province/territory	Period (July 1 to June 30)	Type of Estimate		Ratio Preliminary/ Final
		Preliminary	Final	
Ontario	1993-1994	-51,570	-11,997	4.30
	1994-1995	-14,531	-16,869	0.86
	1995-1996	-4,963	-12,150	0.41
	1996-1997	-10,445	-3,860	2.71
	1997-1998	-8,041	-3,210	2.50
	1998-1999	-1,245	10,638	-0.12
Manitoba	1993-1994	-538	-394	1.37
	1994-1995	701	-84	-8.35
	1995-1996	-346	-225	1.54
	1996-1997	-685	-50	13.70
	1997-1998	136	167	0.81
	1998-1999	238	525	0.45
Saskatchewan	1993-1994	-340	-374	0.91
	1994-1995	445	77	5.78
	1995-1996	257	344	0.75
	1996-1997	-534	122	-4.38
	1997-1998	209	246	0.85
	1998-1999	-55	419	-0.13
Alberta	1993-1994	-5,719	-2,725	2.10
	1994-1995	613	-321	-1.91
	1995-1996	-166	605	-0.27
	1996-1997	-1,389	1,371	-1.01
	1997-1998	1,404	966	1.45
	1998-1999	1,023	2,114	0.48
British Columbia	1993-1994	-10,537	-1,944	5.42
	1994-1995	2,929	2,555	1.15
	1995-1996	6,204	5,027	1.23
	1996-1997	-4,091	2,858	-1.43
	1997-1998	760	-1,332	-0.57
	1998-1999	1,503	4,321	0.35
Yukon	1993-1994	-156	-12	13.00
	1994-1995	-60	16	-3.75
	1995-1996	13	-10	-1.30
	1996-1997	-27	-30	0.90
	1997-1998	-21	16	-1.31
	1998-1999	5	26	0.19
Northwest Territories[1]	1993-1994	-121	-20	6.05
	1994-1995	-46	-25	1.84
	1995-1996	22	11	2.00
	1996-1997	0	12	0.00
	1997-1998	57	33	1.73
	1998-1999	-2	2	-1.00

[1] Preliminary estimates were not available for Nunavut, and are included in estimates for the Northwest Territories.
  As such, the calculation of the preliminary/final estimates ratio includes estimates for Nunavut in the
  Northwest Territories estimates.
Source: Demography Division, Statistics Canada

Chapter 6

Total Emigration

Emigration results in a loss of population due to citizens or landed immigrants who leave the country to establish a residence in another country. This residence abroad may be intended as permanent or temporary. The total emigration component in the calculation of Canada's population is comprised of emigrants, returning emigrants and the net change in the number of persons living temporarily abroad.

Unlike immigration, there is no legal provision in Canada to maintain records for persons leaving the country either on a temporary or permanent basis. Therefore, estimates of the number of emigrants and persons living temporarily abroad and their characteristics must be derived through secondary sources such as Canadian administrative files or immigration statistics of other countries.

As this component of population change is the most difficult to estimate, the methods of estimation have evolved over time in an attempt to produce more accurate emigration estimates, given available sources. This chapter presents current methods used to produce the estimates of the three constituents of total emigration. Previous methods used (from 1951 to 1993) are discussed briefly, as the changes in methods affect the consistency of the historical series of estimates as well as the data quality.

Data Sources and Relevant Concepts

Despite recommendations by the United Nations to establish a universal definition of international migrants, as well as a uniform method of recording information regarding emigration and immigration, not much progress has been made (United Nations, 1998). This has consequences on the ability to compare migration statistics between different countries, as well as the potential to use international migration data from other nations. For the purpose of Canadian population estimates, the following account describes the three constituents of total emigration.

The production of emigration estimates requires a distinction between emigrants (i.e., those persons establishing a permanent residence in another country) and those persons living temporarily abroad. Different data sources and methods are necessary for the two types of emigrants, as well as for returning emigrants.

Emigrants are Canadian citizens or landed immigrants who have migrated from Canada to another country with the intention of settling permanently in that country (sometimes referred to as "permanent emigration"). Permanent emigration involves severing residential ties with Canada and acquiring permanent residency in another country. For example, persons travelling to the United States may be considered permanent emigrants if they acquire permanent resident status there, but are considered temporary emigrants if they are still a visa-holder or on visitor status. Permanent emigration is not necessarily irreversible however, as emigrants can always decide to return to Canada.

Permanent emigration is estimated from administrative sources in terms of the "gross flow" of migrants out of Canada. The Immigration and Naturalization Service (INS) of the U.S. Department of Justice provides data on Canadians who acquire immigrant status in the U.S. Canada Customs and Revenue Agency (CCRA) makes available to Statistics Canada tax data and data from the Child Tax Benefit (CTB) program which provide a base to estimate the number of people who sever their social, economic and residential ties with Canada and those who re-establish their ties after their return. The INS, tax and CTB data are assumed to cover permanent emigration or long-term stays outside the country. Though tax data and CTB coverage is not complete, these are currently the best sources of data providing information on these types of movements.

CTB data, combined with personal income tax data, cover emigration better than tax data alone. The CTB program identifies emigrants through their tax return and/or from their notification of departure to CCRA. The notification of departure can cover, in part, families that will not necessarily file a tax return for the year of their departure. The combination of CTB and tax data allows for an estimate of child and adult emigration and, using Demography population estimates, provides an estimate of the non-covered CTB child population. Tax data on filers and their dependants are produced by Small Area and Administrative Data Division (SAADD) of Statistics Canada, based on files received from CCRA.

Returning emigrants are Canadian citizens or landed immigrants whom after having been classified as a permanent emigrant, subsequently return to Canada to re-establish a permanent residence. The numbers of returning emigrants are subtracted from the estimates for permanent emigrants to produce the net total for this type of emigration (permanent flow).

Persons living temporarily abroad are Canadian citizens and landed immigrants who have migrated from Canada to another country for the purpose of settling there temporarily (sometimes referred to as "temporary emigration"). Estimates of persons living temporarily abroad are derived from the Reverse Record Check (RRC) survey estimate. The emigration remains temporary if there is an intention to return to Canada and the length of stay is longer than 6 months. In cases where intentions are unknown, if the length of stay is between 6 and 24 months, these persons are considered to be temporarily abroad.

Temporary emigration is estimated as a change of persons living temporarily abroad, based on estimates of the number of persons temporarily out of the country on Census Day. Estimates of persons temporarily abroad are derived from the RRC since the INS, tax and CTB data do not cover temporary emigration. The INS data do not cover temporary emigration at all[29], while it is assumed that tax and CTB data may cover only a small fraction. A person could sever their economic, social and residential ties with Canada and still have an intention of returning to the country. It is assumed that these people represent a small fraction of the emigrants identified by CTB and tax data.

Temporary migration constitutes many movements in and out of the country. This would not concern the overall population estimates if the net effect was nil or negligible. However, the census coverage study (Reverse Record Check) in 1996 has shown that this is not the case. The decision to account for persons living temporarily abroad was based on evaluations of the 1996 closure error for

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[29] Although INS provides information on the number of entries for temporary legal stay in the United States, this is not an accurate count of the total number of Canadians entering on a temporary basis. These statistics can represent the multiple entries of the same person if this person enters the United States more than once over the reference period. They cover only entries by plane.

postcensal population estimates and its components against Reverse Record Check estimates. These evaluations concluded that omitting departures of Canadians for temporary residence abroad and their consecutive returns to Canada has an important impact on the quality of the estimate of the country's population (Michalowski, M. (1999)). Including net flows of temporary emigrants in the total emigration component is consequently a fairly new practice, beginning in 1998, with revisions to estimates back to 1996.

It should be noted that further use of the terms "emigrant" and "emigration" in this chapter refer to permanent emigration, except where "total emigration" is discussed, which implies all three constituents.

Estimates of Total Emigration, Canada, Provinces and Territories

Final Estimates

The total emigration component is obtained by estimating its three constituents (i.e., emigrants, returning emigrants and persons living temporarily abroad) separately, as follows.

Permanent Emigrants

Estimates of emigrants refer to permanent emigrants only. As mentioned earlier, emigrants are counted in terms of flows, i.e., each movement into the emigrant population is counted.

CTB data, combined with INS and tax data, are used to produce estimates of permanent emigration. Because the CTB program is not universal and does not provide direct information on the number of adult emigrants, three adjustment factors are used to take this into account:

(i)   the partial coverage of the program (i.e., persons not entitled to the CTB)[30];
(ii)   the differential propensity to emigrate of children receiving benefits compared to those not covered; and
(iii)   the number of adults emigrating based on the number of child emigrants.

Each of these adjustment factors makes use of tax data from SAADD, and are discussed in the following description of estimation methods for child and adult emigrants.

Emigrant Children

The Child Tax Benefit file provides numbers of dependant children (under 18 years of age) whose parents are CTB recipients and have become non-residents as defined by CCRA. These data are available by month and province or territory. As mentioned, the CTB program is not universal, therefore the data are incomplete in terms of estimation of total child emigrants and require adjustment.

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[30] The CTB differs from the Family Allowance program in that for children under the age of 18 years, to be entitled to the monthly benefit, their caregiver(s) must file a personal income tax return, reside with the child, and their income must be less than established thresholds. These thresholds are available on CCRA's web site, www.ccra-adrc.gc.ca.

The adjustment produces the number of children who would be included in the CTB program if it were universal, and involves two factors. The first factor, (i) above, reflects the CTB program's coverage: the ratio of the number of children actually covered by the CTB program to the number of children in the total population, as estimated by Demography Division, for each month and province and territory. The second factor, (ii) above, estimates the "emigration propensity" of children covered by the CTB compared with that of all children for each province and territory, on an annual basis. This factor is calculated based on tax data processed by SAADD, which identify emigrant families by comparing addresses on income tax returns for two consecutive years and include information on persons receiving at least one CTB payment during the taxation year.

It was found that between 1994 and 1997, for each province and territory, the estimated rate of emigrating families receiving the CTB was consistently lower than the rate for all families with children. As such, the adjustment of the CTB data reflects the higher propensity of emigration for non-CTB children. Observations for a three-year period are used in computing this annual factor for all provinces. To eliminate variations due to small numbers in each of the Atlantic provinces, the differential propensity factor is estimated for these provinces as a group. In addition, the estimated factor for Canada is used for the territories.

The formula for estimates of child emigrants by province/territory is as follows:

For each province/territory j:

Equation 6.1:
$$_j\mathrm{PE}^{0-17} = {}^{CTB}_j\mathrm{PE}^{0-17} \times \frac{1}{{}^{CTB}_j\Re} \times {}_jG$$

where

$_j\mathrm{PE}^{0-17}$	=	permanent emigrant children from province/territory j;
${}^{CTB}_j\mathrm{PE}^{0-17}$	=	permanent emigrant children entitled to CTB from province/territory j:
${}^{CTB}_j\Re$	=	coverage rate of CTB program for province/territory j;
$_jG$	=	adjustment factor for the migration rate of children by province/territory j;
CTB	=	CTB data.

The equation above includes the adjustments for incomplete coverage of CTB-entitled children (Equation 6.2) and for the differences in the propensities of CTB-entitled and non-entitled subpopulations to emigrate (Equation 6.3).

The coverage rates are calculated on a monthly basis as follows:

For each province and territory j:

Equation 6.2:
$$_j^{CTB}\Re = \left(\frac{{}^{CTB}_j\mathrm{P}^{0-17}}{{}_j\mathrm{P}^{0-17}} \right)$$

where

$^{CTB}_j\mathfrak{R}$ = coverage rate of CTB program for each province/territory j;

$^{CTB}_j\mathrm{P}^{0-17}$ = number of children aged 0-17 years entitled to receive the CTB in each province/territory j;

$_j\mathrm{P}^{0-17}$ = population estimates by Demography Division of children aged 0-17 years in each province/territory j.

The differential propensity to emigrate is obtained by dividing the emigration rates for all children by the emigration rates for children entitled to the CTB, as follows:

For each province and territory j:

Equation 6.3:
$$_jG = \frac{\left(\dfrac{^{TAX}_j\mathrm{PE}^{0-17}}{^{TAX}_j\mathrm{P}^{0-17}}\right)}{\left(\dfrac{^{CTB\_TAX}_j\mathrm{PE}^{0-17}}{^{CTB\_TAX}_j\mathrm{P}^{0-17}}\right)} \qquad \text{or}$$

$$_jG = \frac{^{TAX}_j\mathrm{PE}^{0-17}}{^{CTB\_TAX}_j\mathrm{PE}^{0-17}} \times \frac{^{CTB\_TAX}_j\mathrm{P}^{0-17}}{^{TAX}_j\mathrm{P}^{0-17}}$$

where

$_jG$ = adjustment factor for the emigration rate of children by province/territory of origin j;

$^{TAX}_j\mathrm{PE}^{0-17}$ = emigration of all children from province/territory j, according to tax data;

$^{CTB\_TAX}_j\mathrm{PE}^{0-17}$ = emigration of CTB-entitled children from province/territory j, as modelled from tax data;

$^{CTB\_TAX}_j\mathrm{P}^{0-17}$ = CTB-recipients in the population of the income tax file processed by SAADD, by province/territory j;

$^{TAX}_j\mathrm{P}^{0-17}$ = SAADD estimates of children in province/territory j based on income tax files.

Emigrant Adults

Finally, the third factor in adjusting CTB data involves a calculation of adult emigrants. Estimates for adults emigrating to the United States are obtained directly from INS data ($^{INS}\mathrm{PE}^{18+}$). Since there are no comparable data for other countries[31], estimation is required for adults emigrating elsewhere than the United States. The method for estimating these figures involves four steps:

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[31] The United Nations publishes emigration data by country of origin and destination. However, these data are neither complete nor uniform, as the definition of emigration varies by country.

Step 1:   The number of children emigrating to countries other than the United States is calculated by subtracting the INS figure for children emigrating to the United States from the CTB-based estimate for child emigrants as follows:

Equation 6.4:
$$_{OC}\text{PE}^{0-17} = {}^{CTB}\text{PE}_{0-17} - {}^{INS}\text{PE}^{0-17}$$

where

$_{OC}\text{PE}^{0-17}$ = number of child emigrants to countries other than the United States;

$^{CTB}\text{PE}^{0-17}$ = total number of child emigrants to all countries, CTB-based data;

$^{INS}\text{PE}^{0-17}$ = number of child emigrants to the United States, per INS data.

Step 2:   The emigration rate for children emigrating to countries other than the United States is calculated, as in Equation 6.5.

Equation 6.5:
$$_{OC}\text{R}^{PE_{0-17}} = \frac{_{OC}\text{PE}^{0-17}}{\text{P}^{0-17}}$$

where

$_{OC}\text{R}^{PE_{0-17}}$ = child emigration rate to countries other than the United States;

$_{OC}\text{PE}^{0-17}$ = as per Step 1;

P^{0-17} = estimate of children aged 0-17 by Demography Division.

Step 3:   The emigration rate for adults emigrating to countries other than the United States is calculated by multiplying the child emigration rate to countries other than the United States by the ratio of overall adult to child emigration rates.[32]

Equation 6.6:
$$_{OC}\text{R}^{PE_{18+}} = \left(\frac{\text{R}^{PE_{18+}}}{\text{R}^{PE_{0-17}}}\right) \times {}_{OC}\text{R}^{PE_{0-17}}$$

where:

$_{OC}\text{R}^{PE_{18+}}$ = emigration rate for adults to countries other than the United States;

$\text{R}^{PE_{18+}}$ = adult emigration rate;

$\text{R}^{PE_{0-17}}$ = child emigration rate;

$_{OC}\text{R}^{PE_{0-17}}$ = emigration rate for children to countries other than the United States.

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[32] Currently, the ratio of adult to child emigration rates $\left(\frac{\text{R}^{PE_{18+}}}{\text{R}^{PE_{0-17}}}\right)$ used is 1.1. This ratio was obtained through the historical analysis of adult and child emigration rates based on SAADD data and INS data.

Step 4:   The estimated number of adults emigrating to elsewhere than the United States is obtained by multiplying the estimated Canadian adult population at the beginning of the reference period by the emigration rate for adults emigrating to countries other than the United States, as in Equation 6.7.

Equation 6.7:
$$_{OC}\text{PE}^{18+} = {}_{OC}\text{R}^{PE_{18+}} \times \text{P}^{18+}$$

Finally, the total number of adult emigrants equals:

Equation 6.8:
$$\text{PE}^{18+} = {}^{INS}\text{PE}^{18+} + {}_{OC}\text{PE}^{18+}$$

The process of combining CTB and INS data produces slightly inconsistent data in that the definitions of emigration used by the two data sources are not entirely the same. The INS definition of an immigrant to the United States (i.e.,. emigrants from other countries) is dependant on a person acquiring legal permanent resident status in their country. According to the CTB definition on the other hand, the acquisition of permanent resident status in another country is not required to be considered an emigrant: one must only lose their resident status in Canada for income tax purposes. It is assumed that the difference between the two definitions is not sufficiently large to produce significant bias in the estimates.

Since the INS data do not provide information about the province of origin of Canadian emigrants, provincial/territorial level estimates of adult emigration must be derived from an alternate source. To estimate the adult emigrant distribution by province/territory of origin, the provincial/territorial distribution for child emigrants is assumed.

Estimates of Emigrants by Age, Sex and Marital Status

The choice of data source for each distribution (age, sex, marital status) was based on comparisons between the various data sources for emigration statistics (annual SAADD data and INS data, as well as the Reverse Record Check (RRC), which provides quinquennial information on emigration).

The estimate of emigrants for Canada is first distributed by sex. For emigrants to the United States, the breakdown is directly available from the INS. For emigrants to other countries, the INS distribution is also assumed, since it was more reflective of the RRC distribution for permanent emigration than the SAADD estimates by sex.

Estimates of male and female emigrants are then distributed by age groups, using SAADD data. The following 5 broad age groups only are available from SAADD: 0-17, 18-24, 25-44, 45-64 and 65 years and over. Then, the INS data are used to further distribute the data into five-year age groups. And finally, Sprague's multipliers are applied to split the estimates into single years of age.[33] Since provincial/territorial level data are either unreliable or not available from these sources, the same age/sex distribution is used for all provinces and territories.

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[33] Sprague's multipliers are interpolation coefficients used to subdivide data. For a detailed description of the use of Sprague's multipliers, see Shryock et al. (1976).

To further distribute the estimates by marital status, the INS distribution of emigrants to the United States is applied to all emigrants in each of the provinces and territories.

Returning Emigrants

Estimates of number of returning emigrants refer essentially to permanent emigrants returning to Canada.

The number of returning emigrants is estimated using CTB data covering the dependant children of CTB recipients who have returned to Canada. A citizen or permanent resident who has emigrated regains eligibility for the CTB if he or she re-establishes residential, economic and social ties in Canada. A returning child emigrant is identified by the presence of both a departure date and return date on the CTB file, as well as the parent's residency status.

As with emigration, a person's return to Canada is dependant on their resident status for income tax purposes. It is assumed that most of the returnees in the CTB records were permanent emigrants.

CTB data for returning emigrants include children born outside Canada. These children are included in the returning emigrant population because the majority of foreign births to Canadian parents are not included in vital statistics (according to provincial registry offices). Their inclusion makes up for what would otherwise be an underestimation of population estimates for the reason of incompleteness of data on birth. As is the case with emigration, estimates of the number of returning emigrant children and the number of returning emigrant adults are calculated separately.

Returning Emigrant Children

The Child Tax Benefit file provides the number of dependant children (under the age of 18 years) of CTB recipients who have returned to Canada after a period of emigration, for each month and province/territory.

As with emigrant children, the CTB data for returning child emigrants are adjusted with a factor reflecting the program's coverage. It is also assumed that the ratio of CTB-eligible to CTB-ineligible returning emigrants is the same as the ratio for emigrants. Hence, the numbers for returning CTB-eligible children are adjusted with the same differential propensity factors that are used for emigration. Therefore, the formula provided earlier to compute the estimate of child emigrants (Equation 6.1) is used to estimate returning child emigrants, where ($^{CTB}_{j}PE^{0-17}$) the number of child emigrants by province/territory, according to CTB data, is replaced by ($^{CTB}_{j}RE^{0-17}$) the number of children returning to Canada.

Returning Emigrant Adults

The number of adults returning to Canada after emigrating can be indirectly estimated using SAADD estimates based on income tax files or Census data. Both sources include returning permanent emigrants, returning temporary emigrants and persons who may have maintained residential ties with Canada. Consequently, neither source can be used directly to provide the number of returning

adult permanent emigrants. However, it is possible to obtain the adult/child ratio in the returning emigrant population as follows[34]:

Equation 6.9:

$$\tau^{RE} = \frac{{}^{C}RE^{18+}}{{}^{C}RE^{0-17}}$$

where

τ^{RE}	=	adult to child ratio of the returning emigrant population;
${}^{C}RE^{18+}$	=	number of returning adult emigrants based on Census counts;
${}^{C}RE^{0-17}$	=	number of returning child emigrants based on Census counts.

The number of returning adult emigrants is estimated through multiplying the estimate of returning child emigrants based on CTB data by the adult/child ratio from Equation 6.9.

Equation 6.10:

$$RE^{18+} = {}^{CTB}RE^{0-17} \times \tau^{RE}$$

where

RE^{18+}	=	estimated number of returning adult emigrants;
${}^{CTB}RE^{0-17}$	=	estimate of returning child emigrants based on CTB data;
τ^{RE}	=	adult/child ratio in the returning emigrant population based on Census counts.

The estimate of the number of returning children is produced monthly for each province and territory. The provincial/territorial distribution of returning children is assumed for returning adults.

Estimates of Returning Emigrants by Age, Sex and Marital Status

The estimates of returning emigrants are distributed by age, sex and marital status using the most recent census data on Canadians who were living abroad one year prior to the Census, excluding immigrants who arrived that year.[35] The census distribution by single years of age and sex is applied to children aged 0-17 years. For adults 18 years and over, census distributions by age, sex and marital status are used.

Net Emigration

The subtraction of the estimate of returning emigrants from the estimate of emigrants provides the estimate for net emigration for any reference period, as follows:

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[34] Though in the past, SAADD data were used in the estimation of the ratio, more recently, SAADD's adult/child ratio in the returning emigrant population has yielded questionable results. Consequently, census data are currently being used to obtain the adult/child ratio.

[35] Returning Canadians can also be identified by Census questions on place of residence five years earlier, once immigrants who arrived in Canada during this period have been excluded. It is judged that demographic characteristics of returning emigrants at the time of return are better reflected by the data obtained through information on their residence one year ago.

Equation 6.11:
$$PE^{net}_{(t,t+i)} = PE_{(t,t+i)} - RE_{(t,t+i)}$$

where

$PE^{net}_{(t,t+i)}$ =   net permanent emigration for the period $(t, t + i)$;

$PE_{(t,t+i)}$ =   estimate of the number of emigrants for the period $(t, t + i)$;

$RE_{(t,t+i)}$ =   estimate of the number of returning emigrants for the period $(t, t + i)$.

Persons Living Temporarily Abroad

Estimates of persons living temporarily abroad are produced in terms of the net change of persons living temporarily abroad (or net flow), based on estimates of the number of persons temporarily out of the country on Census Day, using the Reverse Record Check (RRC).[36] The Census Day number is assumed to be equal to that of July 1st for the reason of simplicity. The annual rate of change between the two most recent RRC estimates is calculated for Canada. This rate is used to estimate the number of Canadians temporarily abroad on July 1 of the years in the current postcensal period.

Equation 6.12:
$$R^{TE} = \frac{1}{5}\left[\ln\left(\frac{^{RRC}TE_t}{^{RRC}TE_{(t-5)}}\right)\right]$$

Equation 6.13:
$$TE_{(t+1)} = {}^{RRC}TE_t \times e^{R^{TE}}$$

where

R^{TE} =   annual rate of change in the population of persons temporarily abroad;

$^{RRC}TE_t$ =   number of persons temporarily out of the country (as obtained from the RRC) on Census Day;

$TE_{(t+1)}$ =   number of persons temporarily out of the country at $(t + 1)$;

t =   July 1 of Census year.

Estimates are produced for the first day of each month, taking into account seasonal variations in the flows. The average between zero seasonal variation (i.e., constant net flow from month to month) and the same seasonal variation as for emigration of children is used. The estimates for each month are then distributed by province/territory on the basis of data from the most recent RRC.[37] Finally, the monthly net flows for each province and territory are determined by calculating the difference between the stock estimates from month to month.

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[36] The Reverse Record Check (RRC) is one of four Census coverage error measurement studies. For more information on the RRC, see Chapter 2 on Base Populations.

[37] Adjustments to the provincial distribution obtained from the Reverse Record Check are required since the RRC does not provide estimates for the territories. Also, due to the small numbers, the RRC temporary emigrants' proportion for the Atlantic provinces as a whole is used. Then, the estimate for the Atlantic provinces is distributed according to the proportional distribution of the total population for the four provinces.

Equation 6.14: $$\Delta TE_{(t,t+i)} = TE_{(t+i)} - TE_t$$

Postcensal estimates of persons living temporarily abroad are, in essence, projections. Since no other data source is available, these estimates are not changed until the completion of the next Census' RRC (i.e., approximately two years after the Census).

Estimates of Persons Living Temporarily Abroad, by Age, Sex and Marital Status

To obtain the estimates of temporary emigrants by age, sex and marital status, the same distributions as observed for permanent emigration are used.[38]

Total Emigration Component

The total emigration component reflects the net flows of permanent, returning and temporary emigrants and represents a net loss of population through emigration. It is calculated as:

Equation 6.15: $$E_{(t,t+i)} = PE_{(t,t+i)} - RE_{(t,t+i)} + \Delta TE_{(t,t+i)}$$

Equation 6.16: $$E_{(t,t+i)} = PE^{net}_{(t,t+i)} + \Delta TE_{(t,t+i)}$$

where

$E_{(t,t+i)}$ =   number of total emigrants over the period $(t, t + i)$;

$PE_{(t,t+i)}$ =   number of permanent emigrants over the period $(t, t + i)$;

$RE_{(t,t+i)}$ =   number of returning emigrants over the period $(t, t + i)$;

$PE^{net}_{(t,t+i)}$ =   net permanent emigrants (per Equation 6.11) over the period $(t, t + i)$;

$\Delta TE_{(t,t+i)}$ =   change in the number of temporary emigrants over the period $(t, t + i)$.

Preliminary Estimates

Final data for emigration estimates are not received until approximately two years after the reference period. As such, two reference periods $(t, t + 1)$ and $(t + 1, t + 2)$ elapse before final data are received for the first reference period $(t, t + 1)$.

For the period $(t, t + 1)$, preliminary estimates of child emigrants are produced using partial, but nearly final CTB data for the reference period. For each province and territory, the CTB coverage factor and the differential emigration propensity are calculated, as in Equation 6.1. The number of adults emigrating to the United States is assumed constant from the most recent final INS data. For

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[38] Although the Reverse Record Check provides age-sex data on temporary emigration, they are unreliable due to the large sampling variances at this level of detail.

adults emigrating to countries other than the United States, the same four-step procedure is used as for final emigration estimates (see Equations 6.4 to 6.7).

For the period $(t + 1, t + 2)$, preliminary estimates of emigration are produced as described for the period $(t, t + 1)$, assuming constant CTB numbers from $(t, t + 1)$ as well as those from INS. Though the same data from these two sources are used, the resulting estimates of emigration differ slightly, due to the change in the estimates of the population of children and adults over the two periods.

Previous Methods of Estimating Emigration

Prior to 1981, two sources of data were used to obtain the annual postcensal emigration estimates. The first source of data, still currently used, was the number of Canadian immigrants to the United States as reported by INS. The second data source was composed of estimates of the number of Canadians entering the United Kingdom to reside there. These estimates were obtained from the International Passenger Survey, which is a survey based on a sample of all passengers using the main sea and air routes between the United Kingdom and other countries.[39] Then, an assumed level of the number of emigrants moving from Canada to countries other than the United States and the United Kingdom was added to the data above. On the basis of Canadian census data, vital statistics, and immigration figures, it was estimated that about 48,000 persons emigrated from Canada to countries other than the United States and the United Kingdom each year (Statistics Canada (1978) and Statistics Canada (1979)).

The total number of emigrants obtained from the three data sources was distributed by province/territory based on data compiled by the United States Embassy on the number of immigration visas issued to residents of Canada.

For intercensal estimates of emigration, the residual method of estimation was used at the national level, which involved two steps:

(i) computation of the change in total population between two successive censuses; and
(ii) subtraction of the change accounted for by natural increase (births minus deaths) and immigration from the change in total population, the result which was assumed to be attributable to emigration.

This procedure can be expressed as follows:

Equation 6.17:
$$E_{(t-5,t)} = \left(C_t - C_{(t-5)} \right) - \left(B_{(t-5,t)} - D_{(t-5,t)} + I_{(t-5,t)} \right)$$

where

$E_{(t-5,t)}$ $\quad=\quad$ emigration for the period $(t - 5, t)$;

$C_t (C_{(t-5)})$ $\quad=\quad$ population counts in the census, in year t $(t - 5)$;

$B_t (B_{(t-5)})$ $\quad=\quad$ births for the period t $(t - 5)$;

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[39] For the purpose of this survey, any person who stated their intention of residing in the United Kingdom for a continuous period of at least 12 months was considered to be an immigrant.

$D_t (D_{(t-5)}) =$ deaths for the period t $(t - 5)$;

$I_t (I_{(t-5)}) =$ immigrants for the period t $(t - 5)$;

t =   last year in which a census was conducted.

The number of persons having immigrated to the United States or to the United Kingdom from Canada during the intercensal years was then subtracted from the estimate of total emigration obtained in the preceding step. This yielded an estimate of emigration from Canada to countries other than the United States and the United Kingdom (i.e., "other" emigration) for the intercensal periods. Next, these estimates of "other" emigration were converted into annual estimates on the basis of the distribution of immigration by year within the intercensal periods. The final step involved the addition of annual estimates of "other" emigration to the annual data on emigration from Canada to the United States and the United Kingdom to obtain annual estimates of emigration from Canada.

The annual estimates of emigration were then distributed by "probable" province of origin. For the years 1961-1962 through 1970-1971, this was done on the basis of the distribution of data compiled by the United States Embassy on the number of immigration visas issued to residents of Canada. For the intercensal periods 1971-1972 through 1975-1976 and 1976-1977 through 1980-1981, the distribution of emigration by province was obtained from the 1976 and 1981 Reverse Record Check, respectively.

The residual method of estimation for emigration is based on the difference between the population figures for two consecutive censuses and comparing it to the population growth attributable to the other components. This means that the residual method is affected by the difference in the undercoverage rates of the two consecutive censuses, and the reliability of the other component estimates. Influenced by the quality of other estimates, the use of the residual method only increases the uncertainty of the quality of the emigration estimate. Although the residual method is still used in some countries where better data are not available, it is no longer used by Statistics Canada for estimates of emigration.

From 1981 to 1993, data from Health and Welfare Canada's Family Allowance Program were used to estimate emigration. The Family Allowance Program was practically universal in that every child under the age of 18 years was entitled to a statutory monthly payment, provided the child was wholly or substantially supported by a parent who was either a Canadian citizen, a landed immigrant, or who was allowed to enter and remain in Canada for at least one year, and was subject to Canadian income taxation.

As is the case with the CTB program, direct information on emigrating adults was not available from Family Allowance data, hence the need for adjustment factors. The use of personal income tax data was introduced to obtain the child-adult migration ratio, as follows:

For each province and territory:

Equation 6.18: $$_j E = {}^{FA}_{j} E^{0-17} + \left(\frac{{}^{FA}_{j} E^{0-17}}{{}^{FA}_{j} P^{0-17}} \times {}_j f \times {}_j P^{18+} \right)$$

where

$_j E$ =   estimated number of emigrants from province/territory j;

$^{FA}_{\;j}\mathrm{E}^{0-17}$ =   number of emigrants from province j, aged 0 to 17 years, who were eligible for family allowance;

$^{FA}_{\;j}\mathrm{P}^{0-17}$ =   the number of children in province j who were eligible for family allowance;

$_{j}\mathrm{P}^{18+}$ =   adult population of province j obtained by subtracting the number of children eligible for the family allowance from the total estimated population;

$_{j}f$ =   annual adjustment factor for estimating adult emigration.

The annual adjustment factor ($_{j}f$) was calculated as follows:

Equation 6.19:

$$_{j}f = \frac{\left(\dfrac{^{TAX}_{\;j}\mathrm{E}^{18+}}{_{j}\mathrm{P}^{18+}}\right)}{\left(\dfrac{^{TAX}_{\;j}\mathrm{E}^{0-17}}{_{j}\mathrm{P}^{0-17}}\right)}$$

where

$^{TAX}_{\;j}\mathrm{E}^{18+}$ and $^{TAX}_{\;j}\mathrm{E}^{0-17}$ =   estimated numbers of adult and child emigrants from province j, based on tax files;

$_{j}\mathrm{P}^{18+}$ and $_{j}\mathrm{P}^{0-17}$ =   population estimate by Demography Division of adults and children for province j.

The provincial/territorial estimates of emigration were consolidated to obtain the national level estimate.

As previously mentioned, the Child Tax Benefit program replaced the Family Allowance Program in 1993. Due to a lack of reliable data during the first few years of the program's operation, estimates of the number of child emigrants from 1993-1994 to 1995-1996 were based on an extrapolation of the trend of the Family Allowances emigration estimates over the 1987-1988 to 1992-1993 period.[40]

Data Quality

Since Canada does not have a complete border registration, emigration is the most difficult component of population change to estimate with precision. While Canadian law requires complete registration of immigrants and non-permanent residents, it is not the case with emigration of Canadian citizens and landed immigrants. Therefore, it is necessary to use techniques of indirect estimation to obtain estimates of persons leaving the country on a permanent or temporary basis. Consequently, estimates of emigration have historically been of a lower quality than the estimates of the other components.

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[40] Further detail on the estimation methods used for the period covering 1993-1994 to 1995-1996 is provided in Morissette, D. (2001).

The quality of data prior to 1996, calculated using previous methods of estimation of emigration, can be assessed by comparing alternate methods of estimation, such as the Reverse Record Check (RRC).[41]   Table 6.1 shows that the estimates of emigrants by Demography Division for all periods prior to 1996 are lower than those obtained through the RRC. One should use caution, however, when comparing the two sets of estimates, as the measures are different. The RRC measures emigration as persons who leave during the period between censuses and who are still abroad at the end of the period, whereas the administrative data used by Demography Division reflect all departures during the period regardless of whether they returned. This means that the RRC would not count persons leaving the country and returning during this period. This suggests that Demography estimates understate emigration more than the comparison with the RRC shows. However, it is also reasonable to assume that the RRC includes some persons who have maintained residential ties with Canada and would be, therefore, not considered as permanently departed.

At this time, the quality of recent emigration estimates, including temporary emigration cannot be assessed since current methods were introduced after the 1996 Census and the results of the Reverse Record Check for the 2001 Census will be available in 2003. Though it is not currently possible to provide a quantitative analysis of the data quality of recent emigration estimates, a qualitative account of factors affecting the data quality is possible.

Table 6.1
Estimates of Emigrants from Canada, Demography Division and the Reverse Record Check: 1976-1981 to 1991-1996

Period	Demography Division	Reverse Record Check	Difference (Number)	Difference (%)
1976-1981	278,228	296,724	-18,496	-6.2
1981-1986	277,579	288,376	-10,797	-3.7
1986-1991	212,532	241,425	-28,893	-12.0
1991-1996	229,136	252,175 [1]	-23,039	-9.1

[1] The 1996 Reverse Record Check estimated 282,253 emigrants. However, some persons that were included in this number were identified at that time as non-permanent residents and were subsequently removed from the Reverse Record Check for the purpose of this analysis.
Source: Morissette, D. (2001)

Incomplete coverage of administrative data affects data quality. The data from INS are complete, however, they are subject to administrative delays in processing applications for permanent residence status in the United States. In the case of Child Tax Benefit data and income tax data, departures from Canada are identified from dates of departure on income tax claims or by notification to the CTB program. It is not known how many persons leave Canada without declaring their departure on their tax forms or to the CTB program.

Incomplete coverage necessitates the use of adjustment factors which introduces some uncertainty with the emigration estimates. The accuracy of the adjustment factor accounting for the non-universality of the CTB program depends especially on the estimation of the ratio between the emigration rate of children covered by the CTB compared with that of all children (i.e., the differential

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[41] For more detailed descriptions and evaluations of alternate methods tested and/or used for emigration estimates prior to 1993, refer to *Population Estimation Methods, Canada*, Catalogue no. 91-528E.

emigration propensity). CTB coverage rates vary considerably by province and territory. Table 6.2 shows that provincial/territorial coverage rates in July 1999 varied from a low of 69% in the Yukon to a high of 87% in Prince Edward Island.

Lower CTB coverage leads to higher uncertainty in the estimation of the non-covered population. Referring back to Equation 6.1, the inverse of the coverage rate (i.e., $\dfrac{P_{0-17}}{P_{0-17}^{CTB}}$) is used in the calculation of the number of child emigrants. Using Ontario as an example where the CTB coverage rate was 70.5% at July 1, 1999, the inverse is equal to 1.42. This means that in order to account for the non-covered population, a factor of 1.42 is applied to the number of child CTB emigrants and the differential emigration propensity, yielding the estimated number of child emigrants. A higher coverage rate decreases this factor, and thus decreases the uncertainty associated with the non-covered population estimate of emigration. The same conclusion applies to estimates of returning emigrant children.

The quality of estimates of persons living temporarily abroad depends on the validity of the assumption of consistency of the growth rate of the preceding 5-year period with that of the estimation period. The growth rate of persons living temporarily abroad for the postcensal period must remain stable from the intercensal period for the estimates to be accurate. Since estimates of persons living temporarily abroad uses RRC estimates, their quality also depends directly on the reliability of the RRC estimates, specifically the sample error[42] and classification error[43]. The higher the sample error, the higher the uncertainty of the estimates of persons living temporarily abroad. Depending on the net effect of misclassification in the RRC, it may result in either an underestimation or overestimation of persons living temporarily abroad.

Table 6.2
Child Tax Benefit Program Coverage Rates, Canada, Provinces and Territories, July 1999

| Province/territory | Estimate of Population | | Coverage (%)[1] |
| | Entitled to CTB | Aged 0-17 | |
	(in thousands)		
Canada	**5,391.1**	**7,143.3**	**75.5**
Newfoundland and Labrador	103.8	121.9	85.2
Prince Edward Island	29.5	34.0	86.7
Nova Scotia	173.9	212.6	81.8
New Brunswick	142.2	169.2	84.1
Quebec	1,294.2	1,618.4	80.0
Ontario	1,919.4	2,723.9	70.5
Manitoba	238.6	290.5	82.1
Saskatchewan	227.2	272.4	83.4
Alberta	565.1	762.5	74.1
British Columbia	672.0	904.6	74.3
Yukon	5.7	8.3	69.0
Northwest Territories[2]	19.5	25.1	77.9

[1] Coverage was calculated using unrounded data.

[2] Data for Nunavut are included with Northwest Territories.

Source: Canada Customs and Revenue Agency, Canada Child Tax Benefit data, July 1999; Demography Division, Statistics Canada

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[42] Sample error is the error attributed to studying a fraction of the population rather than carrying out a study of the complete population.

[43] Classification error is a type of error resulting from assigning units into improper categories.

The availability of estimates with respect to timing is also a measure of the quality of data. The longer the delay in availability of final data, the longer the requirement for alternative data sources for preliminary estimates. Since delays exist in terms of collection and processing of emigration data from available sources, the same numbers (or partial data) from the previous year from the CTB and INS are used for the production of the more timely preliminary estimates.[44] Data obtained from the CTB and tax files are considered final about 18 months after the end of the year to which they apply.[45] Additionally, final data are received from INS about two years after the reference year. As a result, emigration estimates are finalized approximately two years after the reference year.

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[44] Though the same numbers are used from these data sources in the production of preliminary estimates, the emigration estimates do change, as a result of the change in the population estimates, which are used in the calculation of adjustment factors and rates of emigration.

[45] This delay is due to the time that it takes to process income tax returns with departure dates. Not all recipients of the CTB notify Canada Customs and Revenue Agency at the time that they leave the country. Consequently, for some emigrants, their departure from Canada is only known through income tax returns received the following year.

Chapter 7

Interprovincial Migration

Movements of persons who change their usual place of residence, crossing provincial/territorial boundaries, are classified as interprovincial migration. Subprovincial migration also involves a change in usual place of residence, but these movements occur between smaller units of geography such as census divisions (CDs) or census metropolitan areas (CMAs). The term "internal migration" may refer to either of interprovincial or subprovincial migration, or both. This chapter focuses on the interprovincial migration component. For information on subprovincial migration, see Chapter 8 on Subprovincial Estimates of Population.

As with emigration, there is no legal provision for recording migration within Canada. As such, this component of population change requires estimation. Fortunately, it is typically easier to use administrative data in the estimation of migration within Canada than it is in the estimation of emigration. The methods used to prepare estimates of interprovincial migration will be discussed in this chapter.

Data Sources and Relevant Concepts

Canada Customs and Revenue Agency (CCRA) provides Statistics Canada with data from the Child Tax Benefit (CTB) program and personal income tax returns, which are used to estimate interprovincial migration. Preliminary estimates are derived monthly from CTB data, while final estimates are derived annually from personal income tax data.

Since the late 1960's, personal income tax records were used on an experimental basis for estimating migration. It was not until 1976 that they became the official data source for final migration estimates. Since the population covered by tax data is more comprehensive than that of the CTB, in general, interprovincial migration estimates based on tax data are considered to be of higher quality than those produced using data from the CTB. However, tax data are not timely enough for use in preliminary estimates. Small Area and Administrative Data Division (SAADD) of Statistics Canada receives tax data only after annual processing, compared to CTB data which are sent directly to Demography Division on a monthly basis. For a description of the tax files received and produced by SAADD, refer to Chapter 6 on Total Emigration.

Estimates of Interprovincial Migration, Canada, Provinces and Territories

Final Estimates of Interprovincial Migration

Final estimates of interprovincial migration are produced by SAADD, using personal income tax data. By comparing the place of residence at the time of filing, it is possible to identify for those persons who file returns for two consecutive years, those who move, their place of origin and their

destination. Files for two consecutive years are matched by social insurance number to determine persons who filed returns in both years. Address information is then compared and migrants are identified with the census division (CD) of origin and destination. Dependants of migrant tax-filers are obtained from SAADD's Family file, which makes use of a number of sources, including CCRA's CTB file and Statistics Canada's Vital Statistics database and Historical Family File[46].

Estimation is required for those migrants who do not file two consecutive personal tax returns. For this, an inflation factor is calculated. The underlying assumptions in this method are that:

i)   persons not filing two consecutive tax returns have the same propensity to migrate as those who do; and

ii)   these two populations migrate in the same direction.

First, a coverage rate of tax filers and their dependants is calculated for each census division by age[47] and sex groups by dividing SAADD's estimate of the population who are "at-risk"[48] of migrating by Demography Division's population estimate for the census division as follows:

Equation 7.1:

$$_{CD_j}\Re^{a,s} = \frac{_{CD_j}^{TAX}\mathrm{P}^{at-risk,a,s}}{_{CD_j}\mathrm{P}^{a,s}} \times 100$$

where

$_{CD_j}\Re^{a,s}$ =   rate of coverage of tax filers and their dependants, by census division, age group a and sex s;

$_{CD_j}^{TAX}\mathrm{P}^{at-risk,a,s}$ =   SAADD's at-risk population (including their dependants) in the census division, by age group a and sex s;

$_{CD_j}\mathrm{P}^{a,s}$ =   population estimate of census division produced by Demography Division, by age group a and sex s.

The inflation factors (equal to the inverse of the coverage rates) are then applied to migration flows identified from the "at-risk" population to produce final estimates of migration at the CD level by age group and sex.

Equation 7.2:

$$_{CD_j,CD_k}\mathrm{IM}^{a,s} = _{CD_j,CD_k}^{TAX}\mathrm{IM}^{a,s} \times \frac{1}{_{CD_j}\Re^{a,s}}$$

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[46] The Vital Statistics database is maintained by Health Statistics Division of Statistics Canada, which is a collaborative effort with federal and provincial/territorial departments and agencies responsible for the registration of vital events (i.e., births, deaths, marriages and divorces). The Historical Family file, updated annually by SAADD, consists of information of known family relationships obtained from tax returns.

[47] The following 5 broad age groups only are available from SAADD: 0-17, 18-24, 25-44, 45-64 and 65 years and over.

[48] The "at-risk" population refers to persons that are "at-risk" of migrating and is obtained by SAADD through the matching of social insurance numbers for two consecutive years of taxation data. This population consists of migrants and non-migrants that file in two consecutive years. The "at-risk" population also includes the non-filing dependants of the matched filers.

where

$_{CD_j,CD_k} \mathrm{IM}^{a,s}$ = estimate of the number of migrants from census division of origin j to census division of destination k, age group a and sex s;

$_{CD_j,CD_k}^{TAX} \mathrm{IM}^{a,s}$ = number of migrants from census division of origin j to census division of destination k according to SAADD, age group a and sex s;

$_{CD_j} \mathfrak{R}^{a,s}$ = rate of coverage of tax filers and their dependants, by census division of origin j, age group a and sex s.

Finally, the CD estimates are then aggregated to the provincial/territorial level, representing the final estimates of interprovincial migration by age group and sex.

Preliminary Estimates of Interprovincial Migration

Preliminary estimates of migration between provinces/territories are produced using CTB data, along with data from personal income tax records, processed by SAADD. Because the CTB program is not universal and does not provide direct information on the number of adult migrants, this estimation, like emigration, requires three adjustment factors to take into account:

(i) the partial coverage of the program (i.e., persons not entitled to the CTB);
(ii) the difference in the migration propensities between CTB-entitled and non-entitled subpopulations;
(iii) the number of adults migrating between provincial/territorial boundaries, based upon the relationship between the rate of migrating children to the rate of migrating adults.

Preliminary Estimates of Interprovincial Migrant Children

The CTB file sent to Demography Division by CCRA provides monthly information on the changes of usual residence involving provincial/territorial boundaries of entitled children and the total number of entitled children by province and territory. As mentioned, the CTB program is not universal, therefore the data are incomplete in terms of estimation of total child migrants and require adjustment.

The adjustment produces the number of children who would be included in the CTB program if it were universal, and involves two factors. The first factor, (i) above, reflects the CTB program's coverage: the ratio of the number of children, as estimated by Demography Division, to the number of children actually covered by the CTB program, for each month and province and territory. The second factor, (ii) above, estimates the migration propensity of children covered by the CTB compared with that of all children, for each province and territory, on an annual basis. Since the CTB entitlement is directly related to the level of family income, the adjustment factor reflects the relationship between a family's income and a family's propensity to migrate. This adjustment for migration propensities is calculated using tax data, processed by SAADD, identifying migrant families by comparing addresses on income tax returns for two consecutive years. The tax files also include information on persons receiving at least one CTB payment during the taxation year.

The formula for estimates of children migrating between provinces/territories is as follows:

Equation 7.3:

$$_{j,k}\mathrm{IM}^{0-17} = {}^{CTB}_{j,k}\mathrm{IM}^{0-17} \times \frac{1}{_j\Re} \times {}_jG$$

where

$_{j,k}\mathrm{IM}^{0-17}$ = number of migrant children from province/territory of origin j to destination province/territory k;

$^{CTB}_{j,k}\mathrm{IM}^{0-17}$ = migration of children according to CTB data by province/territory of origin j to destination province/territory k;

$_j\Re$ = coverage rate of CTB program for province/territory of origin j;

$_jG$ = adjustment factor for the migration rate of children by province/territory of origin j (see below).

The above calculation includes the adjustments for incomplete coverage of children entitled to the CTB (Equation 7.4) and for the differences in the propensities of CTB-entitled and non-entitled subpopulations to migrate (Equation 7.5).

The coverage rates are calculated on a monthly basis as follows:

For each province and territory j:

Equation 7.4:

$$^{CTB}_{j}\Re = \frac{^{CTB}_{j}\mathrm{P}^{0-17}}{_j\mathrm{P}^{0-17}}$$

where

$^{CTB}_{j}\Re^{0-17}$ = coverage rate of CTB program for province/territory j;

$^{CTB}_{j}\mathrm{P}^{0-17}$ = number of children aged 0-17 years entitled to receive the CTB in province/territory j;

$_j\mathrm{P}^{0-17}$ = population estimate by Demography Division of children aged 0-17 years in province/territory j.

The differential migration propensity is based on a set of $_jG$ factors. Using tax data, the $_jG$ factors are obtained by dividing the migration rates for all children by the migration rates for children entitled to the CTB, as follows:

For each province and territory j:

Equation 7.5:

$$_jG = \frac{\dfrac{^{TAX}_{j}\mathrm{IM}^{out,0-17}}{^{TAX}_{j}\mathrm{P}^{0-17}}}{\dfrac{^{CTB\_TAX}_{j}\mathrm{IM}^{out,0-17}}{^{CTB\_TAX}_{j}\mathrm{P}^{0-17}}} \quad \text{or}$$

$$_jG = \frac{^{TAX}_{\;j}\mathrm{IM}^{out,0-17}}{^{CTB\_TAX}_{\quad j}\mathrm{IM}^{out,0-17}} \times \frac{^{CTB\_TAX}_{\quad j}\mathrm{P}^{0-17}}{^{TAX}_{\;j}\mathrm{P}^{0-17}}$$

where

$_jG$	=	adjustment factor for the differential migration propensity by province/territory of origin j;
$^{TAX}_{\;j}\mathrm{IM}^{out,0-17}$	=	out-migration of all children from province/territory of origin j, according to tax data;
$^{CTB\_TAX}_{\quad j}\mathrm{IM}^{out,0-17}$	=	out-migration of CTB-entitled children from province/territory of origin j as modelled from tax data;
$^{CTB\_TAX}_{\quad j}\mathrm{P}^{0-17}$	=	CTB recipients in the population of the income tax file processed by SAADD;
$^{TAX}_{\;j}\mathrm{P}^{0-17}$	=	SAADD estimates based on income tax files.

The $_jG$ factor will equal one (1) if the migration rate of CTB-entitled children and the migration rate of all children are identical. Otherwise, the value of $_jG$ is greater (less) than one if the propensity to migrate of CTB-entitled children is less (greater) than that of all children.

Preliminary Estimates of Interprovincial Migrant Adults

The third factor in adjusting CTB data involves a calculation of adult migrants. Estimates for adults migrating between provincial/territorial boundaries are obtained through the calculation of F factors. The F factors, calculated from the most recent tax data, are equal to the ratio of the adult migration rate to the child migration rate, by province/territory of origin j and destination province/territory k, as follows:

For each province and territory of destination and origin:

Equation 7.6:
$$_{j,k}F_{(t-3,t)} = \frac{\left(\dfrac{^{TAX}_{\;j,k}\mathrm{IM}^{18+}_{(t-3,t-2)} + ^{TAX}_{\;j,k}\mathrm{IM}^{18+}_{(t-2,t-1)} + ^{TAX}_{\;j,k}\mathrm{IM}^{18+}_{(t-1,t)}}{_jP^{18+}_{(t-2)}} \right)}{\left(\dfrac{^{TAX}_{\;j,k}\mathrm{IM}^{0-17}_{(t-3,t-2)} + ^{TAX}_{\;j,k}\mathrm{IM}^{0-17}_{(t-2,t-1)} + ^{TAX}_{\;j,k}\mathrm{IM}^{0-17}_{(t-1,t)}}{_jP^{0-17}_{(t-2)}} \right)}$$

where

$_{j,k}F_{(t-3,t)}$	=	average adult estimation factor calculated over three migration years by province/territory of origin j and destination province/territory k;
$^{TAX}_{\;j,k}\mathrm{IM}^{18+}$	=	adult migration by province/territory of origin j and destination province/territory k, according to tax data for periods $(t - 3, t - 2)$, $(t - 2, t - 1)$, $(t - 1, t)$;
$_jP^{18+}_{(t-2)}$	=	adult population estimate by Demography Division for province/territory of origin j at time $(t - 2)$;

$_j\mathrm{P}_{(t-2)}^{0-17}$ = child population estimate by Demography Division for province/territory of origin j at time $(t-2)$;

$_{j,k}^{TAX}\mathrm{IM}^{0-17}$ = child migration by province/territory of origin j and destination province/territory k, according to tax data for periods $(t-3, t-2)$, $(t-2, t-1)$, $(t-1, t)$.

The $_{j,k}F$ factors are then applied against child migration rates (based on adjusted CTB data) to obtain estimates of adult interprovincial migration rates. These are multiplied by the provincial/territorial populations to obtain the estimates of the number of adults migrating between provincial/territorial borders, as follows:

For each province and territory:

Equation 7.7:
$$_{j,k}\mathrm{IM}^{18+} = \frac{_{j,k}\mathrm{IM}^{0-17}}{_j\mathrm{P}^{0-17}} \times _{j,k}F_{(t-3,t)} \times _j\mathrm{P}^{18+}$$

where

$_{j,k}\mathrm{IM}^{18+}$ = estimated number of adults migrating from province/territory of origin j to province/territory of destination k;

$\dfrac{_{j,k}\mathrm{IM}^{0-17}}{_j\mathrm{P}^{0-17}}$ = migration rate of children (estimates by origin j and destination k based on the adjusted CTB data);

$_{j,k}F_{(t-3,t)}$ = average adult estimation factor calculated over three migration years by origin j and destination k;

$_j\mathrm{P}^{18+}$ = population estimate of adults at origin j at the beginning of the period.

Finally, after the estimates of the total number of interprovincial migrant children and adults have been independently calculated by province/territory of origin and destination, the total interprovincial migration estimates are obtained by adding the interprovincial migrants of children and adults, as follows:

For each province and territory:

Equation 7.8:
$$_{j,k}\mathrm{IM} = _{j,k}\mathrm{IM}^{0-17} + _{j,k}\mathrm{IM}^{18+}$$

Interprovincial Migrant Population by Age, Sex and Marital Status

Final interprovincial migration estimates are available by age, sex and marital status, as well as, by origin and destination province/territory of migrant.

To estimate the number of interprovincial migrants by sex and age, the following steps are followed:

(i)   migration by sex and five-year age group cohorts is calculated using the number of migrants by province of origin and destination obtained from the one-year ago mobility question from the most recent census;

(ii)   the migration cohorts are then split into single-years of age using Sprague's multipliers;

(iii)   a percentage distribution by single years of age is calculated for each broad age-sex group (under 18, 18-24, 25-44, 45-64 and 65+ years), using the data obtained in step (ii);

(iv)   the distribution obtained in step (iii) (which remains constant for the five-year postcensal estimates) is applied to the interprovincial migration estimates by broad age group and sex, in order to disaggregate them into a distribution by single-years of age;

(v)   to eliminate inconsistencies from one age to another, the number of migrants by single-year of age is aggregated by five-year age groups, to which Sprague's multipliers are again applied;

(vi)   a final adjustment is made to ensure that the number of migrants obtained in step (v), aggregated to broad age groups, is identical to the numbers derived from the tax data. This process involves eliminating any discrepancy by distributing the difference equally to each single-year of age within broad age groups.

For each province and territory, the distributions of out-migrants by marital status for a given sex and age are derived from the most recent census data on mobility. These distributions are applied to the number of out-migrants by province/territory of destination, age and sex, as estimated above, to obtain the estimates of interprovincial migrants by marital status (Statistics Canada (1987)).

Preliminary interprovincial migration estimates are available only by age, sex and marital status at provincial/territorial level. The age and sex distributions of the most recent final estimates of interprovincial migration are applied to the preliminary estimates for provinces and territories.

Previous Methods of Estimation of Interprovincial Migration

Prior to 1993, information for producing preliminary estimates of interprovincial migration was obtained from Family Allowance data produced by CCRA (at that time called Revenue Canada). Family Allowance data were also used to produce final estimates of interprovincial migration until 1976. The Family Allowance program was practically universal in that every child under the age of 18 years was entitled to a statutory monthly payment, provided the child was wholly or substantially supported by a parent who was either a Canadian citizen, a landed immigrant, or who was allowed to enter and remain in Canada for at least one year, and was subject to Canadian income taxation. The Child Tax Benefit (CTB) replaced the Family Allowance Program in 1993.

During the 1956 to 1976 period, the preliminary and final estimates of internal migration were based on interprovincial migration of children obtained directly from data related to Family Allowance recipients, sent to Statistics Canada by Health and Welfare Canada. As with the CTB, notifications of changes in address formed the basis of the Family Allowance migration recording system. Child migration data were compiled by province of origin and destination. Since the Family Allowance files contained no information on adult migrants, the number of adults migrating between provinces and territories had to be estimated. The method used was similar to that described earlier for CTB-based estimates.[49]

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[49] For a more detailed description of the methods used for internal adult migration, see Statistics Canada (1987), pp. 43-68.

Since 1977, the final estimates of interprovincial migration are produced based on tax files using the methods described earlier.

Data Quality

The two data sources and methods used for the production of preliminary and final estimates of interprovincial migration have their advantages and disadvantages. Given the high motivation for filing a change of address as soon as a family moves, CTB data yield a fairly reliable estimate of the migration of CTB recipient children. These files do not, however, provide direct information about adult migrants and those children not in the CTB program, making recourse to another data source (i.e., tax data) necessary. The main advantage of the CTB data is its timeliness, enabling the production of reliable preliminary estimates, earlier than would be otherwise possible, since the availability of tax data is time-lagged.

Preliminary and final interprovincial migration estimates are compared in Table 7.1 (national level) and Table 7.2 (provincial/territorial level). For the 1993-1994 to 1999-2000 period, final estimates of interprovincial migration based on taxation data are systematically lower than preliminary estimates based on the CTB at the national level, the differences ranging from a low of 16% in 1997-1998 to a high of 32% in 1993-1994.

Table 7.1
Comparison of Preliminary and Final Estimates of the Total Number of Interprovincial Migrants, Canada, 1993-1994 to 1999-2000

Period (July 1 to June 30)	Type of Estimate		Ratio Preliminary/ Final
	Preliminary	Final	
1993-1994	380,588	289,391	1.32
1994-1995	370,627	285,464	1.30
1995-1996	360,618	291,770	1.24
1996-1997	353,149	292,857	1.21
1997-1998	358,830	309,234	1.16
1998-1999	333,408	276,930	1.20
1999-2000	340,093	285,817	1.19

Source: Demography Division, Statistics Canada

As Table 7.2 shows, the same holds true for both in- and out-migration for all provinces in 1995-1996 and 1999-2000 (with the exception of out-migration for Prince Edward Island and Northwest Territories), with final estimates lower than preliminary estimates by a substantial margin. For most provinces, the difference between preliminary and final estimates was greater for in-migration compared to out-migration.

One source of discrepancy between the two sets of data lies in their periodicity. Child Tax Benefit data are available monthly, whereas income tax data are collected on an annual basis. Estimates derived from monthly records are expected to exceed those derived from annual records since the monthly file is able to detect persons migrating more than once in a year (provided that the moves do not occur in the same month), while the annual file can record only one move.

Table 7.2
Comparison of Preliminary and Final Estimates of Interprovincial Migration Flows, Provinces and Territories, 1995-1996 and 1999-2000

Province/territory	Type of Estimate	1995-1996		1999-2000	
		Inflow	Outflow	Inflow	Outflow
Newfoundland and Labrador	Preliminary (P)	10,665	18,238	11,609	14,119
	Final (F)	7,005	14,441	8,400	12,663
	Ratio P/F	1.52	1.26	1.38	1.11
Prince Edward Island	P	3,482	2,602	3,361	2,382
	F	2,882	2,244	2,662	2,558
	Ratio P/F	1.21	1.16	1.26	0.93
Nova Scotia	P	20,301	21,194	18,650	17,985
	F	16,263	17,508	16,272	16,542
	Ratio P/F	1.25	1.21	1.15	1.09
New Brunswick	P	14,607	14,835	14,109	13,585
	F	11,770	12,139	11,286	12,469
	Ratio P/F	1.24	1.22	1.25	1.09
Quebec	P	28,090	41,307	25,033	41,376
	F	22,556	35,182	20,989	33,135
	Ratio P/F	1.25	1.17	1.19	1.25
Ontario	P	84,390	89,969	91,347	71,529
	F	69,059	71,881	78,903	56,534
	Ratio P/F	1.22	1.25	1.16	1.27
Manitoba	P	20,811	22,757	18,954	20,244
	F	15,075	18,641	14,075	17,531
	Ratio P/F	1.38	1.22	1.35	1.15
Saskatchewan	P	23,476	24,219	20,781	27,079
	F	17,411	19,572	14,556	22,503
	Ratio P/F	1.35	1.24	1.43	1.20
Alberta	P	66,931	61,192	72,685	60,892
	F	57,037	49,381	70,721	48,047
	Ratio P/F	1.17	1.24	1.03	1.27
British Columbia	P	81,141	57,681	57,866	65,019
	F	66,959	44,934	43,465	58,075
	Ratio P/F	1.21	1.28	1.33	1.12
Yukon	P	2,874	2,073	1,679	2,321
	F	2,203	1,639	1,267	1,958
	Ratio P/F	1.30	1.26	1.33	1.19
Northwest Territories[1]	P	3,850	4,551	2,921	2,570
	F	3,550	4,208	2,164	2,815
	Ratio P/F	1.08	1.08	1.35	0.91

[1] Data for Nunavut are included with the Northwest Territories.
Source: Demography Division, Statistics Canada

The difference in reference periods (i.e., monthly versus annual) does not have an impact on the annual net migration estimates. For instance, if a person moves from province A to province B, and subsequently from province B to province C, the net result is equal to a move from A to C. However, the comparison of net interprovincial migrants from CTB files and tax files, shown in Table 7.3, reveals significant discrepancies between the two sets, indicating that other factors must account for the differences. Note also, several negative ratios of preliminary to final net interprovincial migration (Prince Edward Island, 1996-1997; Nova Scotia, 1999-2000; New Brunswick, 1993-1994 and

1999-2000; Ontario 1994-1995 and 1996-1997; and Northwest Territories including Nunavut, 1998-1999 and 1999-2000). This occurs when preliminary estimates yield a gain of persons due to net interprovincial migration and final estimates yield a loss, or vice versa.

Table 7.3
Preliminary and Final Estimates of Net Interprovincial Migration, Provinces and Territories, 1993-1994 to 1999-2000[1]

Province/territory	Type of Estimate	1993-1994	1994-1995	1995-1996	1996-1997	1997-1998	1998-1999	1999-2000
Newfoundland and Labrador	Preliminary (P)	-4,508	-8,410	-7,573	-9,285	-11,434	-2,625	-2,510
	Final (F)	-4,952	-6,974	-7,436	-8,134	-9,490	-5,695	-4,263
	Ratio P/F	0.91	1.21	1.02	1.14	1.20	0.46	0.59
Prince Edward Island	P	636	875	880	-56	-851	166	979
	F	622	349	638	136	-416	193	104
	P/F	1.02	2.51	1.38	-0.41	2.05	0.86	9.41
Nova Scotia	P	-823	-2,817	-893	-143	-5,040	259	665
	F	-1,887	-2,741	-1,245	-1,648	-2,569	201	-270
	P/F	0.44	1.03	0.72	0.09	1.96	1.29	-2.46
New Brunswick	P	224	-833	-228	-1,911	-3,056	-931	524
	F	-671	-813	-369	-1,263	-3,192	-1,244	-1,183
	P/F	-0.33	1.02	0.62	1.51	0.96	0.75	-0.44
Quebec	P	-12,528	-15,284	-13,217	-16,625	-17,454	-15,682	-16,343
	F	-8,758	-8,947	-12,626	-17,436	-16,958	-13,065	-12,146
	P/F	1.43	1.71	1.05	0.95	1.03	1.20	1.35
Ontario	P	-11,064	4,602	-5,579	-4,820	6,662	16,962	19,818
	F	-9,420	-2,841	-2,822	1,977	9,231	16,706	22,369
	P/F	1.17	-1.62	1.98	-2.44	0.72	1.02	0.89
Manitoba	P	-4,646	-2,162	-1,946	-3,781	-5,383	-1,332	-1,290
	F	-4,614	-3,220	-3,566	-5,873	-5,276	-2,113	-3,456
	P/F	1.01	0.67	0.55	0.64	1.02	0.63	0.37
Saskatchewan	P	-2,940	-4,167	-743	-1,586	-3,367	-2,560	-6,298
	F	-5,431	-3,652	-2,161	-2,794	-1,940	-4,333	-7,947
	P/F	0.54	1.14	0.34	0.57	1.74	0.59	0.79
Alberta	P	-4,725	-4,078	5,739	24,714	46,787	31,064	11,793
	F	-1,630	-556	7,656	26,282	43,089	25,191	22,674
	P/F	2.90	7.33	0.75	0.94	1.09	1.23	0.52
British Columbia	P	41,621	32,412	23,460	14,287	-4,230	-21,103	-7,153
	F	37,871	29,291	22,025	9,880	-10,029	-14,484	-14,610
	P/F	1.10	1.11	1.07	1.45	0.42	1.46	0.49
Yukon	P	-876	94	801	-132	-929	-1,272	-642
	F	-1,094	269	564	-54	-1,024	-747	-691
	P/F	0.80	0.35	1.42	2.44	0.91	1.70	0.93
Northwest Territories[2]	P	-371	-232	-701	-662	-1,705	575	457
	F	-36	-165	-658	-1,073	-1,426	-610	-581
	P/F	10.31	1.41	1.30	0.95	1.30	-0.94	-0.79

[1] As the total number of migrants leaving provinces and territories has to balance with the total number of migrants entering provinces and territories, the net interprovincial migration for Canada is equal to zero.

[2] Preliminary estimates were not available for Nunavut for all years. As such, the calculation of the preliminary/final estimates ratio includes estimates for Nunavut in the Northwest Territories estimates.

Source: Demography Division, Statistics Canada

These discrepancies may, in part, result from the following situation: A person who moves from province A to province B and then emigrates or dies in the same year, will be recorded in a monthly-based system as a migrant from A to B. In an annual record system, however, the interprovincial migration may not have been recorded at all. These types of events are probably infrequent, however,

and would account for little of the difference between migration levels generated by monthly and annual recording systems.

Since the preliminary and final net migration estimates should theoretically be identical, the difference in migration levels (in-, out- and net) between the two sets of data is largely related to the adjustments for incomplete coverage and the assumptions about propensity of covered versus uncovered persons to migrate.

As is the case with emigration estimates, the quality of interprovincial migration estimates depends primarily on the coverage rates for the Child Tax Benefit and personal income tax returns. Since neither has perfect coverage, adjustments are necessary, which introduces some uncertainty with the interprovincial migration estimates.[50]

As Table 7.4 shows, the population coverage provided by the taxation files is more comprehensive and representative than that of the CTB. Overall, tax coverage rates for children ranged between 91% to 95% during the 1993-1994 to 1998-1999 period, while CTB coverage ranged between 75% and 81%, though the rates vary by province and territory. Among the provinces, the difference between tax and CTB coverage rates for children is most noticeable in Ontario for all years presented, where coverage rates were lower than the overall rates (i.e., Canada) from both data sources. Both sets of coverage rates were consistently highest in the Atlantic provinces and Manitoba and Saskatchewan. In general, the difference between the two coverage rates for these provinces was lower than the others.

Despite the higher coverage of children obtained from tax data, the accuracy of the final estimates of interprovincial migration produced using this data source depends on the correctness of the two assumptions when inflating data (i.e., persons not filing two consecutive tax returns have the same propensity to migrate as those who do, and these two populations migrate in the same direction).

Although tax coverage rates are higher than those of CTB, these rates not only vary by province and territory, but also by age. As Table 7.5 indicates, the coverage of SAADD's at-risk population is highest for children under 18 years for all provinces/territories, most greater than 90%. Generally speaking, coverage is lowest for the 65 years and over age group. Coverage for the other age groups falls between the youngest and oldest age groups. Lower coverage implies higher inflation factors, thus less certainty with the estimates.

In addition to better coverage than the CTB, personal income tax records also provide migration data at the provincial/territorial, and census division levels, by broad age group and sex, whereas the CTB data do not entirely provide this information. These factors make tax data as the preferable source for final estimates of interprovincial migration.

Changing regional economic conditions are often the motivation for migratory movements. For persons with intentions to migrate, regions with strong economies are desirable areas of relocation, whereas regions with slow-growing or declining economies often experience negative net migration (Statistics Canada (2001d)). Since interprovincial migration has more of an impact than natural increase (births minus deaths) on the changes in and differences between regional population growth rates, it is important for policy makers and planners to have the most reliable migration data (He, J. and Michalowski, M. (2002)). As such, research continues in the area of methods of estimation of

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[50] For a description of the data quality issues surrounding the use of these adjustment factors, refer to the Data Quality section in Chapter 6 on Total Emigration.

interprovincial migration for both preliminary and final estimates, so as to produce the most accurate estimates in a timely manner.

Table 7.4
Personal Income Tax and Child Tax Benefit Coverage Rates for Children (0-17 years old), Canada, Provinces and Territories, 1993-1994 to 1998-1999

Province/territory	1993-1994	1994-1995	1995-1996	1996-1997	1997-1998	1998-1999
Canada						
Population of 0-17 (in thousands)	**7,100.2**	**7,176.6**	**7,174.9**	**7,205.5**	**7,214.9**	**7,214.0**
Tax coverage (%)	**95.2**	**92.6**	**92.3**	**91.4**	**91.1**	**90.8**
CTB coverage (%)	**80.7**	**80.9**	**78.7**	**78.0**	**78.8**	**75.3**
Difference (%)	**14.5**	**11.7**	**13.6**	**13.4**	**12.3**	**15.5**
Newfoundland and Labrador						
Population of 0-17 (in thousands)	154.1	153.8	142.7	138.4	132.3	125.9
Tax coverage (%)	100.7	98.2	97.5	97.0	96.7	96.2
CTB coverage (%)	88.7	86.3	87.6	84.9	87.2	84.8
Difference (%)	12.0	11.9	9.9	12.1	9.5	11.4
Prince Edward Island						
Population of 0-17 (in thousands)	35.1	35.3	35.3	35.2	34.6	34.4
Tax coverage (%)	100.4	98.6	98.7	97.9	97.7	98.1
CTB coverage (%)	91.7	90.9	86.3	88.4	89.7	86.2
Difference (%)	8.7	7.7	12.4	9.5	8.0	11.9
Nova Scotia						
Population of 0-17 (in thousands)	223.9	225.0	221.9	221.4	219.2	215.9
Tax coverage (%)	97.7	95.5	94.3	93.8	93.0	92.3
CTB coverage (%)	87.6	87.0	84.6	84.4	85.2	82.1
Difference (%)	10.1	8.5	9.7	9.4	7.8	10.2
New Brunswick						
Population of 0-17 (in thousands)	185.1	185.8	180.4	178.4	175.0	171.3
Tax coverage (%)	101.2	99.3	98.5	98.2	97.5	97.1
CTB coverage (%)	89.1	87.8	86.6	85.7	87.0	84.3
Difference (%)	12.1	11.5	11.9	12.5	10.5	12.8
Quebec						
Population of 0-17 (in thousands)	1,709.7	1,721.4	1,701.7	1,692.7	1,680.6	1,648.0
Tax coverage (%)	96.3	94.1	94.0	93.9	93.6	93.7
CTB coverage (%)	83.4	82.8	81.2	81.0	81.6	80.0
Difference (%)	12.9	11.3	12.8	12.9	12.0	13.7
Ontario						
Population of 0-17 (in thousands)	2,610.3	2,644.4	2,665.0	2,691.6	2,715.0	2,734.1
Tax coverage (%)	93.2	90.2	89.8	88.9	88.4	88.2
CTB coverage (%)	75.5	76.5	74.6	73.6	74.5	70.3
Difference (%)	17.7	13.7	15.2	15.3	13.9	17.9
Manitoba						
Population of 0-17 (in thousands)	292.5	293.5	293.5	293.9	292.4	293.5
Tax coverage (%)	97.5	96.1	95.8	95.1	94.8	94.5
CTB coverage (%)	87.4	87.4	86.3	85.1	85.6	82.4
Difference (%)	10.1	8.7	9.5	10.0	9.2	12.1
Saskatchewan						
Population of 0-17 (in thousands)	283.2	284.2	281.2	280.7	277.3	276.0
Tax coverage (%)	100.8	98.1	97.7	97.1	97.9	97.9
CTB coverage (%)	89.0	88.8	87.3	86.2	86.5	83.0
Difference (%)	11.8	9.3	10.4	10.9	11.4	14.9
Alberta						
Population of 0-17 (in thousands)	733.6	740.4	739.7	745.2	750.3	763.0
Tax coverage (%)	95.4	93.0	92.1	90.8	90.4	89.9
CTB coverage (%)	81.7	82.0	79.7	78.5	79.0	73.9
Difference (%)	13.7	11.0	12.4	12.3	11.4	16.0
British Columbia						
Population of 0-17 (in thousands)	840.0	859.9	880.5	894.5	904.6	918.7
Tax coverage (%)	93.3	90.5	90.9	89.1	88.9	87.9
CTB coverage (%)	80.1	80.2	75.8	76.1	77.1	73.6
Difference (%)	13.2	10.3	15.1	13.0	11.8	14.3
Yukon						
Population of 0-17 (in thousands)	9.0	8.8	8.5	8.8	8.5	8.4
Tax coverage (%)	91.8	92.1	92.6	90.7	89.6	87.4
CTB coverage (%)	72.0	72.0	71.4	71.6	72.9	69.2
Difference (%)	19.8	20.1	21.2	19.1	16.7	18.2

Table 7.4
Personal Income Tax and Child Tax Benefit Coverage Rates for Children (0-17 years old), Canada, Provinces and Territories, 1993-1994 to 1998-1999 (concluded)

Province/territory	1993-1994	1994-1995	1995-1996	1996-1997	1997-1998	1998-1999
Northwest Territories[1]						
Population of 0-17 (in thousands)	23.8	24.0	24.4	24.7	25.0	24.8
Tax coverage (%)	92.9	92.1	91.8	90.0	91.7	91.7
CTB coverage (%)	74.9	75.2	72.6	70.8	71.6	70.7
Difference (%)	18.0	16.9	19.2	19.2	20.1	21.0

[1] Data for the Northwest Territories include data for Nunavut.
Source: Demography Division and Small Area and Administrative Data Division, Statistics Canada

Table 7.5
Coverage Rates (%) of the "at Risk to Migrate" Population, by Age Group, Canada, Provinces and Territories, 1994-1995 to 1999-2000

Province/territory	Period (July 1 to June 30)	Age group (years)					
		<18	18-24	25-44	45-64	>65	Total
Canada	**1994-1995**	**92.6**	**86.3**	**86.8**	**87.9**	**83.7**	**88.0**
	1995-1996	**92.3**	**86.0**	**85.9**	**87.4**	**84.3**	**87.6**
	1996-1997	**91.4**	**89.9**	**86.4**	**87.7**	**86.1**	**88.2**
	1997-1998	**91.1**	**84.9**	**85.4**	**87.6**	**86.6**	**87.3**
	1998-1999	**90.8**	**84.7**	**84.4**	**87.1**	**87.1**	**86.9**
	1999-2000	**93.1**	**84.4**	**84.8**	**87.2**	**87.5**	**87.6**
Newfoundland and Labrador	1994-1995	98.2	92.8	92.5	90.8	85.3	92.9
	1995-1996	97.5	92.3	91.5	90.0	86.4	92.3
	1996-1997	97.0	101.8	93.4	90.9	87.1	94.0
	1997-1998	96.7	93.5	92.4	90.7	87.1	92.6
	1998-1999	96.2	93.5	91.2	90.7	87.9	92.1
	1999-2000	97.1	92.6	90.9	90.7	88.6	92.2
Prince Edward Island	1994-1995	98.6	94.4	93.6	91.2	81.4	93.0
	1995-1996	98.7	94.6	93.0	90.8	81.3	92.7
	1996-1997	97.9	103.5	93.5	91.1	83.4	93.8
	1997-1998	97.7	95.4	92.9	91.4	84.0	92.9
	1998-1999	98.1	94.2	91.8	91.7	84.9	92.7
	1999-2000	99.4	93.8	91.5	91.5	87.1	93.1
Nova Scotia	1994-1995	95.5	89.2	89.9	89.6	82.6	90.2
	1995-1996	94.3	88.8	88.5	89.0	83.8	89.4
	1996-1997	93.8	95.1	89.0	89.2	84.6	90.2
	1997-1998	93.0	87.9	87.8	88.7	85.2	88.9
	1998-1999	92.3	87.0	86.0	88.1	86.3	88.1
	1999-2000	94.1	86.2	86.2	88.0	87.6	88.6
New Brunswick	1994-1995	99.3	92.3	93.1	90.9	83.4	92.9
	1995-1996	98.5	92.3	92.3	90.7	84.4	92.5
	1996-1997	98.2	100.7	93.1	91.1	86.1	93.8
	1997-1998	97.5	93.2	92.2	90.9	86.4	92.5
	1998-1999	97.1	92.5	90.7	90.6	87.5	91.9
	1999-2000	98.3	91.7	90.7	90.8	88.8	92.3
Quebec	1994-1995	94.1	87.0	88.5	88.3	83.4	89.0
	1995-1996	94.0	86.1	87.6	87.5	83.7	88.4
	1996-1997	93.9	90.6	88.6	88.3	86.3	89.7
	1997-1998	93.6	86.1	87.9	88.6	86.9	89.0
	1998-1999	93.7	86.7	87.1	88.2	87.4	88.8
	1999-2000	94.4	86.9	86.7	88.2	88.1	88.9

Table 7.5
Coverage Rates (%) of the "at Risk to Migrate" Population, by Age Group, Canada, Provinces and Territories, 1994-1995 to 1999-2000 (concluded)

Province/territory	Period (July 1 to June 30)	<18	18-24	25-44	45-64	>65	Total
				Age group (years)			
Ontario	1994-1995	90.2	85.9	85.0	87.5	84.1	86.8
	1995-1996	89.8	86.0	84.1	86.9	84.8	86.3
	1996-1997	88.9	89.3	85.2	87.4	86.7	87.1
	1997-1998	88.4	84.4	83.9	87.0	87.0	86.1
	1998-1999	88.2	83.7	83.0	86.5	87.4	85.6
	1999-2000	91.6	83.5	83.9	86.8	87.5	86.8
Manitoba	1994-1995	96.1	92.6	90.0	91.3	87.1	91.7
	1995-1996	95.8	92.1	89.0	90.7	87.2	91.2
	1996-1997	95.1	96.8	89.2	90.3	88.1	91.5
	1997-1998	94.8	91.6	87.9	89.9	87.8	90.4
	1998-1999	94.5	91.0	86.9	89.4	88.2	89.9
	1999-2000	95.9	90.7	87.0	89.4	88.4	90.3
Saskatchewan	1994-1995	98.1	89.2	90.4	90.5	84.9	91.6
	1995-1996	97.7	88.5	89.5	90.1	85.7	91.2
	1996-1997	97.1	92.7	89.2	90.1	86.2	91.5
	1997-1998	97.9	87.2	88.6	89.9	86.6	91.0
	1998-1999	97.9	87.7	87.8	89.6	87.1	90.7
	1999-2000	98.9	87.3	87.5	89.3	87.6	90.9
Alberta	1994-1995	93.0	86.0	86.6	88.2	84.1	88.3
	1995-1996	92.1	85.9	85.3	87.3	84.7	87.5
	1996-1997	90.8	88.4	84.8	87.3	86.8	87.4
	1997-1998	90.4	83.9	84.0	87.0	87.3	86.6
	1998-1999	89.9	84.2	83.4	86.7	87.9	86.3
	1999-2000	92.5	84.0	84.4	86.9	88.2	87.3
British Columbia	1994-1995	90.5	79.7	83.8	85.3	81.6	85.0
	1995-1996	90.9	80.0	83.7	85.2	82.2	85.2
	1996-1997	89.1	83.0	82.3	84.9	83.9	84.7
	1997-1998	88.9	78.7	81.6	85.3	85.2	84.3
	1998-1999	87.9	77.8	80.4	84.2	85.1	83.3
	1999-2000	91.0	76.8	80.5	84.1	85.4	84.0
Yukon	1994-1995	92.1	80.1	86.8	80.9	70.0	85.8
	1995-1996	92.6	80.5	86.0	81.5	74.2	86.0
	1996-1997	90.7	82.5	83.3	81.2	78.7	84.6
	1997-1998	89.6	78.4	81.8	80.3	80.4	83.2
	1998-1999	87.4	76.9	80.6	79.1	82.6	81.9
	1999-2000	94.1	79.7	84.0	80.0	86.5	85.5
Northwest Territories[1]	1994-1995	92.1	78.9	83.6	82.8	71.5	85.8
	1995-1996	91.8	78.3	84.2	85.0	70.6	86.1
	1996-1997	90.0	82.9	81.8	81.0	70.6	84.5
	1997-1998	91.7	76.6	81.8	81.7	74.4	84.6
	1998-1999	91.7	77.4	82.6	81.0	75.4	84.9
	1999-2000	93.5	78.8	85.0	82.9	78.0	86.9

[1] Data for the Northwest Territories include data for Nunavut.
Source: Small Area and Admistrative Data Division and Demography Division, Statistics Canada

Chapter 8

Subprovincial Estimates of Population

In addition to estimates at the national and provincial/territorial levels, population estimates are produced for subprovincial areas. Population estimates are readily available for census divisions and census metropolitan areas. Custom requests for estimates at other levels of geography (e.g., census subdivisions, health regions, economic regions) are also available.

This chapter discusses the estimation methods used for the production of postcensal and intercensal estimates of population for CDs and CMAs.

Data Sources and Relevant Concepts

A *census division* (CD) refers to the general term applied to geographic areas established by provincial law, which are intermediate geographic areas between census subdivisions[51] and the province or territory. For example, divisions, counties, regional districts, regional municipalities and seven other types of geographic areas are made up of groups of census subdivisions. Provincial law does not provide for these administrative geographic areas in Newfoundland and Labrador, Manitoba, Saskatchewan and Alberta. Consequently, census divisions have been created by Statistics Canada in co-operation with these provinces.

The general concept of a *census metropolitan area* (CMA) is one of a very large urban area, together with adjacent urban and rural areas which have a high degree of economic and social integration with that urban area. A census metropolitan area is delineated around an urban area (called the "urbanized core") and has a population of at least 100,000 (based on census counts). Once an area becomes a CMA, it is retained in the program even if its population subsequently declines below 100,000.

Like the provincial and territorial estimates, postcensal estimates at the CD and CMA levels are produced according to three time-frames of availability: preliminary, updated, and final estimates. For some components (e.g., births and deaths) the data sources used for provincial/territorial estimates of population provide data at CD and CMA levels, whereas other components must use a combination of different data sources for this level of estimation (e.g., immigration). The data source(s) used for each component is provided in the following section.

Postcensal Population Estimates of Subprovincial Areas

Like provincial/territorial level estimates of population, subprovincial estimates of population are produced using the component method. However, the use of the component method for preliminary

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[51] see Glossary for definition.

estimates at subprovincial levels is quite new, commencing with the 2001 series. Prior to this, two other methods were used (during different timeframes) - the rate of growth method (used for preliminary estimates covering 1998 to 2001) and the regression-nested model (used prior to 1998). These three methods used in the calculation of postcensal estimates for CDs and CMAs are all described in this chapter.

Final and Updated Estimates of Population of Subprovincial Areas

As mentioned, CD and CMA final and updated estimates of population are obtained using the component approach. However, the following details differ slightly from the provincial/territorial approach:

(i)   the adjustment to the base population for net census undercoverage is done by applying the provincial and territorial rates by single year of age and sex[52];

(ii)   since CD and CMA boundaries do not remain stable over time, component data are adjusted to respect the boundaries defined in the most recent census. This ensures a stable base population for all estimates; and

(iii)   in the estimation of migration, an additional component, subprovincial migration, (i.e., migration within provinces/territories and across subprovincial areas) is necessary. Subprovincial migration is discussed later in this chapter.

Prior to generating the population estimates, the total provincial/territorial population counts and the components for CDs and CMAs are adjusted, if necessary, to assure consistency between the two sets of figures. To adjust these data, two adjustment procedures are used: proration and two-way raking[53]. Proration requires that the difference between the sum of subprovincial areas and the total population for a province or territory be distributed proportionally across subprovincial areas. Two-way raking is an iterative procedure whereby differences in population are alternatively adjusted to ensure consistency between:

(i)   the sum of population totals for subprovincial areas and provincial and territorial population totals; and

(ii)   the sum across subprovincial areas for specific age and sex categories and the provincial and territorial population by age and sex (Statistics Canada (2001a).

The component method used in estimating final and updated total subprovincial populations is expressed as follows:

For every subprovincial area:

Equation 8.1: $P_{(t+i)} = P_t + B_{(t,t+i)} - D_{(t,t+i)} + I_{(t,t+i)} - E_{(t,t+i)} + \Delta NPR_{(t,t+i)} + IM^{net}_{(t,t+i)}$

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[52] For more information on these adjustments, see Chapter 2 on Base Populations.

[53] Two-way raking has also alternatively been referred to as the "Deming method" and the "method of iterative proportions" in the literature. Shryock, H.S., J.S. Siegel and Associates. *Studies in Population: The Methods and Materials in Demography*. Orlando, Florida, Academic Press Inc, 1976. Pp 542-544.

where

$P_{(t+i)}$	=	estimate of population for the subprovincial area at time $(t + i)$;
$\mathbf{P}_t$	=	base population for the subprovincial area at time t (most recent census adjusted for net undercount);
$B_{(t,t+i)}$	=	number of births between time t and $(t + i)$;
$D_{(t,t+i)}$	=	number of deaths between time t and $(t + i)$;
$I_{(t,t+i)}$	=	number of immigrants between time t and $(t + i)$;
$E_{(t,t+i)}$	=	number of emigrants, returning emigrants, and persons living temporarily abroad, between time t and $(t + i)$;
$\Delta NPR_{(t,t+1)}$	=	change in the number of non-permanent residents at time t and $(t + i)$;
$IM^{net}_{(t,t+i)}$	=	net internal migration (interprovincial and intraprovincial) between time t and $(t + i)$;
$(t, t + i)$	=	interval between the date of the base population (t = Census year) and the reference date of the estimate.

Since data for births and deaths are not as readily available for CMAs as they are for CDs, conversion factors are applied to these data available for CDs to derive these components for CMAs.

Though CDs and CMAs are both comprised of CSDs, there may be overlap between the two. For example, as illustrated in the diagram below, CMA #1 is comprised of CSDs #2 and #3 from CD #1 as well as CSDs #3, #4, and #5 from CD #2. The relative proportion of the total population of CD #1 is calculated for CSDs 2 and 3. The same calculation is performed for CSDs 3, 4 and 5 from CD #2. This yields the conversion factors. The CMA-CSD data are then adjusted to correspond to the CD-CMA data, using the calculated proportions. The derived CMA totals are then used to bring forward the adjusted CMA data by age and sex to July 1.
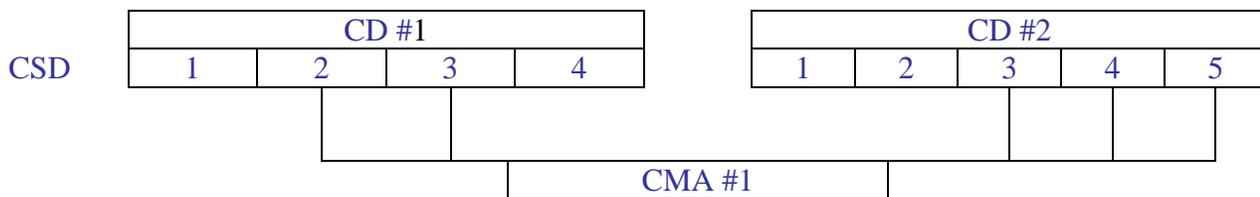
Final Estimates of Components of Subprovincial Areas

Births and Deaths

In addition to the national and provincial/territorial data on births and deaths (Chapter 3), data are also available for CDs, and CMAs from the Vital Statistics database maintained by Health Statistics Division of Statistics Canada.

Immigration

The distribution of the number of immigrants by CD and CMA cannot be obtained from the CIC files as with the provincial/territorial level estimates, because the geographic coding is specific to CIC and is not directly convertible to the coding used by Statistics Canada. Instead, the provincial/territorial estimates of the number of immigrants by sex and broad age group are distributed by CD and CMA using counts derived from Canada Customs and Revenue Agency (CCRA), as processed by Small Area and Administrative Data Division (SAADD) of Statistics Canada.

SAADD identifies immigrants through the use of personal income tax records. Persons who indicated on their tax form that they were living outside of Canada in the previous tax year may be either immigrants or returning emigrants (i.e., Canadian citizens who return to the country after having emigrated). The first step is the identification of returning emigrants, for which there are two methods. First, Social Insurance Numbers (SINs) of tax filers who indicated that they were living outside of Canada in the previous tax year are compared with historical tax files of previous filers who left Canada. If there is a match, then the person is a returning emigrant. The second method of identifying returning emigrants involves the comparison of the taxfilers' SINs to the highest SIN issued in each province/territory two years prior to the current tax year. If the taxfiler's SIN is lower than the highest SIN, then the filer is considered a returning emigrant. In the second step, those individuals not identified as returning emigrants by either of the two methods described are considered immigrants. The distribution of SAADD's estimates of immigrants by CD and CMA is used to distribute Demography Division's provincial/territorial immigrant estimates.

Non-permanent Residents

As is the case with immigrants, since different geographical classification systems are used by CIC and Statistics Canada[54], direct data on non-permanent residents are available only at the provincial/territorial level. Therefore, estimations must be made for subprovincial estimates of non-permanent residents. The most recent census distributions for non-permanent residents at the CD and CMA levels are used to produce the estimates for the total CD and CMA populations as well as the distribution by age and sex.

Total Emigration

The provincial and territorial estimates of the number of permanent and returning emigrants by sex and broad age group are distributed by CD and CMA based on the distribution obtained from CCRA's personal income tax files, as processed by SAADD. The counts within each broad age group are broken down by single year of age using the appropriate provincial or territorial distributions. The number of persons living temporarily abroad (and their sex and age) are distributed by CD and CMA according to the distribution of emigrants.

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[54] In an attempt to improve estimates at subprovincial levels, considerations have been made for CIC to adapt their administrative system to use Statistics Canada's geographical codes.

Subprovincial migration

The number of subprovincial migrants by CD and CMA and the distribution by sex and broad age group are drawn directly from SAADD's income tax files. As described in Chapter 7, migrants are identified by comparing address information for persons filing tax returns for two consecutive years. To account for persons not filing two consecutive tax returns, an inflation factor is applied to the migration flows produced by SAADD, at the CD level, by sex and broad age groups. For further information on the methods used for final estimates of subprovincial migration, refer to Chapter 7, since the methods are the same as those used to obtain interprovincial migration.

Final and Updated Subprovincial Population Estimates by Age and Sex

The estimates of total population by age and sex are prepared using the *cohort-component method*, where the population is aged from year to year and the components are tabulated according to age and sex cohorts. [55]

Preliminary Estimates of Population of Subprovincial Areas

As mentioned earlier, the component method was introduced for the preliminary estimation of population at subprovincial levels in 2001. Preliminary estimates at the provincial/territorial level, produced using the component method, serve as the starting point.

The preliminary provincial/territorial estimates for births and deaths are distributed by CD and CMA using the most recent final distributions of births and deaths by CD and CMA that are available.

Preliminary provincial/territorial level estimates of interprovincial migration and all international migration components (i.e., immigration, non-permanent residents and total emigration) are distributed by CD and CMA based on the most recent final distributions available, using the same sources of data as final and updated estimates, described earlier in this chapter.

Finally, in the case of preliminary estimates of subprovincial migration, the same level of migration from the previous period is assumed.

Preliminary Estimates of Population of Subprovincial Areas by Age and Sex

The preliminary subprovincial population estimates are disaggregated by age and sex using the most recent final distributions by CD and CMA available. To ensure consistency the subprovincial estimates are controlled to the corresponding provincial and territorial figures.

Special Cases: Quebec and British Columbia

Population estimates for CDs and CMAs for Quebec and British Columbia are prepared by their respective statistical agencies. The Institut de la statistique du Québec (ISQ) estimates are based on

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[55] See Chapter 9 for further details of the cohort-component approach.

statistics derived from the Registration File for insured people of the Régie de l'assurance maladie du Québec. BC STATS estimates are produced using a regression model based on residential electrical meters data and Old Age Security data as symptomatic indicators. These estimates are controlled to Demography Division's, Statistics Canada, provincial estimates for the population of Quebec and British Columbia. These estimates, together with CD and CMA estimates prepared by Demography Division for the other provinces and territories, are then disseminated by Statistics Canada.

Previous Methods Used for Preliminary Subprovincial Population Estimates

For the 1998-1999 to 2000-2001 periods, population estimates at CD and CMA levels were produced using the rate of growth method. The total population for each subprovincial area was calculated by assuming a continuation of the geometric growth rate as calculated over the previous two-year period, requiring the population at $(t - 1)$ and $(t - 3)$, as follows:

Equation 8.2:
$$_{CD(CMA)}\mathrm{R}_{(t-3,\ t-1)} = \sqrt[2]{\frac{_{CD(CMA)}\mathrm{P}_{(t-1)}}{_{CD(CMA)}\mathrm{P}_{(t-3)}}} - 1$$

where

$_{CD(CMA)}\mathrm{R}_{(t-3,\ t-1)}$ = the annual rate of population growth for a particular CD (or CMA) during the two-year period $(t - 3, t - 1)$;

$_{CD(CMA)}\mathrm{P}_{(t-1)},\ _{(t-3)}$ = population estimate for a particular CD (or CMA) at $(t - 1)$ and $(t - 3)$.

The population at $(t - 3)$ was required because the population growth from the two previous years implies the growth between the two periods $(t - 2, t - 1)$ and $(t - 3, t - 2)$, which can also be expressed as growth between $(t - 3, t - 1)$. Using the diagram below to illustrate, the total CD population estimates for July 1, 2000 were obtained using the growth between July 1, 1997 and July 1, 1999 at the CD level.

Total growth $(t - 3, t - 1)$			
Growth $(t - 3, t - 2)$	Growth $(t - 2, t - 1)$		Reference date of estimate
Population July 1, 1997 $t - 3$	Population July 1, 1998 $t - 2$	Population July 1, 1999 $t - 1$	Population July 1, 2000 t
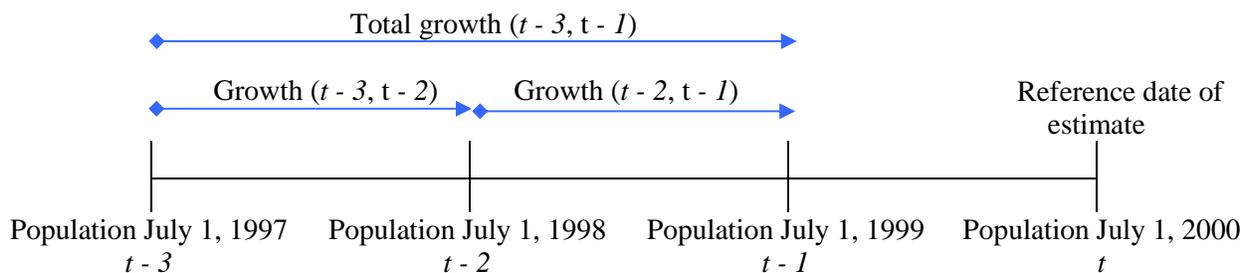
After having been estimated, the CD totals were controlled to the July 1st provincial and territorial estimates.

As is current practice, preliminary subprovincial estimates of population for British Columbia and Quebec were produced by their respective statistical agencies.

The CD and CMA age and sex estimates were prepared by ageing estimates from the previous year, assuming a natural increase (births minus deaths) equivalent to the one observed for the previous

year and zero net growth for all other components. Hence, the ageing of the population was driven by the estimated natural increase. Prorating and raking procedures, as described earlier, were then used to adjust preliminary estimates for subprovincial areas to the more accurate provincial/territorial figures.

Prior to 1998, the regression-nested method[56] was used to produce preliminary estimates of subprovincial populations. This method would yield the CD totals. The distribution by age and sex was obtained using the cohort-component method.[57] However, the regression-nested method was substituted by the rate of growth method because of various uncertainties concerning the quality of the explanatory data available for use in the regression model and recent research showing that this alternative approach is of comparable accuracy.

Intercensal Population Estimates of Subprovincial Areas

Intercensal estimates at the census division (CD) and census metropolitan area (CMA) levels are produced much in the same manner as intercensal estimates at the provincial/territorial level. (For information on the methods refer to Chapter 1). However, the production of these estimates for CDs and CMAs additionally require that changes in census geography over time are accounted for. Hence, base population from the previous census and the components of demographic growth from the corresponding intercensal period are converted to match geographic boundaries defined for the most recent census.

As for the provinces and territories, the error of closure is calculated for each CD and CMA by comparing the postcensal estimates with the most recent censal estimates, by age and sex. The resultant error of closure is then distributed linearly to the postcensal population estimates from those years between the previous and most recent censuses.

When summed, the series of intercensal estimates by age and sex for subprovincial areas differ slightly from the intercensal estimates of total population aggregated to the provincial and territorial level. These differences are then proportionally distributed among the age cohorts, accounting for the final adjustment made to the intercensal estimates of the total population of subprovincial areas.

Data Quality

Subprovincial population estimates can be considered as having a respectable degree of quality. Table 8.1 presents the magnitude of the errors of closure by the number of CDs for each province and territory falling within specific ranges of error. The majority of CDs (71%) have errors less than 2.0%, and 40% are actually less than 1.0%.

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[56] Preliminary estimates (produced using a regression model) and final estimates of population (produced using the component method) at subprovincial levels would yield sometimes significantly different results for a given reference date and area. Consequently, Statistics Canada developed the regression-nested method to tie the preliminary estimates to the more reliable component estimates for the previous year. The method involves summing the component estimates for the previous year and the population change obtained by computing the difference between the regression estimates for the reference year and the previous year. For further information on this method, refer to *Population Estimation Methods, Canada, 1987*.

[57] For information on the cohort-component method, refer to Chapter 9 (Population Estimates by Age, Sex and Marital Status) in this manual.

Table 8.1
Distribution of Census Divisions (CDs) by Province and Territory, Magnitude of Error of Closure, and Mean Absolute Error (MAE) for 1996 Estimates

Province/territory	Number of CDs	Less than 1.0%	1.0%- 1.9%	2.0%- 2.9%	3.0%- 3.9%	4.0% and over	MAE (%)
		Absolute Error[1]					
Total CDs	**288**	**115**	**90**	**52**	**16**	**15**	**1.59**
Newfoundland and Labrador	10	1	3	5	1	0	2.11
Prince Edward Island	3	3	0	0	0	0	0.45
Nova Scotia	18	9	9	0	0	0	0.99
New Brunswick	15	5	5	4	0	1	1.97
Quebec	99	39	28	21	8	3	1.61
Ontario	49	17	19	8	4	1	1.51
Manitoba	23	10	5	4	0	4	2.13
Saskatchewan	18	10	3	4	0	1	1.18
Alberta	19	8	6	1	2	2	1.58
British Columbia	28	12	11	3	0	2	1.42
Yukon	1	0	0	1	0	0	2.32
Northwest Territories	5	1	1	1	1	1	2.44

Note: The quality of any estimate may be expressed as an error of closure, whatever the geographical detail or characteristics considered. However, for smaller geographical areas, a technique that consolidates error size for the entire set of small areas is preferable. Mean absolute error (MAE) is the technique used at Statistics Canada to evaluate estimate quality by CD or CMA. Mean absolute error is defined as the average of the relative differences (either positive or negative) between population estimates and census counts.

[1] The absolute error of closure is expressed as a percent of the population enumerated.

Source: *Annual Demographic Statistics, 1998*, Statistics Canada, 1999

As with provincial/territorial level estimates of population, the two main sources of error for subprovincial estimates are differences in the amount of census undercoverage between two successive censuses and errors in the estimation of components of population change. In addition, the quality of population estimates at the CD and CMA level may also be affected by boundary changes.

Results from the Reverse Record Check indicate that the net undercoverage rates for Canada in the 1991 and 1996 Censuses averaged 2.57%, but were not equally distributed throughout the country. The net undercoverage rates certainly vary among census metropolitan areas and by census year (see Table 8.2). For both the 1991 and 1996 Censuses, the CMAs in urban fringes[58] had the lowest net undercoverage rates (1.52% and 1.26%, respectively, both lower than the national average). Net undercoverage rates were highest in CMAs in urban cores (2.92% for 1991 and 2.67% for 1996, higher than the national average). Looking at selected CMAs, Toronto's net undercoverage rate was much higher than the national average for both 1991 and 1996, (4.03% and 3.39%, respectively), as was Vancouver's in 1996 (3.93%). Note that Toronto's 1991 net undercoverage rate was a fair bit higher than that of 1996, and vice versa for Vancouver. The higher net undercoverage rates in these CMAs may be explained in part by the large number of immigrants and non-permanent residents that these areas attract, as these two groups of migrants tend to have higher rates of net undercoverage than the rest of the population (Statistics Canada (1999c)).

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[58] The urban core, urban fringe and rural fringe distinguish between central and peripheral urban and rural areas within a CMA or a census agglomeration (CA). In the case of CMAs, an urban core is a large urban area around which a CMA is delineated. Based on the previous census, the urban core must have a population of at least 100,000. The urban fringe is the urban area within a CMA that is not contiguous to the urban core. The rural fringe is all territory within a CMA not classified as urban core or urban fringe (Statistics Canada (1999d)).

Table 8.2
Population Net Undercoverage for Census Metropolitan Areas (CMAs), 1991 and 1996

	1991				1996			
Area	Number	Standard Error	Rate (%)	Standard Error (%)	Number	Standard Error	Rate (%)	Standard Error (%)
All CMAs	495,900	34,972	2.89	0.20	474,900	24,609	2.59	0.13
CMA Parts								
Urban Core	456,264	32,848	2.92	0.20	447,556	24,205	2.67	0.14
Urban Fringe	4,893	3,653	1.52	1.11	5,181	2,574	1.26	0.62
Rural Fringe	34,742	7,920	2.84	0.62	22,163	5,299	1.88	0.44
Selected CMAs								
Montreal	76,778	8,631	2.40	0.26	59,779	9,833	1.77	0.29
Ottawa-Gatineau	25,329	6,275	2.68	0.64	19,472	4,989	1.89	0.48
Toronto	163,630	22,214	4.03	0.52	149,810	17,828	3.39	0.39
Vancouver	38,338	5,819	2.34	0.34	75,016	7,427	3.93	0.37
All Others	191,823	16,712	2.62	0.22	170,822	14,914	2.25	0.19

Source: *Coverage: 1996 Census Technical Reports* and *Coverage: 1991 Census Technical Reports*, Statistics Canada

The error in estimation of components is due in part to the weaknesses associated with the data sources and methods used for the individual components. For those components where the data sources and methods used for estimation of subprovincial populations are the same as those at the provincial/territorial level, similar data quality issues exist. For example, there exists some uncertainty with estimates of total emigration and internal migration due to the issue of incomplete population coverage by the data sources used for estimation. At subprovincial levels, however, the error is further compounded by the fact that typically the more detailed the estimate, the lower degree of quality associated with it.

With the exception of immigrants, persons living temporarily abroad and non-permanent residents, data on the components are available for CDs and CMAs. Current information for these three components is only available at the provincial/territorial level. As previously described, SAADD data are used to distribute provincial/territorial level estimates of immigrants and temporary emigrants[59] by CD and CMA. Distributions from the most recent census are used to derive subprovincial distributions for non-permanent residents. In the case of immigration, the accuracy of the subprovincial estimates depends on the consistency between SAADD data and CIC data. For persons living temporarily abroad, the accuracy depends on the truth of the assumption that temporary emigrants are distributed in the same way as emigrants by subprovincial areas. Finally, the accuracy of estimates of non-permanent residents at subprovincial levels is highly dependent on the consistency of the census distribution for the period following the census.

There are often difficulties in estimating population for subprovincial areas associated with CD and CMA boundaries, which may contribute to the error of the estimates. They are:

(i) converting the data compiled for one type of boundary specification to data for the selected boundary specification;
(ii) boundary changes over time.

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[59] SAADD's subprovincial distribution of emigrants is used for temporary emigrants.

Additionally, boundaries of CDs and CMAs are modified from census to census. These changes create difficulty in estimating population over a long period. As previously mentioned, in an attempt to maintain some sort of continuity of population estimates at subprovincial levels, since CD and CMA boundaries do not remain stable over time, estimates are prepared respecting the boundaries defined in the most recent census.

Chapter 9

Population Estimates by Age, Sex and Marital Status

Analysis of populations by age and sex is a fundamental aspect of most demographic studies. The age and sex structure of the population varies with time and place, while at the same time demographic behaviour is often a function of age and sex. For example, fertility rates are based on the number of women in the reproductive ages. Mortality rates are much higher in the older age groups. Higher migration rates are associated with young adults, as they move for personal and economic reasons. Population estimates by age and sex are also widely used by other divisions of Statistics Canada. For example, these estimates are used in the calculation of employment and unemployment rates and crime rates, which tend to vary according to age and sex distributions. The addition of marital status builds the foundation for studying other demographic phenomena such as marriage and divorce rates and changes in family structure. Government and private sector planning and policies are largely driven by the age, sex and marital status profiles of certain populations.

Population estimates by age and sex are available at national, provincial/territorial, census division and census metropolitan area levels. The more detailed breakdown of these estimates by marital status is available only at the national and provincial/territorial levels. This chapter presents the methods used to produce population estimates disaggregated by age, sex and marital status.

Data Sources and Relevant Concepts

Postcensal estimates of population by age and sex are produced using the cohort component approach. This is similar to the component method as used in the production of total population estimates, although additional data is required in its application. The data required for the cohort component method are related to demographic events (deaths, immigration, arrivals and departures of non-permanent residents, internal migration, total emigration) that can be directly linked to persons belonging to the same birth cohort (i.e., persons having been born during the same period or year). Different components require unique treatment, according to the nature of the data used to generate the estimates, and their respective chapters elaborate upon the manner in which the estimate for each component is distributed by age and sex.

The data sources used in the production of the population estimates by age and sex are as follows:

- births and deaths using vital statistics;
- immigration and non-permanent residents using Citizenship and Immigration Canada data;
- emigration and persons living temporarily abroad using data from the U.S. Department of Justice, Immigration and Naturalization Services and Small Area and Administrative Data Division (SAADD);
- returning emigrants using data from the most recent census distribution and Small Area and Administrative Data Division (SAADD); and

- interprovincial migration using data from the one-year ago mobility question of the most recent census.

To obtain the finer-detailed population estimates by age, sex and marital status, data about events resulting in a change of marital status (e.g., marriage, divorce, death of a spouse) are also required. These data are available from the Vital Statistics database maintained by Health Statistics Division of Statistics Canada. The database was created in collaboration with provincial and territorial ministries as well as the federal department of Justice Canada. This collaboration allows Statistics Canada to obtain data on marriage certificates registered by the provinces/territories for legal purposes as well as data related to divorces from the Divorce Registry[60] maintained by Justice Canada.

"Marital status" refers to the conjugal status of a person, that being single, married, divorced or widowed. In demographic estimates, a distinction is made between "legal" marital status and "*de facto*" marital status. Both types of estimates were published in the ***Annual Demographics Statistics 2000*** for the first time, following changes to the methods of estimation of marital status, which will be described later. Prior to the 2000 edition of the publication, only *de facto* marital status estimates were published. The availability of both these sets of estimates is important for many users of demographic data, especially for comparative analysis of trends in common-law unions versus marriages.

A person's "legal" marital status refers to their legal conjugal status. The distinction between legal marital status and *de facto* marital status lies in the concept of who is considered married. In the discussion of legal marital status, a person's marital status is determined by law. Common-law partners are not legally married to each other, thus are considered single, divorced or widowed according to their legal marital status. Separated couples are considered married under both concepts.

The following definitions represent those used by Statistics Canada for each of the legal and *de facto* marital statuses.

Under legal marital status:

Single persons are those whom have never been married, or persons whose marriage has been annulled and have not remarried. All persons under 15 years of age are also included;

Married persons are those whose husband or wife is living, unless a divorce has been obtained. Persons separated are also included in this category;

Widowed persons are those who have lost their spouse through death and who have not remarried;

Divorced persons have obtained a divorce and have not remarried;

Common-law relationships are not legally recognized. As such, persons living in a common-law relationship would be either single, widowed or divorced. However, a person in a common-law relationship is considered married if they are separated from a spouse of a previous legal marriage.

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[60] The Divorce Registry is a database containing all the information related to divorce certificates granted in Canadian courts.

Data on individuals who are living in common-law unions and those who are legally married are combined to obtain what is referred to as "*de facto*" marital status, as described in the following definitions.

Under *de facto* marital status:

Single persons include individuals who have never married, or whose marriage has been annulled and they have not remarried, and who do not live common-law. All persons under 15 years of age are also included;

Married persons include individuals whose husband or wife is living (i.e., includes common-law couples and separated individuals), unless the couple is divorced;

Widowed persons have lost their spouse through death and have not remarried, and do not live in a common-law relationship;

Divorced persons have obtained a legal divorce, have not remarried and do not live in a common-law relationship.

Methods of Estimation

Postcensal estimates of population by age, sex and marital status are produced using the cohort component approach. This approach requires a slight modification of the component approach described in Chapter 1, but the overall principles are the same.

To produce the population estimates by age, sex and marital status, two sets of estimates are prepared, one by age and sex, and the other by age, sex and marital status. The two sets of estimates are then reconciled to ensure consistency.

Population Estimates by Age and Sex, Canada, Provinces and Territories

Final Estimates

As mentioned, the population by age and sex is estimated using the cohort component method. A cohort is a group of persons who experience a certain event in a specified period of time. For the calculation of age and sex estimates, birth cohorts (those persons born during the same year) for both males and females separately, are used. The cohort component approach factors in the ageing of the cohorts over time. For example, persons aged 19 one year will be 20 years old the following year. The data required for the cohort component method includes demographic events such as deaths, immigration, flows of non-permanent residents, interprovincial migration and total emigration that can

be directly linked to persons belonging to the same birth and sex cohorts.[61]

Demographers use a tool called a Lexis diagram (Figure 9.1) to aid in the linking of events to specific cohorts. Time is located on the horizontal axis (abscissa), while the vertical axis (ordinate) represents age. Specific cohorts are identified by the diagonals (lifelines) that cross the diagram. Using the cohort component approach, demographic events are organized to follow these lifelines.

Figure 9.1
Transition from a Distribution of Demographic Events by Age and Period to a Distribution by Age and Birth Cohort
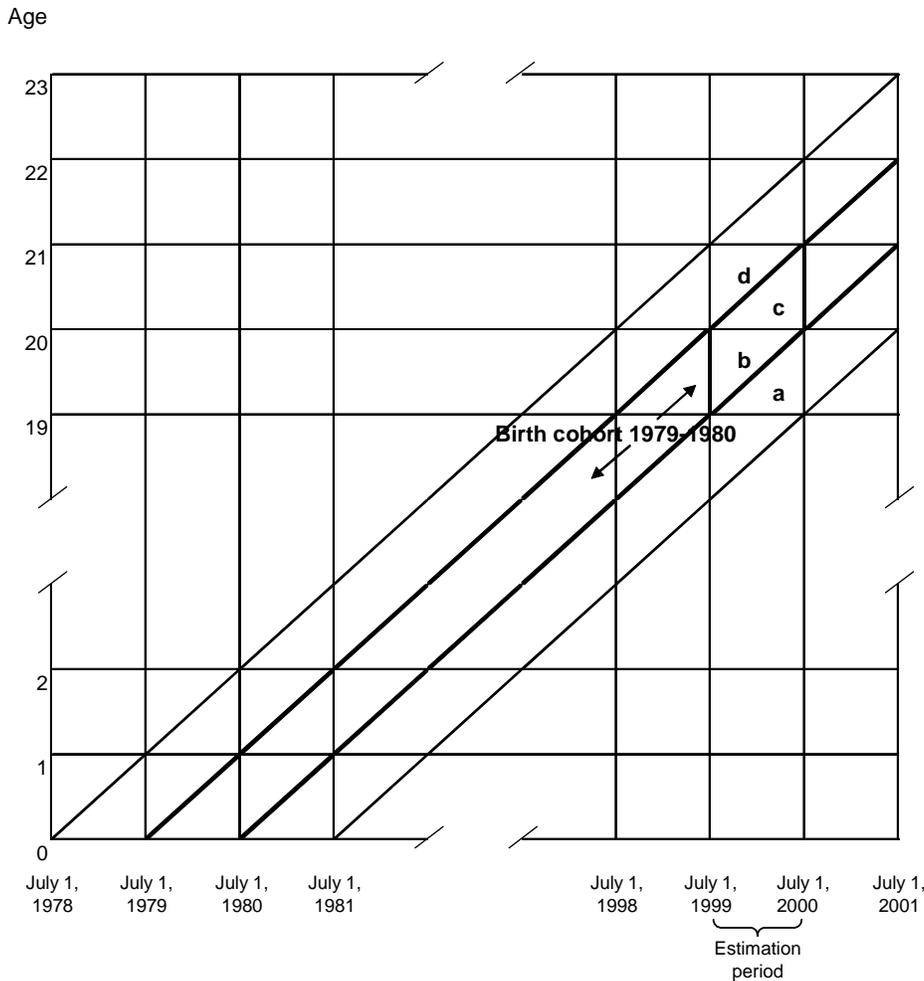
Take, for example, those aged 19 as of July 1, 1999, who belong to the cohort born between July 2, 1979 and July 1, 1980 (inclusive). The demographic events experienced by this cohort during the estimation period are represented by triangles "b" and "c".

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[61] Previously, data on births and deaths provided by Health Statistics Division to Demography Division were recorded by age at the time of the event. Since the date of birth was not provided, these events were not suitable for direct use, as it was necessary to "separate" event data to the birth cohort experiencing them. This was accomplished by the application of a separation factor. For more information on the earlier method of applying a separation factor, refer to *Population Estimation Methods, Canada,* 1987.

The equations for estimating annual population by single years of age and sex, by the cohort component method (at the national and provincial/territorial levels) are as follows:

For each sex, by province/territory:

Age 0:

Equation 9.1: $$P^0_{(t+1)} = B_{(t,t+1)} - D^0_{(t,t+1)} + I^0_{(t,t+1)} - E^0_{(t,t+1)} + NPR^0_{(t,t+1)} + IM^{net,0}_{(t,t+1)}$$

Ages 1 through 89:

Equation 9.2 $$P^{(a+1)}_{(t+1)} = P^a_t - NPR^a_t - D^a_{(t,t+1)} + I^a_{(t,t+1)} - E^a_{(t,t+1)} + NPR^{(a+1)}_{(t+1)} + IM^{net,a}_{(t,t+1)}$$

Ages 90+:

Equation 9.3: $$P^{90+}_{(t+1)} = P^{89+}_t - NPR^{89+}_t - D^{89+}_{(t,t+1)} + I^{89+}_{(t,t+1)} - E^{89+}_{(t,t+1)} + NPR^{90+}_{(t+1)} + IM^{net,89+}_{(t,t+1)}$$

where

$P^0_{(t+1)}$	=	postcensal estimate for persons of age less than one year at time $(t + 1)$;
$P^{(a+1)}_{(t+1)}$	=	postcensal estimate for persons of age $(a + 1)$ at time $(t + 1)$ (for persons aged 1 to 89 years only);
$P^{90+}_{(t+1)}$	=	postcensal estimate for persons aged 90 years and at time $(t + 1)$;
B	=	number of births;
D	=	number of deaths;
I	=	number of immigrants;
E	=	number of total emigrants;
NPR^a_t, $NPR^{(a+1)}_{(t+1)}$	=	estimate of non-permanent residents of age $(a, a + 1)$ at time $(t, t + 1)$;
IM^{net}	=	net interprovincial migration;
a	=	age at time t;
$(t, t + 1)$	=	the interval between the date of the previous population estimate t and the reference date of the estimate $(t + 1)$.

The age of non-permanent resident population at time t or $(t + 1)$ is readily available. For the components, deaths and immigration, over the period $(t, t + 1)$, the age of a person can be calculated since the data are collected by month and year of birth and the month and year of the event. The methods used to obtain estimates by age and sex, by province/territory for total emigration and interprovincial migration are described in their respective chapters.

Population Estimates by Age, Sex and Marital Status, Canada, Provinces and Territories

Final Estimates

As previously mentioned, estimates by age, sex and marital status are available by legal and *de facto* marital statuses. Estimation for each marital status is performed independently, and takes into

account events that result in a change of marital status. Such events include marriages and divorces, as well as deaths of married persons, which consequently modify the marital status of his or her spouse. All migration components by age and sex are distributed by marital status.

Population Estimates by Age, Sex and "Legal" Marital Status

All persons under the age of 15 years are assumed to be single. For persons aged 15 years and over, estimates by single year of age and sex are prepared for four subpopulations: single, married, divorced and widowed, as previously defined for legal marital status. These estimates are based on the census counts, adjusted to July 1st, as well as for net census undercoverage and for incompletely enumerated Indian reserves.

The formulae used to estimate the four legal marital status subpopulations are as follows:

For each sex and age (15 years and older), by province/territory:

Single:
Equation 9.4:

$$P_{(t+1)}^{nm(legal),(a+1)} = P_t^{nm,a} - NPR_t^{nm,a} - D_{(t,t+1)}^{nm,a} + I_{(t,t+1)}^{nm,a} - E_{(t,t+1)}^{nm,a} + NPR_{(t+1)}^{nm,(a+1)} - NMAR_{(t,t+1)}^{nm,a} + IM_{(t,t+1)}^{net,nm,a}$$

Married:
Equation 9.5:

$$P_{(t+1)}^{mar(legal),(a+1)} = P_t^{mar,a} - NPR_t^{mar,a} - D_{(t,t+1)}^{mar,a} + I_{(t,t+1)}^{mar,a} - E_{(t,t+1)}^{mar,a} + NPR_{(t+1)}^{mar,(a+1)} + NMAR_{(t,t+1)}^{nm,a} + NMAR_{(t,t+1)}^{v,a}$$
$$+ NMAR_{(t,t+1)}^{w,a} - NV_{(t,t+1)}^a - NW_{(t,t+1)}^a + IM_{(t,t+1)}^{net,mar,a}$$

Divorced:
Equation 9.6:

$$P_{(t+1)}^{v(legal),(a+1)} = P_t^{v,a} - NPR_t^{v,a} - D_{(t,t+1)}^{v,a} + I_{(t,t+1)}^{v,a} - E_{(t,t+1)}^{v,a} + NPR_{(t+1)}^{v,(a+1)} - NMAR_{(t,t+1)}^{v,a} + NV_{(t,t+1)}^a + IM_{(t,t+1)}^{net,v,a}$$

Widowed:
Equation 9.7:

$$P_{(t+1)}^{w(legal),(a+1)} = P_t^{w,a} - NPR_t^{w,a} - D_{(t,t+1)}^{w,a} + I_{(t,t+1)}^{w,a} - E_{(t,t+1)}^{w,a} + NPR_{(t+1)}^{w,(a+1)} - NMAR_{(t,t+1)}^{w,a} + NW_{(t,t+1)}^a + IM_{(t,t+1)}^{net,w,a}$$

where for each sex

$P_{(t+1)}^{nm(legal),(a+1)}$, $P_{(t+1)}^{(mar,v,w),(a+1)}$	=	population estimate of single (married, divorced, widowed) persons, according to their legal marital status, by age $(a + 1)$, at time $(t + 1)$;
$P_t^{nm,a}$, $P_t^{(mar,v,w),a}$	=	population estimate of single (married, divorced, widowed) persons, according to their legal marital status, by age a, at time t;
$D_{(t,t+1)}^{nm,a}$, $D_{(t,t+1)}^{(mar,v,w),a}$	=	number of deaths of single (married, divorced, widowed) persons, according to their legal marital status, between the period $(t, t + 1)$, age a;

$I_{(t,t+1)}^{nm,a}$, $I_{(t,t+1)}^{(mar,v,w),a}$ = number of single (married, divorced, widowed) immigrants, according to their legal marital status, between the period $(t, t + 1)$, age a;

$E_{(t,t+1)}^{nm,a}$, $E_{(t,t+1)}^{(mar,v,w),a}$ = number of single (married, divorced, widowed) emigrants, according to their legal marital status, between the period $(t, t + 1)$, age a;

$NPR_t^{nm,a}$, $NPR_{(t+1)}^{(mar,v,w),(a+1)}$ = population of single (married, divorced, widowed) non-permanent residents, according to their legal marital status, at time t, $(t + 1)$, age a, $(a + 1)$;

$NMAR_{(t,t+1)}^{nm,a}$, $NMAR_{(t,t+1)}^{(v,w),a}$ = number of newly-married and previously single (divorced, widowed) persons, according to their legal marital status, between the period $(t, t + 1)$, age a;

$NV_{(t+1)}^a$ = number of persons divorcing between the period $(t, t + 1)$, age a;

$NW_{(t,t+1)}^a$ = number of persons whose spouse died between the period $(t, t + 1)$, age a (i.e., new widowhoods; see below for a description);

$IM_{(t,t+1)}^{net,nm,a}$, $IM_{(t,t+1)}^{net,(mar,v,w),a}$ = net number of single (married, divorced, widowed) interprovincial migrants, according to their legal marital status, between the period $(t, t + 1)$, age a;

nm = single persons at time t;

mar = married persons at time t;

v = divorced persons at time t;

w = widowed persons at time t;

a = age at the beginning of the period.

New Widowhoods

The data required for the above estimation are either readily available (e.g., marriages, deaths) or estimated at the time of production of component estimates (e.g., marital status of returning emigrants), with the exception of new widowhoods. The term "new widowhoods" denotes a change in marital status from married to widowed, occurring as a result of the death of a spouse during the period $(t, t + i)$. The difficulty with deaths of married persons is that the age of the surviving spouse is not recorded in the Vital Statistics Registry. Consequently, the age of the new widow or widower must be determined indirectly.

Using the age distribution of deaths to married males and females, compiled by age[62] group, the surviving spouse is assigned to a five-year age group. Assignment is based on the distribution of husband-wife families by age group of husband and age group of wife from the last census (see Table 9.1).

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[62] Age at the beginning of the estimation period.

Table 9.1
Percent Distribution of Husband-Wife Families by Age Group of Wife and Age Group of Husband: Ontario, 1996 Census

Age Group of Husband (Years)	Age Group of Wife (Years)								
	15-19 (1)	20-24 (2)	25-29 (3)	30-34 (4)	35-39 (5)	40-44 (6)	45-49 (7)	50-54 (8)	55-59 (9)
15-19	53.7	29.4	6.5	2.8	1.5	1.9	2.5	0	0
20-24	11.8	62.4	20.4	3.4	1.0	0.4	0.3	0.2	0
25-29	1.1	22.5	57.6	14.8	2.8	0.7	0.2	0.1	0
30-34	0.2	4.0	29.6	51.9	11.4	2.2	0.6	0.1	0
35-39	0	0.9	6.9	35.2	46.2	8.6	1.6	0.4	0.1
40-44	0	0.3	1.8	9.4	36.6	43.0	7.5	1.2	0.2
45-49	0	0.1	0.5	2.5	10.6	37.6	41.3	6.1	1.0
50-54	0	0.1	0.2	1.0	3.5	11.6	41.0	36.2	5.4
55-59	0	0	0.1	0.4	1.1	3.6	13.9	40.0	33.8
60-64	0	0	0	0.2	0.5	1.2	4.1	12.8	38.7
65-69	0	0	0	0.1	0.2	0.5	1.5	4.3	13.1
70-74	0	0	0	0.1	0.1	0.2	0.6	1.5	3.6
75-79	0	0	0	0	0	0.1	0.3	0.7	1.4
80-84	0	0	0	0	0.1	0.1	0.1	0.4	0.4
85-89	0	0.2	0	0.1	0	0	0.1	0.3	0.3
90+	0	0.1	0.6	0.5	0.2	1.1	0.4	0	0.7

	60-64 (10)	65-69 (11)	70-74 (12)	75-79 (13)	80-84 (14)	85-89 (15)	90+ (16)	Total (17)
15-19	0.1	0.6	0.5	0.3	0.2	0	0	100.0
20-24	0	0	0.1	0	0	0	0	100.0
25-29	0	0	0	0	0	0	0	100.0
30-34	0	0	0	0	0	0	0	100.0
35-39	0	0	0	0	0	0	0	100.0
40-44	0.1	0	0	0	0	0	0	100.0
45-49	0.2	0	0	0	0	0	0	100.0
50-54	0.9	0.2	0	0	0	0	0	100.0
55-59	5.7	0.9	0.3	0.1	0.1	0	0	100.0
60-64	34.7	6.4	1.1	0.3	0.1	0	0	100.0
65-69	37.5	34.8	6.8	1.1	0.2	0	0	100.0
70-74	12.5	37.3	36.5	6.7	0.8	0.1	0	100.0
75-79	4.2	16.0	42.9	29.1	4.8	0.4	0	100.0
80-84	1.6	6.5	22.2	38.0	26.9	3.5	0.2	100.0
85-89	0.7	2.8	11.2	21.7	39.2	21.4	2.1	100.0
90+	0.9	2.6	7.4	15.3	23.8	32.5	14.0	100.0

Note: The percentages in this table are rounded to sum exactly to 100.0.
Source: 1996 Census data

The number of new widow(er)s by age group (a, $a + 4$), for $a = 15, 20,\ldots,85$, is estimated as follows for each province/territory:

Equation 9.8:
$$NW^{(a,a+4)} = \sum_{(b=15)}^{90+} D^{mar,(b,b+4)} \times \Phi^{(a,a+4)}$$

with

Equation 9.9:
$$\Phi^{(a,a+4)} = \frac{F^{(a,a+4)}}{\sum_{(a=15)}^{90+} F^{(a,a+4)}}$$

where

$NW^{(a,a+4)}$ = estimated number of new widow(er)s in age group $(a, a + 4)$;

$D^{mar,(b,b+4)}$ = number of deaths of married persons (male or female) in age group $(b, b + 4)$;

$\Phi^{(a,a+4)}$ = proportion of husband-wife families by five-year age group of husbands (wives) cross-classified by five-year age group of wives (husbands) $(a, a + 4)$;

$F^{(a,a+4)}$ = number of husband-wife families by five-year age group of husbands (wives) cross-classified by five-year age group of wives (husbands) $(a, a + 4)$.

Table 9.2 provides an illustration of the above formulae. A sample calculation of the incidence of widowhood among females in the 45-49 year age group for the province of Ontario in 1996-1997 is presented. The percent distribution of husbands with a 45-49 year old wife is taken from column (7) in Table 9.1. This is applied to the 1996-1997 distribution of male deaths (column (1) in Table 9.2), and the results summed to estimate the number of new widows aged 45-49 years, as presented in column (3). To determine the number of widows in another age group, the appropriate distribution from Table 9.1 is substituted for column (2) of Table 9.2, and the same procedure is followed.

Table 9.2
Calculation of the Incidence of Widowhood: An Example for Females Aged 45-49 Years, Ontario, 1996-1997

Age Group of Husband (Years)	Deaths of Married Males	Percent Distribution of Husbands with Wives Aged 45-49 Years	Estimates of New Widows Aged 45-49 Years
	(1)	(2)	(3) = [(1) X (2)] / 100
15-19	1	2.5	0.025
20-24	11	0.3	0.032
25-29	82	0.2	0.202
30-34	182	0.6	1.031
35-39	290	1.6	4.766
40-44	471	7.5	35.364
45-49	712	41.3	294.092
50-54	986	41.0	404.081
55-59	1,506	13.9	209.597
60-64	2,238	4.1	92.293
65-69	3,422	1.5	50.401
70-74	4,427	0.6	27.704
75-79	4,365	0.3	14.548
80-84	3,717	0.1	5.273
85-89	2,117	0.1	1.929
90+	836	0.4	3.242
Total			**1,144.579**
			Rounded to:
			1,145

Source: Demography Division, Statistics Canada

These results by five-year age group are then disaggregated into single years of age using Sprague's multipliers[63]. This distribution of surviving spouses represents the spouse's age at the beginning of the reference period.

Population Estimates by Age, Sex and "de facto" Marital Status

Between censuses information is available only for changes in the legal marital status of individuals. As such, population estimates by *de facto* marital status must be estimated. These can be derived from the legal marital status estimates whereby the number of legal single persons is multiplied by the proportion of census-identified common-law persons to legal single persons. The same method is used for widowed and divorced persons living in a common-law union.

Population estimates for any July 1, postcensal year by *de facto* marital status for a given age and sex can be expressed as follows:

For each province/territory, by sex:

Equation 9.10: $$P_{(t+i)}^{nm(de\ facto),a} = P_{(t+i)}^{nm(legal),a} - P_{(t+i)}^{nm(cl),a}$$

Equation 9.11: $$P_{(t+i)}^{mar,(de\ facto),a} = P_{(t+i)}^{mar(legal),a} + P_{(t+i)}^{nm(cl),a} + P_{(t+i)}^{w(cl),a} + P_{(t+i)}^{v(cl),a}$$

Equation 9.12: $$P_{(t+i)}^{v(de\ facto),a} = P_{(t+i)}^{v(legal),a} - P_{(t+i)}^{v(cl),a}$$

Equation 9.13: $$P_{(t+i)}^{w(de\ facto),a} = P_{(t+i)}^{w(legal),a} - P_{(t+i)}^{w(cl),a}$$

where

Equation 9.14: $$P_{(t+i)}^{nm(cl)} = P_{(t+i)}^{nm(legal)} \times \frac{\mathbf{P}_t^{nm(cl)}}{\mathbf{P}_t^{nm(legal)}}$$

Equation 9.15: $$P_{(t+i)}^{v(cl)} = P_{(t+i)}^{v(legal)} \times \frac{\mathbf{P}_t^{v(cl)}}{\mathbf{P}_t^{v(legal)}}$$

Equation 9.16: $$P_{(t+i)}^{w(cl)} = P_{(t+i)}^{w(legal)} \times \frac{\mathbf{P}_t^{w(cl)}}{\mathbf{P}_t^{w(legal)}}$$

where

$P_{(t+i)}^{nm(de\ facto),a}$ = population of single persons according to the *de facto* marital status concept, by age *a*, at time $(t + i)$;

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[63] Sprague's multipliers are interpolation coefficients used to subdivide data. For a detailed description of the use of Sprague's multipliers, see Shryock et al. (1976).

$P_{(t+i)}^{nm(legal),a}$ = population of single persons according to legal marital status concept, by age a, at time $(t + i)$;

$P_{(t+i)}^{nm(cl),a}$ = population of persons living in common-law unions, never previously married, by age a, at time $(t + i)$;

$P_{(t+i)}^{mar(de\ facto),a}$ = population of married persons according to the *de facto* marital status concept, by age a, at time $(t + i)$;

$P_{(t+i)}^{mar(legal),a}$ = population of married persons according to legal marital status concept, by age a, at time $(t + i)$;

$P_{(t+i)}^{w(cl),a}$ = population of persons living in common-law unions who were widowed by their previous spouse, by age a, at time $(t + i)$;

$P_{(t+i)}^{v(cl),a}$ = population of persons living in common-law unions who divorced their previous spouse, by age a, at time $(t + i)$;

$P_{(t+i)}^{v(de\ facto),a}$ = population of divorced persons according to the *de facto* marital status concept, by age a, at time $(t + i)$;

$P_{(t+i)}^{v(legal),a}$ = population of divorced persons according to legal marital status concept, by age a, at time $(t + i)$;

$P_{(t+i)}^{w(de\ facto),a}$ = population of widowed persons according to the *de facto* marital status concept, by age a, at time $(t + i)$;

$P_{(t+i)}^{w(legal),a}$ = population of widowed persons according to legal marital status concept, by age a, at time $(t + i)$;

$\mathbf{P}_{t}^{nm(cl)}$ = censal estimate of population of single persons living in common-law unions;

$\mathbf{P}_{t}^{nm(legal)}$ = censal estimate of population of single persons according to legal marital status concept;

$\mathbf{P}_{t}^{v(cl)}$ = censal estimate of population of divorced persons living in common-law unions;

$\mathbf{P}_{t}^{v(legal)}$ = censal estimate of population of divorced persons according to legal marital status concept;

$\mathbf{P}_{t}^{w(cl)}$ = censal estimate of population of widowed persons living in common-law unions;

$\mathbf{P}_{t}^{w(legal)}$ = censal estimate of population of widowed persons according to legal marital status concept;

i = 1, 2, 3, 4;

t = the most recent census year.

Preliminary Estimates

Preliminary estimates for the number of marriages and divorces are based on a model using nuptial and divorce rates by age, sex and province or territory of residence from the most recent year for which final data are available. The total number of marriages and divorces are then distributed by legal marital status using data from the most recent year available from Health Statistics Division.

The components data for the period July 1 to June 30 used for preliminary estimates of population by age, sex and marital status are as follows:

Deaths are distributed by legal marital status using the distributions from the most recent final data available from the vital statistics database maintained by Health Statistics Division.

The distribution of immigrants by legal marital status is derived using the most recent data available (typically for the previous reference period) on landed immigrants provided by Citizenship and Immigration Canada.

The number of emigrants (to the United States and all other countries) is broken down by marital status using the most recent data available from Immigration and Naturalization Services of the U.S. Department of Justice. The distribution of returning emigrants by legal marital status is derived from the most recent Census mobility data (1 year ago), after the exclusion of non-permanent residents and immigrants.

The net change in the number of persons living temporarily abroad by legal marital status is distributed using the distribution for emigrants.

The distribution of non-permanent residents by legal marital status is obtained using the same distribution as the most recent final data on permit/authorisation holders and refugee status claimants from Citizenship and Immigration.

Intercensal Estimates

The production of intercensal estimates by age and sex is done by distributing the error of closure across age and sex cohorts. For a description on the calculation and distribution of the error of closure, see Chapter 1.

The relative proportions of the various marital statuses for a given age and sex from the two most recent censuses are used to derive intercensal estimates of population by marital status. Interpolation between censuses is used to obtain the required series of proportions and estimates as follows:

For each age and sex,

(i)   the relative proportions for each marital status from the two most recent censuses are calculated as follows:

Equation 9.17:
$$\Phi_{(t-5)}^{ms} = \frac{\mathbf{P}_{(t-5)}^{ms}}{\mathbf{P}_{(t-5)}}$$

and

Equation 9.18:
$$\Phi_t^{ms} = \frac{\mathbf{P}_t^{ms}}{\mathbf{P}_t}$$

where

ms   =   marital status;

$\Phi^{ms}_{(t-5)}$ and Φ^{ms}_t =   the proportion of the population of marital status *ms* in the two most recent censuses, adjusted for net undercoverage;

$\mathbf{P}^{ms}_{(t-5)}$ and $\mathbf{P}^{ms}_t$ =   the number of persons of marital status *ms* in the two most recent censuses, adjusted for net undercoverage;

$\mathbf{P}_{(t-5)}$ and $\mathbf{P}_t$ =   censal estimate.

    (ii)   the proportions for each intercensal year are calculated by interpolating between the proportions calculated in (i), as follows:

Equation 9.19:
$$\Phi^{ms}_{(t-4)} = \Phi^{ms}_{(t-5)} + \frac{1}{5}\left(\Phi^{ms}_t - \Phi^{ms}_{(t-5)}\right)$$

Equation 9.20:
$$\Phi^{ms}_{(t-3)} = \Phi^{ms}_{(t-5)} + \frac{2}{5}\left(\Phi^{ms}_t - \Phi^{ms}_{(t-5)}\right)$$

$$\downarrow$$

Equation 9.21:
$$\Phi^{ms}_{(t-4)} = \Phi^{ms}_{(t-5)} + \frac{5}{5}\left(\Phi^{ms}_t - \Phi^{ms}_{(t-5)}\right)$$

    (iii)   the proportions obtained in (ii) are applied to the intercensal population estimates by age and sex to obtain estimates by age, sex and marital status.

Equation 9.22: eg. at $(t-4)$: $\mathbf{P}^{ms}_{(t-4)} = \mathbf{P}_{(t-4)} \times \Phi^{ms}_{(t-4)}$

Previous Methods for Postcensal Population Estimates by Age, Sex and Marital Status

Until the 2000 edition of ***Annual Demographic Statistics***, postcensal estimates of the population by age, sex and marital status essentially reflected a combination of legal and *de facto* marital statuses.

The base population for persons aged 15 years and older, by age, sex and *de facto* marital status was used as the starting point. Since information affecting only legal marriages is available between censuses, the component method (as described earlier) using data related to marriages, deaths of married persons, and divorces were used to obtain marital status estimates.

The current methods, which produce separate estimates for legal and *de facto* marital statuses were implemented for the 2002 postcensal estimates. At that time, the two series of marital status estimates were calculated, beginning with the 1996 period, using these methods.

The new methods are anticipated to produce better quality marital status estimates, as they are based upon and distinguish between the two definitions of marital status. Errors of closure based on the 2001 Census for marital status estimates will provide an indication of the quality of the estimates.

Data Quality

As Table 9.3 indicates, the errors of closure by sex and age group are generally small. For the majority of age groups under 70 years (for both sexes), the errors of closure are less than 1%. However, the largest errors of closure (for both sexes) are observed at the 70-74 to 90+ year age groups, ranging from 1.92% for 70-74 year old females to 13.28% for 90+ year old males.

Table 9.3
Error of Closure[1] by Sex and Age Group, Canada, July 1, 1996

	Male		Female	
Age Group	Number	Percent	Number	Percent
0-4	-4,095	-0.41	-4,284	-0.45
5-9	3,394	0.33	5,112	0.52
10-14	-2,526	-0.24	-1,320	-0.13
15-19	-19,819	-1.91	-11,429	-1.17
20-24	11,946	1.17	10,444	1.06
25-29	15,973	1.46	16,425	1.54
30-34	5,659	0.43	12,580	0.99
35-39	4,987	0.38	11,980	0.92
40-44	1,296	0.11	6,845	0.57
45-49	8,043	0.76	6,192	0.58
50-54	11,144	1.35	2,817	0.34
55-59	4,191	0.64	-841	-0.13
60-64	2,139	0.36	3,024	0.49
65-69	5,975	1.12	5,564	0.94
70-74	9,276	2.18	10,360	1.92
75-79	8,288	2.94	10,843	2.66
80-84	5,607	3.29	7,443	2.59
85-89	3,930	5.27	5,606	3.55
90+	3,788	13.28	4,808	5.73
All ages	**79,196**	**0.61**	**102,169**	**0.54**
Mean absolute error[2]		**1.98**		**1.38**

[1] The error of closure is equal to the July 1, 1996 postcensal estimates minus the 1996 Census count adjusted to July 1 and for net undercount.

[2] Mean absolute error is the sum of the absolute values of the percent differences divided by the number of categories.

Source: Demography Division, Statistics Canada

Since the recording of marriages and divorces is required by law, the coverage and quality of these data are also quite high. However, prior to 2000, postcensal estimates produced by Demography Division represented a combination of legal and *de facto* marital statuses. The *de facto* census population counts by age, sex and marital status were used as the base, then using the component method as described earlier for legal marital status, events affecting legal marital status were applied. In effect, the population by marital status reflected a *de facto* marital status, with only legal changes between Censuses, since information is not available for events affecting common-law unions.

As mentioned, it is expected that the new methods will produce better quality population estimates by marital status, as they are based upon and distinguish between the two definitions of marital status. Errors of closure for marital status estimates from the 2001 Census will serve as an indicator of the quality of estimates for both legal and *de facto* marital status.

The quality of census counts by age, sex and marital status also affects the quality of population estimates, according to these characteristics. For example, the misclassification of common-law unions by Census respondents contributes to the error (i.e., when asked to identify themselves as "married", respondents living in common-law unions may erroneously report "single", indicating their legal marital status). Prior to the 1981 Census, no data were available on the number of persons living in common-law unions. With common-law unions becoming more prevalent, as shown in Table 9.4, the requirement for data related to this type of relationship increases.

Table 9.4
Persons Living as Couples and Those Living in Common-law Unions, by Province and Territory, 1986-1996 Censuses (100% data)

Province/territory	Living in Couples (in thousands)			Living in Common-law Unions			Common-law as a Percentage of All Couples		
	1986	1991	1996	1986	1991	1996	1986	1991	1996
Canada	**11,781.7**	**12,823.3**	**13,509.9**	**974.1**	**1,452.4**	**1,827.3**	**8.3**	**11.3**	**13.5**
Newfoundland and Labrador	253.0	266.1	271.4	10.1	19.9	26.3	4.0	7.5	9.7
Prince Edward Island	56.2	59.2	61.7	2.6	4.1	5.5	4.7	6.9	8.9
Nova Scotia	401.4	424.1	430.1	26.4	40.3	47.9	6.6	9.5	11.1
New Brunswick	324.7	343.7	357.0	19.2	31.8	44.8	5.9	9.2	12.5
Quebec	3,000.3	3,231.8	3,303.3	377.4	614.0	798.6	12.6	19.0	24.2
Ontario	4,314.8	4,772.8	5,066.3	269.5	364.4	449.9	6.2	7.6	8.9
Manitoba	487.6	500.0	509.2	30.6	42.6	50.2	6.3	8.5	9.9
Saskatchewan	464.7	456.3	455.3	27.5	35.5	43.9	5.9	7.8	9.7
Alberta	1,090.8	1,174.3	1,261.6	90.3	119.9	143.0	8.3	10.2	11.3
British Columbia	1,359.5	1,561.5	1,755.2	115.3	171.3	205.4	8.5	11.0	11.7
Yukon	9.9	12.1	13.6	2.0	2.8	3.7	19.8	23.3	27.0
Northwest Territories	18.8	21.4	25.2	3.2	5.7	8.1	16.9	26.5	32.2

Source: 1986, 1991 and 1996 Census data

With the 1981 and 1986 Censuses, common-law data were derived from a question concerning the relationship between the reference person and other members of the household. Respondents were instructed to indicate their *de facto* marital status (i.e., common-law persons were to identify their marital status as "married"). However, as illustrated in Table 9.5, many respondents who reported that their relationship to Person 1 was one of "common-law partners" in the 1986 Census, specified their marital status as other than "married": 60% reported themselves as "single", 22% as "divorced", and 3% as "widowed". Only 4% of those living in common-law relationships reported that they were "married" (including those separated).

To improve the quality of marital status data, the census category of marital status underwent an important change in the 1991 Census. Contrary to previous censuses, respondents were instructed to give their legal marital status, and a specific question regarding common-law status was directly introduced, such that common-law data could be derived from this question in conjunction with the information on the relationships among household members. Also, persons in common-law unions could be classified according to their legal marital status. As shown in Tables 9.6 and 9.7, the breakdown of legal marital status as reported by persons living in common-law relationships for the 1991 and 1996 Censuses is somewhat reflective of the breakdown of *de facto* marital status in 1986.

However, because prior to 1991, persons in common-law unions were included in the "now-married (excluding separated)" category, demographic data on marital status are not comparable with data from previous censuses. In order to maintain the historical comparability of the census data on marital status, an additional set of data is required, derived from the question on legal marital status and from the question on whether the person was living with a common-law partner.

Despite the problem of historical comparability, the main advantage to the change in 1991 is the improved quality of data on the number of persons in common-law unions, which also allows for data on the legal marital status of persons living in common-law unions. This change in the Census along with the changes to Demography Division's methods of estimation for *de facto* marital status will allow for improved comparison between the two sets of data.

Table 9.5
Marital Status (*de facto*)[1] as Reported by Persons Living in Common-law Unions, 1986[2]

Province/territory	Single	Now-married	Separated	Divorced	Widowed	Other	Total
Canada	**60.0**	**4.0**	**10.1**	**21.7**	**3.4**	**0.8**	**100.0**
Newfoundland and Labrador	65.8	1.6	9.5	17.7	4.4	0.9	100.0
Prince Edward Island	58.7	2.5	12.0	19.4	6.0	1.4	100.0
Nova Scotia	58.6	2.1	9.5	25.0	4.0	0.8	100.0
New Brunswick	59.1	4.1	11.5	21.2	3.6	0.6	100.0
Quebec	67.4	5.3	5.3	18.5	3.0	0.5	100.0
Ontario	50.9	2.9	16.3	25.2	3.9	0.8	100.0
Manitoba	59.2	3.8	12.2	19.7	3.6	1.5	100.0
Saskatchewan	66.7	3.5	9.1	16.3	3.0	1.3	100.0
Alberta	61.5	3.1	8.3	23.5	2.7	0.9	100.0
British Columbia	54.0	3.7	12.2	25.2	3.6	1.2	100.0
Yukon	66.6	4.0	9.1	15.2	3.5	1.7	100.0
Northwest Territories	68.3	12.1	6.1	8.7	1.7	3.1	100.0

[1] Prior to 1991, respondents living in common-law unions were instructed to indicate their marital status as " now married".
[2] Based on 20% sample.
Source: 1986 Census data

Table 9.6
Legal[1] Marital Status as Reported by Persons Living in Common-law Unions, 1991[2]

Province/territory	Response to Common-law Question[3]	Single	Now-married	Separated	Divorced	Widowed	Other	Total
Canada	**Total**	**64.7**	**1.1**	**6.5**	**23.6**	**3.1**	**1.0**	**100.0**
	Yes	**62.5**	**0.8**	**6.3**	**22.9**	**3.0**	**0.9**	**96.3**
	No	**1.6**	**0.3**	**0.1**	**0.4**	**0.1**	**0.0**	**2.5**
	Other	**0.6**	**0**	**0.1**	**0.3**	**0.1**	**0.1**	**1.1**
Newfoundland and Labrador	Total	71.4	0.7	5.2	18.5	3.2	1.0	100.0
	Yes	69.5	0.6	5.1	18.1	3.1	0.9	97.3
	No	1.3	0.2	0.1	0.3	0.1	0	1.8
	Other	0.6	0	0	0.2	0	0.1	0.9
Prince Edward Island	Total	59.7	0.5	9.4	27.1	2.7	0.7	100.0
	Yes	58.2	0.5	9.2	27.1	2.4	0.2	97.6
	No	1.4	0	0.2	0	0.2	0	1.9
	Other	0	0	0	0	0	0.5	0.5
Nova Scotia	Total	61.1	1.0	6.7	27.1	3.5	0.6	100.0
	Yes	59.4	0.8	6.5	26.4	3.3	0.5	96.8
	No	1.1	0.2	0.2	0.5	0.1	0	2.0
	Other	0.6	0.1	0.1	0.3	0.1	0.1	1.2
New Brunswick	Total	64.3	1.1	9.5	21.3	3.3	0.5	100.0
	Yes	62.7	0.5	9.1	20.9	3.2	0.4	96.7
	No	1.1	0.6	0.3	0.4	0.1	0	2.5
	Other	0.5	0	0.1	0	0	0.1	0.7
Quebec	Total	71.5	0.8	3.9	20.4	2.9	0.5	100.0
	Yes	69.6	0.5	3.8	19.8	2.8	0.4	96.9
	No	1.5	0.2	0.1	0.4	0.1	0	2.3
	Other	0.5	0	0	0.2	0	0.1	0.7

Table 9.6
Legal[1] Marital Status as Reported by Persons Living in Common-law Unions, 1991[2] (concluded)

Province/territory	Response to Common-law Question[3]	Single	Now-married	Separated	Divorced	Widowed	Other	Total
				Reported Legal Marital Status in Percent				
Ontario	Total	54.3	1.6	9.9	29.2	3.6	1.4	100.0
	Yes	52.4	1.2	9.6	28.3	3.4	1.1	96.0
	No	1.2	0.4	0.2	0.5	0.1	0	2.4
	Other	0.6	0.1	0.2	0.4	0.1	0.2	1.6
Manitoba	Total	65.9	1.0	6.7	21.1	3.5	1.8	100.0
	Yes	63.1	0.7	6.4	20.4	3.3	1.4	95.3
	No	2.0	0.3	0.2	0.5	0.1	0	3.0
	Other	0.8	0	0.1	0.2	0.1	0.4	1.6
Saskatchewan	Total	70.3	0.8	5.7	17.7	3.0	2.5	100.0
	Yes	67.7	0.4	5.5	17.4	3.0	2.1	96.1
	No	1.6	0.4	0.1	0.1	0	0.1	2.3
	Other	1.0	0	0.1	0.2	0	0.3	1.5
Alberta	Total	64.4	0.9	6.2	24.6	2.5	1.4	100.0
	Yes	61.4	0.6	6.0	23.7	2.4	1.2	95.3
	No	2.2	0.3	0.1	0.6	0.1	0.0	3.4
	Other	0.7	0	0.1	0.3	0	0.2	1.3
British Columbia	Total	58.9	1.1	8.5	26.5	3.5	1.4	100.0
	Yes	56.3	0.9	8.2	25.7	3.4	1.1	95.7
	No	2.1	0.2	0.2	0.6	0.1	0	3.2
	Other	0.5	0	0.1	0.2	0	0.2	1.0
Yukon	Total	63.1	3.4	6.7	20.3	2.5	4.0	100.0
	Yes	61.2	3.0	6.7	20.0	2.3	3.5	96.7
	No	1.1	0.4	0	0	0.1	0	1.6
	Other	0.8	0	0	0.3	0.1	0.5	1.6
Northwest Territories	Total	77.9	1.2	6.2	11.6	1.9	1.2	100.0
	Yes	76.4	0.9	6.1	11.5	1.8	1.2	97.9
	No	1.3	0.3	0	0.1	0	0	1.7
	Other	0.2	0	0	0	0	0.1	0.3

Note: Values of zero (0) represent either a true value of zero or indicate that the amount is too small to be expressed.

[1] Commencing with the 1991 Census, all respondents were instructed to report their legal marital status. Common-law unions are now identifiable by a separate question on common-law unions as well as the relationship to Person 1.

[2] Based on 20% sample.

[3] "Total" represents common-law unions, as obtained from the "Relationship to Person 1" census question. "Yes" or "No" represent the response of Person 1 to the question of being in a common-law relationship.

Source: 1991 Census data

Table 9.7
Legal[1] Marital Status as Reported by Persons Living in Common-law Unions, 1996[2]

Province/territory	Response to Common-law Question[3]	Single	Now-married	Separated	Divorced	Widowed	Other	Total
				Reported Legal Marital Status in Percent				
Canada	**Total**	**64.5**	**0.9**	**5.4**	**24.0**	**2.7**	**2.4**	**100.0**
	Yes	**63.0**	**0.5**	**5.3**	**23.6**	**2.7**	**2.3**	**97.5**
	No	**1.2**	**0.3**	**0.1**	**0.3**	**0**	**0**	**1.9**
	Other	**0.2**	**0**	**0**	**0.1**	**0**	**0.1**	**0.4**
Newfoundland and Labrador	Total	73.1	0.9	3.5	17.2	2.8	2.5	100.0
	Yes	71.6	0.4	3.5	16.9	2.8	2.4	97.6
	No	1.5	0.5	0.1	0.2	0	0	2.2
	Other	0	0	0	0.1	0	0.1	0.2
Prince Edward Island	Total	60.7	1.2	8.2	23.9	3.1	2.9	100.0
	Yes	58.7	1.0	8.0	23.1	2.7	2.7	96.1
	No	1.8	0.2	0.2	0.2	0.2	0	2.7
	Other	0.2	0	0	0.6	0.2	0.2	1.2
Nova Scotia	Total	59.7	0.9	7.2	26.4	3.1	2.7	100.0
	Yes	58.5	0.6	7.1	25.9	3.0	2.6	97.6
	No	1.1	0.3	0.1	0.3	0.1	0	1.8
	Other	0.2	0	0	0.2	0	0	0.4

Table 9.7
Legal[1] Marital Status as Reported by Persons Living in Common-law Unions, 1996[2] (concluded)

Province/territory	Response to Common-law Question[3]	Reported Legal Marital Status in Percent						
		Single	Now-married	Separated	Divorced	Widowed	Other	Total
New Brunswick	Total	64.5	0.9	9.4	20.1	2.9	2.1	100.0
	Yes	62.8	0.6	9.1	19.9	2.8	2.0	97.1
	No	1.5	0.3	0.3	0.2	0.1	0	2.5
	Other	0.2	0	0	0	0	0.1	0.3
Quebec	Total	70.9	0.5	2.8	21.8	2.6	1.5	100.0
	Yes	69.8	0.3	2.7	21.4	2.5	1.4	98.2
	No	0.9	0.2	0	0.2	0	0	1.3
	Other	0.2	0	0	0.1	0	0.1	0.3
Ontario	Total	54.3	1.5	8.7	29.2	3.0	3.2	100.0
	Yes	52.3	0.8	8.5	28.6	2.9	3.1	96.3
	No	1.6	0.6	0.1	0.4	0.1	0	2.8
	Other	0.4	0.1	0.1	0.2	0	0.1	0.8
Manitoba	Total	66.9	1.1	5.1	20.9	3.0	1.8	98.8
	Yes	65.4	0.7	5.0	20.6	2.9	1.4	95.9
	No	1.4	0.3	0.1	0.2	0	0	2.1
	Other	0.2	0	0	0.1	0	0.4	0.7
Saskatchewan	Total	69.0	1.0	5.2	19.3	2.6	3.0	100.0
	Yes	67.4	0.4	5.1	18.9	2.5	2.9	97.2
	No	1.3	0.5	0.1	0.2	0.1	0	2.2
	Other	0.3	0	0	0.2	0.0	0.1	0.5
Alberta	Total	62.8	0.9	6.3	24.6	2.3	3.1	100.0
	Yes	61.2	0.6	6.2	24.2	2.3	3.0	97.5
	No	1.4	0.3	0.1	0.3	0	0	2.0
	Other	0.2	0	0	0.1	0	0.1	0.4
British Columbia	Total	57.9	1.1	7.3	26.9	3.2	3.5	100.0
	Yes	56.7	0.7	7.2	26.5	3.1	3.4	97.6
	No	1.1	0.3	0.1	0.3	0.1	0	1.9
	Other	0.2	0.1	0	0.1	0	0.1	0.5
Yukon	Total	67.5	0.8	6.4	17.9	2.4	4.9	100.0
	Yes	66.6	0.7	6.4	17.7	2.3	4.8	98.6
	No	0.7	0.1	0	0.2	0.1	0	1.2
	Other	0.1	0	0	0	0	0.1	0.2
Northwest Territories	Total	80.2	0.8	4.3	10.9	1.5	2.3	100.0
	Yes	77.9	0.4	4.3	10.9	1.5	2.3	97.2
	No	2.1	0.3	0.1	0.1	0	0	2.6
	Other	0.1	0	0	0	0	0	0.1

Note: Values of zero (0) represent either a true value of zero or indicate that the amount is too small to be expressed.

[1] Commencing with the 1991 Census, all respondents were instructed to report their legal marital status. Common-law unions are now identifiable by a separate question on common-law unions as well as the relationship to Person 1.

[2] Based on 20% sample.

[3] "Total" represents common-law unions, as obtained from the "Relationship to Person 1" census question. "Yes" or "No" represent the response of Person 1 to the question of being in a common-law relationship.

Source: 1996 Census data

Chapter 10

Census Family Estimates[64]

In addition to population estimates, Statistics Canada produces estimates of census families at national and provincial/territorial levels. The publication of census family estimates dates back to 1948. Several methodological revisions have been made in the interim, with the additional components of common-law families having been introduced in 1982, and non-permanent resident families in 1991. Returning and temporary emigrant families followed in 1998, with revisions to the estimates going back to 1996.

For husband-wife families, estimates related to the family size and structure as well as the age group of children, husband, and wife are available. Estimates for lone-parent families are produced by the age and sex of parent, size of family, and average family size by sex of parent.

Data Sources and Relevant Concepts

For the purpose of generating estimates, the definition of family is the same as that used for the census. As defined up to and including the 1996 Census, a census family can be any of the following:

(i)   a husband-wife family, where the husband and wife live in the same dwelling, with or without never-married sons and/or daughters (of any age) of either or both parents; or

(ii)   a lone-parent family, where the lone-parent can be of any marital status, living in the same dwelling with one or more never-married children, regardless of their age; or

(iii)   a common-law family, where a couple are living in a common-law arrangement, regardless of their legal marital status, but are considered to form a husband-wife family, as in (i), above (Statistics Canada (1999d)).

The data sources used to estimate the components of change in the number of census families are often the same as those used to estimate the components of population change. The base for family estimates is the count of families in the census, adjusted for net undercoverage. Table 10.1 shows the sources and references of data used to generate the postcensal census family estimates.

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[64] This chapter is highly based on Chapter 7 – Family Estimates in *Population Estimation Methods, Canada* (1987).

Table 10.1
Sources and References of Data Used to Generate the Postcensal Estimates of Census Families

Component	Sources and References (if applicable)
Base Population (Censal Estimate)	Census counts of families (Census of Canada, Catalogue no. 93-357-XPB)
	Reverse Record Check (RRC) (in *Coverage, 1996 Census Technical Reports* , Statistics Canada, Catalogue no. 92-370)
Marriages	Statistics Canada, Health Statistics Division
	Statistics Canada, Demography Division (Catalogue nos. 91-002-XPB and 91-002-XIB, Quarterly)
	Census data
Divorces	Statistics Canada, Health Statistics Division
	Statistics Canada, Demography Division
Deaths	Statistics Canada, Health Statistics Division
	Statistics Canada, Demography Division (Catalogue nos. 91-002-XPB and 91-002-XIB, Quarterly)
	Census data
Immigration	Statistics Canada, Demography Division
	Citizenship and Immigration Canada (CIC)
Non-permanent Residents	Statistics Canada, Demography Division
	CIC
Total Emigration	Statistics Canada, Demography Division
	Census data
Interprovincial Migration	Statistics Canada, Demography Division
	Canada Customs and Revenue Agency (CCRA - Canada Child Tax Benefit (CTB) files)
	Census data
Common-law Unions	Statistics Canada, Demography Division
	Census data

Estimates of Census Families, Canada, Provinces and Territories

There are several events which have an impact on the number of families, either through the formation of new families, the dissolution of existing families, or the migration of families. Table 10.2 lists those events and provides possible effects on the number of census families. Postcensal estimates of census families are obtained much in the same manner as are population counts, i.e., they are

derived using data from the most recent census, adjusted for net census undercoverage[65] (of families) and estimates of the components of change in families since that census.

Table 10.2
Events and Hypotheses Used to Reconstruct Changes in the Number of Census Families

Events	Hypothesized Effect of Events on Number of Census Families		
	Increase	No change	Decrease
Marriages and common-law unions[1]	If neither spouse is a family head	If one spouse is a family head	If both spouses are family heads
Divorces, separations[2], and annulments[2] of legal marriages and dissolution[2] of common-law unions	If there is more than one child and custody is shared	If there is at least one child and one parent has custody	If the couple is childless
Deaths of married persons[1] and of persons living in common-law unions[2]		If one spouse in a husband-wife family with children dies, or if a "non-family" married person dies	If one spouse in a childless husband-wife family, or both spouses in a husband-wife family with or without children, or a married lone-parent family head dies
Deaths of widows, widowers, or divorcees[1]		If a non-family person dies	If a lone-parent family head dies
Death[2] or leaving home[2] of a lone-parent family child		If at least another child still lives at home	If a lone child dies or leaves home
Births[1]	If a child is born to a non-family person or to a child at home	If a child is born to a head of a lone-parent family or to a husband and wife	
International migration[1]	If a family immigrates, or a non-permanent resident family enters to reside in Canada		If a family emigrates, or a non-permanent resident family leaves Canada
Interprovincial migration[1]	If a family arrives from another province[3]		If a family leaves for another province[3]

[1] Refers to events for which insufficient information is available.

[2] Refers to events for which no statistical information is available.

[3] Applies only at the provincial level.

Source: Statistics Canada, 1987

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[65] Estimates of net census undercoverage are available only for the total number of families in provinces and territories, i.e., they are not available by family characteristics.

Not all information can be included in the estimates of change as components. Information on marriages, divorces, deaths, immigration, non-permanent residents, emigration and interprovincial migration is either readily available, or can be derived indirectly from administrative data sources. The lack of information on separations, annulments, and on children leaving home, however, makes the estimation of factors contributing to the formation or dissolution of a family rather difficult. In addition, the unavailability of current data on common-law union formations is a serious concern. However, attempts are made to estimate these types of unions and their family characteristics, as described in section (7) in this chapter.

Finally, the components can be divided into three groups, classified by their impact on the number of families as follows:

- events that contribute to the formation of new families (marriages);
- events that result in the dissolution of families (divorce, death of married persons, death of widowed persons and death of divorced persons); and
- events that produce a change in the number of families (net interprovincial migration, immigration and emigration of families, change in the number of families temporarily abroad, returning emigrant families, change in non-permanent resident families and change in common-law unions).

The change in the number of families between any two points in time $(t, t + i)$ is determined by means of the component method. The method involves the addition of events which result in family formation to, and the subtraction of events that result in dissolution from, the number of families at base year.

The total number of census families in the year $(t + i)$ is estimated using the following equation:

For each province/territory:

Equation 10.1

$$F_{(t+i)} = F_t + \left(F_{(t,t+i)}^{mar} + F_{(t,t+i)}^{I} + F_{(t,t+i)}^{IM^{net}} + F_{(t,t+i)}^{RE} \right) - \left(F_{(t,t+i)}^{E} + F_{(t,t+i)}^{TE} + F_{(t,t+i)}^{V} + F_{(t,t+i)}^{D_{mar}} + F_{(t,t+i)}^{D_w} + F_{(t,t+i)}^{D_v} \right) + \Delta F_{(t,t+i)}^{cl} + \Delta F_{(t,t+i)}^{NPR}$$

where

$F_{(t+i)}$	=	number of census families in year $(t + i)$;
F_t	=	number of census families in census year t;
$F_{(t,t+i)}^{mar}$	=	number of new families resulting from marriages during the period $(t, t + i)$;
$F_{(t,t+i)}^{I}$	=	number of families immigrating from another country during the period $(t, t + i)$;
$F_{(t,t+i)}^{IM^{net}}$	=	net interprovincial migrant families, migrating during the period $(t, t + i)$;
$F_{(t,t+i)}^{RE}$	=	number of returning emigrant families during the period $(t, t + i)$;
$F_{(t,t+i)}^{E}$	=	number of families emigrating during the period $(t, t + i)$;
$F_{(t,t+i)}^{TE}$	=	number of families temporarily abroad during the period $(t, t + i)$;
$F_{(t,t+i)}^{V}$	=	number of dissolutions of families due to divorce during the period $(t, t + i)$;

$F^{D_{mar}}_{(t,t+i)}$ = number of dissolutions of families due to deaths of married persons during the period $(t, t + i)$;

$F^{D_w}_{(t,t+i)}$ = number of dissolutions of families due to deaths of widowed persons during the period $(t, t + i)$;

$F^{D_v}_{(t,t+i)}$ = number of dissolutions of families due to deaths of divorced persons during the period $(t, t + i)$;

$\Delta F^{cl}_{(t,t+i)}$ = change in common-law unions during the period $(t, t + i)$;

$\Delta F^{NPR}_{(t,t+i)}$ = change in the number of non-permanent resident families during the period $(t, t + i)$.

The following 7 sections describe how each of the above components is derived.

(1) The contribution of marriages to family formation

In order to estimate the number of marriages contributing to family formation during a period, marriages must first be classified by age, sex, marital status and the headship status of both partners immediately preceding marriage. The Vital Statistics database provides data on marriages, by age and prior marital status, separately for males and females. The database, however, does not provide information on headship status. This information can be estimated from census data. The combined information on marriages (from Vital Statistics) and headship rates (derived from the last census) is used to estimate the number of newly formed families.

The first step in the process is the estimation of the number of marriages, separately for each of the possible sex and marital status combinations, where at least one spouse was the head of a lone-parent family prior to the current marriage. This is accomplished by applying the headship rate for lone-parent families of a given marital status to the number of marriages for a given sex and marital status, both at a given age, as follows:

Equation 10.2:
$$\mathbf{H}^{ms,a} = \frac{\mathbf{L}^{ms,a}}{\mathbf{P}^{ms,a}}$$

where

$\mathbf{H}^{ms,a}$ = headship rate by marital status and age, according to census data;

$\mathbf{L}^{ms,a}$ = number of persons who are lone-parent family head by marital status and age, enumerated in the last census;

$\mathbf{P}^{ms,a}$ = total number of persons by marital status and age enumerated in the last census.

Equation 10.3:
$$\mathrm{MAR}^{ms,a}(h) = \mathrm{MAR}^{ms,a} \times \mathbf{H}^{ms,a}$$

where

$\text{MAR}^{ms,a}(h)$ = number of marriages of family heads by marital status (single, widowed or divorced) and age;

$\text{MAR}^{ms,a}$ = total number of marriages by marital status and age;

The age, sex and marital status-specific number of marriages for non-family heads is obtained by subtracting the number of marriages of lone-parent heads from the corresponding total number of marriages.

Equation 10.4:
$$\text{MAR}^{ms,a}(\overline{h}) = \text{MAR}^{ms,a} - \text{MAR}^{ms,a}(h)$$

where

$\text{MAR}^{ms,a}(\overline{h})$ = number of marriages of persons other than family heads by marital status and age.

The next step is to estimate the number of newly-married persons of a given sex and marital status, according to the headship and marital status of his/her partner (reference spouse) prior to marriage. In order to achieve this, a joint probability of marriage, irrespective of age, according to the various marital and headship status combinations, must first be calculated as follows:

Equation 10.5:
$$\pi^{ms}(h') = \sum_{ms'}\left(\frac{\text{MAR}^{ms,ms'}}{\text{MAR}^{ms}} \times \frac{\text{MAR}^{ms'}(h')}{\text{MAR}^{ms'}}\right)$$

where

$\pi^{ms}(h')$ = probability, for each marital status of reference spouse, that his/her marital partner is a family head;

$\dfrac{\text{MAR}^{ms,ms'}}{\text{MAR}^{ms}}$ = probability that a male (female) of marital status ms (ms′) has a married female (male) of marital status ms′ (ms);

$\dfrac{\text{MAR}^{ms'}(h')}{\text{MAR}^{ms'}}$ = probability that a newlywed female (male) of marital status ms′ (ms) is already a family head, h′ (h); and

Equation 10.6:
$$\text{MAR}^{ms'}(h') = \sum_{a'}\left(\text{MAR}^{ms',a'} \times \text{H}^{ms',a'}\right)$$

Equation 10.7:
$$\pi^{ms}(\overline{h}') = 1 - \pi^{ms}(h')$$

where

ms, ms' = marital status of reference spouse and that of his/her partner, respectively;

h, h' = indicator of lone-parenthood status for reference spouse and his/her partner, respectively;

a, a'	=	age of reference spouse and that of his/her partner, respectively;
$\text{MAR}^{ms,ms'}$	=	the number of reference spouses of a given marital status, by his/her partner's marital status;
$\pi^{ms}(\overline{h}')$	=	complement to $\Pi^{ms}(h')$, representing the probability, for each marital status of the reference spouse, that his/her marital partner is *not* a family head.

The above probabilities, when applied to the number of marriages classified by marital and headship status of the partner, yield the number of marriages by marital and headship status as shown below:

Category 1:   male only is family head

Equation 10.8: $\text{MAR}^{ms,a}(h, \overline{h}') = \text{MAR}^{ms,a}(h) \times \pi^{ms}(\overline{h}')$

Category 2:   female only is family head

Equation 10.9: $\text{MAR}^{ms,a}(\overline{h}, h') = \text{MAR}^{ms,a}(\overline{h}') \times \pi^{ms}(h)$

Category 3:   both male and female are family head

Equation 10.10: $\text{MAR}^{ms,a}(h, h') = \text{MAR}^{ms,a}(h) \times \pi^{ms}(h')$

Category 4:   neither male nor female is family head

Equation 10.11: $\text{MAR}^{ms,a}(\overline{h}, \overline{h}') = \text{MAR}^{ms,a}(\overline{h}) \times \pi^{ms}(\overline{h}')$

In categories 1 and 2, the marriage results neither in the formation nor the dissolution of a family. In category 3, marriage eliminates two existing families and creates a new family. In category 4, a new family is formed. Thus, the probability of net family formation through marriage by age group and marital status, by sex, is given by:

Equation 10.12: $\pi^{ms,a} = \dfrac{\text{MAR}^{ms,a}(\overline{h}, \overline{h}') - \text{MAR}^{ms,a}(h, h')}{\text{MAR}^{ms,a}}$

The final step is the estimation of the net number of families formed through marriages $F^m_{(t,t+i)}$:

Equation 10.13: $F^m_{(t,t+1)} = \dfrac{1}{2}\left[\sum_{ms} \sum_{a} \left(\pi^{ms,a} \times \text{MAR}^{ms,a}_{(t,t+i)} \right) + \sum_{ms'} \sum_{a'} \left(\pi^{ms',a'} \times \text{MAR}^{ms',a'}_{(t,t+i)} \right) \right]$

(2) The contribution of divorces to family dissolution

When a couple who has no children living at home undergo a divorce, a family is dissolved. If there are children living at home, however, the effect of divorce on net family formation is uncertain because of the lack of cross-classified information on child custody by place of residence, as well as the number of children living at home. The estimated number of family dissolutions resulting from

divorce is assumed to be equal to the number of divorces involving couples with no dependent children.[66]

(3) The contribution of death to family dissolution

The families at risk of being dissolved through death can be: two-parent families with or without children (i.e., death of one parent in two-parent families, death of both parents, deaths of parent(s) and child(ren)), and lone-parent families whose head is either single, widowed, separated or divorced (i.e., death of a parent or death of an only child). No information is available on, nor has any attempt been made to estimate family dissolution through either of the following categories: (i) death of an only child in lone-parent families; or (ii) death of either children, or both parents, in the case of two-parent families. These cases are considered rare and have been ignored here. The following sets out the procedures used for estimating the dissolution of family types due to death.

Couples without children and lone-parent families whose head is a separated person

Vital Statistics death data do not differentiate between deaths of separated persons from those of other married persons. This means that the separate estimation of the number of family dissolutions due to deaths in husband-wife families, and in lone-parent families (where the head of the family is separated) is not possible. Estimation of the total number of such family dissolutions because of death is achieved by multiplying the number of deaths of married persons, by age group, by age-specific probabilities of family dissolution due to death, as shown below.

Equation 10.14:
$$F_{(t,t+i)}^{D_{mar}} = \sum_a \left(D_{(t,t+1)}^{mar,a} \times \pi^{mar,a} \right)$$

where

$F_{(t,t+i)}^{D_{mar}}$ = number of families dissolved through deaths of married persons during the period $(t, t + i)$;

$D_{(t,t+i)}^{mar,a}$ = number of deaths of married persons by age group during the period $(t, t + i)$;

$\pi^{mar,a}$ = age-specific probabilities of family dissolution due to deaths of married persons.

The age-specific probabilities of family dissolution are calculated as the ratio of the sum of the number of couples without children and the number of separated lone-parents, to the total number of married persons of the same age, in the last census. The probabilities are derived as follows:

Equation 10.15:
$$\pi^{mar,a} = \frac{C^{mar,a}(c) + L^{mar,a}}{P^{mar,a}}$$

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[66] Dependent children are defined as all children under the age of 16 years, and all children over the age of 16 who are financially dependent.

where

$\pi^{mar,a}$ =   probability of family dissolution due to deaths of married persons, by age group;

$\mathbf{C}^{mar,a}(c)$ =   number of couples without children, by age group, as enumerated in last census;

$\mathbf{L}^{mar,a}$ =   number of lone parents who are separated, by age group, as enumerated in last census;

$\mathbf{P}^{mar,a}$ =   total number of married persons, by age group, as enumerated in last census.

Dissolution of families whose head is widowed or divorced

The number of families dissolved by the death of widowed and divorced persons is calculated by applying the family headship rates (Equation 10.16) in these two marital groups, to the corresponding number of deaths. The family headship rates are calculated from the most recent census, and are, in this case, used as probabilities of family dissolution. Thus:

Equation 10.16: $$\mathbf{H}^{w,a} = \frac{\mathbf{L}^{w,a}}{\mathbf{W}^{a}} \quad \text{and} \quad \mathbf{H}^{v,a} = \frac{\mathbf{L}^{v,a}}{\mathbf{V}^{a}}$$

where

$\mathbf{H}^{w,a}$ and $\mathbf{H}^{v,a}$ =   headship rate of widowed population and of the divorced population, respectively, by age group, in the last census;

$\mathbf{L}^{w,a}$ and $\mathbf{L}^{v,a}$ =   number of lone-parents who were widowed and divorced, respectively, by age group, in the last census;

$\mathbf{W}^{a}$ and $\mathbf{V}^{a}$ =   number of widowed and divorced persons, respectively, by age group, enumerated in the last census.

Equation 10.17: $$F_{(t,t+i)}^{D_w} = \sum_{a} \left(D_{(t,t+i)}^{w,a} \times \mathbf{H}^{w,a} \right) \text{ and}$$

Equation 10.18: $$F_{(t,t+i)}^{D_v} = \sum_{a} \left(D_{(t,t+i)}^{v,a} \times \mathbf{H}^{v,a} \right)$$

where

$F_{(t,t+i)}^{D_w}$ and $F_{(t,t+i)}^{D_v}$ =   number of families dissolved through deaths of widowed and divorced persons, respectively;

$D_{(t,t+i)}^{w,a}$ and $D_{(t,t+i)}^{v,a}$ =   number of deaths of widowed and of divorced persons, by age group, respectively.

The total number of families dissolved by the death of widowed and divorced persons is obtained by summing the results of equations 10.17 and 10.18.

(4) Immigration and total emigration of families

The number of new families to Canada during a reference period resulting from immigration requires information on the number of family units who immigrate, and on the number of family reunifications resulting from the arrival of persons who already have a parent, child or spouse in Canada. As neither is available, certain assumptions must be made.

For estimation purposes, it is assumed that the number of immigrant or emigrant families (including families emigrating permanently, living temporarily abroad and returning after emigrating) is closely approximated by the total number of married immigrant or emigrant females (permanent, temporary or returning). Therefore, for every married immigrant, permanent, temporary or returning emigrant female, it is assumed that there is one immigrant or emigrant family. For more information on immigration and emigration estimates, please see Chapters 4 and 6, respectively.

(5) Change in non-permanent resident families

The estimates of the number of non-permanent resident families are based on the same assumption as for estimates of immigrating and emigrating families, i.e., for each non-permanent married woman, there corresponds a non-permanent resident family. The number of non-permanent married women estimated for July 1 for the preparation of population estimates by marital status is used to derive annual flows.

(6) Interprovincial migration of families

Interprovincial family migration is calculated from Child Tax Benefit (CTB) files. Each month, Canada Customs and Revenue Agency sends information on the number of CTB recipients who transferred from one province to another, by province of origin and destination, as well as the corresponding number of families. To compensate for partial coverage of the program, the ratio between the child migrant matrix adjusted for incompleteness of the program and the child migrant matrix (for CTB recipients only) is applied to monthly family interprovincial migration matrices.

The family migrant matrix is calculated on a monthly basis, as follows:

For each month *m*:

Equation 10.19:
$$_{j,k}F_m^{0-17} = {}^{CTB}_{j,k}F_m^{0-17} \times \frac{_{j,k}IM_m^{0-17}}{{}^{CTB}_{j,k}IM_m}$$

where

$_{j,k}F_m^{0-17}$ = number of families with children aged 0-17 migrating from province/territory *j* to province/territory *k*, for month *m*;

$_{j,k}^{CTB}F_m^{0-17}$ = number of CTB-receiving families with children aged 0-17 migrating from province/territory *j* to province/territory *k*, for month *m*;

$_{j,k}\text{IM}_m^{0-17}$ = total number of children aged 0-17 migrating from province/territory j to province/territory k, for month m;

$_{j,k}^{CTB}\text{IM}_m$ = number of CTB-receiving children migrating from province/territory j to province/territory k, for month m;

To obtain the annual estimates of interprovincial migration of families with children aged 0-17, the July to June estimates are simply summed, as in Equation 10.20.

Equation 10.20:

$$_{j,k}\text{F}^{0-17} = \sum_{m=July}^{m=June} {}_{j,k}\text{F}_m^{0-17}$$

The data are also adjusted to take into account families without children under 18 years, or without children whatsoever. The adjustment is based on the total number of families according to the most recent census data, adjusted to July 1, and the same reference period for data from the CTB file.

Equation 10.21

$$_{j,k}\text{F}_{(t,t+1)} = \frac{\mathbf{F}}{{}^{CTB}\mathbf{F}} \times {}_{j,k}\text{F}_{(t,t+1)}^{0-17}$$

where

$_{j,k}\text{F}_{(t,t+1)}$ = total number of families (with and without children) migrating from province/territory j to province/territory k;

$\mathbf{F}$ = number of families according to census data, adjusted for net undercoverage;

$^{CTB}\mathbf{F}$ = number of CTB-receiving families;

$_{j,k}\text{F}_{(t,t+1)}^{0-17}$ = number of families with children aged 0-17 migrating from province/territory j to province/territory k.

(7) Contribution of common-law families to family formation

To obtain the net change in the number of common-law families, first the net change in the number of persons living in common-law unions between censuses is estimated. For each province, the annual change in the number of persons living in common-law relationships as a proportion of the population, by age group and sex is calculated. This is done by way of extrapolation of data from the two most recent censuses, divided by the censal estimates by age group and sex. These annual ratios are applied to the corresponding postcensal estimates of population as follows:

For each province/territory, by sex:

Equation 10.22:

$$\Delta\text{P}_{(t,t+1)}^{cl,a,s} = \left\{ \frac{1}{5} \left[\frac{\mathbf{P}_t^{cl,a,s} - \mathbf{P}_{(t-5)}^{cl,a,s}}{\frac{1}{2}\left(\mathbf{P}_t^{a,s} + \mathbf{P}_{(t-5)}^{a,s}\right)} \right] \right\} \times \text{P}_{(t+1)}^{a,s}$$

where, for each sex

$\Delta P^{cl,a,s}_{(t,t+1)}$ = annual change in the number of persons living in common-law relationships, by 5-year age group;

cl = number of persons living in common-law unions;

a = 5-year age group;

s = sex;

t = most recent census;

$(t-5)$ = second most recent census;

P = census enumerated population;

P = estimated population.

The annual change in the number of persons living in common-law relationships is then translated into changes in the number of common-law families, by averaging the number of males and females living in common-law relationships, as follows:

Equation 10.23:
$$\Delta F^{cl}_{(t,t+1)} = \frac{1}{2}\left(\sum_{s}\sum_{a}\Delta P^{cl,a,s}_{(t,t+1)}\right)$$

where

$\Delta F^{cl}_{(t,t+1)}$ = annual change in the number of common-law families;

$\Delta P^{cl,a,s}_{(t,t+1)}$ = annual change in the number of persons living in common-law relationships, by 5-year age group and sex;

a = 5-year age groups (from 15-19 to 60-64 and 65+ years);

s = sex.

Family Characteristics

The following characteristics of families are estimated using a linear extrapolation of trends based on data from the two most recent censuses[67]:

- size of family (2, 3, 4, 5 and 6+ members) and total number of persons in families of each size;
- type of family, as husband-wife or lone-parent;
- broad age group of children;
- broad age group of husband and wife;
- broad age group and sex of lone-parent.

The following four operations are involved in this procedure:

(i)   extrapolation of proportions of families by characteristics for each province;
(ii) adjustment for extrapolated proportions less than zero;
(iii) estimation of the number of families by characteristics;

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[67] These extrapolations are based on census data, which have not been adjusted for net undercoverage, since estimates of net undercoverage are not available for family characteristics.

(iv)   estimation of the number of persons in census families.

(i) Extrapolation of Proportions

The proportion of the number of census families (Φ) classified by characteristic is calculated for each province, for the census years (t - 5) and t. From these two sets of proportions, linear extrapolation produces a table containing annual estimates of Φ for postcensal years, as shown below:

Equation 10.24:

$$\Phi^k_{(t+i)} = \Phi^k_t + \left[\frac{i}{5} \left(\Phi^k_t - \Phi^k_{(t-5)} \right) \right]$$

where

Φ^k =   proportion of census families with characteristic k out of the total number of census families in a province.

A separate table is calculated for each province and time interval (t, t + i). The sum of all cells in a table, ($\sum \Phi^k_{(t+i)}$) is equal to one.

(ii) Adjustment for Negative Proportions

Linear extrapolation can result in projected proportions, which are less than zero. If a negative proportion in any of $\Phi^k_{(t+i)}$ tables is obtained, it is replaced by a value of zero (0) and each cell is then adjusted so that the new table sums to 1. The adjusted cell values are calculated as follows:

Equation 10.25:

$$\Phi'^k_{(t+i)} = \Phi''^k_{(t+i)} \times \left(\frac{1}{\sum \Phi''^k_{(t+i)}} \right)$$

where

$\Phi'^k_{(t+i)}$ =   adjusted cell value after removing negative proportions from the table;

$\Phi''^k_{(t+i)}$ =   unadjusted cell values after removing negative proportions (these values are zero where $\Phi^k_{(t+i)}$ is negative, and equal to $\Phi^k_{(t+i)}$ otherwise, i.e., where $\Phi^k_{(t+i)} \geq 0$).

(iii)   Estimated Number of Census Families by Characteristics

For each province and territory, the number of families for the year (t + i) with characteristic k is calculated by multiplying the provincial/territorial total number of families $F_{(t+i)}$ (estimated by the component method described in the first section of this chapter) by the adjusted proportions $\Phi'^k_{(t+i)}$, specific to the province/territory, as follows:

Equation 10.26:
$$F^k_{(t+i)} = F_{(t+i)} \times \Phi'^k_{(t+i)}$$

(iv) Estimated Number of Persons in Census Families

Estimating the total number of persons in census families requires several steps, due to the existence of the open-ended family size category, '6+'. First, the proportion of all persons in census families at the time of the last two censuses (Φ_t and $\Phi_{(t-5)}$), for any province or territory, is calculated from the appropriate census data. Taking the most recent census as the base, the proportions of all persons in census families for the estimate year ($\Phi_{(t+i)}$) again by province/territory, is calculated by linear extrapolation as follows:

Equation 10.27:
$$\Phi_{(t+i)} = \Phi_t + \left[\frac{i}{5}\left(\Phi_t - \Phi_{(t-5)}\right)\right]$$

The extrapolated proportion is then applied to the estimated total population in the estimate year ($P_{(t+i)}$) to arrive at the estimated number of persons in all census families ($P^F_{(t+i)}$), as follows:

Equation 10.28:
$$P^F_{(t+i)} = P_{(t+i)} \times \Phi_{(t+i)}$$

The next step involves calculating the proportion of all persons in census families in the estimate year who are in families of at least 6 persons ($\Phi^{6+}_{(t+i)}$). This is again accomplished by extrapolation from the two most recent censuses (*t* and *t - 5*), such that:

Equation 10.29:
$$\Phi^{6+}_{(t+i)} = \Phi^{6+}_t + \left[\frac{i}{5}\left(\Phi^{6+}_t - \Phi^{6+}_{(t-5)}\right)\right]$$

Next, the estimated number of persons in census families of at least 6 persons ($P^{F,6+}_{(t+i)}$) is calculated by applying the result of Equation 10.29 to that of Equation 10.28. Specifically:

Equation 10.30:
$$P^{F,6+}_{(t+i)} = P^F_{(t+i)} \times \Phi^{6+}_{(t+i)}$$

Finally, having derived the number of families of 2 through 5 persons from Equation 10.26 and the estimate of the number of persons in families of 6 or more, the adjusted estimate of the total number of persons living in census families $P'^F_{(t+i)}$ can be obtained by using the following equation:

Equation 10.31:
$$P'^F_{(t+i)} = \left[\sum_{(n=2)}^{5}\left(n(F^n_{(t+i)})\right) + P^{F,6+}_{(t+i)}\right]$$

where

$P'^F_{(t+i)}$ = total number of persons living in census families;

n =   number of persons in the family;

$F_{(t+i)}^n$ =   number of families of n persons (n = 2, 3, 4 or 5);

$P_{(t+i)}^{F,6+}$ =   number of persons living in families of 6 or more persons.

Intercensal Estimates of Census Families, Canada, Provinces and Territories

As with population estimates, intercensal estimates of census families are produced for reference dates between censuses. However, the method used is different than the one applied for population estimates. Intercensal estimates of census families are calculated by interpolating between the counts of census families based on the most recent and the previous censuses adjusted for census coverage error. The postcensal estimates of census families for reference dates between these two censuses are not considered.

Intercensal Estimates of Census Families by Characteristics

The following characteristics of families are estimated for the intercensal period (for each province and territory) using a linear interpolation of trends based on data from the two most recent censuses (Census t and Census (t - 5)):

- family type (husband-wife or lone-parent);
- family size (2, 3, 4, 5 and 6 or more members);
- age of children;
- age of parents in husband-wife families and age and sex of parent in lone-parent families.

The method used is based on the change in the selected characteristics between the two censuses. The following steps are carried out for each province and territory:

(i)   the distributions of families is calculated from the Census t and Census (t - 5);

(ii)   to obtain the distributions for each intercensal year, interpolation between the proportions calculated in (i) is performed;

(iii)   for each intercensal year, the interpolated proportions are multiplied by the estimated totals;

(iv)   the number of persons in census families by characteristic are calculated.

Data Quality

One method of evaluating family estimates is to compare the estimates for the census year to the census counts. Table 10.3 presents the results of this comparison, the error of closure, for 1996 and 1991. Two important features are revealed. First, there is a considerable variation in the error of closure for families by province/territory. For both 1991 and 1996, the error of closure was lowest for New Brunswick (0.14% and –0.03%, respectively) and highest for the Yukon (4.11% and 6.05%). Second, there is variation when comparing the error of closure for the two years. For instance, in 1996, the overall error of closure was almost half of that for 1991. Reduced error for 1996 estimates was most noticeable for Quebec, Manitoba and Saskatchewan. However, the error of closure was considerably higher (more than double) in 1996 for Nova Scotia and the Northwest Territories. A

portion of this difference may be explained by the fact that the 1991 estimates (both Demography Division's and the censal estimates) do not account for an adjustment for net census undercoverage of families and could be affected by the differentiated census coverage of 1986 and 1991. The 1996 estimates do include this adjustment, therefore they are affected only by errors in the estimates of the completeness of families' enumeration in both 1991 and 1996.

Four sources of error contribute to the error of closure:

(i)   the universes covered;
(ii)   census undercoverage;
(iii) errors arising from estimation methods and from data sources other than census; and
(iv)   common-law unions.

Table 10.3
Error of Closure[1] for Census Families, Canada, Provinces and Territories, 1991 and 1996

Province/territory	1991[2]				1996[3]			
	Postcensal Estimate	Censal Estimate	Error of Closure		Postcensal Estimate	Censal Estimate	Error of Closure	
			Number	Percent			Number	Percent
	(in thousands)				(in thousands)			
Canada	**7,233.3**	**7,364.8**	**-131.6**	**-1.79**	**7,921.2**	**7,998.9**	**-77.7**	**-0.97**
Newfoundland and Labrador	152.8	150.8	2.0	1.30	160.1	157.5	2.6	1.63
Prince Edward Island	34.7	33.9	0.8	2.24	36.6	36.1	0.5	1.35
Nova Scotia	242.7	244.8	-2.1	-0.86	252.4	256.9	-4.5	-1.75
New Brunswick	198.5	198.2	0.3	0.14	210.9	211.0	-0.1	-0.03
Quebec	1,854.5	1,885.1	-30.5	-1.62	1,980.8	1,974.2	6.6	0.33
Ontario	2,682.1	2,730.6	-48.6	-1.78	2,964.3	3,005.1	-40.8	-1.36
Manitoba	280.8	286.1	-5.3	-1.86	295.3	296.9	-1.6	-0.54
Saskatchewan	252.9	257.5	-4.6	-1.80	262.0	264.6	-2.6	-0.97
Alberta	660.4	668.7	-8.3	-1.25	724.8	731.9	-7.1	-0.97
British Columbia	853.7	889.2	-35.5	-3.99	1,009.2	1,040.8	-31.5	-3.03
Yukon	7.4	7.1	0.3	4.11	8.8	8.3	0.5	6.05
Northwest Territories[4]	12.9	12.7	0.1	0.86	15.9	15.5	0.4	2.37

[1] Error of closure was calculated using unrounded data.

[2] Demography Division postcensal estimates of census families for 1991 do not account for net undercoverage of families from the 1986 Census.

[3] The estimates of census families produced by Demography Division for 1996 include adjustment for net undercoverage from the 1991 Census.

[4] Data for the Northwest Territories include data for Nunavut.

Source: Demography Division, Statistics Canada

Family Universes

Family data from the census is not compatible with family data available from the Vital Statistics registration system, due to the differential treatment of collective households[68] and the events affecting their formation or dissolution. Families living in collective households are not included in census family tabulations, while the vital events experienced by the members of families or non-family

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[68] A collective household, as defined in the 1996 Census, refers to "a person or group of persons who occupy a collective dwelling and do not have a usual place of residence elsewhere in Canada." (Statistics Canada, *1996 Census Dictionary*). Collective dwelling refers to "a dwelling of a commercial, institutional or communal nature" (included are lodging or rooming houses, hotels, motels, tourist homes, nursing homes, hospitals, staff residences, communal quarters (military camps), work camps, jails, missions, group homes, and so on). (Statistics Canada, *Ibid.*).

persons in collective households are registered by Vital Statistics. This results in a discrepancy between families as identified by the census, and families as estimated on the basis of family-related events captured by Vital Statistics. The magnitude of error associated with this discrepancy is however, unknown.

Census Undercoverage

As with population estimates, net undercoverage is an important aspect of estimating the number of census families. As shown in Table 10.4, the net undercoverage for census families was only slightly higher in 1996 than in 1991. However, undercoverage rates vary between the provinces and territories, and by census year. For both 1991 and 1996, the lowest rate of undercoverage was in Prince Edward Island (0.32% and 0.60%, respectively), and the highest rate was in the Northwest Territories (3.00% and 3.32%, respectively). However, for some provinces, the net undercoverage rate was significantly higher in 1996 compared with 1991 (e.g., Saskatchewan, Alberta and British Columbia), while the only notable decrease was for Newfoundland and Labrador.

Table 10.4
Census Family Undercoverage, Canada, Provinces and Territories, 1991 and 1996

Province/territory	1991		1996	
	Number	Percent	Number	Percent
Canada	**139,038**	**1.82**	**147,957**	**1.85**
Newfoundland and Labrador	3,411	2.17	1,661	1.06
Prince Edward Island	109	0.32	217	0.60
Nova Scotia	1,438	0.58	2,656	1.04
New Brunswick	3,725	1.81	3,502	1.66
Quebec	23,034	1.19	22,445	1.14
Ontario	77,536	2.69	67,167	2.24
Manitoba	4,718	1.60	3,844	1.30
Saskatchewan	2,311	0.88	4,087	1.55
Alberta	5,936	0.87	12,877	1.76
British Columbia	16,264	1.77	28,789	2.78
Yukon	150	2.03	198	2.39
Northwest Territories[1]	406	3.00	514	3.32

[1] Data for the Northwest Territories include data for Nunavut.
Source: Social Survey Methods Division, Statistics Canada

One might assume that the net undercoverage rate for families would be fairly comparable with the rate for population. However, for most provinces and territories, the net undercoverage rate for families is notably lower than that for population (refer to Table 2.1 in Chapter 2).

Errors Arising from Estimation Methods and from Data Sources other than the Census

The estimates of the total number and characteristics of families contain a certain degree of error that stems from the data sources and estimation methods used for components. Error may be introduced as a result of: (i) the estimation of components for which direct statistical information is not available, and the assumptions that may be made in these estimations; and (ii) events which are

considered to cause formation or dissolution of families but are not taken into account in the estimation procedure due to lack of statistical information (i.e., unrecorded events).

The first group, (i), encompasses the estimation for the migration of families (international and interprovincial), the dissolution of families due to death of married, widowed or divorced persons, the formation or dissolution of families related to common-law union and changes in the number of non-permanent residents' families. For example, for estimation purposes, it is assumed that the number of immigrant families is closely approximated by the total number of married immigrant females in that for every married immigrant female, it is assumed that there is one immigrant family. A similar assumption is made for the estimation of emigrating families and the change in non-permanent resident families. Therefore, the quality of the family estimates depends on how accurately such assumptions reflect reality.

The second group, (ii), (unrecorded events) includes: (a) the formation of families by birth of a child whose parent is either a non-family person or who is a child living with a family, (b) dissolution of families due to separation, annulment of a legal marriage, death or departure of a sole child in a lone-parent family. The net effect of this second group is likely small.

Common-law Unions

Data on common-law unions obtained from the census are considered to be of good quality, especially since the introduction of "common-law" as a response to the question on relationship to Person 1 in 1991 Census. However, postcensal estimates of common-law arrangements are of much lower quality than the census. This is due to the fact that information on the formation and dissolution of common-law relationships is not available since common-law unions are not subject to Vital Statistics registration. Therefore, the number of persons living in these unions must be estimated based on extrapolation of past tendency (obtained from the two most recent censuses). The estimation is accurate only if the population's tendency to live in common-law arrangements continues past the two most recent censuses. Any change in this tendency with respect to the age and sex of partners results in a major discrepancy between the estimate and the reality it is supposed to approximate.

Chapter 11

Products, Services, Research and Development

To fill the gap between censuses, Demography Division of Statistics Canada produces population estimates and projections at the national, provincial, territorial and subprovincial levels. For the larger areas, the estimates and projections are produced more frequently and according to more detailed demographic characteristics. Statistics Canada also estimates the number and characteristics of census families.

As described in the Introduction to this manual, **The Daily** delivers the first and official release of statistical data and publications produced by Statistics Canada. Population estimates are released quarterly and annually. Quarterly estimates are produced for periods ending on the first day of January, April, July and October, and are available in **Quarterly Demographic Statistics**, Catalogue no. 91-002. Annual estimates of population and census families[69], referenced to July 1, are available in **Annual Demographic Statistics**, Catalogue no. 91-213. On occasion, Statistics Canada issues a comprehensive publication of long term projections entitled **Population Projections for Canada, Provinces and Territories**, Catalogue no. 91-520.

More specifically, the population and family estimates and the corresponding components of demographic change produced by Statistics Canada include the following:

Published Material

Canada, Provinces and Territories

1. Quarterly estimates of the total population by age and sex, as well as the components of population change (births, deaths, immigration, total emigration, non-permanent residents, interprovincial migration indicating province or territory of origin and destination);

2. Annual estimates of the population by age, sex and marital status and the components of population change, but only by age and sex (those mentioned above, in addition to marriages, divorces and new widowhoods);

3. Annual estimates of the number of census families by characteristics: family size and structure (husband-wife or lone-parent), structure and age group of children, age group of husband, age group of wife, age group and sex of parent and family size (lone parent families);

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[69] Up to 2001, this publication also included short-term projections (for 5-year period).

Subprovincial Areas

1. Annual estimates of the population areas and the components of demographic change by age and sex (births, deaths, immigration, total emigration, non-permanent residents, internal migration) of census divisions and census metropolitan areas;
2. Annual estimates of the population by age and sex for user-specified areas;
3. Annual projections of total population by age and sex for census metropolitan areas and census divisions.

In order to satisfy criteria of timeliness, accuracy and consistency, Statistics Canada releases various sets of estimates for a given reference date. Preliminary estimates are generally available within a few months of the reference date, whereas the final estimates based on final source data, involve a much longer time lag. A distinction is also made between estimates based on the census preceding the reference date (postcensal estimates) and those based on the two censuses defining the period (intercensal estimates).[70]

The most current population estimates and projections, as well as other demographic statistics, are also available from Statistics Canada's Canadian Socio-economic Information Management System (CANSIM II). CANSIM II is a database of time series data on a wide variety of social and economic topics made available for public use. CANSIM II can be accessed on Statistics Canada's website, www.statcan.ca, CD-ROM (Catalogue no. 10F0007XCB), and on Directory Disc (Catalogue no. 10F0005XCB). Data retrieved through the www.statcan.ca commercial services are subject to specific conditions of use detailed in the Limited Use Data Products Licence Agreement statement associated with these services.

You can order or subscribe to any of the aforementioned products by sending an email to order@statcan.ca, by calling toll-free 1-800-267-6677, or by contacting the nearest Statistics Canada Regional Reference Centre (see inside cover of this publication).

Custom Services Available

In addition to published reports and data, Demography Division is sufficiently flexible in terms of its data sources and methods to allow for a wide variety of custom work on a cost-recovery basis. A great many user-defined areas can be built to meet the demands of the data users for timely and accurate data for relatively fine geographic levels, depending on the specifications. For example, annual estimates of the population by broad age group and sex for census divisions and census metropolitan areas are available upon request, as are annual 25-year population projections.

Other types of custom estimates may be used to describe current demographic and socio-economic conditions, and also to simulate future patterns in an effort to assess the impact of current and expected trends in population growth and distribution. Services such as hospitals, schools, roads, facilities for the aged and the chronically ill, as well as services for target groups such as lone parents, aboriginals and the immigrant population are planned, implemented and evaluated using demographic estimates or projections as an important part of their input. Private industry makes use of estimates to meet a broad range of consumer-related needs, including marketing and distribution of products and services. Examples of non-standard geographic areas for which custom estimates have been produced by

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[70] For further information on postcensal and intercensal estimates, please refer to Chapter 1 of this manual.

Demography Division include municipalities, urban centres and economic regions for the Statistics Canada Labour Force Survey, and health regions for Health Statistics Division.

Research and Development

Due to the importance of population estimates at all levels of geography, producing the best quality estimates in a timely manner is a priority. Though estimates for the majority of the components of demographic change are of excellent quality, Demography Division is constantly conducting research to improve the quality of the weaker components (i.e., total emigration and interprovincial migration). This may involve seeking out and evaluating different data sources and/or changes to the theoretical approach, resulting in the implementation of new methods. Recent developments and research are described below.

Recent Developments

Adjustment for Net Census Undercoverage

In January 1993, Statistics Canada announced a decision to incorporate estimates of census error undercoverage into the estimation program.[71] Measurement of net undercoverage is based mainly on the Reverse Record Check and overcoverage studies. Other sources (e.g., results of demographic analysis) are also used. For detail on this adjustment, refer to Chapter 2 on Base Population.

Non-permanent Residents, Returning Emigrants and Persons Temporarily Abroad

In 1991, the universe for the Census of Canada was extended to include non-permanent residents (i.e., every person holding an employment or student authorisation, or Ministerial permit as well as refugee status claimants, including their dependants). In order to factor in the expansion of the census universe, a new component of population change has been introduced to measure change in the size of the non-permanent resident population. The procedure uses data from Citizenship and Immigration Canada's Field Operations Support System (FOSS) as the source of data on the number and movement of these individuals.

Also, population estimates now account for Canadian citizens and landed immigrants who leave the country and return at a later date (i.e., returning Canadians). Data about these movements are obtained from CCRA's Child Tax Benefit file and the most recent census. In addition, net flows of Canadian citizens and landed immigrants temporarily abroad are estimated. These estimates are derived from the number of persons living temporarily abroad as provided by the Reverse Record Check survey.

For details on the methods used to estimate non-permanent residents, returning emigrants and persons temporarily abroad, refer to Chapters 5 and 6.

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[71] Only population and family estimates are affected by this decision. Census data are not adjusted.

Estimation of Persons Living in Common-law Unions

Between censuses information is available only for changes in the legal marital status of individuals. As such, the changes to their *de facto* marital status must be estimated. In 2000, the method used to estimate the number of persons by *de facto* marital status was modified to better reflect evolution of the number of persons living in common-law unions. Chapter 9 describes the new method in detail, which uses population estimates by legal marital status and data from the most recent census.

Ongoing Research

Estimation Methods for Emigration Component

The estimation of emigration of Canadians has always been the weakest part of the Population estimation program due to incompleteness of the direct information. With a replacement of the Family Allowance Program by the Child Tax Benefit (CTB) in 1993, this incompleteness was increased as information on the families with children not entitled for this benefit was lost. As described in Chapter 6, additional data sources[72] and adjustments are required.

Ongoing research is being conducted in an attempt to increase the accuracy of emigration and return emigration estimates within the available data sources. Also, the exploitation of the current data sources to expend the information on different types of emigrants should lead to an improvement of the estimation methods. With respect to the third element of the total emigration component, persons temporarily abroad, research is concentrated on development of the current indicator of the changes in the size of this population. The method used now is based on an assumption that the trends observed in the past are good approximation of the present situation.

Estimation Methods for Interprovincial Migration Component

As with the emigration component, data from the Family Allowance Program were used to estimate internal migration until 1993. Current methods of estimation employ data from the CTB program and personal income tax returns. Preliminary estimates are derived monthly from CTB data, while final estimates are derived annually from personal income tax data.

As described in Chapter 7, the data sources and methods used for the production of preliminary and final estimates of internal migration have their strengths and weaknesses. Substantial differences exist between final and preliminary estimates (for in-, out- and net interprovincial migration) for all provinces and territories. Currently, research is being conducted in an attempt to reduce these differences. Additionally, research is in progress, with the objective of developing new methods to improve the data quality of final estimates of interprovincial migration for provinces and territories.

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[72] Data on Canadians emigrating to the United States are obtained from Immigration and Naturalization Services (INS) of the U.S. Department of Justice. Adult emigration is estimated using personal tax data from Small Area and Administrative Data Division of Statistics Canada, and information available from INS data and the CTB files.

Demography Division - Other Activities and Services

Although Demography Division is responsible for the development, production, and dissemination of population estimates, the division does not work in isolation. Demography Division maintains close ties with its federal/provincial-territorial focal points, which have a strong interest in the quality of the statistics produced. For example, before any changes are made to methods of estimation, the focal points are consulted. Also, prior to the release of estimates, the data are sent to the provinces and territories for their review and comments. Consultations on the concepts, details and dissemination approaches of Demography Division products are also conducted with experts from the academia.

In addition to producing and disseminating population estimates and projections, Demography Division provides a number of other services to its clients. For example, occasionally the division offers workshops to clients internal and external to Statistics Canada on the use and interpretation of population estimates. These workshops are geared to both frequent and occasional users of population statistics.

Demography Division also provides ongoing support to data users who may require further explanation of estimates and/or the methods used to produce them. Enquiries may be made to Demographic Estimates Section, Statistics Canada, Ottawa, Ontario, K1A 0T6 (telephone: (613) 951-2320, for information on demographic estimates or (613) 951-0694, for enquiries related to methods, concepts and data quality of population estimates.

Appendix I
Glossary

Age: Age at last birthday in years: age at the beginning of the period and as as of July 1.

Ageing (of a population): An increase in the number of old persons as a percentage of the total population.

Average Absolute Error of Closure: The mean of the absolute percent differences between the postcensal estimates and the population adjusted for net undercoverage according to a census for the same date.

Base Population: The base population refers to the population at the beginning of a period used as a reference or starting point for the estimation process. For postcensal estimates, the base population is the population enumerated in the most recent census, adjusted to July 1 and corrected for net undercoverage. The base population for intercensal estimates is the postcensal-estimated population.

Birth Cohort (or Generation): Unless otherwise specified, refers here to a group of persons born within the 12-month period between July 1 of a given year and June 30 of a given year.

Censal Estimate: The population enumerated in the census, corrected for net undercoverage. Censal estimates adjusted to July 1, are used as the base population for postcensal population estimates, to which the components of population growth are added (or subtracted).

Census Coverage

   Net undercoverage: Difference between undercoverage and overcoverage.

   Overcoverage: Number of persons who should not have been counted in the census or who were counted more than once.

   Undercoverage: Number of persons not enumerated in a census (who were intended to have been enumerated).

Census Division (CD): Refers to the general term applying to geographic areas established by provincial law, which are intermediate geographic areas between *census subdivision* and the province (e.g., divisions, counties, regional districts, regional municipalities and seven other types of geographic areas made up of groups of census subdivisions).

   In Newfoundland, Manitoba, Saskatchewan and Alberta, provincial law does not provide for these administrative geographic areas. Therefore, census divisions have been created by Statistics Canada in co-operation with these provinces.

Census Family: Refers to a now-married couple (with or without never-married children, regardless of their age, of either or both spouses), a couple living common-law (with or without never-married

children, regardless of their age, of either or both partners), or a lone parent of any marital status, with at least one never-married child, regardless of age, living in the same dwelling.

Census Metropolitan Area (CMA): The general concept of a census-metropolitan area (CMA) is one of a very large urban area, together with adjacent urban and rural areas which have a high degree of economic and social integration with that urban area.

A Census Metropolitan Area is delineated around an urban area (called the urbanized core and having a population of at least 100,000 (based on the previous census). Once an area becomes a CMA, it is retained in the program even if its population subsequently declines.

CMAs are comprised of one or more *census subdivisions (CSDs)* which meet at least one of the following criteria: (1) the CSD falls completely or partly inside the urbanized core; (2) at least 50% of the employed labour force living in the CSD works in the urbanized core; or (3) at least 25% of the employed labour force working in the CSD lives in the urbanized core.

Census Subdivision (CSD): Refers to the general term applying to municipalities (as determined by provincial legislation) or their equivalent (for example, Indian reserves, Indian settlements and unorganized territories).

In Newfoundland and Labrador, Nova Scotia, and British Columbia, the term also describes geographic areas that have been created by Statistics Canada in cooperation with the provinces as equivalents for municipalities for the dissemination of statistical data.

Children in Family: Children in the family are defined as never-married sons and/or daughters (including adopted children and stepchildren), regardless of their age, living in the same dwelling as their parents. Ever-married sons and/or daughters of any age are not considered members of their parents' family even if they live in the same dwelling (see also **Census Family**, **Family Structure** and **Lone-Parent Family**).

Cohort: Denotes a group of persons who experience a certain event in a specific period. Thus, the married cohort of 1996 consists of the number of persons who married in 1996. Persons born within a specified year is called a birth cohort or a generation.

Cohort Component Approach: This is a method used to produce estimates by age and sex, whereby the population is aged from year to year, and the components of demographic change are organised according to age and sex cohorts. Data required for this method includes demographic events such as deaths, immigration, emigration, etc. that can be directly linked to persons belonging to the same birth and sex cohorts.

Common-law Union: Union consisting of a male and female living together as husband and wife, without being legally married.

Component Method: A method of generating population estimates which uses the components of demographic change and a base population as the input.

Components of Demographic Change: The factors responsible for population growth and variations in the demographic composition of populations between two points in time. These include births, deaths, marriages, divorces, and other vital events, as well as migration in its various forms.

Emigration: Represents departures from Canada of Canadian citizens or landed immigrants to another country, involving a change in usual place of residence. Emigration may be either temporary or permanent. Where the term 'emigration' is used alone in this manual, it references permanent emigration which involves severing residential ties with Canada and acquiring permanent residency in another country. (See also 'Persons Living Temporarily Abroad').

Empirical Bayes Model: A small area modelling procedure used to reduce the overall variance of estimates which initially suffer from high sampling errors. This procedure is based on a fundamental understanding in statistics, that it is possible to reduce the variance of small domain estimates by borrowing strength from related domains. Details of the Bayes model for estimating provincial census undercoverage are found in Dick and You (1997a; 1997b).

Enumerated Population: The population of an area according to an official census.

Error of Closure: Refers to the difference between a postcensal estimate at the census date and the population according to a Census.

Ever-married: A person is considered ever-married if he/she is currently married, separated, widowed or divorced.

Family Structure: Refers to the classification of a census family into two groups: husband-wife family and lone-parent family.

Flows: In migration statistics, refers to the movement of persons from one geographical area to another (often involves a change in residence from one region to another). Some flows result in an increase in population for a specific area (e.g. immigration, return emigration, inflows of non-permanent residents and internal migrants), while others result in a decrease in population (e.g. emigration, outflows of non-permanent residents and internal migrants).

Husband-Wife Family: A husband-wife family consists of a legally married male and female (with or without children, regardless of age), or two persons living in a common-law union (with or without children, regardless of age).

Immigration: Immigration represents entries into Canada of **landed immigrants** from another country, involving a change in usual place of residence.

Intercensal Population Estimate: **Population estimate** for intercensal years derived by using **postcensal estimates** and population counts from the last census.

Internal Migration: Movements of persons within Canada's geographical boundaries, involving a change in usual place of residence. Internal migration denotes movements from one province or territory to another (i.e., interprovincial migration) or movements from some other smaller geographical unit to another (i.e., subprovincial or interprovincial migration).

International Migration: Movement in either direction (i.e., in or out) between Canada and other countries involving a change in usual place of residence.

Interprovincial Migration: Interprovincial migration represents movements from one province to another involving a change in usual place of residence.

Landed Immigrant: A person who is not a Canadian citizen by birth and who has been granted the right to live in Canada permanently by immigration authorities. This person falls under one of three classes (independent, business and family), as identified and described in Canada's *Immigration Act*.

Lone-parent Family: A lone-parent family consists of a father or mother, with one or more never-married children, regardless of age, living in the same dwelling.

Marital Status: Refers to the conjugal status of a person, that being single, married, divorced or widowed. In demographic estimates, a distinction is made between "legal" marital status and "*de facto*" marital status. See Chapter 9 for details of this distinction.

Natural Increase: The excess number of births over deaths during a given period for a particular population. If the number of births during the reference period is less than the number of deaths during the same period, the natural increase will be a negative result.

Never-married: A person who is not now, and never has been married.

Non-permanent Residents: Persons who have been legally granted the right to live in Canada on a temporary basis, which includes refugee status claimants, persons holding a student authorisation, an employment authorisation or a Minister's permit. Permits and authorisations may include coverage for family members of the principal document holder, and these persons are also included in the non-permanent resident population. Children born in Canada to persons of non-permanent resident status are not considered non-permanent residents, but Canadian citizens.

Persons Living Temporarily Abroad: Canadian citizens and landed immigrants who have migrated from Canada to another country for the purpose of settling there temporarily (i.e., temporary emigration).

Population: Estimated population and population according to the census are both defined as being the number of Canadians whose usual place of residence is in that area, regardless of where they happened to be on Census Day. Also included are any Canadians staying in a dwelling in that area on Census Day and having no usual place of residence elsewhere in Canada, as well as those considered "non-permanent residents".

Population Estimate: A non-census accounting of the current size of a population and/or its spatial distribution and/or demographic characteristics (see also **Population Projections**, **Postcensal Estimate**, **Intercensal Estimate**).

Population Projections: As distinct from population estimates, a projection is an attempt to quantify what the size, spatial distribution and/or demographic characteristics of a population will be in the future, based on assumptions about future demographic trends. Population estimates are used as the base population for projections.

Postcensal Estimate (Preliminary, Updated and Final): Population estimate produced by using data from the most recent census and estimates of the **components of demographic change** since that census.

Population Growth: Change in population size from one date to another. Growth can be positive (increase) or negative (decrease).

Precocity Error: The difference between preliminary and final estimates in terms of its relative proportion of the total population for the relevant geographical area.

Returning Emigrants: Canadian citizens or landed immigrants who, after being classified as a permanent emigrant, subsequently return to Canada to re-establish a permanent residence.

Reverse Record Check (RRC): The Reverse Record Check is one of four studies which provide estimates of census coverage error, including independent estimates of census undercoverage and overcoverage. The RRC begins by working with a sample of all persons who were enumerated (or missed) in the previous census, along with all persons who were either born or entered into Canada over the intercensal period. With the exception of a very small sub-population of returning emigrants, the RRC sampling frame includes all persons who could potentially be part of the census target universe. For a detailed description of the RRC study, please refer to Chapter 2 on Base Populations.

Sprague's Multipliers: Sprague's multipliers are interpolation coefficients used to subdivide data. For a detailed description of the use of Sprague's multipliers, see Shryock et al. (1976).

Subprovincial Migration: Movement between geographical areas within a province or territory involving a change in usual place of residence.

Total Emigration: The total emigration component reflects the net flows of permanent and returning, and temporary emigrants.

Variance: The sum of the squared deviation of each observation from the arithmetic mean of all observations.

Vital Events: Any event such as birth, death, marriage, divorce for which there exists a legal requirement to file a notification with the Provincial or Territorial Registrar's Office.

Whittaker-Henderson Graduation: A graduation technique used to obtain a smooth and consistent set of data from an irregular set of observed data.

Appendix II
Symbols Used in Equations and Their Meaning

Population and Demographic Events (may sometimes also be used for characteristics)

B	=	number of births
C	=	population counts in Census (i.e., unadjusted for net undercoverage)
D	=	number of deaths
E	=	number of emigrants
F	=	average adult migration estimation factor
I	=	number of immigrants
IM	=	number of interprovincial migrants
IP	=	intercensal population estimate
MAR	=	number of marriages
NM	=	number of single persons (i.e., never-married)
NMAR	=	number of newly married persons
NV	=	number of newly divorced persons
NW	=	number of new widowhoods
IM^{net}	=	number of net internal migrants
ΔNPR	=	change in the number of non-permanent residents
P	=	censal estimate (i.e., census count, adjusted for net undercoverage)
P	=	population estimate
PE	=	number of permanent emigrants
RE	=	number of returning emigrants (refers to previously classified permanent emigrants)
TE	=	number of Canadian citizens or landed immigrants temporarily out of the country (i.e., temporary emigrants)
V	=	number of divorced persons
W	=	number of widowed persons

Census Families

F	=	number of census families
$\Delta \mathbf{F}^{cl}$	=	change in number of common-law families
F^{E}	=	number of families emigrating to another country
F^{I}	=	number of families immigrating from another country
$F^{IM^{net}}$	=	number of net interprovincial migrant families
$F^{\Delta NPR}$	=	change in number of non-permanent resident families
H	=	headship rate
h	=	male head of a lone-parent family
h´	=	female head of a lone-parent family
L	=	lone-parent families, as enumerated in most recent census
n	=	family size
$\mathbf{P}^{cl}$	=	number of persons living in common-law families
$\mathbf{P}^{F}$	=	number of persons in census families
$\mathbf{P'}^{F}$	=	adjusted total number of persons in census families

Characteristics (right-hand superscript)

a	=	age
a´	=	cohort age/age of spouse
cl	=	common-law
in	=	"in" migrants
k	=	characteristic 'k' (used for census families)
mar	=	married
ms	=	marital status
nm	=	single (never married)
out	=	"out" migrants
v	=	divorced
w	=	widowed

Time Dimensions (right-hand subscript)

i	=	unit of time
t	=	reference date

Data Sources (left-hand superscript)

AMS	=	Automated Match Study
CDS	=	Collective Dwelling Study
CTB	=	Child Tax Benefit Program data from Canada Customs and Revenue Agency
CTB_TAX	=	CTB recipients in the population of the income tax file processed by Small Area and Administrative Data Division, Statistics Canada
DEM	=	Demography Division, Statistics Canada
f	=	final data
p	=	preliminary data
RRC	=	Reverse Record Check
TAX	=	personal income tax return data from Canada Customs and Revenue Agency
VC	=	Vacancy Check

Geographic Area (left-hand subscript)

CD	=	census division
CMA	=	census metropolitan area
j	=	a given area or origin of migration (province or smaller unit)
k	=	destination of migration (province or smaller unit)
OC	=	countries other than the United States (refers to emigration)

Note that the following three symbols for geographic areas are used solely in Chapter 2 – Base Population:

c	=	Canada, less the territories
p	=	province

terr   =   territory

Others

EN	=	total persons enumerated at least once in the census
$\hat{M}P$	=	estimate of number of persons missed in the census (i.e., not enumerated)
NU	=	net undercoverage
O	=	total overcoverage
R	=	rate
U	=	total undercoverage
Φ	=	proportion
π	=	probability
Δ	=	difference/net change
ϑ	=	precocity error
τ	=	coverage rate (e.g., children covered by the CTB program)
ε	=	error of closure
f	=	separation factor

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