Population forecasting for the town of Ancaster
Mark Allemang 1986

ABSTRACT

This paper applies a cohort survival model to an age- and sex-disaggregated 1985 'base' population of Ancaster. Using a fortran programme, low, high, and 'most probable' projections were made for a 1986 to 2001 time horizon. The migration component was found to be the single most important projection variable. Consequently, only migration was varied between the three sets of projections. In analyzing migration for Ancaster, we identified a persistent trend in net migration over the 1971 to 1985 period. This finding allowed us to apply the 1985 male and female age profiles of net migration to the in-migrants. Thus, this study more accurately quantified net migration than previous studies.

ACKNOWLEDGEMENTS

I would like to thank my supervisor, Dr. K.L. Liaw, for all the assistance and advice he provided. This paper could not have been completed without his support.

I also wish to offer my thanks to Mr. Peter Tollefsen, Town Planner for Ancaster, and Mrs. Gail Folland, Clerk's Department, for their assistance.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 Introduction

1.1 Research Objectives

There are two basic objectives of this research. First, the modification and application of the projection methodology, used at a large scale, to a municipality (Ancaster). Second, the production of population projections for Ancaster given a number of scenarios. The projections will be produced for a 1986 to 2001 time horizon.

Using the basic population projection model, the Leslie Model, a number of trial runs will be made from the 'base' year (1982) to 1985, for which we have the current census report. Therefore, we will be able to compare the projected 1985 population with the actual population, and gauge the model's performance. The first run will be made using constant 1982 fertility and mortality rates, and zero net migration. Subsequent runs will then be made for varying trends in the fertility and migration rates. Upon inspection of these runs, the relative importance of these projection variables will be determined. The important variable(s) will then be selected and varied in order to produce low and high projection scenarios. Finally, given the results of these scenarios and using recent historical trends for the Town of Ancaster, this research will produce a 'most probable' projection for Ancaster.

1.2 The Importance Of The Research

Over the years very little population forecasting has been done for the Town of Ancaster. This is probably the case for most other municipalities in Ontario as well. Therefore, population forecasting at the municipal level is an important research topic, not only for its applied value, but also from a methodological perspective.

From an application standpoint, the population projections for specific years are important statistics for the business community, educatonal authorities, and municipal governments. The business community is interested in the age and sex breakdown of the population projections when considering the location of businesses. The various boards of education are interested in the age and sex compositions of the future populations for a number of reasons, not the least of which is future enrollment. From a planning perspective municipal governments are interested in population projections when considering housing, education, recreations, health and other social welfare services.

Population forecasting at the municipal level is also an important study from a methodological standpoint. Most of the research in population forecasting is done for a large area, such as a nation, state or province. Therefore, the forecasting methodology for a small area is not well developed. Often the data available for a small area, like a municipality, is not as detailed as that available for a large area, like a nation. Consequently, a number of inferences will need to be made about the data. These inferences make population forecasting at the municipal level quite different from forecasting done at the national level.

2.0 Population Forecasting

2.1 Prior Research

There exists a number of projection methodologies which could have been selected for this research. These include the Migration and Natural Increase Method, the Extrapolation Method, the Ratio Method, and the Cohort Survival Method. The Migration and Natural Increase Method was used in the 1976 population study done by the Hamilton-Wentworth Regional Planning and Development

Department. They selected this method because it took into account the demographic components of population growth and yet was fairly simplistic to use (Hamilton-Wentworth, 1976). However,this method applies average growth rates to the whole population instead of applying them to particular age groups within the population. Thus the model is inherently less accurate. Furthermore, this method does not take into account changing birth rates, which occur for example, when daughters of the babyboom pass through their childbearing years. Similarly, an increasing death rate, which occurs when a greater proportion of the population reaches the older age categories, is not accounted for. Therefore, the Natural Increase and Migration Method is considered to be less accurate than the Cohort Survival Method. For these reasons, the Hamilton-Wentworth Planning and Development Department, in their 1981 "Population Projections Review", considered and subsequently rejected the Migration and Natural Increase Method (Hamilton-Wentworth, 1981).

The Extrapolation Method, along with the Migration and Natural Increase Method, was used in the September 1975 " Demographic Analysis And Population Trend Forecast For The Regional Municipality Of Halton." This method, which tends to be the most common over the years, assumes that the future growth will be smooth and regular (Halton, 1975). Using these assumptions, this method uses past population changes and extrapolates them into the future. The major drawback of this procedure involves the assumption of stability. Extrapolations invoke the unrealistic assumption that there will be no shift in exogenous factors (Siegal, 1974).

The Ratio Method, which is a less commonly used method in population forecasting, assumes that the population growth of an urban area bears a relationship with the population growth of another area. A ratio is determined between the two populations, and the forecasts for the reference population are applied to this ratio producing a population forecast for the study area. This procedure, as with the extrapolation, is plagued with the problem of stability (Siegal, 1974).

The ability to make accurate population predictions is largely dependent on the forecaster's ability to predict components of population change over time. Of course, the most important components are births, deaths, and migration. As inputs to the model, future fertility, mortality, and migration rates must be predicted. The assumptions of future growth are based on observations of historical trends for each component, adjusted to reflect recent trends (Hamilton-Wentworth, 1981). As noted in the 1976 and 1981 Hamilton-Wentworth

Population Projection reports, observed growth patterns of fertility and migration have been especially erratic. The 1976 report points out that the recent trend of a declining birth rate could be the result of a delay in the timing of family formation or a desire on the part of an increasing segment of the population not to raise children (Hamilton-Wentworth, 1976). The 1981 report details a range of positive and negative socioeconomic factors influencing the fertility rate (Hamilton-Wentworth, 1981). Therefore, due to the uncertainty of future levels of fertility and migration, a number of population projection studies have introduced the concept of high, low, and 'most likely' projections based on varying fertility and migration rates. Both the 1976 and 1981 Hamilton-Wentworth Regional Population Projections employed this approach, which seems the most prudent approach given the uncertainty involved. However, many studies do not employ this method; these include: Prince Edward Island Population Dynamics (1981-1996), Atlantic Region Population Dynamics (1981-2001), and the Demographic Analysis And Population Trend Forecast For The Regional Municipality Of Halton (1975). The latter, for example, uses the average fertility rate of the recent past (1965-1974) for their 1975 to 2001 projections. Obviously, this is a brave, if not naive, assumption which could lead to some quite inaccurate results. Similarly, migration is an extremely difficult factor to quantify, especially for a small area like a municipality or a region. A number of different techniques have been used by the various studies, including the Residual Method and the Ratio Method. Again, the Hamilton-Wentworth studies, as previously mentioned, were the only researched studies to use high, low, and 'most likely' scenarios for migration.

The cohort survival methodology is, of course, the methodology selected for this research. The theory behind this approach has been around for over forty years. P.H. Leslie, in 1945, applied a cohort survival model to a population of female Norwegian rats. He dealt with the concept of a stationary population in which the age specific fertility and mortality rates remain constant over time (Leslie, 1945). This concept provides the major simplifying assumption used in the cohort method employed in my research. In recent years, researchers such as Andrei Rogers and Nathan Keyfitz have applied the Leslie methodology to human populations (Keyfitz, 1964). Rogers, in his paper, "Matrix Methods Of Population Analysis", developed projection matrices to simulate the combined effects of fertility, mortality, and migration. He first simulated the effects of fertility and mortality by matrix multiplication and then described migration in terms of a transition matrix. Finally, Rogers presented an integrated matrix model of population growth in which the combined effects of fertility, mortality, and migration are applied to an age-disaggregated population (Rogers, 1966). From a general methodological point of view, this approach is not unlike the approach taken in my research. Other studies have also used this cohort survival method as well. Three studies previously mentioned all used the cohort survival method; they are: Atlantic Region Population Dynamics (1981-2001), Prince Edward Island Population Dynamics (1981-1996), and the Hamilton-Wentworth Population Projections Review (1981).

2.2 Context Of This Research

In recent years, as evidenced by the above studies, the most popular forecasting model has been the age-cohort survival model. There are a number reasons for this trend. First, as pointed out in the 1981 Hamilton-Wentworth study, the cohort survival model requires a great deal of information to operate. Therefore, due to the fact that the wide-spread use of computers is only a recent phenomenon ,past studies found the method too cumbersome. However, since we have computers at our disposal and since this model can be computer driven, we can manipulate the model to test a number of variable conditions (Hamilton-Wentworth, 1981). Second, as is also pointed out by the Hamilton-Wentworth report, population forecasts employing the cohort survival method provide detailed age and sex breakdowns of the population. These detailed forecasts are important tools when planners attempt to quantify future demand or future needs for various types of facilities, services, and programmes (Coffey et al, 1979). For example, if the Town of Ancaster were considering the building of a centre for seniors, an important piece of information to consider would be the population totals of the older age groups for future years.

3.0 Research Methodology

3.1 The Leslie Model

The projection methodology for this research is based on an extension of the cohort survival model, known as the Leslie Model. This model incorporates the combined effects of birth and death processes on an age and sex disaggregated population. The model has the following form:

$$\underset{\sim}{k}(t+5) = \underset{\sim}{H} * \underset{\sim}{k}(t)$$

where:

1. $\underset{\sim}{k}(t)$ is the vector of the age- and sex-disaggregated 'base' population.

2. $\underset{\sim}{H}$ is the projection matrix which combines the effects of births and deaths by applying age specific birth rates and age and sex specific survivorship proportions.

3. $\underset{\sim}{k}(t+5)$ is the vector of the projected population at time t+5 years.

Using five years as the unit time and age interval, the model can be written as :

$$\underset{\sim}{k}(t+5) \qquad\qquad \underset{\sim}{H} \qquad\qquad \underset{\sim}{k}(t)$$

$$\begin{bmatrix} k_0\ (t+5) \\ k_5\ (t+5) \\ k_{10}\ (t+5) \\ \vdots \\ k_{85}(t+5) \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 & B_{15} & B_{20} & \cdots \\ {}_5S_0 & 0 & 0 & 0 & 0 & \cdots \\ 0 & {}_5S_5 & 0 & 0 & 0 & \cdots \\ \vdots & \vdots & \vdots & \vdots & \vdots & \\ 0 & 0 & 0 & \cdots & {}_5S_{80} & {}_5S_{85} \end{bmatrix} * \begin{bmatrix} k_0\ (t) \\ k_5\ (t) \\ k_{10}\ (t) \\ \vdots \\ k_{85}(t) \end{bmatrix}$$

3.2 The Projection Model

The projection model formulated for this research is a modified version of the Leslie Model, expanded to incorporate the effects of in and out migration. Furthermore, the model has been modified to accept the 'base' population, fertility rates, and survivorship proportions on a year by year basis. The model is computer driven using a fortran programme written specifically for this research. This cohort survival model has the following properties;

the model:

1. produces yearly population projections.
2. disaggregates the projected population by single years of age, by sex, and by totals, for persons under 1, 1 to 84, and 85+.
3. uses age-specific fertility rates for females from age 15 to 49. It should be noted that these rates have been adjusted downwards to account for the attrition due to infant mortality.
4. uses age- and sex-specific survivorship proportions for persons under 1, 1 to 84, and 85+.
5. uses a variable number of in-migrants by sex.

3.2.1 Incorporation Of Migration

As previously mentioned, my projection model is based on the Leslie model, which applies birth and death processes to the population. However, the whole projection model incorporates the effects of in- and out-migration. Thus, the projection model adds in- and out-migration to the 'Leslie population' (i.e. the population projected by the Leslie model) in order to arrive at the final projected populations. The computer programme PROJ1, which will be discussed in detail in section 3.7, will print out not only the 'base' and projected populations but also the Leslie population. Therefore, the individual importance of births and deaths and migration will be observable.

3.2.2 Staging Of The Model

The projection model will be run in two stages. First, the 'evaluation' stage will be performed on the model. This stage involves running the model from a 'base' year of 1982 to 1985. The 1985 projections will be compared to the actual 1985 assessment census data in order to evaluate both the general accuracy of the model and the relative contributions of each of the projection variables. The second stage of the model is the 'projection' stage. The projection stage involves running the model from a 'base' year of 1985 and producing three sets of projections, low , high, and 'most probable', for the 1986 to 2001 time period. These projection scenarios and their results are discussed in sections 3.6 and 4.0, respectively.

3.3 The Projection Variables

3.3.1 'Base' Population

The 'base' population is the population from which the projection model initiates the projection process. The 'base' population for the 'evaluation' run is the 1982 assessment census data for single years of age by sex (see Appendix, Table A.1). It is worth noting that the 'base' population for each year, following the initial year of the projection, is simply the projected population of the previous year. The 'base' population for the 'projection' stage of the model is the 1985 census data for single and aggregated years of age by sex (see Appendix, Table A.2). The method for disaggregating this data will be discussed in section 3.4. The disaggregated 1985 'base' population is stored on a computer file called POP85 and is used as one of the inputs to the projection programme PROJ1.

3.3.2 Survivorship Proportions

The survivorship proportion is the proportion of people that survive from one age group to the next age group. This research determines the 1982 age- and sex-specific survivorship proportions for Ancaster (see Appendix, Table A.3). This determination will be discussed in detail in section 3.4.3. The survivorship proportions matrix is stored on a computer file called SURVIV1 and is one of the input matrices for the computer program PROJ1.

3.3.3 Fertility Rates

The age-specific fertility schedule needed for this research is the 1982 Ancaster fertility schedule by single years of age and by sex. However, no such schedule exists for Ancaster. Consequently, the Ancaster schedule was estimated using the 1982 Ontario age-specific fertility schedule. As with the survivorship proportions, the estimation and disaggreagation procedure will be discussed in section 3.4. Furthermore, the estimated age-specific fertility schedule for Ancaster will be used as a constant for all projections (see Appendix, Table A.4). The Ancaster fertility schedule is stored in a computer file called FERT8 and is used as an input to the projection programme PROJ1.

3.3.4 Sex Ratio of Infants

The sex ratio of infants is thenumber of male infants divided by the number of female infants. The average proportion of males born in Hamilton-Wentworth between 1970 and 1977 is approximately 51%, implying a sex ratio of 1.02. This proportion has remained fairly constant over the last 15 years. Therefore, for this research, the sex ratio will be held constant at 1.02 over the projection period.

3.3.5 Migration

The migration component of the projection model is split into positive and negative net migrations. For simplicity, we will call them in- and out-migration components, respectively. The out-migration component is in the form of a matrix of out-migration rates. This out-migration matrix is stored on a computer file called XOUT and is one of the inputs for PROJ1. This matrix will be applied to the Leslie population, by PROJ1, to determine the number of out-migrants for single years of age. The in-migration component is in the form of a matrix of in-migration proportions. This in-migration matrix is stored on a computer file called XIN and is the second migration input to PROJ1. This matrix will be applied to the total number of in-migrants and will produce the number of in-migrants in each age group. The total number of in-migrants will be used as a variable input to PROJ1 and will be varied for each set of projections. Both the in- and out-migration matrices will be held constant throughout each set of projections. The determination of the in- and out-migration will be discussed in the next section.

3.4 Data Modifications/Assumptions

This section discusses the modifications performed on the projection variables in order to make them acceptable inputs for the projection model. The assumptions necessary to make these modifications will also be discussed.

3.4.1 Disaggreagation Of The 1985 'Base' Population

As previously mentioned, the 1985 'base' population is available in a form that is partly aggregated for certain age groups. In order to make this data matrix palatable for PROJ1, it must be disaggregated into single years of age. This disaggregation was done using a statistical package programme on the mainframe called Minitab. Minitab is used throughout this research whenever matrix arithmetic is required. First, proportions were obtained from the projected age-disaggregated 1985 population produced during the 'evaluation' stage. These proportions were calculated by dividing the number of persons in each year within the aggregated group by the total population of that group. These proportions were then applied to the totals for each of the aggregated groups within the 1985 population using Minitab. Thus the age-disaggregated 1985 'base' population was obtained and saved in a computer file called POP85.

3.4.2 Incorporation Of Unknowns

In both the 1982 and 1985 census populations there is a sex-disaggregated group whose ages were recorded as unknown. For this research, these unknown age groups were disaggregated and then distributed among all the single year age groups. To do this, the age- and sex-disaggregated 1982 and 1985 'base' populations were divided by the sex-disaggregated total populations using minitab. Thus, a sex-disaggregated matrix of proportions for both 'base' populations was obtained. These matrices were then multiplied by the sex-disaggregated unknown totals producing age- and sex-disaggregated matrices of unknowns. Finally, using Minitab, these matrices of unknowns were added to the 1982 and 1985 'base' populations to produce the final versions which are stored in computer files POP82 and POP85, respectively.

3.4.3 Determination Of The Survivorship Proportions

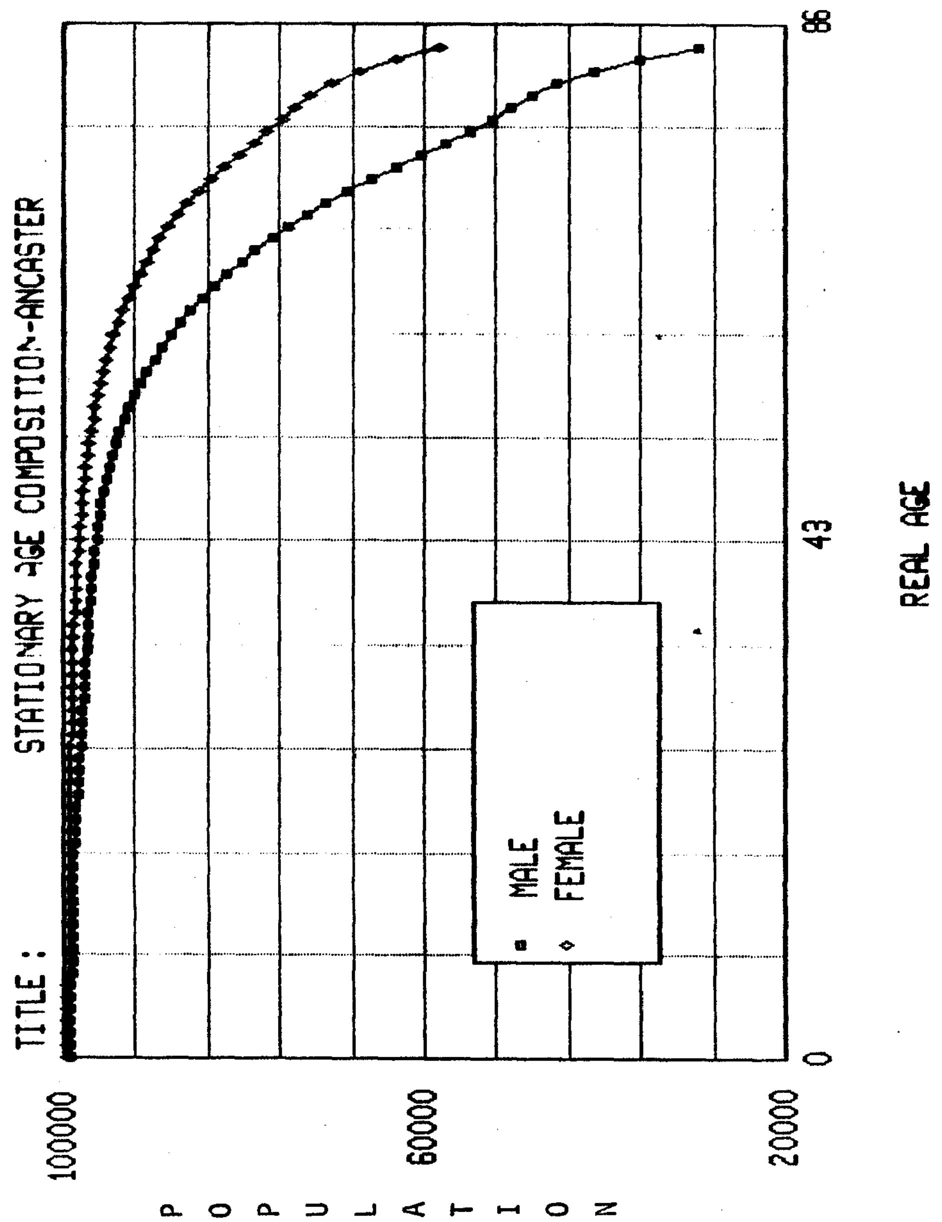
3.4.3.1 Estimation Of The 1982 Age- and Sex-Specific Mortality Rates

Since the age- and sex-specific mortality rates for Ancaster are unknown, the 1982 male and female mortality schedules for Ancaster were estimated using the 1982 Ontario mortality schedules (see Appendix, Table A.5). As seen from table A.5, the Ontario mortality rates were aggregated into 5 year age groups. Before these mortality rates could be applied to the age- and sex-disaggregated 1982 Ancaster population, this population was aggregated into 5 year age cohorts. At this point it was necessary to make the assumption that the Ancaster mortality schedule, which is unknown, is similar in shape to the Ontario schedule. The Ontario mortality schedule could then be applied to the 1982 Ancaster population using Minitab. The resulting schedule of 'expected' deaths was totalled and compared with the total number of observed deaths recorded in Ancaster in 1982. The number of observed female and male deaths for Ancaster were 39% and 26% lower, repectively, than the 'expected' number of deaths. Consequently, the Ontario mortality schedules were lowered by 39% and 26%, respectively, to yield the best estimate of the Ancaster mortality schedules.

3.4.3.2 Determination Of The Stationary Age Composition

Since the determination of the survivorship proportions requires the knowledge of the age compositions of the stationary populations that are implied by the Ancaster mortality schedules, the next step is to find the stationary populations. The estimated sex- and cohort-specific Ancaster mortality schedule was applied to the 1982 Ancaster sex- and cohort-specific age compostion in order to produce the sex- and cohort-specific number of deaths. The sex- and cohort- specific number of deaths and the Ancaster age composition were the inputs required to operate a computer programme called LIFE. LIFE was used to produce a life table for Ancaster, as shown for females in table A.7 of the appendix, containing the LL(x) column (i.e. the stationary age compostion) for Ancaster. This LL(x) column contained data which was in 5 year age cohorts. Therefore, data was fed into the computer programme called SPLN which performed a smooth disaggregation on the data by a third degree spline function. Consequently, the resulting output from SPLN contained the age- and sex-specific stationary age compositions for Ancaster, asshown in figure 1.1.

FIGURE 1.1


TITLE : STATIONARY AGE COMPOSITION-ANCASTER
100000
60000
20000
P O P U L A T I O N
0
43
86
REAL AGE
MALE
FEMALE

3.4.3.3 Determination Of The Survivorship Proportions

A survivorship proportion is defined as the proportion of people who survive from one age group to the next age group. Consequently, to determine the female and male survivorship proportions for Ancaster, each row of the female and male LL(x) columns were divided by the previous row. This matrix manipulation was performed using Minitab and produced the age- and sex-specific survivorship proportions. As previously mentioned, these proportions were stored in a computer file called SURVIV1 which was used as one of the inputs to PROJ1.

3.4.4 Determination Of The 'Birth' Rates

In order to determine the age-specific 'birth' rates, we first had to determine the 1982 age-specific fertility schedule for Ancaster. However, as discussed in section 3.3.3, this schedule had to be estimated from the 1982 Ontario age-specific fertility schedule (see Table A.6). As with the estimation of the mortality schedule in section 3.4.3.1, we had to assume that the Ancaster fertility schedule was similar in shape to the Ontario fertility schedule. Therefore, using Minitab, the same procedure was followed to estimate the Ancaster fertility schedule as was followed to determine the Ancaster mortality schedule. This produced the cohort-specific fertility rates which were then disaggregated in a smooth fashion using SPLN. In order to determine age-specific 'birth' rates for Ancaster, the effects of mortality from one age to the next had to be applied to the age-specific fertility rates. This was done using the following formula:

$$Ba = 1/2 * ({}_1L_0 / l_0) * [\ F_a + (\ F_{a+1}\ )*({}_1S_a)]$$

where:

1. Ba is the 'birth' rate for real age a.
2. ${}_1L_0$ is the number of persons less than one year old in the stationary population.
3. l_0 is the annual number of births in the stationary population.
4. Fa is the fertility rate at age a.
5. Fa_{+1} is the fertility rate at age a .
6. ${}_1S_a$ is the annual survivorship proportion at age a.

Minitab was used to do the matrix arithmetic required by the 'birth' rate formula. Thus, Ba was calculated for the 15 to 49 age groups and was stored in the computer file called FERT8, as an input to PROJ1.

3.4.5 In- and Out-Migration

3.4.5.1 Determination Of 1985 In- and Out-Migration

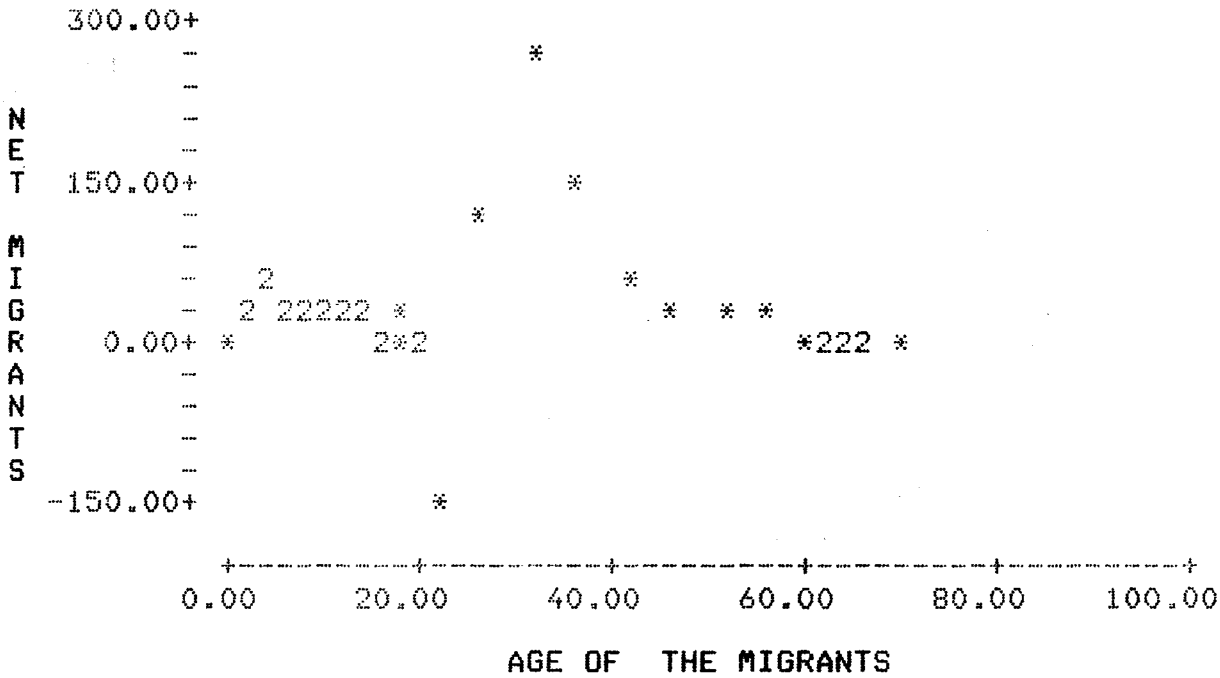
Determining the in- and out-migration for a place is difficult, especially for a small town for which very little data is available. In order to quantify this migration for Ancaster, the Residual Method was employed. Therefore, the 1985 age- and sex-specific Leslie population for Ancaster projected during the evaluation stage, was compared with the 1985 age- and sex-specific assessment population. Using the Residual Method, the Leslie population was subtracted from the assessment population and the difference was assumed to be the net migration. Consequently, the most up to date matrix of in- and out-migration was obtained.

3.4.5.2 Determination Of A Persistent Migration Pattern

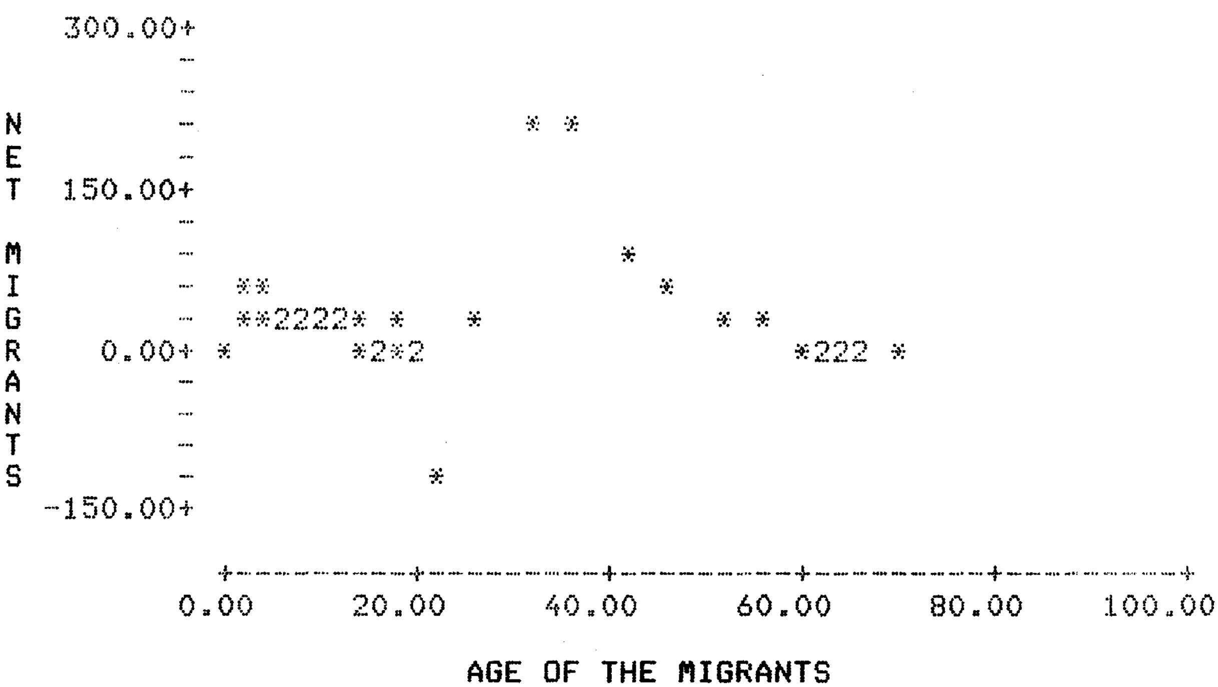
Before any future predicting about in- and out-migration could be made, some pattern in migration had to be identified as persistent over time. The 1985 net migration for Ancaster, discussed in section 3.4.5.1, was observed graphically using Minitab (see Figure 1.2).

FIGURE 1.2

Age Profile Of The Female Net Migrants
For Ancaster (1985)



Age Profile Of The Male Net Migrants
For Ancaster (1985)



Having viewed this graph, it was evident that there was a substantial out-migartion of males and females between the ages of 21 and 25. There was also a substantial in-migration between the ages of 26 and 45, peaking in the middle 30's for females and late 30's for males (see Table 1.2). This table included 5 – year age cohorts starting at age 21. In order to produce age-specific figures for net migration, a smooth disaggregation was performed on the 5 year age cohorts using SPLN. At this point it was necessary to determine if this net migration pattern in the 1985 data has been persistent through time. Towards that end, this research developed a Lexis table, as shown in Table 1.1, tracing the variations in the age compositions of each 5 – year age cohort between 1971 and 1981. After inspecting Table 1.2, it became evident that there was a significant drop in both the male and female populations as the 16 to 20 age cohort of 1971 moved into the 21 to 25 age cohort of 1976, as indicated in bold print. This trend continued as the 16 to 20 age cohort of 1976 moved into the 21 to 25 age cohort of 1981. Furthermore, as seen in the Lexis Table, there was a persistent pattern of in-migration within the 26 to 45 year old cohorts. These findings supported the hypothesis that the 1985 net migration pattern was a persistent pattern over time, at least since 1971. Therefore, the

1985 net migration figures were used to develop separate in- and out-migration data to be used for the projections.

Table 1.1 Lexis Table (1971 to 1981)

	Males				Females		
Age	1971	1976	1981		1971	1976	1981
0-1	29	40	63	||	24	48	63
1-5	575	367	460	||	590	456	495
6-10	874	581	487	||	929	593	595
11-15	899	847	576	||	972	785	644
16-20	747	775	735	||	840	875	809
21-25	350	355	438	||	458	486	556
26-30	413	383	420	||	363	339	384
31-35	456	485	558	||	405	425	504
36-40	494	465	588	||	482	443	559
41-45	606	471	489	||	569	483	495
46-50	609	531	464	||	590	508	452
51-55	388	573	490	||	475	532	493
56-60	302	350	514	||	349	429	516
61-65	227	252	344	||	238	293	380

Source : Clerk's Department, Town of Ancaster.
(Compiled using 1971, 1976, and 1981 assessment data.)

TABLE 1.2 1985 Net Migration Table For Ancaster

	Leslie Population		Census Population		Net Migration	
Age	F	M	F	M	F	M
0.	84.	89.	75.	75.	-9.	-14.
1.	81.	86.	107.	110.	26.	24.
2.	80.	85.	112.	132.	32.	47.
3.	62.	63.	123.	118.	61.	55.
4.	76.	89.	121.	124.	45.	35.
5.	97.	103.	141.	139.	44.	36.
6.	93.	103.	128.	139.	35.	36.
7.	105.	90.	127.	117.	22.	27.
8.	89.	110.	118.	133.	29.	23.
9.	96.	101.	125.	132.	29.	31.
10.	88.	126.	120.	161.	32.	35.
11.	90.	104.	112.	121.	22.	17.
12.	120.	119.	143.	140.	23.	21.
13.	93.	145.	115.	160.	22.	15.
14.	85.	108.	114.	120.	29.	12.
15.	136.	141.	141.	142.	5.	1.
16.	114.	124.	123.	128.	9.	4.
17.	119.	134.	136.	152.	17.	18.
18.	122.	137.	123.	141.	1.	4.
19.	144.	148.	139.	137.	-5.	-11.
20.	141.	150.	131.	156.	-10.	6.
21-25	679.	779.	543.	653.	-136.	-126.
26-30	358.	434.	468.	452.	110.	18.
31-35	476.	415.	745.	614.	269.	199.
36-40	593.	535.	739.	744.	146.	209.
41-45	536.	578.	588.	658.	52.	80.
46-50	487.	433.	522.	492.	35.	59.
51-55	461.	486.	489.	506.	28.	20.
56-59	387.	372.	411.	391.	24.	19.
60.	126.	115.	118.	120.	-8.	5.
61.	106.	87.	100.	92.	-6.	5.
62.	84.	104.	85.	108.	1.	4.
63.	94.	94.	95.	90.	1.	-4.
64.	91.	73.	89.	74.	-2.	1.
65.	78.	92.	82.	92.	4.	0.
66-69	225.	260.	230.	250.	5.	-10.
70+up	521.	443.	507.	431.	-14.	-12.

3.4.5.3 Determination Of Separate In- and Out-Migration Rates

First, the male and female out-migration (i.e. negative net migration) values were removed from the 1985 net migration table (Table 1.2). These two columns contained negative integers, representing the number of out-migrants, and were assigned zeros where positive values existed. Using Minitab, each of the values was divided by the corresponding projected total cohort-specific populations. This produced male and female columns containing the age- and cohort-specific out-migration rates. In order to disaggregate the 5-year cohort-specific rates, we simply decided, for the lack of additional information, to split up the cohort-specific rates evenly. Thus, a matrix of age- and sex-specific out-migration rates was developed and stored on a computer file called Xout, for use in PROJ1.

The second task was the determination of the age- and sex-specific in-migration proportions for Ancaster. As with out-migration, a matrix of age- and cohort-specific in-migrants was extracted from the 1985 net migration table. Using minitab, each element of the male and female columns was divided by the total number of male and female in-migrants, respectively. The cohort-specific values were then disaggregated evenly in the same fashion as the out-migration rates. Thus a matrix of age- and sex-specific in-migration proportions was provided and stored in a computer file called Xin, for use in PROJ1.

3.5 Projection Assumptions

The accuracy of any population projection is dependent upon the ability of the forecaster to predict the three components of change (births, deaths, and migration). The three most important components are births, deaths, and migration. Within this section, we will discuss the reasons for holding the 'birth' rates and the survivorship proportions constant for all projections. Likewise, reasons for varying the migration levels, through the varying of the number of building permits issued and the number of persons per dwelling unit, will also be discussed.

3.5.1 Survivorship Proportions

There has been a steady decline in mortality in Canada since 1929. In recent years the decline seems to have leveled off. As a reasonable approximation, the 1982 survivorship proportions, discussed in section 3.4.3 , were used as a constant for all projections.

3.5.2 'Birth' Rates

For population forecasting performed on a metropolitan, provincial, or national scale, the fertility component would be a major factor. However, for small town forecasting, in which you are dealing with populations well below 50,000, varying the 'birth' rate is of less significance. This is especially true in situations, such as Ancaster, in which the net migration component is of such relative importance. In order to substantiate this claim, the relative importance of the fertility and migration components was compared using a couple of runs made from the 1982 'base' population. First, a population projection for 1983, using the established 1982 'birth' rates and migration levels, was made. A second run was then made holding in-migration at the same level and increasing the 'birth' rates by 35%. Finally, a third run was made holding 'birth' rates constant and increasing in-migration levels by 35%. The results of all three runs was as follows:

	Run 1	Run 2	Run 3
1982 Population =	14780	14780	14780
1983 Projection =	15368	15427	15779
Increase =	588	647	999
% Increase =	–	9%	41%

As seen from these results, a 35% increase in the 'birth' rates resulted in only a 9% increase in the projected 1983 population. On the other hand, a 35% increase in the number of in-migrants to Ancaster resulted in a 41% increase in the 1983 population. Therefore, due to these results, it was decided that the 'birth' rates would not be varied in the projection stage. Furthermore, a 35% increase in the 'birth' rates is inconceivable. However, it should be pointed out that in cases where the in-migration rate is not as large a factor, the effects of varying fertility levels should also be explored.

3.5.3 In- and Out-Migration

For the projection stage of the model, the age- and sex-specific out-migration rates were held constant. Therefore, there were only small variations in the total out-migration between years due to the changes in the age composition over time. Furthermore, there were no changes in the levels of out-migration between sets of projections. The in-migration proportions were also held constant over time and over all sets of projections. Consequently, both the in- and out-migration populations were assumed to have age and sex profiles that were the same as the 1985 in- and out-migration schedules for Ancaster, discussed in section 3.4.5.3. Therefore, only the number of in-migrants were varied between projections. The number of in-migrants to Ancaster was determined using the number of building permits issued and the person per dwelling unit (p.p.d.u.). The number of building permits issued, for the years 1982 through 1985, were obtained from the Ancaster Building Department. Two different numbers of persons per dwelling unit were used for this research. A p.p.d.u. of 3.1 was obtained from the Hamilton-Wentworth Planning Department and a p.p.d.u. of 2.6 was obtained from the Town Planner of Ancaster.

3.6 Projection Scenarios

Three projection scenarios were used during the projection stage of the research. The first two scenarios involved the projected low and high levels of in-migration based on the number of building pernits issued. The number of building permits issued in 1985 was 292. Due to a number of conditions it was assumed that the average number of building permits issued per year for the next 15 years would not go below 150 or above 450. The conditions existing in Ancaster which could affect in-migration are as follows:

1. Ancaster has a positive residential atmosphere.
2. Dwelling units have mostly been of the low density and high quality (cost) type relative to housing available elsewhere in the region.
3. The Allarco development will be the first large 'new town' type planned community in Ancaster developed by a major private development company.
4. A variety in the housing unit types is expected.
5. The Allarco lands are well serviced by transportation routes which provide easy access to the employment areas in Ancaster, Hamilton and the highway 403-QEW corridor.
6. The Ancaster Industrial Bussiness Park.[1]

After considering these conditions, it was assumed that the average number of building permits issued over the next 15 years would fall within the 150 to 450 range. As mentioned in section 3.5.3, two person per dwelling units were used in this research. The actual p.p.d.u. for Ancaster is not known. Consequently, for the low projection, the number of in-migrants were determined by using the p.p.d.u. of 2.6 and 150 building permits issued. The high projection found the number of in-migrants using a p.p.d.u. of 3.1 and 450 building permits issued.

1. Hamilton-Wentworth Population Projections 1981 Review, p. 47-48.

Finally, the 'most probable' projection used a p.p.d.u. of 2.85 and a figure of 292 building permits issued. The p.p.d.u. of 2.85 is the average between the 2.6 and 3.1 values. Due to the fact that the actual p.p.d.u. for Ancaster is unknown, using the average value would seem to provide the most likely approximation. The selection of an average of 292 building permits issued was made because this value falls in the middle of the assumed range of 150 to 450. Furthermore, this value is the actual number of permits issued in 1985 and, therefore, represents the most up to date figure. Thus the projection scenarios are as follows:

	p.p.d.u.	Permits Issued	In-Migrants
Low Projection :	2.6	150	390
High Projection :	3.1	450	1395
'Most Probable' :	2.85	292	832

3.7 The Computer Programme

A fortran programme, called PROJ1, was written specifically for this research. The programme, shown in Figure B.1 of the Appendix, was used to drive the projection model. Thus the programme applied the effects of births, deaths, and migration to an age- and sex-disaggregated 'base' population. The projection programme was used during both the 'evaluation' stage and the 'projection' stage of the research. Thus, the inputs required by PROJ1 are as follows :

<u>'Evaluation' Stage</u>	<u>Computer File</u>
1. Age- and sex-disaggregated 1982 'base' population.	POP82
2. Age- and sex-disaggregated survivorship proportions.	SURVIV1
3. Age-disaggregated 'birth' rates.	FERT8
4. Age- and sex-disaggregated out-migration rates.	XOUT
5. Age- and sex-disaggregated in-migration proportions.	XIN

Another input required by the programme is the value for the number of projections (NPJ). As seen on line 140 of the programme, this value was 16 for the 'projection' stage in order to project from 1985 to 2001. For the 'evaluation' stage it was 3.

<u>'Evaluation' Stage</u>	<u>Computer File</u>
1. Age- and sex-disagregated 1985 'base' population.	POP85

* Note : All other inputs for the 'projection' stage are the same as for the 'evaluation' stage (listed above)

4.0 Research Findings

4.1 Population Projections For Ancaster

The projected populations for the three scenarios, at 5 year intervals, are as follows:

Projection Scenario	1986	1991	1996	2001
Low	16753	17545	18272	18856
High	17759	23745	29762	35478
'Most Probable'	17195	20227	23208	25979

4.2 Projection Accuracy

The 'evaluation' stage involved running the model, until 1985, using constant 1982 levels of 'birth' rates and survivorship proportions. The number of in-migrants used for this run was determined by multiplying the number of permits issued in 1985 (292) by a p.p.d.u. of 2.6. The results of the two runs are as follows :

	Total	Female Total	Male Total	Sex Ratio
Assessment Population	16542	8181	8361	1.02
Projected Population	16449	8132	8317	1.02
Difference	93	49	44	
% Difference	0.6	0.6	0.5	

As seen from these results, the model appears to be predicting quite well. The projected and assessment total populations are reasonably close. Furthermore, the sex ratios of both the assessment population and the predicted population are the same. Due to the fact that the migration component is an estimated quantity, one cannot expect the model to predict total population with much more accuracy than is evident in these results. Consequently, it appears that the Leslie part of the model is working well. Although the prediction of total populations is acceptible, there still remains the age profiles to be checked. To do this the 1985 projected population was aggregated into age cohorts for the purpose of direct comparison with the 1985 assessment figures (see Table A.8 in the Appendix). The results of the comparison, between the age-specific totals, are as follows :

TABLE 1.3

Age Group	Grand Total *Assessment Population	Grand total Projected Population	% Difference
0	146	160	+ 8.8
1	211	159	- 24.6
2	238	161	- 32.4
3	235	150	- 36.2
4	239	193	- 19.2
5	273	227	- 16.8
6	260	218	- 16.2
7	238	213	- 10.5
8	244	215	- 11.9
9	250	213	- 14.8
10	274	232	- 15.3
11	238	210	- 11.8
12	276	253	- 8.3
13	268	249	- 7.1
14	229	205	- 10.5
15	276	285	+ 10.5
16	245	244	0.0
17	281	257	- 8.5
18	258	263	+ 1.9
19	270	286	+ 5.6
20	281	261	- 7.1
21-25	1169	960	- 17.9
26-30	899	862	- 4.1
31-35	1328	1495	+ 11.2
36-40	1449	1715	+ 15.5
41-45	1217	1384	+ 12.1
46-50	991	1067	+ 7.1
51-55	971	1026	+ 5.4
56-59	784	817	+ 4.0
60	233	248	+ 6.0
61	187	192	+ 2.6
62	188	180	- 4.3
63	180	179	0.0
64	160	161	0.0
65	170	165	- 2.9
66-69	469	461	- 1.7
70+up	916	883	- 3.6

* Adjusted to incorporate unknowns.

As seen from Table 1.3, the model significantly under-predicts the number of children from ages 1 to 6. Furthermore, the model significantly under-predicts the 21 to 25 age cohort, for which we anticipated significant out-migration. The model over-predicted for the 31 to 35, 36 to 40, and 41 to 45 age cohorts for which we anticipated significant in-migration. Therefore, the model would appear to over emphasize the expected in- and out-migrations, to a certain degree. Generally, the rest of the age groups are predicted quite well with the older age categories being especially well predicted.

4.3 Limitation Findings

The population projections made in this research are the best possible, given present knowledge about the conditions in Ancaster and about migration levels. However, accurate prediction is not an easy task given the smallness of the at-risk population. Although conditions point to the continued growth of Ancaster, the land use development patterns are politically controlled and are thus somewhat uncertain. In order to overcome this problem of reliability, a range of population projections was formulated. These are the low, high, and 'most probable' projections. This researcher believes that the future populations of Ancaster will fall within this range and that the future populations will most closely follow the 'most probable' projections.

4.4 Conclusions

As shown in Figure B.1 in the Appendix, low, high and 'most probable' projections were produced for Ancaster. The 'most probable' projection, which was the middle projection, predicted a population of 25,979 for Ancaster in 2001 (see p.36). The computer programme, shown in Appendix B, produced yearly projections for the projection period. An example of such a print-out, showing the Female, Male, and Female+Male Table, can be seen in Table A.8a, A.8b, and A.8c, respectively.

All projections were made holding the 'birth' rates and survivorship proportions constant at 1982 levels. Although this did not seem to diminish the quality of the projections, further research should test the projection model by varying the 'birth' rates and survivorship proportions. However, given the time constraints, the projections produced proved to be quite worthwhile. Furthermore, this research demonstrated that, with certain data modifications and assumptions, forecasting methodology developed on a national scale can be used at a small town scale.

APPENDIX

The 1982 Age- And Sex-Disaggregated 'Base' Population

TABLE A.1 (Computer File : POP82)

Age	F	M	Age	F	M
0.	63.	63.	50.	85.	90.
1.	76.	89.	51.	90.	99.
2.	97.	103.	52.	99.	109.
3.	93.	103.	53.	104.	108.
4.	105.	90.	54.	100.	108.
5.	89.	110.	55.	97.	99.
6.	96.	101.	56.	93.	97.
7.	88.	126.	57.	129.	121.
8.	90.	104.	58.	109.	91.
9.	120.	119.	59.	86.	110.
10.	93.	145.	60.	97.	97.
11.	85.	108.	61.	93.	78.
12.	136.	141.	62.	80.	94.
13.	114.	124.	63.	59.	68.
14.	119.	134.	64.	58.	77.
15.	122.	137.	65.	54.	63.
16.	144.	148.	66.	59.	63.
17.	141.	150.	67.	61.	54.
18.	152.	195.	68.	44.	61.
19.	166.	160.	69.	50.	48.
20.	132.	156.	70.	37.	53.
21.	116.	143.	71.	37.	32.
22.	113.	125.	72.	31.	42.
23.	79.	111.	73.	33.	34.
24.	65.	91.	74.	39.	30.
25.	65.	86.	75.	26.	26.
26.	77.	75.	76.	28.	15.
27.	72.	71.	77.	28.	20.
28.	73.	66.	78.	17.	21.
29.	107.	84.	79.	17.	15.
30.	91.	88.	80.	25.	9.
31.	96.	78.	81.	11.	12.
32.	109.	99.	82.	24.	8.
33.	94.	87.	83.	8.	1.
34.	126.	108.	84.	6.	3.
35.	133.	132.	85.	55.	26.
36.	145.	107.			
37.	98.	101.			
38.	113.	105.			
39.	121.	106.			
40.	111.	140.			
41.	103.	113.			
42.	88.	117.			
43.	101.	78.			
44.	102.	94.			
45.	95.	93.			
46.	94.	93.			
47.	95.	78.			
48.	92.	108.			
49.	98.	83.			

1985 Age- and Sex-Specific Assessment Population
TABLE A.2 (Computer File : POP85)

Age	F	M	Age	F	M
0.	73.	75.	42.	121.	135.
1.	105.	108.	43.	120.	135.
2.	110.	129.	44.	104.	116.
3.	120.	116.	45.	104.	116.
4.	118.	122.	46.	101.	96.
5.	137.	136.	47.	107.	101.
6.	125.	136.	48.	101.	96.
7.	124.	115.	49.	101.	96.
8.	115.	130.	50.	97.	91.
9.	122.	129.	51.	105.	108.
10.	117.	158.	52.	90.	94.
11.	110.	119.	53.	86.	89.
12.	139.	137.	54.	95.	99.
13.	112.	157.	55.	100.	103.
14.	112.	118.	56.	109.	103.
15.	137.	139.	57.	92.	88.
16.	120.	125.	58.	100.	95.
17.	132.	148.	59.	100.	95.
18.	120.	138.	60.	115.	118.
19.	135.	134.	61.	97.	90.
20.	128.	152.	62.	83.	105.
21.	149.	179.	63.	92.	88.
22.	122.	146.	64.	87.	73.
23.	96.	115.	65.	80.	90.
24.	80.	96.	66.	58.	63.
25.	86.	102.	67.	60.	66.
26.	79.	75.	68.	51.	56.
27.	83.	80.	69.	54.	58.
28.	101.	97.	70.	59.	50.
29.	100.	97.	71.	54.	46.
30.	95.	93.	72.	49.	42.
31.	101.	84.	73.	44.	48.
32.	146.	120.	74.	30.	26.
33.	160.	132.	75.	35.	30.
34.	153.	126.	76.	30.	26.
35.	167.	138.	77.	35.	30.
36.	130.	131.	78.	19.	17.
37.	152.	152.	79.	15.	12.
38.	159.	160.	80.	25.	21.
39.	152.	152.	81.	15.	12.
40.	129.	131.	82.	15.	12.
41.	126.	141.	83.	15.	12.
			84.	10.	8.
			85.	44.	38.

The 1982 Age- And Sex-Specific Survivorship Proportions
TABLE A.3 (Computer File : SURVIV1)

Age	Survivorship Prop's F	Survivorship Prop's M
1.	.995720	.992950
2.	.999960	.999919
3.	.999930	.999849
4.	.999879	.999758
5.	.999849	.999698
6.	.999829	.999627
7.	.999829	.999677
8.	.999849	.999738
9.	.999869	.999788
10.	.999889	.999859
11.	.999910	.999899
12.	.999899	.999839
13.	.999889	.999778
14.	.999879	.999697
15.	.999869	.999626
16.	.999849	.999545
17.	.999849	.999464
18.	.999829	.999383
19.	.999829	.999292
20.	.999799	.999210
21.	.999799	.999128
22.	.999778	.999117
23.	.999778	.999117
24.	.999758	.999126
25.	.999748	.999115
26.	.999728	.999125
27.	.999728	.999134
28.	.999718	.999154
29.	.999707	.999173
30.	.999687	.999173
31.	.999687	.999203
32.	.999677	.999192
33.	.999657	.999201
34.	.999646	.999211
35.	.999626	.999210
36.	.999616	.999189
37.	.999555	.999127
38.	.999484	.999034
39.	.999423	.998950
40.	.999362	.998856
41.	.999290	.998762
42.	.999209	.998616
43.	.999127	.998449
44.	.999045	.998291
45.	.998973	.998133
46.	.998870	.997942
47.	.998756	.997656
48.	.998643	.997348
49.	.998508	.997027
50.	.998383	.996703
51.	.998247	.996334
52.	.998018	.995803
53.	.997777	.995201
54.	.997525	.994613
55.	.997291	.994004
56.	.997025	.993364
57.	.996777	.992668
58.	.996516	.991935
59.	.996253	.991185
60.	.995976	.990406
61.	.995664	.989549
62.	.995169	.988325
63.	.994623	.986992
64.	.994080	.985610
65.	.993507	.984172
66.	.992901	.982669
67.	.992206	.981081
68.	.991463	.979396
69.	.990701	.977641
70.	.989908	.975751
71.	.988968	.973550
72.	.987426	.970326
73.	.985667	.966640
74.	.983860	.962599
75.	.981947	.958160
76.	.980301	.954228
77.	.979917	.954138
78.	.979885	.955271
79.	.979847	.956669
80.	.979842	.958338
81.	.977879	.956249
82.	.967892	.936776
83.	.954977	.909318
84.	.940432	.874772
85.	.923480	.827662
86.	.906528	.780552
87.	.889576	.733442

<u>The 1982 Age-Specific 'Birth' Rates For Ancaster</u>
<u>TABLE A.4</u> (Computer File : FERT8)

Age	'Birth' Rates	Age	'birth' Rates
0.	0.000000	46.	0.000168
1.	0.000000	47.	0.000068
2.	0.000000	48.	0.000005
3.	0.000000	49.	0.000000
4.	0.000000	50.	0.000000
5.	0.000000	51.	0.000000
6.	0.000000	52.	0.000000
7.	0.000000	53.	0.000000
8.	0.000000	54.	0.000000
9.	0.000000	56.	0.000000
10.	0.000000	57.	0.000000
11.	0.000000	58.	0.000000
12.	0.000000	59.	0.000000
13.	0.000000	60.	0.000000
14.	0.000000	61.	0.000000
15.	.007362	62.	0.000000
16.	.013260	63.	0.000000
17.	.021866	64.	0.000000
18.	.033180	65.	0.000000
19.	.047202	66.	0.000000
20.	.063280	67.	0.000000
21.	.078804	68.	0.000000
22.	.093123	69.	0.000000
23.	.106236	70.	0.000000
24.	.118143	71.	0.000000
25.	.128155	72.	0.000000
26.	.133518	73.	0.000000
27.	.133542	74.	0.000000
28.	.128227	75.	0.000000
29.	.117574	76.	0.000000
30.	.102643	77.	0.000000
31.	.087678	78.	0.000000
32.	.073741	79.	0.000000
33.	.060831	80.	0.000000
34.	.048948	81.	0.000000
35.	.038180	82.	0.000000
36.	.028881	83.	0.000000
37.	.021136	84.	0.000000
38.	.014948	85.	0.000000
39.	.010315	86.	0.000000
40.	.007075		
41.	.004578		
42.	.002661		
43.	.001326		
44.	.000570		
45.	.000305		

TABLE A.5

TABLE 19. Death Rates Per 1,000 Population by Sex and Age, Canada and Provinces, 1982 – Concluded

No.	Age – Âge	Canada	Nfld. – T.-N.	P.E.I. – Î.-P.-É.	N.S. – N.-É.	N.B.	Qué.	Ont.
		Female – Féminin						
1	Under 1 year	7.8	7.3	6.6	7.2	6.7	7.7	7.1
2	1- 4	0.4	0.5	0.8	0.5	0.5	0.5	0.3
3	5- 9	0.2	0.2	0.2	0.2	0.3	0.2	0.2
4	10-14	0.2	0.1	0.4	0.2	0.3	0.2	0.2
5	15-19	0.4	0.3	–	0.5	0.6	0.4	0.3
6	20-24	0.4	0.2	0.2	0.3	0.4	0.4	0.4
7	25-29	0.5	0.4	0.6	0.3	0.6	0.5	0.5
8	30-34	0.6	0.4	1.1	0.5	0.7	0.6	0.6
9	35-39	1.0	0.5	1.1	1.0	0.8	1.0	0.9
10	40-44	1.6	1.4	1.0	1.5	1.7	1.5	1.6
11	45-49	2.4	2.5	2.8	3.0	2.8	2.2	2.4
12	50-54	4.0	4.6	3.1	4.0	3.7	4.0	4.0
13	55-59	6.3	6.5	5.2	6.9	6.7	6.3	6.3
14	60-64	9.3	11.0	10.1	11.3	8.3	9.6	9.4
15	65-69	15.2	15.8	10.1	16.0	14.4	16.1	15.6
16	70-74	24.2	26.6	13.5	25.0	25.8	25.3	24.8
17	75-79	39.3	45.2	36.2	42.6	40.5	41.6	39.7
18	80-84	68.2	80.1	59.0	66.9	68.7	70.4	69.4
19	85 and over	143.2	143.0	125.6	144.3	128.6	139.4	145.7
20	Total	6.1	5.0	6.6	7.0	6.2	5.7	[illegible]
21	Standardized age (adjusted)	4.2	4.4	3.6	4.4	4.2	4.3	4.2
		Male – Masculin						
22	Under 1 year	10.4	14.2	8.8	10.0	14.1	9.9	9.5
23	1- 4	0.5	0.6	–	0.7	0.6	0.5	0.5
24	5- 9	0.3	0.4	0.4	0.4	0.4	0.3	0.3
25	10-14	0.4	0.4	0.2	0.2	0.4	0.4	0.3
26	15-19	1.2	1.5	0.5	1.1	1.6	1.1	1.0
27	20-24	1.4	1.3	0.8	1.6	2.1	1.4	1.2
28	25-29	1.4	1.0	0.6	1.7	1.5	1.4	1.2
29	30-34	1.3	1.6	0.6	1.3	1.5	1.3	1.1
30	35-39	1.6	1.5	0.7	1.6	2.0	1.8	1.4
31	40-44	2.6	2.4	2.3	3.4	3.2	2.7	2.3
32	45-49	4.3	3.9	4.6	4.6	4.7	4.7	3.9
33	50-54	7.5	8.6	6.9	8.4	6.7	8.2	7.1
34	55-59	12.4	13.2	10.1	14.1	13.9	13.1	12.0
35	60-64	19.2	18.7	23.2	20.2	20.7	21.5	18.8
36	65-69	30.6	30.6	38.9	31.8	31.7	33.8	30.8
37	70-74	47.4	45.5	42.3	49.6	45.8	52.2	47.6
38	75-79	70.9	63.9	69.5	75.8	73.3	75.2	72.7
39	80-84	106.6	106.4	91.8	111.6	111.6	111.6	109.0
40	85 and over	192.5	190.3	171.3	198.2	180.2	185.2	193.8
41	Total	8.0	6.9	9.4	9.3	8.7	7.8	8.1
42	Standardized age (adjusted)	7.1	7.1	6.7	7.6	7.5	7.6	7.0

Source: Vital Statistics

TABLE A.6

TABLE 5. Age-specific Fertility Rates, Canada and Provinces, 1981-1982

Province and year – Province et année	Fertility rate per 1,000 women by age group – Taux de fécondité pour 1,000 femmes selon le groupe d'âges						
	15-19	20-24	25-29	30-34	35-39	40-44	45-49
Canada:(1,2)							
1982	26.5	95.4	124.7	68.6	20.2	3.1	0.2
1981	26.4	96.7	126.9	68.0	19.4	3.2	0.2
Percentage change	0.4	– 1.3	– 1.7	0.9	4.1	– 3.1	–
Prince Edward Island:							
1982	34.0	110.8	136.9	77.4	28.8	2.3	0.4
1981	33.5	109.0	135.2	73.0	26.4	4.0	0.4
Percentage change	1.5	1.7	1.3	6.0	– 6.1	– 42.5	–
Nova Scotia:							
1982	35.6	101.4	117.8	59.7	15.7	3.0	0.1
1981	35.2	103.9	113.9	56.9	15.4	3.0	0.3
Percentage change	1.1	– 2.4	3.4	4.9	1.9	–	– 66.7
New Brunswick:							
1982	35.0	117.3	118.0	53.8	13.4	2.9	0.1
1981	35.1	116.7	118.3	54.0	15.6	2.6	0.2
Percentage change	– 0.3	0.5	– 0.3	– 0.4	– 14.1	11.5	– 50.0
Québec:(2)							
1982	15.1	84.1	122.0	62.8	17.7	2.7	0.1
1981	15.0	87.8	131.1	67.8	18.1	2.8	0.2
Percentage change	0.7	– 4.2	– 6.9	– 7.4	– 2.2	– 3.6	– 50.0
Ontario:							
1982	23.5	87.9	122.6	71.5	21.7	3.1	0.1
1981	23.1	89.1	121.9	68.6	20.4	3.4	0.1
Percentage change	1.7	– 1.3	0.6	4.2	6.4	– 8.8	–
Manitoba:							
1982	38.9	104.5	129.3	69.1	21.9	3.9	0.4
1981	39.9	107.7	130.8	68.3	20.3	4.0	0.3
Percentage change	– 2.5	– 3.0	– 1.1	1.2	7.9	– 2.5	33.3
Saskatchewan:							
1982	49.6	138.7	148.6	73.0	20.3	3.6	0.2
1981	47.9	137.6	149.2	69.6	19.8	4.2	0.3
Percentage change	3.5	0.8	– 0.4	4.9	2.5	– 14.3	– 33.3
Alberta:							
1982	44.2	113.4	133.5	74.7	21.9	4.1	0.2
1981	43.6	112.0	134.6	72.0	20.8	3.8	0.3
Percentage change	1.4	1.3	– 0.8	3.8	5.3	7.9	– 33.3
British Columbia:							
1982	27.7	100.4	122.3	72.4	21.5	3.3	0.2
1981	29.0	99.5	121.9	68.9	19.1	2.8	0.1
Percentage change	– 4.5	0.9	0.3	5.1	12.6	17.9	100.0
Yukon:							
1982	45.9	124.1	138.2	79.1	19.8	1.6	–
1981	66.3	137.1	126.8	78.6	18.7	–	–
Percentage change	– 30.8	– 9.5	9.0	0.6	5.9	–	–
Northwest Territories:							
1982	113.5	185.9	147.2	91.3	48.0	13.8	–
1981	113.0	175.4	153.0	96.5	47.0	11.1	2.6
Percentage change	0.4	6.0	– 3.8	– 5.4	2.1	24.3	–

Footnote(s) at end of tables.

TABLE A.7

AGE	PP	[illegible]	[illegible]	[illegible]	D(X)	LL(X)
0	63	0	.004141	100000	414	99617
1	371	0	[illegible]	[illegible]	70	398168
5	482	0	[illegible]	[illegible]	58	497434
10	548	0	[illegible]	[illegible]	58	497148
[illegible]	725	0	.000870	[illegible]	87	496791
[illegible]	506	0	.001170	[illegible]	116	[illegible]
[illegible]	395	0	[illegible]	[illegible]	145	[illegible]
30	515	0	.001755	[illegible]	174	[illegible]
35	610	0	[illegible]	[illegible]	260	493794
40	505	0	.004693	[illegible]	463	492016
45	473	0	.007027	[illegible]	689	[illegible]
50	478	1	.011646	[illegible]	1135	[illegible]
55	514	1	.018310	[illegible]	1764	[illegible]
[illegible]	386	2	.027370	[illegible]	2588	[illegible]
[illegible]	268	2	.045062	[illegible]	[illegible]	[illegible]
[illegible]	177	2	.070732	[illegible]	6213	[illegible]
75	116	2	.111093	[illegible]	9068	[illegible]
80	74	3	.185641	[illegible]	13469	[illegible]
85	55	4	1.000000	[illegible]	59084	[illegible]

AGE	M(X)	A(X)	TT(X)	R(X)	E(X)	MM(X)
0	.004157	.077	8666101	.0000	86.661	.004157
1	.000176	1.500	8566483	.0000	86.021	.000176
5	.000117	2.500	8168315	.0000	82.080	.000117
10	.000117	2.604	7670881	.0000	77.127	.000117
15	.000176	2.638	7173732	.0000	72.171	[illegible]
20	.000234	2.604	6676940	.0400	67.232	[illegible]
25	.000293	2.583	6180658	.0078	62.308	[illegible]
30	.000351	2.638	5685029	.0000	57.395	[illegible]
35	.000527	2.731	5190185	.0000	52.491	[illegible]
40	.000941	2.693	[illegible]	.0220	47.623	[illegible]
45	.001408	2.703	4204374	.0094	42.834	.001405
50	.002342	2.697	3715185	.0000	38.118	.002342
55	.003693	2.672	3230472	.0078	33.535	.003688
60	.005544	2.692	2752928	.0400	29.111	.005503
65	.009205	2.682	2286071	.0400	24.854	.009133
70	.014630	2.665	1835786	.0400	20.901	.014519
75	.023433	2.667	1411125	.0400	17.289	.023242
80	.040631	[illegible]	1024178	.0001	14.116	.040630
85	.029741	11.724	692681	.0000	11.724	.085298

14.49.35.UCLP, BB, [illegible]. 0.[illegible]KLNS.

Source: Output from Computer Programme Life

TABLE A.8a

TABLE OF POPULATION PROJECTIONS FOR ANCASTER

PROJECTION YEAR:
1991

FEMALE TABLE

AGE	BASE POPULATION	LESLIE POPULATION	OUT MIGRATION	IN MIGRATION	PROJECTED POPULATION
0	89.	98.	-10.	0.	89.
1	90.	88.	0.	2.	90.
2	93.	90.	0.	3.	93.
3	99.	93.	0.	7.	100.
4	102.	98.	0.	5.	103.
5	93.	101.	0.	5.	106.
6	126.	92.	0.	4.	96.
7	130.	126.	0.	2.	128.
8	137.	130.	0.	3.	133.
9	134.	137.	0.	3.	140.
10	152.	134.	0.	3.	137.
11	138.	152.	0.	2.	154.
12	137.	138.	0.	2.	140.
13	127.	137.	0.	2.	139.
14	134.	127.	0.	3.	130.
15	127.	134.	0.	1.	135.
16	118.	126.	0.	1.	127.
17	146.	117.	0.	2.	119.
18	116.	145.	0.	0.	145.
19	109.	116.	-3.	0.	113.
20	126.	108.	-9.	0.	99.
21	87.	126.	-17.	0.	109.
22	90.	87.	-18.	0.	69.
23	49.	89.	-10.	0.	79.
24	73.	48.	-15.	0.	33.
25	20.	73.	-4.	0.	69.
26	81.	19.	0.	11.	30.
27	94.	81.	0.	11.	92.
28	100.	94.	0.	11.	105.
29	106.	100.	0.	11.	111.
30	141.	106.	0.	11.	117.
31	152.	141.	0.	29.	170.
32	173.	151.	0.	29.	180.
33	208.	172.	0.	29.	201.
34	224.	207.	0.	29.	236.
35	236.	223.	0.	29.	252.
36	229.	235.	0.	16.	251.
37	261.	228.	0.	16.	244.
38	262.	260.	0.	16.	276.
39	242.	261.	0.	16.	277.
40	242.	240.	0.	16.	256.
41	195.	240.	0.	6.	246.
42	207.	194.	0.	6.	200.
43	203.	206.	0.	6.	212.
44	188.	202.	0.	6.	208.
45	153.	187.	0.	6.	193.
46	150.	151.	0.	4.	155.
47	143.	150.	0.	4.	154.
48	140.	143.	0.	4.	147.
49	129.	139.	0.	4.	143.
50	123.	125.	0.	4.	129.
51	118.	123.	0.	3.	126.
52	125.	118.	0.	3.	121.
53	118.	125.	0.	3.	128.
54	119.	118.	0.	3.	121.
55	112.	115.	0.	3.	118.
56	119.	112.	0.	2.	114.
57	[illegible]	119.	0.	2.	121.
58	97.	102.	0.	2.	104.
59	106.	97.	0.	2.	99.
60	102.	106.	-6.	0.	100.
61	102.	100.	-6.	0.	94.
62	84.	101.	0.	0.	101.
63	90.	83.	0.	0.	83.
64	83.	90.	-2.	0.	88.
65	106.	81.	0.	1.	82.
66	95.	105.	0.	1.	106.
67	81.	93.	0.	1.	94.
68	89.	78.	0.	1.	79.
69	86.	88.	0.	1.	89.
70	74.	85.	-2.	0.	83.
71	53.	74.	-2.	0.	72.
72	52.	52.	-2.	0.	50.
73	42.	51.	-1.	0.	50.
74	44.	41.	-1.	0.	40.
75	45.	42.	-1.	0.	41.
76	42.	44.	-1.	0.	43.
77	36.	38.	-1.	0.	37.
78	38.	35.	-1.	0.	34.
79	21.	38.	-1.	0.	37.
80	28.	21.	-1.	0.	20.
81	18.	28.	-1.	0.	27.
82	29.	18.	-1.	0.	17.
83	15.	26.	0.	0.	26.
84	5.	14.	0.	0.	14.
85	65.	63.	-2.	0.	61.
TOTAL	9761.	9789.	-118.	412.	10084.

Source: Output from Computer Programme PROJ1

TABLE A.8b

MALE TABLE

AGE	BASE POPULATION	LESLIE PROJECTION	OUT MIGRATION	IN MIGRATION	PROJECTED POPULATION
0	87.	100.	-14.	0.	86.
1	88.	84.	0.	3.	87.
2	94.	87.	0.	6.	93.
3	99.	93.	0.	7.	100.
4	100.	98.	0.	4.	102.
5	95.	100.	0.	4.	104.
6	130.	95.	0.	4.	99.
7	150.	130.	0.	3.	133.
8	134.	150.	0.	3.	153.
9	138.	133.	0.	3.	136.
10	152.	138.	0.	4.	142.
11	150.	152.	0.	2.	154.
12	128.	149.	0.	3.	152.
13	142.	127.	0.	2.	129.
14	139.	141.	0.	2.	143.
15	163.	138.	0.	0.	138.
16	124.	162.	0.	1.	163.
17	142.	123.	0.	3.	126.
18	159.	141.	0.	1.	142.
19	116.	158.	-2.	0.	156.
20	132.	116.	-8.	1.	109.
21	97.	131.	-16.	0.	115.
22	104.	96.	-17.	0.	79.
23	84.	103.	-13.	0.	90.
24	67.	83.	-11.	0.	72.
25	41.	66.	-7.	0.	59.
26	102.	41.	0.	3.	44.
27	102.	100.	0.	3.	103.
28	93.	101.	0.	3.	104.
29	86.	92.	0.	3.	95.
30	113.	85.	0.	3.	88.
31	107.	111.	0.	24.	135.
32	132.	106.	0.	24.	130.
33	170.	131.	0.	24.	155.
34	191.	169.	0.	24.	193.
35	209.	190.	0.	24.	214.
36	199.	208.	0.	25.	233.
37	239.	199.	0.	25.	224.
38	253.	239.	0.	25.	264.
39	247.	253.	0.	25.	278.
40	263.	247.	0.	25.	272.
41	240.	262.	0.	9.	271.
42	243.	240.	0.	9.	249.
43	235.	243.	0.	9.	252.
44	213.	234.	0.	9.	243.
45	175.	213.	0.	9.	222.
46	182.	175.	0.	7.	182.
47	174.	181.	0.	7.	188.
48	172.	173.	0.	7.	180.
49	150.	171.	0.	7.	178.
50	145.	149.	0.	7.	156.
51	121.	144.	0.	3.	147.
52	123.	120.	0.	3.	123.
53	115.	122.	0.	3.	125.
54	111.	113.	0.	3.	116.
55	102.	109.	0.	3.	112.
56	116.	100.	0.	3.	103.
57	101.	114.	0.	3.	117.
58	99.	100.	0.	3.	103.
59	107.	97.	0.	3.	100.
60	108.	106.	0.	1.	107.
61	108.	105.	0.	1.	106.
62	91.	107.	0.	1.	108.
63	87.	89.	-3.	0.	86.
64	85.	85.	0.	0.	85.
65	107.	85.	0.	0.	85.
66	78.	106.	-3.	0.	103.
67	88.	72.	-4.	0.	68.
68	76.	84.	-3.	0.	81.
69	54.	73.	-2.	0.	71.
70	68.	53.	-2.	0.	51.
71	38.	66.	-1.	0.	65.
72	47.	37.	-1.	0.	36.
73	41.	46.	-1.	0.	45.
74	44.	38.	-1.	0.	37.
75	37.	43.	-1.	0.	42.
76	33.	35.	-1.	0.	34.
77	23.	32.	-1.	0.	31.
78	31.	22.	-1.	0.	21.
79	15.	27.	0.	0.	27.
80	18.	15.	-1.	0.	14.
81	16.	18.	0.	0.	18.
82	23.	15.	-1.	0.	14.
83	9.	21.	0.	0.	21.
84	5.	8.	0.	0.	8.
85	28.	25.	-1.	0.	24.
TOTAL	9836.	9839.	-116.	420.	10143.

TABLE A.8c

FEMALE+MALE TABLE

AGE	BASE POPULATION	LESLIE PROJECTION	OUT MIGRATION	IN MIGRATION	PROJECTED POPULATION
0	175.	199.	-24.	0.	175.
1	178.	172.	0.	5.	177.
2	187.	177.	0.	9.	186.
3	197.	186.	0.	13.	199.
4	202.	196.	0.	9.	205.
5	188.	201.	0.	9.	210.
6	256.	187.	0.	8.	195.
7	281.	256.	0.	6.	262.
8	271.	280.	0.	6.	286.
9	273.	270.	0.	7.	277.
10	305.	272.	0.	8.	280.
11	288.	304.	0.	4.	308.
12	265.	287.	0.	5.	292.
13	269.	264.	0.	4.	268.
14	273.	268.	0.	5.	273.
15	290.	272.	0.	1.	273.
16	242.	288.	0.	2.	290.
17	287.	240.	0.	4.	244.
18	275.	286.	0.	1.	287.
19	225.	274.	-6.	0.	268.
20	258.	224.	-17.	1.	208.
21	184.	257.	-33.	0.	224.
22	193.	183.	-35.	0.	148.
23	133.	192.	-23.	0.	169.
24	140.	131.	-25.	0.	106.
25	61.	139.	-11.	0.	128.
26	183.	60.	0.	14.	74.
27	196.	181.	0.	14.	195.
28	193.	195.	0.	14.	209.
29	192.	192.	0.	14.	206.
30	254.	191.	0.	14.	205.
31	259.	252.	0.	53.	305.
32	305.	257.	0.	53.	310.
33	378.	303.	0.	53.	356.
34	415.	376.	0.	53.	429.
35	445.	413.	0.	53.	466.
36	428.	443.	0.	41.	484.
37	500.	427.	0.	41.	468.
38	515.	499.	0.	41.	540.
39	489.	514.	0.	41.	555.
40	505.	487.	0.	41.	528.
41	435.	502.	0.	15.	517.
42	450.	434.	0.	15.	449.
43	438.	449.	0.	15.	464.
44	401.	436.	0.	15.	451.
45	328.	400.	0.	15.	415.
46	332.	326.	0.	11.	337.
47	317.	331.	0.	11.	342.
48	312.	316.	0.	11.	327.
49	275.	310.	0.	11.	321.
50	268.	274.	0.	11.	285.
51	239.	267.	0.	6.	273.
52	248.	238.	0.	6.	244.
53	233.	247.	0.	6.	253.
54	226.	231.	0.	6.	237.
55	214.	224.	0.	6.	230.
56	235.	212.	0.	5.	217.
57	203.	233.	0.	5.	238.
58	196.	202.	0.	5.	207.
59	213.	194.	0.	5.	199.
60	209.	212.	-6.	1.	207.
61	210.	205.	-6.	1.	200.
62	175.	208.	0.	1.	209.
63	177.	172.	-3.	0.	169.
64	168.	175.	-2.	0.	173.
65	213.	166.	0.	1.	167.
66	173.	211.	-3.	1.	209.
67	169.	165.	-4.	1.	162.
68	165.	162.	-3.	1.	160.
69	140.	161.	-2.	1.	160.
70	142.	138.	-4.	0.	134.
71	92.	140.	-3.	0.	137.
72	98.	89.	-3.	0.	86.
73	82.	97.	-2.	0.	95.
74	87.	79.	-3.	0.	76.
75	82.	85.	-2.	0.	83.
76	75.	79.	-2.	0.	77.
77	59.	70.	-2.	0.	68.
78	70.	57.	-2.	0.	55.
79	36.	65.	-1.	0.	64.
80	47.	36.	-1.	0.	35.
81	34.	46.	-1.	0.	45.
82	51.	33.	-2.	0.	31.
83	24.	47.	-1.	0.	46.
84	10.	22.	0.	0.	22.
85	94.	88.	-3.	0.	85.
TOTAL	19597.	19629.	-234.	832.	20227.

POPULATION OF ANCASTER=20227.

1991

FIGURE B.1a

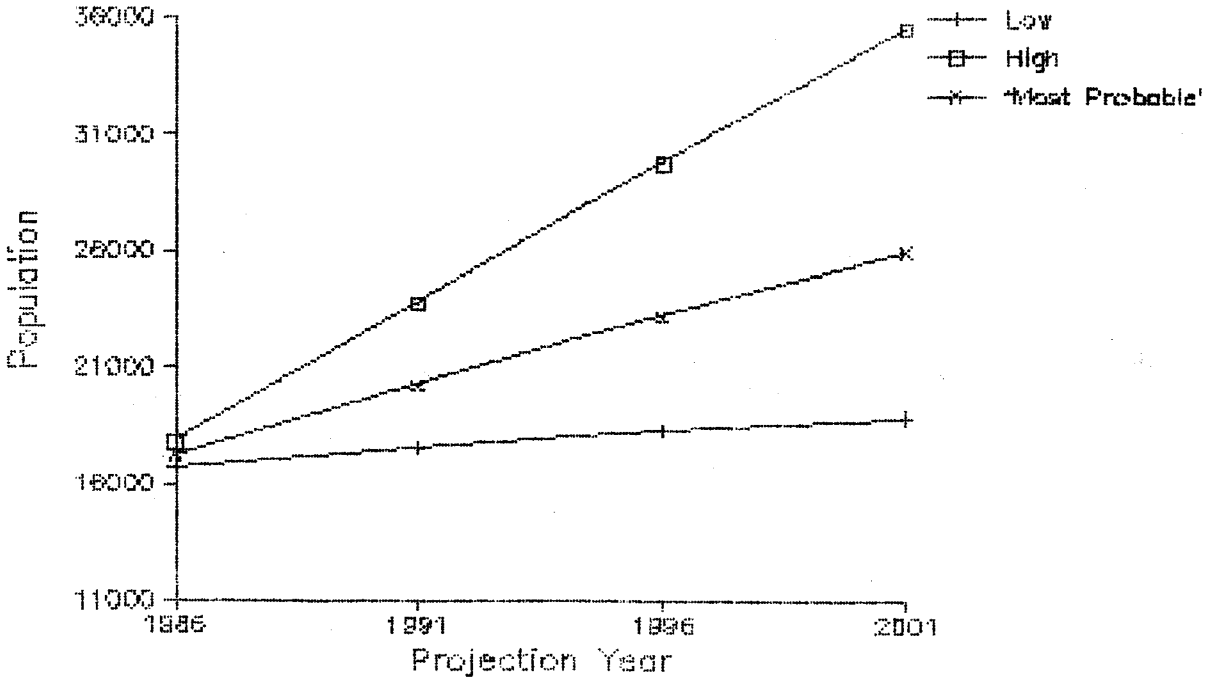
```
      PROGRAM PROJ1
      REAL KP(2,87),SP(2,87),B(87)
      REAL KQ(2,87)
      REAL X
      DATA NPJ/16/
      DATA NS,NA/2,86/
      DATA SEXR/1.02/
      IYEAR=1985
      NA1=NA+1
      FEM=1.0/(SEXR+1.0)
      OPEN(UNIT=1)
      OPEN(UNIT=2)
      OPEN(UNIT=3)
      OPEN(UNIT=8)
      NAM1=NA-1
      SP(2,87)=1.0
      SP(1,87)=1.0
      B(87)=0.0
      KP(2,87)=0
      KP(1,87)=0
      DO 50 IA=1,NA
      READ(1,1010) KP(1,IA),KP(2,IA)
1010  FORMAT(2F7.0)
      READ(2,1020) (SP(IS,IA),IS=1,NS)
1020  FORMAT(4X,2F9.6)
      READ(3,1030) B(IA)
1030  FORMAT(10X,F10.6)
      B(NA1)=B(NA1)+B(IA)
      DO 30 IS=1,NS
      SP(IS,NA1)=SP(IS,NA1)+SP(IS,IA)
30    KP(IS,NA1)=KP(IS,NA1)+KP(IS,IA)
50    CONTINUE
      WRITE(8,1040)
1040  FORMAT('1',T20,'TABLE OF INPUTS FOR PROJ1')
      WRITE(8,1045)
1045  FORMAT(T20,'-------------------------')
      WRITE(8,1050)
1050  FORMAT(//,T5,'BASE POP.(1985)',T29,'SURV. PROP.',T49,'"BIRTH" RATE&
     +S')
      WRITE(8,1055)
1055  FORMAT(T5,'---------------------------------------------------&
     +--')
      WRITE(8,1060)
1060  FORMAT(/,T2,'AGE',T9,'F',T16,'M',T29,'F',T39,'M')
      WRITE(8,1065)
1065  FORMAT(T2,'---------------------------------------------------&
     +-----')
      DO 65 IA=1,NA1
      IA1=IA-1
      WRITE(8,1070)IA1,(KP(IS,IA),IS=1,NS),(SP(IS,IA),IS=1,NS),B(IA)
1070  FORMAT(T2,I2,T5,F6.0,T12,F6.0,T25,F9.6,T36,F9.6,T50,F10.6)
65    CONTINUE
      DO 800 IPJ=1,NPJ
      CALL RANSET(N)
      SUM=0.0
      DO 75 IA=1,NA
      SUM=SUM+B(IA)*KP(1,IA)
75    CONTINUE
      KQ(1,1)=SUM*FEM
      KQ(2,1)=SUM-KQ(1,1)
      DO 400 IS=1,NS
      DO 200 IA=1,NAM1
      IA1=IA+1
      NSIM=KP(IS,IA)
      KQ(IS,IA1)=0
      DO 100 ISIM=1,NSIM
      X=RANF( )
      IF(X .GT. SP(IS,IA)) GO TO 100
      KC(IS,IA1)=KQ(IS,IA1)+1
100   CONTINUE
200   CONTINUE
      NSIM=KP(IS,NA)
      DO 300 ISIM=1,NSIM
      X=RANF( )
      IF(X .GT. SP(IS,NA)) GO TO 300
      KQ(IS,NA)=KQ(IS,NA)+1
300   CONTINUE
350   CONTINUE
400   CONTINUE
      CALL MIGRAT(IPJ,KP,KQ)
800   CONTINUE
      STOP
      END
      SUBROUTINE MIGRAT(IPJ,KP,KQ)
      REAL KP(2,87)
      REAL KQ(2,87)
      REAL KO(2,87)
      REAL KI(2,87)
      REAL KR(2,87)
      REAL KS(2,87)
      REAL NV(2)
      REAL KL(2,87)
      DATA NS,NA,NA1/2,86,87/
      DATA  NV/412.,420./

      OPEN(UNIT=9)
      OPEN(UNIT=4)
      OPEN(UNIT=5)
      REWIND(4)
      REWIND(5)
      KQ(1,87)=KQ(2,87)=0.0
      KL(1,87)=KL(2,87)=0.0
      KO(1,87)=KO(2,87)=0.0
      KI(1,87)=KI(2,87)=0.0
      KR(1,87)=KR(2,87)=0.0
      KS(1,87)=KS(2,87)=0.0
      KP(1,87)=KP(2,87)=0.0
      DO 30 IA=1,NA
      READ(4,10)(KI(IS,IA),IS=1,NS)
10    FORMAT(7X,2F7.4)
      READ(5,20)(KO(IS,IA),IS=1,NS)
20    FORMAT(2F7.2)
30    CONTINUE
```

FIGURE B.1b

```
      WRITE(9,1080)
1080  FORMAT('1',T20,'TABLE OF POPULATION PROJECTIONS FOR ANCASTER')
      WRITE(9,1085)
1085  FORMAT(T20,'------------------------------------------')
      WRITE(9,1086)
1086  FORMAT([illegible]T5,'PROJECTION YEAR:')
      WRITE(9,1087)
1087  FORMAT(T5,'----------------')
      WRITE(9,1088)IPJ+IYEAR
1088  FORMAT([illegible]I4)
      WRITE(9,1089)
1089  FORMAT(//,T5,'FEMALE TABLE')
      WRITE(9,1090)
1090  FORMAT(T5,'------------')
      WRITE(9,1100)
1100  FORMAT(///,T14,'BASE',T26,'LESLIE',T40,'OUT',T52,'IN',T61,'PROJECT&
     +ED')
      WRITE(9,1110)
1110  FORMAT(T5,'AGE',T11,'POPULATION',T24,'POPULATION',T37,'MIGRATION',&
     +T49,'MIGRATION',T61,'POPULATION')
      WRITE(9,1120)
1120  FORMAT(T5,'-------------------------------------------------------&
     +------------')
      DO 40 IA=1,NA
      DO 50 IS=1,NS
      KL(IS,IA)=KQ(IS,IA)
      KR(IS,IA)=KP(IS,IA)*KO(IS,IA)
      KS(IS,IA)=KI(IS,IA)*NV(IS)
      KQ(IS,IA)=KR(IS,IA)+KS(IS,IA)+KQ(IS,IA)
      KP(IS,NA1)=KP(IS,NA1)+KP(IS,IA)
      KL(IS,NA1)=KL(IS,NA1)+KL(IS,IA)
      KR(IS,NA1)=KR(IS,NA1)+KR(IS,IA)
      KS(IS,NA1)=KS(IS,NA1)+KS(IS,IA)
      KQ(IS,NA1)=KQ(IS,NA1)+KQ(IS,IA)
50    CONTINUE
40    CONTINUE
      DO 55 IA=1,NA
      IA1=IA-1
      WRITE(9,1130)IA1,KP(1,IA),KL(1,IA),KR(1,IA),KS(1,IA),KQ(1,IA)
1130  FORMAT(T6,I2,T14,F4.0,T27,F4.0,T40,F4.0,T52,F4.0,T64,F4.0)
55    CONTINUE
      WRITE(9,1135)
1135  FORMAT(T6,'------------------------------------------------------ &
     +---------')
      WRITE(9,1138)KP(1,NA1),KL(1,NA1),KR(1,NA1),KS(1,NA1),KQ(1,NA1)
1138  FORMAT(T6,'TOTAL',T12,F6.0,T25,F6.0,T38,F6.0,T50,F6.0,T62,F6.0)
      WRITE(9,1140)
1140  FORMAT('1',/,T5,'MALE TABLE')
      WRITE(9,1141)
1141  FORMAT(T5,'----------')
      WRITE(9,1142)
1142  FORMAT(///,T14,'BASE',T26,'LESLIE',T40,'OUT',T52,'IN',T61,        &
     +'PROJECTED')
      WRITE(9,1143)
1143  FORMAT(T5,'AGE',T11,'POPULATION',T24,'PROJECTION',T37,'MIGRATION',&
     +T49,'MIGRATION',T61,'POPULATION')
      WRITE(9,1144)
1144  FORMAT(T5,'-------------------------------------------------------&
     +------------')
      DO 57 IA=1,NA
      IA1=IA-1
      WRITE(9,1145)IA1,KP(2,IA),KL(2,IA),KR(2,IA),KS(2,IA),KQ(2,IA)
1145  FORMAT(T6,I2,T14,F4.0,T27,F4.0,T40,F4.0,T52,F4.0,T64,F4.0)
57    CONTINUE
      WRITE(9,1146)
1146  FORMAT(T6,'-------------------------------------------------------&
     +------------')
      WRITE(9,1147)KP(2,NA1),KL(2,NA1),KR(2,NA1),KS(2,NA1),KQ(2,NA1)
1147  FORMAT(T6,'TOTAL',T12,F6.0,T25,F6.0,T38,F6.0,T50,F6.0,T62,F6.0)
      WRITE(9,1150)
1150  FORMAT('1',T5,'FEMALE+MALE TABLE')
      WRITE(9,1160)
1160  FORMAT(T5,'-----------------')
      WRITE(9,1170)
1170  FORMAT(///,T14,'BASE',T26,'LESLIE',T40,'OUT',T52,'IN',T61,'PROJECT&
     +ED')
      WRITE(9,1180)
1180  FORMAT(T5,'AGE',T11,'POPULATION',T24,'PROJECTION',T37,'MIGRATION',&
     +T49,'MIGRATION',T61,'POPULATION')
      WRITE(9,1190)
1190  FORMAT(T5,'-------------------------------------------------------&
     +------------')
      DO 58 IA=1,NA
      IA1=IA-1
      WRITE(9,1200)IA1,KP(1,IA)+KP(2,IA),KL(1,IA)+KL(2,IA),KR(1,IA)+KR(2&
     +,IA),KS(1,IA)+KS(2,IA),KQ(1,IA)+KQ(2,IA)
1200  FORMAT(T6,I2,T14,F4.0,T27,F4.0,T40,F4.0,T52,F4.0,T64,F4.0)
58    CONTINUE
      WRITE(9,1205)
1205  FORMAT(T6,'-------------------------------------------------------&
     +------------')
      WRITE(9,1210)KP(1,NA1)+KP(2,NA1),KL(1,NA1)+KL(2,NA1),KR(1,NA1)+KR(&
     +2,NA1),KS(1,NA1)+KS(2,NA1),KQ(1,NA1)+KQ(2,NA1)
1210  FORMAT(T5,'TOTAL',T12,F6.0,T25,F6.0,T38,F6.0,T50,F6.0,T62,F6.0)
      WRITE(9,1220)KQ(1,NA1)+KQ(2,NA1)
1220  FORMAT(///,T10,'POPULATION OF ANCASTER=',F6.0)
      WRITE(9,1230)
1230  FORMAT(T33,'------')
      WRITE(9,1240)IPJ+IYEAR
1240  FORMAT(/,T24,I4)
      WRITE(9,1250)
1250  FORMAT(T24,'----')
      DO 60 IA=1,NA
      DO 70 IS=1,NS
      KP(IS,IA)=KQ(IS,IA)
70    CONTINUE
60    CONTINUE
      RETURN
      END
10.44.37.UCLP, BB, TBSBLP2,      0.280KLNS.
```

FIGURE B.2

POPULATION PROJECTIONS FOR ANCASTER
(1986 to 2001)



BIBLIOGRAPHY

Coffey, W.J., P.M. Smith and A.S. Harvey. 1979. Atlantic Region Population Dynamics, 1981-2001. Halifax, Nova Scotia: Institute of Public Affairs, Dalhousie University.

Halton Regional Planning Department. 1975. Demographic Analysis and Population Trend Forecast for the Regional Municipality of Halton. Oakville, Ontario.

Hamilton-Wentworth Regional Planning and Development Department. 1981. Hamilton-Wentworth Population Projections 1981 Review. Hamilton, Ontario.

Hamilton-Wentworth Regional Planning and Development Department. 1976. Population: Future Growth in the Hamilton-Wentworth Region. Hamilton, Ontario.

Keyfitz, N., " The Population Projection as a Matrix Operator," Demography, I. (1964), 56-73.

Leslie, P.H., " On the use of Matrices in Certain Population Mathematics," Biometrika, XXXIII (November 1945), 183-212.

Rogers, A., " Matrix Methods of Population Analysis," Journal of the American Institute of Planners, XXXII, 1 (January 1966), 40-44.

Siegel, J., " Forecasting Urban Populations," Urban Futures for Central Canada: Perspectives on Forecasting Urban Growth and Form. University of Toronto Press, 1974.