Methodology and Assumptions for the Population Projections of the United States: 1999 to 2100

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ABSTRACT

This working paper discusses the methodology and assumptions used to develop the recently released projections of the population of the United States from 1999 to 2100. The new series includes projections of the population by single year of age, sex, race, Hispanic origin, and nativity. While the basic methodology used to produce these projections is the same as in earlier Census Bureau national population projections, there have been changes, in both the time horizon and reference dates of the projections, as well as in the specific methods used to estimate population change. The extension of the series to 2100 carries the projections 20 years further into the future than any series previously issued by the Census Bureau. For the first time, projection results include a break on nativity, defined dichotomously by the presence or absence of U.S. citizenship at birth, as well as its cross-classification with other variables. Also new with this series is the projection to quarterly reference dates, allowing users to view the national population seasonally, or simply to select annual reference dates other than July 1. In addition, international migration in the new series is allowed to vary over time, remaining somewhat lower than the constant value in the previous series for the first two decades of the century, but reaching considerably higher levels than in the previous one after 2020. Fertility rates in both models are allowed to change very little over time. However, fertility rates by race and Hispanic origin are allowed to converge in the new middle series, whereas in the previous middle series they remained constant within race and origin category. Finally, the new mortality assumptions show more improvement in life expectancy for all racial and Hispanic origin groups, except the non-Hispanic White population, than did the assumptions of the previous projection series.

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* This paper reports the results of research and analysis undertaken by Census Bureau staff. It has undergone a more limited review than official Census Bureau publications. This report is released to inform interested parties of research and to encourage discussion.

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INTRODUCTION

This working paper discusses the methodology and assumptions used to develop the recently released projections of the population of the United States from 1999 to 2100.[1] The new series includes projections of the population by single year of age, sex, race, Hispanic origin, and nativity.[2] While the basic methodology used to produce these projections is the same as in earlier Census Bureau national population projections, there have been changes, in both the time horizon and reference dates of the projections, as well as in the specific methods used to estimate population change. The extension of the series to 2100 carries the projections 20 years further into the future than any series previously issued by the Census Bureau. For the first time, projection results include a break on nativity, defined dichotomously by the presence or absence of U.S. citizenship at birth, as well as its cross-classification with other variables. Also new with this series is the projection to quarterly reference dates, allowing users to view the national population seasonally, or simply to select annual reference dates other than July 1. In addition, international migration in the new series is allowed to vary over time, remaining somewhat lower than the constant value in the previous series for the first two decades of the century, but reaching considerably higher levels than in the previous one after 2020. Fertility rates in both models are allowed to change very little over time. However, fertility rates by race and Hispanic origin are allowed to converge in the new middle series, whereas in the previous middle series they remained constant within race and origin category.[3] Finally, the new mortality assumptions show more improvement in life expectancy for all racial and Hispanic origin groups, except the non-Hispanic White population, than did the assumptions of the previous projection series.

Aside from these changes, the basic structure of the product closely resembles previous Census Bureau projections. Race consists of four categories; 1) White, 2) Black, 3) American Indian, Eskimo, and Aleut, 4) Asian and Pacific Islander (API). Hispanic origin is dichotomous: the two categories are Hispanic and non-Hispanic. All race and Hispanic origin detail incorporates the full distribution of eight cross-categories. As in previous projections, we have provided alternate series, defined by alternative assumptions on the three major determinants of population change, fertility, mortality, and migration. However, the interpretation of “low” and “high” assumptions has changed somewhat with respect to previous projections. In the present series, the extreme assumptions are presented primarily with the purpose of illustrating a degree of uncertainty around the central series. They should not be interpreted as alternative scenarios to be adopted on their face value, as they are not intended to be probable developments.

The results of the new projections are not substantially different from those of the last series issued by the Census Bureau, when the comparison is made across matching dates.[4] Both middle series show the national population growing at a large fraction of one percent per year until 2050. Both series show the rate of growth declining over time, from approximately 0.9 percent per year in 1999 to about 0.7 percent per year around 2050. These results are shown in Table A. The lack of major difference in the population results for the middle series between

[1] At the time of release for this report, the results of these projections are located on the Census Bureau site of the Worldwide Web. U.S. Census Bureau; “National Population Projections;” <http://www.census.gov/population /www/projections/natproj.html>

[2] The information on the Hispanic population shown in this report was collected in the 50 States and the District of Columbia and, therefore, does not include residents of Puerto Rico.

[3] People of Hispanic origin may be of any race.

[4] Jennifer Cheeseman Day, U.S. Census Bureau, *Population Projections of the United States by Age, Sex, Race, and Hispanic Origin: 1995 to 2050*, Current Population Reports, P25-1130, U.S. Government Printing Office, Washington, District of Columbia, 1996.

the new and old projections can be explained in large part by the deterministic nature of the age distribution of the base population, and the predictability of its aging over time. This initial age distribution represents essential information that is conveyed to the projected series. The means of its conveyance is the cohort component method, discussed in the section that follows.

THE METHOD OF PROJECTING THE POPULATION

The method used to produce projections of the United States population for future reference dates from a current base population reflects three fundamental principles.

1) The projections are demographic. Future populations are derived from a base population through the projection of population change by its major demographic components, births, deaths, and migration.

2) The projection of the demographic components of change is driven by the composition of the population by age, sex, race, Hispanic origin, and nativity, and the way these variables determine the propensity to bear children, die, and migrate to or from the United States.

3) The definition of the population with respect to who is included and the characteristics of included people remains the same throughout the projection period. We refer to these definitions collectively throughout the work as the "population universe." This concept embraces such issues as the inclusion or exclusion of people uncounted by a census, the rule defining residency in the United States, and the way we classify people by age, race, and Hispanic origin. The population universe for these projections is defined primarily by the 1990 census, albeit with some modifications.

The first two principles mandate the use of "cohort component" methodology in projecting the population. Under this methodology, knowledge of the age and sex composition of the population at any point in time is fundamental to the projection of the population. Knowing the age-sex distribution at one date allows us to impute the age-sex distribution of those still alive at later dates, since sex does not change while age advances with the passage of time. This knowledge also allows the projection of demographic behaviors such as fertility, mortality, and the propensity to migrate, differentiated by age. Thus, current age-sex distribution influences future age-sex distribution through the components of change, as well as the aging of people over time.

To comply with the second principle described above, standard cohort component methodology is applied to each racial and Hispanic origin category as if they were separate populations. Race and Hispanic origin are chosen because they are reflected in a wide range of administrative data in the United States, and because their categories are distinct with respect to rates of fertility and mortality. Nativity, defined by citizenship at birth, is used to distinguish rates of emigration from the United States. The foreign-born population is also projected separately, but without births, since children born within the United States are U.S. citizens at birth (native) by United States law.

The third principle, preservation of the population universe, imposes the need for a special adaptation of cohort component methodology. The population universe for these projections is defined by the decennial census of April 1, 1990, with some adaptations. In certain critical regards, the distribution of this population by age, sex, race, and Hispanic origin does not submit well to projection by the cohort component method. It is characterized by a pattern of underenumeration highly differentiated by age, as well as some misreporting of age, and a distribution by race and Hispanic origin substantially different from what appears in other administrative data sources. In order to preserve these irregularities of the age detail in the projected population while maintaining the applicability of the cohort component method, we apply the standard method to a synthetic base population with characteristics "friendly" to the method. We then adapt the resulting projections back to the actual base population universe. This process is known as "inflation-deflation." The following sections discuss this modified cohort component methodology.

Base Population and Base Series

The current series of population projections are "launched" from an estimated resident population by age, sex, race, Hispanic origin, and nativity, as of January 1, 1999.[5] While we refer to this population as the base population for the series, the population universe for the series is defined by the *estimates base population* of April 1, 1990. The *estimates base population* is the population that forms the base for national-level estimates produced for the Census Bureau's population estimates program. This program yields the projections base population of January 1, 1999. We refer to the population series from April 1, 1990, to January 1, 1999, as the *base* series for the projections. This series, and its associated estimates of the demographic components of change, form the data base from which most of the assumptions regarding fertility, mortality, and migration in the projections are formulated.

The base population universe is derived primarily from the 1990 census and consists of residents of the 50 states and the District of Columbia. The universe excludes the U.S. Armed Forces overseas and citizens ordinarily residing outside the United States. It is subject to net underenumeration in the 1990 census, with the exceptions of adjustments for net underenumeration in certain localities resulting from the Census Test of 1995. The race distribution is modified to comply with the Office of Management and Budget Directive 15, which places all individuals within one of four major racial groups, 1) White, 2) Black, 3) American Indian, Eskimo, and Aleut, and 4) Asian and Pacific Islander.[6] The age distribution is modified to eliminate the effect of inconsistencies between age and year of birth in the census, arising primarily from delayed reporting of an age inconsistent with the decennial enumeration date (April 1, 1990).[7]

The Cohort-Component Method

The *cohort-component method* for estimating and projecting a population, as previously indicated, is distinguished by its ability to preserve knowledge of an age distribution of a population (which may be of a single sex, race, and Hispanic origin) over time. It is a special case of a *component method*, which is defined simply by the use of estimates or projections of births, deaths, and net migration to update a population.[8] In its simplest statement, the component method is expressed by the following equation:

$$P_t = P_{t-1} + B_{t-1,t} - D_{t-1,t} + M_{t-1,t} \qquad (1)$$

where

P_t = population at time t;

P_{t-1} = population at time $t-1$;

$B_{t-1,t}$ = births, in the interval from time $t-1$ to time t;

$D_{t-1,t}$ = deaths, in the interval from time $t-1$ to time t; and

$M_{t-1,t}$ = net migration, in the interval from time $t-1$ to time t.

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[5] U.S. Census Bureau, "Population Growth Rate Remains Stable, Census Bureau Reports," National Population Estimates, Released as Press Release No. CB99-101, June 4, 1999. At the time of release for this report, the results of the national estimates are located on the Census Bureau site of the Worldwide Web. U.S. Census Bureau; "National Population Estimates;" published June 1999, <http://www.census.gov/population/www /estimates/uspop.html>

[6] Throughout the remainder of this report, "American Indian" is used to describe the American Indian, Eskimo, and Aleut population.

[7] U.S. Census Bureau, *Age, Sex, Race, and Hispanic Origin Information from the 1990 Census: A Comparison of Census Results with Results Where Age and Race Have Been Modified*, CPH-L-74, U.S. Government Printing Office, Washington, District of Columbia, 1991.

[8] These methods are discussed in various demographic texts, e.g., Henry Shryock and Jacob Siegel, *Methods and Materials of Demography*, Academic Press, Orlando, Florida, 1976.

Components of population change are estimated or projected separately, and applied to equation (1) recursively to produce a series of populations. We have not specified the measurement unit of time, so the interval from *t-1* to *t* may be of any duration.

The cohort-component method is based on similar logic for individual age groups, recognizing that the source population for a given age group is the population at time *t-1* in the adjacent younger age group. For the initial age group, it is births during the interval from *t-1* to *t*. For the moment, let us assume that the time unit is one year. The equation is replaced by two equations, depending on whether the age group is zero (meaning under 1) or any other age as of the last birthday, denoted by *a*.

$$P_t(0) = B_{t-1,t} - D_{t-1,t}(0) + M_{t-1,t}(0) \qquad (2)$$

$$P_t(a) = P_{t-1}(a-1) - D_{t-1,t}(a) + M_{t-1,t}(a) \qquad (3)$$

In the case of deaths (D) and net migration (M), the interval *a* denotes age of decedents or migrants at time t--not necessarily equal to age at time of death or migration. Each of the terms in equations (2) or (3), whether defined as a population or a number of events, relates to people born in a particular year (from *t-a-1* to *t-a*). Such a group is known as a *birth cohort*, hence the term "cohort component method." While it is essential that age and time in equations (2) and (3) be measured in the same unit, there is no requirement that the interval be one year. For most applications, the time unit employed is either a single year or a five-year interval.

The current projections are somewhat unusual in this regard, in that the time interval used is a calendar quarter. There are various reasons for the choice of quarter-year intervals. The base date for the series is April 1, 1990, while the reference date most frequently cited tends to be mid-year, or July 1. Data sources used to estimate the components of population change for the base series are produced for varying time intervals. Births and deaths are produced by calendar year; immigration data by federal fiscal year (ending September 30). Although these event data are based on administrative records coded by month, there would be no cost advantage in standardizing them to any particular year on the calendar. We therefore use the calendar quarter because it is the largest common subinterval of the various reporting intervals in the data. Extending the series to future dates by quarter facilitates the integration of future assumptions with base series data, and yields an added bonus of flexibility, in allowing users to either utilize the quarterly series or select any quarterly date for an annual series.

The Inflation-Deflation Method

The cohort-component method described above requires that the base population age distribution observe the fundamental attribute that birth cohorts are affected only by mortality and migration as they age. The population universe specified by the estimates base population does not observe this simple requirement for two salient reasons. First, the universe reflects underenumeration of the population at certain ages. Second, the misstatement of year of birth in the census causes spurious irregularities in the age distribution, especially "heaping" on certain terminal digits. If we did not employ the inflation-deflation method, the application of the cohort-component method would have the effect of advancing the age pattern of these irregularities over time, rendering age groups uncomparable from one year to the next.

The *inflation-deflation method* is a procedure designed to overcome this problem. It can be summarized in six steps, each of which is carried out for each sex, race, Hispanic origin, and nativity category.

1) An alternative base population universe, that is deemed to eliminate, or at least minimize the described irregularities in the age distribution, is utilized as a base population for cohort

component projections. The population used here, known as a *Demographic Analysis Population* (DA population), is developed from an amalgam of historical data on births, deaths, and migration for ages under 65, and a population of Medicare enrollees for ages 65 and over. The reference date for this population is April 1, 1990.[9]

2) An "inflation-deflation factor" is computed for each single-year age group, as the ratio of the estimates base population to the DA population in that group, both as of April 1, 1990. The resulting factors may be less than or greater than one, although they are more likely to be less than one, because the net effect of census underenumeration, census duplication, age heaping, and discrepancies in racial classification are more likely to be negative than positive.

3) The DA population by age is updated from April 1, 1990 to January 1, 1999, then projected to future dates, by the cohort-component method, per equations (2) and (3), as described earlier. Births, deaths, and foreign-born emigrants by age are derived by application of rates, to be discussed in the next section.

4) The population in each age group is multiplied by the inflation-deflation factor for the group, for each quarterly reference date. While the factors are defined for full-year age groups, they are assumed to be constant across quarter-year ages within the full-year groups.

5) The actual base population for the projections, the estimates base universe, is projected using the simple component method without distribution by age, per equation (1) described earlier. The total number of births, deaths, and foreign-born emigrants from January 1, 1999, forward are those derived in step 3), with results summed across age groups. Because the number of births is considered to be adjusted for underregistration, births are reduced by a factor to reflect what would actually be registered. The balance of the migration components are derived numerically via the projection assumptions, to be discussed later in this report.

6) A pro-rata adjustment is used to force the age distributions from step 4) to match the population totals from step 5).

Derivation of Births, Deaths, and Foreign-Born Emigration from Rates

The application of the cohort-component method, as stated in equations (2) and (3) requires numerical projections of births, deaths, and net migration. The formulation of assumptions (see below) yields *numerical projections* of the net migration component (without the effect of foreign-born emigration) for the full matrix of characteristics for each quarter. These numerical projections are exogenous, in the sense that they are unaffected by population. However, the assumptions yield *population-based rates* of fertility, mortality and foreign-born emigration. Therefore, the resulting numerical projections of these components are endogenous, meaning they are themselves partly a consequence of the projected population. The derivation of numerical projections of endogenous components is part of step 3) in the procedure described in the previous section. Because the projection procedure produces the population at quarterly intervals, the application of rates occurs for each quarterly interval and by quarter year of age. Mortality and emigration rates are applied to the mid-quarter population of each age group as the population is generated, taking account of the fact that mortality and migration, along with the exogenous components, affect the mid-quarter population in its generation. Equation (3) is applied to produce all quarter-year age groups for the beginning of the succeeding quarterly time interval. Fertility rates are then applied to mid-quarter populations of female age groups to

[9] For a description of the 1990 Demographic Analysis population and its derivation, see J. G. Robinson, B. Ahmed, P. Das Gupta, and K.A. Woodrow, "Estimation of Population Coverage in the 1990 United States Census Based on Demographic Analysis," *Journal of the American Statistical Association,* Vol. 88-423 (1993): pp. 1061-1071.

generate births, and mortality and emigration rates for first-quarter infants are applied to complete the youngest age group, per equation (2).

An exception to this procedure occurs in the case of the foreign-born population. Foreign-born and native women of the same age, race, and Hispanic origin are assumed to have the same fertility and mortality rates, since the base data to differentiate fertility and mortality by nativity were unavailable. It was therefore convenient to project the population of both nativity categories together, then project the foreign-born population by assuming zero fertility, since all newly born are native by definition. The native population could then be determined by subtracting foreign-born from total population.

The projection assumptions produce rates for full years of age, and full-year rates are assumed constant across quarter-year subdivisions of age. However, empirical observation of the seasonality of death and childbearing is considered in the derivation of deaths and births by quarter. Data from the National Center for Health Statistics for calendar year 1996 provide the basis for the seasonal distribution of annual births and deaths.[10] Foreign-born emigration rates are projected from information for an entire decade, so no information on seasonality was available, and none was assumed. For foreign-born emigration the quarterly series was determined by the quarterly application of emigration rates to the foreign-born population.

Reflecting Uncertainty of Assumptions Through High and Low Variants

The new projections do not include a systematic measurement of uncertainty. However, in the development of each of the component assumptions, we established high and low variants based on a reasoned assessment of what represented "extreme" values. Applying variant assumptions for each component individually resulted in the range of population series that would be identified with the maximum likely variance of that component. To produce our lowest and highest series, we combined the extreme values of all three major components that favored, respectively, the lowest and highest population growth. Therefore, the extreme projections *do not represent likely scenarios in themselves*, but purport to represent the extremes between which most likely outcomes should fall. Fertility and international migration imposed a greater uncertainty on the projections than did mortality, because childbearing and mobility, to a greater extent than death, are functions of individual and collective decision-making that are difficult to forecast accurately.

ASSUMPTIONS FOR THE COMPONENTS OF CHANGE

The following sections describe the assumptions that determined future levels of fertility, mortality, and international migration, for application of the methodology described above.

Fertility

The total fertility rate (TFR) for the United States has remained fairly constant since 1989.[11] As of 1997, the total fertility rate was 2,032.5 births per 1,000 women.[12] Evaluating the fertility trends of the recent past is useful in establishing the immediate direction of fertility.

[10] For seasonality of births see Stephanie J. Ventura, J. Martin, S. Curtin, T. Mathews, National Center for Health Statistics, *Report of Final Natality Statistics*, 1996, Monthly Vital Statistics Report, Vol. 46-11 Supplement, 1998.; for seasonality of deaths see unpublished tabulations from National Center for Health Statistics, 1996 detailed mortality file.

[11] The total fertility rate is a standardized measure of the average number of live births per 1,000 women experiencing specific age-specific fertility rates throughout their childbearing years without accounting for mortality.

[12] Stephanie J. Ventura, J. Martin, S. Curtin, T. Mathews, National Center for Health Statistics, *Births: Final Data for 1997*, National Vital Statistics Report, Vol. 47-18, 1999.

However, such evaluation provides little information regarding the trend for the next 100 years. To formulate our fertility assumptions, we relied on demographic theory, analyzed past and current national and international fertility trends, and made use of data on birth expectations from a national survey.

Assumptions and Methodology

The previous projections assumed constant fertility throughout the projection period by race and Hispanic origin for the middle series.[13] The fertility assumptions for the current set of projections allow fertility to vary for the short- and long-term by race and Hispanic origin. Fertility trends are projected separately for non-Hispanic Whites, non-Hispanic Blacks, non-Hispanic American Indians, non-Hispanic Asian and Pacific Islanders, and Hispanics.[14]

Short-term Fertility Assumptions

To project the short-term fertility trends, the period from 1999 to 2025, we assumed fertility levels will reach target total fertility rates determined by birth expectations data and demographic theory. Once collected and analyzed, birth expectations are used to represent the total number of children ever born for three of the five race and Hispanic origin groups in 2025. The birth expectations are further adjusted according to the method developed by van Hoorn and Keilman.[15] Because birth expectations data for non-Hispanic American Indians and non-Hispanic Asian and Pacific Islanders are deficient, total fertility rates are derived for these groups by assuming they converge halfway to "replacement level," a total fertility rate of 2,100 per 1,000 women, by the year 2025. The total fertility rate for non-Hispanic American Indians and non-Hispanic Asian and Pacific Islanders is assumed to decline by .006 and .002 births per woman per year respectively between 1998 and 2025.

Long-term Fertility Assumptions

Beyond the year 2025, we relied upon an analysis of past and current national and international fertility trends and demographic theory to formulate our assumptions. However, a review of fertility trends and existing research by Westoff[16] and Day,[17] among others, provide no definitive long-term direction for the fertility of the United States. Therefore, following 2025, long-term total fertility rates for each race and Hispanic origin category are assumed to move regularly toward replacement level, reaching 2.1 in 2150. The rate of increase or decrease to the total fertility rates differ among the five race and Hispanic origin groups. Table B displays the total fertility rates by race and Hispanic origin for the projections period of 1999 to 2100.

Long-term Assumptions for Fertility by Race and Hispanic Origin

Because the long-term assumptions project a slow stabilization of the total fertility rate, in about 150 years, the fertility rates of racial and Hispanic origin groups are posited to slowly converge. Historically, such convergence was not exhibited by non-Hispanic Blacks, particularly in reference to non-Hispanic Whites. While non-Hispanic Whites maintained total fertility rates near 2.0 and 2.1 between 1989 and 1993, non-Hispanic Blacks experienced rates between 2.4 and 2.6.[18] However, since 1993

[13] Jennifer Cheeseman Day, U.S. Census Bureau, *Population Projections of the United States by Age, Sex, Race, and Hispanic Origin: 1995 to 2050*, Current Population Reports, P25-1130, U.S. Government Printing Office, Washington, District of Columbia, 1996.

[14] Each sub-group of Hispanics is assumed to maintain identical fertility trends.

[15] W. van Hoorn and N. Keilman, "Birth Expectations and Their Use in Fertility Forecasting," *Eurostat Working Papers*, E4/1997-4 (1997).

[16] Charles Westoff, "The Return to Replacement Level Fertility: A Magnet Force?" *Future of Demographic Trends in Europe and North America*, Academic Press, London, England, 1991.

[17] Lincoln H. Day, "Recent Fertility Trends in Industrialized Countries: Toward a Fluctuating or Stable Pattern?" *European Journal of Population,* Vol. 11 (1995): pp. 275-288.

[18] Stephanie J. Ventura, J. Martin, S. Curtin, T. Mathews, National Center for Health Statistics, *Report of Final Natality Statistics, 1996,* Monthly Vital Statistics Report, Vol. 46-11 Supplement, 1998.

non-Hispanic Black fertility has declined and converged toward non-Hispanic White fertility rates.

Fertility trends for particular Hispanic and Asian and Pacific Islander groups also diverge from national trends. These groups, however, are comprised predominately of foreign-born populations which generally maintain higher fertility rates than native women of the same race and origin group.[19] According to assimilation theory, the longer an immigrant female remains in the U.S., the more likely she will be to adopt fertility behaviors of native women of the same racial or Hispanic origin group. Researchers have found evidence to support the assimilation theory in regard to foreign-born and native fertility trends within the United States.[20] Therefore, fertility rates among Hispanic and Asian and Pacific Islander women are assumed to converge with national levels. In addition, exogamy and interracial childbearing are projected to increase in the future, further diminishing fertility differentials among racial and Hispanic origin groups.

Methodology
The middle series age-specific fertility rates were calculated for women 10 to 49 years old by single year of age and five race and Hispanic origin groups from 1999 to 2100. To begin, single year age-specific fertility rates were calculated using birth registration data from the National Center for Health Statistics and population estimates for 1996 to 1998. Age-specific fertility rates by race and Hispanic origin for 1996 and birth registration data by race and Hispanic origin (adjusted for under-registration) for 1997 and 1998 were available. However, at the time of production, birth registration data by age of the mother were not available for 1997 and 1998. Therefore, total births by mother's age and race were calculated for 1996, 1997 and 1998 using indirect standardization. The base population used to create the age-specific fertility rates was the mid-year population of the Demographic Analysis (DA) universe, as defined for purposes of the inflation-deflation method, described above.[21]

The 1995 National Survey of Family Growth Cycle V (NSFG Cycle V) data set were obtained and birth expectation data were calculated for women 15 to 44 years of age.[22] Total fertility rates were adjusted by reducing birth expectations for non-Hispanic Whites and non-Hispanic Blacks as proposed by the van Hoorn and Keilman method and supported by findings from the National Center for Health Statistics.[23] The model developed by van Hoorn and Keilman adjusts birth expectations to account for issues of uncertainty, period fertility, and "limiting factors." Because the NSFG Cycle V adjusts for item non-response and total non-response, and the period adjustment is unnecessary as specified by the proposed method, the birth expectations were only reduced by 10 percent to account for the "limiting factors," which generally result in overestimation.

Once births by single year of age of the mother were calculated, a single set of age-specific fertility rates were calculated and imputed to 1998 for purposes of the projections. Because

[19] Martin O'Connell, U.S. Census Bureau, *Studies In American Fertility*, Current Population Reports, P23-176, U.S. Government Printing Office, Washington, District of Columbia, 1991.

[20] Joan R. Kahn, "Immigrant and Native Fertility During the 1980s: Adaptation and Expectations for the Future," *International Migration Review*, Vol. 28-3, (1994): pp. 501-519.; and Deanna Pagnini, "Immigration and Fertility in New Jersey: A Comparison of Native and Foreign-Born Women," pp. 259-290 in *Keys to Successful Immigration*, Urban Institute Press, Washington, District of Columbia, 1997.

[21] Age-specific fertility rates calculated for the projections differ from those calculated by the National Center for Health Statistics as a result of applying different base populations.

[22] National Center for Health Statistics, *National Survey of Family Growth, Cycle V*, 1995.

[23] According to the National Center for Health Statistics, "The expectations of young women 25-29 years of age in 1988 exceed the estimated completed fertility of women in their earliest 40's at the time by about 9 percent (the difference between 2.33 and the average of 2.07, 2.12, and 2.17, above)." In Linda S. Peterson, National Center for Health Statistics, *Birth Expectations of Women in the United States, 1973-88*, Vital and Health Statistics, Vol. 23-17, 1995: p. 8.

separate short- and long-term assumptions were made, rates for each of the five race and Hispanic origin groups were interpolated separately from 1998 to 2025 and 2025 to 2100 to reach target total fertility rates. Age-specific fertility rates for Whites, Blacks, American Indians, and Asian and Pacific Islanders, with the Hispanic and non-Hispanic component of each group combined, were calculated after completing the projections.

Low and High Fertility Assumptions
The fertility assumptions for the highest and lowest series are based on a proportional increase or decrease relative to the middle series. The range widens steadily as an acknowledgment of increased uncertainty, although the series do not represent statistical confidence intervals. The assumptions required the calculation of an increase and decrease to the middle series age-specific fertility rates by a series of proportions. The proportions were interpolated linearly from zero in 1998 to reach 15 percent in 2025, and from there to 25 percent in 2100. Inflating the middle series fertility rates by this series of proportions yields the high variant, while deflating it by the same proportion yields the low variant. The total fertility rates by race and Hispanic origin for the middle, low, and high series for the projections period of 1999 to 2100 are detailed in Table B.

Mortality

At the present time, significant mortality differentials exist between males and females and between race and ethnic groups in the U.S. Life expectancy at birth (hereafter abbreviated as "life expectancy") has generally increased throughout the century for both sexes and for Whites and Blacks. For other race and ethnic groups, however, data are too scarce to identify trends over time. Throughout the 20th century, differentials in life expectancy between males and females, and between Blacks and Whites, have been quite irregular, increasing in some periods, and decreasing in others. During the 1990's, the differentials between males and females, and between Blacks and Whites, have tended to narrow. By 1997, life expectancies for males and females had reached 73.6 and 79.4 respectively.[24]

In order to project age-specific death rates (ASDRs) and life expectancies, we construct current ASDRs by sex, race, and Hispanic origin groups for use as a projection base, using deaths provided by the National Center for Health Statistics (NCHS) and our own population denominators. Readers with an interest in the full details of these procedures are referred to the latter part of this section. As discussed later, data are not available to allow accurate measurement of ASDRs and life expectancies for all race and Hispanic origin groups.

Table C shows fairly large differences in life expectancy between males and females, and across race and Hispanic origin groups for the first projected year (which is very similar to the 1998 base period).[25] Our projections assume a narrowing of the observed mortality gaps among race and Hispanic origin groups over time, such that by year 2100 the ASDRs of the race and Hispanic origin groups are much closer together than what is observed today. We also assume a slight narrowing of the sex gap in mortality over the next 100 years. As discussed in detail in the next section on assumptions and methodology, our projection models are based on a mixture of projected data by other researchers, with our own research incorporated into the models. For example, we use the research of Lee and Tuljapurkar as a source of overall life

[24] For detailed information on mortality trends between 1900 and 1990, see Robert N. Anderson, National Center for Health Statistics, *U.S. Decennial Life Tables for 1989-91*, Vol. 1-3, Hyattsville, Maryland, 1999.

For mortality patterns trough 1997 and mortality rates for the five race and Hispanic origin groups see Donna L. Hoyert, K. D. Kochanek, and S. L. Murphy, National Center for Health Statistics, *Deaths: Final data for 1997*, National Vital Statistics Reports, Vol. 47-19, Hyattsville, Maryland, 1999.

[25] In this mortality section, the term "race and Hispanic origin groups" refers specifically to five groups: Hispanic, Non-Hispanic White, Non-Hispanic Black, Non-Hispanic American Indian, and Non-Hispanic API. We use "race and ethnicity" in a more general sense to include all race and ethnic groups.

expectancy levels for males and females separately (without regard to race and Hispanic origin) for year 2065, but we use our own extrapolations for dates beyond that.[26] Thus, Lee and Tuljapurkar's research influences our assumption about the future sex differential, but our assumptions about future race and Hispanic origin differentials are generated internally. A few methodological considerations led to our assumption of declining race and Hispanic origin mortality differentials. First, such differentials, even for the current period, are difficult to estimate accurately. The definitions of race and origin are themselves mutable and ever-changing. Second, and related to the above, increasing rates of intermarriage may serve to reduce differentials in the future.

Assumptions and Methodology

The previous projections report projected survival rates primarily by extrapolating past annual rates of change, separately by age, sex, race and Hispanic origin group.[27] In the current set of projections we create male and female target life tables corresponding to a far-future year (2150, which is beyond our projection horizon), and we force the base life tables (which are discussed later) for the separate race and Hispanic origin groups to converge over time to these target life tables.[28] The end result of this process is a slight narrowing of the sex difference in mortality over time, and a more prominent narrowing of race and Hispanic origin differences over time, such that by year 2100 the race and origin groups are quite a bit more similar in their life expectancy than they are today. The year 2150 was chosen as a target for race and ethnic convergence because it allowed our models to yield plausible rates of mortality decline over time for each sex, race, and Hispanic origin group.

A few different sources of information entered into the construction of the year 2150 target life tables for males and females. First, we used projected life expectancies for total males and females (all race and Hispanic origin groups combined) for the year 2065 produced by Lee and Tuljapurkar,[29] which updates the original Lee-Carter stochastic time-series model.[30] For our middle series, these year 2065 life expectancies are 83 for males and 88 for females.[31] Second, we used expert opinion regarding how much faster the mortality rates of some age groups will decline in the future relative to the others. These were obtained by utilizing the results of a survey conducted at the 1997 mortality projection conference sponsored by the Society of Actuaries.[32] We use the term "decline" to mean *annual average rate of mortality decline* in the rest of this section. Survey results are shown below.

	Age 0-14 vs. 65+	Age 15-64 vs. 65+
"Next 10 years"	2.1	1.3
"After 25 years"	1.6	1.2

For example, most participants at the Society of Actuaries conference predict that the decline experienced by the age group under 14 years will be 2.1 times that of the age group 65 years and

26 Ron Lee and S. Tuljapurkar, *Population Forecasting for Fiscal Planning: Issues and Innovations,* unpublished manuscript, September, 1998.

27 Jennifer Cheeseman Day, U.S. Census Bureau, *Population Projections of the United States by Age, Sex, Race, and Hispanic Origin: 1995 to 2050,* Current Population Reports, P25-1130, U.S. Government Printing Office, Washington, District of Columbia, 1996.

28 We use the term "life table" throughout this text for convenience. Most of our work is actually based on schedules of age-specific central death rates, which can be converted to life tables and used to calculate life expectancies at birth and at age 65.

29 Ron Lee and S. Tuljapurkar, *Population Forecasting for Fiscal Planning: Issues and Innovations,* unpublished manuscript, September, 1998.

30 Ron Lee and L. Carter, "Modeling and Forecasting US Mortality," *Journal of the American Statistical Association*, Vol. 87-419 (1992): pp. 659-675.

31 Personal correspondence, Carl Boe for Lee and Tuljapurkar 10/19/98.

32 Margorie Rosenberg and Warren Luckner, "Summary of Results of Survey of Seminar Attendees," *North American Actuarial Journal,* Vol. 2-4 (1998): pp. 64-82.

older over the "next ten years."

Instead of "next 10 years" and "after 25," as reported in the Society of Actuaries report, we used two time periods: 1990 to 2020 and 2021 to 2150. This was done because one of our projection base years is 1990 (as discussed later), and we wanted to adapt the Society of Actuaries report data to fit our data requirements. We also constrained the age group 65 years and older decline to be the same for the two time periods, since there is no information in the Society of Actuaries report about the 65 years and older decline for time periods before year 2020.

With the above-mentioned projected life expectancies and ratios, and with a base set of ASDRs by sex, race, and Hispanic origin, we obtain declines out to the year 2150 that satisfy the above conditions (four ratios representing age patterns of decline over time) as well as the conditions involving life expectancies for year 2065 as explained above. Given the assumed fixed relationships between the declines across the broad age groups over time, there is only one trend that needs to be derived, which is the decline for the age group 65 years and older. We then use these declines to produce ASDRs and life tables for males and females in 2150. This is done by a simple extrapolation which assumes that the declines that led to year 2065 life tables will continue thereafter. Projected ASDRs for each sex, race, and Hispanic origin group are then derived by interpolating between the 1990 base ASDRs (by each sex, race, and Hispanic origin) and the year 2150 ASDRs, a procedure which reflects our race and Hispanic origin convergence assumption. This yields life tables for the ten groups which are consistent with the year 2065 male and female life expectancies (all race and origin groups combined) projected by Lee and Tuljapurkar.

However, we do not present life expectancies and ASDRs for years beyond 2100--those data points are beyond our projection horizon, and were developed solely to achieve a narrowing of differentials over time within the projection period (to 2100). Year 2150 was chosen because it yields the most acceptable rates of mortality decline for the sex, race, and ethnic groups. For example, using year 2100 as a target life table would yield too rapid rates of mortality decline for some subgroups, in our opinion.

Table C shows projected life expectancies for each of the ten specific sex, race, and Hispanic origin groups. Life expectancies for aggregations of these groups (White, Black, American Indian, and API) are based on life tables we constructed at a later stage using weighted averages of ASDRs. To weight the averages, we used the separate sex and race populations (in the case of race aggregation) or the separate sex populations (in the case of sex aggregation) (not shown).

Low and High Mortality Assumptions

As discussed earlier, the year 2150 target life tables for males and females are based partly on Lee and Tuljapurkar's projected life expectancies for year 2065 (83 for males, 88 for females). The low and high life expectancy series are constructed using the same methodology and data as the middle series, except that different values are used for year 2065 life expectancies. For the low life expectancy series, we use 81 and 86 for males and females respectively. For the high life expectancy series, we use 86 and 90 for males and females respectively. These low and high values are the lower limit and upper limit respectively of the 95 percent confidence interval reported by Lee and Tuljapurkar.[33] Thus, we end up with a set of male and female target life tables (year 2150) for each of the three series. The procedures for producing the ASDRs for all intervening years between the base and target (year 2150) years, and for the sex, race, and ethnic groups, are identical across the three series. As expected, there is an increasing divergence of life expectancies over the course of the projection period between the low and high series, for any given sex, race, and ethnic group.

[33] Personal correspondence, Carl Boe for Lee and Tuljapurkar 10/19/98.

Two Sets of Base Mortality Rates: General Issues

While the general procedure to obtain projected ASDRs for all sex, race, and Hispanic groups involves interpolation between a base set of ASDRs (one set for each sex, race, and Hispanic origin subgroup) and year 2150 target ASDRs (one set for each sex, as described earlier), the procedures are, in fact, more complicated because we use two sets of base ASDRs at different stages of the projection process.

We first create the long-term series of ASDRs out to year 2150 using 1990 ASDRs as a starting point. We call these 1990 ASDRs the "primary base." We construct these base ASDRs using 1990 deaths from NCHS and 1990 census population denominators, by sex, race, and Hispanic origin. We consider these to be more appropriate for projecting a long-term series, as compared with rates which use our postcensal population estimates as denominators. Yet, we prefer to have a smooth transition from our national estimates in 1998 to our national projections for subsequent years. In order to avoid sharp breaks between the ASDRs for 1998 (and earlier) assumed in our national estimates, and those assumed for the projections for 1999 and beyond, we subsequently create a new set of ASDRs for 1999 through 2020 for use in the projections. These new ASDRs are produced by interpolating from the 1996 to 1998 combined ASDRs of the national estimates series (which we refer to here as the "secondary base") to the year 2021 ASDRs of the projection series that was based on the primary base, for each sex, race, and Hispanic origin group. We call these new and more consistent ASDRs the "bridge series," and we replace the original 1999 to 2020 projected ASDRs with this bridge series, in order to smooth out the transition from national estimates to national projections.

Base Mortality Rates: Detailed Construction

Procedures for constructing the primary base ASDRs are discussed below. Because the procedures for constructing the secondary base ASDRs are similar, we do not repeat those here.

Base ASDRs are constructed with 1990 deaths obtained from NCHS (by age, race, and Hispanic origin) divided by a July 1, 1990, population in the demographic analysis (DA) universe (as discussed under “inflation-deflation”) for the appropriate subgroup. All ASDRs in this study are central death rates, and based on single years of age. Although we obtain NCHS deaths for Whites, Blacks, American Indian, API, and Hispanics, we do not obtain deaths for the non-Hispanic portions of the four racial groups. The latter are constructed using a series of steps described below.

Mortality Rates by Hispanic Origin

We first calculate Hispanic ASDRs using a 45-state 1990 numerator of Hispanic deaths and a corresponding 45-state Hispanic population denominator (1990 uncorrected, census-level). We excluded five states either because they did not collect Hispanic origin on the death certificate (Louisiana, New Hampshire, and Oklahoma) or because they had relatively high proportions of unknown Hispanic origin (Connecticut and New York). Excluding these five states eliminates most of the approximately 106,000 unknown Hispanic origin deaths (5 percent of all deaths) that appear in the 1990 NCHS mortality files. Among the 45 states, only 0.67 percent of the deaths are of unknown Hispanic origin and are excluded from the calculation of ASDRs (probably contributing to an underestimation of Hispanic death rates).

The following steps are used to derive ASDRs for the non-Hispanic portions of racial groups:

1) We obtain estimated numbers of deaths to Hispanic White, Hispanic Black, Hispanic American Indian, and Hispanic API by multiplying the Hispanic ASDRs by the Hispanic portion of each race population (DA-level), by age and sex.

2) We obtain estimated numbers of deaths to four race (any Hispanic) groups by multiplying race (any Hispanic) ASDRs by the respective race populations.

3) Subtracting 1) from 2) yields deaths to Non-Hispanic White, Non-Hispanic Black, Non-Hispanic American Indian, and Non-Hispanic API, by age and sex.

4) ASDRs for each sex, race, and Hispanic origin group are then obtained by dividing these deaths by their respective sex, race, and Hispanic origin population denominator.

Problems With Race and Hispanic Origin Mortality Rates
There are well-known difficulties in calculating accurate mortality rates for some race and Hispanic origin groups in current or past years, including both the 1990 primary base years and the 1996 to 1998 secondary base years. The numerators and denominators of the ASDRs come from different sources, and they differ in important ways. Some of these differences include 1) how race and ethnicity is reported and classified (being self-reported in the census, but not self-reported on death certificates) 2) how missing data are handled, and 3) how responses such as "other race" are handled. Thus, there is inconsistent reporting of race and ethnicity between the two data sources--death records and census records. There is convincing evidence that the ASDRs for some race and ethnic groups, as currently measured, are underestimated. One study that compared race and ethnic identification on CPS surveys with those of death certificates suggests that API death rates could be underestimated by 12 percent, and by 25 percent for American Indians.[34] [35] However, we do not yet know of an adequate way to adjust our race and ethnic mortality rates, and correction factors are not available at this time. We currently use the existing data until we have a stronger basis for making adjustments.

Old-age Mortality Rates
We do not calculate ASDRs for the age group 85 years and older in the same manner as we do for the under 85 years population (i.e, NCHS deaths divided by population denominators), due to the inaccuracies that can result from such a procedure. There are problems of age mis-reporting in both the numerators (death records) and denominators (census-based population data). Instead, we use a mathematical model developed by Coale and Kisker to obtain ASDRs for each subgroup.[36] We inserted different parameters into the original Coale and Kisker formulas in order to force them to produce death rates of 1.0 for both males and females at age 115 for all race and Hispanic origin groups.

International Migration

Among the three major components of national population change--births, deaths, and international migration--international migration is the component for which demographic science offers the least to future projections. Births and deaths can be projected as rates, with demographic detail, so the emerging size and structure (age, sex, race, and Hispanic origin) of the populations at risk of death and childbearing are a key determinant of these components of population change. Moreover, the epidemiological basis for the propensity to die, as well as the social and economic basis for the propensity to bear children are both the subjects of substantial academic inquiry. This body of research has yielded a basis for projecting their future course, as reflected in previous sections of

[34] P. Sorlie, E. Rogot, and N. Johnson, "Validity of Demographic Characteristics on the Death Certificate," *Epidemiology*, Vol. 3-2 (1992): pp. 181-184.
Additional discussion and evidence related to the underestimation of American Indian mortality can be found in U.S. Department of Health and Human Services, Indian Health Service, *1997 Trends in Indian Health*, Rockville, Maryland, 1997.; and in Support Services International, Inc., *Adjusting for Miscoding of Indian Race on State Death Certificates*, Final Report Submitted to the Division of Program Statistics, Indian Health Service, 1996.

[35] The use of the DA universe for population denominators tends to obviate biases of differential reporting between Blacks and all other races combined, since the DA procedure uses death registration data to define these categories. However, the break of "other race" into American Indian, API, and White required the use of census data, with all it's biases relative to death registration.

[36] Ansley Coale and E. Kisker, "Defects in Data on Old-Age Mortality in the U.S.: New Procedures for Calculating Schedules and Life Tables at the Highest Ages," *Asian and Pacific Population Forum,*Vol. 4-1 (1990): p. 32.

this report. International migration to the United States, by contrast, has public policy as a major determinant. While it may be acceptable in the near term to view migration as a consequence of existing immigration law and policy, this assumption loses merit for the longer term. Emigration of the foreign-born population can be projected relative to a population at risk (e.g., the foreign-born population) through the use of emigration rates, but there is little or nothing in the way of theory to indicate how these rates might change over time.

Assumptions and Methodology

International migration, in previous United States population projections produced by the Census Bureau, has been projected as a constant value with a constant matrix of demographic characteristics. The constant-level assumption has been based on the experience of the last few years prior to the launch date of the projections, incorporating separate assumptions for legal immigration, refugee movements, emigration (of natives and foreign-born combined), net migration from Puerto Rico, and net undocumented migration. High and low variants have been determined by establishing reasonable maximum and minimum values of each of these components, and holding them constant over time, with a linear transition over a few years from current to ultimate values.

The current projection series incorporate three major changes from past practice in the projection of international migration. First, we decided that the constant migration assumption was inappropriate for a projection series (the middle series) that would be widely interpreted as the Census Bureau's forecast of population. This determination was primarily on account of an increased level of public debate regarding immigration policy, as well as the highly transitory nature of some recent developments in international migration. The former mandated a more critical view of how migration might change in the future, while the latter tended to discredit the interpretation of the base series in a simplistic manner. However, we have not been able to develop a dynamic model for future international migration that reflects adequately the current base series information, yet conforms to any unifying theory of future change. We have, therefore, projected migration with consideration of a large amount of underlying current detail, coupled with some consideration of factors that could influence its change in the future. The resulting projections seek to reflect current trends in specific aspects of migration, and to gauge their likely future direction and magnitude.

The second change from past practice is that we allow characteristics of the projected population to influence the migration assumption. In the past, we have expressly avoided incorporating population "feedback" mechanisms when formulating assumptions on any components of population change, assuming a unidirectional causative sequence from determinants of components to components and from components to the population. In the case of fertility and mortality, we continue this practice, simply because there is little evidence that such feedbacks are important. In order to develop a dynamic assumption regarding future migration, it is necessary to consider the plausible links that tie demographic characteristics of the future population to immigration policy. Thus, we consider the future direction in the age composition of the population, as it might affect policy regarding the immigration of working-age people.

A third major innovation in the current projections of international migration relates to the projection of the emigration of foreign-born residents. Because we have projected the foreign-born population in the current projections, we were able to model foreign-born emigration as a function of the population at risk, in much the same way as we projected mortality. Thus, foreign-born emigration is projected, in all series, as rates by age, and sex, rather than as number of emigrants. The comparatively low level of native-born emigration is projected numerically, as in the past.

We are unable to project total in-migration and total out-migration, as we have no such estimates in the base series. For some of the components of international migration, information sources for the base series offer no disaggregation of gross in-migration from gross out-migration. Specifically, the net flow of migrants from Puerto Rico (treated as international in this context), the net flow of undocumented migrants from foreign countries, and the net flow of other legal non-immigrant residents (mostly foreign students) are imputed only as net flows--not as a balance of measured in- and out-migration. Consequently, the concept of “in-migration” to the U.S. in these projections is a somewhat artificial construct consisting of in-migration of refugees, in-migration of newly arriving legal immigrants, in-migration of non-immigrants who will later become legal immigrants, net undocumented migration, net Puerto Rican migration, and the net movement of other legal but temporary non-immigrants to the United States. This flow is in large part a one-way flow to the U.S., but embodies some reverse elements in the components only measurable as net flows in the base series. By the same token, the separately projected “out-migration” component is confined to the emigration of legal permanent U.S. residents to permanent residence abroad, excluding resettlement in Puerto Rico.

Table D provides a summary of “in-migration” (as previously described) and the emigration of legal residents for four single years in the projection series.

Projection of the Level of In-Migration: Middle Series, 1999 to 2020

The determination of the trend in migration to the United States from 1999 to 2020 in the middle series is based on consideration of current trends in the arrival of people born in different areas of the world. The trend is based on the following guiding assumptions.

1) A rapid increase in the level of migration during the 1990's occurred largely because millions of people legalized in 1987 and 1988 under the Immigration Reform and Control Act (IRCA) of 1986, were becoming U.S. citizens in increasing numbers. As they became citizens, they could sponsor the legal immigration of immediate relatives without being subject to numerical limits. We deemed this flow, composed largely of people from Mexico and Central America, to be somewhat transitory. Hence, migration from this source is projected to reach a peak early in the decade of 2000 to 2010, then gradually decline to zero as the supply of potential reunifications is exhausted. In particular, legal migration from Mexico is assumed to return to the levels of the early 1990's by 2010.

2) We assume that there will be no change in immigration policy which would result in any change in the quantity of immigrant visas available in numerically limited legal categories between 1998 and 2020. Numerically limited categories embrace all legal immigration except for the adjustment of refugees and asylees to immigrant status, the admission of immediate relatives of U.S. citizens, and a few other categories of little demographic consequence.

3) The flow of refugees to permanent residence in the U.S. would tend to decline between 1998 and 2020, except for a near-term increase to 2000 in the number of refugees from the republics of the former Yugoslavia. The decline in the flow from the principal sources of the last 30 years, Southeast Asia and Cuba, is apparent in the current refugee data series from 1995 forward. The trend from the former Yugoslavia has been sharply upward since 1991, although the timing and the height of the peak in this trend will depend on the course of world events, as well as the direction of United States refugee resettlement policy.

4) Undocumented migration of people born in Mexico and Central America is viewed primarily as a function of the degree of success in controlling the southwest border, and is not projected to change from levels assumed for the 1990's base series.

5) Legal migration from places other than Mexico, Central America, and refugee sources will vary in trend, depending on recent observations, and, to a lesser extent, the perceived demographic capacity of the source countries to supply migrants. The emerging sources of migration that continue to increase in importance under this assumption are South Asia, Sub-Saharan Africa, and the Middle East. We project a modest decline for the Philippines, and little change in the influx from other areas.

A summary of the numerical assumption for migration to the United States used for the middle series is excerpted in Table E, together with the current trend from 1991 to 1998. The first block of this table, showing the middle series assumption, indicates a modest rise in in-migration from 1,234,000 in 1998 to 1,272,000 in 2002, a decline to 1,036,000 by 2010, followed by a gradual rise to 1,090,000 by 2020. The rise and decline are propelled mainly by the previously postulated trends from Mexico (IRCA-related family reunifications) and the former Yugoslavia (refugee movements), while the subsequent rise is dominated by the relatively more gradual trends from the emerging sources identified in point 4 above.

Projection of the Level of In-Migration: Middle Series, 2021 to 2100

For the period from 2021 to 2100, the focus of the projection of migration into the U.S. shifts from the individual consideration of various sources of migration from abroad to the trend in the aggregate level. The projection of migration by source region follows, but only with the aim of establishing a distribution that can be used to impute demographic characteristics. The principal assumptions are as follows, and are reflected, once again, in the first block of Table E.

1) Driven by a rapid increase in the dependency ratio (number of people in the traditionally dependent age groups, under 15 years and 65 years and over, relative to the balance of the population), migration to the U.S. would increase from 2020 to 2030, from a level of 1,090,000 in 2020 to 1,450,000 in 2030.

2) From 2030 to 2100, migration into the United States would remain numerically constant at 1,450,000, even in the presence of an increasing population, hence, its direct proportional impact on the population would decline.

The phenomenon underlying the projected increase through the 2020's is a pervasive one in all considerations of the future demographic characteristics of the United States. The historic rise in births that occurred in the United States from 1946 through the 1950's, followed by the decline through the early 1970's, left a bulge in the age distribution that has ensured an unnaturally low dependency burden through the 1980's and 1990's on into the early 2010's. Table F shows the trend in population, the dependency ratio, and the elderly dependency ratio (defined as the ratio of people aged 65 and over to people in ages 15 to 64), under various migration assumptions. In the complete absence of migration in or out of the United States from 1999 onward (“zero migration,” in Table F), the dependency ratio rises from 53.0 percent in 2015 (close to the current level) to 69.4 percent by 2030, while the elderly dependency ratio endures a near parallel rise from 23.5 to 37.1. Our projections anticipate an increase in the influx of migrants to the United States as a response to this dramatic downward shift in the availability of potential workers relative to people outside the normal working ages. The anticipated increase, from 1,090,000 to 1,450,000 annually, while large in percentage terms (33 percent) is modest relative to shifts that have occurred in migration in the United States and elsewhere in the industrialized world in response to economic and demographic shifts of this importance. The migration response to the economic boom of the 1920's in the United States, and the labor migration from southeastern to northern Europe in the period following World War II are examples of migratory shifts far more dramatic than the one projected here. On the other hand, to project a much larger shift (for example, a shift comparable to what the U.S. experienced in the early 20th century) would tend to overlook the possibility of restrictive policies intended to limit such a shift.

The impact of this projected migration trend on the dependency ratio, while not impressive, should be of some significance in the long-term. In the zero migration model (first block, Table F), the dependency ratio increases from 58.1 percentage points, to 69.4, an increase of 11.3 percentage points, from 2020 to 2030. Under the middle-series migration assumption, it increases from 57.2 percentage points to 65.9, up 8.7 percentage points during the same period.

Migration to the U.S. by Race and Hispanic Origin
As previously indicated, the projection methodology makes use of the distribution of international migration by country of birth in the base year, distinguishing among major regions of the world in establishing the trend. This fact is most reflected in the resulting distribution of international migration by age, sex, race, and Hispanic origin. In the projection of in-migration from 1999 to 2020, projections are determined primarily by current trends by country of birth, with consideration of the legal bases of migration. In the projections from 2021 to 2100, the international population projections of the International Program Center (IPC) of the Census Bureau are tapped for information on the relative projected growth of the working-age component of the population of various world regions to the year 2050.[37] These projections show considerably more rapid population growth through the early part of the next century for countries of South Asia, sub-Saharan Africa and the Middle East, than for countries of the Western Hemisphere including Mexico, which have seen considerable declines in fertility in recent years.

The strategy in these projections was to allow the composition of international migrants by race and Hispanic origin to reflect the probable contribution of the various world regions to the level of in-migration to the United States dynamically. The resulting percentage distribution by race and Hispanic origin for the middle series is shown in Table D, middle block, for selected years in the series. The declining contribution of the Western Hemisphere and Europe, and the industrialized countries of East Asia are reflected in decreasing levels of in-migration for the Hispanic and White populations. The increasing contribution of the Middle East, South Asia, Southeast Asia, China, and sub-Saharan Africa are reflected in increased migration for the Black and API populations.

Low and High International Migration Assumptions
The objective in projecting low and high variants for the international migration assumption is to establish a candid view of the uncertainty surrounding the middle series projection. Three qualitative considerations governed the choice of the upper and lower limits for in-migration.

1) The margin of uncertainty around the middle-level assumption is, of necessity, relatively wider for international migration than for births and deaths. The exogenous character of this component, and its reliance on unpredictable external factors such as the internal policy environment and world events, as well as the lack of demographic determinism in its projection, ensure a comparatively high level of uncertainty for this component.

2) The displacement between high, middle, and low variants should increase over time, as it did for both fertility and mortality. Uncertainty in any component increases along with the elapsed time from the relatively certain present to any projected reference date.

3) The pace of the increase in the spread between high and low should decrease over time. While somewhat less obvious, this follows from the

[37] U.S. Census Bureau, International Program Center; *International Data Base (IDB)*; <http://www.census.gov/ipc/www/idbnew.html>; (11 January 1999)

goal to reflect uncertainty in the population series. The population series is most affected by *cumulative*, rather than current levels of international migration. Because some of the error in the middle series migration assumption should be caused by fluctuations in the level of migration, rather than long-term trends, a portion of it can be expected to wash out with the passage of time. Similar reasoning was applied to the projection of the low and high variants of fertility, where fluctuations over time are also expected. This effect was not considered important in the projection of mortality.

4) We assume that the difference between high and middle assumptions will exceed the difference between low and middle assumptions. Specifically, we assume that the differences in the logarithms of the three series (high minus middle, middle minus low) are equal. This is equivalent to saying that the series are equidistant in a multiplicative sense, or that the ratios of high to medium equal the ratios of medium to low. This follows from the nature of the theoretical upper and lower bounds. We can presume that the theoretical high-end constraints on gross in-migration are defined only by the population of the rest of the world, and can thus be ignored (treated as infinity), while the low-end constraint is zero. We discount the fact that some out-migration of illegal residents, temporary residents, and people moving to Puerto Rico are included in our definition of in-migration, previously described, on the assumption that these elements are small relative to in-migration as a whole. A similar reasoning would not apply to fertility and mortality, because the determinants of their variability above and below the middle assumption are presumed comparable.

To establish the high variant, we assumed a deviation from the middle series of zero in 1998 (since this was the base year), 75 percent in 2010, and 150 percent in 2100. Multipliers applied to the middle series were thus 1.00 for 1998, 1.75 for 2010, and 2.50 for 2100. A logarithmic function was fitted to these three multipliers to produce an annual series. We established the low variant by computing the reciprocal of these multipliers: 1.00 for 1998, 0.57 for 2010, and 0.40 for 2100, which amounted to reducing the middle series by 43 percent (actually 3/7) in 2010, and 60 percent in 2100.

At its most extreme, the implied range for international migration to the U.S. in 2100 was from 580,000 migrants to the U.S. to 3,625,000, with the middle-level assumption at 1,450,000. In 2010 (the low point in the middle series), the low, high, and middle values were, respectively, 592,000, 1,812,000, and 1,036,000. Data for these and other selected dates in the series are shown in Table E.

In reviewing the extreme variants for their plausibility (albeit as extreme assumptions), we also considered their impact on population size and dependency ratios over the period of the projections. We projected the population using each of the three migration assumptions and equal values for fertility and mortality rates. These results are shown in Table F. The results for dependency ratios show a spread between the low and high migration series of 1.3 percentage points in 2020, increasing to 4.3 points by 2030, after the projected increase (reflected in all three series) of the 2020's. The spread increases to 6.2 percentage points by 2100. For total resident population, the three models produce levels of 437 million, 571 million, and 854 million, respectively, in 2100. The long-term spread in the dependency ratio between high and low appears comparatively modest, and changed very little over the last 70 years of the projection period. This is explained by the fact that many of the larger numbers of annual migrants entering under the high assumption have dependent children and age out of the working life span during the period of the projections, thereby reducing the difference in the dependency ratio. The differences in population are indeed stark, with the high-migration assumption yielding near double the population produced by the low-migration assumption in 2100. International migration may address a high dependency ratio decisively in the short-term, yet is highly inefficient in reducing it over the longer term--especially if considerations of population scale, as well as age composition, are taken into account.

Projection of Emigration of Legal U.S. Residents

As previously indicated, emigration of legal foreign-born residents is projected on the basis of age-sex-specific rates, applied to a population at risk, rather than a postulated numerical trend. Current values of these rates were developed on the basis of research conducted by the Census Bureau.[38] The underlying method involves computing a matrix of differences between the number of foreign-born people enumerated in the 1980 census, and the number of foreign-born people arrived before 1980 enumerated in the 1990 census. This calculation is carried out for large groupings of country of birth, age, and sex, an adjustment is made for residents who died during the decade, and the balance is assumed to be the number of emigrants. Considerable modification of the numbers had to be carried out because of problems such as negative differences for some countries of birth (theoretically impossible, but for misreporting on the census) and allowances for differential reporting of undocumented residents in the two censuses. When these distributions are divided by an interpolated mid-decade population, they produce a schedule of rates, which, when applied to the foreign-born population, produce a projection of emigration. Unlike the case of in-migration, this projection method also produced the results in the base series from 1990 to 1998, since no current data on foreign-born emigration are available.

For the middle series, we assumed that foreign-born emigration rates remained constant throughout the duration of the projections. This means that trends in emigration are driven mainly by the size of the foreign-born population, and secondarily by its composition by age, sex, and country of birth. As shown in Table G, the age-sex-country-standardized rate (standardized on the 1990 base population) is set at 12.1 per thousand population.

Native emigration was estimated as a constant for the base series and the middle series, at 48,000 per year. This assumption is based on research employing reports of U.S.-born respondents in foreign censuses, as well as some imputation for countries of destination for which no such data were available.[39]

As shown in Table E, these two assumptions yield an annual emigration trend from 252,000 in 1991, to 278,000 in 1998, the base year for the projections. This increases steadily with the increase in the foreign-born population, to a level of 524,000 in the year 2100. The juxtaposition of constant in-migration with increasing emigration throughout the last 70 years of the next century, presumes a decline in the numerical level of annual net migration to the United States, and an even greater decline in the impact of this component relative to overall population size.

Low and High Emigration Assumptions

The extreme variants of foreign-born emigration rates are based on the same logic underlying the derivation of the extreme variants of in-migration, except that the application was to rates, rather than numbers. Because higher emigration implies lower net migration, the high-level multipliers were used to determine the emigration rates used for the low migration series, and the reverse was true for the high migration series. Because emigration in a given year in the middle series was on the order of 1.2 percent of the foreign-born population, the upper-level constraint of 100 percent was assumed to be infinity, while the lower-level constraint was

[38] Bashir Ahmed and J. Gregory Robinson, Population Division, U.S. Census Bureau, “Estimates of Emigration of the Foreign-born Population: 1980-1990,” *Working Paper No. 9*, 1994.

[39] Edward Fernandez, Population Division, U.S. Census Bureau, “Estimation of the Annual Emigration of U.S. Born People by Using Foreign Censuses and Selected Administrative Data: Circa 1980,” *Working Paper No. 10*, 1995.

zero. Thus, the multiplicative approach to producing the extreme variants was deemed appropriate. Low-migration foreign-born emigration rates for 2010 were obtained by multiplying the middle-series by 1.75, while the multiplier for 2100 was 2.50. The multipliers for the high-migration series were the reciprocals of the multipliers for the low-migration series. The results are shown in Table G.

The fact that foreign-born emigration is driven by projected rates, rather than projected numbers, allows a crossover in numerical emigration among the three series, around 2055. In the early years of the projections, from 1999 to 2054, the numerical level of emigration is higher for the low-migration series than for the high-migration series. From 2055 to 2100 the reverse is true, since the larger size of the foreign-born population in the high-migration series relative to the low-migration series overcomes the effect of the lower emigration rates for the foreign-born in the high migration series.

The derivation of native-born emigration for the high and low assumptions follows essentially the same logic as that used to derive high and low variants for gross in-migration. Multipliers that increase (for the high assumption) or decrease (for the low assumption) logarithmically are applied to the middle series assumption of 48,000 per year.

Net Migration of U.S. Citizens

The net migration of U.S. citizens (aside from emigrants who depart the U.S. permanently) is a small component of population change that tends to be driven primarily by the movement of U.S. military personnel between the U.S. and abroad. Because it is dominated by military movement, this migration is highly dependent on the future course of world events. Because of the impossibility of projecting such developments, we adopt a conservative strategy in projecting this component. The overseas population of military and dependents is held at a constant level, with a constant distribution by age, sex, race, and Hispanic origin. Migration is therefore equal to the number of overseas births, minus the number of overseas deaths, plus the balance of net inductions and discharges to the military from the overseas population. The age distribution of this flow is based on the characteristics of net migration required to counteract the natural aging of each category of sex, race, and Hispanic origin in the overseas population. No high and low variants were determined for the net migration of U.S. citizens.

SUMMARY

In developing population projections for the United States, we have made a number of decisions regarding the scope of the projections and the assumptions that were somewhat "bolder" than those adopted in most previous series. The boldest decision was undoubtedly the one to extend the series to the year 2100. In making this decision, we were fully aware of the precarious nature of any population projection that is three human generations past the existing population base. While the trend over the first 20 years of a projection series is generally dominated by the characteristics of the base population in demographic projections, populations for dates 50 to 100 years in the future are highly subject to behavioral decisions by individuals, policy decisions by governments at home and abroad, and possible unexpected developments in health and morbidity. In formulating assumptions for the highest and lowest series that are progressively extreme, we have attempted to convey a sense of the caution with which any such long-term projections should be interpreted.

Another area of innovation in these projections is in the projection of international migration. Once again, we recognize the uncertainty about the future course of migration that has tended to motivate simpler, more parsimonious assumptions in the past. Yet, we decided that this component of change had received enough public attention in recent years that we could not credibly assume it to be unaffected by demographic changes in the population, as the constant-level projection tacitly assumes.

Projecting the human population continues to be an evolving science, and we fully expect that future developments, including the upcoming 2000 census, will provide us with the basis to revise these assumptions in future years.

Table A. Comparison of Total Population, Present Series with 1994-Based Projections.

(Numbers in thousands. As of July 1. Resident population.)

Year	Population			Average Annual Percent Change		
	Lowest Series	Middle Series	Highest Series	Lowest Series	Middle Series	Highest Series
1994-Based Projections[1]						
1998	268,396	270,002	271,647	--	--	--
2000	271,237	274,634	278,129	0.53	0.85	1.18
2025	290,789	335,050	380,781	0.28	0.80	1.26
2050	282,524	393,931	518,903	-0.12	0.65	1.24
2100	--	--	--	--	--	--
New Series (1998-Based)						
1998 [2]	270,299	270,299	270,299	--	--	--
2000	274,853	275,306	275,816	0.84	0.92	1.01
2025	308,229	337,815	380,397	0.46	0.82	1.29
2050	313,546	403,687	552,757	0.07	0.71	1.49
2100	282,706	570,954	1,182,390	-0.21	0.69	1.52

[1] Jennifer Cheeseman Day, U.S. Bureau of the Census, *Population Projections of the United States by Age, Sex, Race, and Hispanic Origin: 1995 to 2050* , Current Population Reports, P25-1130, U.S. Government Printing Office, Washington, DC, 1996.

[2] Consistent with population estimates produced by the Bureau of the Census in 1998.

Table B. Projected Total Fertility Rates by Race and Hispanic Origin, 1999 to 2100.

(Rates per 1,000 women. As of July 1. Resident population.)

Race and Hispanic Origin	Lowest Series				Middle Series				Highest Series			
	1999	2025	2050	2100	1999	2025	2050	2100	1999	2025	2050	2100
Total Fertility Rate												
Total	2,035.8	1,865.5	1,799.7	1,632.1	2,047.5	2,206.8	2,219.0	2,182.9	2,059.2	2,557.5	2,646.8	2,737.4
White, Non-Hispanic	1,822.9	1,725.5	1,668.8	1,552.5	1,833.0	2,030.0	2,043.3	2,070.0	1,843.2	2,334.5	2,417.9	2,587.5
Black, Non-Hispanic	2,066.9	1,802.0	1,725.9	1,575.0	2,078.4	2,120.0	2,113.3	2,100.0	2,090.0	2,438.0	2,500.8	2,625.0
American Indian, Non-Hispanic[1]	2,407.2	1,929.5	1,823.9	1,620.1	2,420.6	2,270.0	2,233.3	2,160.0	2,434.1	2,610.5	2,642.8	2,699.9
Asian, Non-Hispanic[2]	2,216.6	1,845.5	1,759.5	1,590.9	2,229.0	2,171.2	2,154.5	2,121.2	2,241.4	2,496.9	2,549.5	2,651.4
Hispanic Origin[3]	2,904.3	2,275.7	2,092.9	1,750.4	2,920.5	2,677.3	2,562.8	2,333.8	2,936.7	3,078.9	3,032.6	2,917.2
White	1,998.0	1,867.4	1,806.5	1,640.3	2,009.5	2,210.2	2,230.1	2,198.0	2,021.0	2,563.9	2,667.5	2,764.5
Black	2,110.1	1,836.7	1,760.4	1,598.8	2,121.9	2,164.1	2,159.1	2,131.0	2,133.8	2,493.5	2,558.6	2,663.6
American Indian[1]	2,492.5	2,003.9	1,893.5	1,663.9	2,506.6	2,366.3	2,329.4	2,224.3	2,520.8	2,736.1	2,774.9	2,791.3
Asian[2]	2,264.9	1,877.8	1,785.5	1,603.8	2,277.4	2,205.8	2,180.8	2,134.7	2,289.9	2,531.4	2,573.8	2,664.6

[1] "American Indian" is used to describe the American Indian, Eskimo, and Aleut population.

[2] "Asian" is used to describe the Asian and Pacific Islander population.

[3] Hispanic origin may be of any race.

Table C. Projected Life Expectancy at birth by Race and Hispanic Origin, 1999 to 2100.

(As of July 1. Resident population.)

Race and Hispanic Origin	Lowest Series				Middle Series				Highest Series			
	1999	2025	2050	2100	1999	2025	2050	2100	1999	2025	2050	2100
Life Expectancy at Birth (Years)												
Total Population (Male)	74.0	76.5	79.5	85.0	74.1	77.6	81.2	88.0	74.1	79.1	83.8	92.3
Total Population (Female)	79.7	82.6	84.9	89.3	79.8	83.6	86.7	92.3	79.8	84.6	88.4	95.2
White, Non-Hispanic (Male)	74.7	76.9	79.5	84.8	74.7	77.8	81.1	87.6	74.7	79.2	83.5	91.8
White, Non-Hispanic (Female)	80.1	82.6	84.8	89.0	80.1	83.6	86.4	91.8	80.1	84.5	88.0	94.6
Black, Non-Hispanic (Male)	68.3	72.4	76.6	83.9	68.4	73.6	78.5	86.9	68.5	75.3	81.3	91.4
Black, Non-Hispanic (Female)	75.1	79.3	82.7	88.4	75.1	80.5	84.6	91.5	75.2	81.7	86.5	94.5
American Indian, Non-Hispanic (Male)[1]	72.8	77.2	80.3	85.6	72.9	78.4	82.2	88.5	73.0	80.1	84.9	92.9
American Indian, Non-Hispanic (Female)[1]	82.0	85.3	87.3	90.6	82.0	86.5	89.2	93.6	82.1	87.7	91.0	96.5
Asian, Non-Hispanic (Male)[2]	80.8	81.5	83.2	86.6	80.9	82.4	84.8	89.4	80.9	83.8	87.1	93.5
Asian, Non-Hispanic (Female)[2]	86.5	86.8	88.1	90.7	86.5	87.7	89.7	93.4	86.6	88.7	91.2	96.2
Hispanic Origin (Male)[3]	77.1	79.0	81.4	85.8	77.2	80.0	83.0	88.6	77.2	81.5	85.5	92.9
Hispanic Origin (Female)[3]	83.7	85.1	86.8	90.1	83.7	86.1	88.4	92.9	83.8	87.1	90.0	95.6

[1] "American Indian" is used to describe the American Indian, Eskimo, and Aleut population.
[2] "Asian" is used to describe the Asian and Pacific Islander population.
[3] Hispanic origin may be of any race.

Table D. Projected Migration by Race and Hispanic Origin, 1999 to 2100.

(Numbers in thousands.)

Race and Hispanic Origin	Lowest Series				Middle Series				Highest Series			
	1999	2025	2050	2100	1999	2025	2050	2100	1999	2025	2050	2100
Yearly Net Migration												
Total	739	183	169	117	954	912	984	926	1191	2268	2812	3039
White	459	59	43	5	588	451	448	374	735	1121	1262	1196
Black	93	28	24	14	120	139	155	147	153	367	485	561
American Indian[1]	6	1	1	1	8	6	7	6	9	14	17	18
Asian[2]	180	94	101	98	238	315	374	398	294	765	1048	1264
Hispanic[3]	384	86	79	67	468	303	297	264	567	693	748	712
White, Non-Hispanic	109	-18	-28	-55	161	180	184	136	218	499	594	555
Black, Non-Hispanic	71	22	18	9	93	118	133	130	119	317	430	512
American Indian, Non-Hispanic[1]	1	0	0	0	2	2	3	3	2	5	7	9
Asian, Non-Hispanic[2]	174	92	99	96	229	309	368	392	285	752	1033	1250
Migration to the U.S.[4]												
Total	1065	628	643	580	1236	1270	1450	1450	1435	2569	3271	3625
White	670	334	314	246	771	655	685	597	893	1280	1474	1415
Black	131	92	103	106	153	196	244	275	181	419	582	723
American Indian[1]	8	4	4	3	9	8	8	8	10	15	18	19
Asian[2]	256	198	222	225	304	411	513	569	351	855	1197	1468
Hispanic[3]	455	170	149	115	530	364	359	315	620	740	802	761
White, Non-Hispanic	257	183	183	145	290	331	366	316	329	618	758	731
Black, Non-Hispanic	102	79	90	96	120	169	216	253	142	365	521	669
American Indian, Non-Hispanic[1]	2	1	2	2	2	3	4	4	2	6	8	10
Asian, Non-Hispanic[2]	248	195	219	222	294	403	505	562	341	841	1181	1453
Emigration of Legal Residents[5]												
Total	326	445	474	463	282	358	466	524	244	301	459	586
White	211	274	272	242	183	205	237	223	158	159	211	218
Black	38	64	79	92	33	56	89	128	28	52	97	162
American Indian[1]	1	2	2	2	1	1	2	2	1	1	2	2
Asian[2]	76	104	122	127	66	96	139	171	57	90	149	204
Hispanic[3]	71	84	70	49	62	62	63	51	53	46	55	49
White, Non-Hispanic	149	200	211	200	129	151	183	180	111	119	164	176
Black, Non-Hispanic	31	56	72	87	27	50	82	122	23	47	91	157
American Indian, Non-Hispanic[1]	1	1	1	1	1	1	1	1	0	1	1	1
Asian, Non-Hispanic[2]	74	102	120	126	64	94	137	170	56	89	148	203

[1] "American Indian" is used to describe the American Indian, Eskimo, and Aleut population.

[2] "Asian" is used to describe the Asian and Pacific Islander population.

[3] Hispanic origin may be of any race.

[4] Migration to the U.S. is net of the departures of illegal residents and temporary residents, as well as departures to Puerto Rico.

[5] Emigration of legal residents excludes departures of illegal residents and temporary residents, as well as departures to Puerto Rico.

Table E. Major Components of Net International Migration to the United States, 1991 to 2100.

(Numbers in thousands. As of July 1. Resident population.)

Year	Lowest Series			Middle Series			Highest Series		
	Net Migration	In [2]	Out [2]	Net Migration	In [2]	Out [2]	Net Migration	In [2]	Out [2]
Estimates [1]									
1991	--	--	--	664	916	252	--	--	--
1992	--	--	--	824	1,078	254	--	--	--
1993	--	--	--	805	1,063	258	--	--	--
1994	--	--	--	747	1,008	260	--	--	--
1995	--	--	--	853	1,116	263	--	--	--
1996	--	--	--	857	1,124	267	--	--	--
1997	--	--	--	954	1,227	273	--	--	--
1998	--	--	--	956	1,234	278	--	--	--
Projections									
1999	739	1,065	326	954	1,236	282	1,191	1,435	244
2000	624	983	358	964	1,251	287	1,363	1,593	231
2001	550	932	382	974	1,267	293	1,497	1,722	225
2002	491	890	400	974	1,272	298	1,594	1,818	224
2003	422	835	413	939	1,243	303	1,624	1,849	225
2004	365	788	423	905	1,213	308	1,639	1,866	227
2005	317	748	430	872	1,184	311	1,645	1,874	229
2010	149	592	442	713	1,036	322	1,571	1,812	242
2015	130	570	440	734	1,063	329	1,726	1,982	256
2020	120	558	438	751	1,090	339	1,854	2,127	274
2025	182	628	446	912	1,270	358	2,269	2,569	301
2030	233	696	463	1,061	1,450	389	2,680	3,020	340
2050	166	643	477	984	1,450	466	2,814	3,271	456
2100	113	580	467	926	1,450	524	3,047	3,625	578

[1] Population estimates produced by the Bureau of the Census in 1998.

[2] "In" is actually the net of in-migration from all sources and the out-migration of undocumented residents, persons moving to Puerto Rico, and temporary legal residents returning home. "Out" refers to the emigration of permanent legal residents to destinations other than Puerto Rico.

Table F. Population and Dependency Ratios per 100 Persons, Four Series, 1990 to 2100.

(Numbers in thousands. As of July 1. Resident Population.)

Year	Zero Migration Series			Lowest Migration Series			Middle Series			Highest Migration Series		
	Population	*Dependency Ratio* Age 65 and over and under 15 [2]	Age 65 and over [3]	Population	*Dependency Ratio* Age 65 and over and under 15 [2]	Age 65 and over [3]	Population	*Dependency Ratio* Age 65 and over and under 15 [2]	Age 65 and over [3]	Population	*Dependency Ratio* Age 65 and over and under 15 [2]	Age 65 and over [3]
Estimates [1]												
1990	–	–	–	–	–	–	248,765	51.9	19.0	–	–	–
1995	–	–	–	–	–	–	262,765	53.1	19.6	–	–	–
1998	–	–	–	–	–	–	270,299	52.1	19.4	–	–	–
Projections												
2000	273,818	51.5	19.2	274,910	51.4	19.2	275,306	51.3	19.1	275,756	51.3	19.1
2010	287,710	49.7	20.4	293,438	49.6	20.1	299,862	49.4	19.8	308,668	49.1	19.4
2015	294,741	53.0	23.5	302,069	52.9	23.0	312,268	52.6	22.5	327,011	52.2	21.7
2020	301,636	58.1	27.7	310,584	57.7	26.8	324,927	57.2	26.0	346,661	56.4	24.8
2025	307,923	64.4	32.8	318,817	63.3	31.3	337,815	62.3	30.1	367,912	60.7	28.2
2030	313,219	69.4	37.1	326,641	67.6	35.0	351,070	65.9	33.2	391,446	63.4	30.5
2035	317,534	71.3	39.0	333,854	69.0	36.3	364,319	67.0	34.3	416,564	63.9	31.0
2040	321,167	71.2	39.1	340,510	68.8	36.3	377,350	66.8	34.1	442,528	63.5	30.6
2045	324,449	70.9	38.8	346,910	68.5	35.9	390,398	66.5	33.8	469,462	63.2	30.2
2050	327,641	71.2	38.9	353,314	68.8	36.1	403,687	66.9	33.9	497,509	63.5	30.3
2060	334,724	72.9	40.2	367,135	70.4	37.4	432,011	68.1	35.0	557,864	64.5	31.3
2070	343,815	73.1	40.7	383,186	70.8	38.1	463,639	68.4	35.4	624,724	64.9	31.9
2080	354,471	74.1	41.7	400,744	72.1	39.4	497,830	69.6	36.6	697,016	66.2	33.3
2090	365,689	75.9	43.6	418,845	73.6	41.1	533,605	70.9	38.1	773,579	67.5	34.8
2100	377,444	77.3	45.2	437,515	74.9	42.6	570,954	72.0	39.5	854,299	68.7	36.2

[1] Population estimates produced by the Bureau of the Census in 1998.

[2] The dependency ratio is defined here as the ratio of the population aged under 15 or 65 and over to the population aged 15 to 64 stated as a percentage.

[3] The elderly dependency ratio is the ratio of the population aged 65 and over to the population aged 15 to 64 stated as a percentage.

Table G. Standardized Rates of Foreign-Born Emigration, 1991 to 2100.

(Rates are per thousand foreign-born persons. As of July 1.)

Years	Migration Series		
	Lowest	Middle	Highest
Estimates [1]			
1991	--	12.1	--
1998	--	12.1	--
Projections			
2000	15.4	12.1	9.5
2005	19.2	12.1	7.7
2010	21.2	12.1	6.9
2015	22.6	12.1	6.5
2020	23.7	12.1	6.2
2030	25.3	12.1	5.8
2040	26.4	12.1	5.6
2050	27.4	12.1	5.4
2060	28.1	12.1	5.2
2070	28.8	12.1	5.1
2080	29.4	12.1	5.0
2090	29.9	12.1	4.9
2100	30.3	12.1	4.9

Note: Rates are standardized by age, sex, and country of origin, using the population estimates base distribution of April 1, 1990.

[1] Population estimates produced by the Bureau of the Census in 1998.

January 7, 2000

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