ESTIMATES AND PROJECTIONS AREA METHODOLOGY
PUERTO RICO COMMONWEALTH AGE-SEX POPULATION ESTIMATES

## OVERVIEW

The U.S. Census Bureau produces estimates of the resident population for each state and county in the United States and for the commonwealth of Puerto Rico and its municipios on an annual basis. The following documentation outlines the methodology used for the production of the age-sex estimates for the commonwealth of Puerto Rico.

## BACKGROUND

During the 1990s, the Puerto Rico commonwealth age-sex estimates were produced using the U.S. Census Bureau's *Rural-Urban Projection* (RUP) program, which employs a cohort-component method. An evaluation of these estimates in the light of Census 2000 showed that this method performed very well[1]. For the post-Census 2000 period, a consensus was reached to continue the use of this method while remaining open to the possibility of alternatives that would make the methodology for the commonwealth estimates closer to that of the estimates for the states. The methodology for the July 1, 2004 estimates in this document is a continuation of that used for the previous post-Census 2000 estimates.

## THE METHOD

The cohort-component population estimation method follows each birth cohort according to its exposure to mortality, fertility, and migration. Starting with a base population by age and sex, the population at each specific age is exposed to the chances of dying as determined by estimated or projected mortality levels and patterns by sex and age. Once deaths are estimated, they are subtracted from the population, and those surviving become older. Fertility rates are estimated or projected and applied to the female population in childbearing ages to estimate the number of births every year. Each cohort of children born is also followed through time by exposing it to mortality. Finally, the component method takes into account any in-migrants who are incorporated into the population and out-migrants who leave the population. Migrants are added to or subtracted from the population at each specific age-sex group. The whole procedure is repeated for each year of the projection period, resulting in the projected population by age and sex.

The RUP program of the U.S. Census Bureau is designed to estimate and project the population of an area using the cohort component method. To do so, it uses a base population by age and sex and estimates of fertility, mortality, and migration. The specification of these components for the program is detailed below.[2]

---

[1]Christenson, Matthew. (forthcoming). "An Evaluation of the Population Estimates for the Commonwealth and Municipios of Puerto Rico during the 1990s." (*Population Division Working Paper*) U.S. Census Bureau: Washington, D.C.

[2] For a more detailed description of the RUP program, see Eduardo E. Arriaga, 1994, *Population Analysis with Microcomputers, Volume II: Software and Documentation*, Washington, D.C.: U.S. Census Bureau.

STEP 1: SPECIFICATION OF THE BASE POPULATION

Upon the recommendation of the Executive Steering Committee for Accuracy and Coverage Evaluation Policy (October, 2001), the Secretary of Commerce decided that the unadjusted census is to be used for all official non-redistricting purposes. This includes the production of the official estimates for Puerto Rico. The data by sex and 5-year age groups (under 1, 1-4, 5-9, ... 80+) for Census 2000 were used as the base population for the RUP input file for July 1, 2004. It included all Count Question Resolution and boundary updates in place as of January 1, 2004. The base population was moved from April 1, 2000 to July 1, 2000 by applying the intercensal growth rate between 1990-2000 for the commonwealth as a whole to each 5-year age group. To assist with this, the U.S. Census Bureau's *Population Analysis Spreadsheet* (PAS) ADJAGE was used.

STEP 2: SPECIFICATION OF FERTILITY

Births by age of mother for calendar years 2000-2003 were taken from vital registration as received from the Puerto Rico Planning Board. These data were aggregated into 5-year age groups (from 15-19 to 45-49), with births reported to mothers under the age of 15 added to the 15-19 category.

STEP 3: SPECIFICATION OF MORTALITY

Deaths by age and sex for calendar years 2000-2003 were taken from vital registration as received from the Puerto Rico Planning Board. These data were aggregated into 5-year age groups except for the population age 0 to 4 for years 2000-2002, which were entered by single years of age. The single year of age data for 2003 were not available.

STEP 4: SPECIFICATION OF INTERNATIONAL MIGRATION

For the July 1, 2004 commonwealth estimates for Puerto Rico, net migration rates by sex and 5-year age groups as calculated during the production of previous post-Census 2000 estimates were used. These estimates were calculated from residual differences between a hypothetical population and Census 2000. The residual technique starts with the 1990 Census population and projects a hypothetical population for 2000 by only accounting for changes due to fertility and mortality. This approximates what the 2000 population would be with no migration. Net migration for the 10-year period is estimated by subtracting the hypothetical 2000 population from the Census 2000 population, The net migration for the decade is next converted to annual rates. These net migration rates are assumed to apply to the post-Census 2000 period. The work done to produce these estimates is detailed below.

1) A RUP input file with a 1990 Census base and the assumption of no net migration over the decade was used to project the population of Puerto Rico to July 1, 2000. It was constructed as follows:
   a) Base population: The base population by age and sex was taken from the 1990 Census. Due to a processing error for the under-1-year age group, the data for this age group was increased by 10 percent, which results in an overall adjustment to the census of around 0.1 percent. The adjusted census population was then moved to midyear by applying the intercensal growth rate between 1980-1990 for the commonwealth as a whole to each 5-year age group. To assist with this, the U.S. Census Bureau's *Population Analysis Spreadsheet* (PAS) ADJAGE was used.
   b) Mortality: Deaths by 5-year age groups (<1, 1-4, 5-9, …, 75-79, 80+) and sex were input for 1990-2000. These data came from vital registration as received from the

Puerto Rico Planning Board. Before entry, deaths to people of unknown age were distributed proportionally among the other age groups.

c) Fertility: Births by age of mother (5-year age groups from 15-19 to 45-49) and by the sex of the child were input for the years 1990 to 2000. These data came from vital registration as received from the Puerto Rico Planning Board. Births reported to mothers under the age of 15 were added to the 15-19 category and births to women of unknown age were distributed proportionally among each age group.

d) Migration: Migration was assumed to be nil in order to estimate the population with no migration.

2) The estimated populations for July 1, 1999 and July 1, 2000 were used to interpolate an April 1, 2000 estimate by sex and 5-year age groups.
3) The April 1, 2000, estimates were subtracted from the actual Census 2000 enumerated population. The differences gave an estimate of the net migration by age and sex over the entire intercensal period.
4) The product of the above procedure was used to create an estimate of the annual migration by age and sex during the intercensal period (1990 to 2000). To do so, it was important to account for the fact that the total net intercensal migrants associated with a given age cohort actually migrated as members of several different cohort groups, including those to which they belonged at the beginning of the period, and the ones they joined upon turning an age which is a multiple of 5. A rough correction for this was made by shifting the estimate of intercensal migration associated with a given cohort to the next youngest 5-year cohort, which approximated the average age at migration over the 10-year period. For the 0-4 age group, the 0-4 and 5-9 estimates were added together to give an estimate over the entire 10-year period. These numbers were then divided by the number of years in the intercensal period (10).
5) These estimated migrants were input into the preliminary RUP input file from step 1 (above) and a new set of intercensal estimates were run.
6) Finally, the estimated annual number of net migrants from step 4 (above) was divided by the estimated population for July 1, 1995 from step 5 (above) to arrive at an estimated set of net migration rates. It was assumed that this estimated set of net migration rates applied to the post-Census 2000 period and, therefore, were kept constant throughout the entire estimation period. A similar assumption was used when applying 1980 to 1990 annual migration rates to the 1990 to 2000 estimates. Comparisons of the 2000 estimates to Census 2000 results showed this assumption to be robust.

## LIMITATIONS

The major limitation of the July 1, 2004 Puerto Rico commonwealth estimates is the absence of reliable information about international migration. The assumption that the migration in the post-Census 2000 period follows the same pattern as that during the 1990s may be untenable. At this point, however, few if any additional sources of data have been found that might shed some light on the migration to and from Puerto Rico.

Net migration between 1990 and 2000 as calculated with the residual technique also includes any differential coverage in the two censuses. To the degree that there are large differences in the 1990 Census coverage and Census 2000 coverage for Puerto Rico as a whole or for segments of the Puerto Rican population, the estimated net migration rates will be inaccurate.

Another potential limitation of the July 1, 2004 commonwealth estimates is the quality of the birth and death data. For the purposes of these estimates, it is assumed that these as received from the Department of Health in Puerto Rico are complete and accurate. However, there is no direct measure of the completeness of coverage of these measures.