

## **Methodology for the State and County Total Resident Population Estimates (Vintage 2009): April 1, 2000 to July 1, 2009**

NOTE: These estimates include adjustments due to the effects of hurricanes Katrina and Rita. For a description of these adjustments, refer to the Special Processing Procedures for the Areas Affected by Hurricanes Katrina and Rita – 2009 at [www.census.gov/popest/topics/methodology/2009-hurr-spcl-meth.pdf](http://www.census.gov/popest/topics/methodology/2009-hurr-spcl-meth.pdf).

The U.S. Census Bureau annually produces estimates of the resident population for each state and county using a component of population change method at the county level. To produce the state population estimates, we simply sum all county populations within each state. The following documentation describes the process by which we produce the April 1, 2000 through July 1, 2009 annual resident population estimates at the county level.

### **Overview**

The Census Bureau develops county population estimates with a component of population change method in which we use administrative records and other data to estimate the household and group quarters population. For the household population, the components of population change are births, deaths, net domestic migration, and net international migration. We measure change in the non-household, or group quarters, population by the net change in the population living in group quarters facilities.

A major assumption underlying this approach is that changes in selected administrative and other data sources closely approximate the components of population change. Therefore, Census Bureau demographers separately estimate each component of population change based on administrative records, including registered births and deaths, Federal income tax returns, Medicare enrollees, and military movement. We also separately estimate net international migration using information from the American Community Survey (ACS), Census 2000, and other data sources.

Most administrative record data sources lag the current estimate year (by as much as two years), therefore, we project the data for the current year based on past years' data. As updated data become available, we revise the projected input data so that each vintage's estimates are always based on the most recent data available.

We produce the estimate of each county's population, starting with the base population from either Census 2000 (for the July 1, 2000 estimates) or the revised population estimate for the prior year (for the July 1, 2001 and later estimates). We then add or subtract the demographic components of population change calculated for that time period. Basically, we add the estimated number of births and subtract the estimated number of deaths for the time period. Next, we add the estimates of net domestic migration, net international migration, and the net change in the group quarters population.

We produce separate population estimates for the populations under age 65 and age 65 and over, mainly because different data are used to measure the domestic migration of these two populations. For the population under age 65, we use person-level data from individual Federal tax returns to estimate net domestic migration. We use Medicare enrollment data to calculate measures of migration for the population age 65 and over because this population is not always well represented on tax returns. County total population estimates are the sum of the estimates of the population under age 65 and age 65 years and over.

State and county estimates may also incorporate other changes due to corrections made since Census 2000. The corrections occur outside the component estimation framework and are the result of successful local challenges or special censuses.

## **Method**

### Base Population

The enumerated resident population in Census 2000 is the starting point for the post-2000 population estimates. We modify this enumerated population in two ways to produce the April 1, 2000 population estimates base. First, we reconcile the Census 2000 race categories with the race categories that appear in our administrative records data by recoding the “Some other race” Census 2000 responses to one or more of the five 1997 Office of Management and Budget (OMB) race categories: White; Black or African American; American Indian and Alaska Native; Asian; and Native Hawaiian and Other Pacific Islander.<sup>1</sup> Second, we update the population estimates base to reflect changes to the Census 2000 population due to the Count Question Resolution program, legal boundary updates as of January 1, 2009, and other geographic program revisions.<sup>2</sup>

### Demographic Components of Population Change

#### *Births and Deaths*

The birth and death components are estimated using data from two sources. Where possible, members of the Federal-State Cooperative for Population Estimates (FSCPE) provide summary data on all registered births and deaths to residents of their respective states and counties from 2000 to the most recent calendar year. The National Center for Health Statistics (NCHS) also provides birth and death data, but these data are not as current as those available from members of the FSCPE. However, the NCHS data include individual record data on each registered birth and death by state, county, month, sex, race, Hispanic origin, and age (for deaths). Where FSCPE vital statistics data are not available, we use only NCHS data.

County birth totals from FSCPE and NCHS sources are controlled to the national NCHS birth total for the corresponding year. Then the county-level sex, race, and Hispanic origin distribution of NCHS births for that year is applied to these totals to derive births for each demographic group for all U.S. counties. Estimates of annual deaths for demographic groups are calculated in similar fashion. We reconcile county death totals from the two data sources to the NCHS national death total for the corresponding year and assign the county-level age, sex, race, and

Hispanic origin distribution of NCHS deaths for that year. Since we produce estimates for July 1 of each year, we use the NCHS month-of-occurrence information to derive births and deaths for the July 1 to June 30 period for each year.

### *Net Domestic Migration*

Under Age 65: We use person-level data from Federal income tax returns supplied by the Internal Revenue Service (IRS) to measure the domestic migration of the household population under age 65. These data are limited to filers and their dependents that are under age 65. We match two years of IRS tax returns and compare the addresses to identify the number of individuals who moved from one county to another between tax filings. Since we know that every U.S. resident may not file or be claimed as an exemption on a tax return, we cannot use these data as direct information on the number of migrants. Therefore, we derive net domestic migration rates using these data and apply these rates to all potential migrants within each county. To calculate these rates, we subtract the out-migrants from the in-migrants for each county to produce the number of IRS-based net migrants. Then, we divide the number of IRS-based net migrants by the total number of non-migrants and out-migrants for each county.

Age 65 and Over: To measure domestic migration for the age 65 and over population, we use Medicare enrollment data as of each July 1 from 1999 to 2008 for each county. We project the number of Medicare enrollees as of July 1, 2009 for each county based on earlier trends in Medicare enrollment. We estimate the April 1, 2000 enrollment for each county by linear interpolation between the July 1, 1999 and July 1, 2000 data. We know that not all U.S. residents age 65 and over receive or are eligible to receive Medicare benefits. Therefore, we use the year-to-year change in the Medicare enrollment to calculate a domestic net migration rate. We assume that the year-to-year change in enrollment represents the total change in the age 65 and over population in each county. We have independent estimates of the deaths and international migration of the age 65 and over population, as well as the number of individuals turning 65 years old, which we benchmark to the Medicare data. The population change not attributable to either deaths or international migration must, by default, be due to net domestic migration. We calculate a Medicare-based net migration rate for each county by dividing the net domestic migration estimate by the total number of Medicare enrollees at the beginning of the time period.

### *Net International Migration*

International migration, in its simplest form, is any change of residence across the borders of the United States (the 50 states and District of Columbia). The net international migration component of the population estimates combines four parts: (a) net international migration of the foreign born, (b) net migration between the United States and Puerto Rico, (c) net migration of natives to and from the United States, and (d) net movement of the Armed Forces population to and from the United States.

Net international migration of the foreign-born population at the national level is estimated in two parts, immigration and emigration. The estimate of immigration utilizes information from the American Community Survey (ACS) on the reported residence of the foreign-born population in the prior year. The foreign born who reported living abroad in the year prior to the

survey are considered immigrants. Because this question is only asked of those age one and older, we make an additional assumption for foreign-born immigrants under the age of one. We assume that the number of foreign-born immigrants under the age of one is equal to half of the number of one-year-old foreign-born immigrants.

At the national level, emigration of the foreign born is estimated using a residual method. We age forward the foreign-born household population in Census 2000 using NCHS life tables to obtain the expected population in 2005, 2006, 2007, and 2008. We then compare the expected foreign-born population to the foreign-born population estimated by ACS 2005, ACS 2006, ACS 2007, and ACS 2008. Subtracting the estimated from the expected population produces a residual, which serves as the basis for emigration rates for the 2000 to 2005, 2000 to 2006, 2000 to 2007, and 2000 to 2008 time periods. We perform this calculation for two period-of-entry groups: the foreign born who entered the United States between 1990 and 1999; and the foreign born who entered before 1990. An average of the rates for each period-of-entry group are then applied to the population at risk of emigrating each year (i.e., the foreign-born population in the ACS who indicated that they lived in the United States one year ago) to obtain annual estimates of emigrants for 2000 to 2009. To estimate emigration from 2000 to 2008, we use an average of the rates developed from the 2000 to 2005, 2000 to 2006, and 2000 to 2007 residuals. To estimate emigration in 2009, we use an average of the rates developed from the 2000 to 2006, 2000 to 2007, and 2000 to 2008 residuals.

We estimate the net international migration of the foreign-born population at the national level by subtracting the number of emigrants from the number of immigrants. The state distribution and state-level age, sex, race and Hispanic origin information are estimated for foreign-born immigrants and emigrants separately using data from Census 2000 and the ACS three-year estimates for the 2005 to 2007 time period (ACS 2005-2007). Estimate year 2000 uses information from Census 2000, while 2005 and later years use information from the ACS 2005-2007. The incorporation of ACS data is phased in at the state level through linear interpolation between estimate years 2000 and 2005. The county distribution and county-level age, sex, race, and Hispanic origin information are applied to foreign-born immigrants and emigrants separately using information from Census 2000 for all estimate years. County-level data are controlled to state-level data to ensure the component data sum as required.

Foreign-born immigrants are assigned the state- and county-specific age, sex, race, and Hispanic origin distribution of the foreign-born population who entered the United States within five years of the Census/survey year. Age is adjusted for foreign-born immigrants to represent age at arrival to the United States. Characteristics are applied to the estimates of foreign-born emigration by period of entry. The state- and county-specific age, sex, race, and Hispanic origin distribution of the foreign born who entered the United States within ten years of the Census/survey year is applied to the estimate of emigrants who entered the United States within ten years of the estimate year. The state- and county-specific age, sex, race, and Hispanic origin distribution of the foreign born who entered the United States more than ten years before the Census/survey year is applied to the estimate of emigrants who entered the United States more than ten years before the estimate year.

Net migration between the United States (the 50 states and the District of Columbia) and Puerto Rico is also estimated at the national level in two parts, immigration and emigration, when possible. For 2005 and later years, the ACS and the Puerto Rico Community Survey (PRCS) allow us to estimate annual migration flows directly using the question on place of residence one year ago.<sup>3</sup> People who indicated in the ACS that they lived in Puerto Rico one year ago are considered immigrants (i.e., they moved from Puerto Rico to one of the 50 states or the District of Columbia). People who indicated on the PRCS that they lived in the United States one year ago are considered emigrants (i.e., they moved from one of the 50 states or the District of Columbia to Puerto Rico). We assume the number of immigrants and emigrants under the age of one is equal to half of the number of one-year-old immigrants and emigrants, respectively.

For 2000 to 2004, we use prior research to establish a base estimate of net migration between the United States and Puerto Rico for 2000 and linearly interpolate between the 2000 net estimate and the 2005 net estimate to generate the estimates for 2001 to 2004.<sup>4</sup> For 2000, the state distribution and state-level age, sex, race and Hispanic origin distribution is based on the Census 2000 population born in Puerto Rico who entered the United States in 1995 or later. For 2005 and later years, we base the state distribution and state-level age, sex, race, and Hispanic origin distribution of these net migrants on the demographic characteristics of the ACS 2005-2007 population born in Puerto Rico who entered the United States within 10 years of the survey year. As described for foreign-born immigration and emigration, the incorporation of ACS data is phased in at the state level through linear interpolation between estimate years 2000 and 2005. The county distribution and county-level age, sex, race, and Hispanic origin information from Census 2000 are applied to net Puerto Rico migrants for all estimate years using characteristics of the population born in Puerto Rico who entered the United States in 1995 or later. County-level data are controlled to state-level data to ensure the component data sum as required.

We estimate the net migration of natives to and from the United States at the national level using levels observed during the 1990s.<sup>5</sup> We apply the age, sex, race, and Hispanic origin distribution of natives residing in the United States to the estimate of net native migration. For 2000, the state distribution and state-level age, sex, race, and Hispanic origin information are obtained from Census 2000. For 2005 and later years, the state distribution and state-level age, sex, race, and Hispanic origin information are obtained from ACS 2005-2007. The incorporation of information on the state-distribution and state-level characteristics from ACS 2005-2007 is phased in through linear interpolation between estimate years 2000 and 2005. The county distribution and county-level age, sex, race, and Hispanic origin information from Census 2000 is applied to the net native migrants for all estimate years using characteristics of natives residing in the United States. County-level data are controlled to state-level data to ensure the component data sum as required.

We derive county-level data on net overseas movement of the Armed Forces population for the current estimate period using a three-stage process. First, we distribute the national-level overseas Armed Forces movement total to states using Armed Forces data originally supplied by the Defense Manpower Data Center (DMDC). Then, we distribute these state-level data to counties using the county distribution of the Armed Forces data from Census 2000. We assume that all net overseas Armed Forces migrants are under age 65. Finally, we control the county-level data to the original national-level data to ensure the component data sum as required.

## Group Quarters Population

We use group quarters population data from two sources to estimate the change in the group quarters (GQ) populations: (1) Census 2000 group quarters population by single year of age and facility type (i.e., correctional institutions, juvenile facilities, nursing homes, other institutional facilities, university dormitories, military barracks, other noninstitutional facilities) for each subcounty area (e.g., cities, towns, etc.) and (2) a time series of individual GQ records from the Group Quarters Report (GQR) prepared by the FSCPE members.

From these GQ population data, we derive a time series of GQ population. First, we separately sum the GQ populations from Census 2000 and the GQR to the subcounty level by facility type for each estimate date in the time series. Then, we calculate a time series of subcounty GQ population by facility type from July 1, 2000 to July 1, 2009 by adding the year-to-year change indicated by the GQR data to the Census 2000 GQ populations for the same subcounty area by facility type.

We sum the subcounty GQ population to the county level by type and derive the total group quarters population under age 65 and age 65 and over by GQ type from the total GQ population by type using the Census 2000 age distribution of the GQ population by type in each county. Finally, we aggregate the county group quarters population across facility types to calculate the county GQ population under age 65 and 65 years and older.

## Estimation of the County Populations: Under Age 65 and 65 and Over

To begin the calculation of county population estimates, we first need to calculate the appropriate beginning populations for April 1, 2000. We assume that one-fourth of the 64 year olds in each county as of April 1, 2000 will have turned 65 by July 1, 2000. We calculate the July 1, 2000 base resident populations under and over age 65 by subtracting and adding, respectively, the base resident population turning age 65 from the April 1, 2000 population under age 65 and age 65 and over. From these aged base resident populations, we subtract the base group quarters populations under and over age 65 to calculate the aged base household populations under and over age 65, respectively. We need this population base to represent the household population because we assume that the GQ population grows and migrates differently than the rest of the population. Consequently, we want to apply the county-to-county migration rates to the household population only.

The population bases of potential domestic migrants under age 65 and age 65 and over represent all people who have the possibility of moving within the United States during the estimate period. The population at the beginning of the estimate period includes those people who died or moved out of the county during the period, but excludes people who were born or moved into the county during the period. The population at the end of the estimate period is just the opposite. Since neither population is an accurate depiction of the population at risk of moving into or out of the county during the estimate period, an appropriate demographic compromise is to use the population at the midpoint of the period in our calculation of the population base of potential domestic migrants under age 65 and age 65 and over.

We assume that estimated resident births, estimated deaths, and net international migration are evenly distributed throughout the estimate period. Therefore, people experiencing these events are at risk of migrating, on average, for one-half of the period. We develop the domestic migration population base for each age group by adding one half of the births and net international migration and subtracting one half of the deaths from the aged household base population by age group.

There is a slight difference in the formula for the two age groups in that we calculate the migration base for the age 65 and over population by subtracting one half of the deaths and one half of the net native international migrants and adding one half of the international migrants between the United States and Puerto Rico. We make these adjustments in the migration base calculation for the older group because 1) birth cohorts entering the younger age group do not apply and 2) most foreign-born international migrants (the other part of the total net international migration) are not eligible to receive Medicare upon arrival in the United States.

Once we have calculated these base populations, we then calculate the net number of county-to-county migrants for the under age 65 and age 65 and over populations by multiplying the IRS-based migration rates and the Medicare-based migration rates by the respective migration bases. Since the IRS-based migration rate represents the movement over the course of one year, we divide the number of net migrants under age 65 by four to calculate the net migration in this population between April 1, 2000 and July 1, 2000. This is not necessary for the net migrants who are age 65 and over because the Medicare-based migration rate for this period exactly represents the period of interest, April 1, 2000 to July 1, 2000.

We subtract the county net Armed Forces movement of the population under age 65 to prevent any double counting of migrants since we assume those military personnel moving between the United States and overseas are included in the IRS tax return universe. From the net migrants 65 years and older, we subtract out all of the net international migration except the foreign-born migrants.

Once we have calculated the county-to-county migration for both age groups, we estimate the household population as of July 1, 2000 for each age group by starting with the aged base household population, adding the births, county-to-county net migration, and net international migration and subtracting the deaths. Then, we add in the GQ population by age group as of July 1, 2000 to produce the county resident population for the under age 65 and age 65 and over groups as of July 1, 2000.

Finally, we must ensure consistency between the county population estimates and the independently produced national population estimates. We do this by proportionally adjusting, or raking, all county populations so the sum of the county estimates by under and over age 65 equals the national estimates by under age 65 and age 65 and over.

We then use the controlled July 1, 2000 population estimate for each county as the starting point for the July 1, 2001 population estimates by county and repeat the procedure described above for each year of the time series until reaching July 1, 2009. The only differences between the

calculation of the July 1, 2000 estimates and subsequent calculations are due to the change in the length of the estimate period. When calculating the population turning 65 years old, we can assume that all people age 64 at the beginning of the time period would have become 65 years old after one year. Also, we no longer need to divide the number of net domestic migrants under age 65 by four to represent only three months of migration.

### Other Population Change

We incorporate data from other administrative sources into the estimates as necessary. These other sources include revisions from the population estimates review and update program (challenges) to the population estimates and the results of whole-entity special censuses.<sup>6</sup>

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<sup>1</sup> Detailed information on the race modification is available at <http://www.census.gov/popest/archives/files/MRSF-01-US1.html>. The modified race data summary file is available at <http://www.census.gov/popest/archives/files/MR-CO.txt>. The OMB standards are detailed in Office of Management and Budget, “Revisions to the Standards for the Classification of Federal Data on Race and Ethnicity” Notice, Vol. 62, No. 210, Thursday, October 30, 1997 <http://www.whitehouse.gov/omb/fedreg/1997standards.html>.

<sup>2</sup> For more information on the Census 2000 Count Question Resolution program, see <http://www.census.gov/dmd/www/CQR.htm>.

<sup>3</sup> The Puerto Rico Community Survey was first fielded in 2005. See <http://www.census.gov/acs/www/SBasics/FlyerPR.htm> for more information.

<sup>4</sup> For more information on the estimate of net migration between the United States and Puerto Rico for 2000, see Christenson, M., 2002, “Evaluating Components of International Migration: Migration Between Puerto Rico and the United States,” Population Division Working Paper No. 64 <http://www.census.gov/population/www/documentation/twps0064.html>.

<sup>5</sup> For information on estimates of net native migration, see Gibbs, J., G. Harper, M. Rubin, and H. Shin, 2003, “Evaluating Components of International Migration: Native-Born Emigrants,” Population Division Working Paper No. 63 <http://www.census.gov/population/www/documentation/twps0063.html>.

<sup>6</sup> For more information on the challenge program, see <http://www.census.gov/popest/archives/challenges.html>. For more information on the special census program, see [http://www.census.gov/field/www/specialcensus/files/program\\_overview.htm](http://www.census.gov/field/www/specialcensus/files/program_overview.htm). For more information on the incorporation of challenges, see <http://www.census.gov/popest/topics/methodology/2008-est-relnotes.pdf>.