# Population Projections for Maine State and Counties Methodology – Maine State Planning Office

Released March 2010

The Maine State Planning Office (SPO) periodically produces population projections for Maine's counties and towns that are used by a variety of state and local agencies for planning purposes. In 2010, the SPO updated its projections of county populations. Town projections will be released when data from the 2010 Census become available.

This paper briefly describes the methodology behind these projections. The complete projections are available on the SPO website at: http://www.maine.gov/spo/economics/projections.

## County Projections

The updated estimates described in this report are based on a cohort-component model of demographic change. The cohort-component method models population growth based on anticipated changes in the key components of demographic change: births, deaths, in-migration and out-migration. The cohort-component method has several advantages:

1.  it is based on a well-established and accepted model of demographic change,
2.  it produces a detailed breakdown of anticipated county population by age and sex, and
3.  it makes full use of actual counts of county-specific birth and death rates available through Maine's Vital Statistics program.

Note that these projections offer only a *possible* scenario of future population change using the best data and methods that are currently available. The projections rely on recent estimates of the age and sex profile of each county. Any estimation errors in recent population estimates will be incorporated into future projections. The model also assumes that past birth, death and migration rates within each group will persist into the foreseeable future. The model cannot account for unprecedented future events that may dramatically alter a county's demographic composition, such as future military base closings; large factory openings and closures; or changes in technologies, personal choices, or environmental conditions in the next 25 years that may alter migration behavior and/or birth and death rates.[1] As such, population projections are more accurate for the near future versus the distant years and should be updated regularly.

---

[1] The impending 2011 closure of the Naval Air Station Brunswick (NASB) is an important case in point. A January 2007 SPO study estimates a potential peak loss of roughly 7,000 persons as a direct and indirect consequence of the NASB closure. The neighboring counties of Cumberland, Sagadahoc and Androscoggin are likely to bear the brunt of the loss.

The potential impact of the NASB closure is not included in the population projections provided in this report. This is because a) the cohort model relies upon *existing* county demographic profiles to estimate future populations; and, more importantly, b) the NASB impact study provides only a worse-case-scenario estimate of population loss and does not account for the offsetting impacts from base redevelopment. Including only the worst-case scenario estimates would just as likely under-count future population as failing to include them would likely over-count it.

The cohort-component model

Population can only change through the addition or subtraction of residents through births, deaths, in-migration (new residents moving in), or out-migration (existing residents moving out). Mathematically this identity is written:

**Future population = Current population + births – deaths + (in-migration – out-migration).**

The cohort-component method separately estimates each component of population change and combines these estimates to project population change into the future. County birth, death, and migration rates vary considerably by sex and age. Producing separate projections for these groups can greatly improve the accuracy of the overall model. Male and female populations are divided into 17 five-year age cohorts (0-4 years, 5-9 years, etc.) and one open-ended cohort (85 years and older). These age cohorts match the categories used by the U.S. Census Bureau.

Estimates from the Census Bureau's Population Estimates Program provide the data for the "launch-year" population profile. Recent data from the Maine Office of Data, Research, and Vital Statistics are used to estimate five-year fertility and mortality rates by county for each sex-specific age cohort. Net migration rates are calculated as the cohort-specific change in county population from one five-year period (e.g. 10-14 year olds in year 2000) to the next (e.g. 15 to 19 year olds in year 2005) after accounting for deaths and births (in this case 0 to 4 year olds). The model assumes that these rates will persist throughout the projection period.

As people age the likelihood of them having children, moving, and dying changes. The model accounts for these changes by aging the population in five year increments, each time applying estimated mortality, fertility and net migration rates in order to estimate the next sex-age cohort. Births are estimated from age-specific fertility rates applied to the female population. The process continues for the next five-year increment, until the target forecast year (in this case 2028) is reached.

Methodology

The cohort-component model for Maine counties was developed as a SAS program with an accompanying set of Excel files that follow the same calculations and are used as a check. The following pieces of data were used as inputs:

- county name
- the population age cohort
- year of historical data
- total population in the age cohort (source: Census Population Estimates Program)
- male population in the age cohort (Census Population Estimates Program)
- female population in the age cohort (Census Population Estimates Program)
- number of live births to mothers in the age cohort (Maine Vital Statistics)
- total number of deaths by persons in the age cohort (Maine Vital Statistics)
- number of deaths by males in the age cohort (Maine Vital Statistics)

- number of deaths by females in the age cohort (Maine Vital Statistics)

The first step in calculating the county population projections is to calculate the birth rate, survival rates, and migration rates for the male and female populations.

The five-year fertility rate for females in each age cohort is calculated as the annual average fertility rate (births by age cohort of mother divided by female population by age cohort) from 2004 to 2008 multiplied by five. Because females in each cohort can, on average, expect to spend half of their next five years in two different age cohorts, the "operational fertility rate" used in calculations is the average fertility rate calculated from subsequent cohorts. For example, females between ages 15 and 19 in year 2000 will, on average, spend half of the next five years in the 15-19 cohort and half in the 20-24 cohort. Thus, the operational fertility rate is the average between the 15-19 fertility rate and the 20-24 fertility rate.

Operational survival rates are calculated for both males and females. Survival rates are calculated for each age cohort by taking the proportion of deaths to the total population for each age cohort and subtracting this proportion from one. The five year survival rate is calculated as the average annual survival rate from 2004 to 2008 *raised to the 5th power*.[2] As with fertility, the operational survival rate is calculated as the average of subsequent age cohorts. The applicable operational survival rate for the 85+ population is simply its five-year average raised to the 5th power.

Migration rates are also calculated for both males and females. The migration rate essentially attributes to migration any difference between the 2008 actual population estimate and what the 2008 population would have been from applying the fertility and survival rates to each age cohort in 2003. In order to calculate the migration rate the number of births in 2008 must first be calculated. For births of females, the population in each age cohort is multiplied by the five-year operational birth rate times the proportion of births in 2003 that were female. The calculation is the same for the births of males, using one minus the proportion of births in 2003 that were female.

The population in 2008 for each cohort is then calculated as if there were no migration. For the 0-4 cohort, the sum of the projected births in all age cohorts is multiplied by the five-year operational survival rate for the 0-4 age cohort in 2003. For the 85+ cohort, the population of the 80-84 cohort in 2003 is multiplied by the five-year operational survival rate for the 80-84 cohort and added to the population of the 85+ cohort in 2003 multiplied by the five-year operational survival rate for the 85+ cohort. For all other cohorts, the population of the previous cohort in 2003 is multiplied by the five-year operational survival rate for that previous cohort.

The migration rate for each cohort is then calculated as one plus the difference between the actual 2008 population and the predicted 2008 population calculated above divided by the actual 2003 population. A migration rate greater than one indicates net in-migration for persons in a specific cohort. A migration rate less than one indicates net out-migration for persons in a specific age cohort.

---

[2] This follows from the laws of probability. Unlike births, where the same mother may have more than one child, mortality is permanent. Thus if the probability of surviving for one year is 0.9, the probability of surviving 5 years is $0.9^5 = 0.59$.

The projections themselves are calculated separately for males and females in each age cohort. In each cohort, the number of survivors from the previous cohort are added to the number of in- or out-migrants for that cohort. For the 0-4 cohort, the number of survivors in 2013 is calculated as the sum of births by mothers in all age cohorts multiplied by the five-year operational survival rate for the 0-4 cohort. Births are calculated as the 2008 female population in each cohort multiplied by the five-year operational birth rate for each cohort times the five-year average proportion of female births (or one minus the proportion of female births if calculating male births).

For the 85+ cohort, the number of survivors in 2013 is calculated as the population in 2008 of 80-84 year olds multiplied by the five-year operational survival rate for that cohort *plus* the population in 2008 of the 85+ cohort multiplied by the five-year operational survival rate for the 85+ cohort. For all other cohorts, the number of survivors in 2013 is calculated by taking the population in 2008 of the previous age cohort multiplied by the five-year operational survival rate for that previous cohort.

The number of survivors in each cohort is then multiplied by the migration rate to get the population in 2013 of each age cohort by sex. The 2013 population projections then become the base for the 2018 projections, which are calculated the same way as the 2013 projections using 2013 figures in place of the 2008 figures. This process repeats for 2023 and 2028.

County projections are summed to obtain statewide projections.