MINNESOTA STATE DEMOGRAPHIC CENTER
DEPARTMENT OF ADMINISTRATION

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METHODOLOGY FOR MINNESOTA POPULATION PROJECTIONS

TO FULFILL THE EXPECTATIONS OF MINESOTA STATE STATUTES 4A.02 AND 4A.03, THE DATASET THAT THIS DOCUMENT ACCOMPANIES SERVES AS THE ANNUAL POPULATION PROJECTIONS FOR THE STATE OF MINNESOTA. UPDATES WERE MADE TO EXISTING INPUTS FROM RECENT RELEASES, YET THE METHODOLOGY REMAINS CONSISTENT.

By Megan Dayton

This describes the methodology used to produce Minnesota population projections by single year of age and by gender for each year from 2015 to 2070. This dataset has been re-issued in December 2017. The method for projecting future population is outlined below. Each step is then discussed in more detail.

STEP 1: Project total regional population for each year from 2015 to 2070 using a formula based on the Midwest's share of the national population

STEP 2: Project total state population for each year from 2015 to 2070 using a formula based on Minnesota's share of the regional population

STEP 3: Apply the cohort-component method of population projections

- **STEP 3A:** Project births and deaths as rates of natural increase/decrease
- **STEP 3B:** Compute preliminary net-migration

STEP 4: Adjust net-migration figures

STEP 5: Control age/gender totals to annual state totals

STEP 1: PROJECT REGIONAL TOTAL POPULATION

The first step was to obtain a target annual population for the Midwest based on its share of the national population. Regression techniques were used to obtain the yearly, predicted share of the population starting in 2015. Decennial Census counts,[1] Intercensal Estimates,[2] and the US Census Bureau's projections[3] were used as data inputs. The formula:

Log (Midwest Population / U.S. Population)

was regressed on a constant, year, and year*year.

The first model used data from 1900 to 2050, the second from 1960 to 2050. The second model was chosen to reduce error introduced by using data from volatile periods of population change. The predicted values from this procedure were included through 2070. Starting in 2061, the Midwest share of the US population was held at a constant rate. This regression analysis was conducted in Stata.

Generally, the regional share of the national population has fallen modestly over time. This decline is projected to continue into the future. In 2010, just over 21% of the US population lived in the Midwest region; by 2070 this is projected to decline to just over 14%.

For the period between 2015 and 2070, this projected share was then applied to the national population from the US Census Bureau's 2014 projections series.[3] For the 2060 to 2070 period, the annual average rate of growth from 2045 to 2060 was used to project the total population.

For the 2015 starting year, the Census Bureau's Intercensal Estimates by single year of age were used. These estimates are based on the 2010 Decennial Census. The estimates combine the older ages (85+) into a single group. The 85+ age group was distributed into single years of age using the 2010 Census distribution of this population. The 2010 Census is the most recent dataset that provides single year of age data above age 85 and up to age 100.

STEP 2: PROJECT STATE TOTAL POPULATION

The second step was to obtain a target annual population for Minnesota based on its share of the Midwest Regional population. Regression techniques were used to obtain the yearly, predicted share of the population starting in 2015. Decennial Census counts,[1] Intercensal Estimates,[2] and the US Census Bureau's projections[3] were used as data inputs. The formula:

Log (Minnesota Population / Midwest Population)

was regressed on a constant, year, and year*year.

The first model used data from 1900 to 2050, the second from 1960-2050. The second model was chosen to reduce error introduced by using data from volatile periods of population change. The predicted values from this procedure were included through 2070. Starting in 2061, the MN share of the Midwest population was held at a constant rate. This regression analysis was conducted in Stata.

Generally, Minnesota's share of the regional population has fluctuated over time but in more recent years, has increased modestly. This increase is projected to continue into the future. In 2010, nearly 8% of the Midwest population lived in Minnesota; by 2070, this is projected to increase to nearly 10%.

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[1] Decennial Census counts: http://www.census.gov/prod/www/decennial.html
[2] Intercensal Estimates: http://www.census.gov/popest/data/intercensal/state/state2010.html
[3] US Census Bureau's national projections: http://www.census.gov/projections/data/national/2014.html

For the period between 2015 and 2070, this projected share was then applied to the Midwest regional population from the previous step. For the 2060 to 2070 period, the annual average rate of growth from 2045 to 2060 was used to project the total population.

For the 2015 starting year, the Census Bureau's Intercensal Estimates by single year of age were used. These estimates are based on the 2010 Decennial Census. The estimates combine the older ages (85+) into a single group. The 85+ age group was distributed into single years of age using the 2010 Census distribution of this population. The 2010 Census provides single year of age data up to age 100.

STEP 3: APPLY COHORT-COMPONENT METHOD

The cohort-component method is an approach to demographic projections that accounts for age distribution in a given population. This method consists of segmenting the population into different subgroups that may be differentially exposed to the components of change, being births and deaths, by separately calculating the changes over time in each group.[4]

A base population of July 1, 2013 was used because 2013 is the most recent year for which corresponding vital statistics are available from the Minnesota Department of Health. First, components of natural increase were calculated and applied as a projection. Next, for each subsequent year, the population of a given age group was advanced one year of age and the new age categories were updated using the projected survival rates for that year from the life tables created. A new birth cohort was then added to form the population under one year of age by applying the projected age-specific fertility rates to the average female population aged 10 to 54 years and updating the new cohort to the effects of mortality.

The assumptions for the components of change were based on a time-series analysis of historical trends. The next section provides details about the methods used to project fertility rates, mortality rates, and levels of net-migration.

STEP 3A: PROJECT BIRTHS AND DEATHS

Births were projected using fertility rates by single year of age among women of childbearing age. Age-specific fertility rates were used from 2013 and the birth sex ratio was controlled to 1.05.

Deaths are projected using survival rates by single year of age and gender. Data from 2011-2013 were averaged and used as the base (most recent available from the Department of Health). For 2011-2013, survival rates were obtained from a Minnesota life table.

STEP 3B: COMPUTE PRELIMINARY NET-MIGRATION

Historic net-migration rates were observed from 1990 to 2013 using the following formula:

$$P_{x+1} = P_x + (B - D) + M$$

where:

P_x is the population of any given year
B is births occurring during P_x
D is deaths occurring during P_x
M is net-migration during P_x

[4] Preston, S.H., P. Hueveline, and M. Guilliot. 2001. *Demography: Measuring and Modeling Population Processes*. Malden, MA: Blackwell Publishing

By solving for M, the following formula is left as a residual:

$$M = P_{x+1} - (P_x + (B - D))$$

The residual of M is considered as net-migration for the given year. This process was continued through the projection time frame where the difference between the product of the cohort-component and the desired state level population achieved from steps 1 and 2 results in net-migration. If there are more people than expected, there was net-in-migration. If there were fewer people than expected, there was net-out-migration.

STEP 4: ADJUST NET-MIGRATION FIGURES

In this step, the total number of net-migrants across all age/gender groups from the preliminary migration calculations in step 3b was compared to the historical migration trends also calculated in step 3b. The preliminary numbers were then adjusted to equal the target value.

STEP 5: CONTROL AGE/GENDER TOTALS TO ANNUAL STATE TOTALS

The final step involves rounding and making minor adjustments to the existing population in age groups. Fertility rates, mortality rates, and net-migration rates, when applied to a total population, will yield a decimal that cannot exist in a dataset expressing total population. This is the formula used to make these adjustments

$$_nP_x * (P_t / \Sigma_nP_x)$$

where for any given year:

$_nP_x$ is the total population in a single sex/age group
P_t is the total population
Σ_nP_x is the sum of all single sex/age groups

NOTE ABOUT ZERO-MIGRATION SERIES

The zero-migration series was created following steps 1 through 3 of this document. See above.

POTENTIAL SOURCES OF ERROR IN PROJECTIONS

There are many potential sources of error in demographic projections. These include:

1. The estimates used for the base population may be inaccurate. The further estimates are from the Census year, the less accurate they are likely to be.
2. The national projections could be in error.
3. The predicted trend in the Midwest regional share of the national population could change in an unexpected way.
4. The predicted trend in the Minnesota share of the Midwest regional population could change in an unexpected way.
5. Fertility rates may change in a pattern other than that assumed by this model.
6. Mortality rates could change in a pattern other than that assumed by this model.
7. Future migration trends could shift depending upon economic trends, immigration law changes, climate change and many other factors.

For more information regarding the methodology described here, please contact Megan Dayton at megan.dayton@state.mn.us (preferred) or 651.201.2461.