Projected Population of the State of North Carolina and Its Counties

July 1, 2024 – July 1, 2060

Vintage 2024

Technical Document

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Methods for Producing Population Projections for the State and Counties of North Carolina

Introduction

The North Carolina State Demographer in the Office of State Budget and Management (OSBM) published on January 15, 2025, population projections for the state and counties of North Carolina, showing population by age, sex, and race/ethnicity. OSBM refers to these latest projections as the Vintage 2024 projections. We use indicator data (e.g., vital statistics, school enrollment, vehicle registration, voter registrations) in models used to estimate population for past periods. Our last population estimates (Vintage 2023) estimated the population for July 1, 2020 through July 1, 2023. We use these population estimates to extrapolate historical population trends into the future. Our first projected population is for July 1, 2024. For this reason, these population projections are considered the Vintage 2024 population projections.

To meet the needs of our data users, we once again extended our projection horizon beyond twenty years. These are our first population projections to predict population and demographic characteristics by year through 2060. In addition, this will be the third year we produced a dataset that provides population by Hispanic origin and five-year age groups. Data users may find summaries of these projections on the OSBM website. In addition, data users may download four different datafiles. These datafiles include the 2020-2023 population estimates and the 2024-2060 population projections but differ in the demographic characteristics presented:

1. ***Sex and Single Years of Age:*** Estimates and projections of the population for each year by sex and single years of age;
2. ***Sex, Race, Age Groups:*** Estimates and projections of the population for each year and by sex, 5 categories of race (*American Indian or Alaska Native*, *Asian or Pacific Islander*, *Black*, *White,* and *Other*), and broad age groups;
3. ***Hispanic Origin by Race:*** Estimates and projections of the population for each year from 2020 through 2060 by sex, Hispanic origin (*Hispanic* and *non-Hispanic*) and race (*White* and *non-White*).
4. ***Hispanic Origin/Race by Sex and Age:*** Estimates and projections of the population for each year from 2020 through 2060 by sex, 5-year age groups, and Hispanic origin/race combinations (*Hispanic, Non-Hispanic White*, and *Non-Hispanic Non-White*)

This document provides an overview of the methods and assumptions used to produce these population projections.

Limitations

These population projections provide a look into a demographic future assuming historical trends in population change and components of population change (fertility, mortality, and migration) will continue into the future. This is a safe assumption given that alterations in the trajectories of population change and components of population change tend to occur more slowly in the absence of catastrophic events or economic shocks. Thus, these serve as a baseline for decisions regarding the allocation of

resources and planning to meet the needs of future populations. We do not know the future with absolutely certainty, however, and users should recognize that there is a degree of uncertainty implied within these population projections. In addition, these projections may also be used as an impetus for public and private decisions that may ultimately alter population trajectories shown in these baseline population projections. Degrees of uncertainty increase as time increases from 2023 and for smaller populations (e.g. smaller populated counties or for sub-groups of the population by sex, age, race, ethnicity). For the state and most counties, the population projections produced in the 2010s were relatively close to the actual census count. At the state level the Vintage 2020 Population projections were 122,000 (or 1.2%) above the 2020 Census count. However, there were several rural counties where the 2020 Census counts came in well below what was expected in our previous estimates and projections (meaning we over-predicted the population for those counties when compared to the 2020 Census results).

Users should be aware that we made certain assumptions related to race categories. The US Census Bureau, based upon years of testing, improved their survey forms to solicit more accurate responses to questions about race and ethnicity. In addition, they improved the way responses were coded to better reflect the various ways in which respondents self-identified racially and ethnically. While these welcome changes better reflect the racial and ethnic diversity of our population, these improvements also create challenges in bridging the race/ethnic characteristics reported in previous censuses and with vital statistics.

Typically, within four years of a decennial count, the US Census Bureau produces a datafile that refines the race and ethnic statistics and another that re-calibrates trend lines (for total population and demographic characteristics) of the previous decade's population estimates to match trends shown when comparing the beginning of the decade and end of the decade censuses (e.g. 2010 Census to 2020 Census). Due to delays in Census reporting as a result of the impacts of the COVID-19 pandemic, changes to methods for protecting privacy, and the modifications to race/ethnicity reporting, the Census Bureau has not yet published these datafiles. For this reason, we assumed that the race/ethnic characteristics reported in the 2020 Census reflect the population and adjusted the reporting of two or more races using an approximation of the US Census Bureau's logic for the Modified, Age, Race, Sex (MARS) datafile produced for the 2010 census as outlined later in this document. In addition, we used the age characteristics from the Census Bureau's 2020 blended base[1] from the Vintage 2023 county population estimates by single years of age to inform our base 2020 age characteristics. The Census Bureau's 2020 census blended base borrowed characteristics derived from the Vintage 2020 post-2010 census population estimates, the 2020 Census, the 2020 Census Demographic Analysis (DA), and the 2020 Census Post-Enumeration Survey (PES). By using the age characteristics from the Census Bureau's blended base, we adjust for age groups (such as the population under age five) that have been consistently under-counted in the decennial census count and thus under-estimated in post-census estimates prepared by our office and the U.S. Census Bureau.[2]

[1] Luke Rogers and Christine Hartley, "Adapting Population Estimates to Address COVID-19 Impacts on Data Availability." US Census Bureau, April 14, 2022.
[2] Eric Jensen, "Census Bureau Expands Focus on Improving Data for Young Children," US Census Bureau, March 10, 2022.

Because of these changes to the blended base, there will be differences between the 2020 base population and the 2020 census base of previous versions as well as in the estimated and projected populations. Because of these updates to the race, ethnicity, sex, and age characteristics, users should not compare detailed characteristics estimates of previous vintages estimates/projections to these estimates/projections. It is our intention to update the detailed characteristics for historical estimates (from at least 2010) once the US Census Bureau MARC and intercensal datafiles are available and as time permits.

Methodology

Understanding Population Change: The Demographic Balancing Equation

The demographic balancing equation has two main component processes of population change – natural change and net migration. Natural change is the difference between births and deaths within a population. Natural increase occurs when there are more births than deaths.

Net migration is the difference between the number of in-migrants and out-migrants. More in-migrants than out-migrants can provide a basis for population growth. Migrants include both migrants to and from other countries (international migration) and domestic migrants (those moving to and from other states and counties). In context of population change at the county level, any permanent move from one county to another is considered migration.

Counties experience population growth when births exceed deaths and there are more in-migrants than out-migrants. Counties can also grow when one of these main components of change (natural change or net migration) is negative as long as the positive change in the other component is large enough to exceed the negative change (e.g. +100 net migrants vs. -50 natural change [50 births – 100 deaths] = +50 new people).

This demographic equation is useful in understanding population change, in developing methods for estimating or projecting population, or for estimating the components of population change. Demographers use a variety of methods to project population, including those described here.[3]

[3] Steve H. Murdock and David R. Ellis, Applied Demography: An Introduction to Basic Concepts, Methods, and Data (Boulder, CO: Westview Press, 1992); Steve H. Murdock et al., Demographics: A Guide to Methods and Data Sources for Media, Business, and Government (Boulder, CO: Paradigm Publishers, 2006); Jacob S. Siegel, Applied Demography: Applications to Business, Government, Law, and Public Policy (United States of America: Academic Press, 2002); Stanley K. Smith, Jeff Tayman, and David A. Swanson, State and Local Population Projections : Methodology and Analysis, The Plenum Series on Demographic Methods and Population Analysis (New York: Kluwer Academic/Plenum Publishers, 2002); Bryan, Thomas. 2004. “Population Estimates.” Pp. 523–60 in The Methods and Materials of Demography, edited by J. S. Siegel and D. A. Swanson. Amsterdam: Elsevier.

Projection Model

The current population projection model includes two main components: a forecast model to project total population and population of each major race and Hispanic origin group, and a cohort-component method to model the projected change in the age characteristics of the population.

First, the total household population was projected for each of the 100 counties in North Carolina using time-series forecasting models that pattern future population change based upon historical trends in population for each county. For the current set of projections, OSBM selected a forecast model for each county that most accurately projected the 2010 through 2023 estimates. We selected projections that had low predicted errors [measured in terms of Mean Absolute Percentage Error (MAPE)]. OSBM then added the group quarters population to the projected household population for each county to obtain the projected total population for each county for each year from 2024 through 2060. The summation of these projected total populations for each county yielded the total population by year for the state of North Carolina.

After preparing projections of the total population for all counties and the state, OSBM prepared the population of each sex and race group and each sex and Hispanic origin group combination using time-series forecast models. We then controlled the resulting projections by sex, race, and Hispanic origin to the projections of the total population for each county. We then summed these sex, race, and Hispanic origin population projections for each county and year to obtain the sex, race, and Hispanic origin population projections for the state.

Cohort-Component

Race/Sex/Age characteristics

OSBM used a cohort-component technique to project the age characteristics of each sex and race combination. Estimated survival rates for each age, sex and race combination are based on data from the 2010 and 2020 censuses.[4] We adjusted these survival rates based upon actual reported deaths by age, sex, and race between 2010 and 2023, and assumed that these adjusted rates continue through the projection horizon. OSBM applied these survival rates to the population for each group at the beginning of each period to project the survived population for the subsequent year (the population assuming no net migration). We derived estimated net migration by subtracting the survived population for the following year from the population as projected by the time-series forecasting models (described in the previous section).

OSBM adjusted this total net migration for each county for each year for age specific rates of net migration by using net migration trends by age from 2010-2020. The resulting net

[4] Detailed age characteristics from the 2020 Census were not yet available.

migration by age for each sex and race group was added to the survived population, yielding the final projected population by age; the process was repeated for the next period.

We prepared an initial model with the derived measures of total net migration based upon forecasted trends. The final step was to add the population at the youngest age by applying the most recent race specific birth rates for the female population age 10 to 49. Statewide fertility rates by race were calculated based upon actual births over the last three years (2021-2023). These statewide rates were then adjusted to reflect five-year historical trends in births for each county. The adjusted fertility rates were then applied to the female population age 10 to 49 by race for each county and repeated for each projected year.

Data

Base population

The most fundamental part of any population projection are the historical data from which the projections are derived. The Vintage 2023 certified and revised county population estimates produced by OSBM and released in September 2024 were used to project future populations.[5] The decennial censuses serve as a basis for the population estimates and projections this office produces, especially the 2000 and 2010 decennial censuses. Population totals by race for each county were used to benchmark the July 1, 2020, population estimate and revise the 2010 through 2019 population estimates.

OSBM obtained 2000 and 2010 decennial census population by race, sex, and single years of age from 0-99 and a combined age group for population age 100+ from the US Census Bureau's 2000 and 2010 Modified Age, Race, and Sex (MARS) file. The race categories used in these projections include: *American Indian or Alaska Native*, *Asian or Pacific Islander*, *Black*, *White*, and *Other*. We report Hispanic origin (*Hispanic* or *non-Hispanic*) separately in these projections and we further categorize Hispanic origin by race: *White* or *non-White*.

The US Census Bureau has not produced a modified race datafile for the 2020 census. To produce population projections this year, OSBM prepared an approximate MARS file by using the same logic as that used for the 2010 MARS file. The logic is as follows:

1. All persons reporting a single identified race are coded as that race (e.g. *Black Alone* = *Black*);
2. All persons reporting three or more races are coded as *Other*;
3. All persons reporting two identified races are coded as Other (e.g. *White & Black* = *Other*);
4. All persons reporting as an identified race & *Some Other Race (SOR)* are re-coded as the identified race (e.g. *Asian & SOR = Asian or Pacific Islander*);
5. Finally, the *SOR Alone* category was apportioned to a race category based upon allocations used in the 2010 MARS data. The allocations were as follows: (*American*

[5] *Certified Estimates of the Total Population of North Carolina Counties for July 1, 2023, and Revised Estimates of the Total Population and Population by Age, Sex, Race, and Hispanic Origin of North Carolina Counties for 2010 through 2022.*

Indian or Alaska Native: 6%; *Asian or Pacific Islander*: 2%; *Black*: 8%; and *White*: 82%, *Other*: 2%).[6]

We prepared an initial set of estimates and projections using the 2010 Census MARS data and then controlled to the 2020 Census modified values as described above. We further adjusted the characteristic data using the age characteristics from the 2020 Base in the US Census Bureau's Vintage 2023 population estimates.

Vital Statistics

The North Carolina State Center for Health Statistics provided vital statistics data for the years 2000 through 2023, which include recorded births and deaths by county of residence. OSBM used the data to calculate mortality and fertility rates and derive estimates of net migration for counties for the 2010 to 2020 period. Because the birth data rely on the race/ethnicity of the mother to assign race/ethnic characteristics of the child, multi-racial births are likely under-reported. For this reason, we adjusted the race characteristics of children at birth to age 1 (age 0) proportionally based upon estimates from the American Community Survey.

Group Quarters

Every year, OSBM obtains group quarters population counts for hundreds of facilities within the state from various federal and state agencies, as well as through an annual survey of municipalities and counties. These group quarters include college and university dormitories, state and federal prisons, military quarters, and nursing homes, among other facilities. Because demographic change for group quarters population do not follow the same pattern as the general population, it is necessary to account for this population by excluding it from the general projection model and then adding it back to obtain the final projections of the total population. For the purposes of producing population projections, OSBM assumed that the group quarters population for each county for all future years remained the same as it was in 2023.[7] A private prison in Hertford County closed in May 2021. Thus, the projections for Hertford County were adjusted to account for the loss of that prison population.

Assumptions

Both population estimates and population projections rely on historical data that are symptomatic of population change to approximate historical or future populations. For these population projections, we assumed that patterns of change in total population and rates of fertility and mortality continue through 2060.

Total Population Change

As described above, the forecast model uses historical data to project total population and total population by sex, race, and Hispanic origin through 2060.

[6] Persons of Hispanic ethnicity can be of any race.

[7] This is based partly on information provided by major sources of groups quarters populations, including prisons (North Carolina Sentencing and Policy Advisory Commission), military installations, and college and universities.

Fertility

Prior to the pandemic, the precipitous decline in fertility rates that began during the Great Recession halted, remaining stable but significantly lower than rates observed in the 1990s and early 2000s. At the peak in 2007, there were 69.6 births to women aged 15 to 44. This rate dropped to 58.4 by 2018.[8] These population projections assume fertility rates remain constant through the projection period and use a three-year (2021, 2022, and 2023) average of age- and race-specific fertility rates. The projections also assume a constant distribution of births into male and female for each race group through the projection period equal to the average of the corresponding fractions for calendar years 2013 through 2023.

North Carolina began to experience the impacts of the pandemic in March 2020. The effects on fertility began to show by the end of 2020. Statistics on births showed a decline in the number of births in the final months of 2020 when compared to previous years. Other states and countries showed similar trends. In 2020, births were about 3% below that of 2019. The number of births recovered to pre-pandemic levels in 2021 and 2022.

Mortality

OSBM prepared an unabridged lifetable[9] for 2019. Except for 2020 through 2022, survival rates obtained from this lifetable were assumed to remain constant through the projection period with adjustments to the survival rates based upon actual deaths that occurred through 2023. In January 2022, the 20,000th COVID death was recorded. A review of the data show trends consistent with those seen in other states and countries – that deaths from all causes were more for 2020 and 2021 than what we would have expected given the state's population age structure but have returned back to pre-COVID trends during the last few years.

Net Migration

As previously outlined, the forecast model uses historical data to project total population and total population by sex and race through 2060. Net migration was then derived from a residual between the forecast model and the cohort-component model. The resulting derived measure of total net migration provided a reasonable assumption about future levels of net migration based upon recent trends.

[8] Joyce Martin et al., "Births: Final Data for 2007," National Vital Statistics Reports (Hyattsville, MD: National Center for Health Statistics, 2010); Joyce Martin et al., "Births: Final Data for 2018," National Vital Statistics Reports (Hyattsville, MD: National Center for Health Statistics, 2019).

[9] An unabridged life table shows the probabilities of someone dying for each age. These probabilities are converted to survival rates to estimate the population living in the following year.

Adjustments

Institutional Effects

When a large institution – such as a college or prison – is located within a county, its population characteristics can lead to errors in the county's projected population characteristics if the institutional population is not properly accounted for. Many counties may have a relatively large young adult population solely because one of these institutions is present. College students are likely to move elsewhere once they graduate from their university. For this reason, OSBM modified the population projections to account for change in certain institutions, such as colleges, universities, military installations, and, to a lesser extent, prisons and some state hospitals. There are twelve counties in North Carolina with age structures significantly affected by institutions. These counties and the major institution types that affect them are: Avery (prisons and college), Craven (military), Cumberland (military), Durham (university), Jackson (university), Madison (university), New Hanover (university), Onslow (military), Orange (university), Pasquotank (university and prisons), Pitt (university), and Watauga (university). OSBM adjusted the projections to account for institutional populations and assumed that the institutional population would stay constant at 2023 levels.

Projection Controls

OSBM controlled the initial set of population projections for total population from 2020 through 2023 to the independently derived estimates of the total population for counties. The projections were controlled to the revised estimates for 2020 through 2023 and for the certified estimates for 2023.

Then, we controlled the estimates and projections of the population by race, sex, and Hispanic origin of each county to the estimates and projections of the total population of each county for the estimation/projection period (2024 through 2060).

Projections of Hispanic Origin/Race Population by Age and Sex

In the spring of 2023, OSBM produced population projections by Hispanic origin/race, age, and sex for the Vintage 2022 population projections. The Vintage 2024 population projections will mark the third time that this additional dataset was created. OSBM began with the US Census Bureau's Vintage 2020 population estimates by Hispanic origin, race, age, and sex. While these estimates were produced prior to the 2020 Census, they provide a means of tracing age specific trends over time which were used to produce preliminary projections of the population by Hispanic origin/race, sex, and age. These preliminary population projections were then controlled to the OSBM projections of population by Hispanic origin, broad race groups, and sex, and the total population by age and sex.

Population Groups

For these population projections, the population were divided into three major race/ethnic groups: Hispanic (of any race), Non-Hispanic White, and Non-Hispanic Non-White. The Non-Hispanic White population is the largest population in the state and for most counties in North

Carolina. The Hispanic population is present in most counties at a size large enough to provide estimates and projections by age. The Non-Hispanic Non-White population includes Black, American Indian, Asian/Pacific Islander, and multi-racial populations. Each of these race groups are sufficiently large for some counties but not all counties – making it difficult to provide accurate estimates cross tabulated by Hispanic origin and age. Thus, in this dataset, these population groups were combined. These populations are reported separately in the race, age, and sex population estimates/projections data file (not divided by Hispanic origin) described in the previous sections.

Preliminary Population Projections

First, OSBM prepared preliminary population projections for the population by 5-year age groups (from 0 to 85+) for 5-year intervals from 2025 through 2060. These were produced using the Hamilton-Perry method of population projections.[10] The Hamilton-Perry method of population projections uses information from prior censuses or population estimates to track age groups over time and project age groups forward. This is done by applying cohort-change ratios to each age group for a time previous to the projected year (typically 5- or 10-year intervals). The projections for each age groups are calculated as follows:

$$P_x^{2025} = P_{x-5}^{2020} X (P_x^{2020} / P_{x-5}^{2015})$$

Where,

$$P_x^{2025} = Population\ of\ age\ group\ x\ in\ 2025$$

$$P_{x-5}^{2020} = Population\ of\ age\ group\ x-5\ years\ in\ 2020$$

$$P_x^{2020} = Population\ of\ age\ group\ x\ in\ 2020$$

$$P_{x-5}^{2015} = Population\ of\ age\ group\ x-5\ years\ in\ 2015$$

Whereas traditional cohort-component models model change using separate calculations and assumptions about net migration and natural change, the Hamilton-Perry method measures only the total change. For instance, a population age 25-29 in 2020 would change as a result of both deaths and migration into and out of the area of people in the same cohort during the five-year period since 2015 – a group that would have been age 20-24 in 2015. A cohort-change ratio greater than 1 would indicate net migration into an area above deaths to the cohort, while a ratio less than 1 would indicate net migration out of an area and/or deaths that exceed net in-migration for the cohort. These cohort-change ratios were calculated for 5-year age groups through age 85. The ratio for the oldest age group (85+) was calculated

[10] Hamilton, C. Horace and Josef Perry (1962). "A Short Method for Projecting Population by Age from One Decennial Census to Another," Social Forces, Vol. 41(2): 163-170. Swanson, David A., Alan Schlottmann, and Bob Schmidt. 2010. "Forecasting the Population of Census Tracts by Age and Sex: An Example of the Hamilton-Perry Method in Action." Population Research and Policy Review 29(1):47–63. doi: 10.2307/40608415.

slightly differently to account for the terminal age group. The ratio for 85+ was calculated as follows:

$$P_{85+}^{2025} = (P_{85+}^{2020} + P_{80-84}^{2020})X\ (P_{85+}^{2020}/(P_{85+}^{2015} + P_{80-84}^{2015}))$$

We projected the population for the youngest age group (age 0-4) by using child/woman ratios calculated as follows:

$$P_{0-4}^{2025} = FP_{15-44}^{2025}X\ (P_{0-4}^{2020}/FP_{15-44}^{2020})$$

Where,

$$FP_{15-44}^{2020} = Female\ Population\ age\ 15-44\ in\ 2020$$

$$P_{0-4}^{2020} = Population\ age\ 0-4\ in\ 2020$$

$$FP_{15-44}^{2025} = Female\ Population\ age\ 15-44\ in\ 2025$$

$$P_{0-4}^{2025} = Population\ age\ 0-4\ in\ 2025$$

The cohort-change ratios and child-woman ratios calculated for 2015 to 2020 were used for projecting the population in five-year intervals through 2060. These ratios and projection were prepared for the three Hispanic origin/race categories and for males and females. In a few counties, cohort-change ratios were modified by substituting ratios from other population groups. In all such cases, these modifications involved small population groups within certain counties.

The five-year interval projections were then extended to one-year interval projections using interpolation. These preliminary projections by 5-year age groups for three categories of Hispanic origin/race and sex were then controlled to the population projections by age and sex and the population projections by Hispanic origin and race (as described in previous sections).