Demographic Forecasting and Future Interstate Highway System Demands

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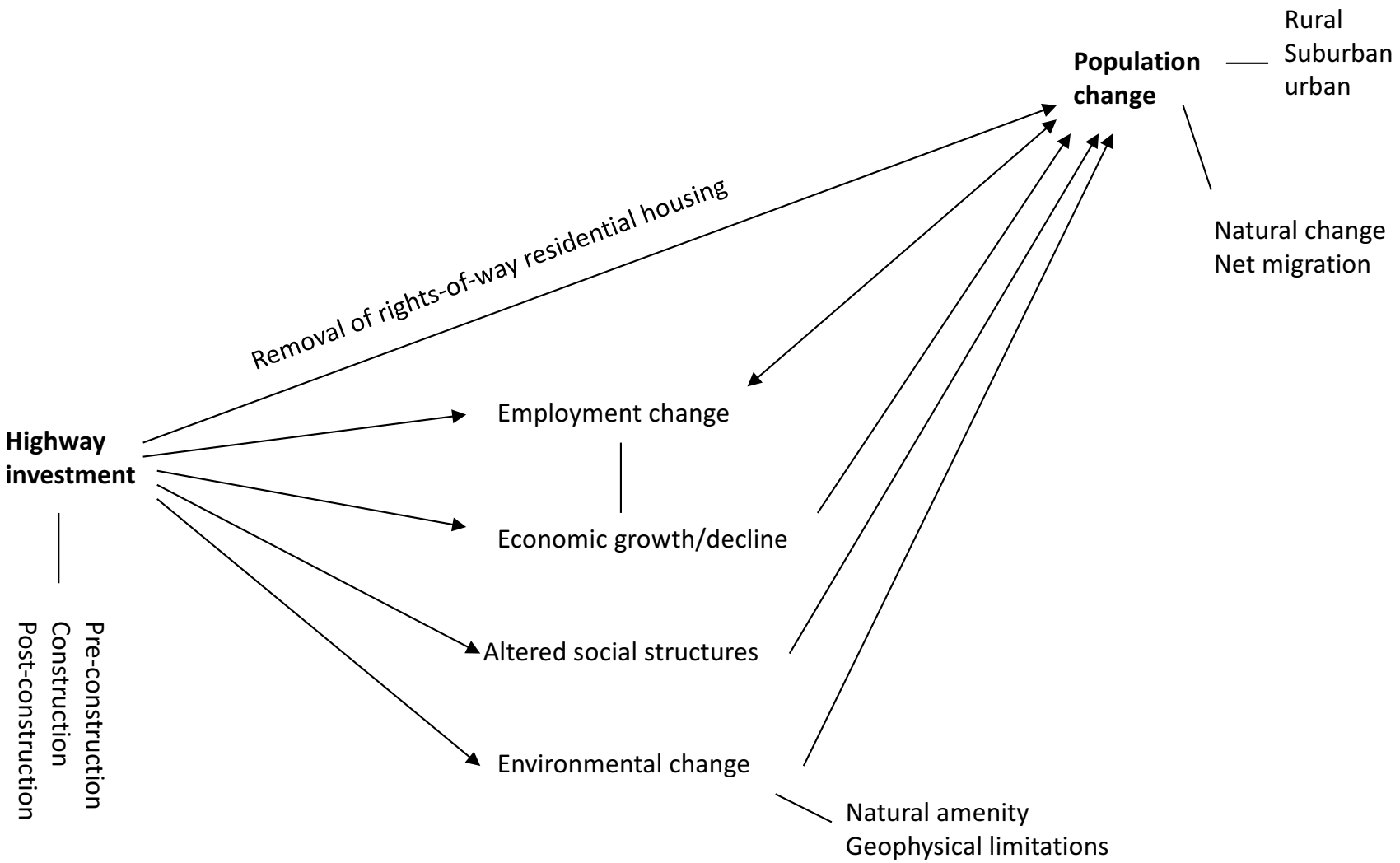
Outline

1. Population and Interstate Highway System in 2016
2. Population projections into 2060 at the county level
3. Identifying counties that may need additional or less Interstate Highway System capacity
4. Implications of aging population, millennials, immigrants, and telecommuting
5. Conclusions

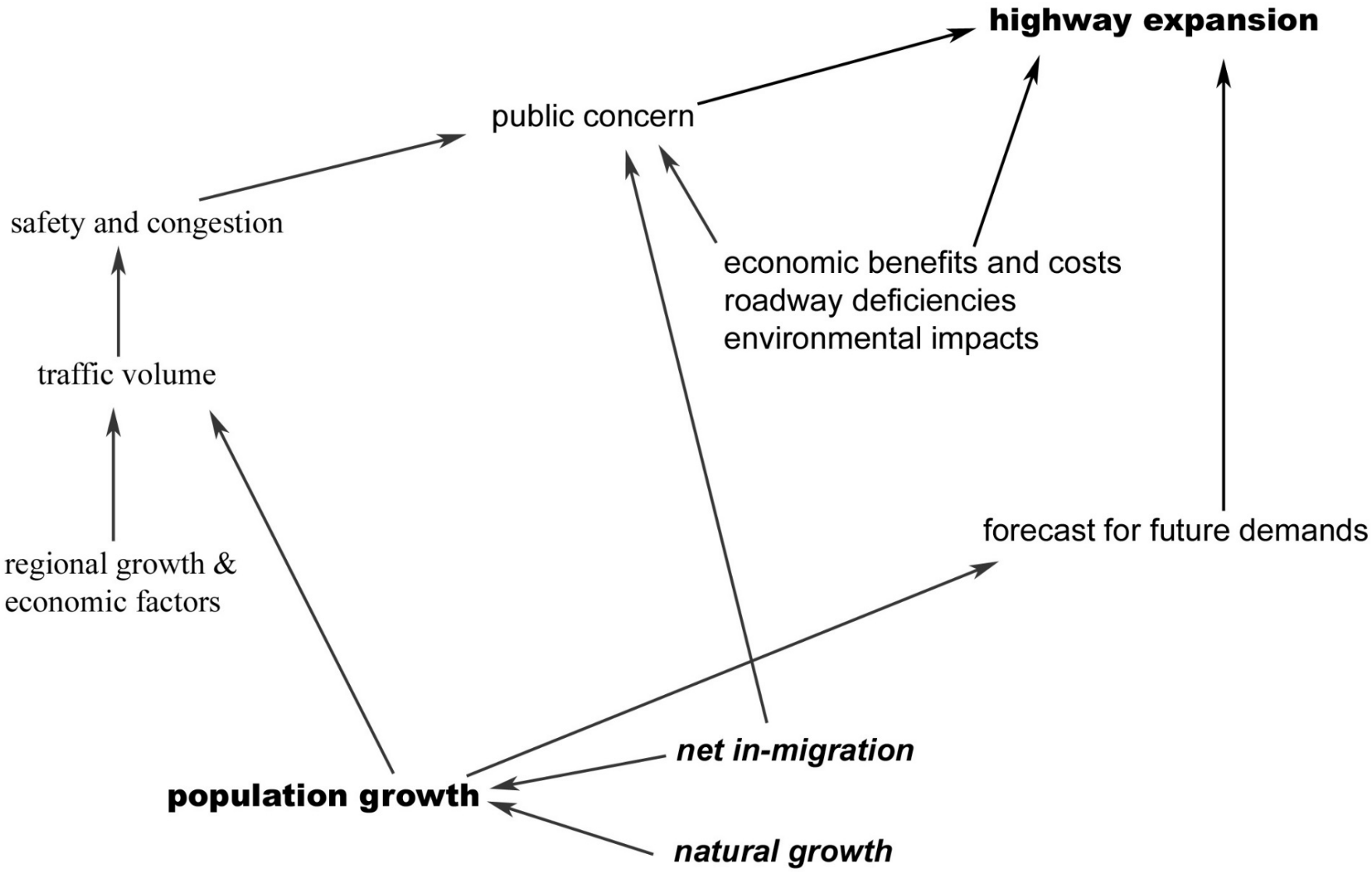
An Overview of Literature on Population-Highway Dynamics:

a) Highway Impacts on Population Change

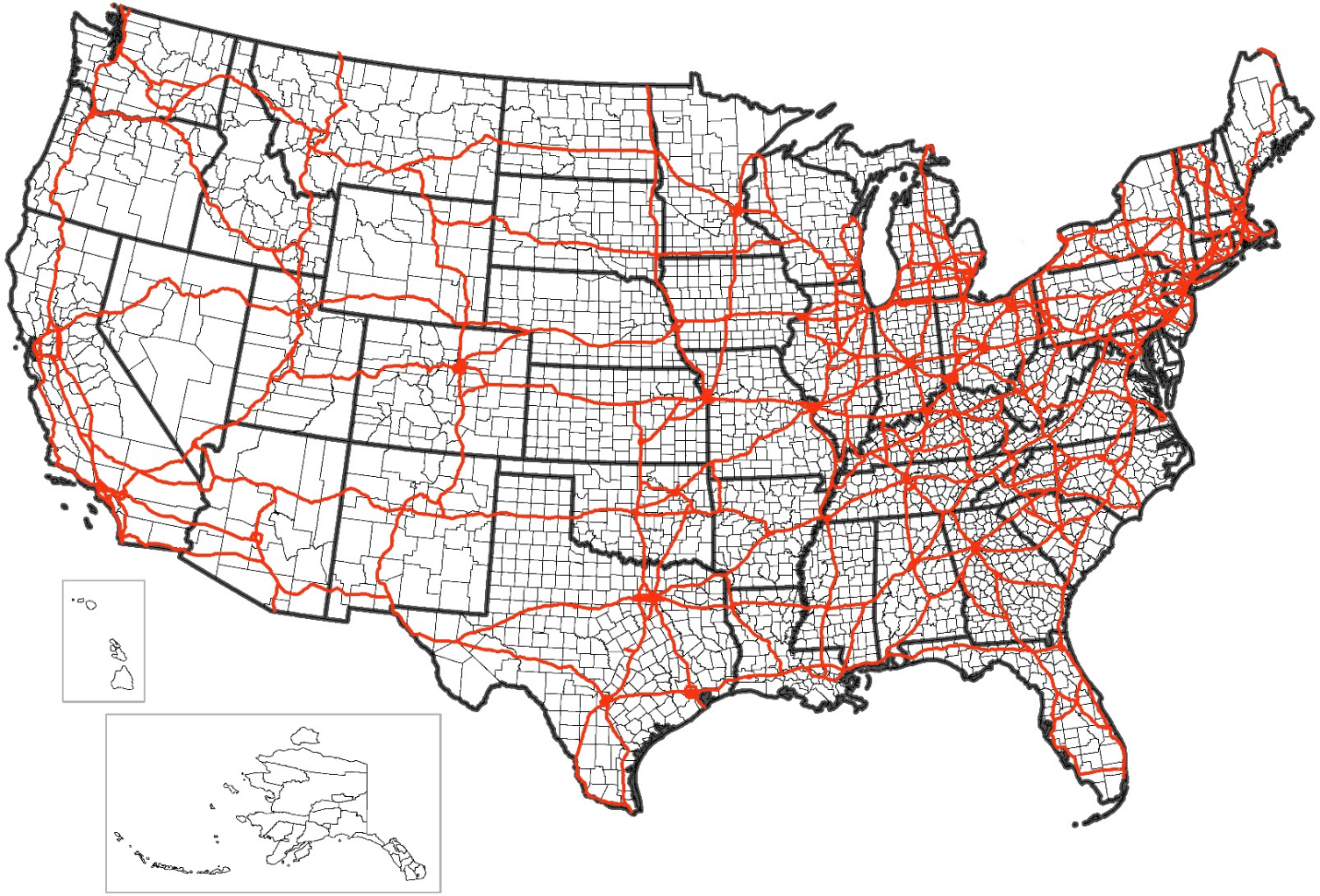


An Overview of Literature on Population-Highway Dynamics:

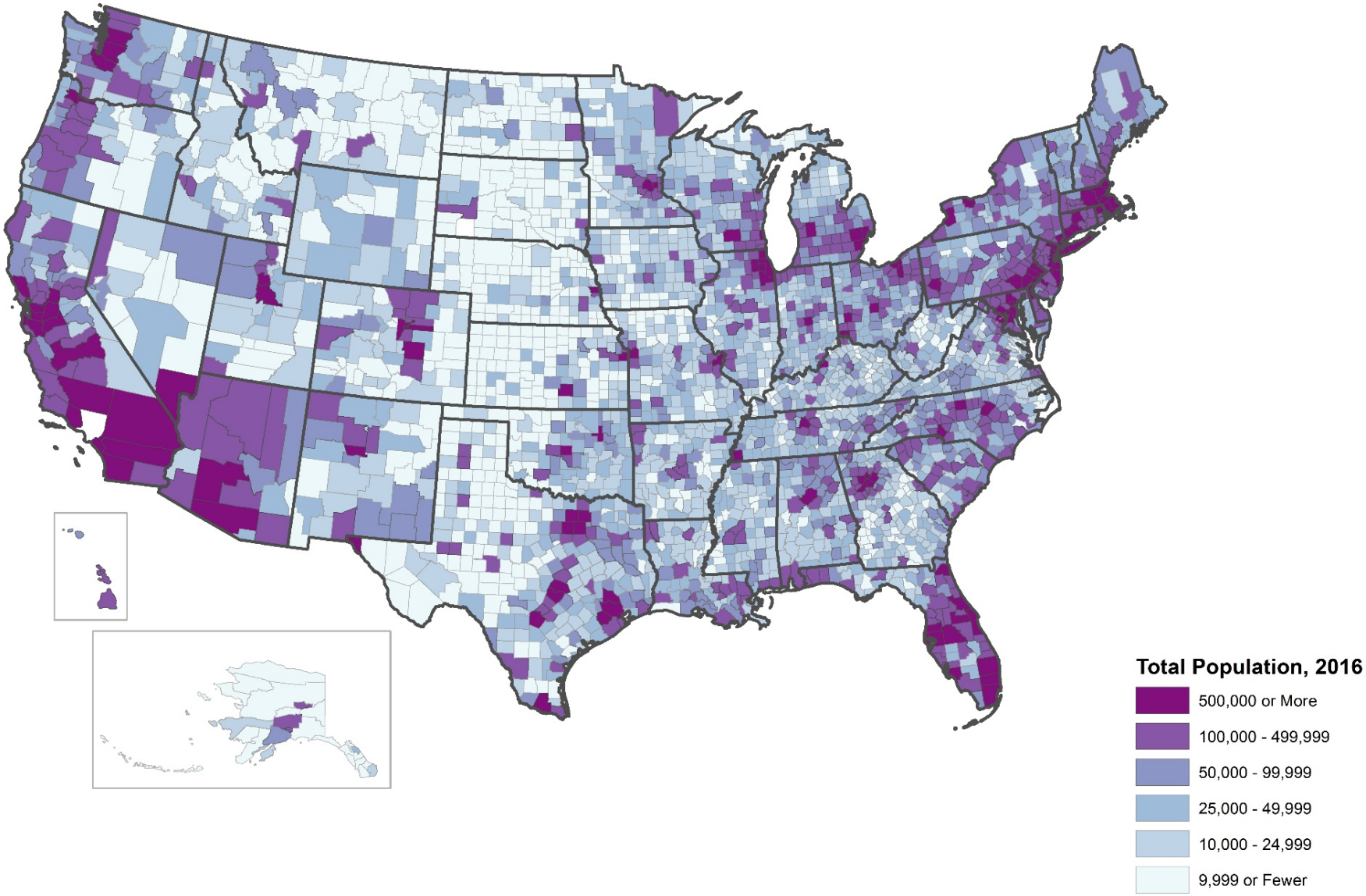
b) Population Impacts on Highway Investment



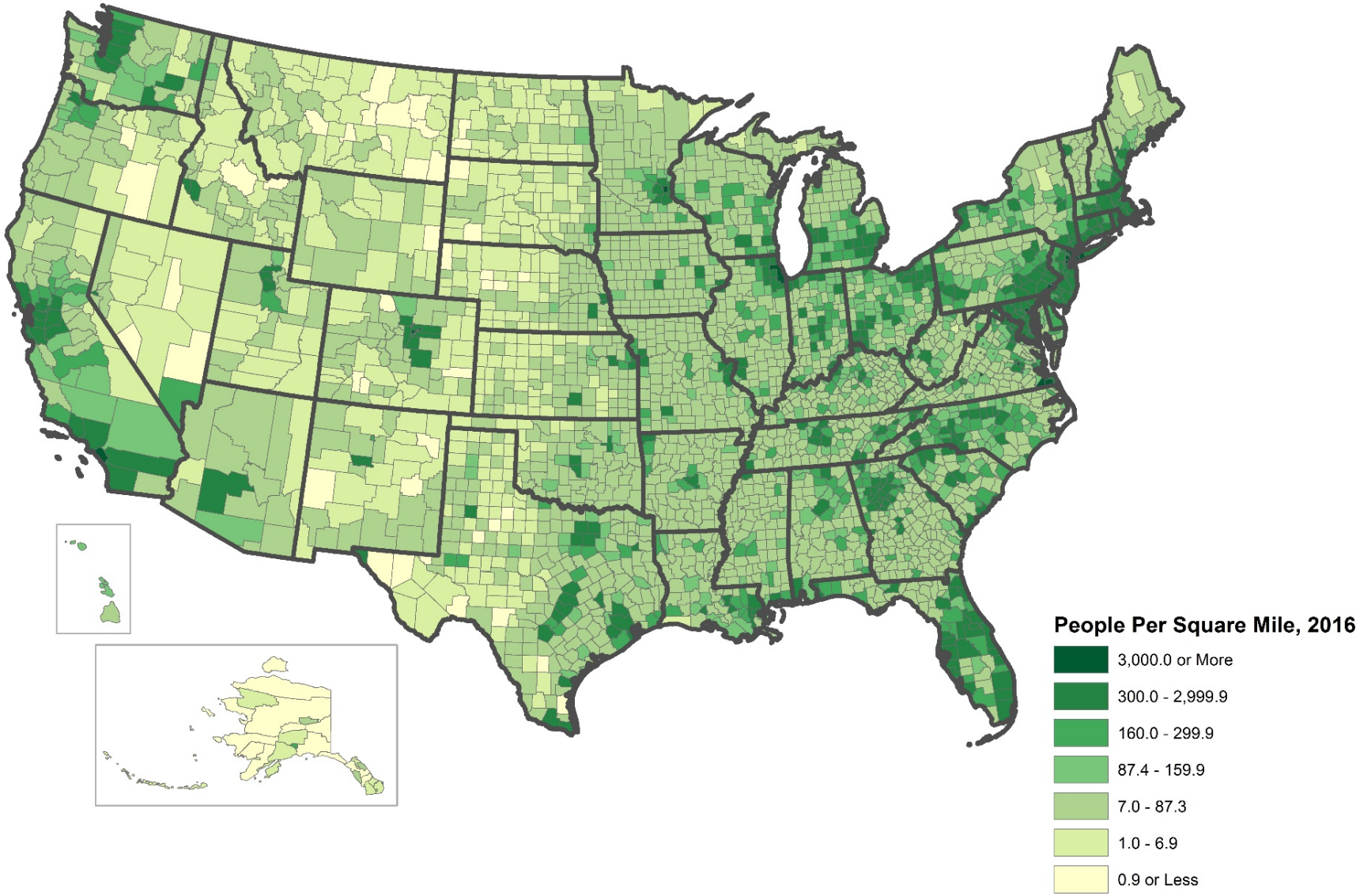
The Interstate Highway System in the United States



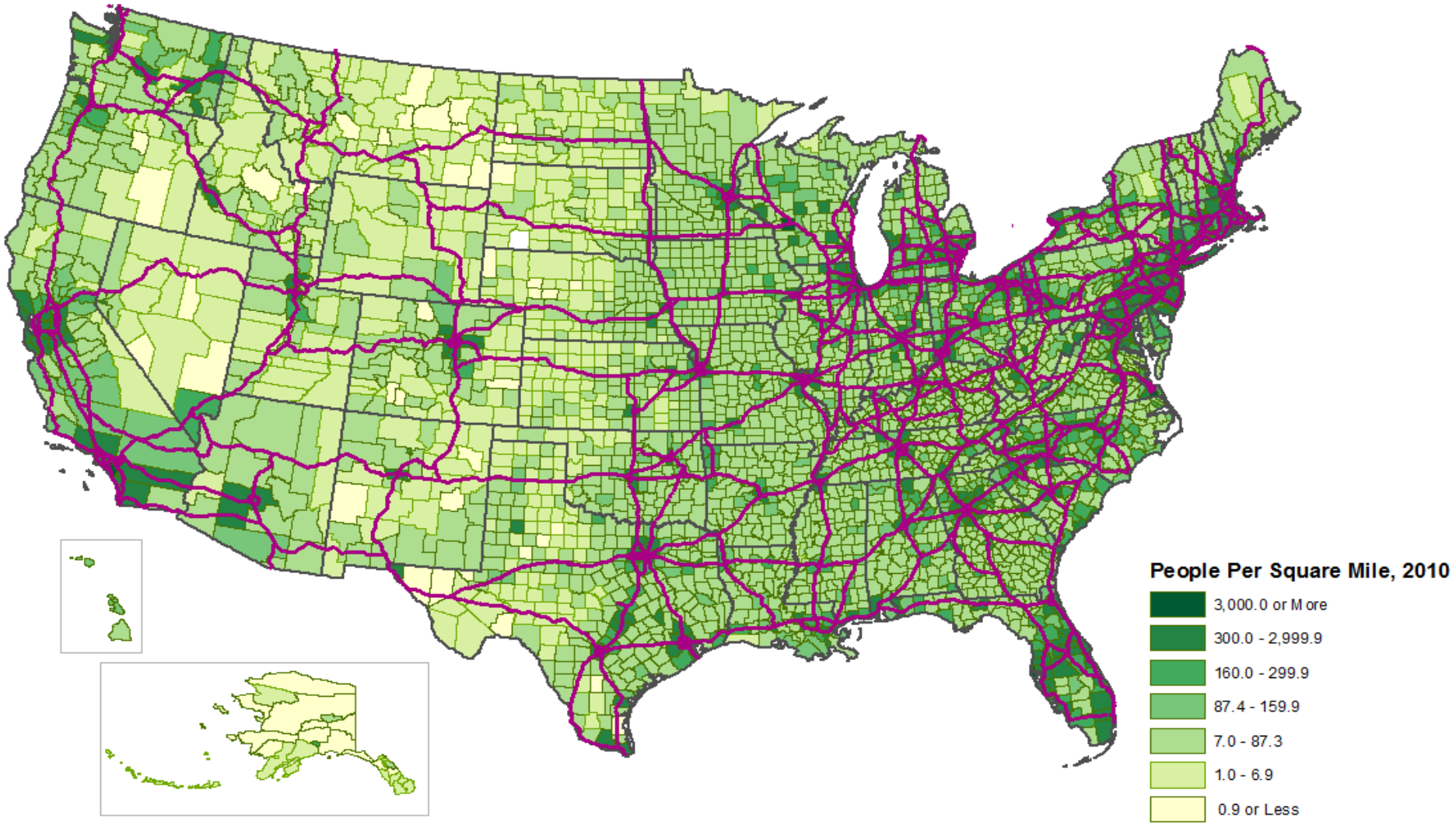
Total Population as of 2016



Population Density as of 2016

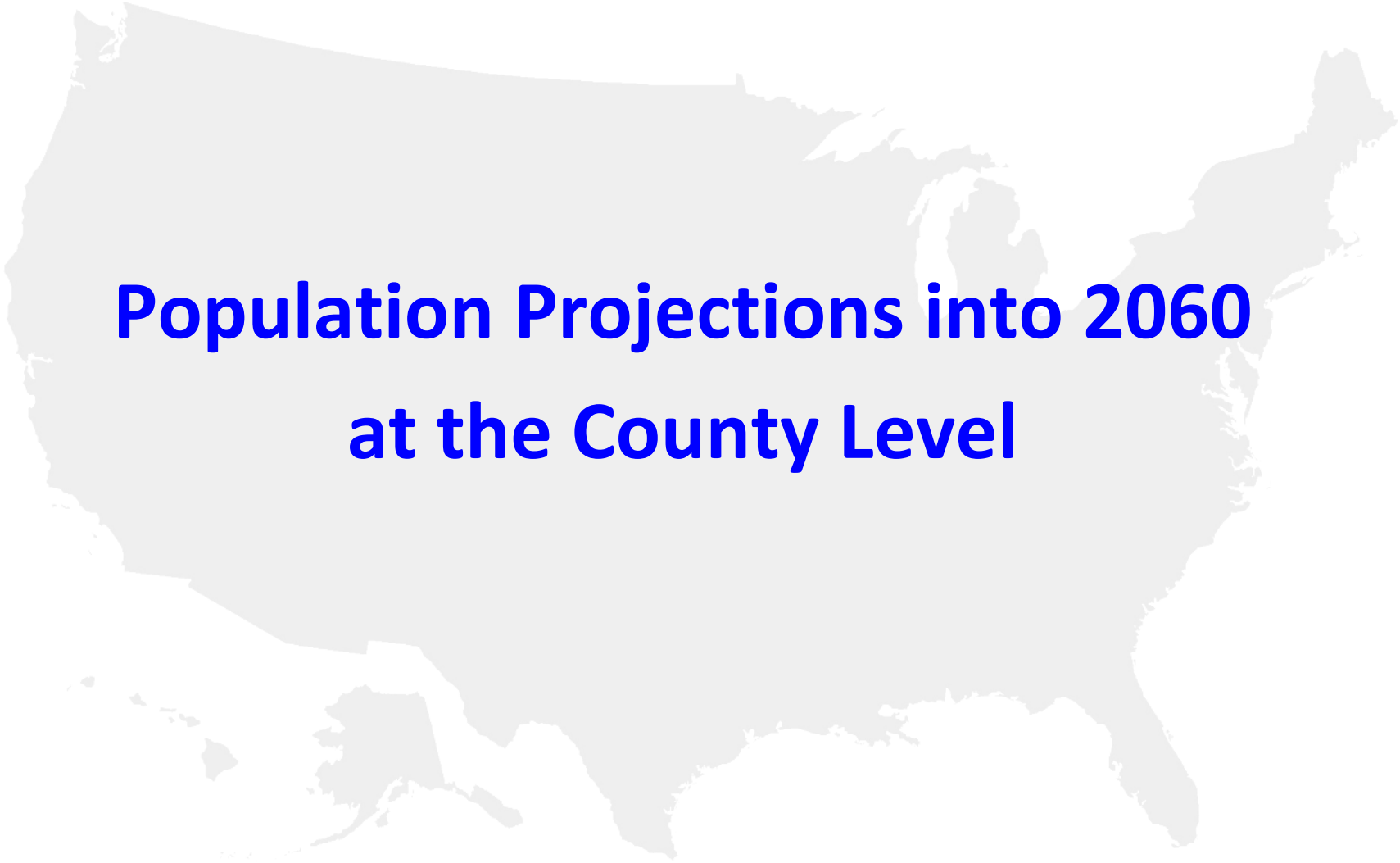


Population Density in 2010 and the IHS Network



Population in 2010 and Proximity to IHS

	N	Mean	Std Dev	Min	Max
Counties with IHS	1,444	178,412	440,712	415	9,825,473
Counties without IHS	1,698	29,941	78,950	83	2,510,240
Counties within 20 miles of IHS	2,477	119,080	349,453	83	9,825,473
Counties beyond 20 miles of IHS	665	20,312	29,348	90	293,415



Population Projections into 2060 at the County Level

Existing Population Projection Methods

1) Time-series methods
2) Post-censal population estimation modeling
3) Knowledge-based regression models
4) Conditional probabilistic forecasting
5) Integrated land use models
6) Population estimation and forecasting by grid cells
7) Cohort component methods

Cohort Component Methods

1) Population change = births – deaths + net migration
2) Projecting the three components for each birth cohort (i.e., persons born in a given year)
3) The base population as of the projection launch year: by age, gender, and race/ethnicity
4) Births: projected and added to the population by applying the projected fertility rates to the female population
5) Deaths: the projected survival rates
6) Migration: net migration rate

Estimation/Projection Methodology

The population in year *t* as of July 1 for a county is estimated or projected as:

$$P_t = P_{t-1} + B_{t-1,t} - D_{t-1,t} + M_{t-1,t}$$

where

$_t$ refers to year *t*, on July 1;
P_t is resident population as of July 1, year *t*;
P_{t-1} is resident population as of July 1, year *t*–1;
$B_{t-1,t}$ refers to births during period 6/30/*t*–1 to 7/1/*t*;
$D_{t-1,t}$ refers to deaths during period 6/30/*t*–1 to 7/1/*t*;
$M_{t-1,t}$ refers to net migrants during period 6/30/*t*–1 to 7/1/*t*.

Estimation/Projection Methodology

$$P_{2011} = P_{2010} + B_{2010,2011} - D_{2010,2011} + M_{2010,2011}$$

$$\vdots$$

$$P_{2017} = P_{2016} + B_{2016,2017} - D_{2016,2017} + M_{2016,2017}$$

$$\vdots$$

$$P_{2060} = P_{2059} + B_{2059,2060} - D_{2059,2060} + M_{2059,2060}$$

Estimation/Projection Methodology

1) Age: each age (0-84) and 85+
2) Race/ethnicity: non-Hispanic White, non-Hispanic Black, Hispanics, and others
3) Age-gender-race/ethnicity specific rates for births, deaths, and migration

3,221 counties
× 86 age groups
× 2 genders
× 4 races/ethnicities
× 44 projection years (2017–2060)
= 97,506,112 projections for different combinations

Step 1: Establish Baseline (Launch Point) Population Data

1) 2010 decennial census: April 1 -> July 1
2) Partition the data by 86 age groups by 2 genders by 4 race/ethnicity groups for each county

Step 2: Project Births

1) Predict age-race/ethnicity specific fertility rates;
2) Apply the rates to the corresponding racial/ethnic female population aged 15 to 54 years; and
3) Split the births into boys and girls based on a boy-girl ratio.

Step 3: Project Deaths

1) Predict age-gender-race/ethnicity specific death rates for each county; and
2) Apply the rates to corresponding age-gender-race/ethnicity people.

Step 4: Project Net Migration

1) Predict age-gender-race/ethnicity specific net migration rates for each county; and
2) Apply the rates to corresponding age-gender-race/ethnicity people.

Step 5: Produce Total Population Projections

1) $P_t = P_{t-1} + B_{t-1,t} - D_{t-1,t} + M_{t-1,t}$

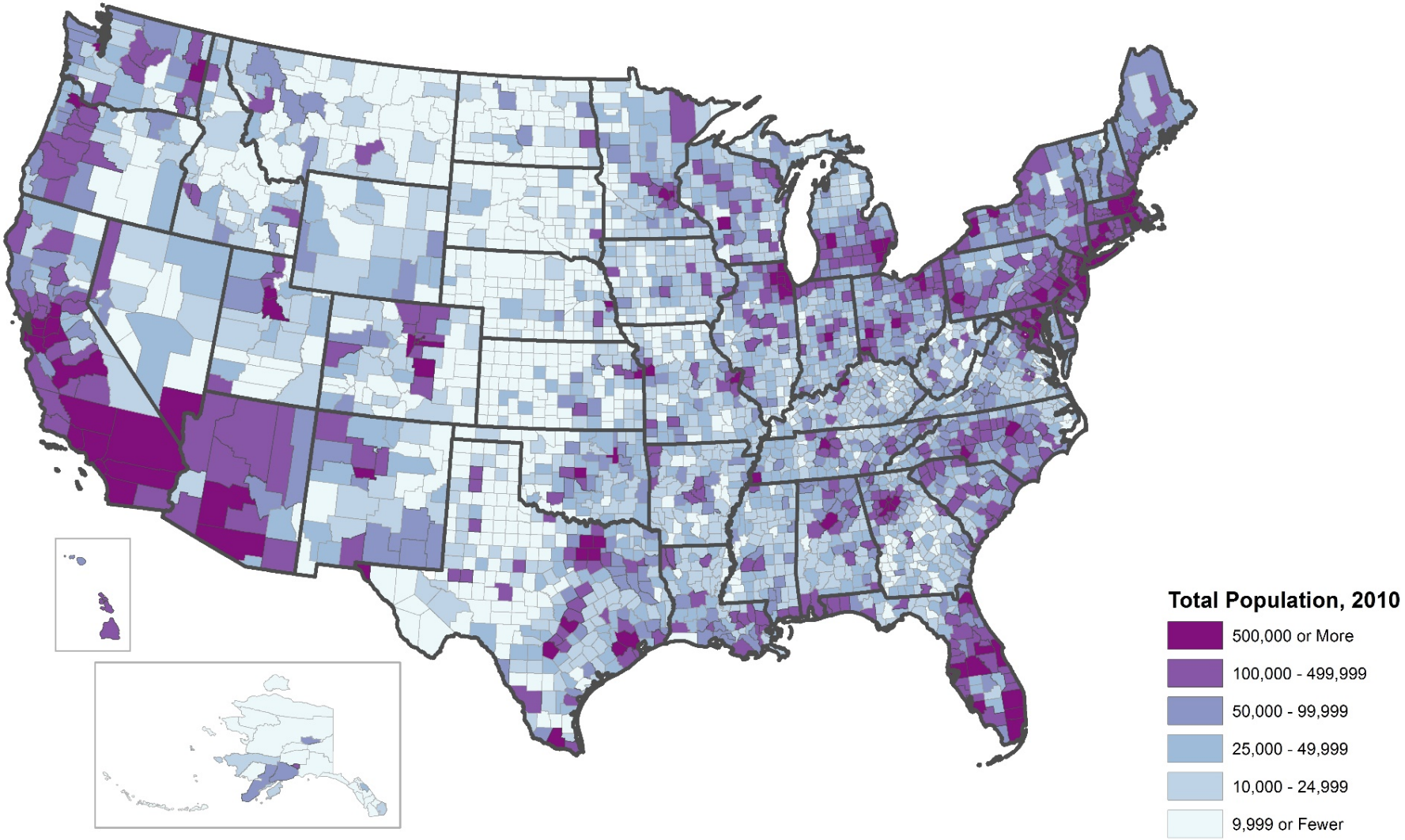
2) Modifications to severely abnormal change rates
   - Under the assumption that rapid population change cannot be sustained for long periods.

3) Adjustment to national projections
   - National population projection prepared by the Census Bureau: the “golden” standard
   - But it produce projections only for the nation, not for states or counties

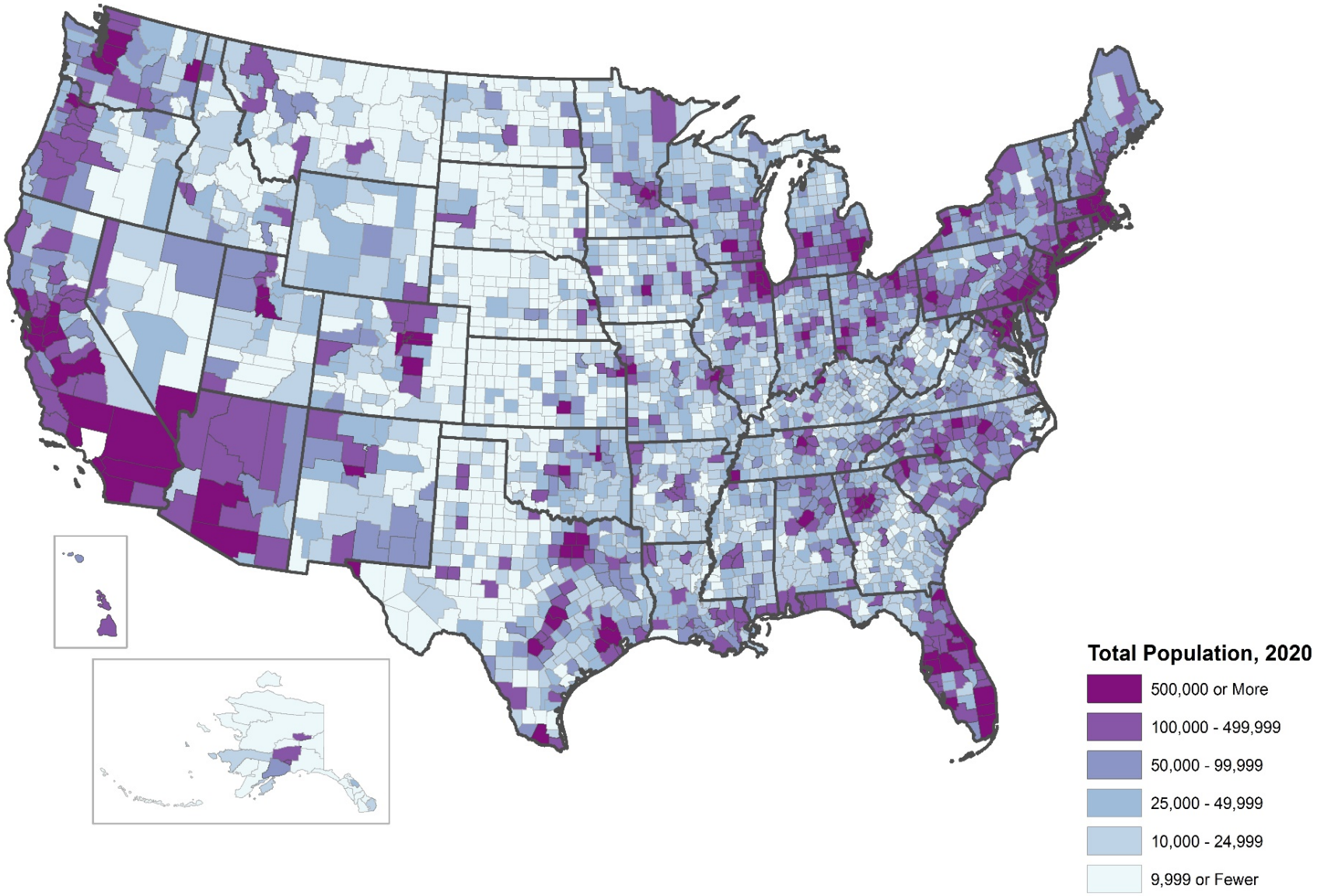
Assumptions

1. No major local or national disasters between now and 2060.
2. Many assumptions about the specifications (many rates) of the projection methodology.

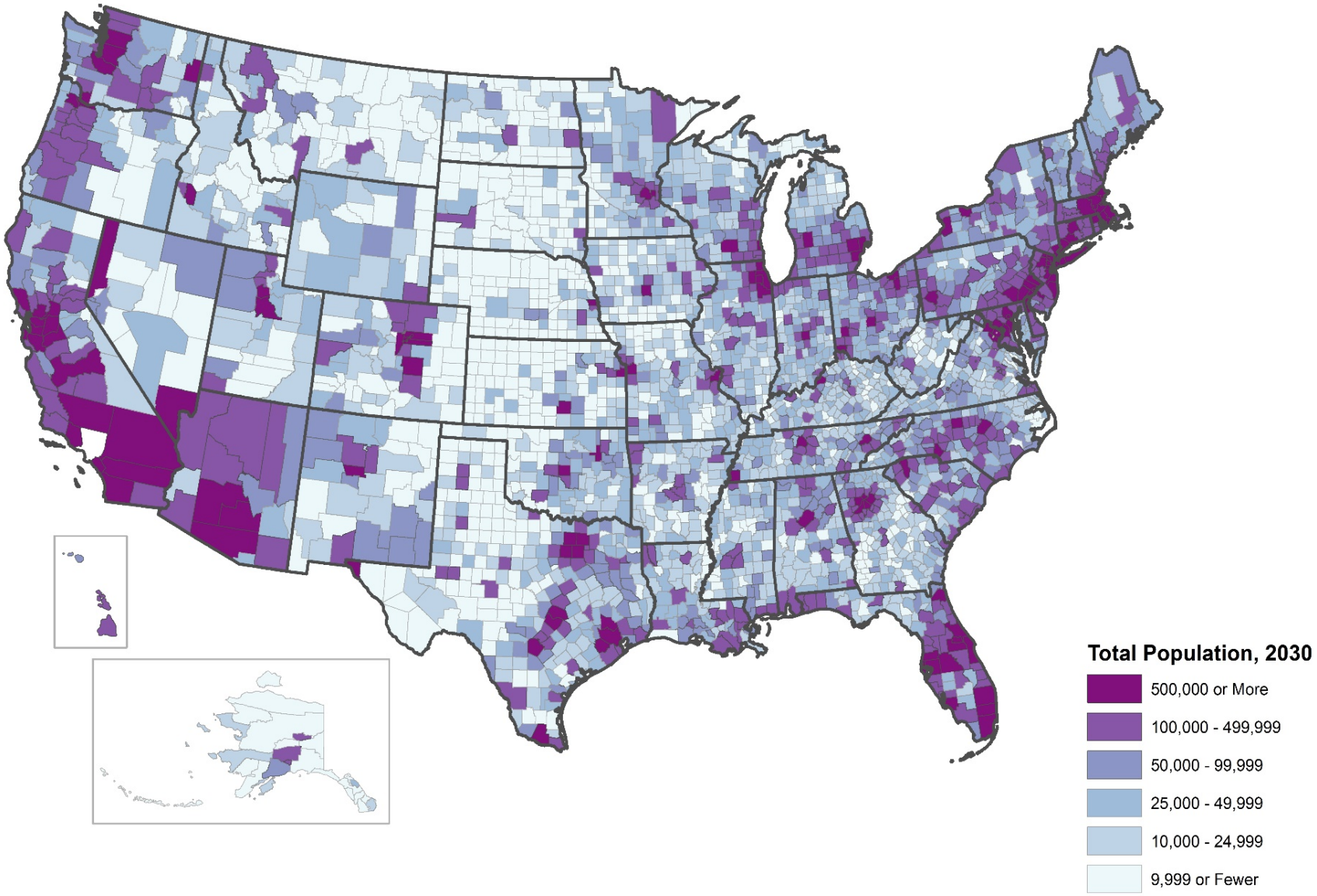
Total Population in 2010



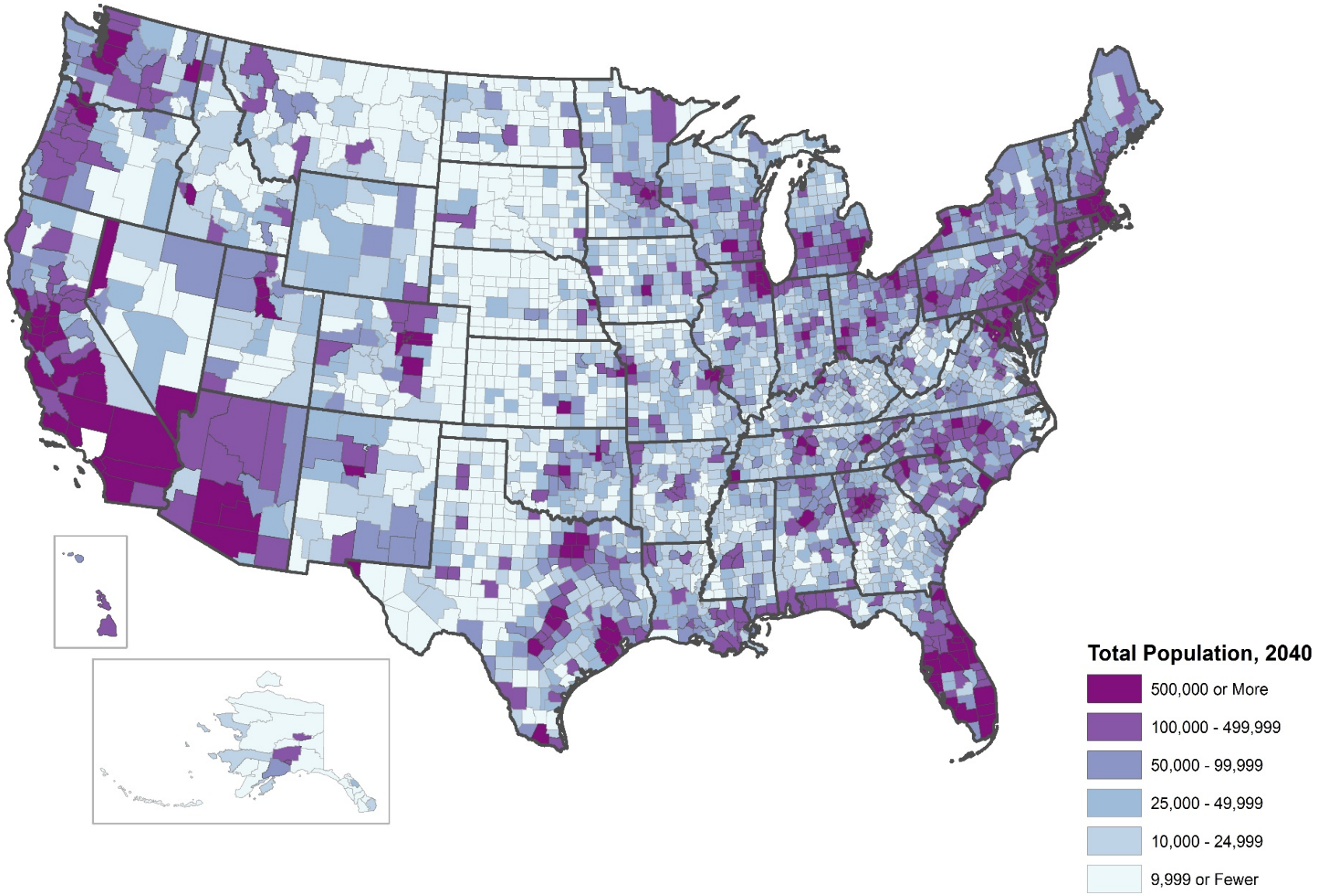
Projected Total Population in 2020



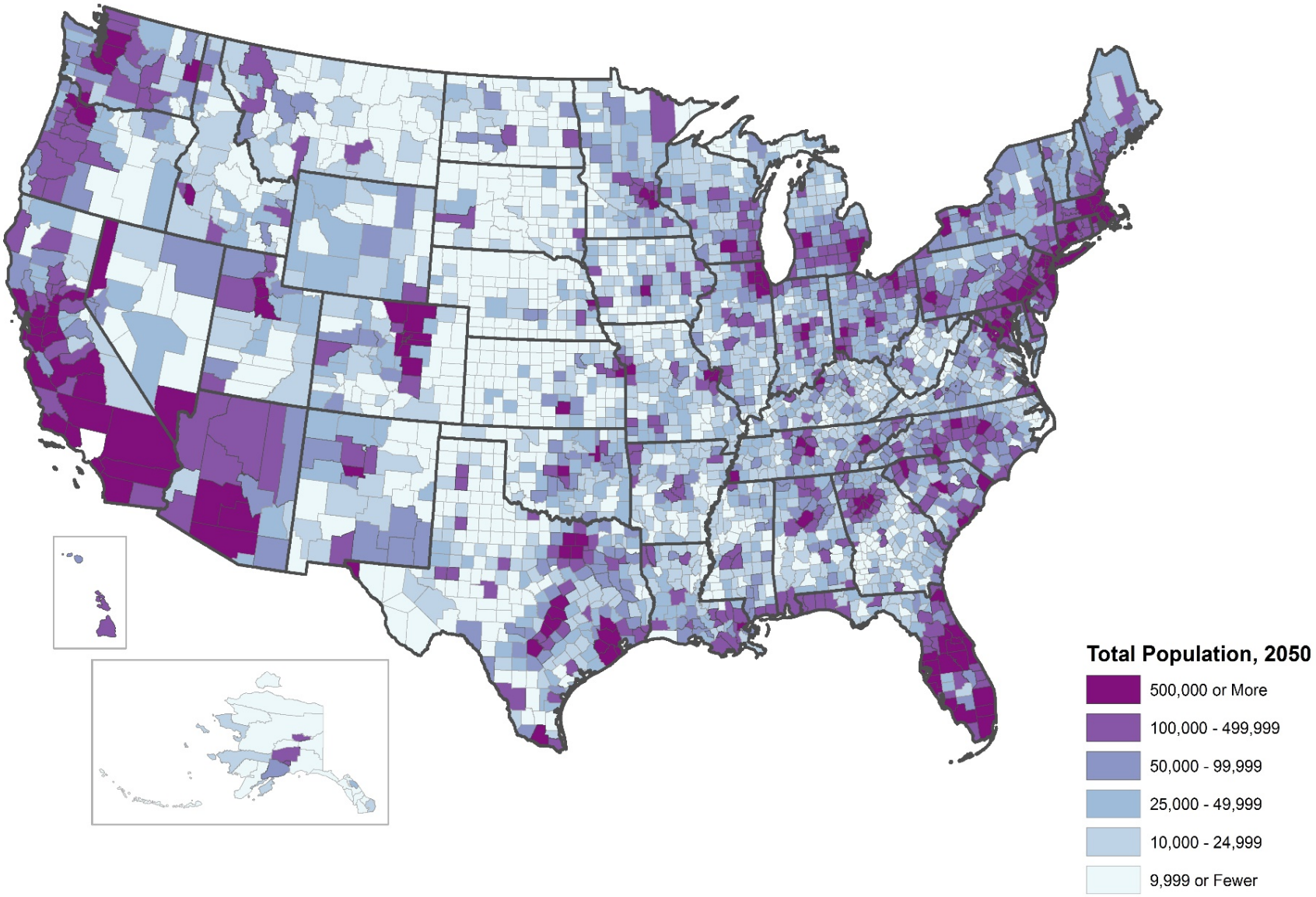
Projected Total Population in 2030



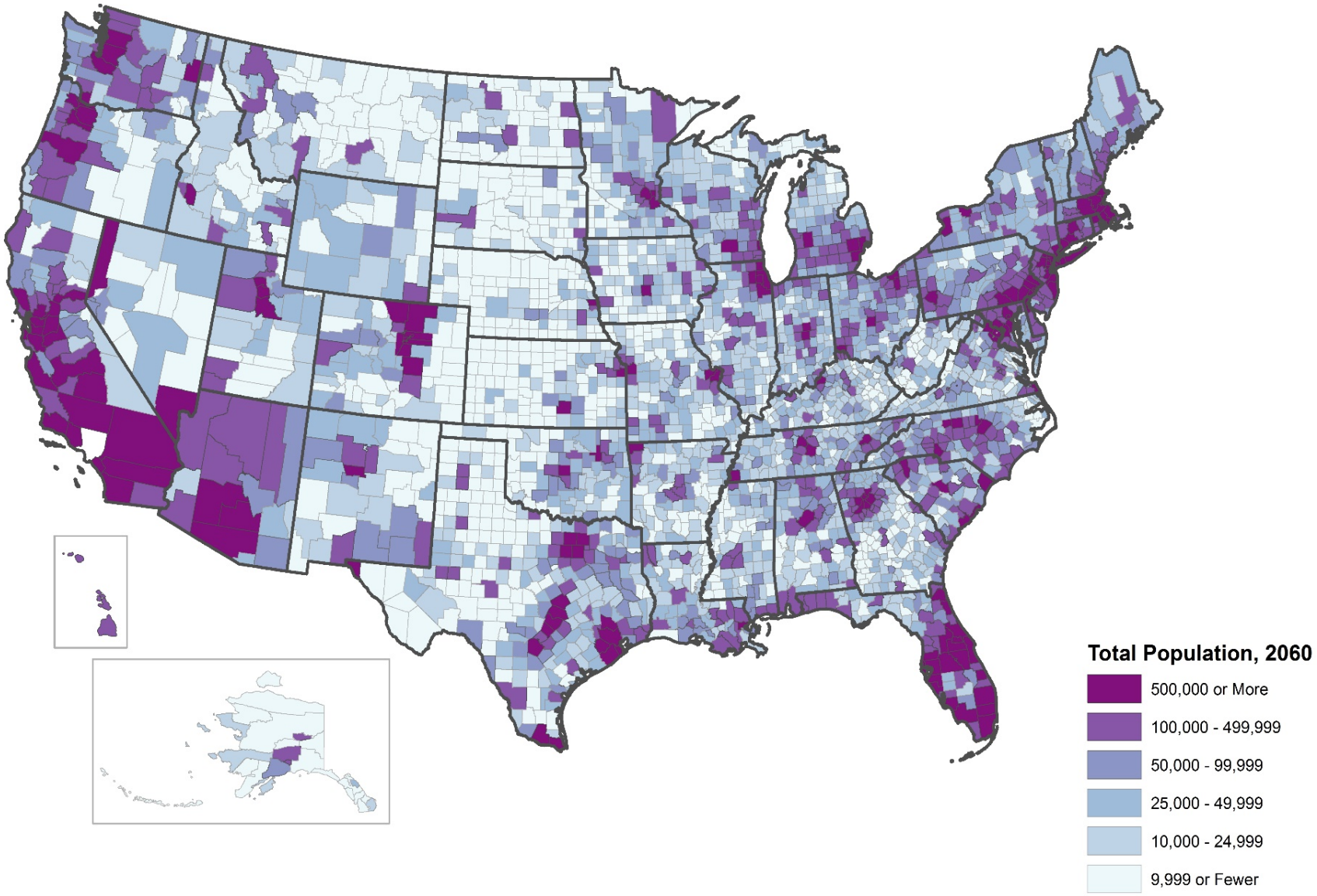
Projected Total Population in 2040



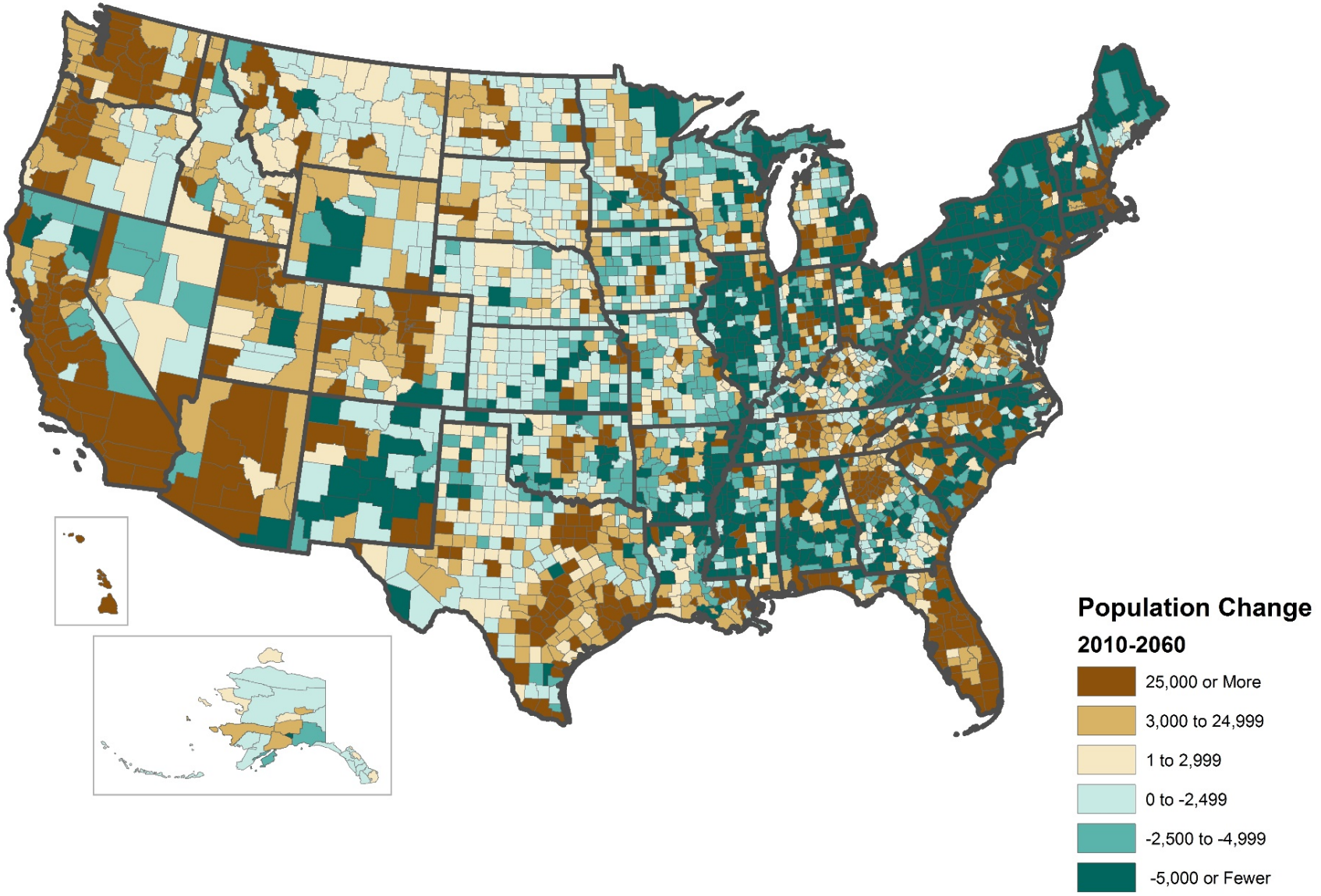
Projected Total Population in 2050



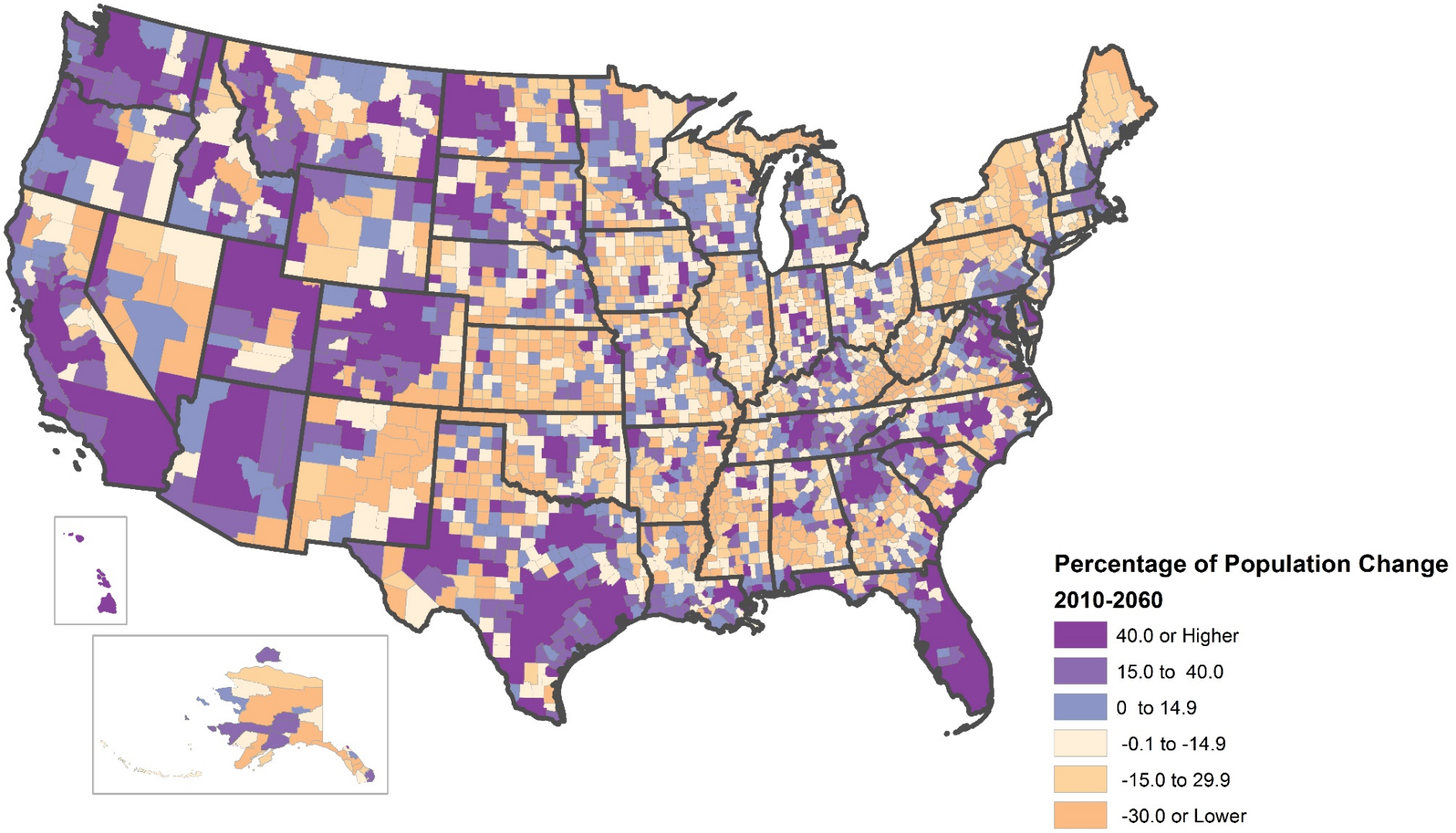
Projected Total Population in 2060



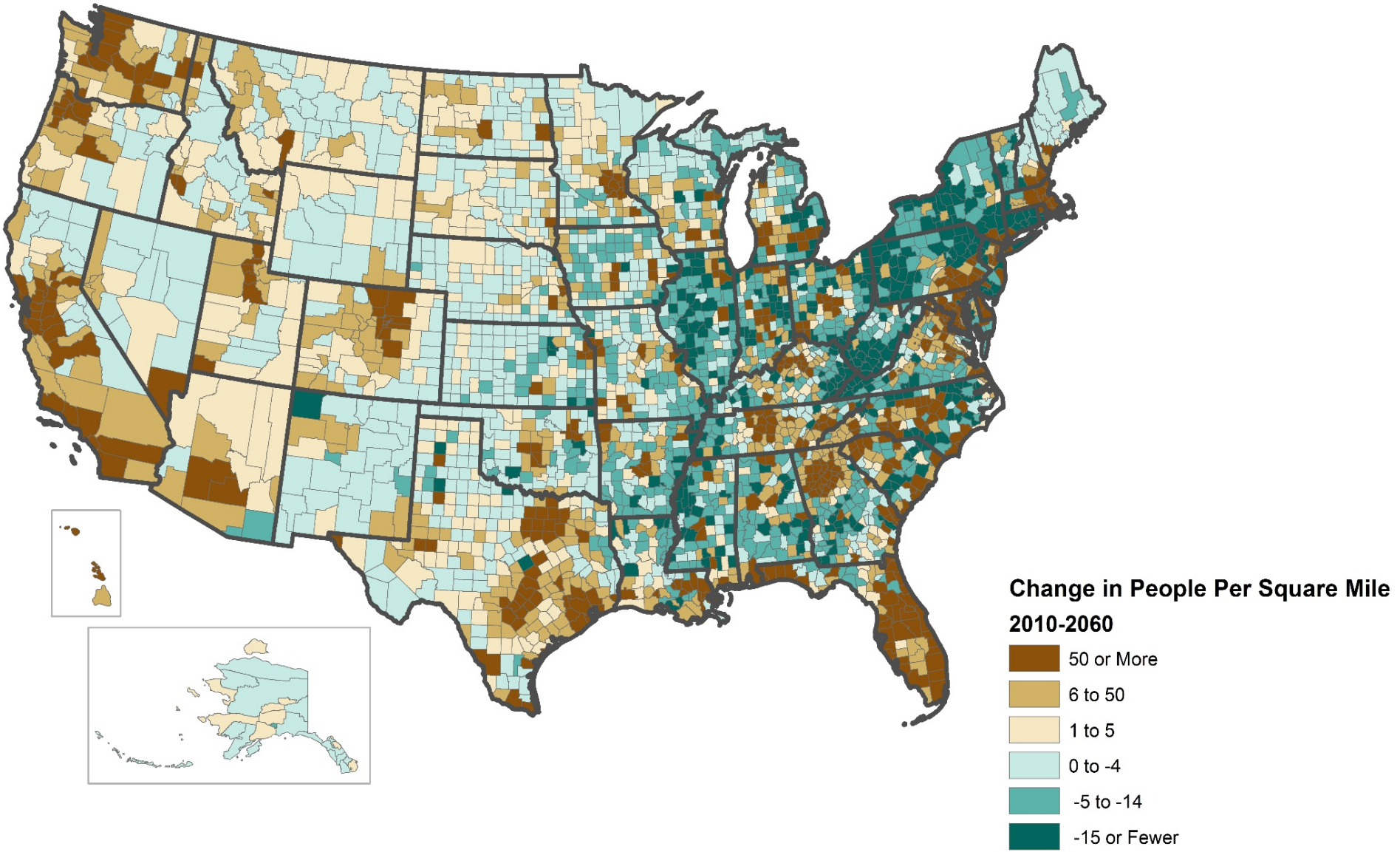
Projected Population Change from 2010 to 2060



Projected Percentage Population Change from 2010 to 2060

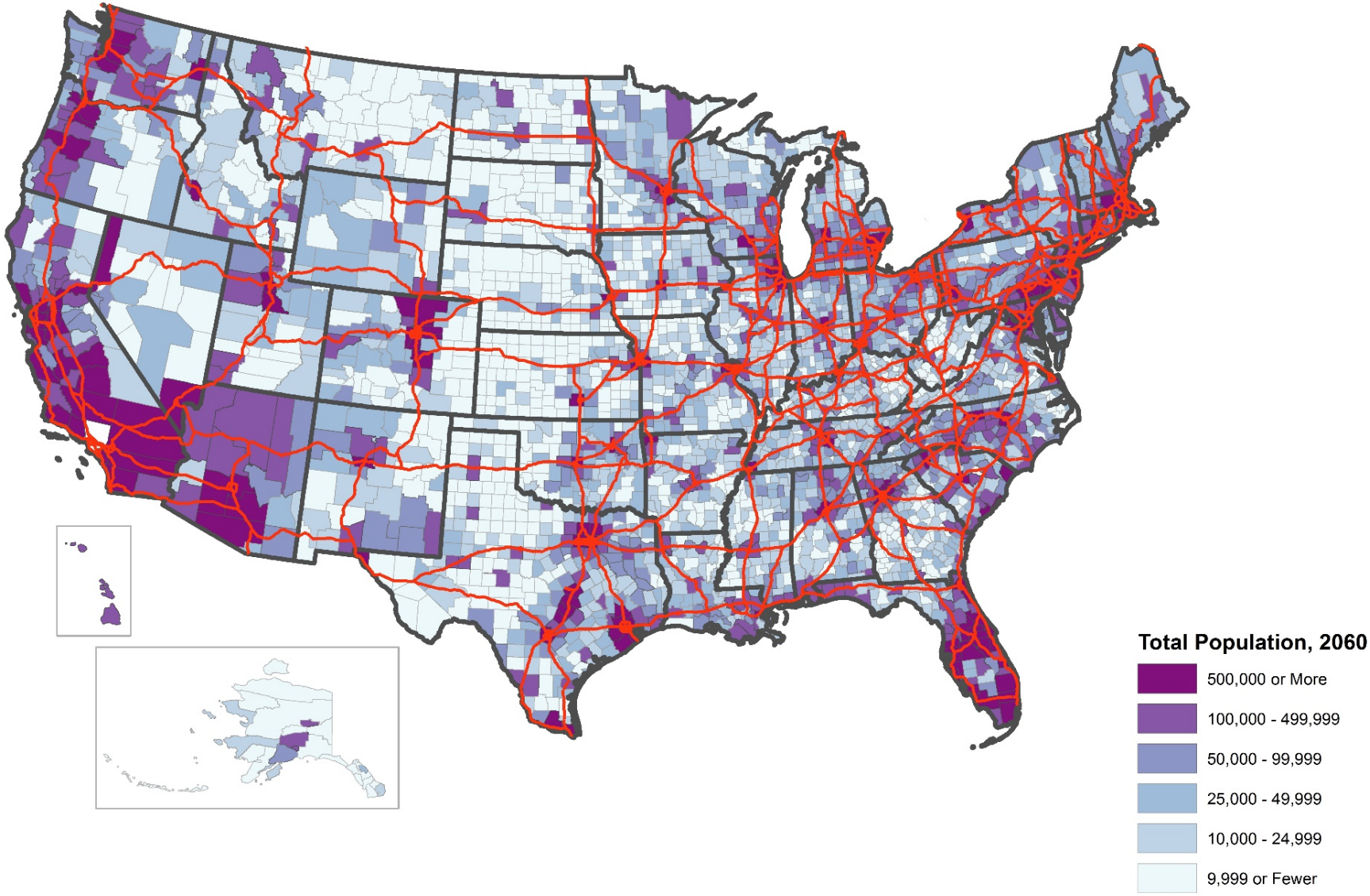


Projected Population Density Change from 2010 to 2060

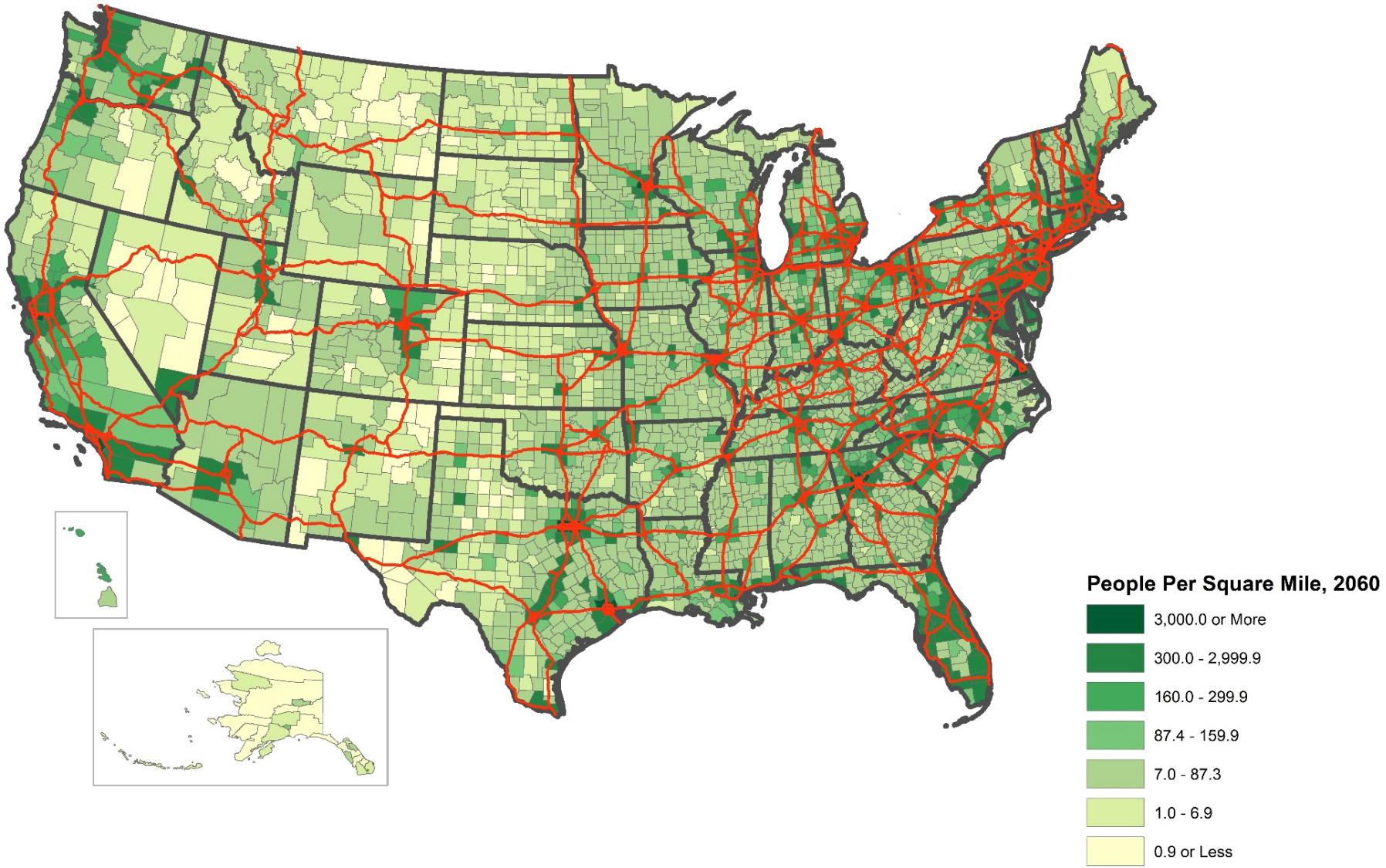


Identifying Counties That May Need Additional or Less Interstate Highway Systems Capacity

Projected Population in 2060 and the IHS Network



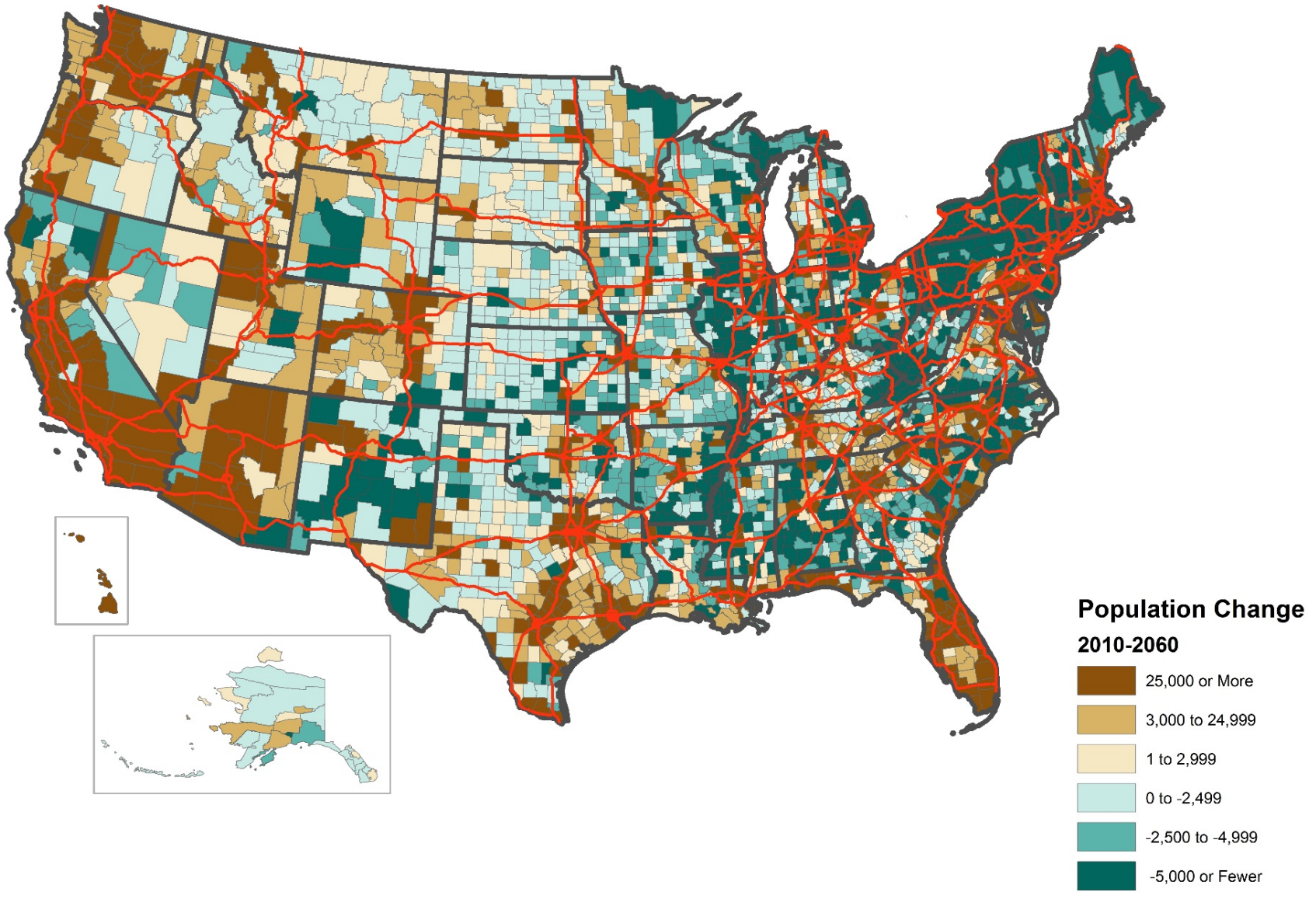
Projected Population Density in 2060 and the IHS Network



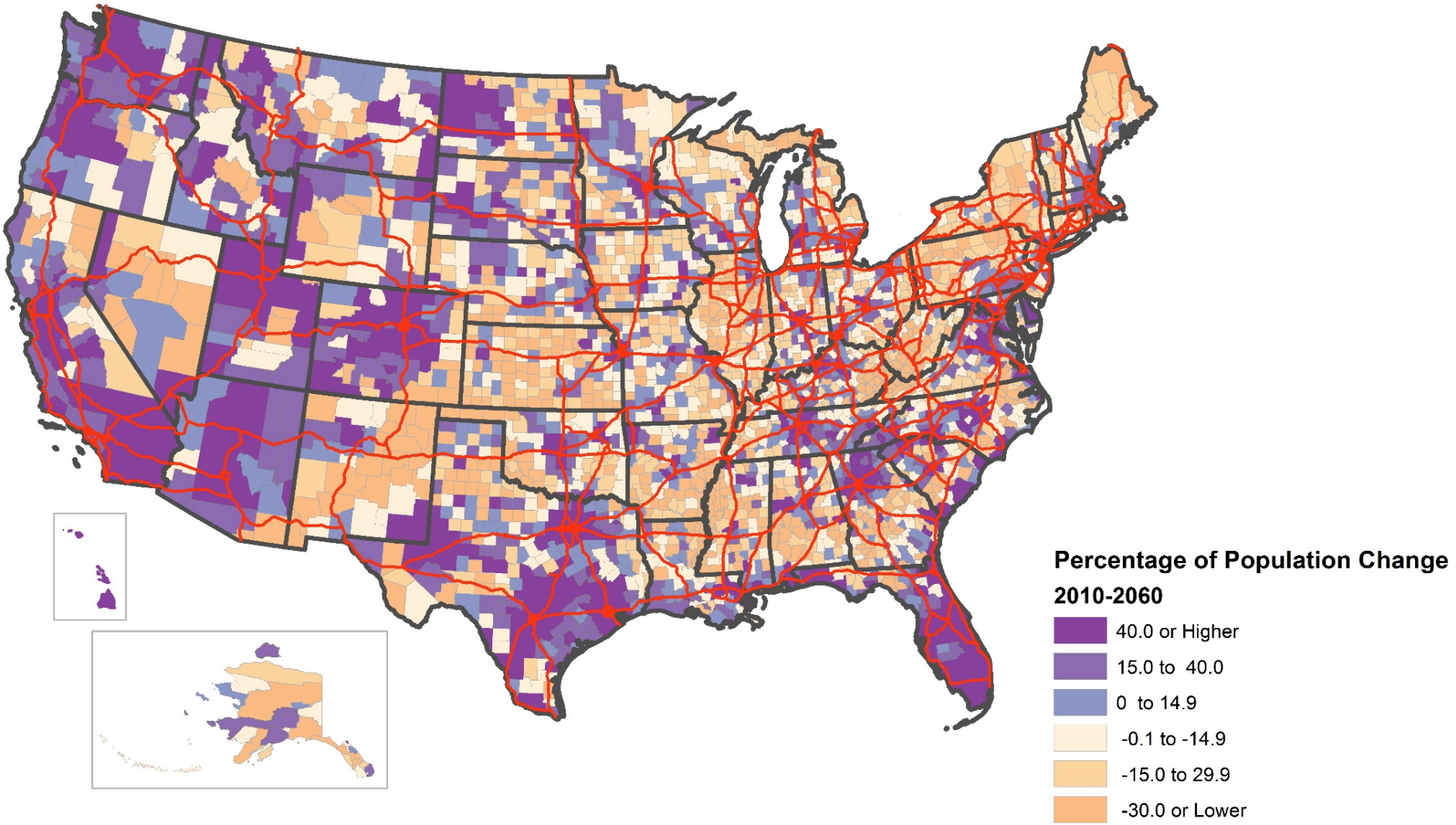
Projected Population in 2060 and Proximity to IHS

	N	Mean	Std Dev	Min	Max
Counties with IHS	1,444	247,207	637,467	104	12,099,604
Counties without IHS	1,698	34,203	110,294	100	3,263,590
Counties within 20 miles of IHS	2,477	161,821	504,828	104	12,099,604
Counties beyond 20 miles of IHS	665	21,372	40,346	100	477,731

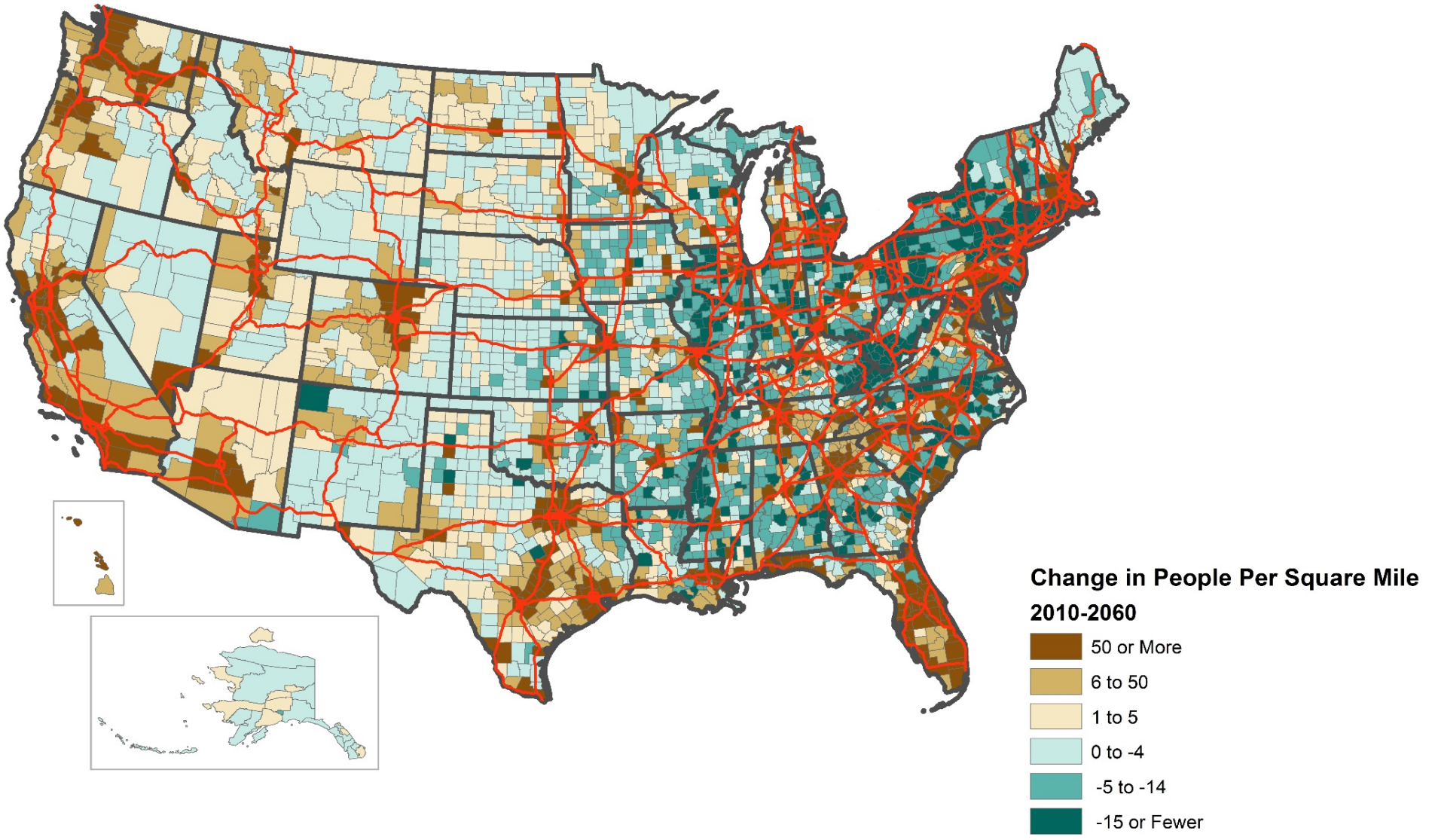
Projected Population Change 2010-2060 and the IHS Network



Projected Percentage Population Change 2010-2060 and the IHS Network



Projected Population Density Change 2010-2060 and the IHS Network

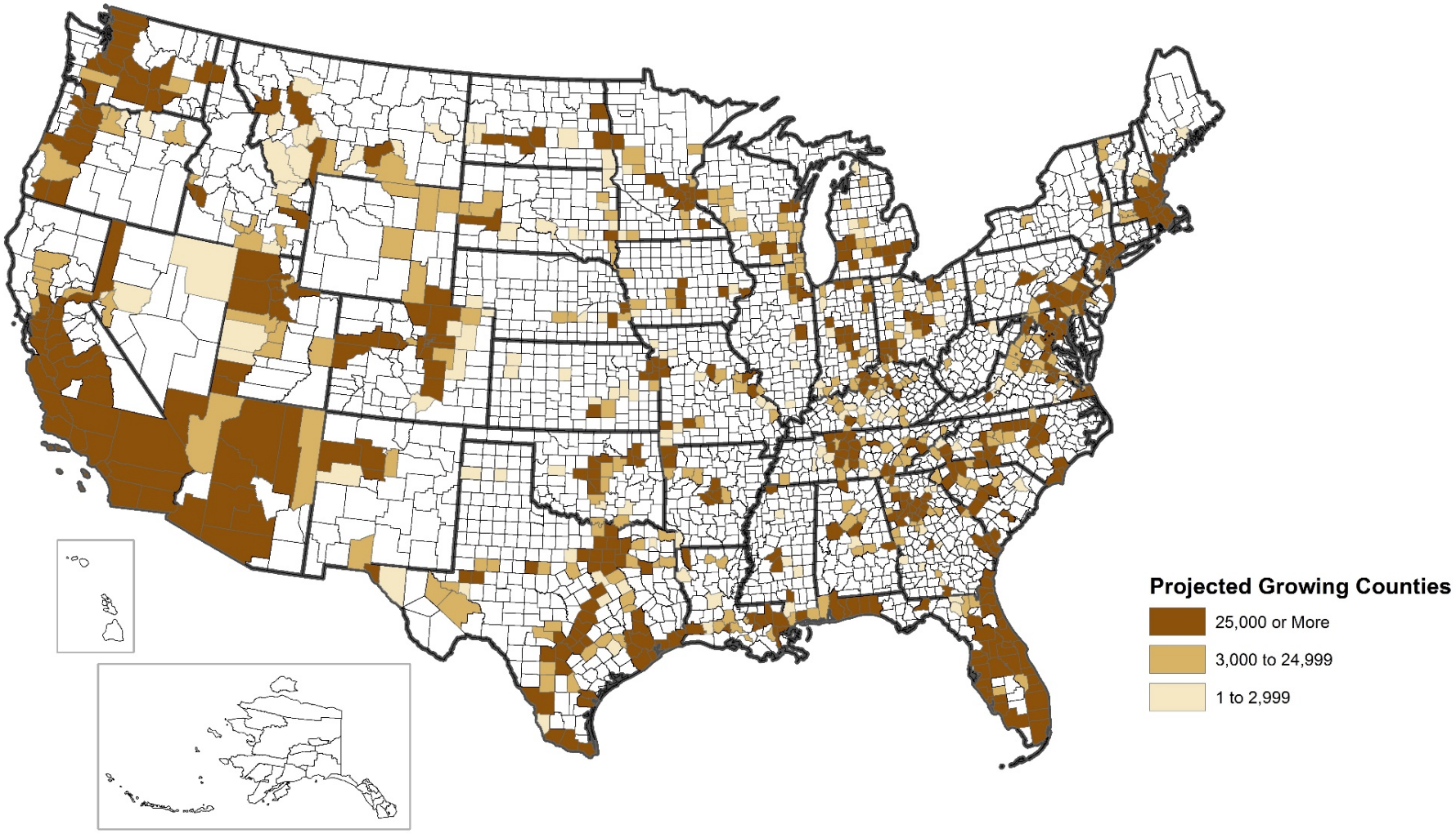


Projected Population Change 2010-2060 and Proximity to IHS Network

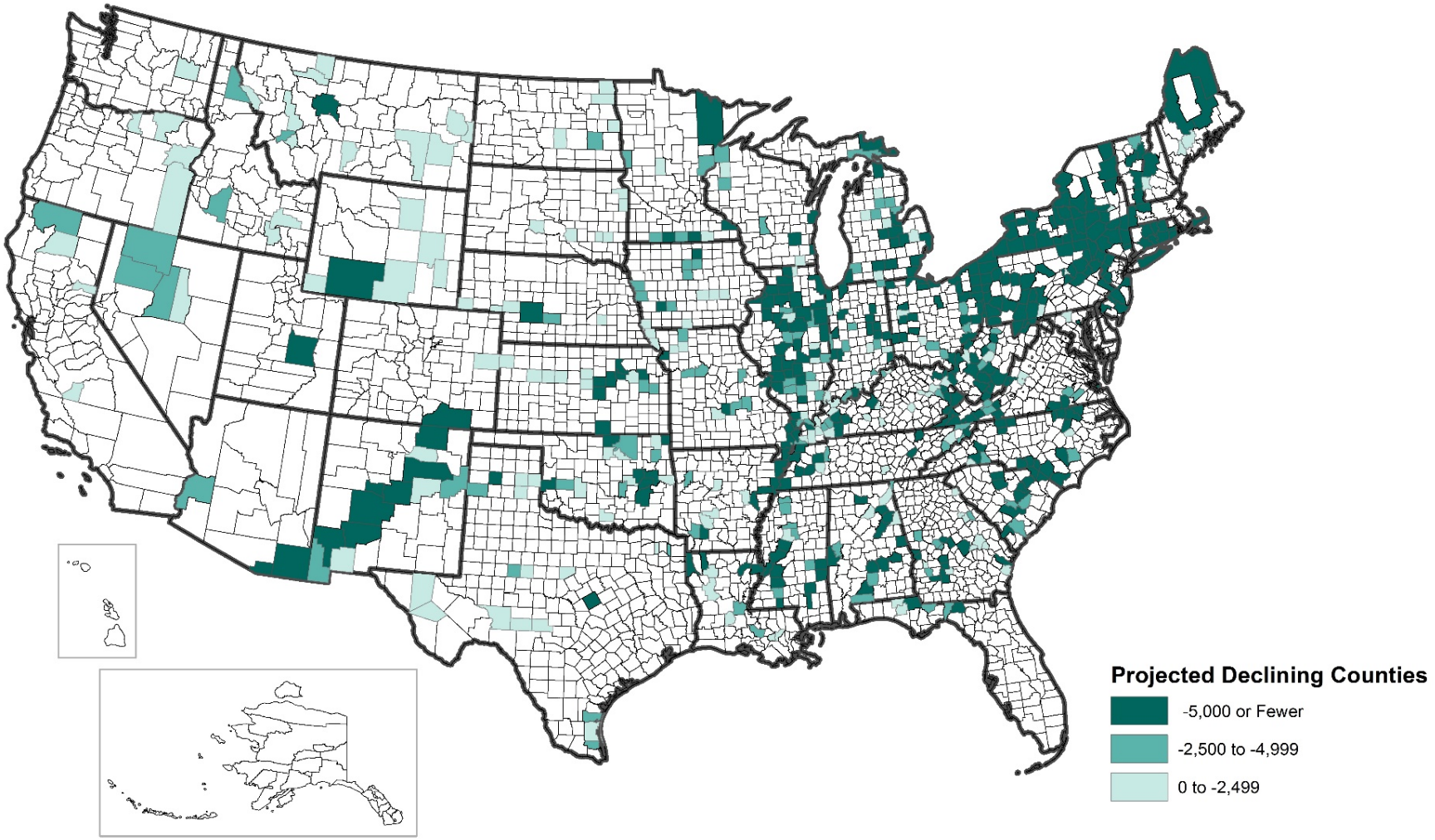
	N	Mean	Std Dev	Min	Max
Population change 2010–2060					
Counties with IHS	1,444	68,795	24,4524	–378,001	3,529,548
Counties without IHS	1,698	4,262	37,741	–103,561	753,350
Percentage population change 2010–2060					
Counties with IHS	1,444	15.51%	46.75%	–79.70%	281.10%
Counties without IHS	1,698	–4.28%	40.13%	–79.80%	531.40%

- It should be noted that the mean of percentage change is calculated as the average of percentage change in each county.
- The overall percentage population change 2010–2060 in the United States is 38.56% for counties with IHS and 14.23% for counties without IHS.

Projected Growing Counties Along the IHS Network



Projected Declining Counties Along the IHS Network

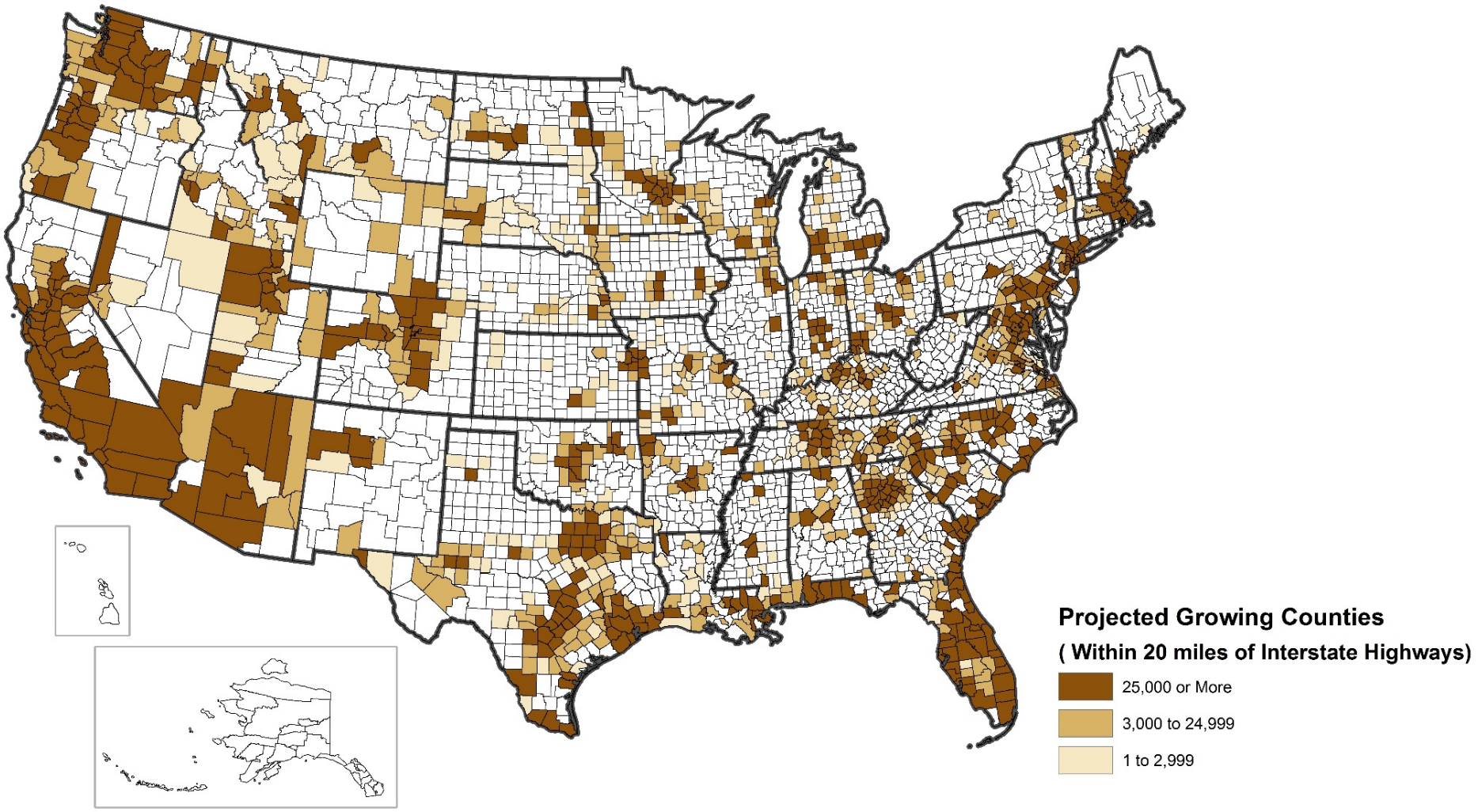


Population change 2010-2060 and proximity to IHS network

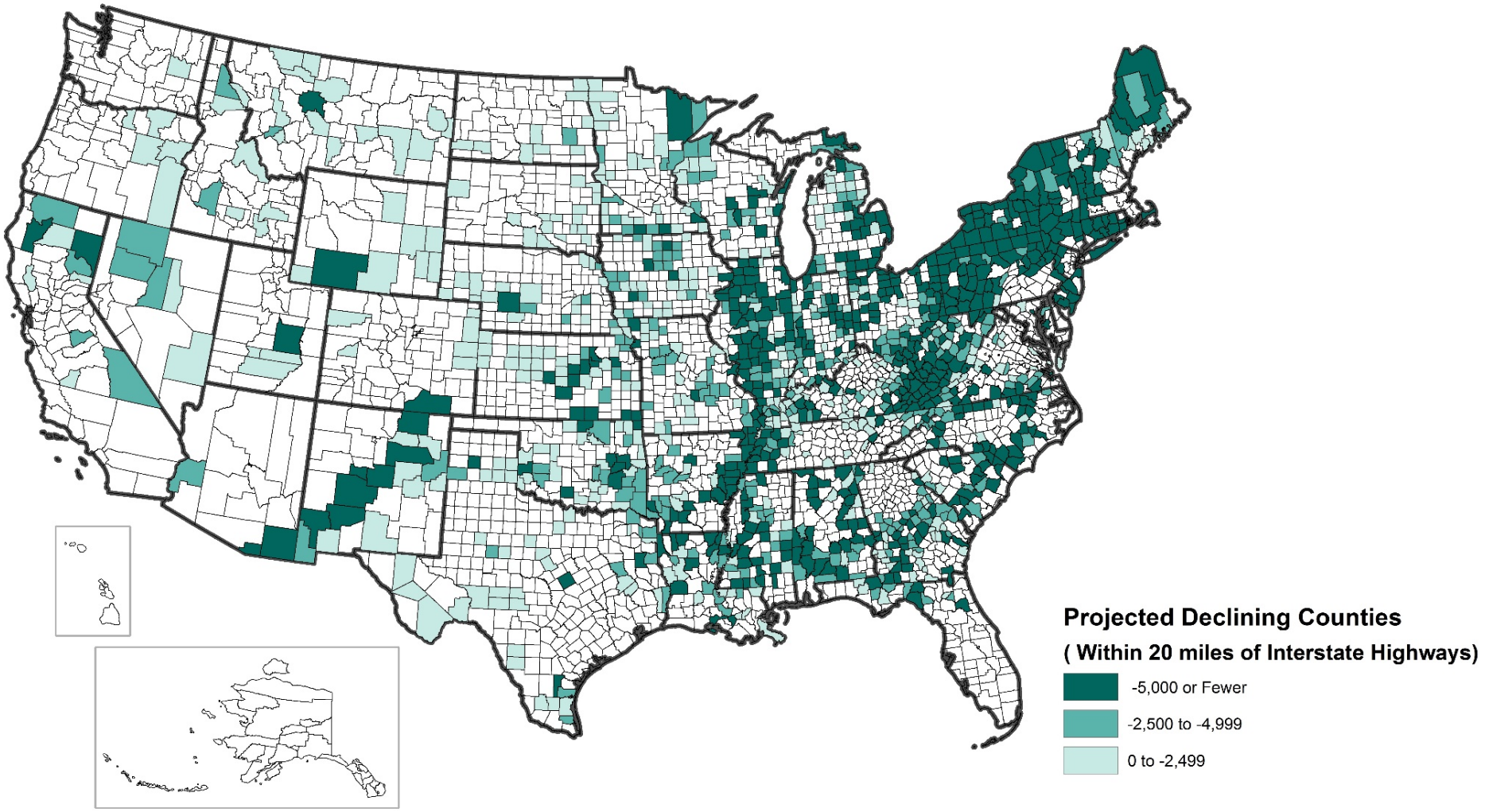
	N	Mean	Std Dev	Min	Max
Population change 2010–2060					
Counties within 20 miles of IHS	2,477	42,742	191,554	–378,001	3,529,548
Counties beyond 20 miles of IHS	665	1,060	16,661	–103,561	203,613
Percentage population change 2010–2060					
Counties within 20 miles of IHS	2,477	8.11%	44.29%	–79.80%	281.10%
Counties beyond 20 miles of IHS	665	–7.45%	42.67%	–79.60%	531.40%

- The overall percentage population change 2010–2060 in the United States is 35.89% for counties within 20 miles of IHS and 5.22% for counties beyond 20 miles of IHS.

Counties Neighboring the IHS with Projected Increasing Populations

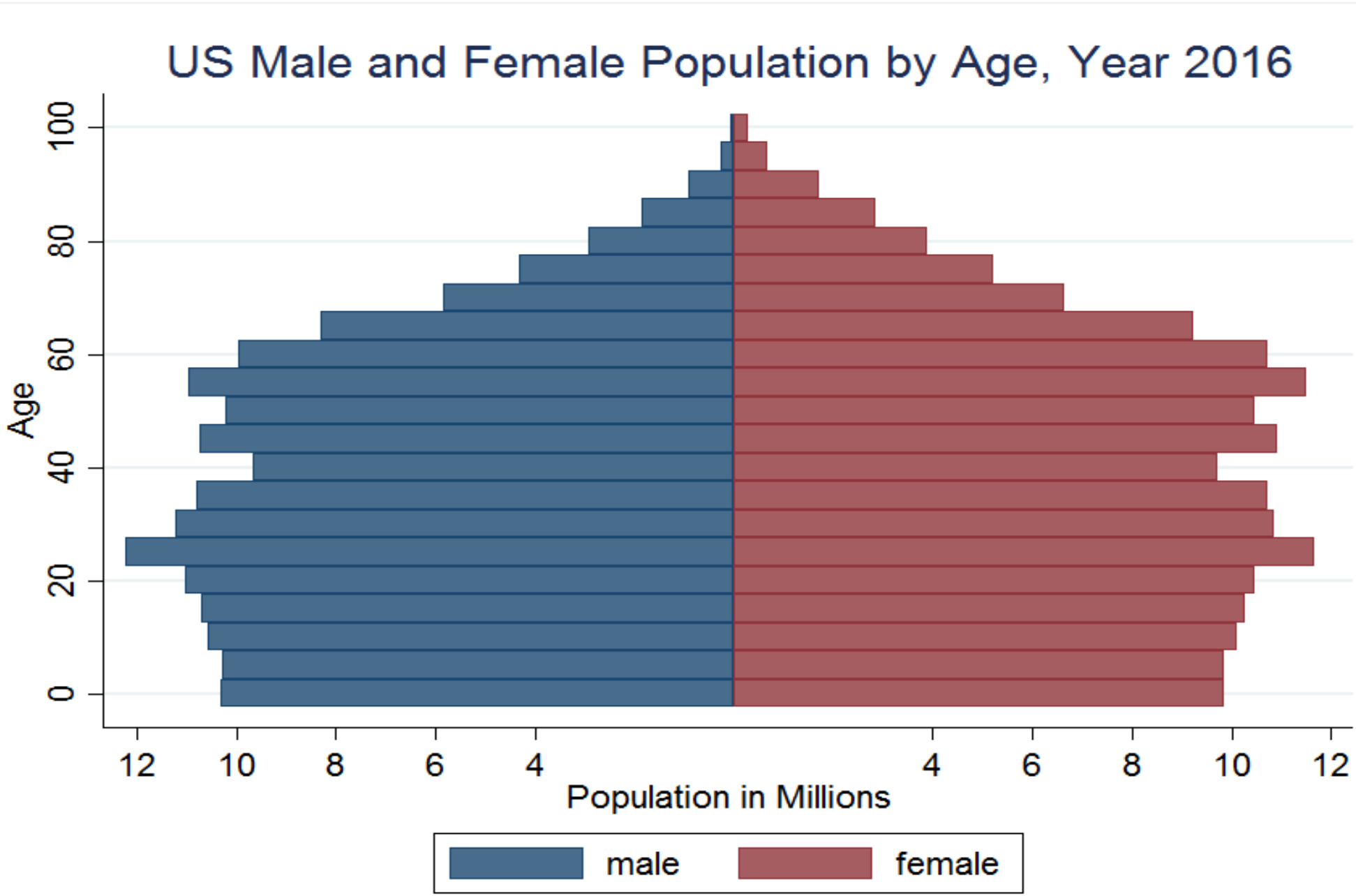


Counties Neighboring the IHS with Projected Decreasing Populations

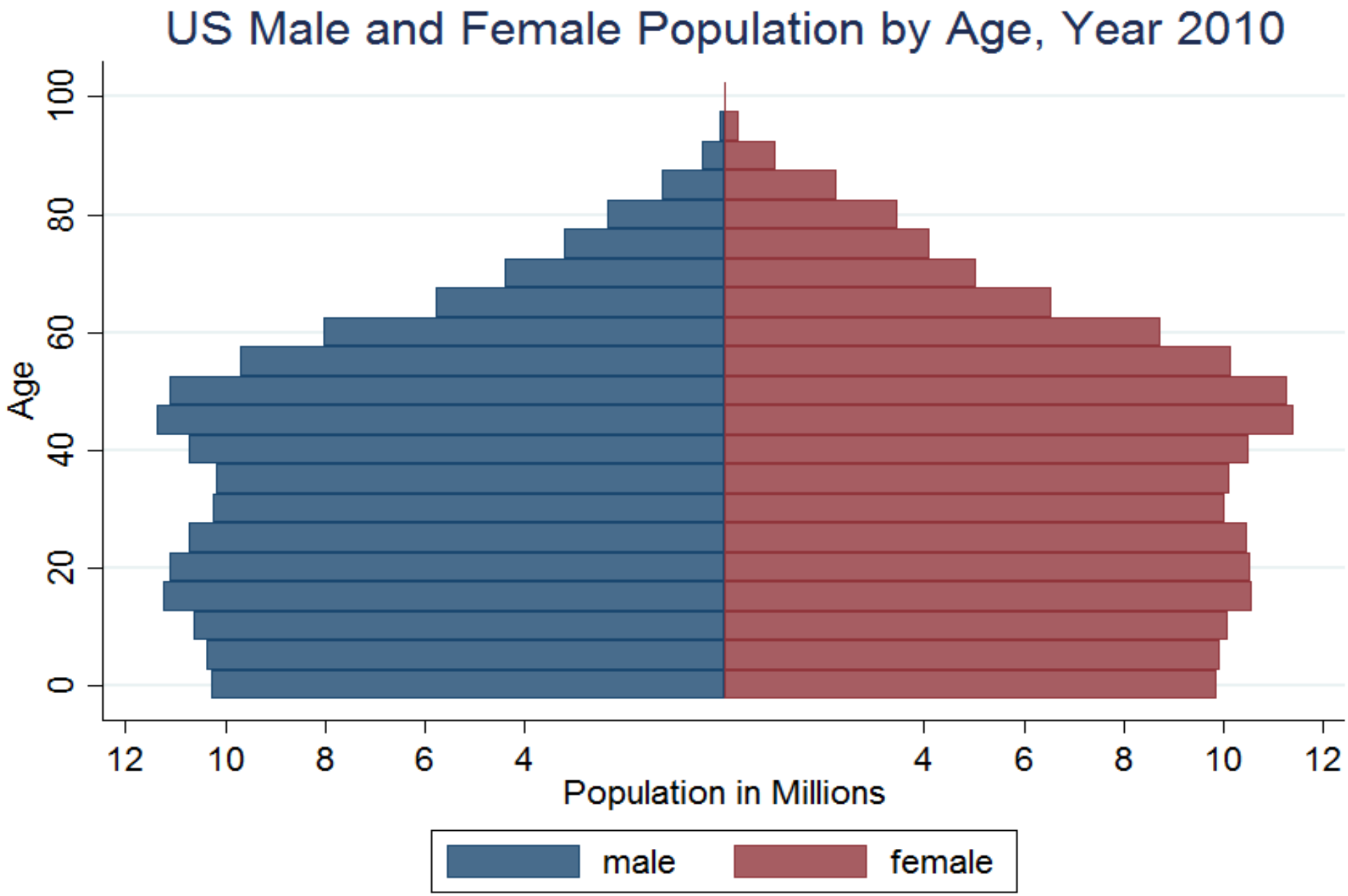


Implications of Aging Population, Millennials, Immigrants, and Telecommuting

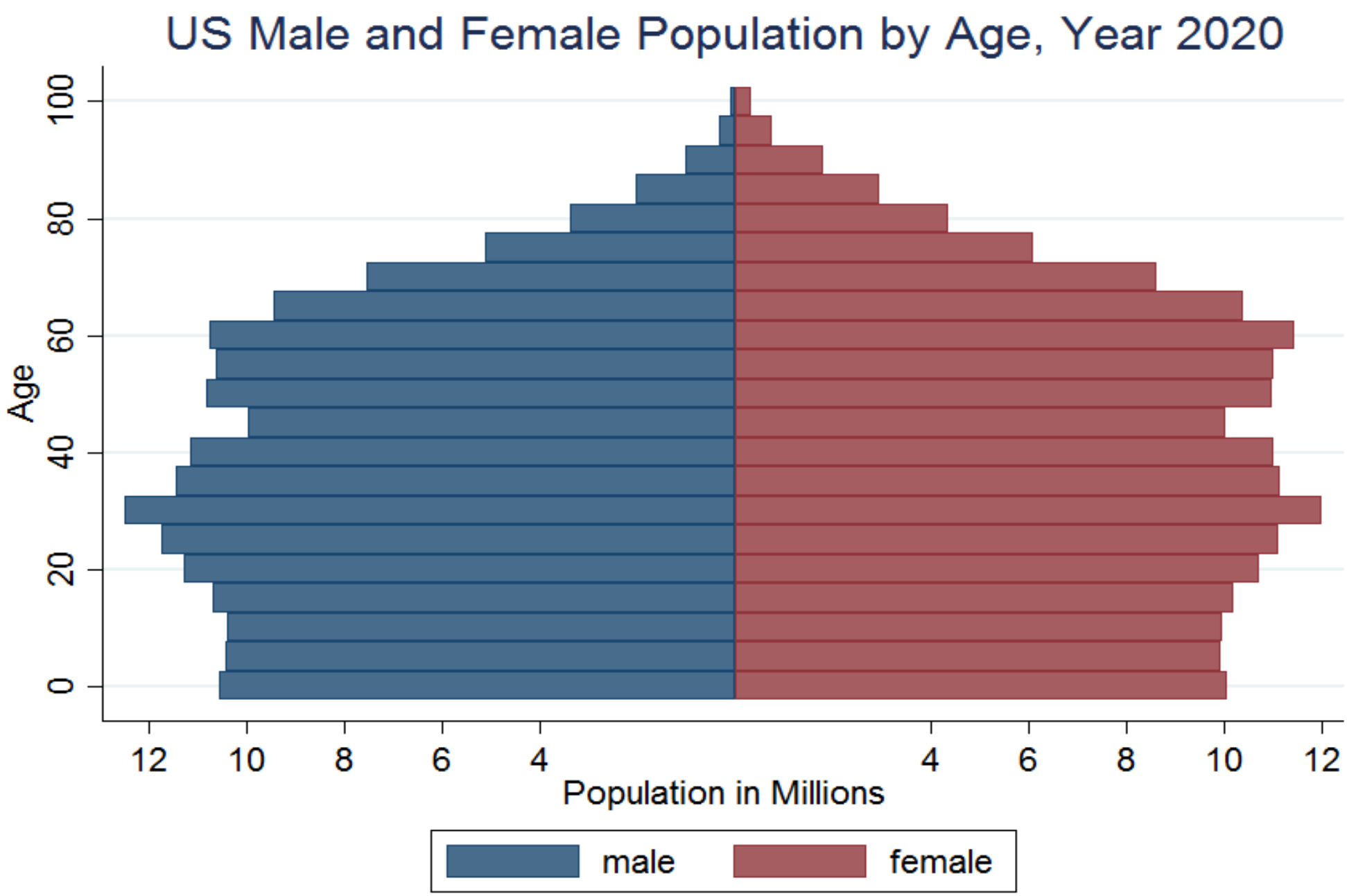
Population Pyramid in 2016



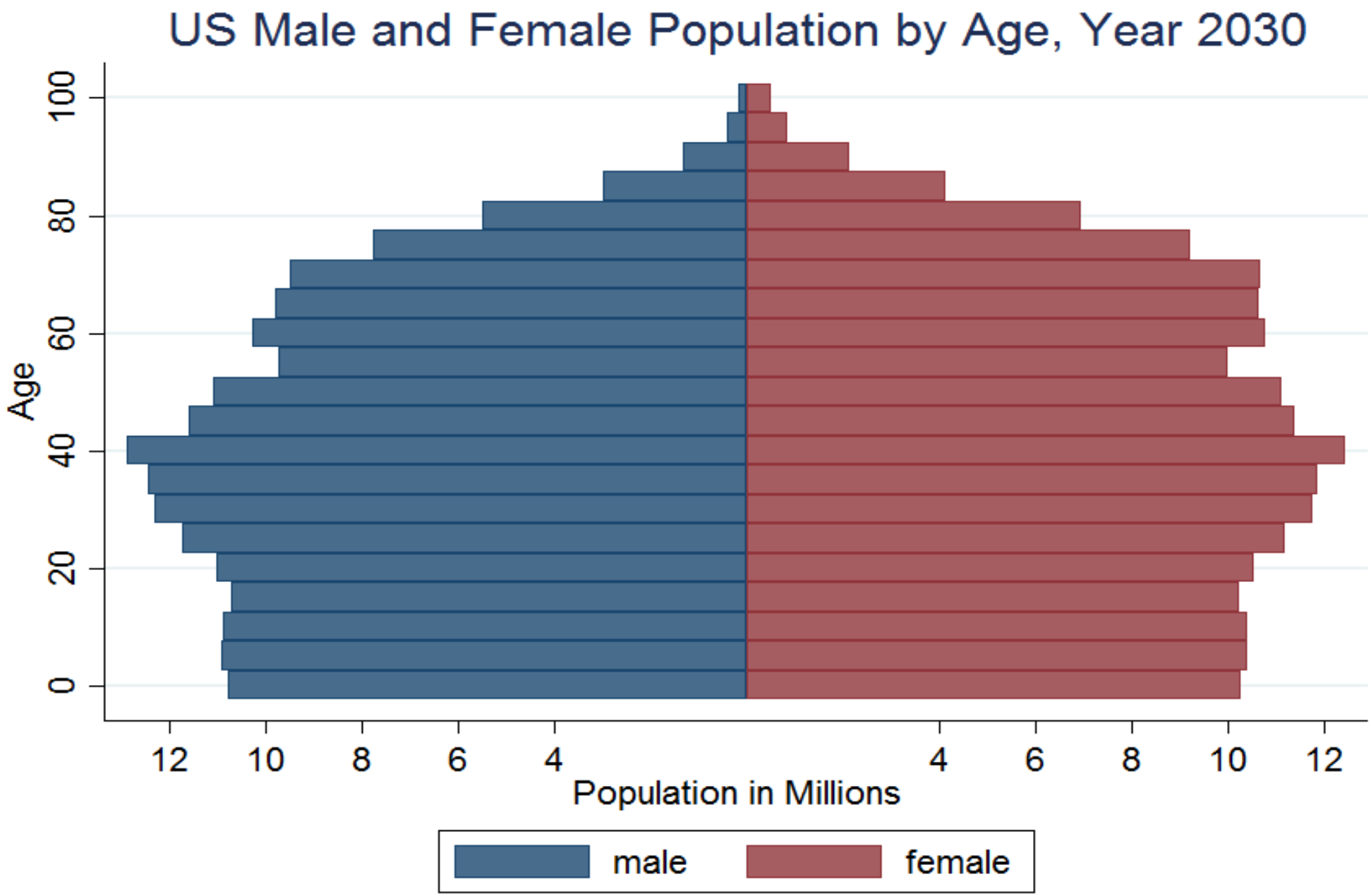
Population Pyramid in 2010



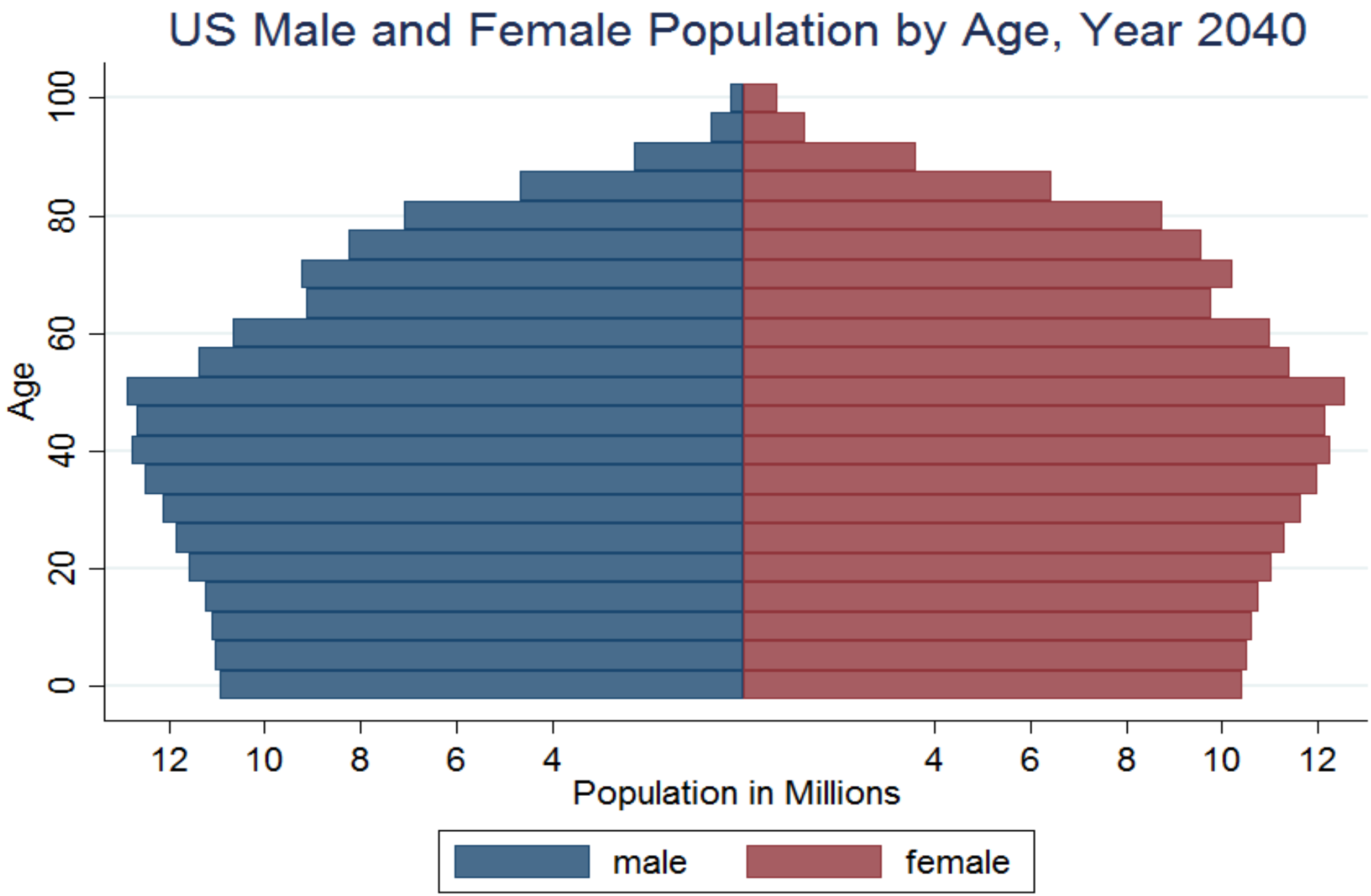
Projected Population Pyramid in 2020



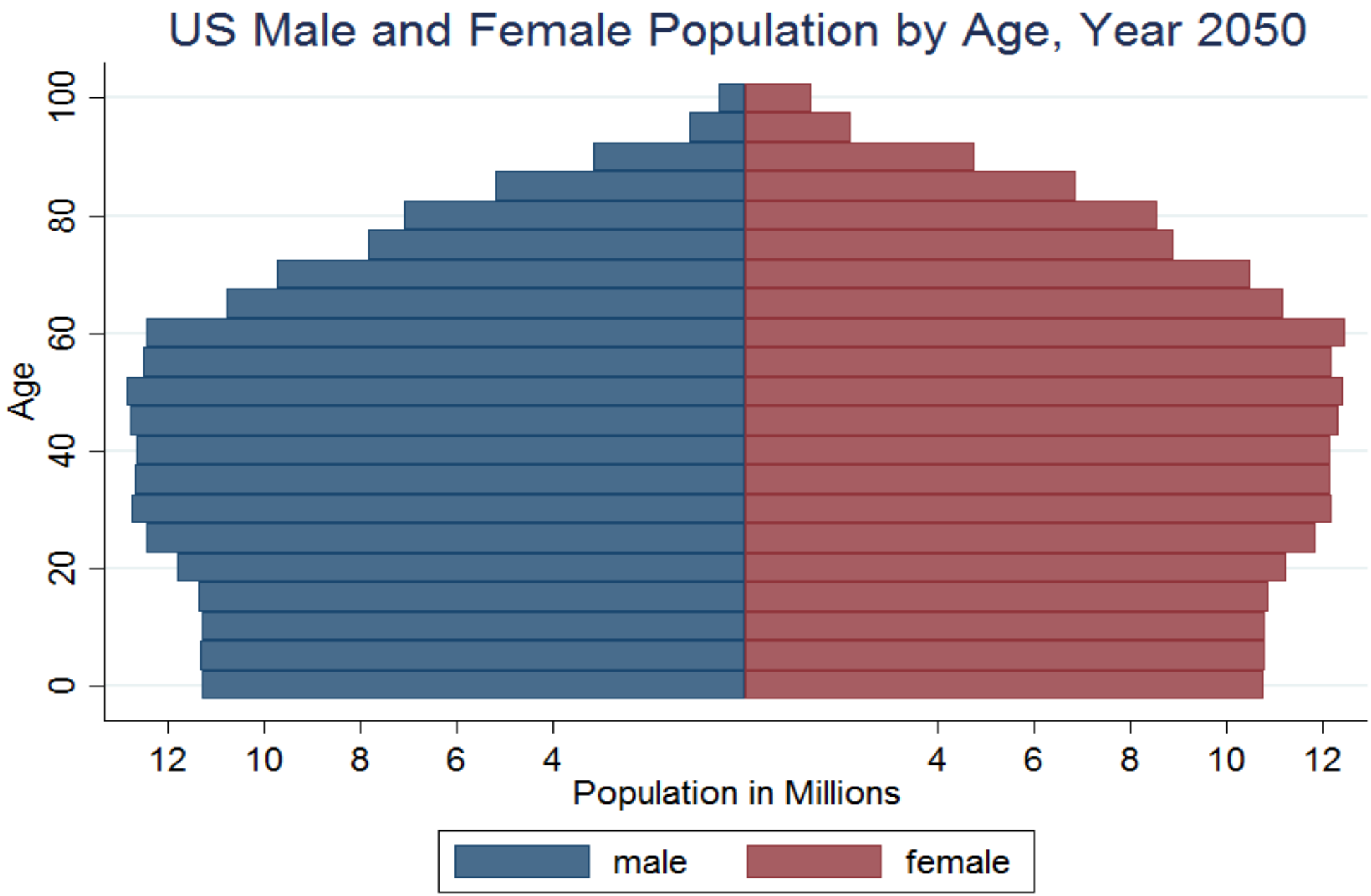
Projected Population Pyramid in 2030



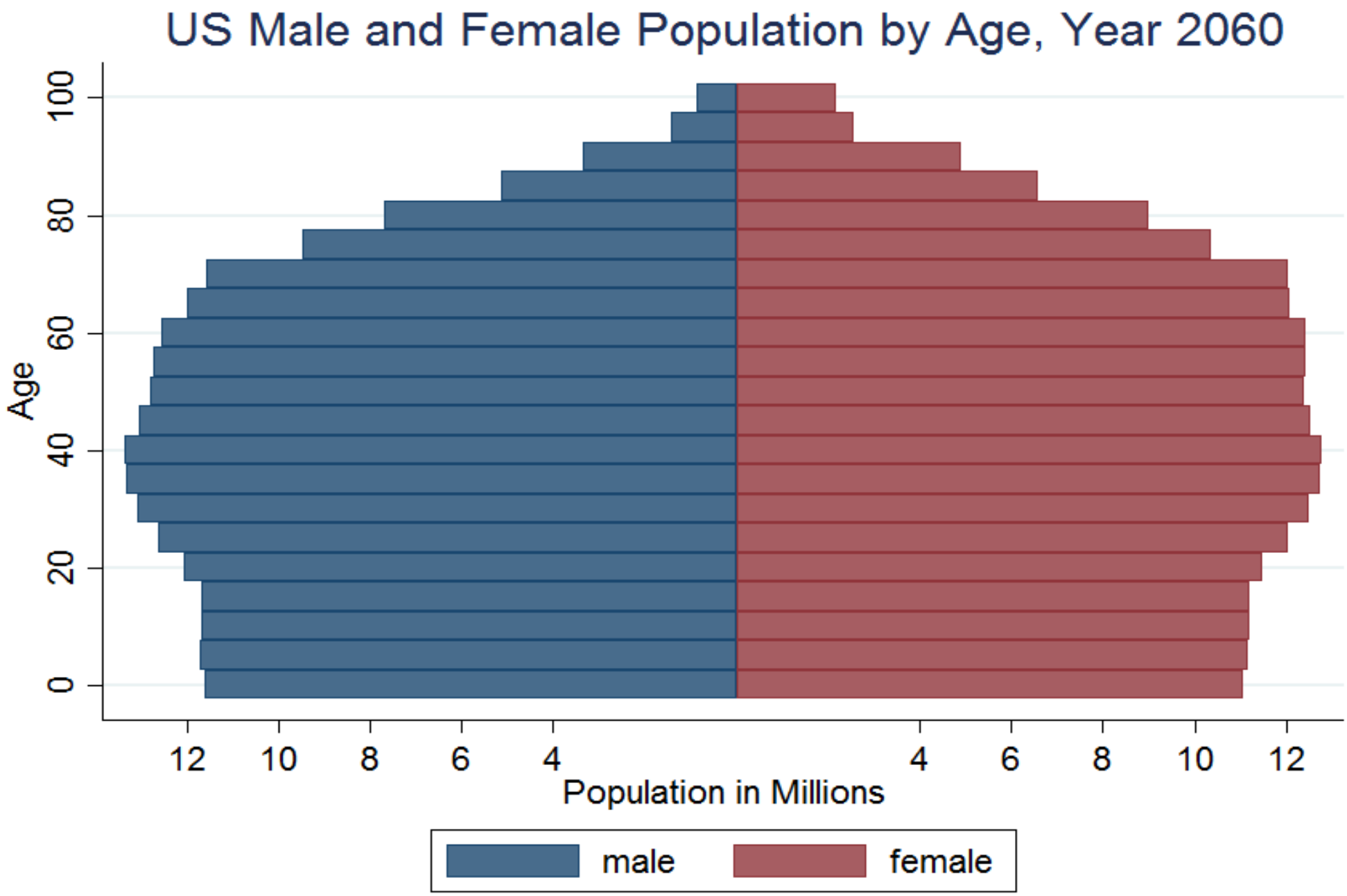
Projected Population Pyramid in 2040



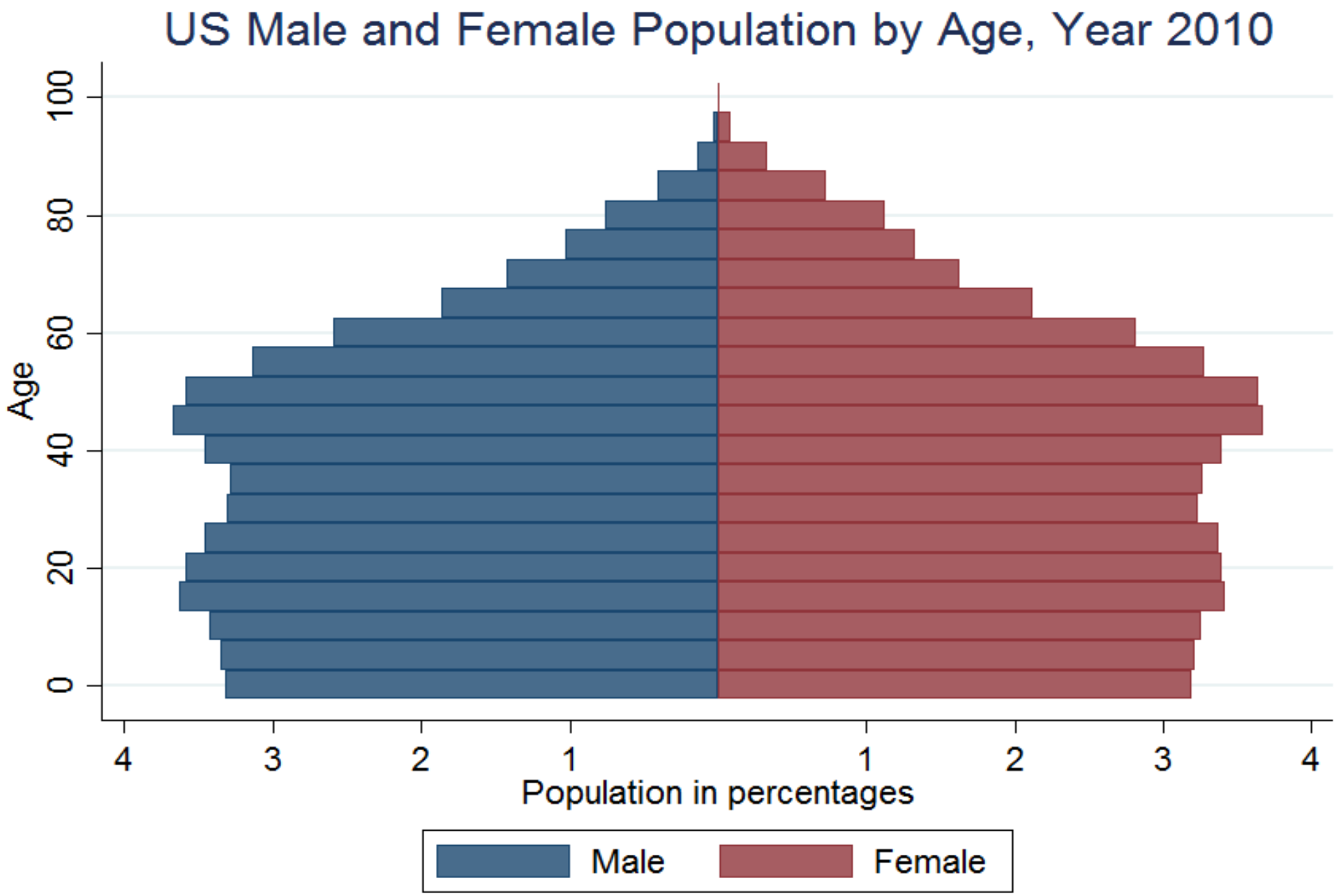
Projected Population Pyramid in 2050



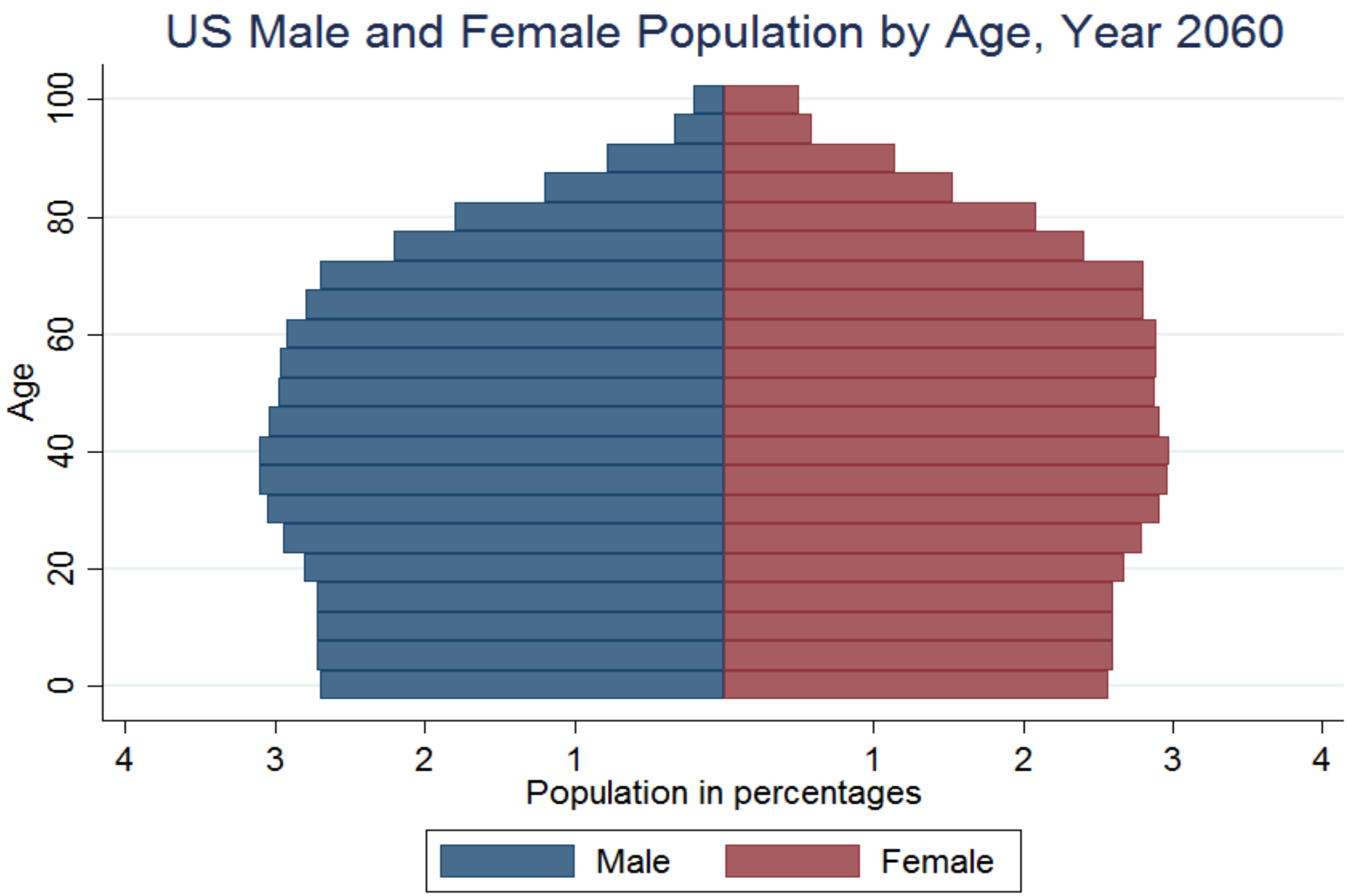
Projected Population Pyramid in 2060



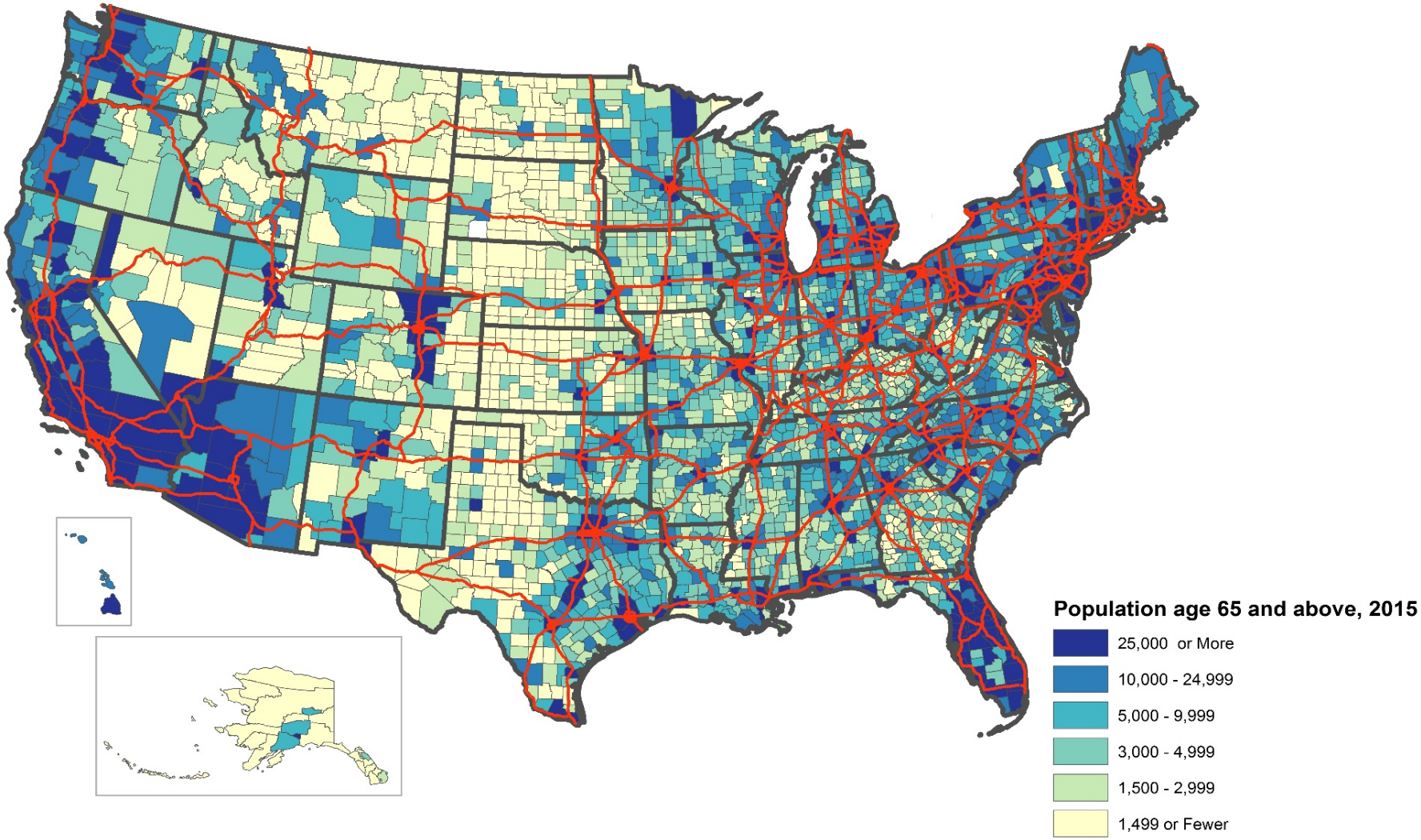
Population Pyramid in Percentage in 2010



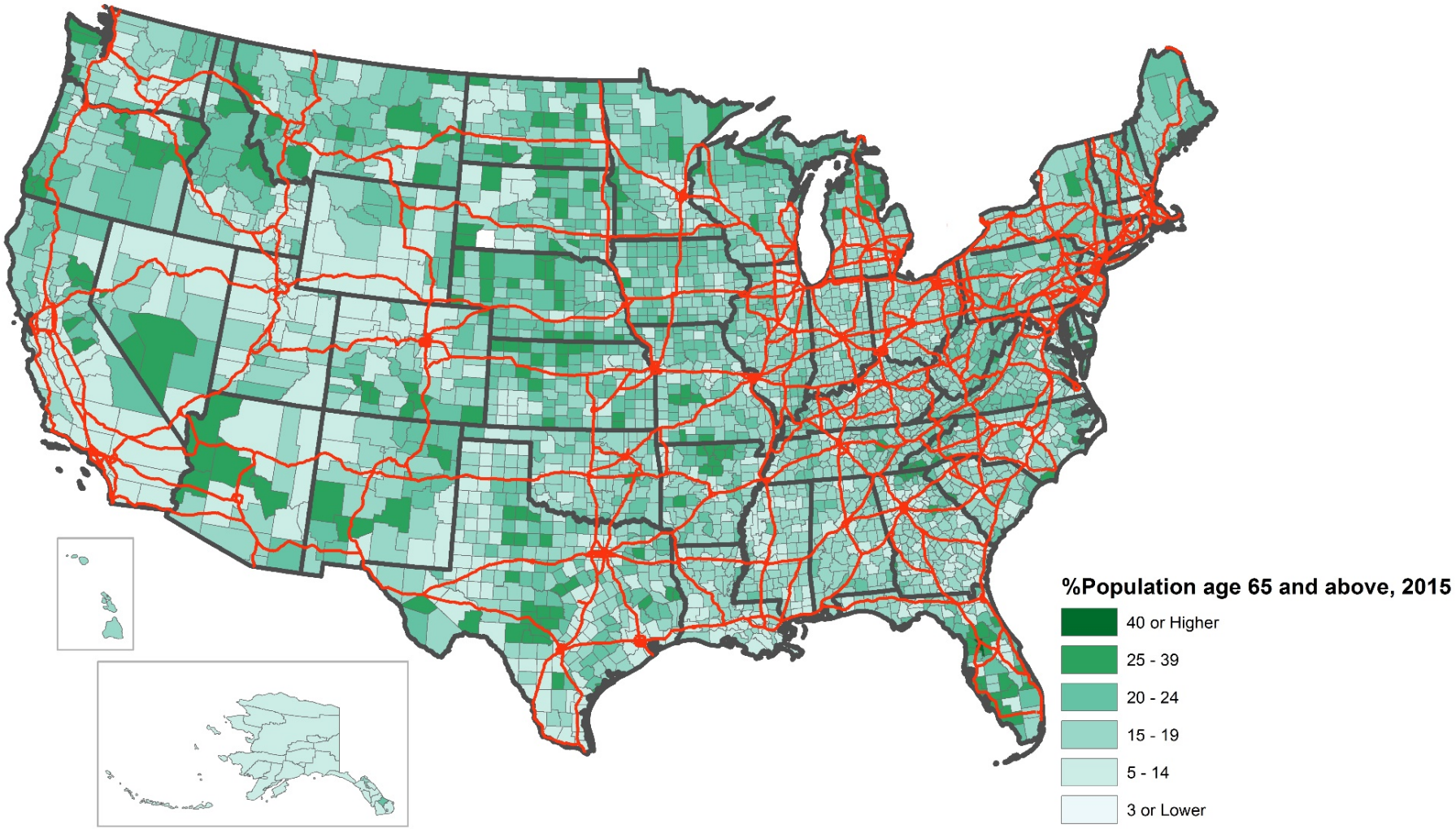
Projected Population Pyramid in percentage in 2060



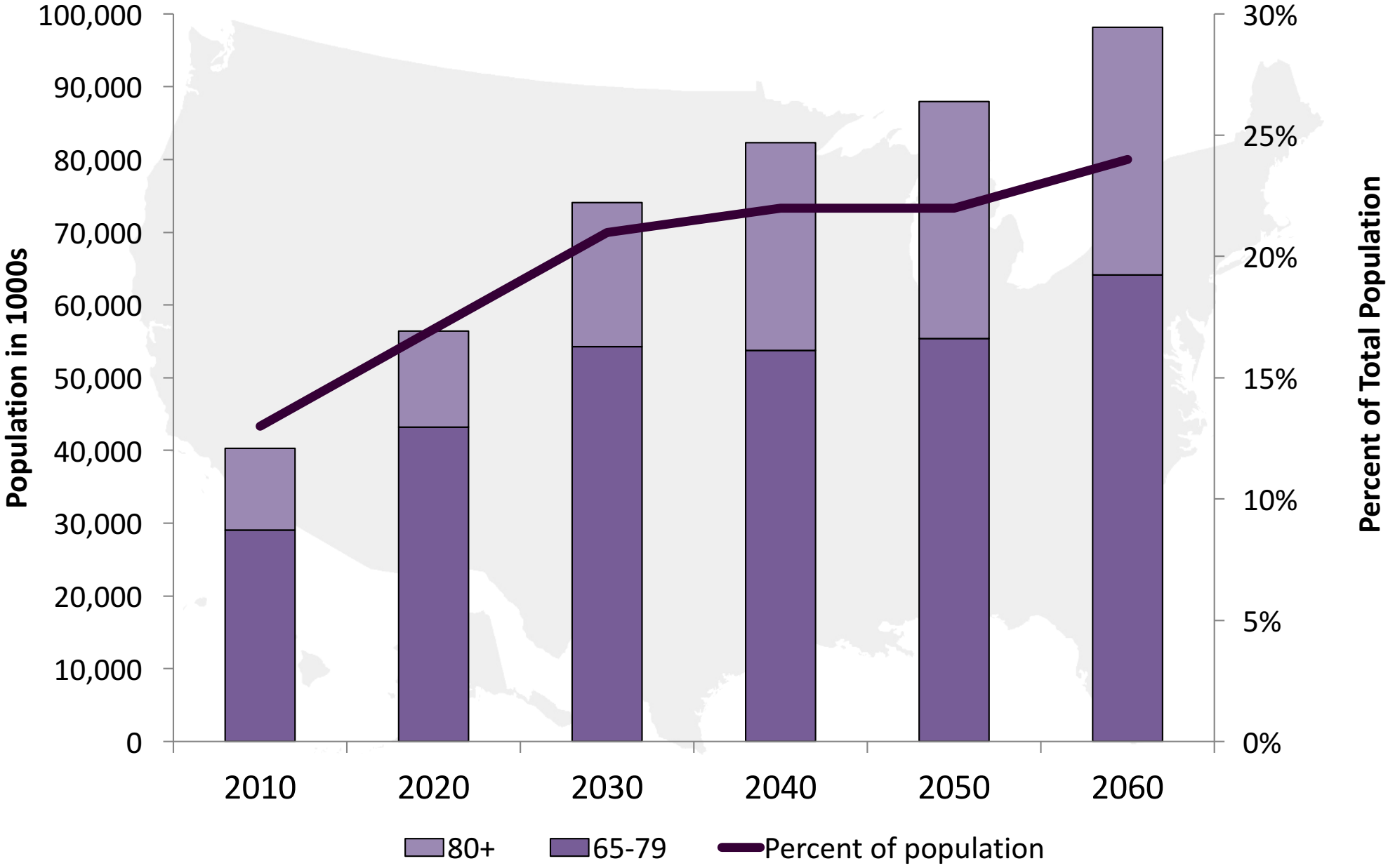
Aging Population (65+) in 2015



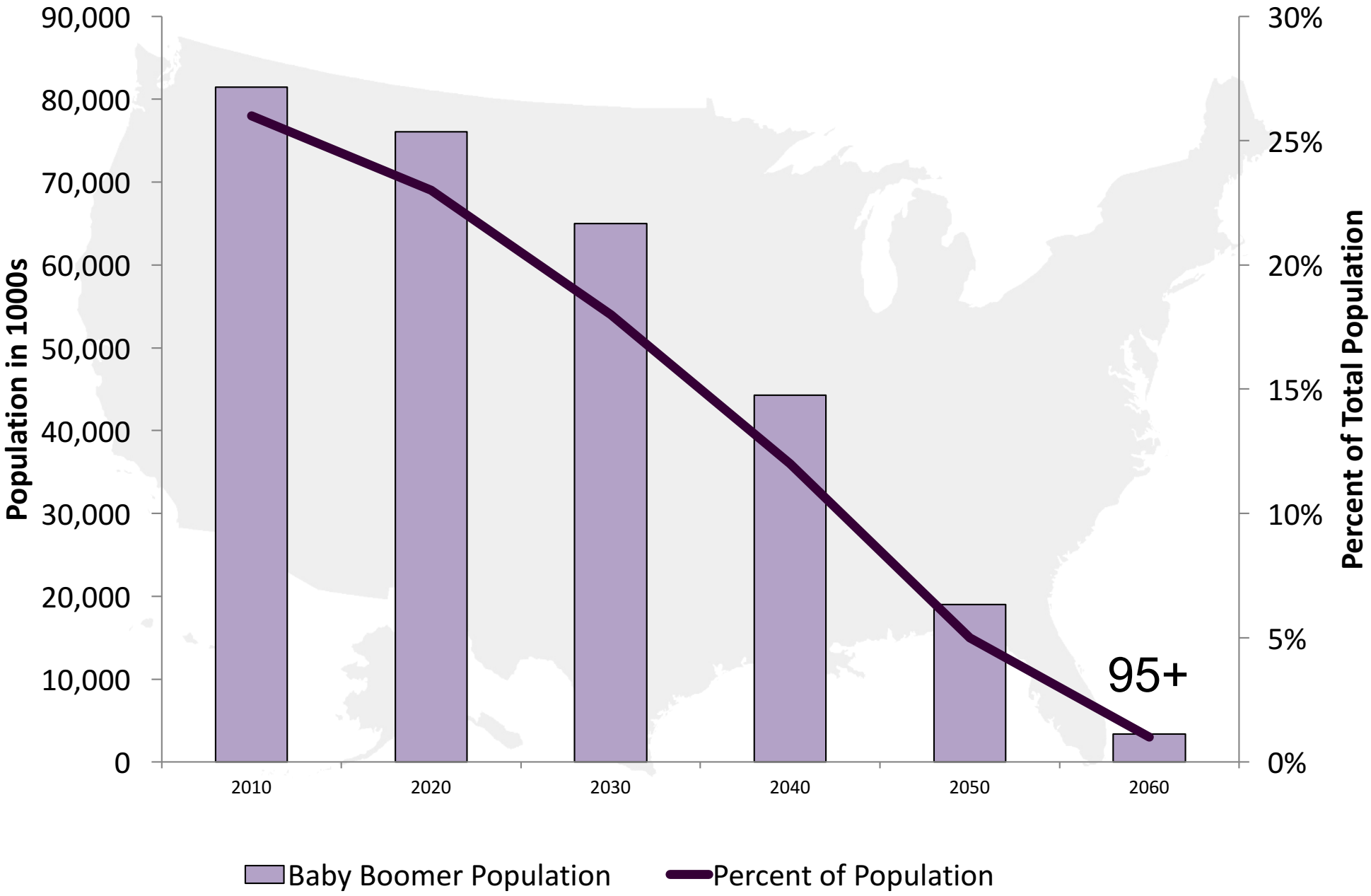
Aging Population (65+) in percentage in 2015



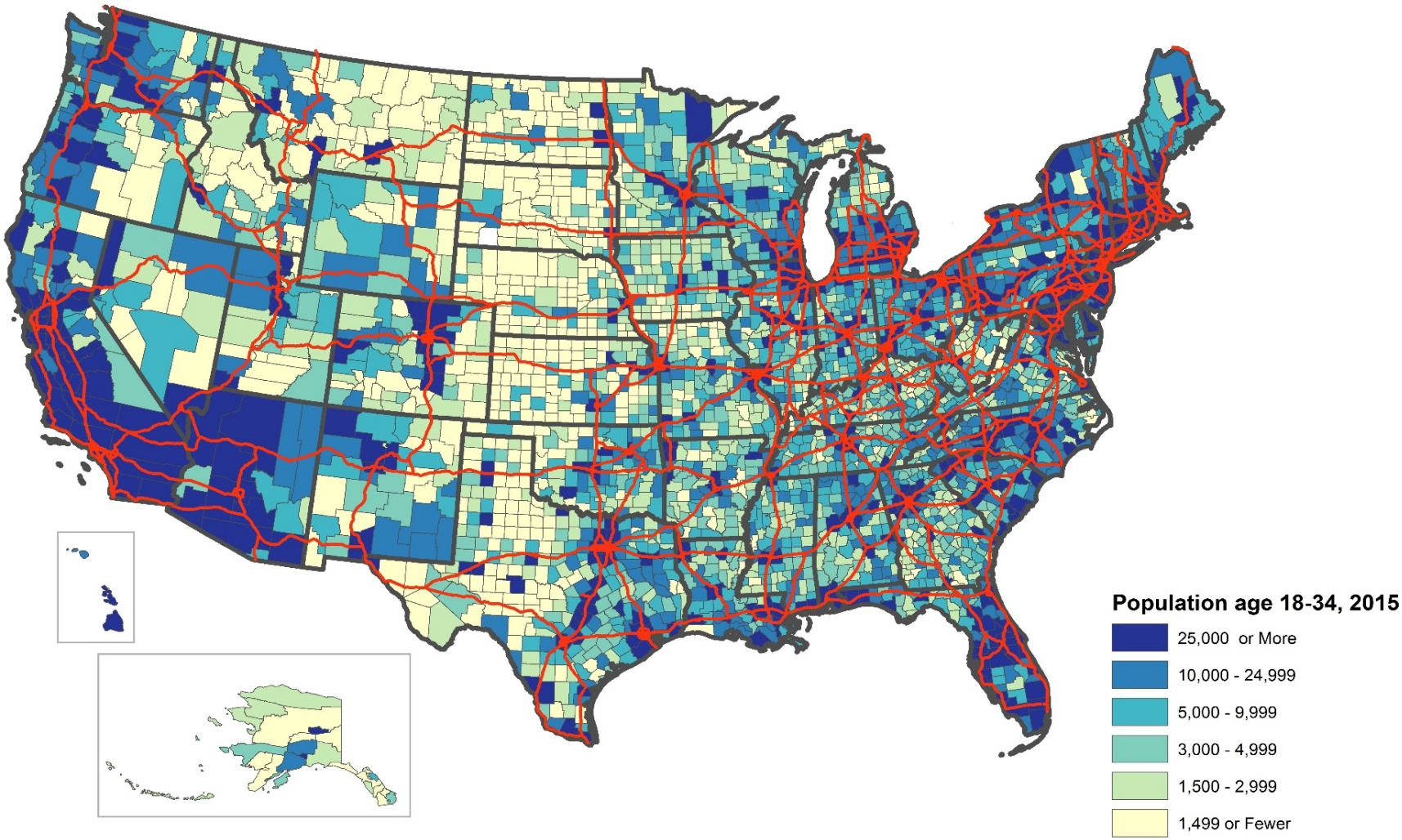
Projected Aging Population (Age 65+) in the U.S., 2010–2060



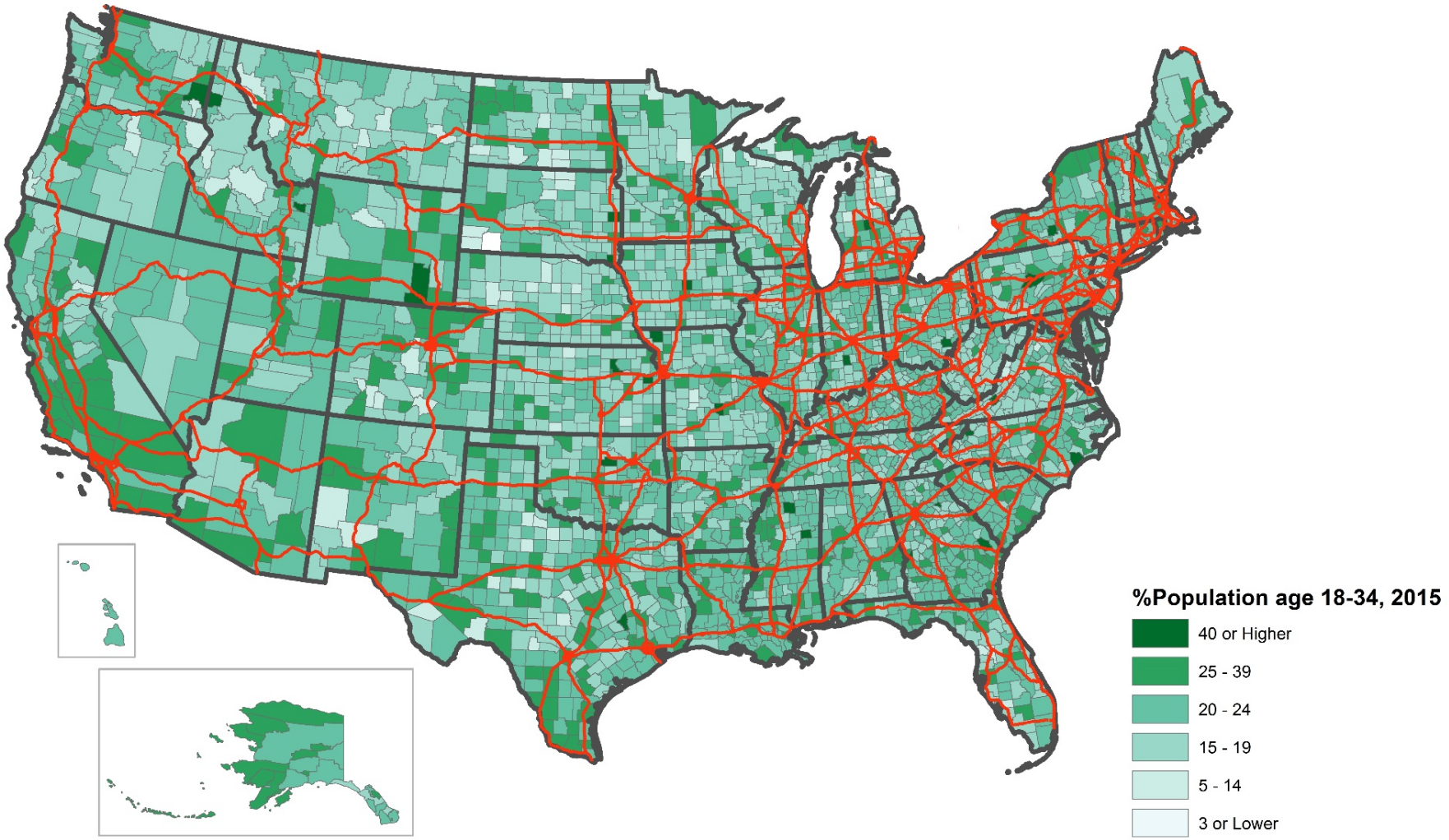
Projected Population of Baby Boomers (Born 1945–1964) in the U.S., 2010–2060



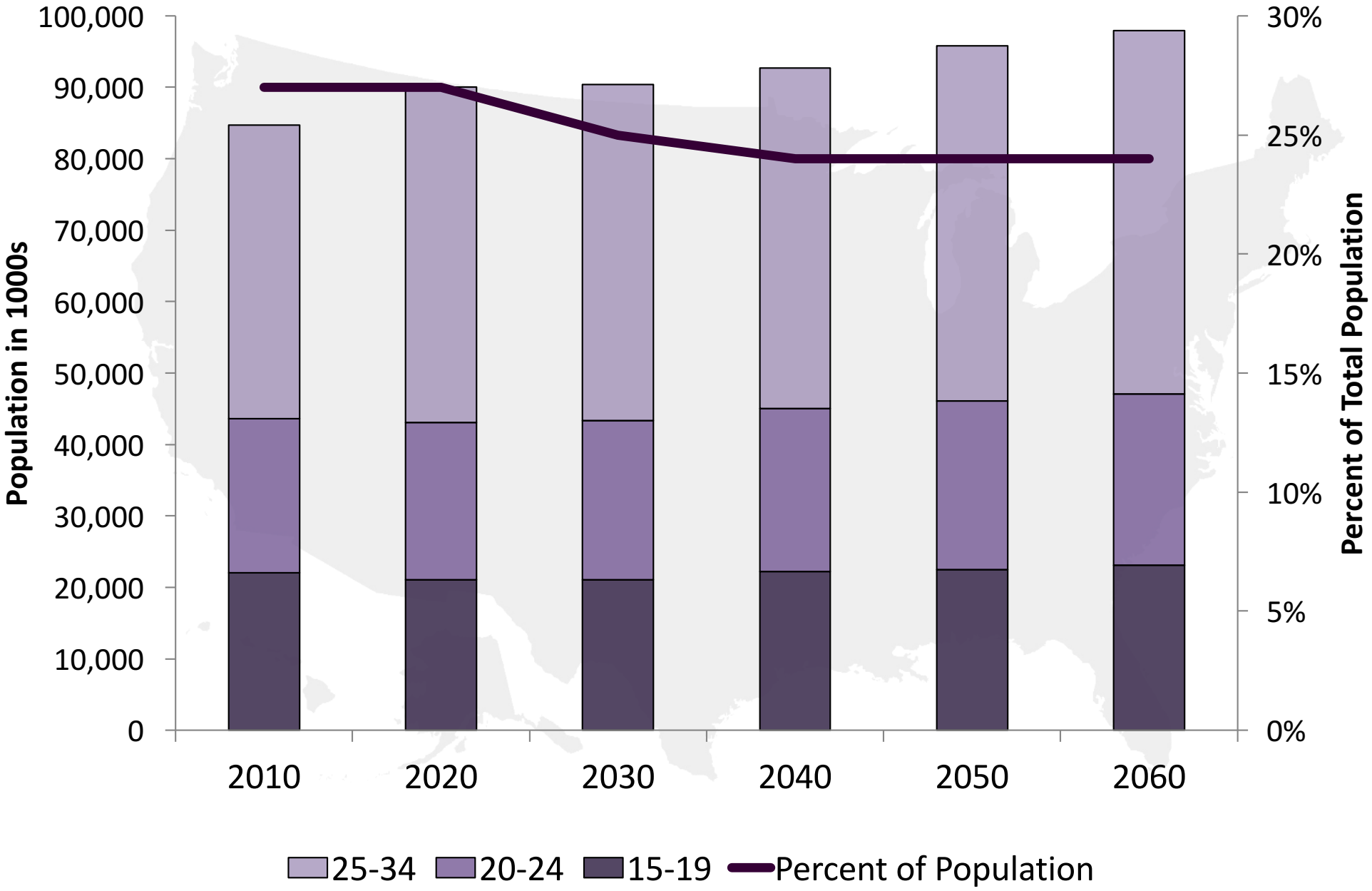
The Young Population (Ages 18-34) in 2015



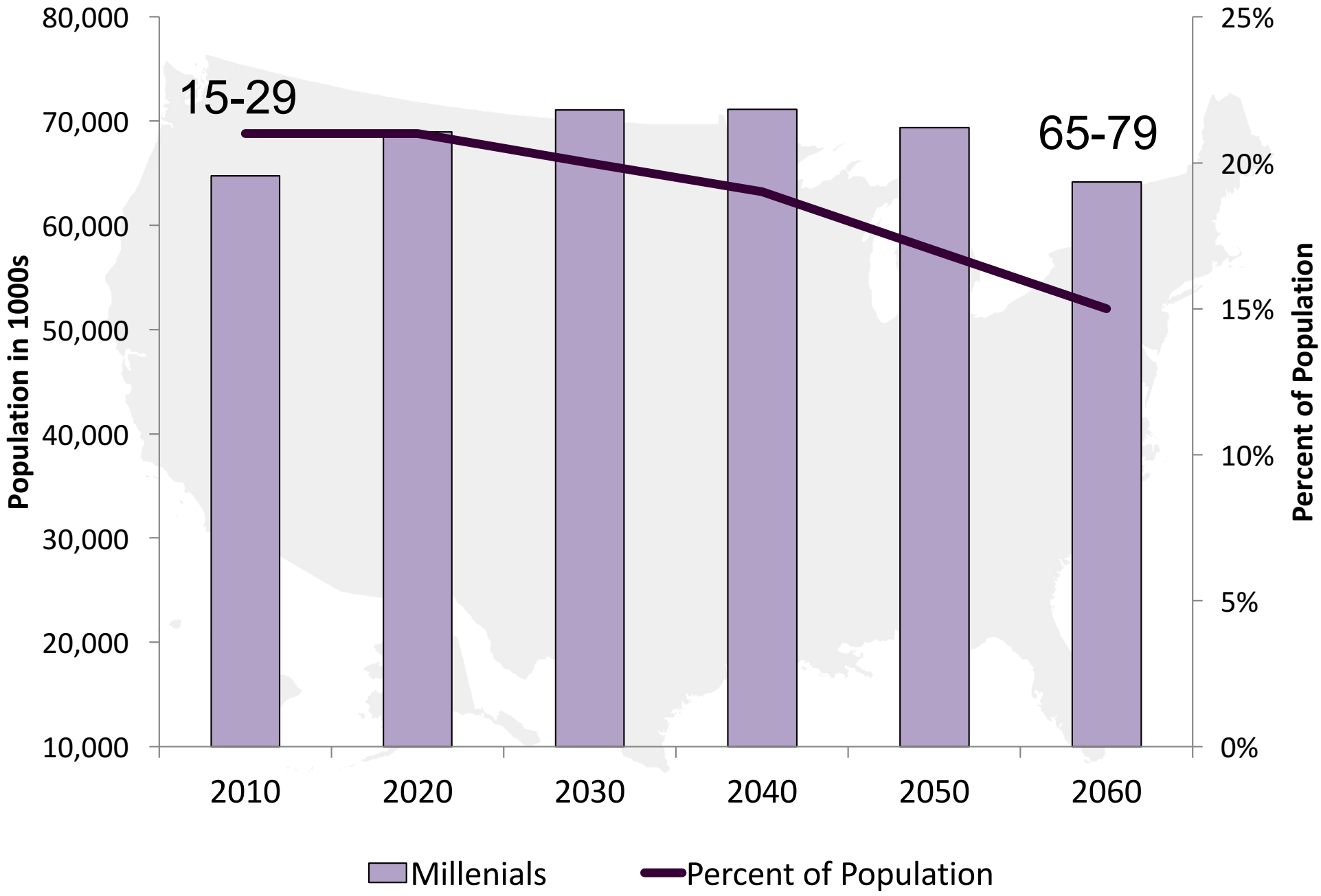
The Young Population (Ages 18-34) in Percentage in 2015



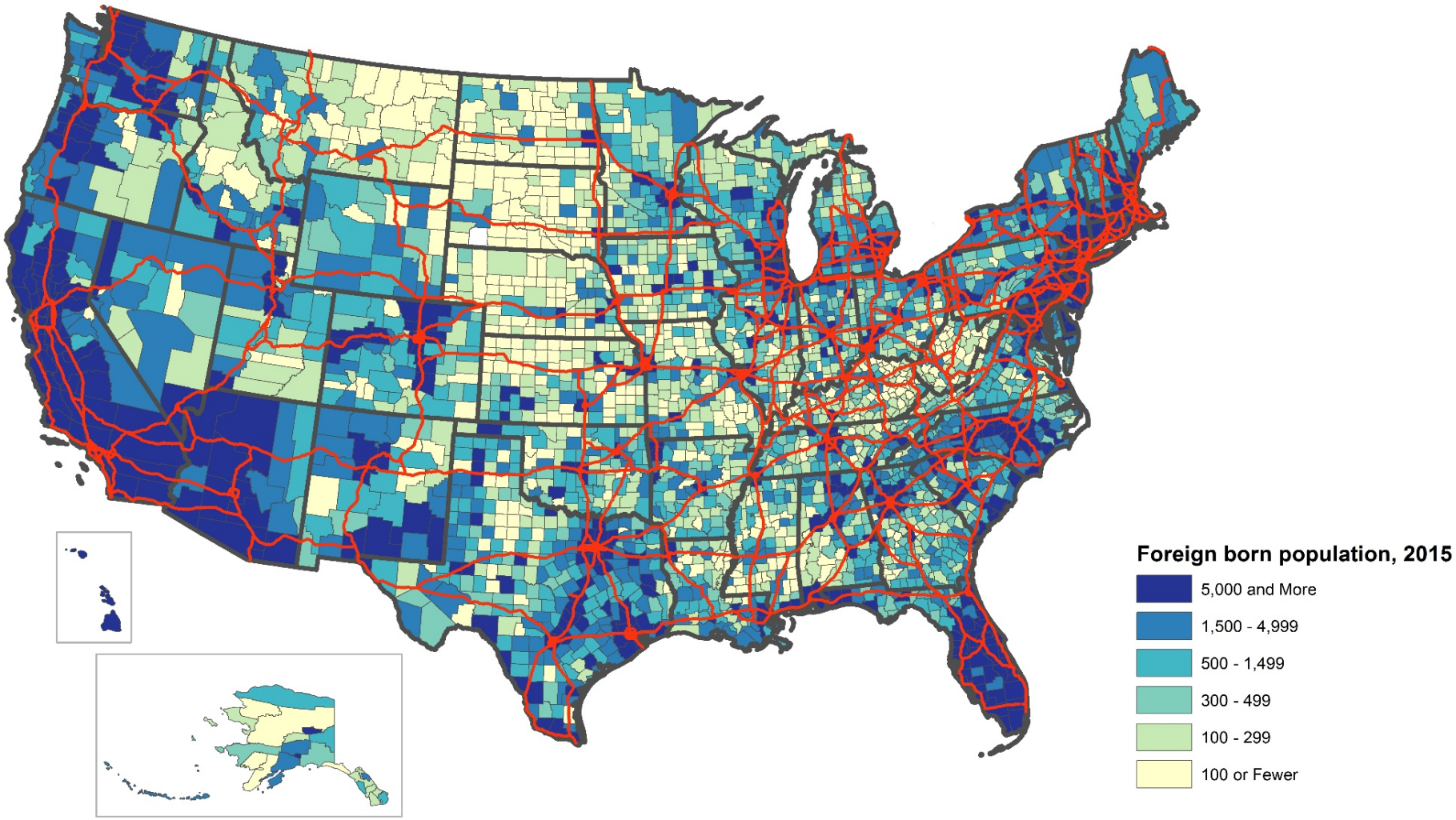
Projected Young Population (Ages 15–34) in the U.S., 2010–2060



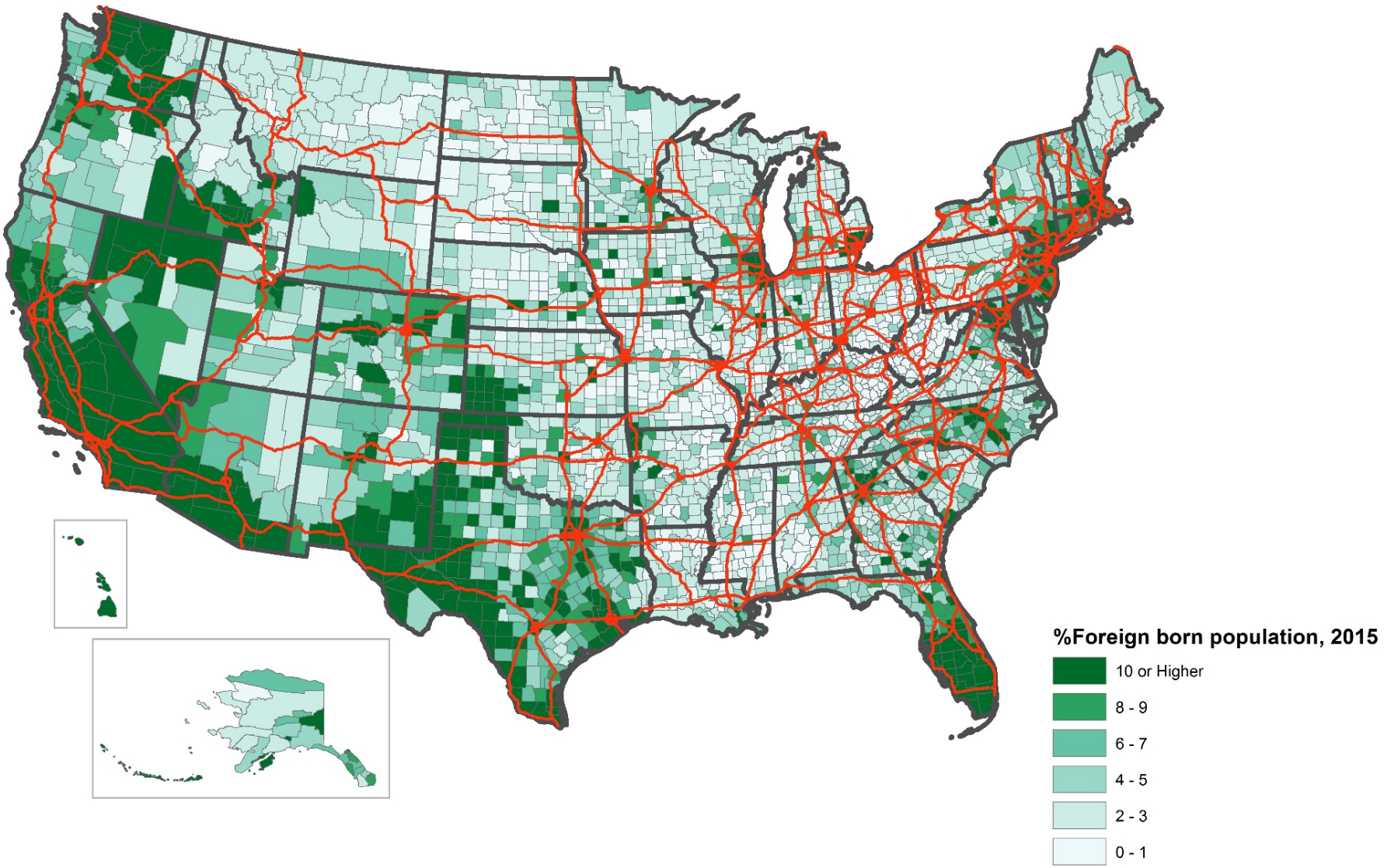
Projected Population of Millennials (Born 1982–1996) in the U.S., 2010–2060



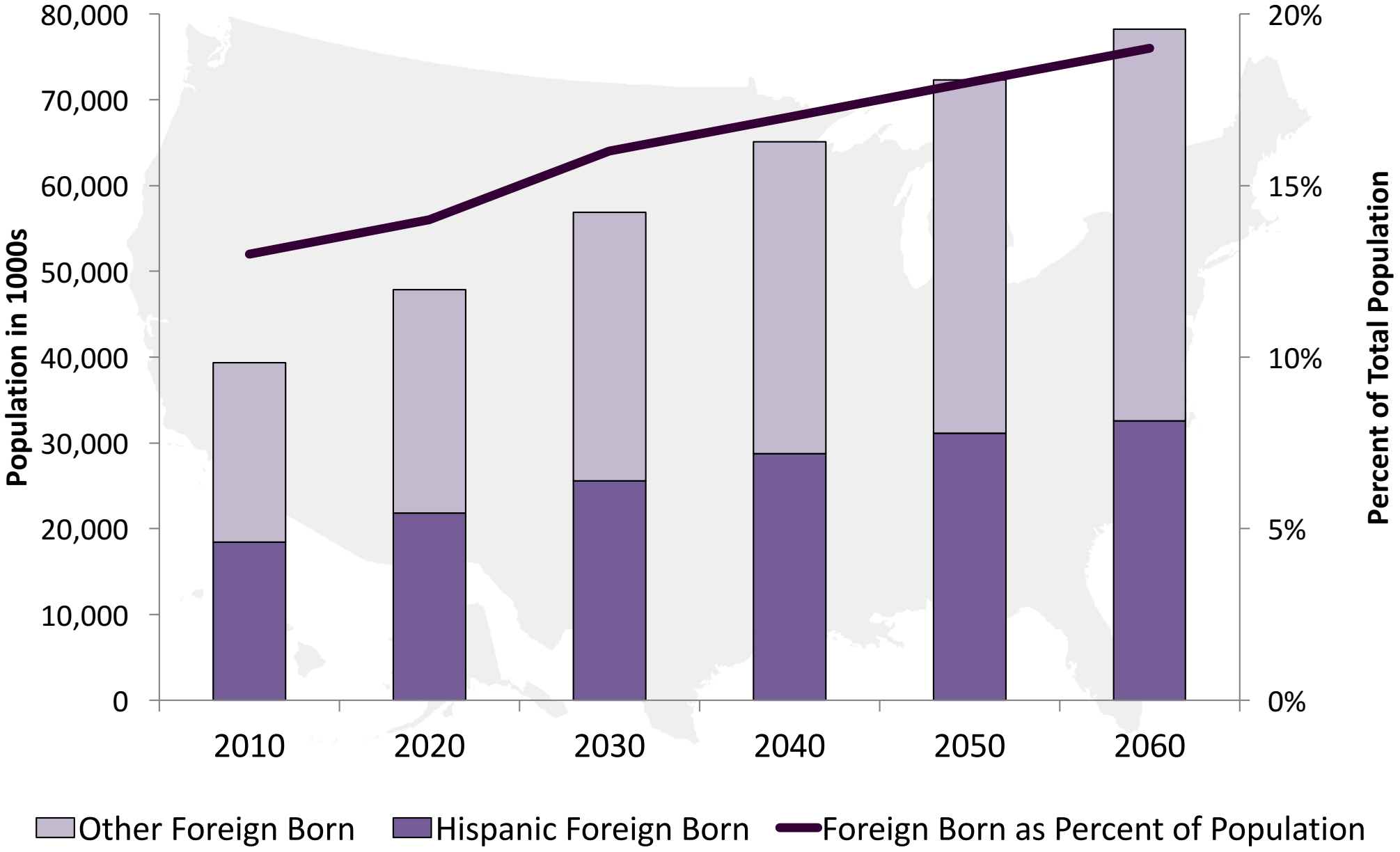
Immigrants in 2015



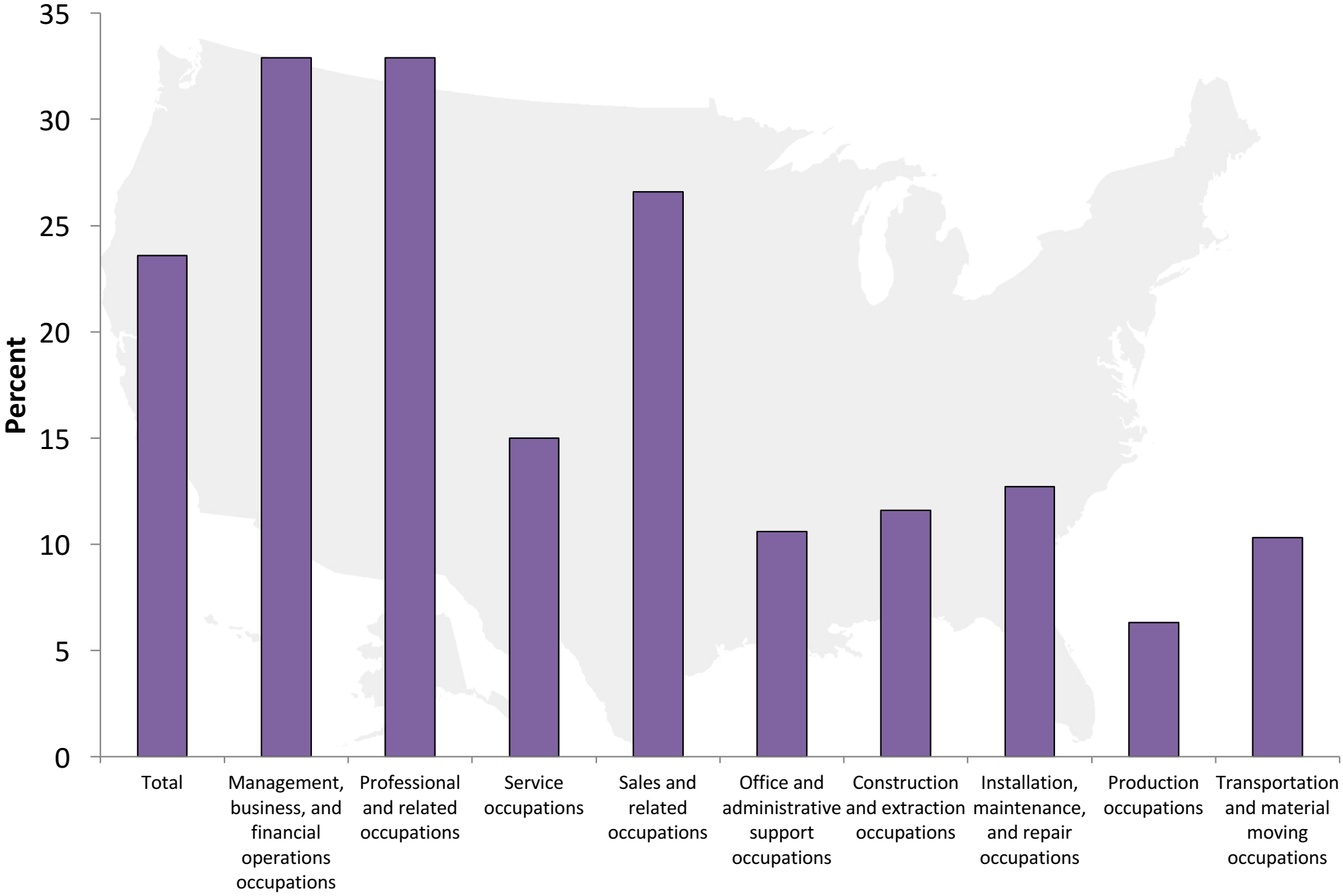
Immigrants in Percentage in 2015



Projected Immigrants in the U.S., 2010–2060



Percentage of Workers Doing Some or All of their Work from Home in the U.S., 2010



Conclusions

1. The U.S. is projected to experience population growth across all age groups over the next 50 years.
2. The projected growth, however, varies across the entire U.S.
3. Population growth areas seem to be concentrated in the border states of the west, south, and east, and the triangle between Atlanta, GA, the Triangle of North Carolina, and Nashville, TN.
4. Population decline areas include many counties from the northeast corner to the Appalachian region, counties bordering the five Big Lakes except Lake Michigan, counties along the Mississippi River, the Deep South states, and Alaska.
5. The areas that may need additional (or less) IHS capacity, based off of their population projections, are identified along the IHS network.

Conclusions

6. The U.S. population is aging quickly and the percentage of the aging population is rising, from 13 percent of the total population in 2010 to 23 percent in 2060.
7. Both the baby boomers and the millennials will have a declining share of the total population.
8. Immigrants are projected to increase from about 13 percent in 2010 to 20 percent in 2060.
9. Telecommuting could affect the usage of the IHS as well.

Future Work

1. Population projections for specific demographic groups.
    - For example, population projections by age and projections of immigrants at the county level could provide useful information for the local decision makers.
2. Population projections for finer geographic scales.
    - Population projection at subcounty levels could be particularly useful for metropolitan areas, where the IHS needs could vary greatly.

Demographic Forecasting and Future Interstate Highway System Demands

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