Exploring our Future - King County Forecasts to 2045

Presented by the 2020 Population Health Initiative Applied Research Fellows

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Project Overview

> *Exploring our Future - King County Forecasts to 2045* provides small area population projections at the Census tract and Health Reporting Area levels for King County by age, race and ethnicity, and sex. These projections are for each five-year interval from 2020-2045.

> Our interactive forecast map provides our results.

> Our forecasts fall well-within the bounds of other forecasts and add new information about sex, age, race and ethnicity, not otherwise available from other sources.

> This project was conducted for the Public Health Services Division of Seattle & King County and the King County Demographer's Office.

> Support for the project was provided by the UW's Population Health Initiative and Center for Studies in Demography & Ecology

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Presentation Overview

Background
Project Motivation, Aims & Research Questions
Methods
Research Question 1 Results
Research Question 2 Results
Research Question 3 Results
Discussion
Appendices

Background

> Since 1990, King County has experienced a 50% growth in population, leading to more diversity in terms of age, race and ethnicity.
> While the White population has remained numerically stable, all other groups have grown.
> Changes in population growth and numbers are not evenly distributed across the county.
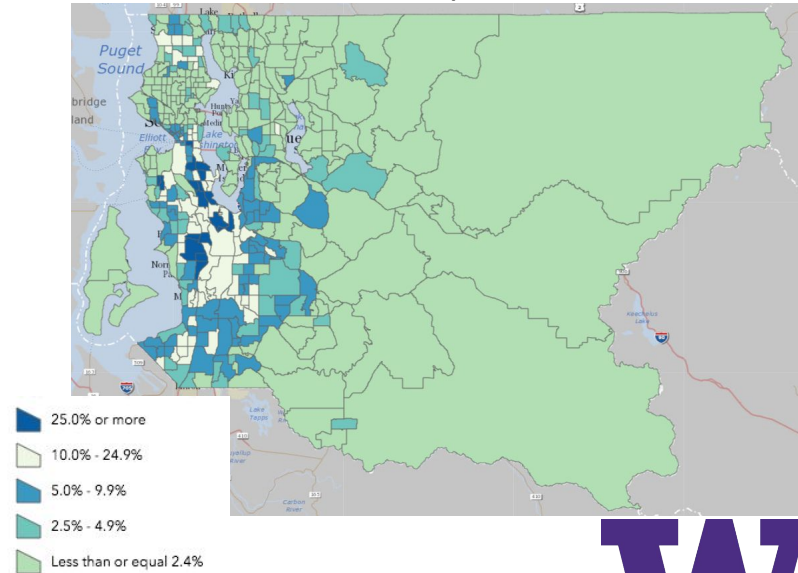
Background

> Significant variation in % white and black population across King County's tracts, based on American Comm. Survey (5 year avg for 2010-2014)
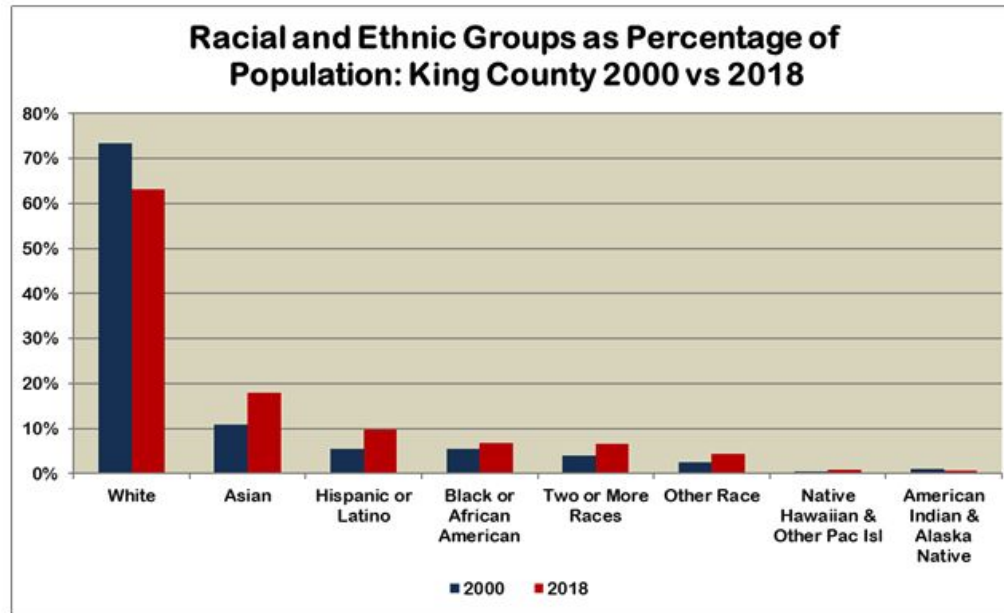

% of White Population
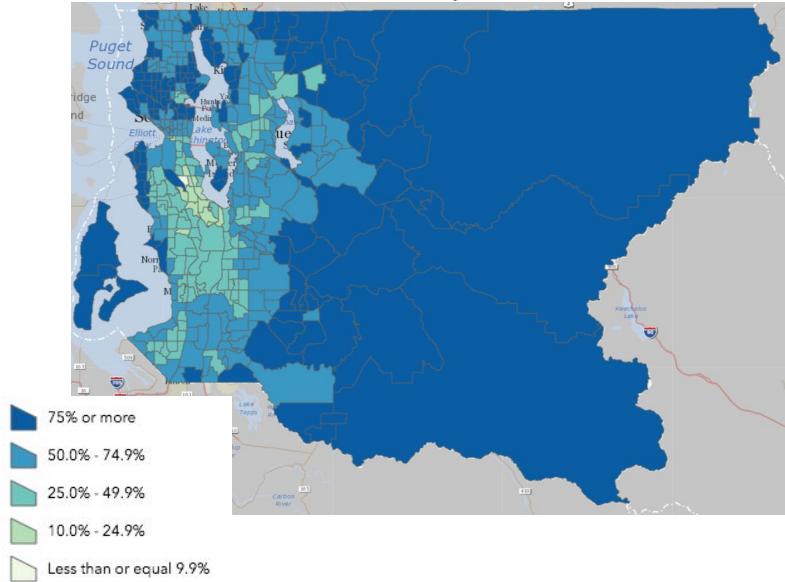

% of Black Population

Background

> In King County, the % White population declined relative to other racial and ethnic groups between 2000 and 2018

Racial and Ethnic Groups as Percentage of Population: King County 2000 vs 2018

Background

> In 2018, King County had a higher concentration of working age and older adults than the entire country, with 30% more 30-39 year olds than the U.S. average

Population by age range

Age range	Percentage
0-9	12%
10-19	11%
20-29	15%
30-39	17%
40-49	14%
50-59	13%
60-69	10%
70-79	6%
80+	3%
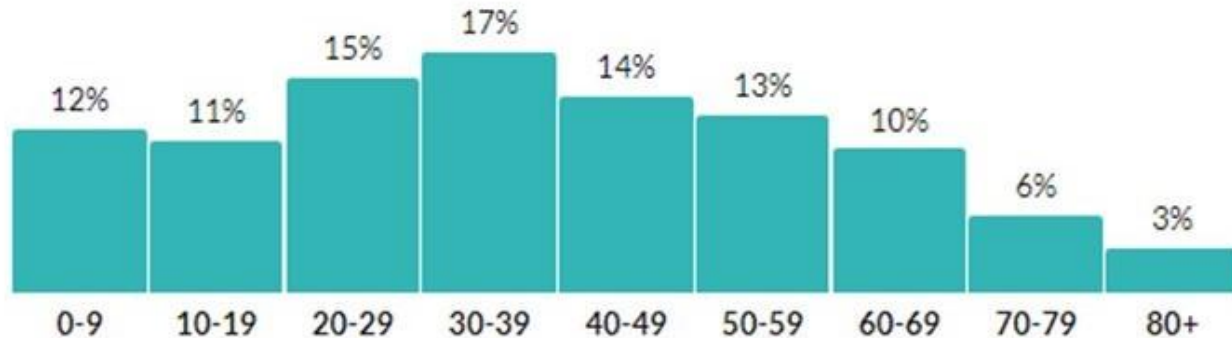
Background

Components of population change are:
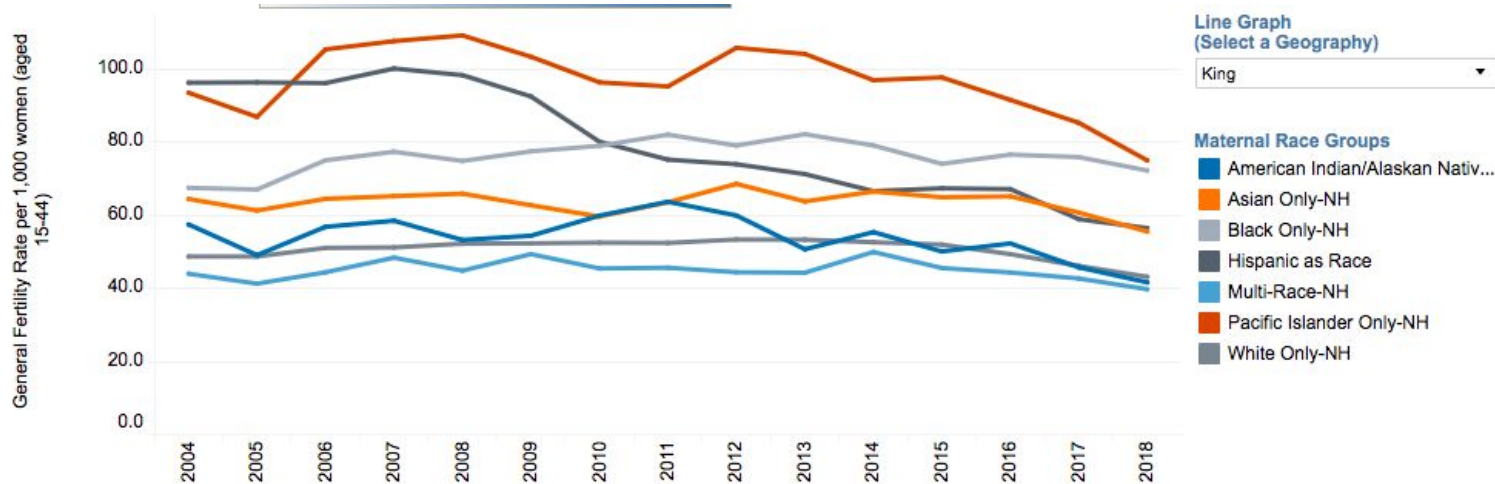> fertility, mortality, and migration

Next slides provide snapshot of observable measures of these components for King County:
> Fertility, life expectancy, and migration

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Background

> Fertility declined for all race and ethnic groups from 2004-2018

Background

> Life expectancy in King County is high but varies across the county.

Tract-level life expectancy at birth in 2014

Males

Females
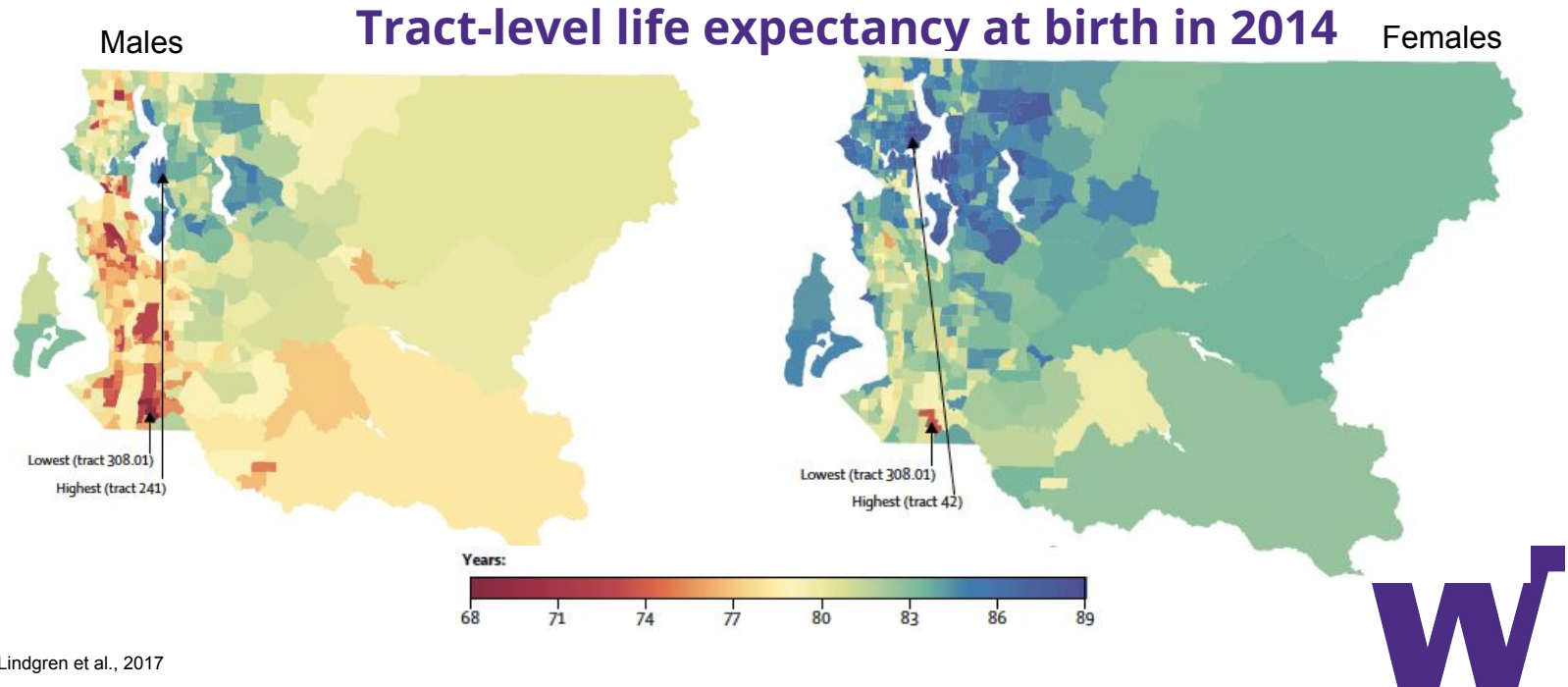
Background

> Life expectancy varies across racial and ethnic group

Life expectancy at birth, King County (average: 2013-2017)

		Life expectancy (years)
King County	Total	81.7
Gender	Female	83.9*
	Male	79.4*
Ethnicity	Hispanic	84.7*
Race	AIAN	75.9*
	Asian	85.8*
	Black	77.6*
	NHPI	73.3*
	White	81.6
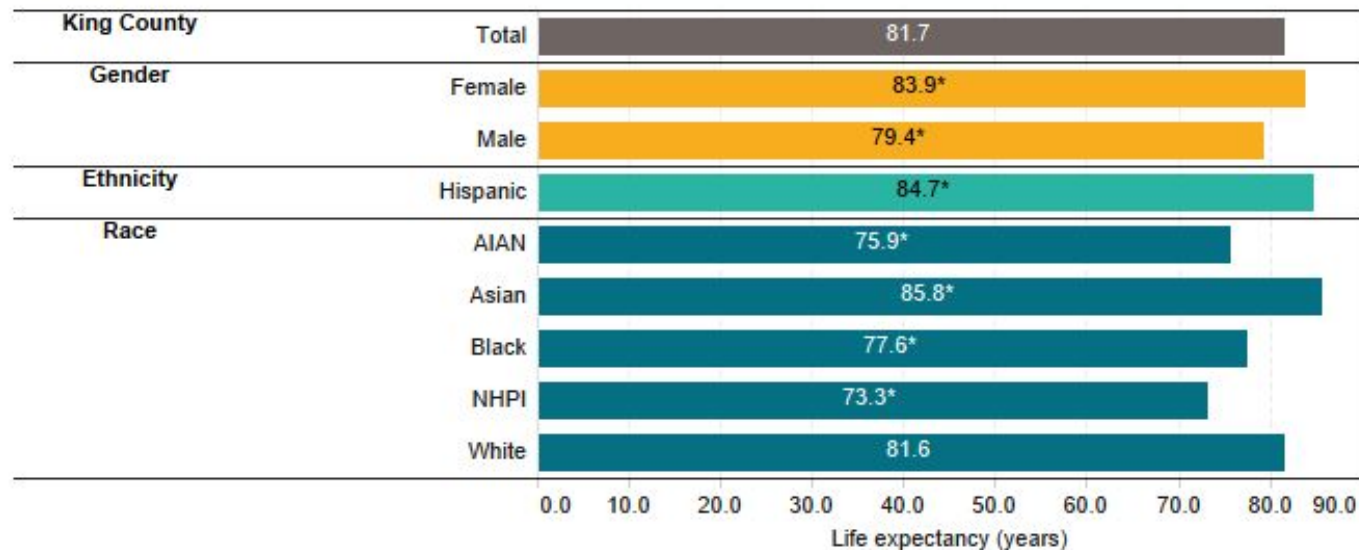
Background

> Migration trends mirror for population growth trends in King County
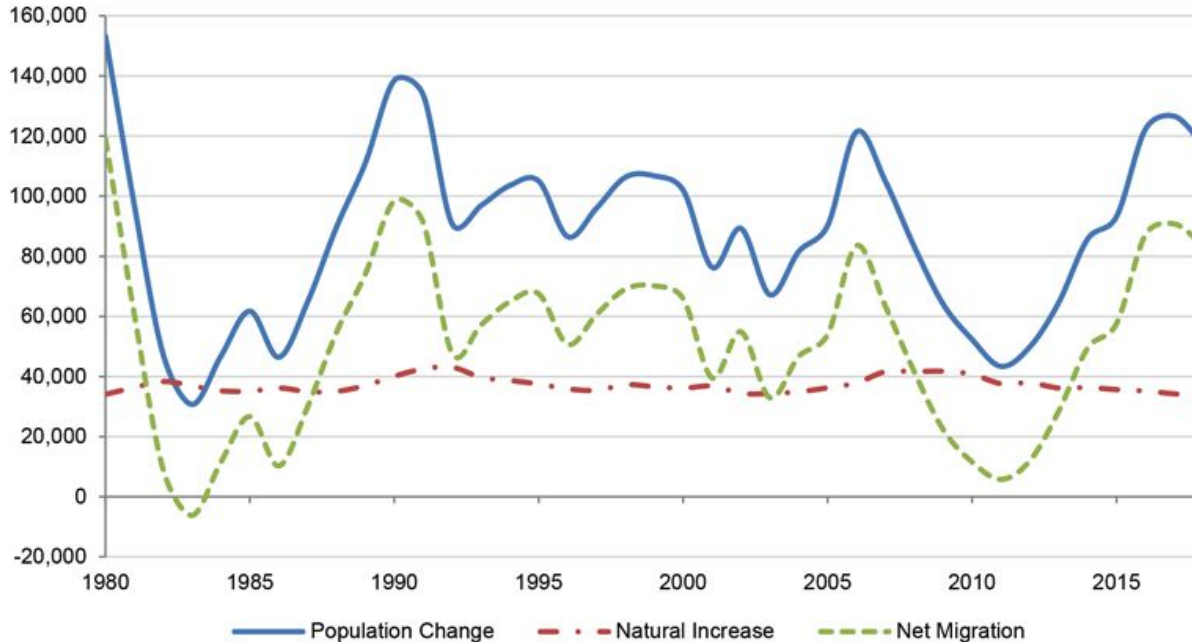
Project Motivation

> King County's demographic shifts are not uniform across the entire county

> Anticipating population changes and assessing where populations are changing the most may be crucial for policy makers

> Sub-county population projections are a valuable tool for promoting equity and ensuring populations have access to the resources they need

> Currently available products exist largely at the county, regional and state level and don't include racial and ethnic details

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Value of Small Area Projections

> Provide detailed forecasts of future local community needs

> Disaggregating changes by age, race and ethnicity, and sex assists with equitably targeting resources

> Overlaying the location of existing facilities assists with analyses for anticipating population growth and demands.

> Finer scale data reveals trends that are often overlooked at county, regional, or state levels.

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Project Aims

> Produce census tract and health reporting area (HRA) population projections by sex, race, ethnicity and 5 year age groups for King County, in 5 year intervals from 2020 to 2045.

> Develop a visualization tool that showcases a graphical presentation of our results and allows for easily manipulatable capabilities to explore and understand projections

> Provide insights into how King County's neighborhoods and areas are anticipated to change in the coming decades, including:
  – Identifying potential population challenges and responses
  – Informing future resource distribution

Research Questions

1. What do we expect the distribution of King County's population to be at the tract and health-reporting area level by sex, race, ethnicity, and age between 2020-2045?

2. Where are people expected to be living in King County (at the tract and health-reporting area unit level) and how does that vary across sex, race, ethnicity, and age?

3. How do these projections inform policy-relevant questions such as the effectiveness of current facility locations, future facility locations, and potential resource challenges King County might face in the future?

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Methods

Data Sources

For projection estimates:

> Office of Finance and Management (OFM) Population Estimates of 5-year age population data by race, ethnicity, and sex at state, county, & tract level for 2010 and 2015

For comparison:

> OFM **state-level** population projections by sex, age, race and ethnicity
> OFM **county-level** population projections by sex and age
> Puget Sound Regional Council (PSRC) **tract-level** population projections

Data sources not available:

> Fertility, mortality, and migration data at tract level
> Need to proxy for this

Hamilton Perry (HP) Method

> Variant of the Cohort-Component population projection method
> Comprised of:
  – Cohort Change Ratio: Proxies for mortality and migration
    > Captures change in the population size of an age-, race-specific group from one period to the next
  – Child Woman Ratio: Proxy for fertility
    > Captures ratio of child population to population of women of childbearing age
    > This ratio is used to anticipate what the child population will be given the population of women of childbearing age

Swanson, David A., Schlottmann, Alan, & 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.

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Smoothing the HP Method

> As originally outlined, the HP method can predict runaway growth
  – Especially true for small populations experiencing large growth
> A modification of the HP method introduced by Inoue (2017) to smooth estimates
> In practice, closely related to empirical Bayes
> Smooth group specific estimates of ratios to total population ratio
> We further expand on this method to include multi-stage smoothing that includes not only geography but also race and ethnicity

Inoue, Takashi. 2017. "A new method for estimating small area demographics and its application to long-term population projection." Pp. 473-489 in The Frontiers of Applied Demography. Springer.

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Additional Modifications

> The smoothing method can lead to unrealistic estimates for tracts that exhibit substantially different population dynamics
 – Group quarter populations tend to exhibit unique population distributions
> Two tracts around UW exhibit unique population change patterns
 – Large number of college-aged individuals
 – High percentages living in group quarters (student housing)
> To account for this, we held the population of these two tracts constant

Reasonable Comparison With Other Expert Projections

Projected Total Population in King County, 2020-2040
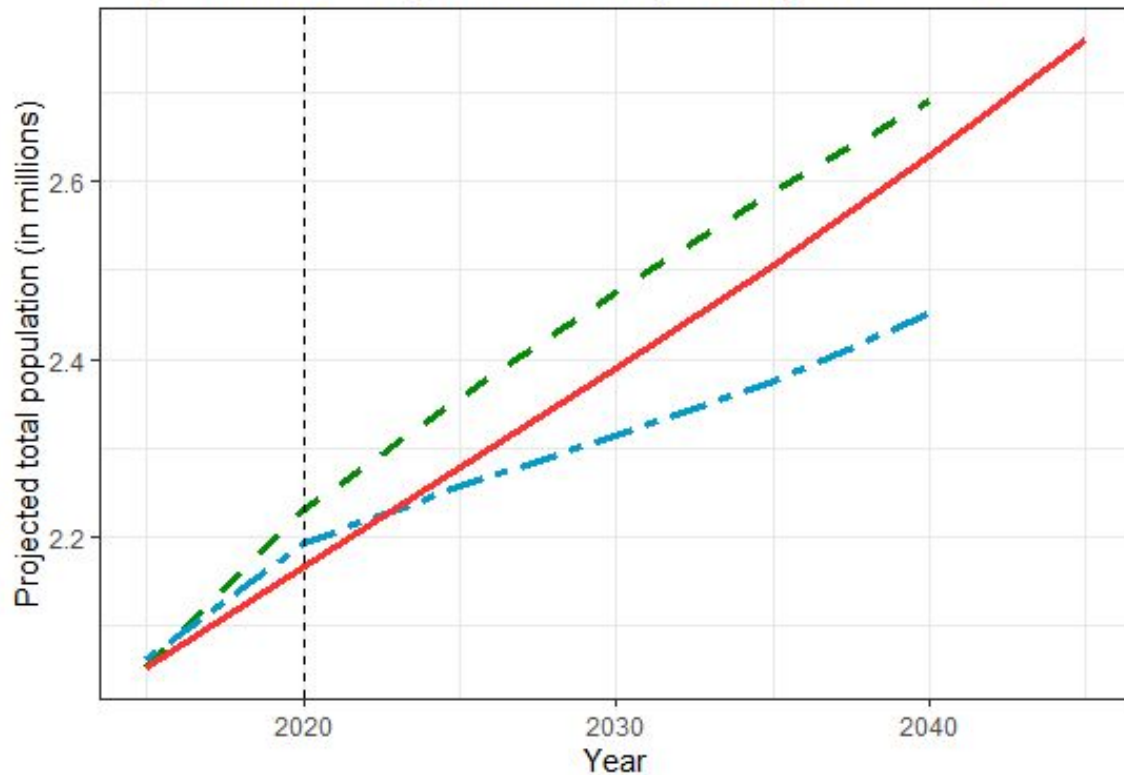
UW-HPS' forecasts tend to fall between those of **OFM (the WA State Office of Financial Management)** and **PSRC (the Puget Sound Regional Council)**

Research Question 1: What is King County's projected population distribution?
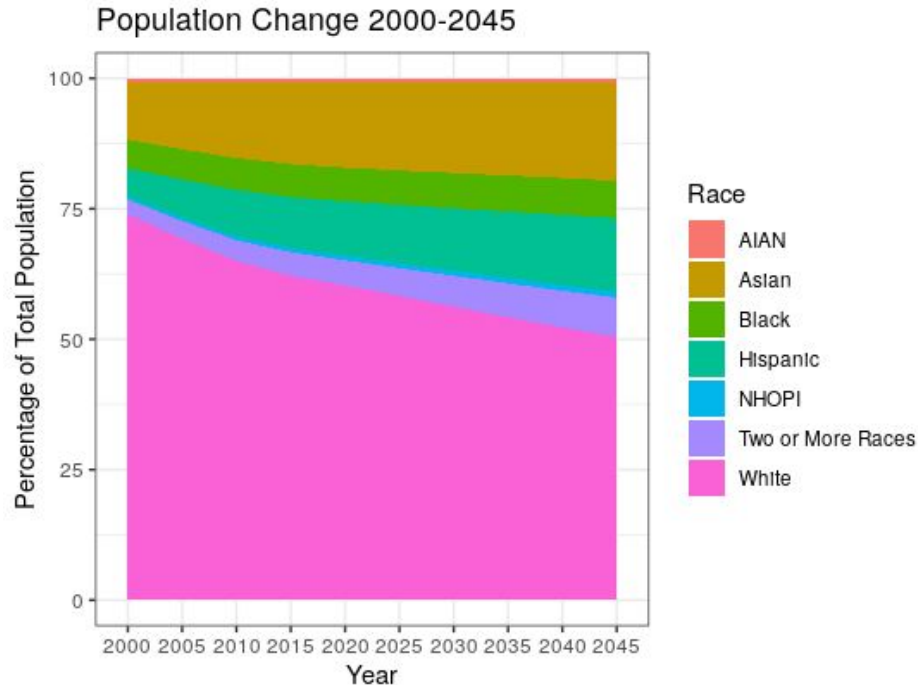
UW Forecast 2045:
King County's Total Population

> The population will grow by 700,000 by 2045 and the growth rate is fairly constant for the next 25 years

## Aggregated Tract Projections for County
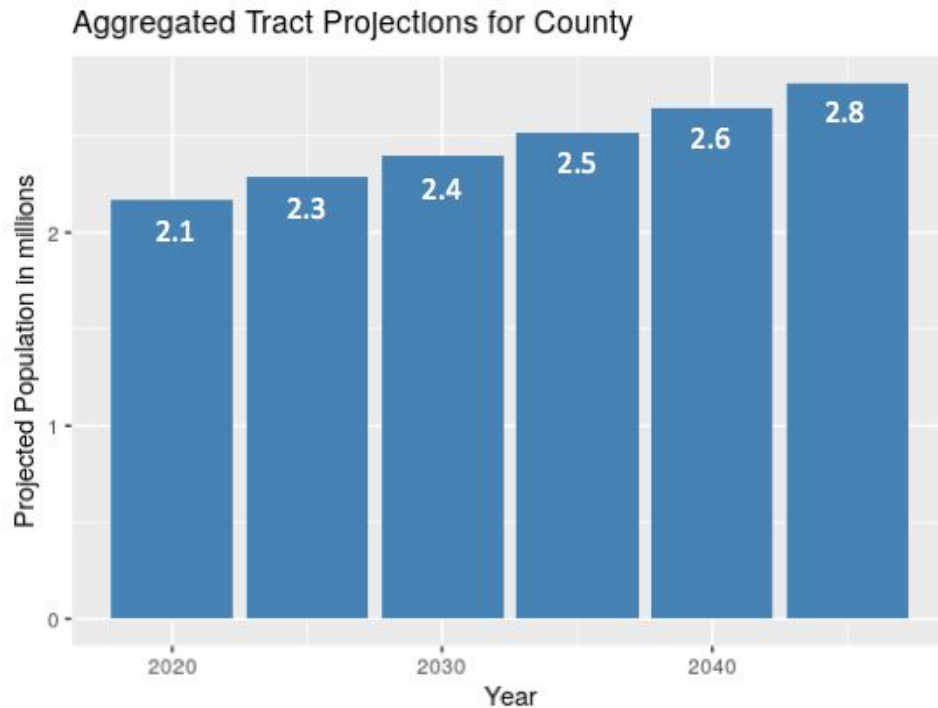
UW Forecast 2045:
Distribution by Race and Ethnic Group

> The proportion of the White population is projected to decline to 50% by 2045; fastest growing race and ethnicity groups are Two or More Races, Asian and the Hispanic population


Population Change 2000-2045

UW Forecast 2045:
Distribution by Age Group

> The 15-44 age group is consistently largest; proportion of population that is 65+ is growing over time

> The 0-14 and 45-64 age groups are projected to grow proportionally to overall county growth

Aggregated Tract Projections for County
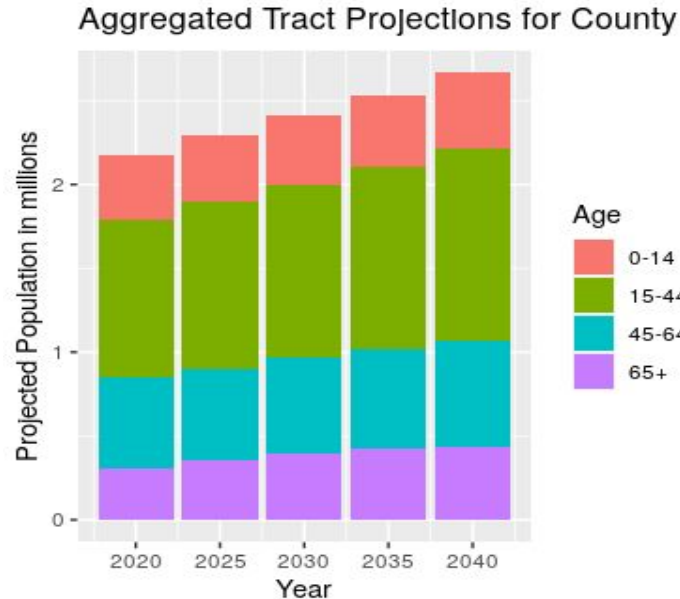
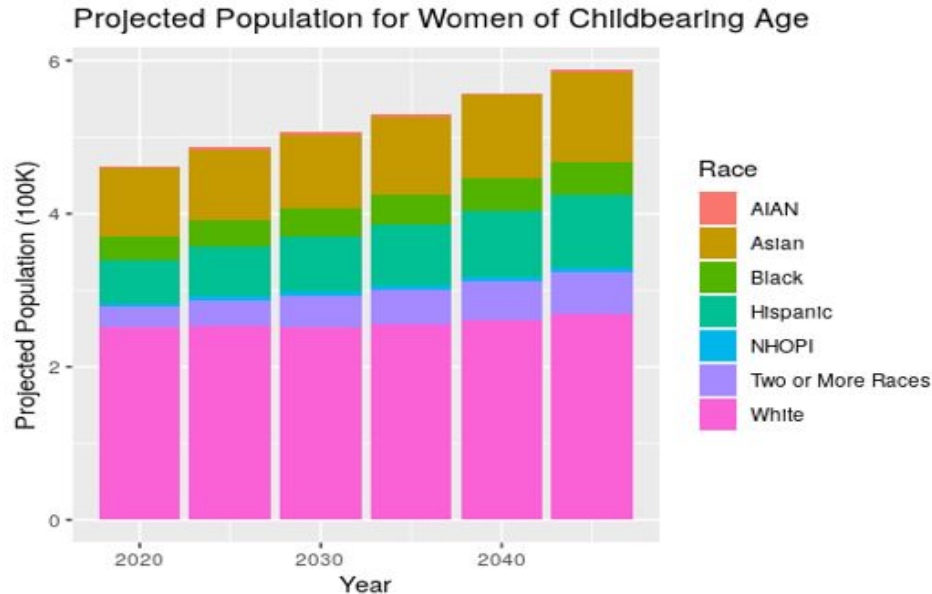# UW Forecast 2045:
Distribution by Age, Race and Ethnic Group

> The Asian and Hispanic population are growing the fastest in the 15-44 age group. Growth of the White population plateau's from 2030 onwards, contributing to the greater trend of shrinking white proportion of the total population.

Projections Broken Down by Age and Race
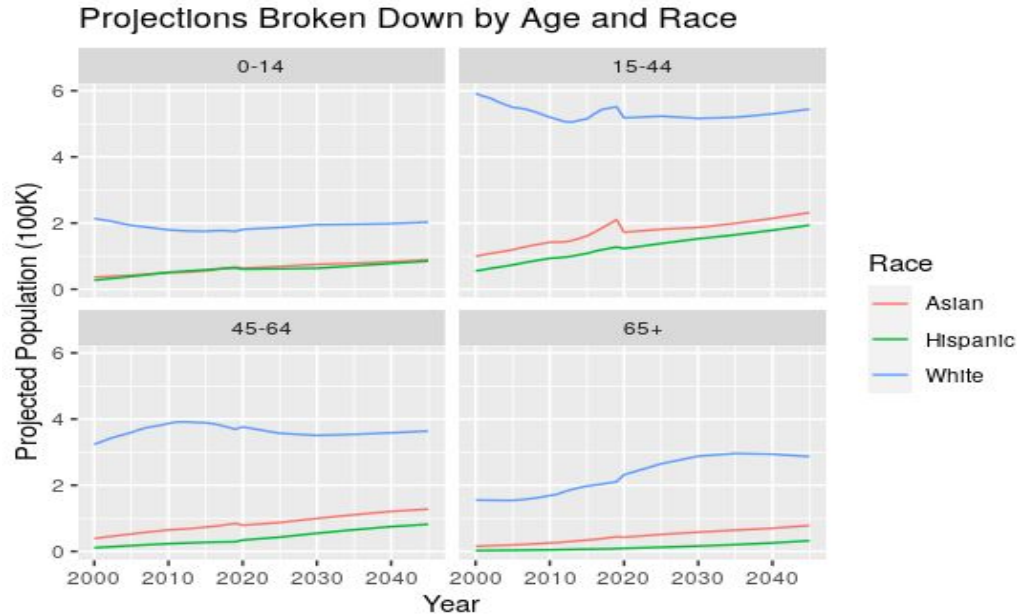
UW Forecast 2045:
# Women of Childbearing Age by Race and Ethnic Group

> Classified childbearing age as 15-44 years. For each race and ethnic group, the population is growing but the rates of growth vary. The White population growth stagnates, while there are higher growth rates for Asians, Hispanics and Two or More Races.

Projected Population for Women of Childbearing Age

Research Question 2: Where are people expected to live?

UW Forecast 2045:
Visualization Tool – Exploring Our Future

http://population-dynamics-lab.csde.washington.edu:8080/kc_forecast_2045/
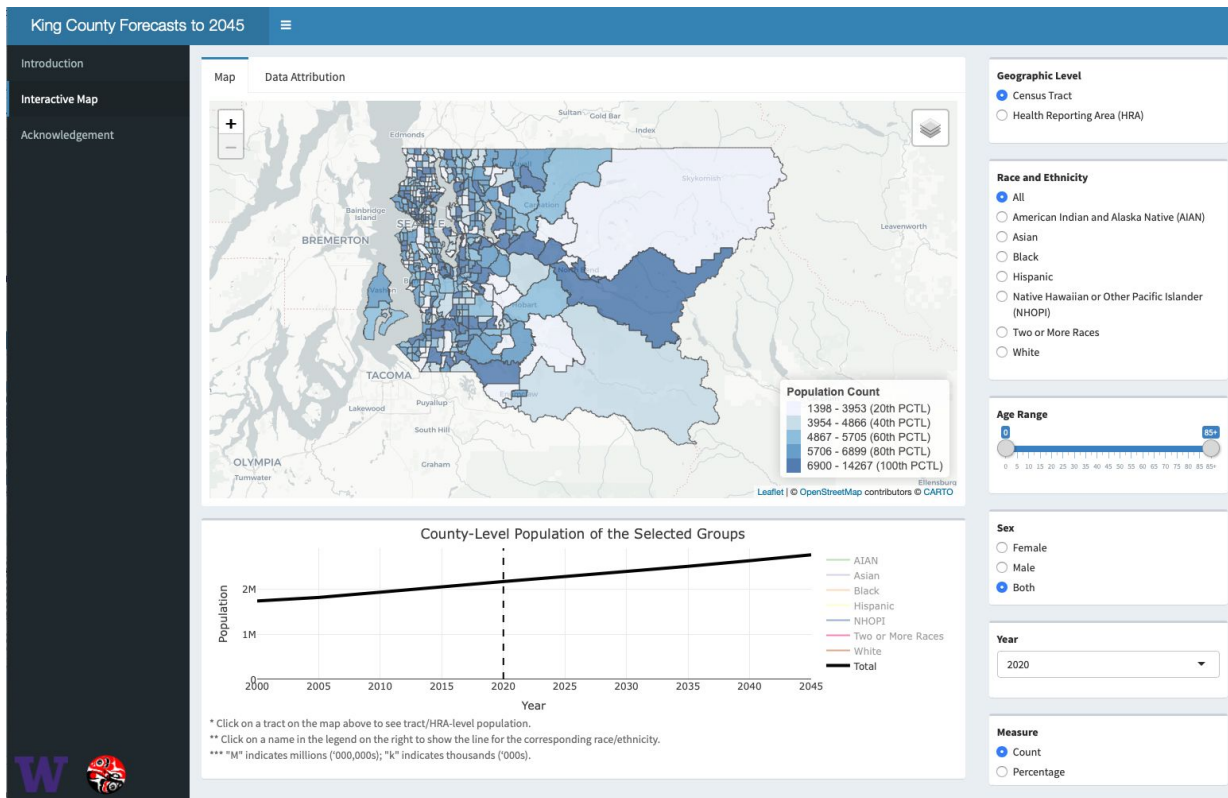
Research Question 3:
What are the policy implications of these projections?

Examining Projected Patterns

> The UW-PHI Projections give us a glimpse into a possible future, and allow us the flexibility to examine variations in population change and distibutions by age, sex, race, and ethnicity. As such, we can provide important insights into changes that may occur among populations of interest, such as:
>> – The elderly
>> – Women of childbearing age
>> – Infants and children
>> – Specific racial or ethnic groups
>> – Cross-sections of the above groupings
> We will show how our projections can be used to explore projected changes in the population size and distribution of the elderly and women of childbearing ages

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Example 1: Aging Populations

> The aging (65+) population has different health care and public health service needs than the adult and youth populations.

> Understanding population changes and geospatial distribution for this age cohort helps target programs, services, and future facilities, such as elder care homes and senior centers.

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UW Projections: Aging Populations

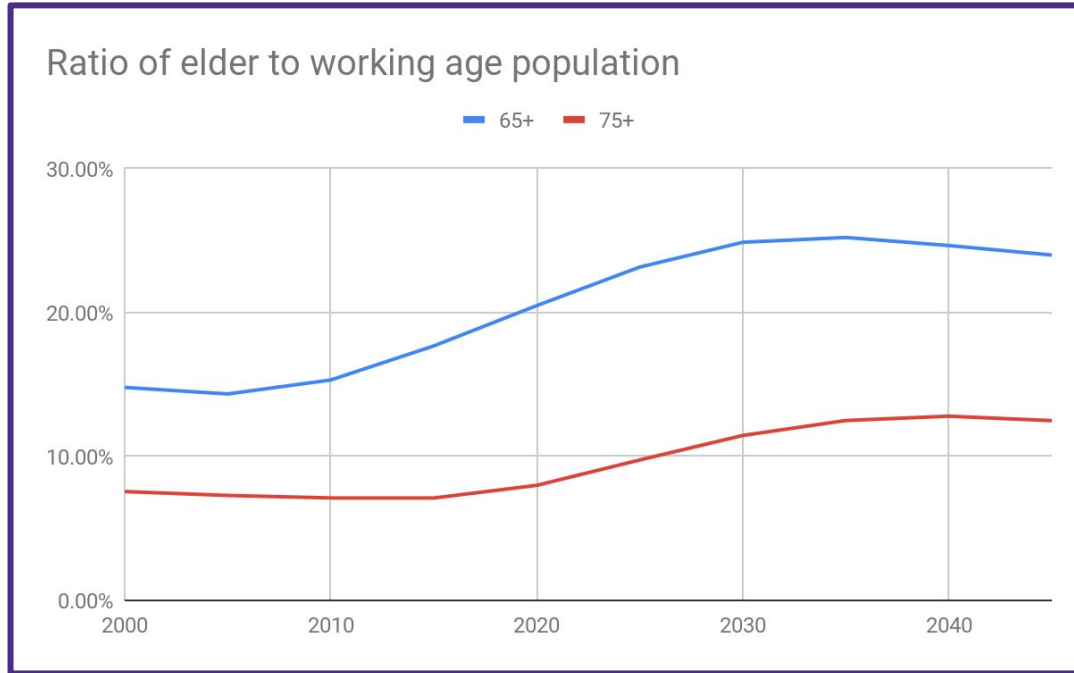## Mean age by sex and race and ethnicity in King County, 2000-2045
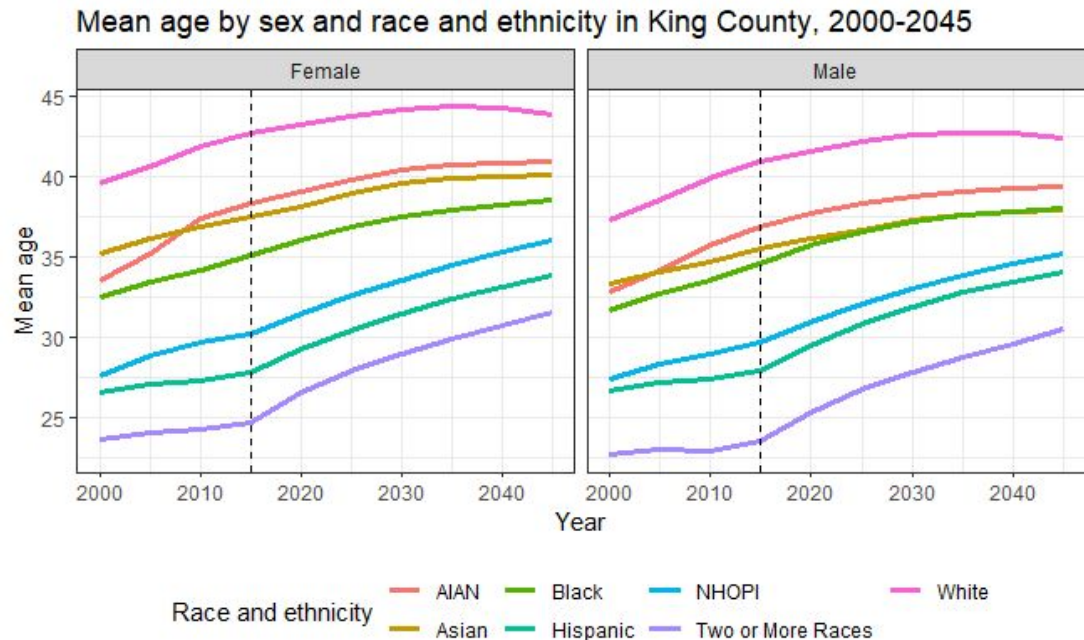
Mean age in King County is increasing for all races and ethnicities. This is largely driven by oldest age groups.

Compared with 22% average growth county-wide, older age groups grow by:
> 45% for 65+,
> 94% for 75+,
> 115% for 85+

Chart legend — Race and ethnicity: AIAN, Asian, Black, Hispanic, NHOPI, Two or More Races, White

Old Age Dependency Ratio
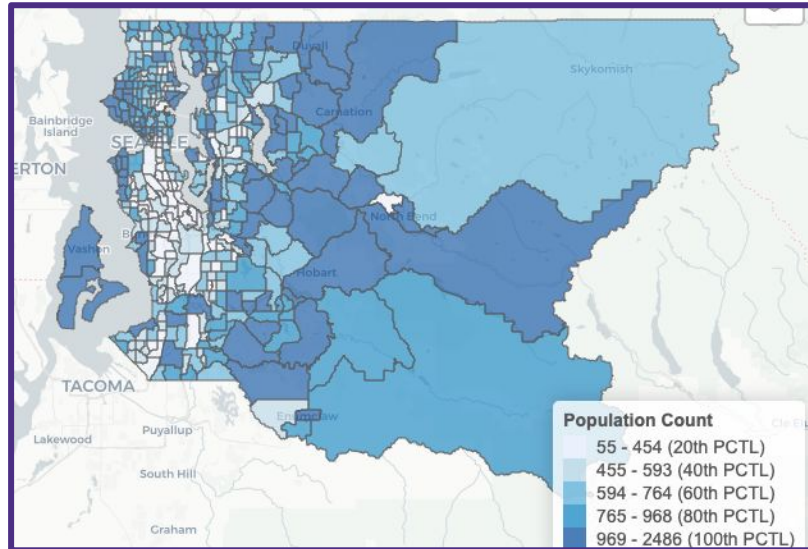

Ratio of elder to working age population

— 65+ — 75+

> The OADR is the ratio of 65+ (or 75+) to 15 - 64 year olds, and is a measure of the economic and care burden of the aging population
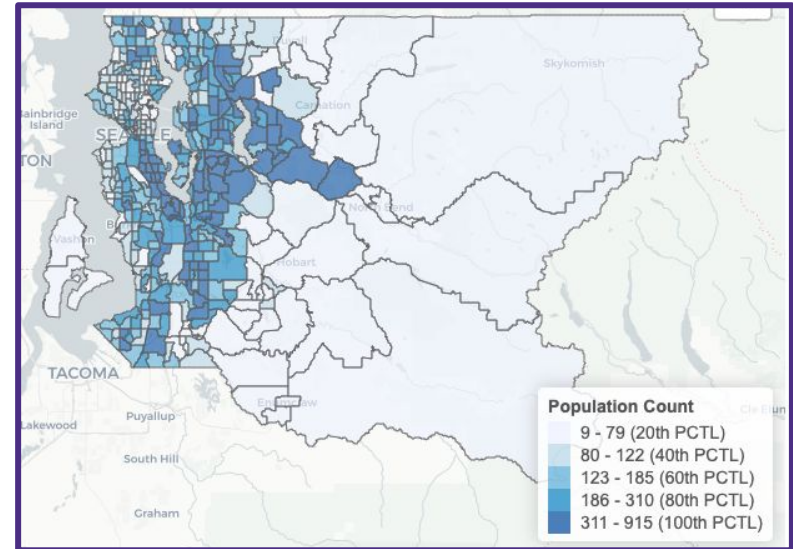> We see the fastest growth in this ratio between 2020 and 2030

Racial Clustering of 65+ Populations

Our visualization tool allows decomposition by race and ethnicity, which unmasks variation in the spatial distributions of sub-populations. Below shows that the populations of 65+-year-old Whites and Asians are projected to be located in very different areas in King County in 2045.

Population Count
- 55 - 454 (20th PCTL)
- 455 - 593 (40th PCTL)
- 594 - 764 (60th PCTL)
- 765 - 968 (80th PCTL)
- 969 - 2486 (100th PCTL)

White, 65+, 2045 projection

Population Count
- 9 - 79 (20th PCTL)
- 80 - 122 (40th PCTL)
- 123 - 185 (60th PCTL)
- 186 - 310 (80th PCTL)
- 311 - 915 (100th PCTL)

Asian, 65+, 2045 projection

Example 2: Women of Childbearing Age

> **Women of childbearing age (15-44) are targeted for public health services around reproductive health and neonatal and child health services**
> **Understanding where this population resides helps increase equitable access to such services**
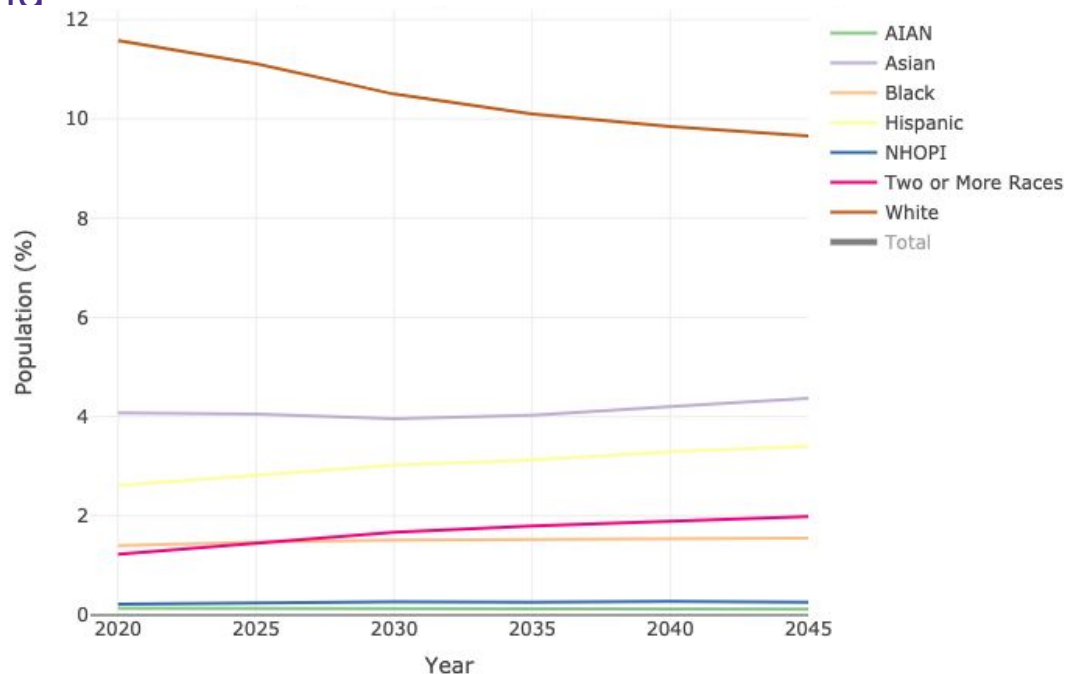
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UW Projections: Women of Childbearing Age

Women of childbearing age are projected to become more racially and ethnically diverse and locate farther away from the Seattle center
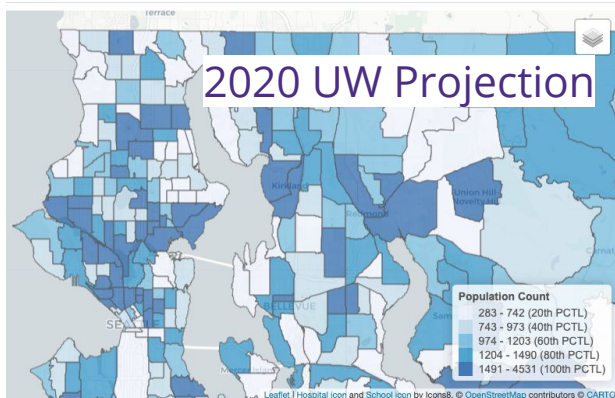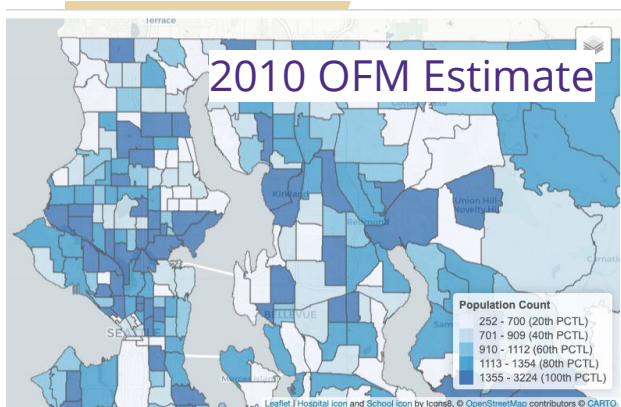
Planning implications:

> Increased demand for reproductive health service which are tailored to particular races, ethnicities and cultures

> Need will be more geographically widespread

Proportion of population who are 15-45 year old women by race & ethnicity
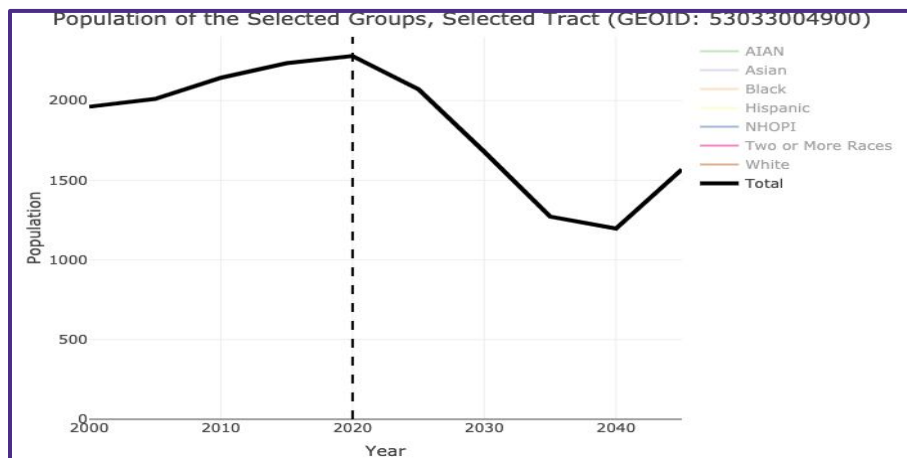
Spatial Spreading of Women aged 15-45

2010 OFM Estimate

Population Count
- 252 - 700 (20th PCTL)
- 701 - 909 (40th PCTL)
- 910 - 1112 (60th PCTL)
- 1113 - 1354 (80th PCTL)
- 1355 - 3224 (100th PCTL)

2020 UW Projection

Population Count
- 283 - 742 (20th PCTL)
- 743 - 973 (40th PCTL)
- 974 - 1203 (60th PCTL)
- 1204 - 1490 (80th PCTL)
- 1491 - 4531 (100th PCTL)

2030 UW Projection

Population Count
- 239 - 830 (20th PCTL)
- 831 - 1073 (40th PCTL)
- 1074 - 1310 (60th PCTL)
- 1311 - 1604 (80th PCTL)
- 1605 - 4531 (100th PCTL)

2040 UW Projection

Population Count
- 256 - 904 (20th PCTL)
- 905 - 1166 (40th PCTL)
- 1167 - 1446 (60th PCTL)
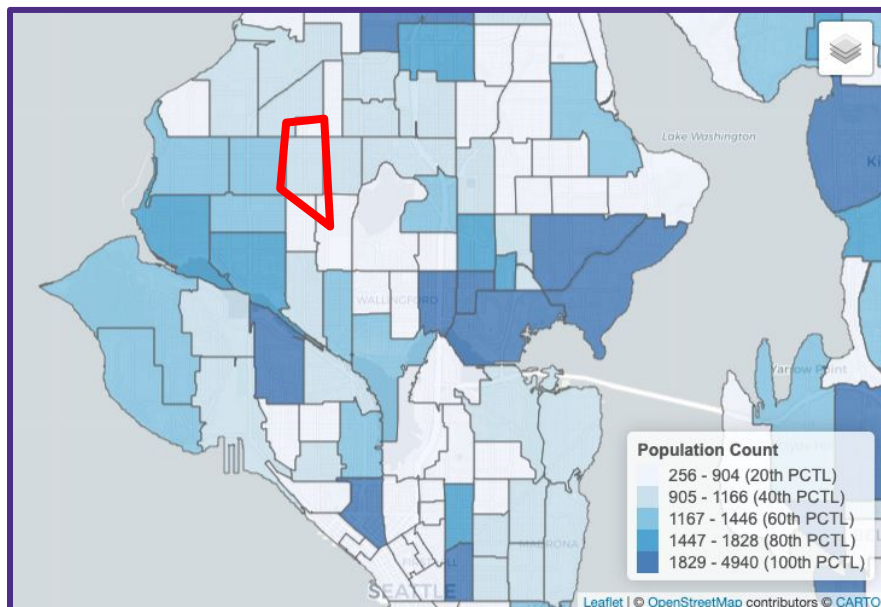- 1447 - 1828 (80th PCTL)
- 1829 - 4940 (100th PCTL)

Women of childbearing age are projected to increasingly locate outside of the Seattle city center

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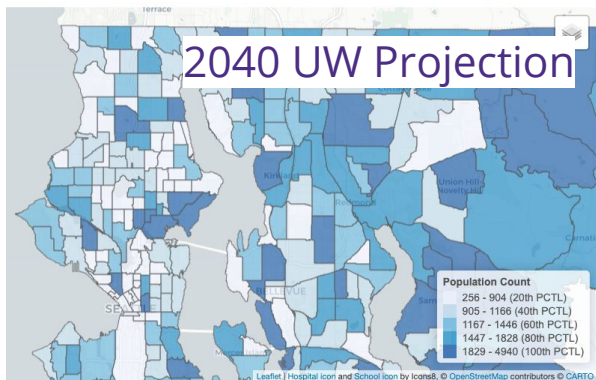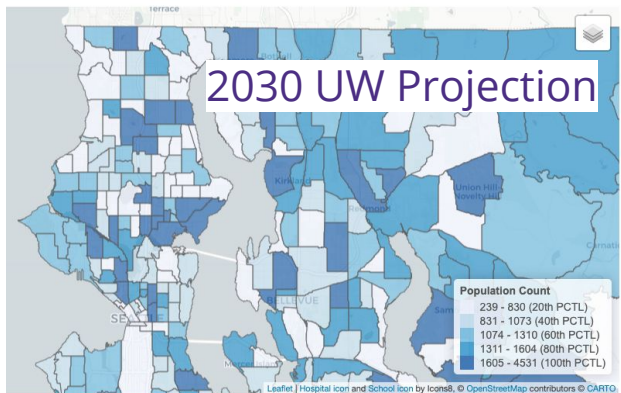
Zooming in on a Representative Tract

Even as total population grows, the projected number of women of childbearing age in many central Seattle tracts is projected to decline. In contrast, women of childbearing age are projected to increasingly locate in North, East and South KC neighborhoods (tracts)


Population of the Selected Groups, Selected Tract (GEOID: 53033004900)

Legend: AIAN, Asian, Black, Hispanic, NHOPI, Two or More Races, White, Total

UW Projection:
Women aged 15 - 45, 2040

Mapping Facility Locations

In addition to these analyses, our visualization tool allows us to overlay the locations of current infrastructure and resources, such as public health clinics, to guide future planning decisions
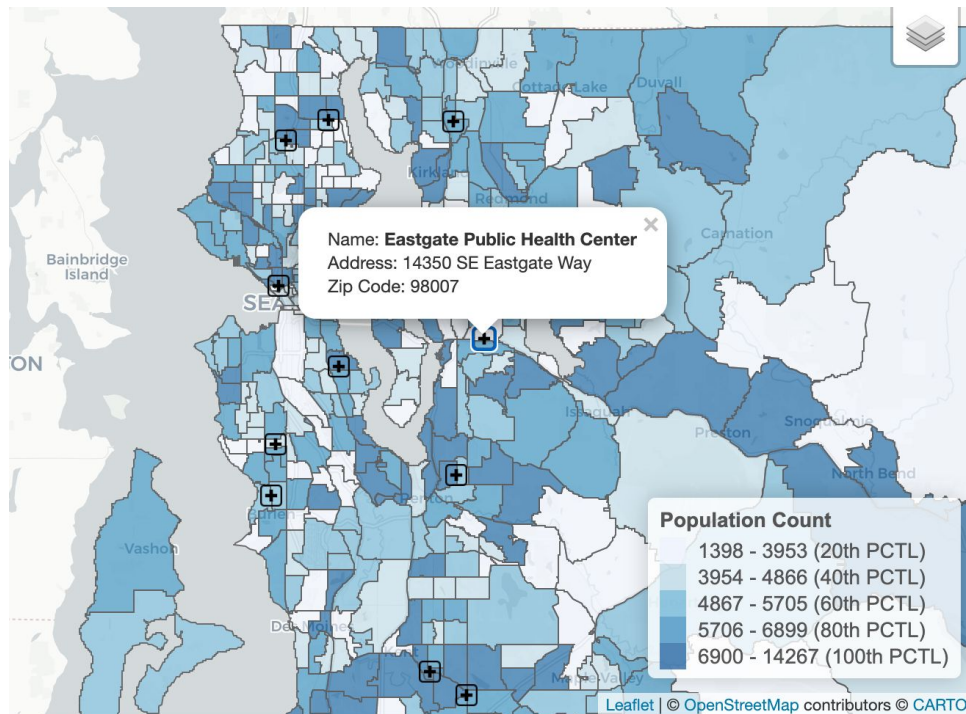
DISCUSSION

Key Points

- Findings suggest that King County is growing, aging, and diversifying rapidly, though trends vary across sub-county geographic levels

- Developed a novel method, based on work by Inoue and Swanson et al, to create small area projections by sex, race, ethnicity and 5-year age groupings

- Projections are accompanied by an interactive visualization and mapping tool, and were validated by comparison to OFM and PSRC projections

- Met increasing demands for small area projections for use by local policy makers, and provides a template for other localities

Limitations of Analysis

- Projections are suggestive, not determinative, and reflect past and present trends

- Had to proxy for fertility, mortality, and migration

- Unable to capture subgroup variation in racial and ethnic categories, such as native or foreign born status and more specific racial or ethnic groups

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Future Analyses

> Overlay additional resource locations and examine their distance from neighborhoods

> Simulate how projections may change in response to changes in policy or population component changes, such as:
  – Fertility decline in response to an economic decline
  – Migration decline in response to policy changes or economic decline
  – Mortality declines or increases in response to technological changes, pandemics, healthcare availability, etc.
  – Opportunity to create nuanced scenarios that vary across race and ethnicity, age

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Acknowledgements

APPENDICES

Appendix A: Methodology

UNIVERSITY *of* WASHINGTON

Hamilton Perry Method

> Cohort change ratio

  – Helps capture survival and net migration of 5-year age cohorts from one 5-year period to the next 5-year period

  – For example, proportion of 20-24-year-old in 2015 who survive to 2020 would be represented by:

  > $_5CCR_{20} = {_5P_{25,2020}} / {_5P_{20,2015}}$

> Child woman ratio

  – Proxy for fertility

  – Conducted separately by child sex and 0-4 and 5-9-year-olds

  – Male 0-4-year-olds: $_5MP_{0,2020} = ({_5MP_{0,2015}} / {_{30}FP_{15,2015}}) * {_{30}FP_{15,2020}}$

Tract Level Smoothing Method

$$i = \text{tract}$$

$$a = \text{age}$$

$$y = \text{year}$$

$$\underbrace{{}_5\mathbf{CCR}_a}_{\text{County Estimate}} = \frac{{}_5\boldsymbol{P}_{a+5,y+5}}{{}_5\boldsymbol{P}_{a,y}}$$

$$\underbrace{{}_5\mathrm{CCR}_{a,i}}_{\substack{\text{Direct} \\ \text{Tract Estimate}}} = \frac{{}_5P_{a+5,i,y+5}}{{}_5P_{a,i,y}}$$

$$\underbrace{{}_5\hat{\mathrm{CCR}}_{a,i}}_{\substack{\text{Smoothed} \\ \text{Tract Estimate}}} = \underbrace{\frac{\sqrt{{}_5P_{a,i,y}}}{\sqrt{{}_5P_{a,i,y}} + \sqrt{{}_5\boldsymbol{P}_{a,y}}}}_{\text{Tract weight}} * {}_5\mathrm{CCR}_{a,i} + \underbrace{\frac{\sqrt{{}_5\boldsymbol{P}_{a,y}}}{\sqrt{{}_5P_{a,i,y}} + \sqrt{{}_5\boldsymbol{P}_{a,y}}}}_{\text{County weight}} * {}_5\mathbf{CCR}_a$$

Tract Level Race Specific Smoothing Method

$$j = \text{race}$$

$$\underbrace{{}_5\mathbf{CCR}_a}_{\substack{\text{County Estimate}}} = \frac{{}_5\boldsymbol{P}_{a+5,y+5}}{{}_5\boldsymbol{P}_{a,y}}$$

$$\underbrace{{}_5\text{CCR}_{a,j}}_{\substack{\text{Direct} \\ \text{Race Estimate}}} = \frac{{}_5P_{a+5,j,y+5}}{{}_5P_{a,j,y}}$$

$$\underbrace{{}_5\hat{\text{CCR}}_{a,j}}_{\substack{\text{Smoothed} \\ \text{Race Estimate}}} = \underbrace{\frac{\sqrt{{}_5P_{a,j,y}}}{\sqrt{{}_5P_{a,j,y}} + \sqrt{{}_5\boldsymbol{P}_{a,y}}}}_{\substack{\text{Race weight}}} * {}_5\text{CCR}_{a,j} + \underbrace{\frac{\sqrt{{}_5\boldsymbol{P}_{a,y}}}{\sqrt{{}_5P_{a,j,y}} + \sqrt{{}_5\boldsymbol{P}_{a,y}}}}_{\substack{\text{County weight}}} * {}_5\mathbf{CCR}_a$$

$$\underbrace{{}_5\hat{\text{CCR}}_{a,i,j}}_{\substack{\text{Smoothed} \\ \text{Race Tract} \\ \text{Estimate}}} = \underbrace{\frac{\sqrt{{}_5P_{a,j,i,y}}}{\sqrt{{}_5P_{a,j,i,y}} + \sqrt{{}_5P_{a,j,y}}}}_{\substack{\text{Tract-Race weight}}} * {}_5\text{CCR}_{a,i,j} + \underbrace{\frac{\sqrt{{}_5P_{a,j,y}}}{\sqrt{{}_5P_{a,j,i,y}} + \sqrt{{}_5P_{a,j,y}}}}_{\substack{\text{County-Race weight}}} * {}_5\hat{\text{CCR}}_{a,j}$$

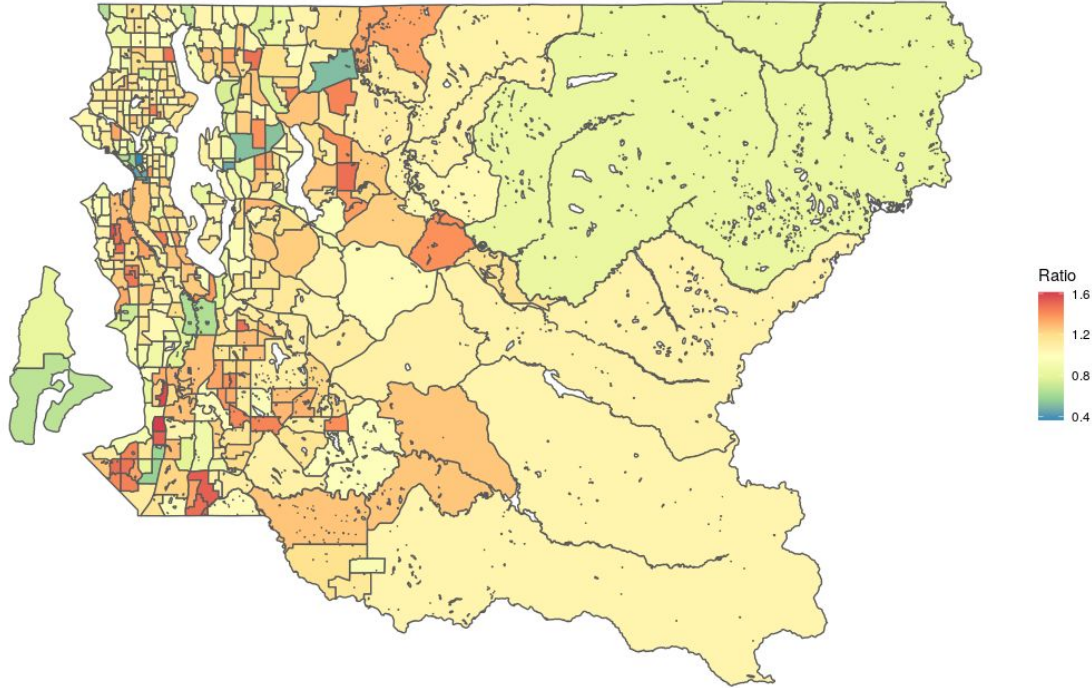# Appendix B: Comparisons to OFM and PSRC Forecasts

PSRC to PHI Tract Comparisons

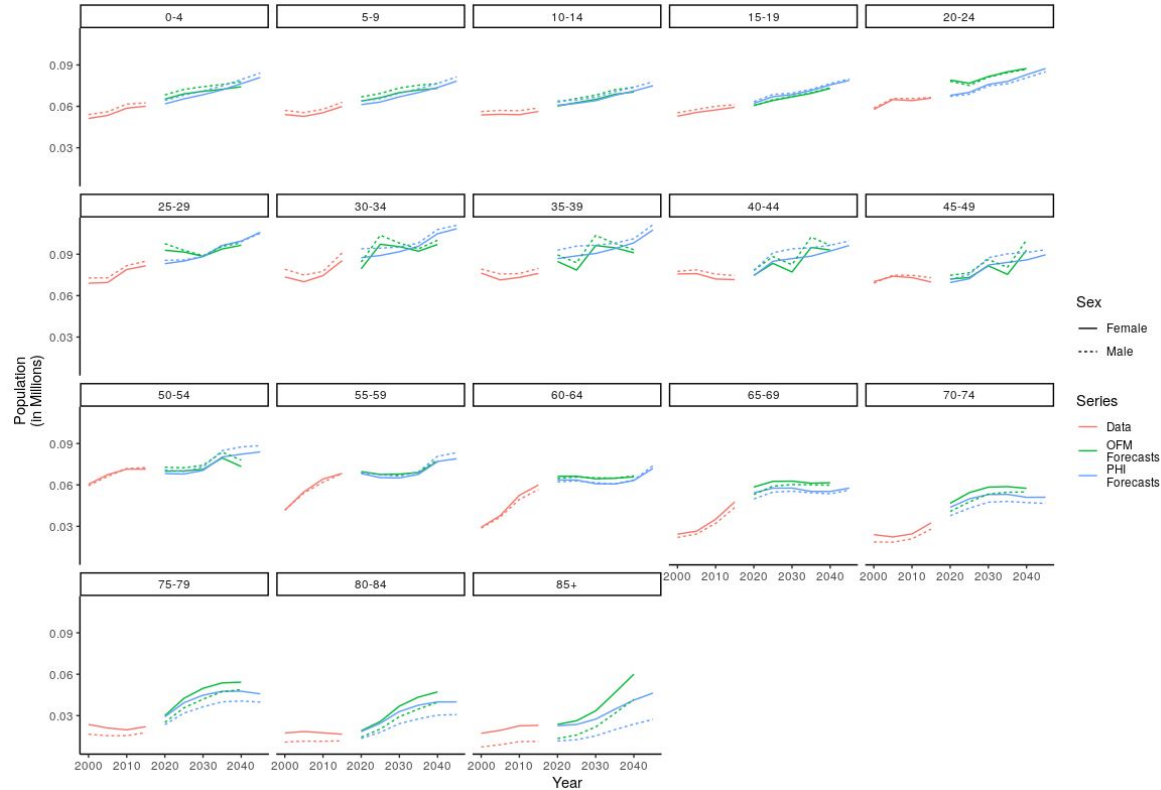Ratio of PHI to PSRC tract projections
Total Population 2040
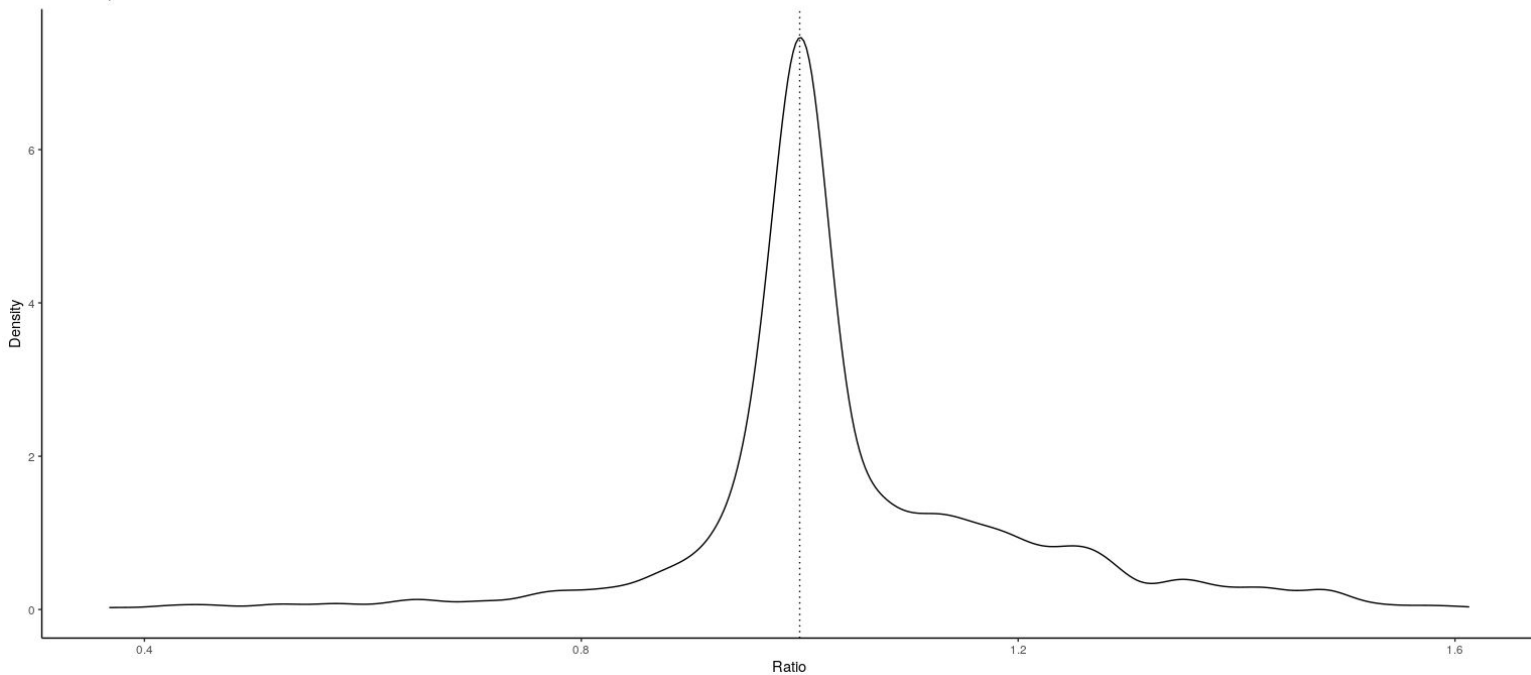
PSRC to PHI Tract Comparisons

Ratio of PHI to PSRC tract projections
Total Population 2040

OFM to PHI Projection Comparisons

Appendix C: Health Reporting Areas

Health Reporting Areas (HRA)

> Created by Public Health - Seattle & King County for examining health-related issues and policies
> Closely aligned to city boundaries
> 48 in total

> Constructed from block groups
> Consequently, do not necessarily have a 1:1 correspondence to census tracts
> To produce preliminary HRA-level projections, we use spatial weights to redistribute population counts at the census tract level to the corresponding HRAs
> Exploring the use of population weights to produce HRA-level projections

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