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Probabilistic Population Projection Model: In-Development

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Agenda

- OFM and the Growth Management Act
- Why a new model?
- What is this new model?
- Simulation of GMA 2022 projections
- Discussion

OFM and the Growth Management Act

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OFM Responsibilities

RCW 43.62.035 authorizes OFM to create population projections for GMA

- **Provide population projections by county every 5 years** with a 20-year horizon. Provide a middle series with reasonable ‘high’ and ‘low’ ranges that most counties are required to plan within.
- **Timing is based on census data** availability and the 5-year cycle, therefore the “2’s and 7’s” of each decade.
- **Local governments must be allowed to review projections** provide input and can petition for changes.

Why a new model?

Current County Model

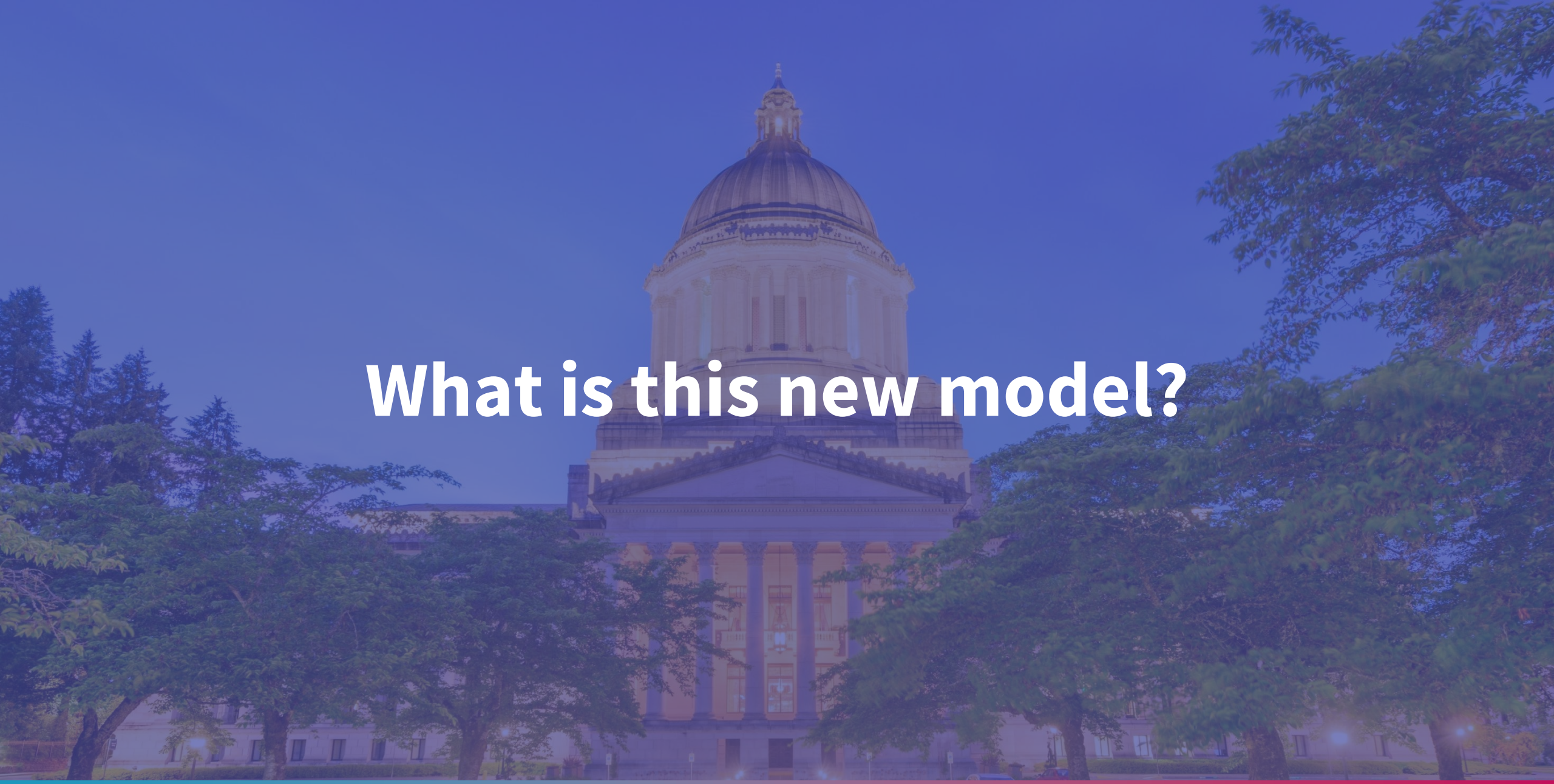
Three separate models for totals, age-sex, and bands.

- **An ensemble of demographic models**
- **It's a top-down approach** that relies the total population from the November State Forecast.
- **County totals** are developed from a number of models based on historic patterns of population and migration change.
- **A controlled cohort-component model** then allocates these totals by age-sex across the projection years (interpolates 5-year projections to 1-year projections).
- **High and low bands are created** using historical variation in population and parameters to set the slope of each trajectory.

County Cohort Model Issues

The model had become difficult to maintain.

- **Dated programming language and approaches** that made supporting the model more difficult over time.
- **Highly reliant on initial models** for totals that would drive the rest of the process.
- **Integration of the three models was difficult** and caused issues interpreting and communicating all components.



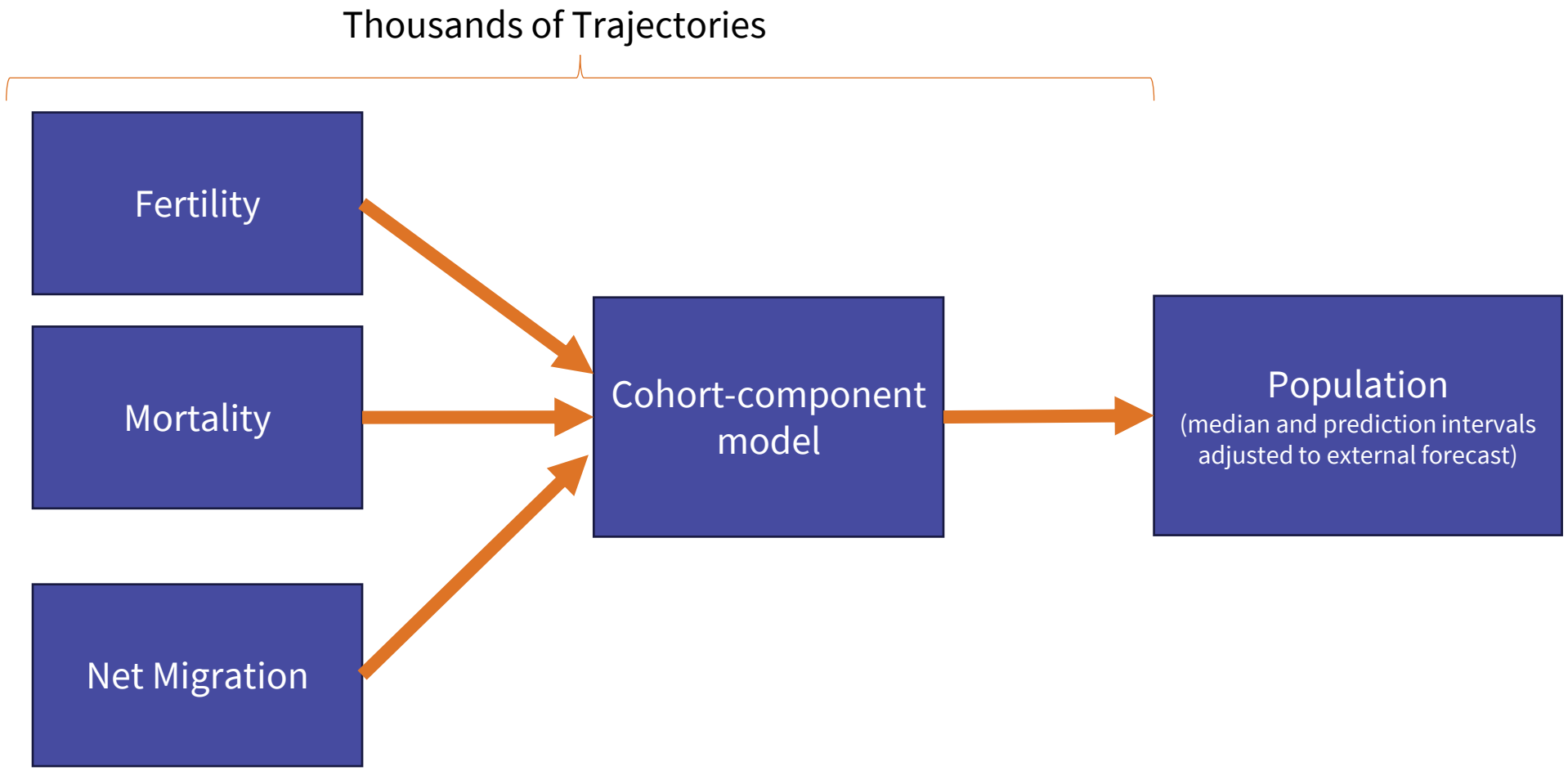
What is this new model?

Probabilistic Projection Model

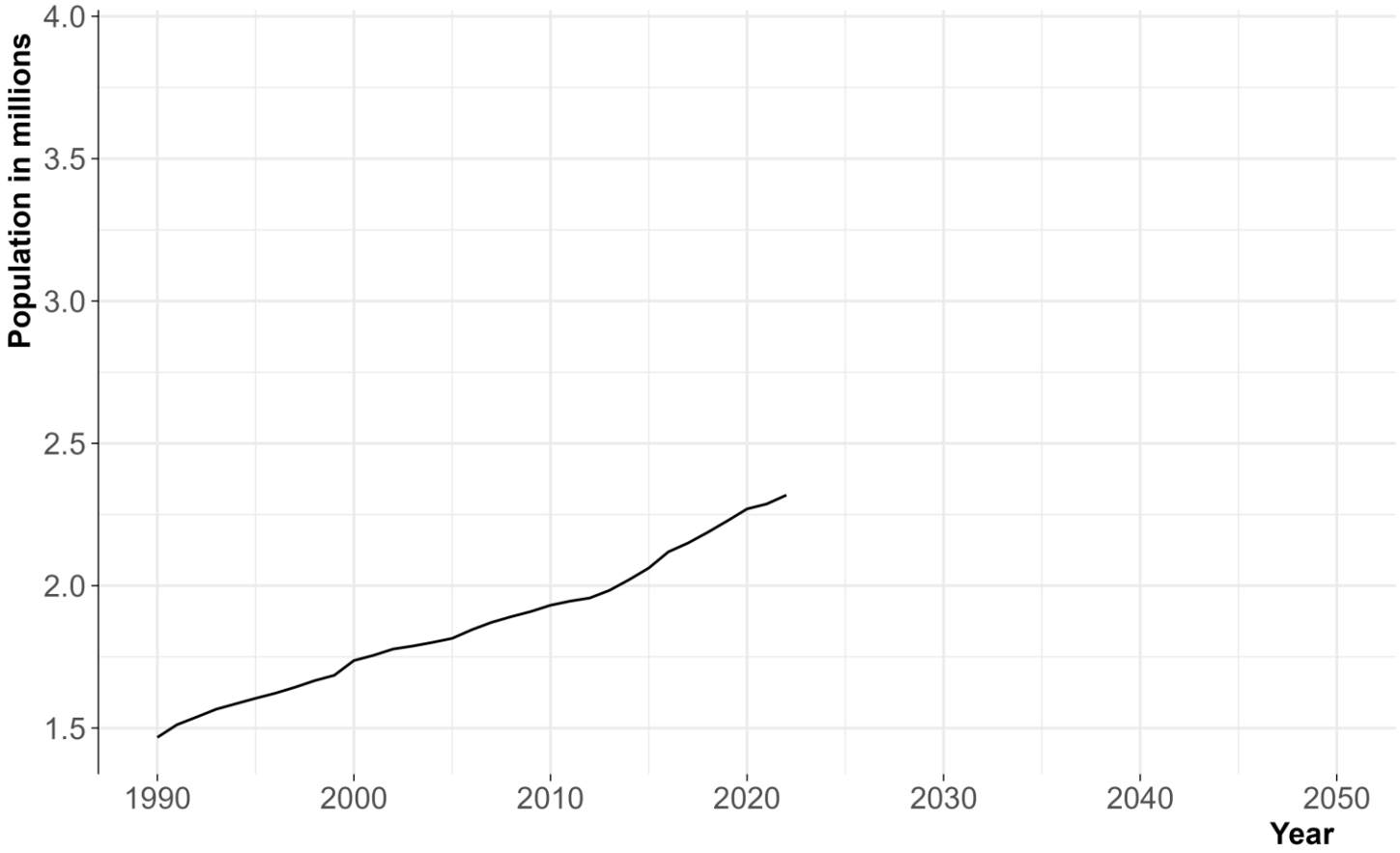
Adds probabilistic claims to the bands required by law.

- **Bayesian approach developed at University of Washington (bayesPop and CSDE)** with collaboration from OFM.
- **Population is projected using a standard cohort-component model** run thousands of times with independently estimated component trajectories.
  - Outputs **median and user-defined prediction interval** population and component values.
- **Adjusts for Special Pop (GQ + unique populations)** each year by age and adds **age-specific uncertainty to net migration** for each county based on residual age-profiles.
- **Can be controlled to external forecasts** by age and sex (e.g. our annual state forecast).

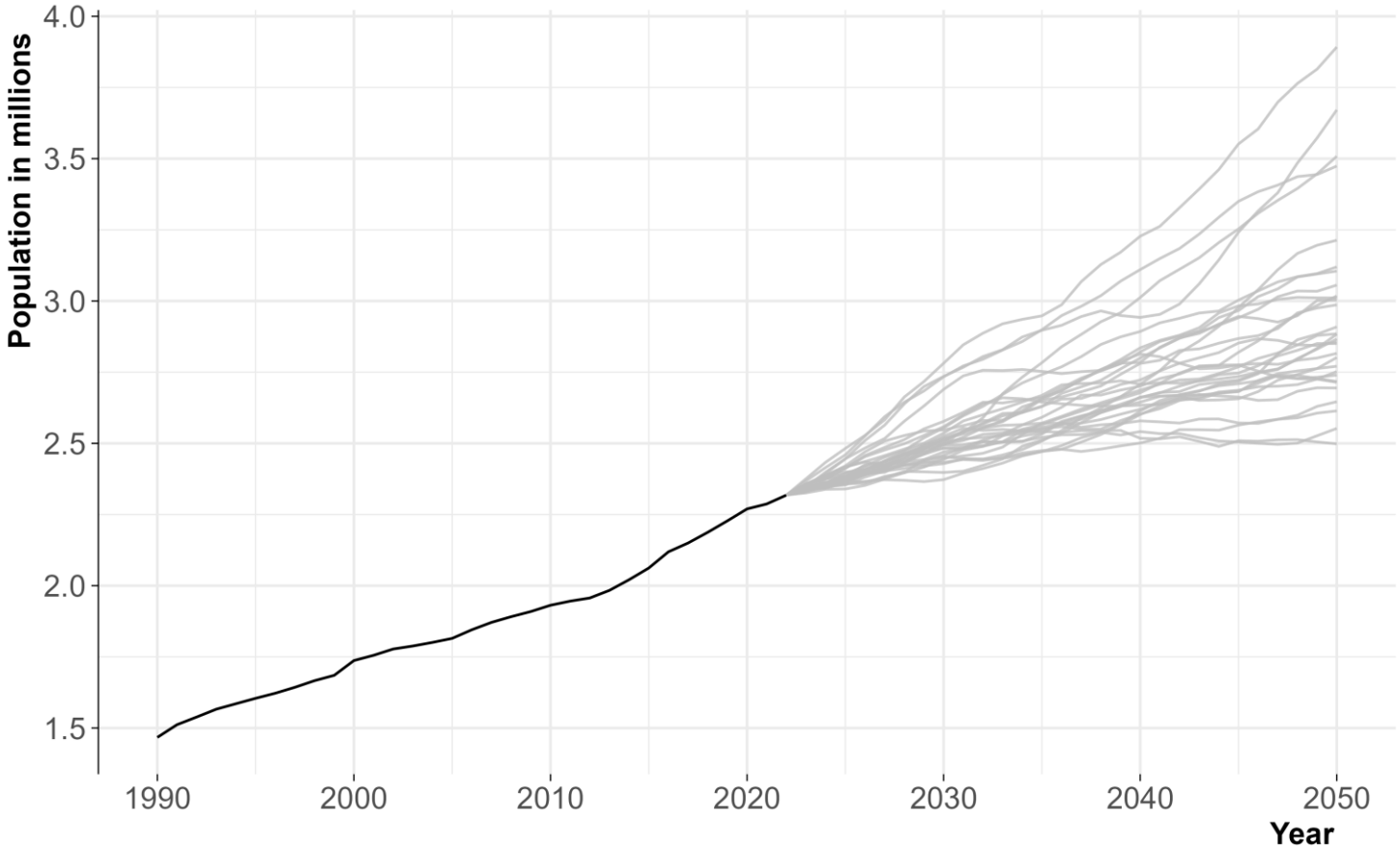
County-level Bayesian Model



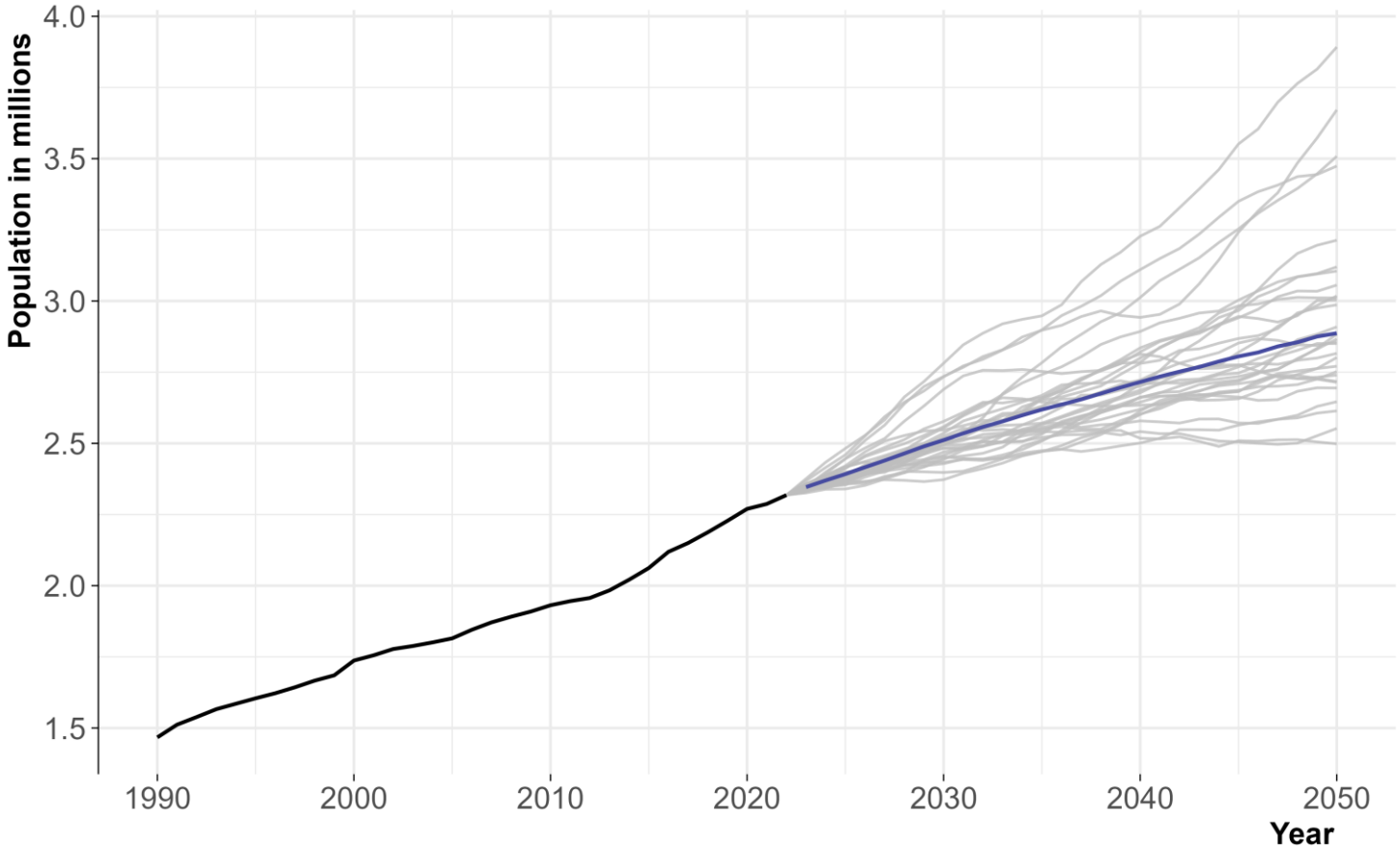
Step 1: Historical data



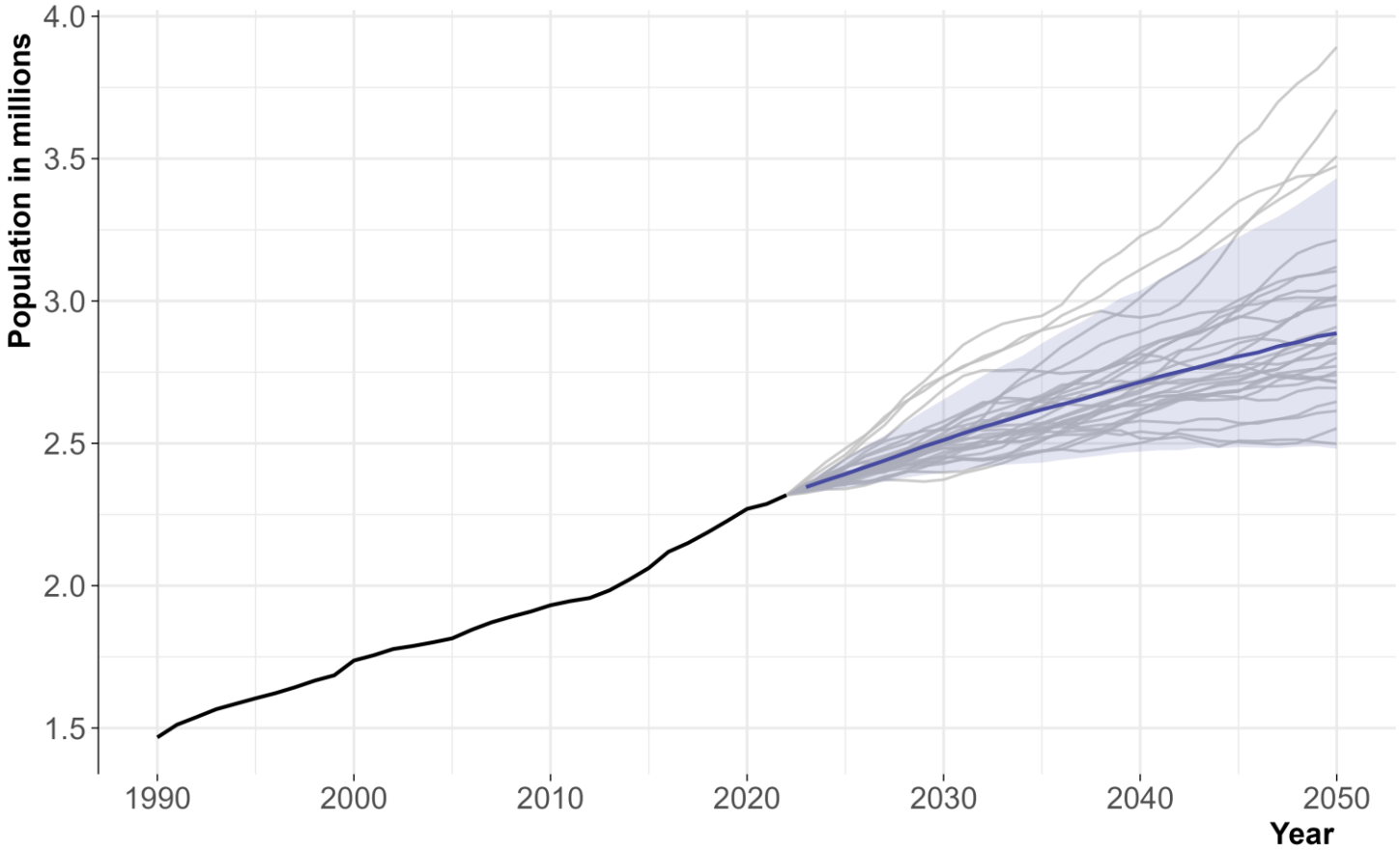
Step 2: Generate trajectories



Step 3: Identify median (most likely)



Step 4: Choose a prediction interval



Accuracy evaluation: total population

We compared our **2012 and 2017 medium projections** for our current model and the **original probabilistic model** to the 2020 Census.

Error Measure	Current Model	Probabilistic Model
Percentage (MAPE)	3%	2%
Numeric (RMSE)	20,475	15,914

Note: These represent a sum across both projections and all years.

Take aways:

The **probabilistic model** was more accurate for **totals**, which are the key for GMA.

We then made significant improvements to **age-sex** before calling the model ready.

Simulation of GMA 2022 projections

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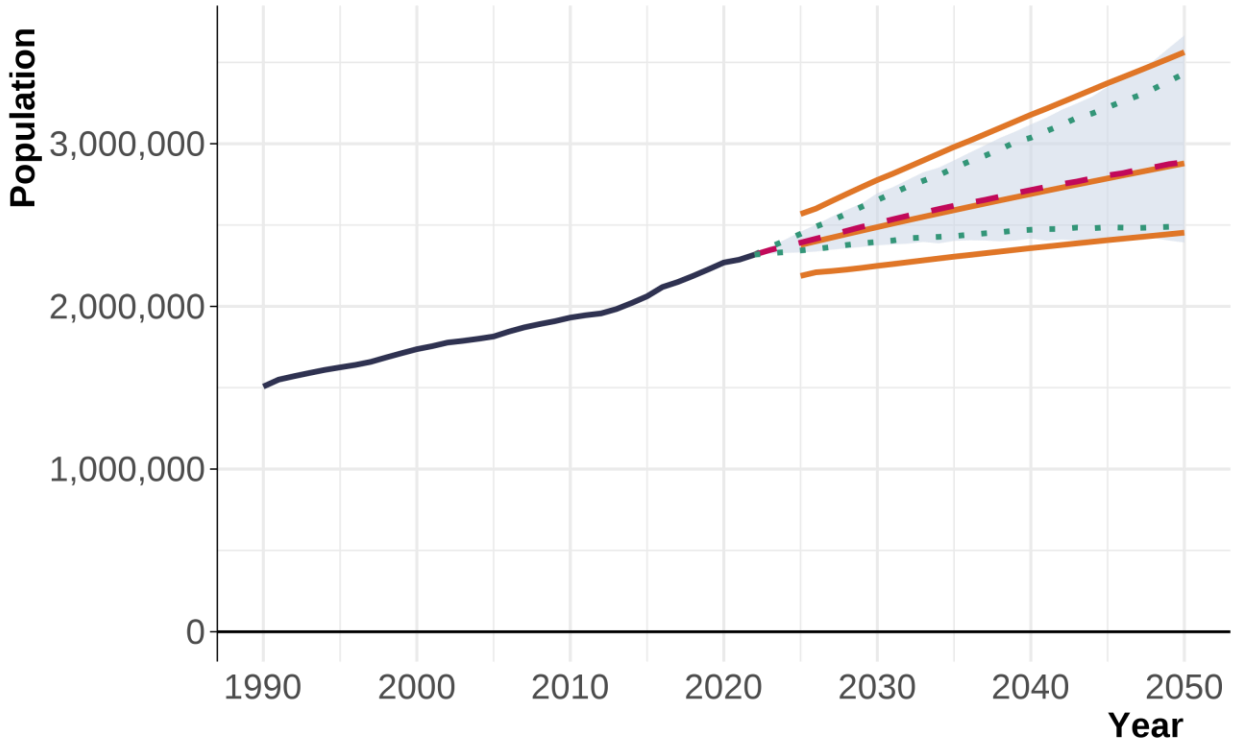
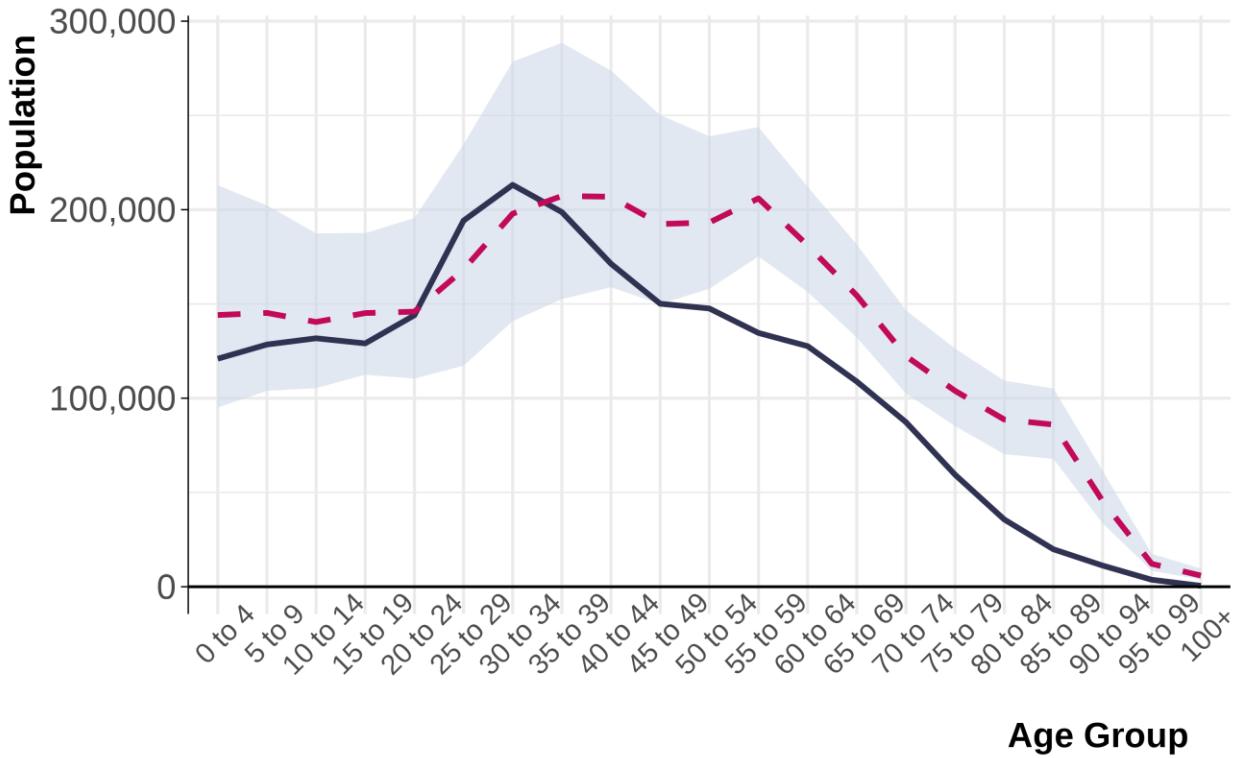
Simulation approach

How different are the two models?

- **Basic guidelines** for the test (as much as practicable):
  - Same inputs we had by about November of 2022 then for base population, fertility, and mortality.
  - Tune the model using only data we'd have had at that time.
- **Compare the results** to the published GMA 2022 projections.
- **These will not replace or supersede the published GMA 2022 projections.**

Simulation results: King County



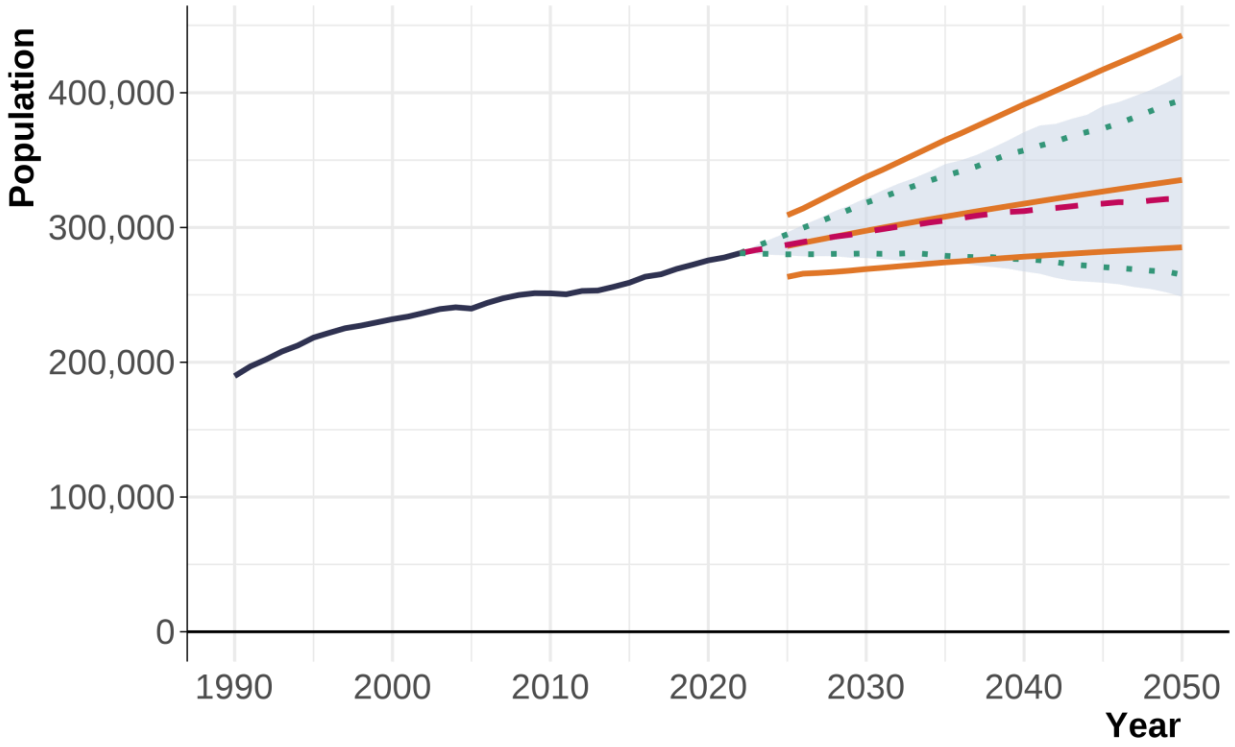


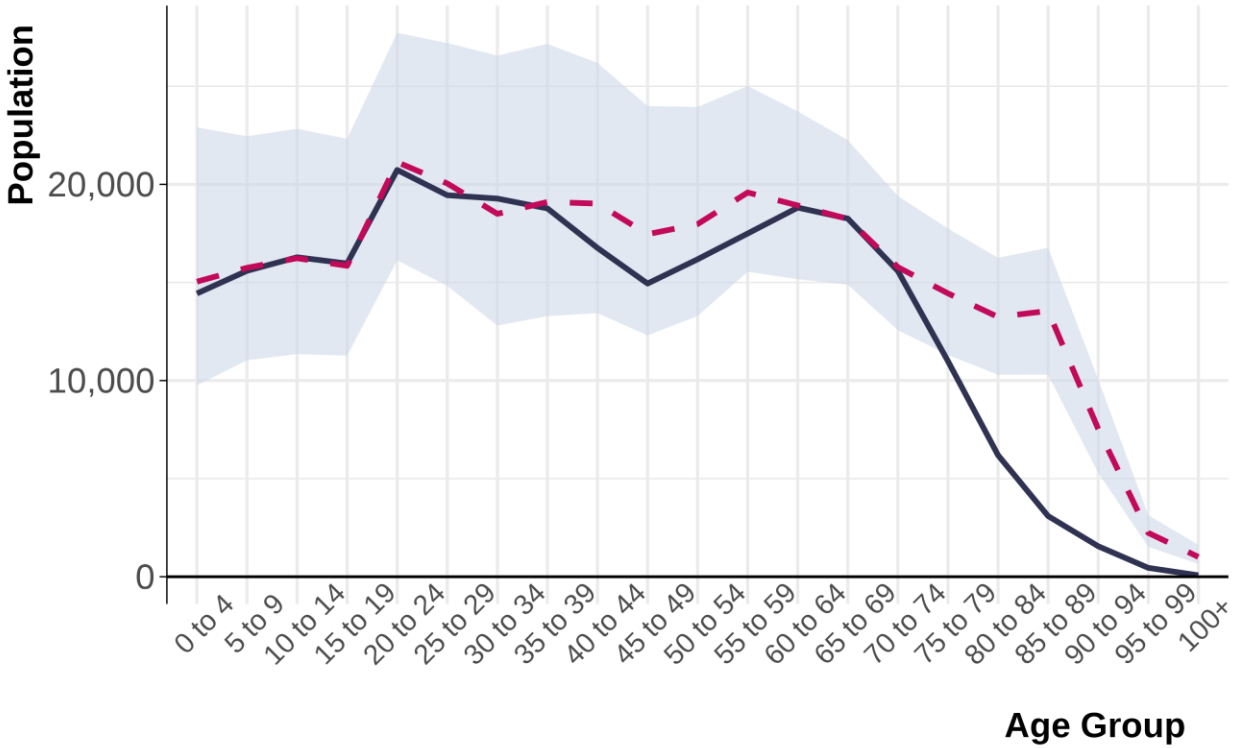
Historical Median GMA 2022 90% PI 95% PI

2022 (Historical) 2050 (Median) 95% PI

These simulations are for demonstration only and are not official projections.

Simulation results: Kitsap County





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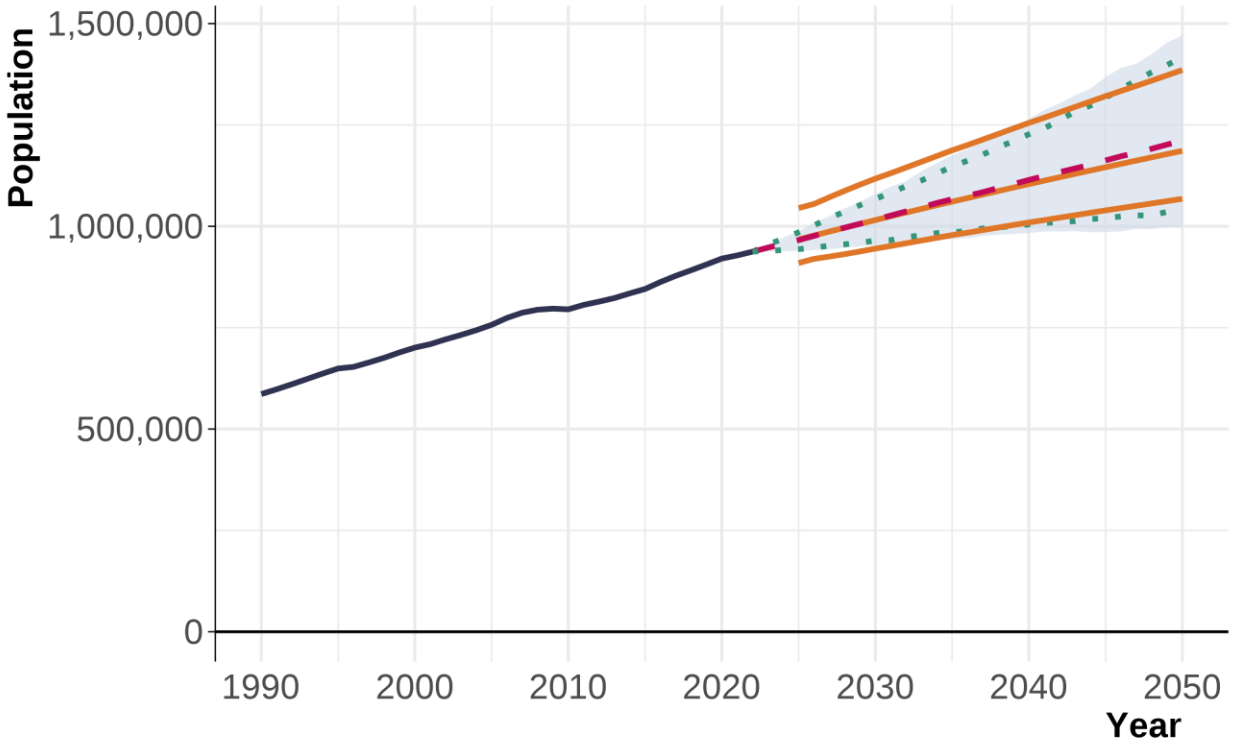
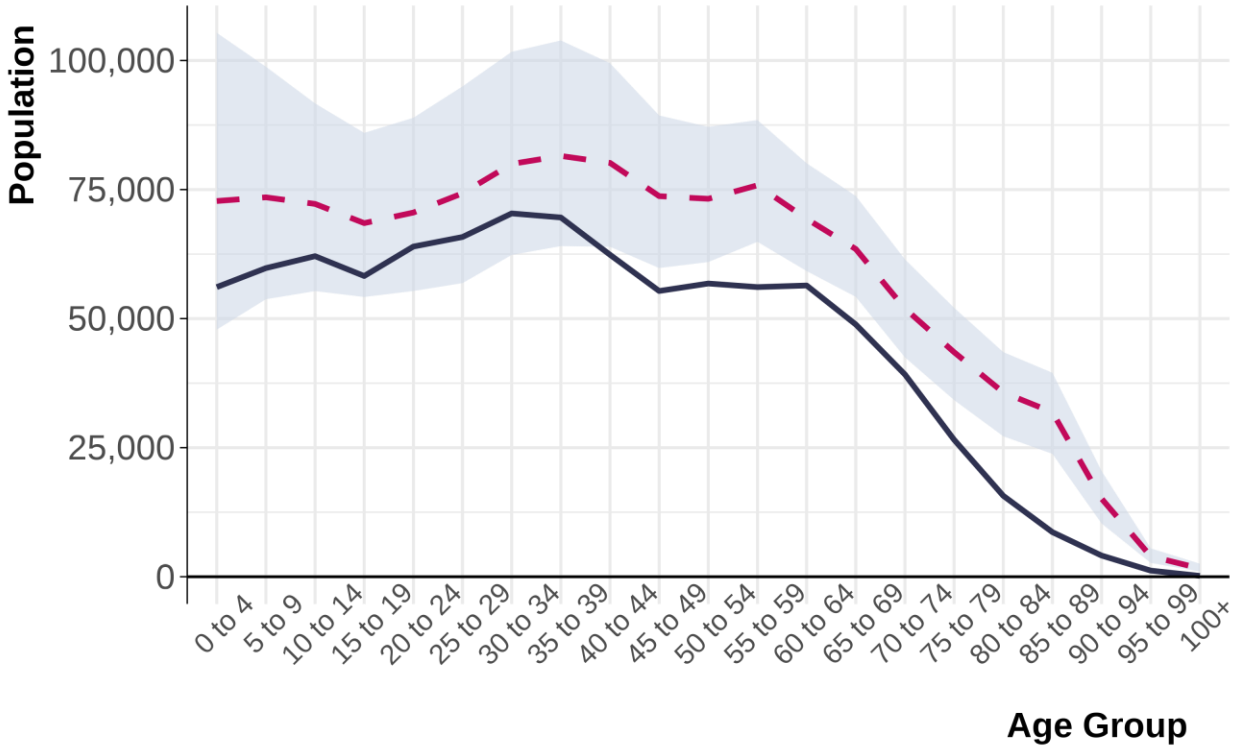
Simulation results: Pierce County





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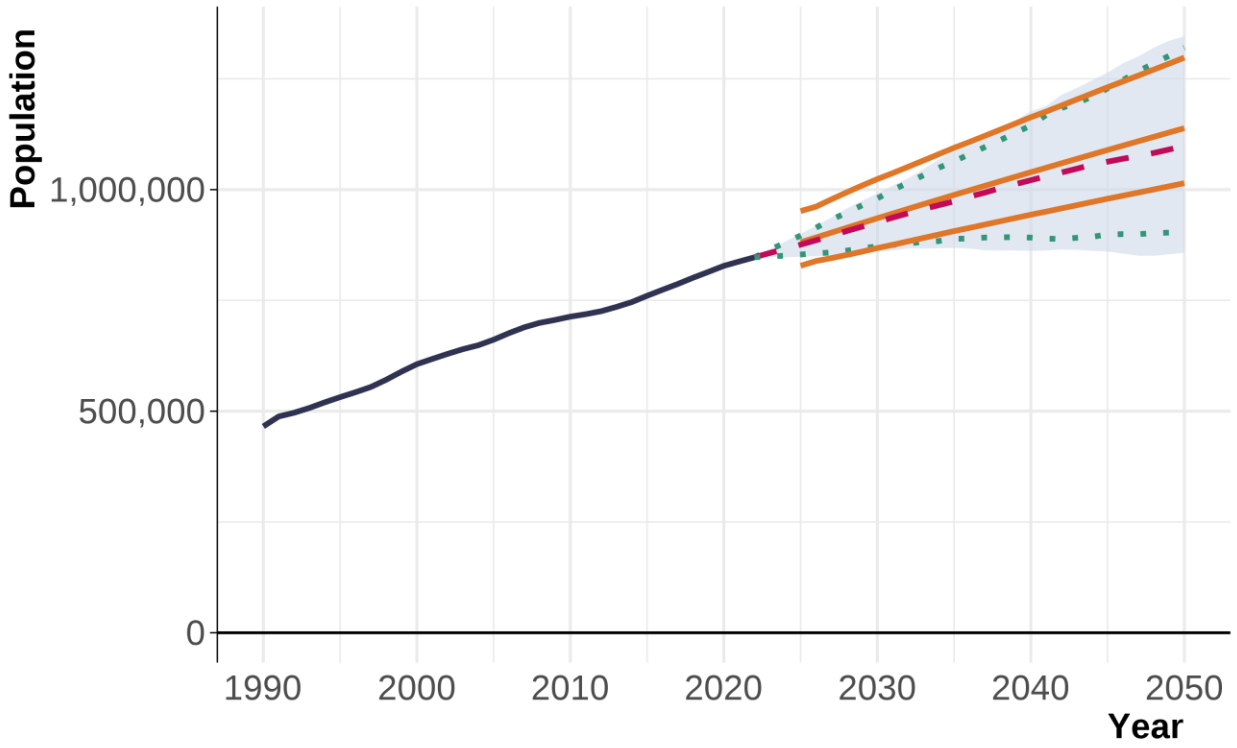
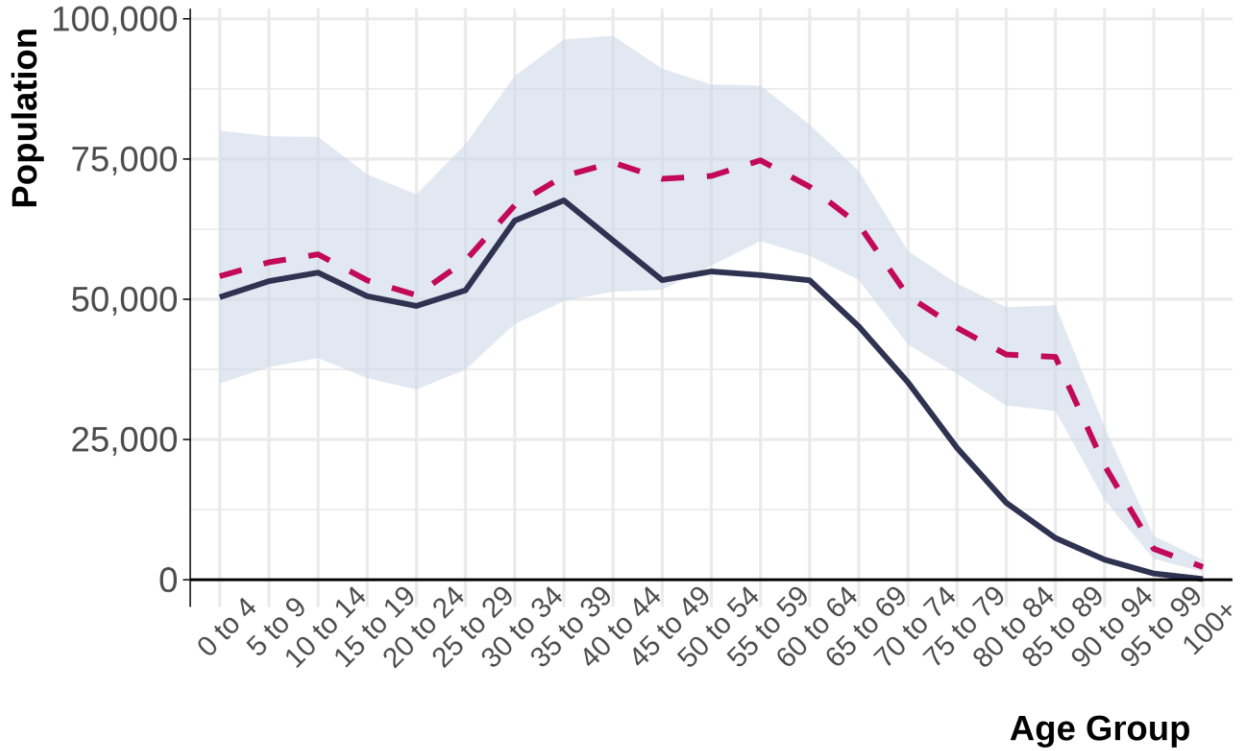
Simulation results: Snohomish County





Historical Median GMA 2022 90% PI 95% PI

2022 (Historical) 2050 (Median) 95% PI

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Discussion

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Questions we have for you

- Do the explicit probabilistic claims make a difference for your work?
- Would the estimates exceeding the bounds in the five years before the next projection be problematic?
- What are your thoughts on the width of the bands (we presented a couple options for prediction intervals)?
- What are your use cases for the age-sex data?
- Would adding another five to ten years to the official forecast horizon be helpful?

For more information

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Resources mentioned

- bayesPop website: https://bayespop.csss.washington.edu/
- Yu, C., Ševčíková, H., Raftery, A.E., and Curran, S.R. (2023). Probabilistic County-Level Population Projections. *Demography*, Vol. 60(3): 915-937. (https://doi.org/10.1215/00703370-10772782)
- Ševčíková, H., Raymer, J., and Raftery, A.E. (2024 preprint) Forecasting Net Migration By Age: The Flow-Difference Approach *stat ArXiv*, Vol. 60(3): 915-937. (https://doi.org/10.48550/arXiv.2411.09878)