



Point-Based Population Models: Making your data count!

Shannon Porter

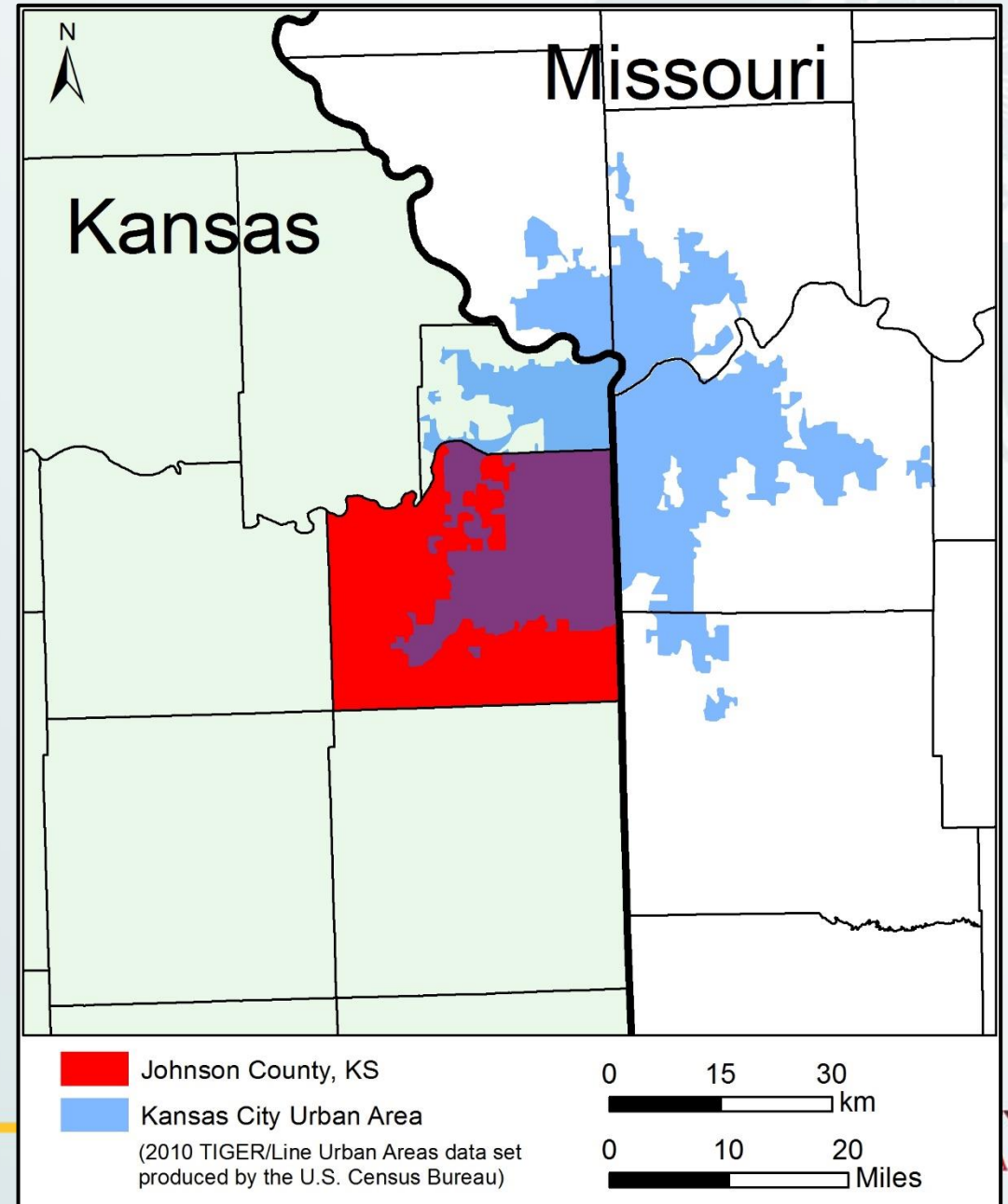
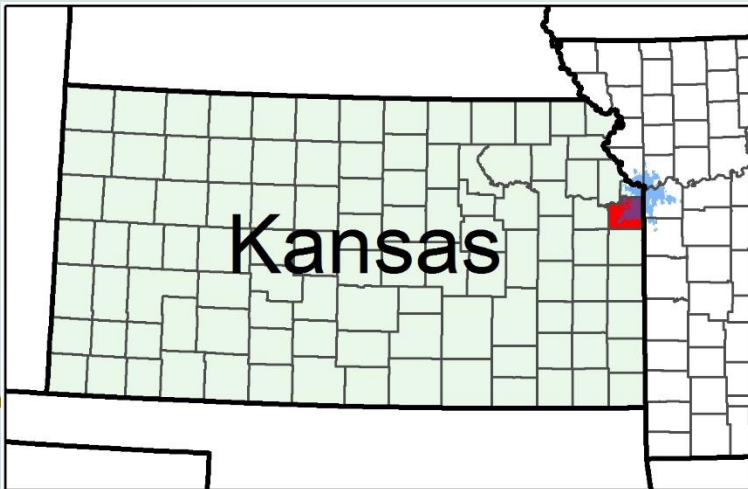
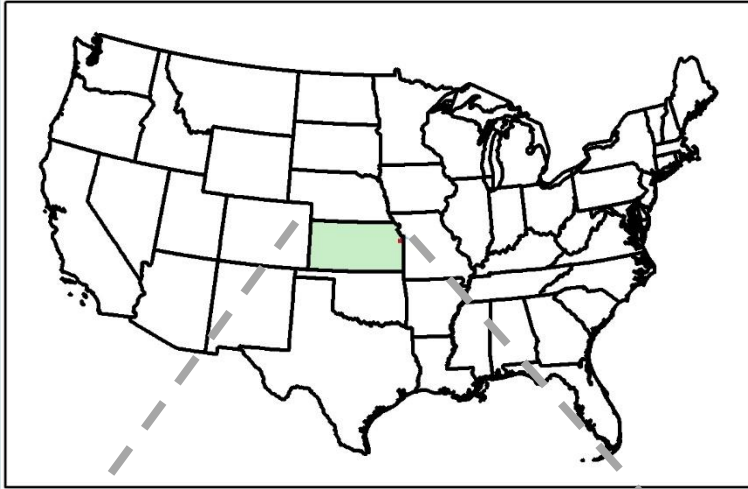
Jin Yao



Abstract

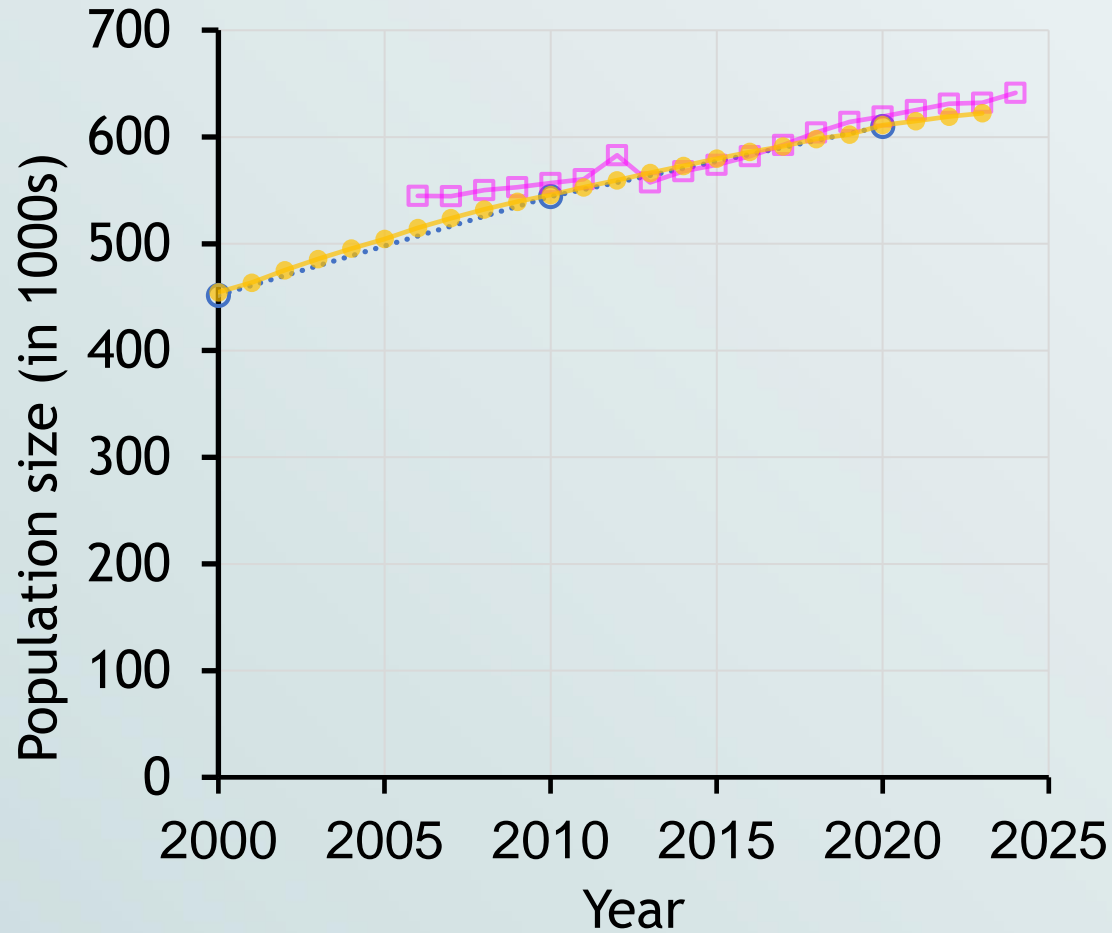
- Join Johnson County, KS AIMS for a presentation on our point-based population models. In response to frequent requests for current or near-future population estimates in geographies not typically covered by Census Bureau datasets (such as school attendance zones or county commissioner districts) we have developed four distinct point-based population models over the past 20 years. These models effectively integrate local GIS data, including property centroid locations, address points, and land use codes, with Census Bureau data. Our approach allows for precise population estimation in any custom-defined area. This enhances both accuracy and adaptability in population estimation, making our models exceptionally valuable for local government planning and response initiatives.
- In my presentation, I will provide an overview of these models, highlighting the conceptual framework and input data unique to each. I will briefly discuss the model validation process and the challenges encountered

Johnson County, KS



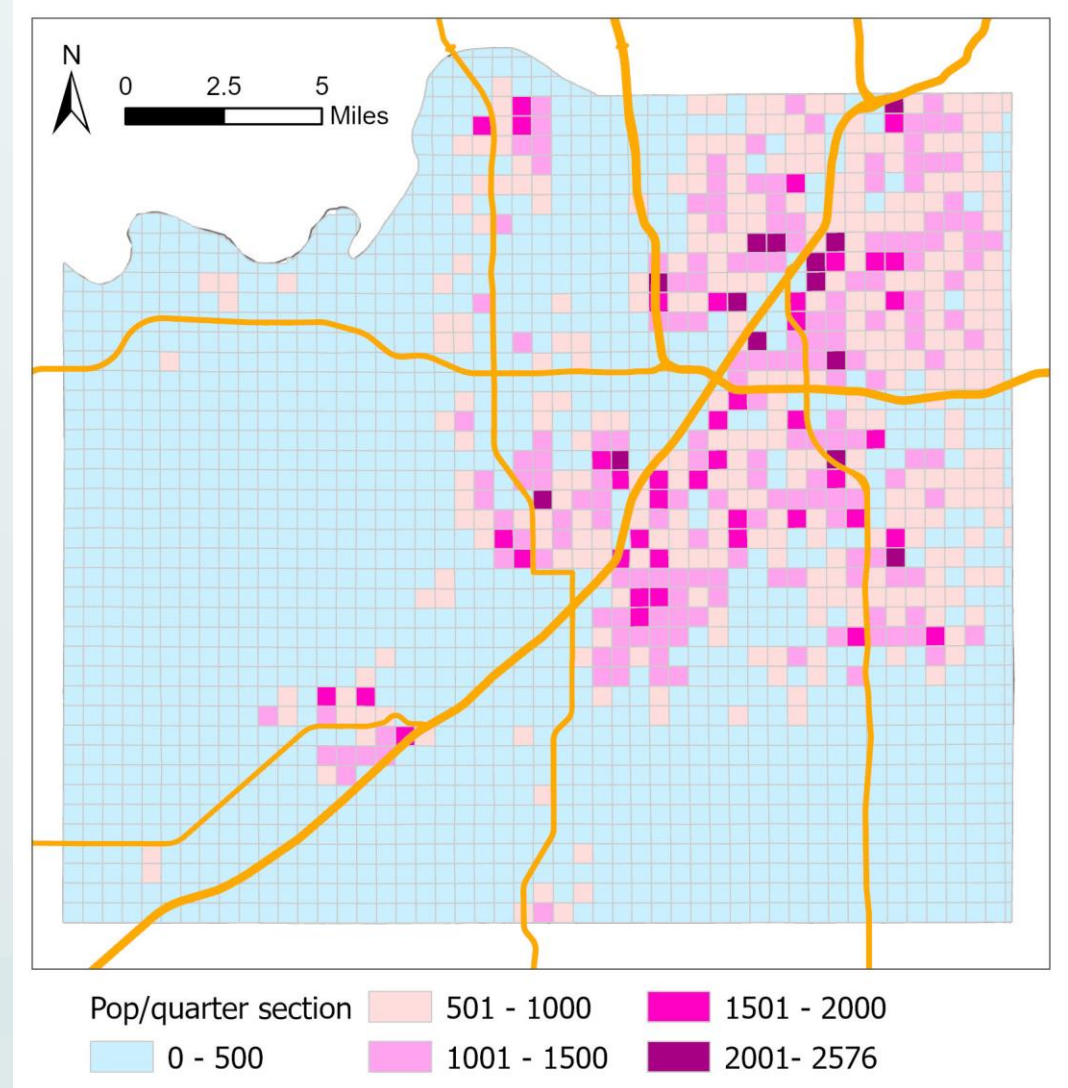
Johnson County Population

In Time



Decennial Census Pop Model 1 PEP

In Space on 2024-04-12 (Pop Model 1)

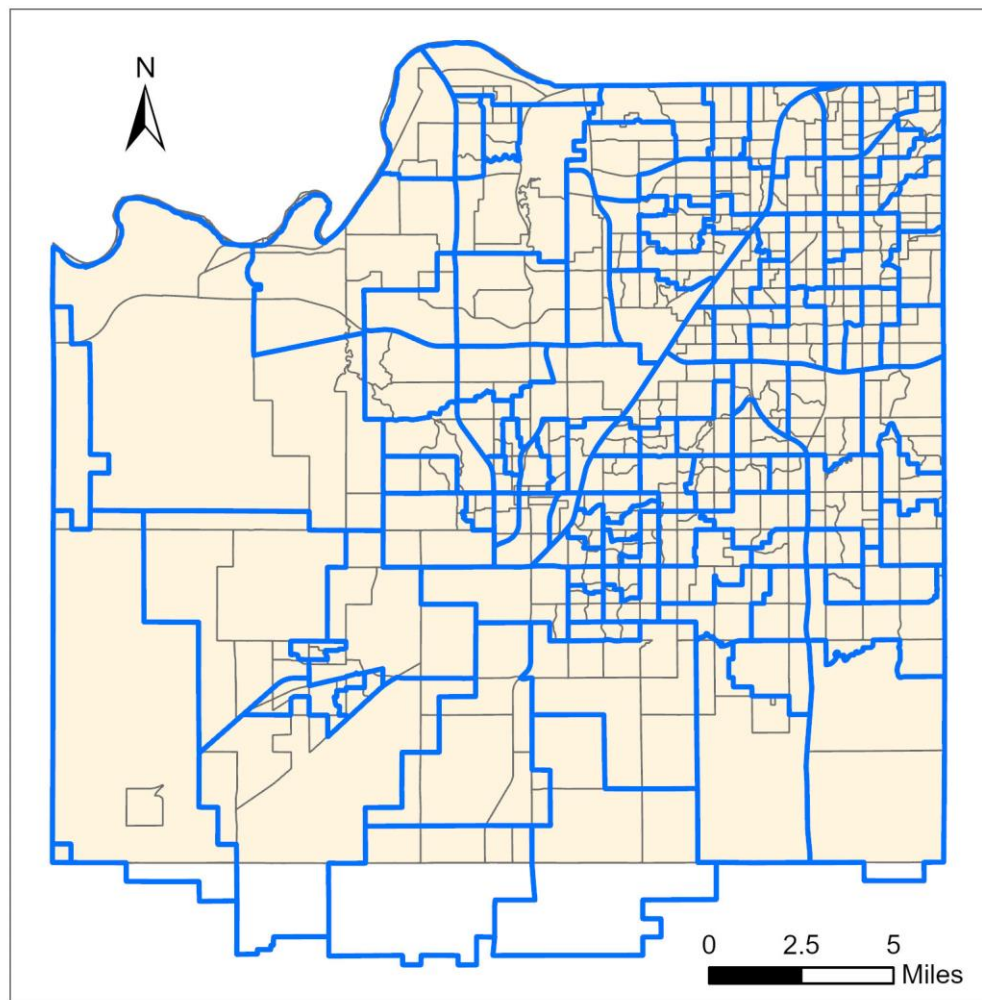


Why a point-based population model?

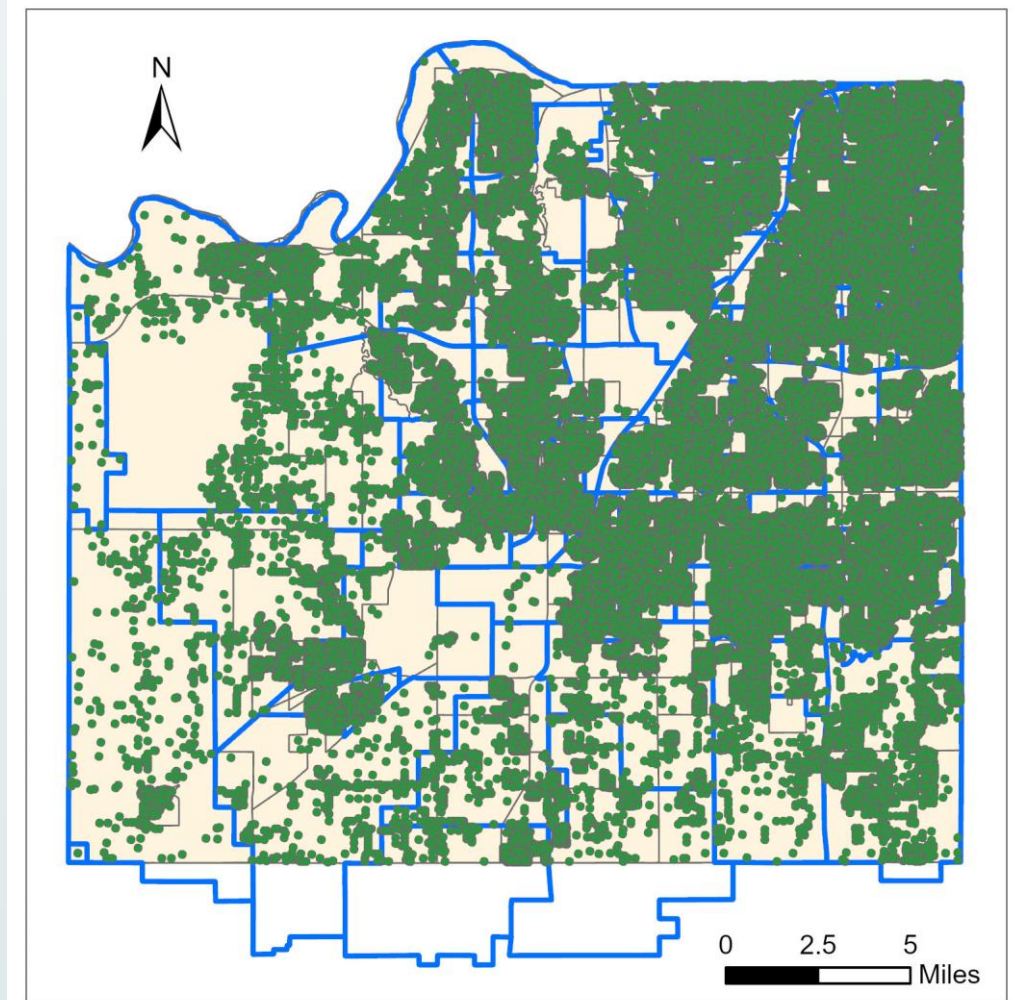
- A population model is quite simply a bunch of points on a map, and each point is attributed with an estimate of the number of occupants at that location. So, for instance, the model would have a point at each single-family residence and an estimate of 2.5 occupants (for example) at each point.
- By drawing a circle, polygon, or some other shape on a map, we can simply add up the number of occupants at the points within that shape and, voila, that is your population estimate.



Why a point-based population model?



Elem School Attend Bnd County Bnd
Census Block Group



Pop Model1_PT Census Block Group
Elem School Attend Bnd County Bnd

Why not just rely on estimates from the Census Bureau?

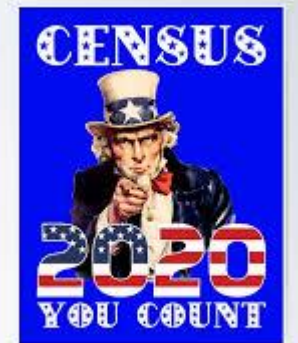
- Spatial - not limited to standard census geography
 - Watersheds, School districts, Subdivisions, etc.
- Temporal - can estimate at any time and/or predict
- Delay - census often a year delayed



Make your local data count!

What are the model inputs?

- Local data
 - Property, address, permit
 - land use, dwelling units, permit type, floodplains
- Census Bureau data
 - Average Household Size (AHS) and vacancy rate (VR)
 - Implemented 2021 ACS
 - update every year instead of every 10 years



Overview of our Models

- **Model One** provides a cautious, but very reliable, estimate of current population. It relies heavily on County Land Record data.
- **Model Two** is used when an informed, forward-looking projection is needed. It can be better than a simple extrapolation of past estimates since that assumes growth occurs as it always has (and in areas it historically has). Model Two uses the County's address dataset to inform where growth is most likely.
- **Model Three** is best applied when the user already has a census count for a particular area, as it simply adds on to that base number using residential building permit data that has occurred since the count.
- **Model Four** facilitates estimates of “ultimate” population for an area, when development is complete and full build-out has taken place.

Population Model 1

Local data: Parcel polygons

- polygon centroids
- Residential parcels
 - # Dwelling units (DU)
- Tenure
 - Owner-occupied:
 - Site address = owner address
 - Renter-occupied:
 - Site address != owner address

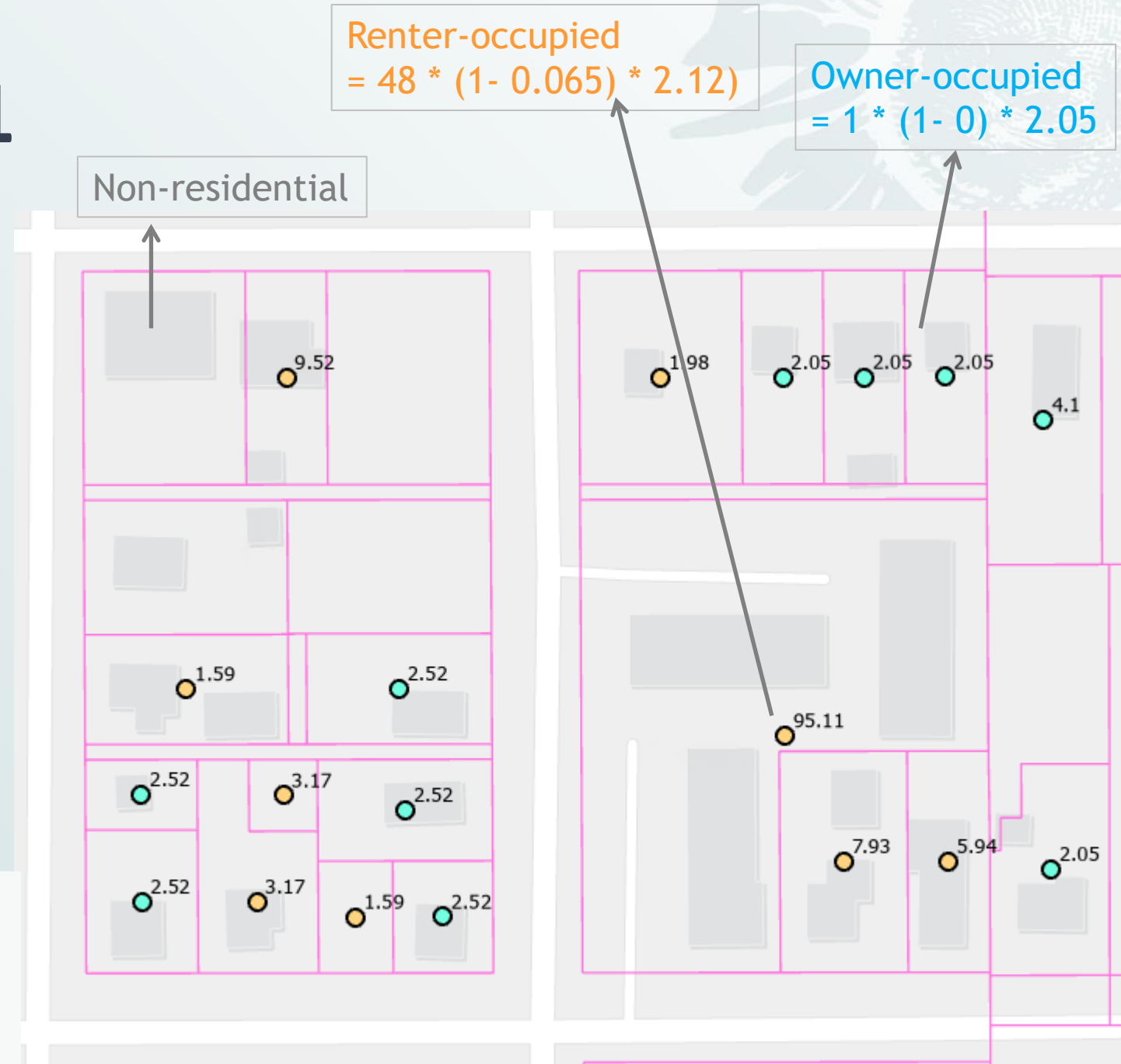
Census Bureau data

- Average household size (AHS)
- Vacancy Rate (VR)

$$\# \text{ Occupants} = \text{DU} * (1 - \text{VR}) * \text{AHS}$$

Property_PL

 Pop Model1_PT
 OccupiedBy
 Owner
 Renter



Population Model 2




Local data: Address points (AddPnt)

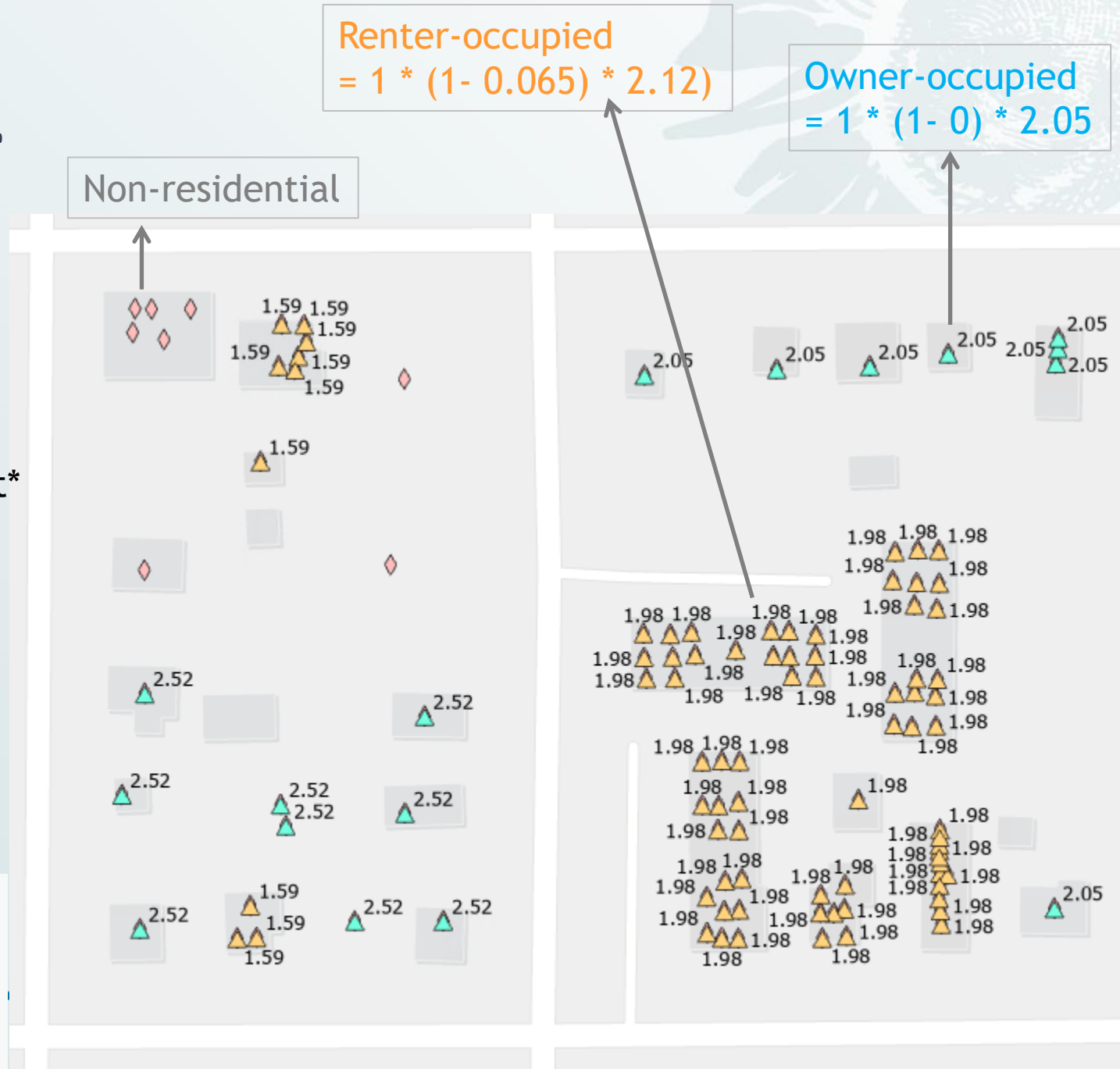
- Residential addresses
 - 1 AddPnt = 1 household
- Tenure
 - Owner-occupied
 - SnglFamRes, TwoFamRes, AgVacant*
 - Renter-occupied
 - MultFamRes

Census Bureau data

- Average household size (AHS)
- Vacancy Rate (VR)

$$\# \text{ Occupants} = \text{AddPnt} * (1 - \text{VR}) * \text{AHS}$$

Address_PT

 PopulationModel2_PT
 OccupiedBy
 Owner
 Renter



Population Model 3

Projects population growth since 2010

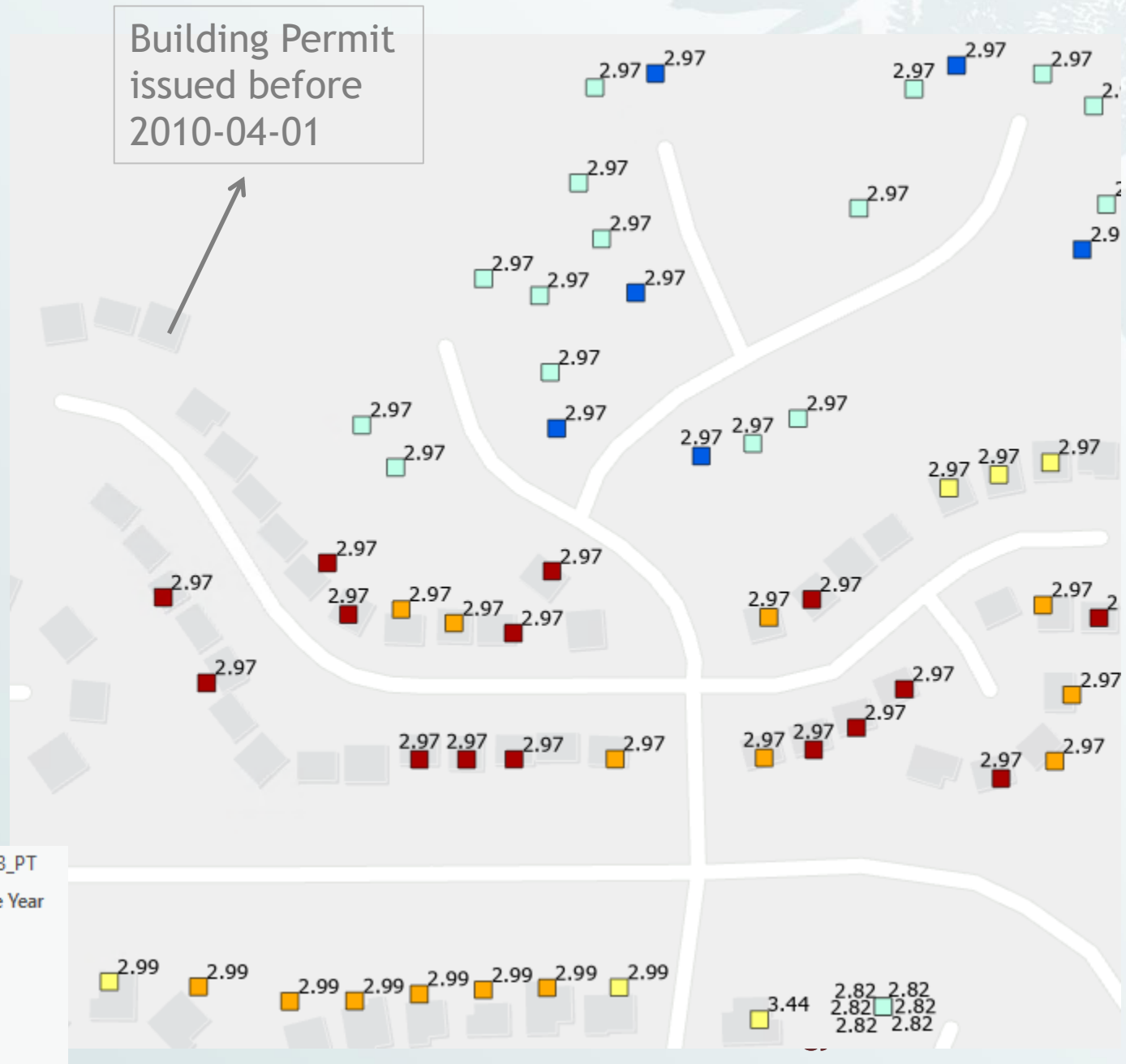
Local data: Building permits (BP)

- Residential BP
 - 1 BP = 1 household
- Tenure
 - Owner-occupied
 - Single Family, Duplex
 - Renter-occupied
 - Triplex, Fourplex

Census Bureau data

- Average household size (AHS)
- Vacancy Rate (VR)

$$\# \text{ Occupants} = \text{BP} * (1 - \text{VR}) * \text{AHS}$$



Population Model 4

Projects MAX growth potential beyond current population (= Pop model 1)

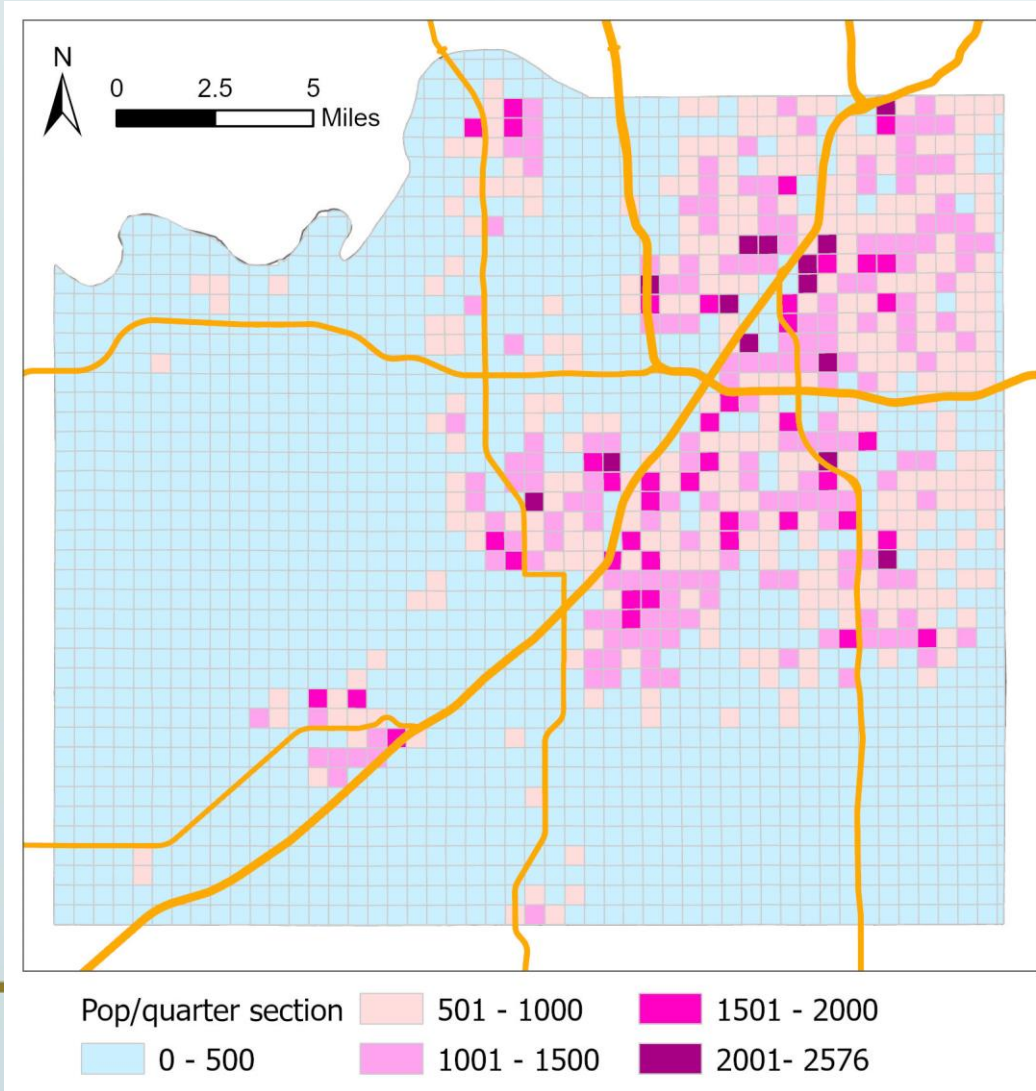
Local data: Parcel polygons

- Developable parcel centroids

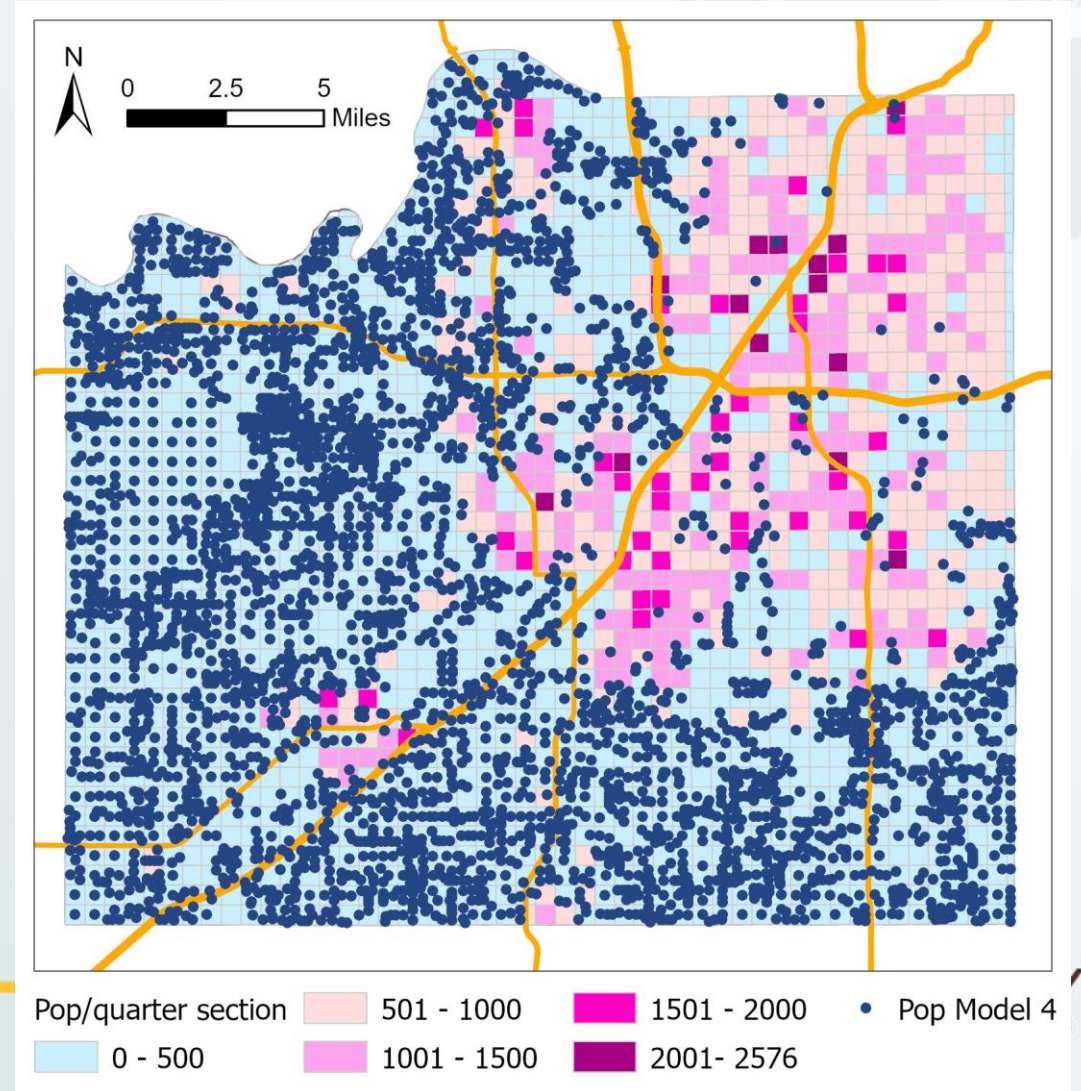
Occupants = AcresNotInFEMAZoneA * AvgUnitsPerAcre * AvgHouseholdSize

Population Model 4

Pop Model 1



Pop Model 4 points overlaying on top of Pop Model 1



How do we use them?

- Redistricting (Board of County commissioner, school districts, etc)
- Wastewater capacity planning - model 4
- Facility planning (libraries, fire, ambulance, etc)
- Emergency and disaster response
 - Tornado scenario app
 - Hazmat exercises

How do we use them (continued)?

- Public use - model 1 and 2
 - Standard Admin boundaries
 - Advanced layers - Economic development
 - Any shape - available on our website for any self created geography.

Standard Admin Boundaries - precalculated

The screenshot displays the AIMS interface with a search bar at the top. The left sidebar shows a 'Layers' panel with 'Admin Layers' expanded, where 'Voting Precincts' is checked. A 'Select Layers to Identify' dialog box is open, with 'All visible layers (excluding parcels)' selected. An 'Identify Results' dialog box shows details for 'Voting Precincts - 306', including precinct name, city ward, city, population estimate, dwelling units, and appraised value. A larger 'Identify Results' panel on the right shows details for 'Attendance Bnd - Elem School - 13', including elementary school name, district, district name, website link, and census estimates.

AIMS
AUTOMATED INFORMATION MAPPING SYSTEM

search for location

Map Tools: [Icons]

Layers

- Parcels
 - Parcels
 - Address Points
 - Landuse
 - Zoning
 - Parcel Outlines
- Flood Zone
- Planimetrics
- School Layers
- Admin Layers
 - Commissioner Dist.
 - KS Representative Dist.
 - KS Senate Dist.
 - KS Board of Education
 - School Board Dist.
 - Voting Precincts
 - City Wards
 - Zip Codes
 - Fire Districts

Select Layers to Identify

- Parcels
- Open Results in New Browser Window
- All visible layers (excluding parcels)

Identify Results

Voting Precincts - 306

Precinct	D102.01
Precinct Name	Olathe 1-02
City Ward	D1
City	Olathe
Population Estimate	2,673
Dwelling Units Est.	1,166
Avg Appraised Value	\$201,208 (n=482)

Attendance Bnd - Elem School - 13

Elementary School	Havencroft
District	233
District Name	Olathe
Website	Link

Layer Source: [Link](#) (AIMS only)

Population Estimate	4,045
Dwelling Units Est.	1,497
Avg Appraised Value	\$310,124 (n=675)
Avg Sale Value (3yrs)	\$309,323 (n=102)

Census BG ACS Estimates

Advanced Layers - Economic Development

AIMS
AUTOMATED INFORMATION MAPPING SYSTEM

search for location Search Map Clear

Map Tools: [Icons]

Advanced Layers

- Annexation History
- Tax Layers
- Public Improvements Financing
- Economic Development - [More Info](#)
 - Plat - % Developed
 - Undeveloped Parcels
 - Avg Single Family Res Sale Price
 - Avg Single Family Res Appraised Value
 - Population
 - Population Density (per acre)
 - Population Forecast (3-5yr)
 - Population Forecast (MARC)
 - Population % Change Forecast
- Dwelling Units
 - By Zip
 - By Tract
 - By Block Group
 - By Block
 - By Subdivision
 - By Plat
 - By Section
 - By Quarter Section
 - By City
 - By Commissioner
 - By School District
 - By High School
 - By Middle School

Select Layers to Identify

- Parcels
- Open Results in New Browser Window
- All visible layers (excluding parcels)

Identify Results

▼ **BySubdivision - 1037** [Show](#) [Pan To](#)

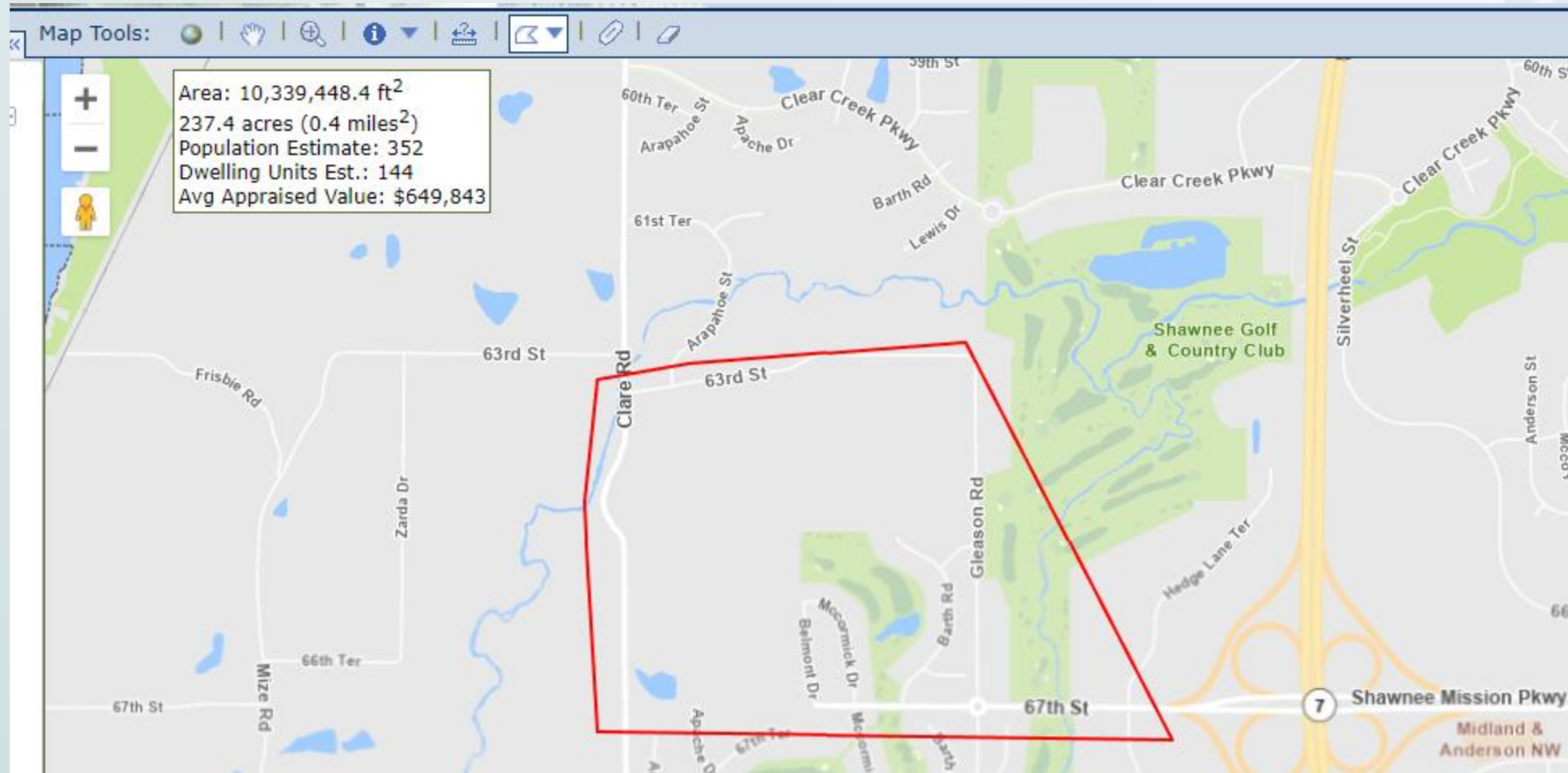
Subdivision Name	HAYES ADDITION
Area (ft)	0.1 mi, 68.3 ac
Acres	68
Avg Single-Family Sale Price	\$210,230
Avg Single-Family Sale Count	10
Avg Single-family Appraised Value	\$242,471
Avg Single-family Appraised Count	67
Population Estimate	439
Population Density (per acre)	6.43
Dwelling Units	277
Population Forecast (3-5 yr)	459
Population % Change Forecast	4.56%
New Res Bldg Permit Count	0
New Res Permit Avg Value	\$0

Identify Results

▼ **BySubdivision - 1037** [Show](#) [Pan To](#)

Subdivision Name	HAYES ADDITION
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Custom Shape - on the fly calculation



Model validation process

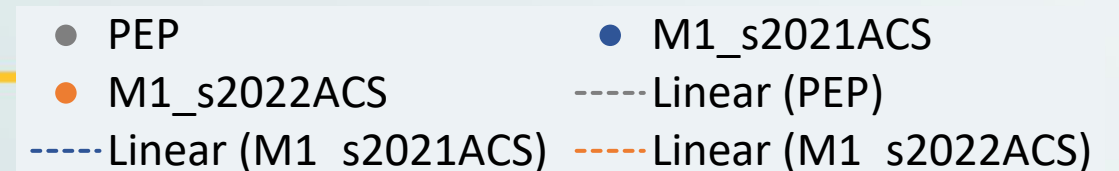
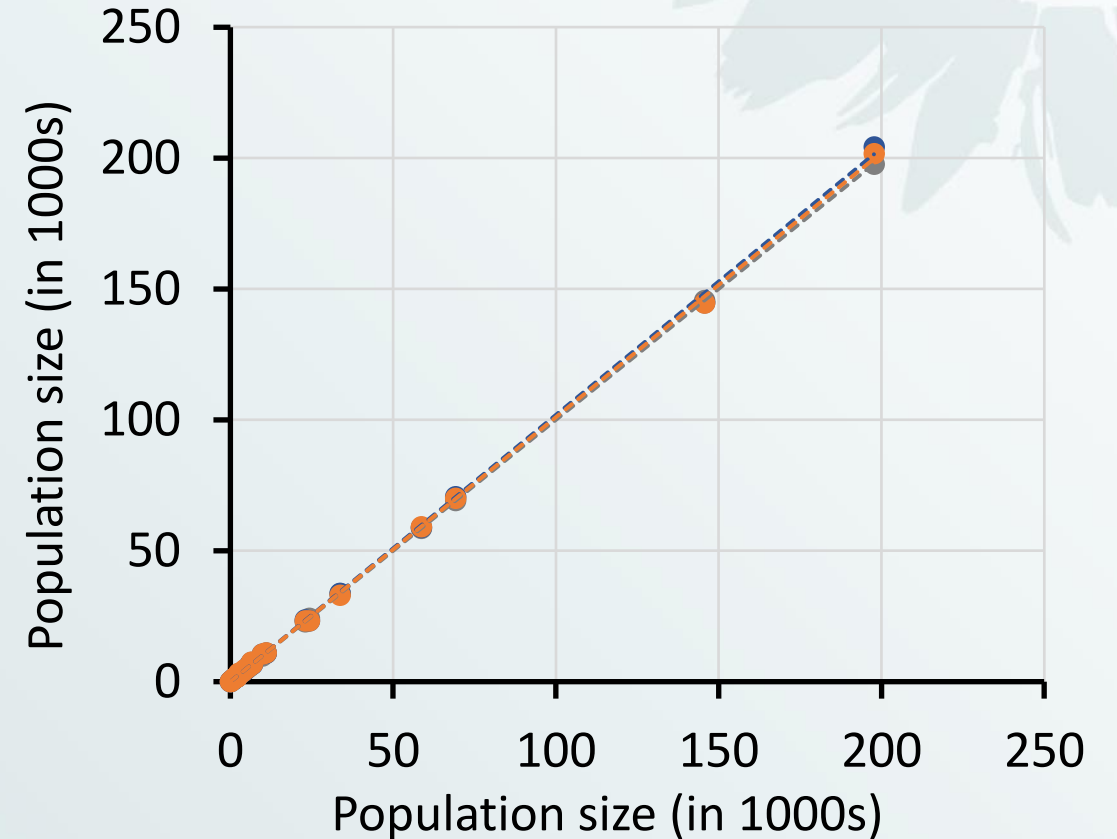
- Compare our population estimates to Census Bureau's dataset
 - On 2022-07-01
 - County, and 27 minor civil divisions (i.e., cities or townships)
 - Census Bureau: Population Estimate Program (PEP) estimates
 - Our population Model 1
 - 2 sources of Average Household Size and Vacancy Rate
 - 2021 ACS 5 year
 - 2022 ACS 5 year
 - All local data are the same

Population estimates on 2022-07-01

County, & 3 largest cities

	PEP	M1_ s2021ACS	M1_ s2022ACS
Johnson County	619,195	629,626	625,666
Overland Park	197,726	204,311	201,707
Olathe	145,616	144,809	144,629
Shawnee	69,198	70,716	70,083

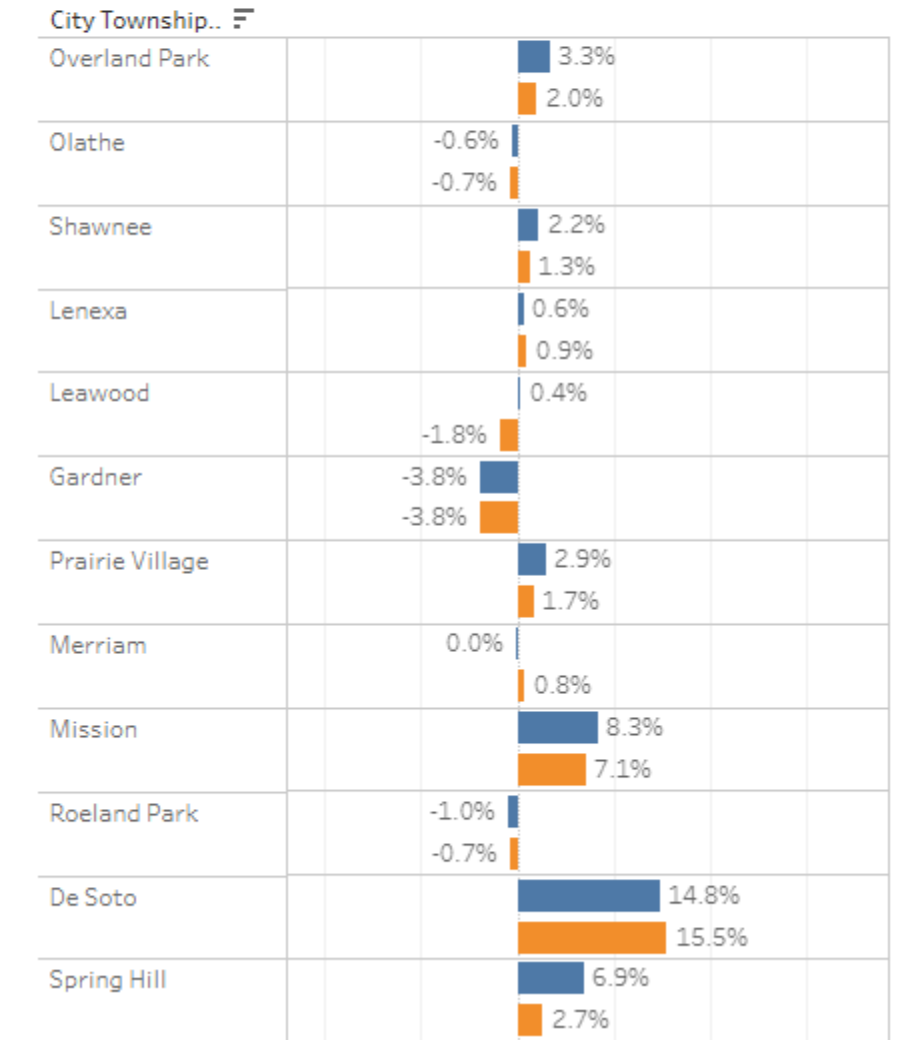
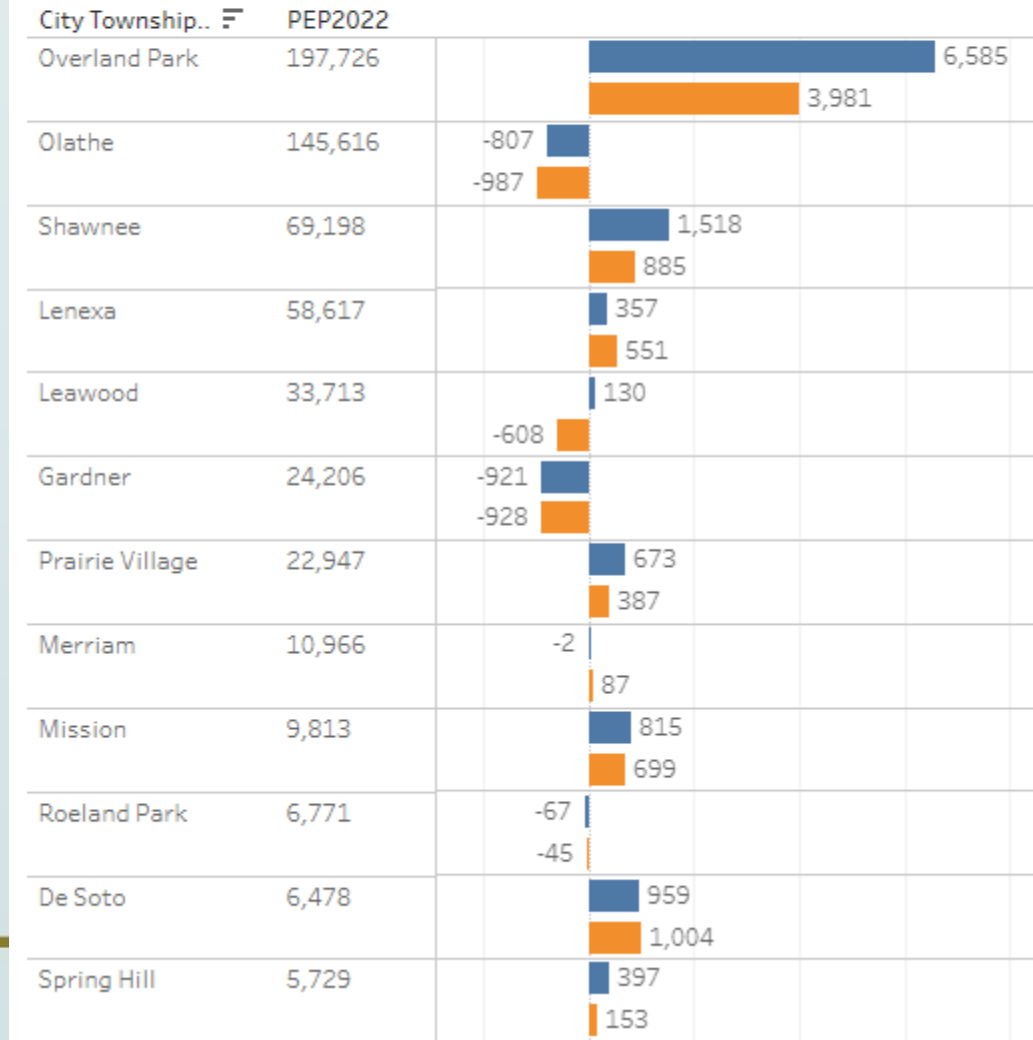
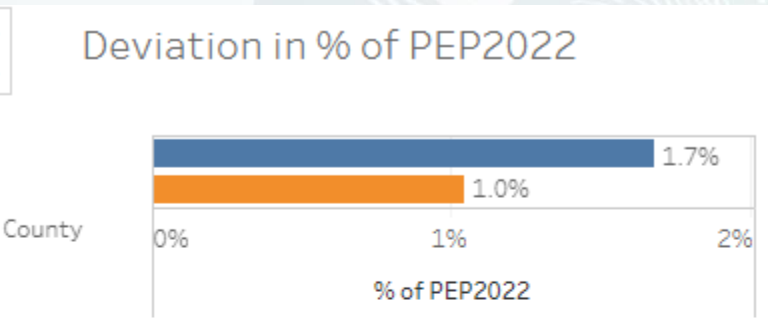
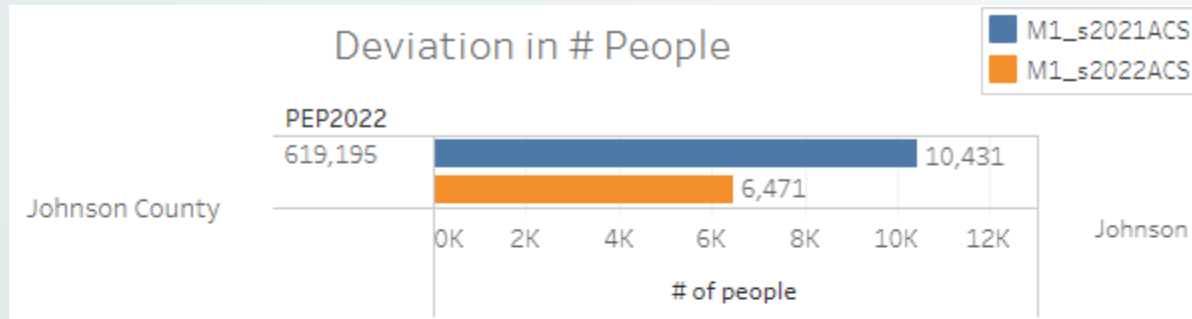
All 27 cities/townships



Population estimates on 2022-07-01

Difference:

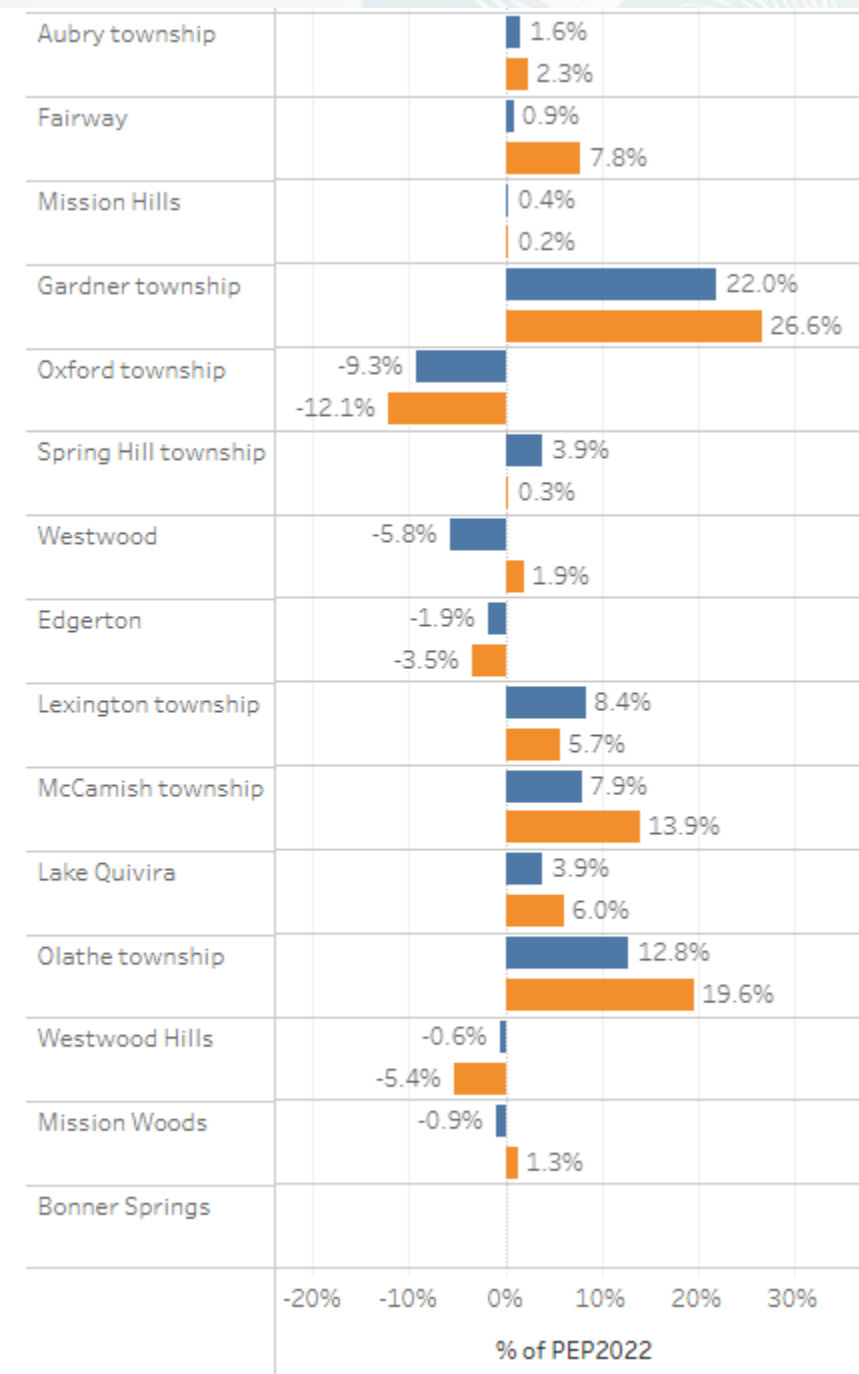
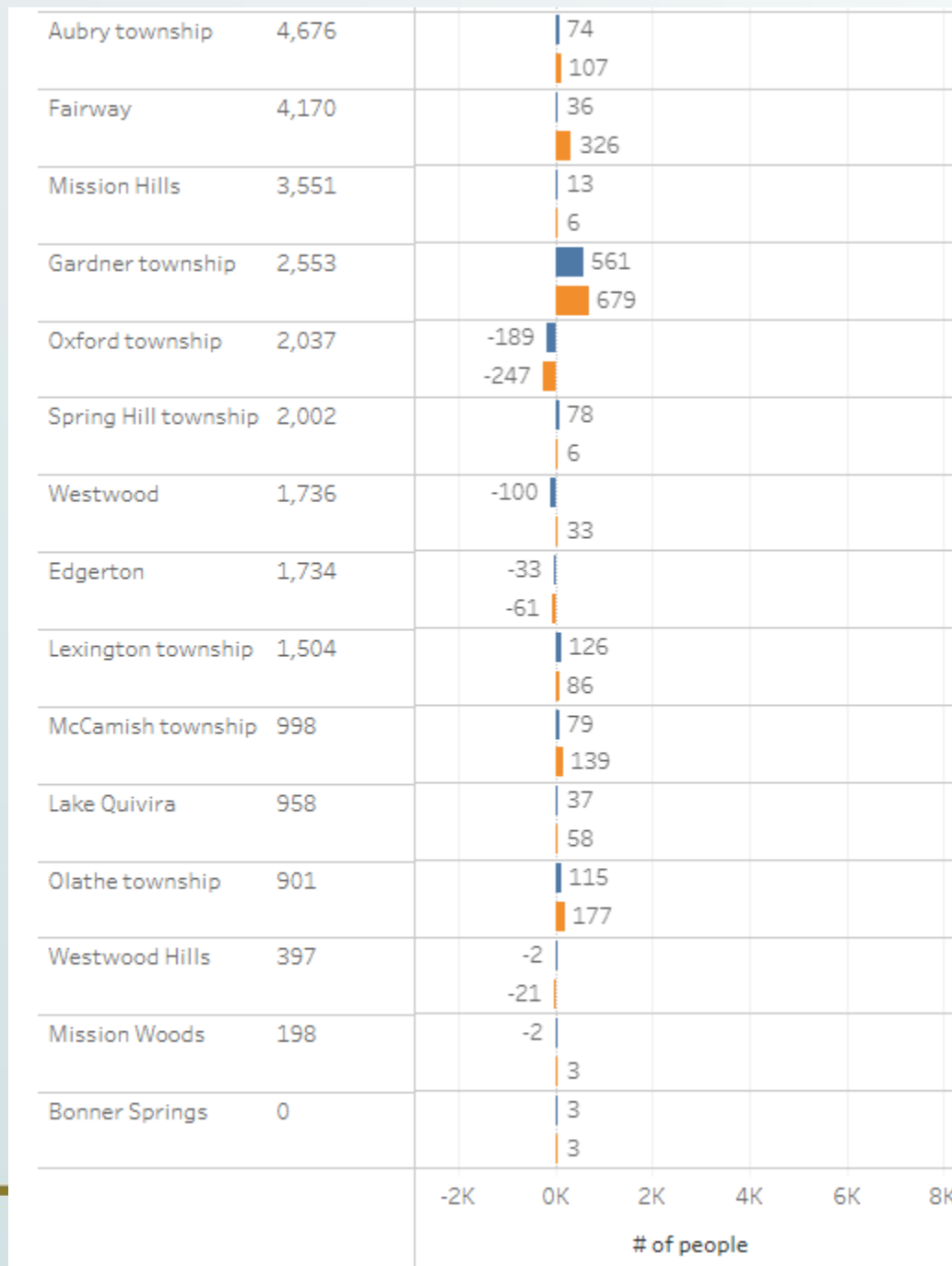
- M1_s2021ACS - PEP
- M1_s2022ACS - PEP



Population estimates on 2022-07-01

Difference:

- M1_s2021ACS - PEP
- M1_s2022ACS - PEP



Challenges/Limitations

- Challenges:
 - Ensuring you keep data sources up to date
 - Explaining why it is different than census
 - Always ways to improve it - how much time to invest?
- Limitations:
 - It is a residential model
 - NOT a daytime model of where people are (i.e. Work)
 - NOT an “event” model (i.e., where people are for events (e.g., Fri night football game, Sunday AM church, Parade))

Recent/Upcoming improvements

- Implement 2022 ACS 5 year
- Improve Group quarter occupants
 - Use local data that can be acquired regularly rather than only update every 10 years
- Situs/owner address improvements/corrections
- Working on model 3 and 4 updates to bring to current
- Appraiser Working Tax Year (LBCS, Dwelling Units)
- ACS 2023 - Dec?

Summary

- With some simple local data and basic Census data you can create models of your own.
 - Parcel centroid and dwelling units (Appraiser)
 - or address points (filtered to residential)
 - Census Avg household size for your county
- Recommend archiving on key census dates



Questions?

- AIMS Website: <https://aims.jocogov.org/>
- About AIMS Storymap: <https://arcg.is/1mKivb0>
- Mapper - mapper@jocogov.org

- Shannon Porter - GIS Manager - Shannon.porter@jocogov.org
- Jin Yao - Senior Data Analyst - Jin.yao@jocogov.org